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A conceptual framework for selecting and testing potential social and community health indicators linked to changes in coastal resource management or condition: a discussion paper

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A Conceptual Framework for Selecting and Testing Potential Social and Community Health Indicators Linked to Changes in Coastal Resource Management or Condition.

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INTRODUCTION

Since the World Commission on Environment and Development (1987) popularised the idea of 'sustainable development' in the 1980s it has become an enduring plank of planning and development policy. Sustainable development is based on the proposition that long-term economic development cannot be achieved without adequate consideration of environmental protection and social equity, as failure to do so will undermine, eventually, the natural and human resources on which stable and productive economies are based. Nevertheless, despite widespread support for the concept of sustainability, one of the key issues facing industry, government and communities alike has been monitoring progress towards it.

Difficulty in monitoring progress towards sustainability stems from a variety of factors. These are not limited to, but include: (1) the multiple and complex relationships between ecosystem components, ecological processes and human uses; (2) competing resource uses and the intrinsically political decisions involved in deciding what ecosystem components and processes are to be sustained, for what purpose, and to whose benefit; (3) uncertainty over the long-term consequences of particular ecological processes and interventions or how, indeed, the various components fit together; and (4) the possibility that future generations of resource users will bring with them different values and aspirations to those we work with today (Lockie and Jennings, 2004).

In recent years, the concept of triple-bottom line reporting has emerged as one sustainability monitoring approach based on the establishment of benchmarks and auditing systems at the level of individual enterprises or business units (Elkington, 1997). TBL reporting allows private and public enterprises to evaluate and report on economic activities alongside reporting of efforts to minimise negative social impacts and maintain continued use of the ecological resource base. With evidence internationally both of growing markets for ecologically and/or socially friendly products, and of minimum social and environmental standards as conditions of market access, TBL reporting is only likely to increase in popularity in one form or another for the foreseeable future. However, while TBL reporting holds promise as a meaningful planning and management tool at the enterprise level, questions remain as to how to integrate the activities and reporting frameworks of multiple enterprises at regional and larger scales.

The impetus for this discussion paper, and the research from which it is drawn, is twofold. First, extensive consultation with resource users and community representatives in the Fitzroy and Port Curtis catchments of Central Queensland revealed considerable levels of dissatisfaction with the extent to which existing natural resource planning and decision-making took account of social issues. Yet, as suggested above, the relationships between natural resource management actions and social outcomes are not necessarily obvious or direct. Second, recent changes in the way in which the Commonwealth supports natural resource management have placed an increased burden of responsibility on regional planning bodies, such as the Fitzroy Basin Authority, to demonstrate that progress is being made towards sustainability and that planning and target setting exercises have taken account of potentially adverse social impacts.

Identifying, validating and thence monitoring change in a variety of social indicators is thus of considerable relevance to the pursuit of sustainability. To this end, this discussion paper articulates a conceptual framework within which indicator selection and testing may be framed. Importantly, it does not seek to identify or propose a definitive set of indicators since the relevance of particular indicators is dependent on a variety of contextual factors ranging from local ecologies and resource uses to community values and institutional dynamics. Where specific indicators are discussed in this paper, they are discussed either for the purpose of illustrating the logic of the conceptual framework and to stimulate readers' thinking about what sorts of indicators and data sources may be useful in other contexts or, in the case of the Fitzroy and Port Curtis catchments, to identify those issues that require further research.

The draft indicator framework developed in this paper is comprised of two aspects:

1. a conceptual framework for the selection of indicators that is informed by current and past selection criteria; and
2. a list of potential indicators of social and community health for the Fitzroy and Port Curtis coastal catchment to be tested and validated using social impact assessment methods.

The approach outlined in this paper may assist other coastal regions to identify suitable social and community health indicators for incorporation into monitoring and reporting activities. Furthermore, this indicator framework may be useful to other natural resource management regions and/or at a national level to allow for some degree of comparison.

Chapter 2

DEVELOPMENT OF A CONCEPTAL FRAMEWORK FOR SOCIAL AND COMMUNITY HEALTH INDICATOR SELECTION

Background: the use of social and community health indicators in environmental management

The literature and research base on the development and use of social and community health indicators in environmental management is in its infancy (Elmer, Christensen & Donoghue, 2002. Even so, this literature draws attention to some key findings and issues in environmental management. One of the more common is the apparent lack of understanding about what social and community health indicators are. In part, this stems from problems measuring social and community health in valid ways to facilitate decision making (ANZECC, 2000). Many researchers, as a consequence, have tended to operationalise social and community health by using publicly available socio-economic and demographic data (Lorenz, Gilbert & Cofino, 2001) because these data have the advantage of being inexpensive and readily accessible from publicly available databases. A number of researchers have questioned, however, the utility of social statistics (such as census data) as indicators of social and community health (Beckley, 2000; Lockie, Lawrence, Dale & Taylor, 2002). Such variables are often not good or useful predictors of community sustainability and health because there are mitigating variables that contaminate or influence the construct. Further, despite its comprehensive coverage, reporting of such data generally is focused on the provision of averages at an individual or household level. This potentially obscures the distribution of differences between communities, particularly those susceptible communities at greater risk of being impacted on and with less capacity to respond to change.

An emphasis upon the collection of 'other' kinds of data appears necessary to measure community health. This remains another fundamental challenge for the field; how to operationalise and measure social issues in the form of indicators. Rich, qualitative data tends to be expensive to collect, and has limited utility for decision makers who need valid, objective information allowing an overall impression of the phenomena in quick and easy formats. Researchers have devised various ways of quantifying and summarising descriptive data in order to facilitate decision making about social and natural resource management issues. For example, the use of *ratings* by Smallwood, Wilcox, Leidy and Yarris (1998) enabled qualitative or descriptive information to be quantified and mapped. While this approach requires description and categorisation of properties, and an indicator framework, once these have been devised, the assigned ratings of these properties can have much utility. That is, ratings have the potential to simplify the collection of data in situations that are data poor, and to improved reliability.

Other researchers who have attempted to incorporate the social in meaningful ways have tended to do so by collecting data using methods and techniques typical of the social sciences including questionnaires with Likert-type scales or closed response categories (Barr, 2003; Lockie, Lawrence, Dale & Taylor, 2002; Morse, McNamara, Archolo & Okwoli, 2001) interviews with individuals and focus groups (Beckley, 2000; Lockie et al, 2000; Morse et al, 2001), and anecdotal information based on observations over time (Adger, 2000; Morse et al,

2001). Some research employing these techniques have raised important questions about the utility, validity and assumptions underlying research that does *not* consider the social in meaningful ways when measuring the construct(s) of interest.

For example, research by Lockie, Lawrence, Dale and Taylor (2002) interviewed farmers and other stakeholders through a series of focus groups and consulted the literature to develop a list of potential indicators of 'capacity for change'. Following a rigorous process of indicator selection, the researchers conducted phone surveys with farmers in order to investigate further 'capacity for change'. Similarly to Beckley (2000) and Barr (2003), this work calls into question the value of research that does not test the assumptions underlying social indicators and highlights the value of consultation with landholders and other stakeholders in order to appreciate more fully the influence of the social.

Information from stakeholder groups can also facilitate interpretation of indicator data and reduce some of the problems arising from assumptions. Morse, McNamara, Archolo and Okwoli (2001) investigated the problem of indicator integration when assessing sustainability by drawing upon the results of a 6 year 'anthropological' type project based in a village in Nigeria. That is, the researchers questioned how diverse sustainability indicators are to be integrated into an answer of whether something is sustainable or not. They found that, in many cases, indicators used to assess sustainability constructs were contradictory, in that one indicator value was interpreted as sustainable while another indicator value was interpreted as unsustainable. Their work drew attention to the layers of subjectivity associated with indicators, and demonstrated that 'objective' measures such as the actual amount of pesticide used, can be interpreted incorrectly based on the assumptions underlying the measure, especially in the absence of qualifying data. The researchers conclude that an element of qualitative integration incorporating value judgements is inevitable with a concept such as sustainability.

Instead of merely providing some kind of qualitative description for decisions as advocated by Morse et al (2001), King, Gunton, Freebairn, Coutts and Webb (2000) found particular value in encouraging high levels of participation in indicator selection and use, directly from the stakeholder group concerned. The researchers used a focus group approach to explore: (1) farmers perceptions about sustainability; (2) farmers knowledge about and use of sustainability indicators; and (3) commonalities between farmer and scientist perceptions. They found that the farming community have much to offer in terms of both on farm and off farm indicators, and they questioned the relevance and appropriateness of indicators developed by scientists without farmer input. For example, the common assumption that farmers did not use indicators because they did not understand or know about them was found to be incorrect. Farmers had often tested some of the indicators through experience and found they did not work in practice, but this was often ignored. The authors concluded that farmer knowledge was often complimentary to that of scientists and in many cases was more developed.

Clearly, some researchers in the field recognise and value stakeholder input (or the social), as outlined by King et al (2000) and Lockie et al (2002), when considering issues of sustainability and indicator design and selection. Another body of literature in the field has attempted to overcome the problem of accessing stakeholder input and representation in ways that aim to be more cost effective in the long term (see Bell & Morse, 2004; Kelly & Moles, 2003; Lourens, van Zwol & Kuperus, 1997; Valentin & Spangenberg, 2000). This literature typically discusses the methods used to access stakeholders representing a wide cross-section

of interest groups, the role of the stakeholder group(s) and then evaluates the approaches adopted.

The common problem with this body of literature tended to be that once stakeholders had been accessed and groups were formed, they often engaged in developing lists of indicators with little regard for their validity and a theoretical framework by which to interpret results, and a general absence of definitions of key concepts. The overall concern of these papers was upon the formation of the groups and their participation. However, the question of whether groups of this kind are likely to address the complexity of issues for various stakeholder groups is questionable. In the case of Kelly and Moles (2003), individuals on the advisory group representing stakeholder interest groups were prevented as much as possible from focussing discussion on issues of concern to them. This was achieved by focussing attention on the results of surveys. It could be argued that this mechanism of participation was, in effect, silencing the voices and input of various stakeholder groups. Given the potential value of input from stakeholders, as identified in the research above, a case can be made that dialogue, information sharing and critique should be important functions of representative stakeholder advisory groups.

There is little doubt that negotiating the differential and sometimes opposing views of stakeholder groups present problems, and hence, collaboration remains a challenge for the field. For example, Lorenz, Gilbert and Cofino (2001) describe some of the fragmented approaches to river management, with the policies of various sectors (e.g. agriculture, fishery, drinking water, industry, and transport) being hardly coordinated even though they influence the same water system, and the data they collect may not be meaningful to other agencies or stakeholder groups (Casazza, Silvestri, Spada & Melley, 2002). However, the work of Rogers and Biggs (1999) provides some direction for how certain kinds of relationships may be forged in order for the field to move forward.

Rogers and Biggs (1999) propose and discuss the roles and relationships of science and management for the Kruger National Park. The general pattern detected by the researchers was that science loses the hypothesis-testing approach and becomes too descriptive, resulting in a focus on the production of models which are seldom explicitly tested. The consequence is a body of pseudo-fact. Instead, Rogers and Biggs propose that science should follow a hypothetico–deductive approach of hypothesis testing under an umbrella of established theory. Management, on the other hand, should devise policy that is translated into operational goals, and incorporates a monitoring, feedback and evaluation program to cross-check the accuracy of the definition of the problem and the appropriateness of the selected solution. Feedback is essential to effective interaction. Similarly, feed-on from science improves the policy framework, and management's ability to define problems generates a healthy interactive environment for science and management.

This brief review suggests that attempts to operationalise social and community health have often been limited in a number of ways. While some of these limitations relate to difficulties associated with developing indicators, cost, data availability and validity, and a lack of stakeholder participation, other limitations relate to inadequacies in the conceptualisation of indicators and what they seek to measure. This chapter turns, therefore, to discussion of these conceptual issues before moving on to the empirical research that underlies this discussion paper

Conceptualising social indicators

Indicators are instruments to define and monitor those aspects of a system that provide the most reliable clues as to its overall well-being (Slobodkin, 1994). They are used, in other words, to provide cost and time-effective feedback on the health of a system without necessarily examining all components of that system. According to proponents, the validity of indicators is based on the degree to which the wider network of components and relationships in which they are situated link together in a relatively stable and self-regulating manner (Slobodkin, 1994), and the degree to which the indicators themselves represent the most salient or critical aspects of the system that can be monitored over time (Andrews and Withey, 1976).

The conceptualisation of social indicators presents a significant challenge, however, as the communities in which we are interested seldom resemble the sorts of stable and self-regulating systems we find in nature. Human action, combined with the variable impact of change within communities, its cultural and subjective dimensions, and the influence of power relations between stakeholders (Howitt, 1989) all contribute to what may better be described as a changing landscape of interests, coalitions, values, resources and aspirations, than a self-regulating system.

In light of this complexity, Land (2000) identifies three ways that social indicators have been defined by social scientists:

- *Criterion Indicators* are based on the premise that social indicators should relate directly to social policymaking considerations. They should provide a direct measure of welfare and not of the implementation of measures to improve welfare. From this perspective, crime rates are a valid social indicator but numbers of police are not.
- *Life Satisfaction and/or Happiness Indicators* seek to measure psychological satisfaction, happiness, and life fulfilment by using survey research instruments. This may provide insight into the relationships between the subjective reality in which people live (including their values and aspirations) and objective social outcomes.
- *Descriptive Social Indicators* focus on social measurements and analyses designed to improve understanding of the main features of society, their interrelationships, and how these are subject to change. From this perspective, valid indicators include those features of society that lead to particular welfare outcomes such as rates of substance abuse.

In contrast with this focus in social indicator research on understanding the relationships between social conditions, individual life experiences and human welfare outcomes, many attempts to deploy social indicators in the field of natural resource management have been based on untested assumptions and hypotheses (Coakes et al, 1999). Often, however, indicators that intuitively might be expected to be closely linked with community health and well-being are, upon closer examination, found not to have reliable effects due to the complex array of intervening variables and the cumulative impacts of multiple interventions and influences (Lockie et al, 2002).

None of this is to suggest that the development of social indicators should not be pursued. What it does suggest is that careful consideration be given to:

- identifying indicators that may be related in demonstrable ways to changes in resource use and condition and which are responsive, on that basis, to changes in management;
- monitoring variation in the values, aspirations and resources of target communities over time and across interest groups to provide a dynamic baseline against which the desirability and impact of other changes may be evaluated;

- developing monitoring and reporting strategies that address the impact of natural resource activities on human welfare, not just the impact of human attitudes and activities on natural resources;
- identifying — in cases where the impact of resource management on important aspects of social welfare cannot be disaggregated from other influences — *process* indicators (see below) that provide evidence of whether or not management interventions are at least influencing social welfare in the right direction; and,
- providing opportunities for interest groups within target communities to contribute to the identification of relevant aspects of social well-being on which to focus indicator identification, monitoring and interpretation (Lockie & Jennings, 2004).

Additionally, as suggested by Long's (2000) description of descriptive social indicators, one of the key elements of indicator sets that do relate to important changes in resource use and condition is a clear understanding of how the various indicators interact in determining, or reflecting, those changes (see also Coakes et al, 1999). This report turns, therefore, to discussion of a number of conceptual frameworks that are used to provide a starting point in establishing these relationships.

Conceptual frameworks for indicator monitoring and application

Adaptive management

The Cooperative Research Centre for Coastal Zone, Estuary and Waterway Management has championed the application of an adaptive management framework by natural resource managers. This framework emphasises the importance of utilising indicators and other monitoring tools as a basis to assess the likely outcomes of actions before they are undertaken and thence to evaluate their effectiveness and refine future actions (Allen et al, 2001). Adaptive management seeks to treat management strategies as experimental steps in an ongoing process of social learning. The iterative processes of information collation, planning, implementation, monitoring, re-planning and so on are applied by the adaptive management model as much to the institutional arrangements in place to manage natural resources as they are to the ecosystems and resources for which those arrangements are responsible.

Adaptive management thus provides a conceptualisation of how social, economic and biophysical monitoring programs may be integrated and incorporated in decision-making despite the inherent difficulties involved in interpreting what otherwise divergent forms of data and knowledge. But while the adaptive management framework provides a useful model of the components of an effective learning system, it is necessary also to consider how linkages between social, economic and ecological processes and indicators may be conceptualised.

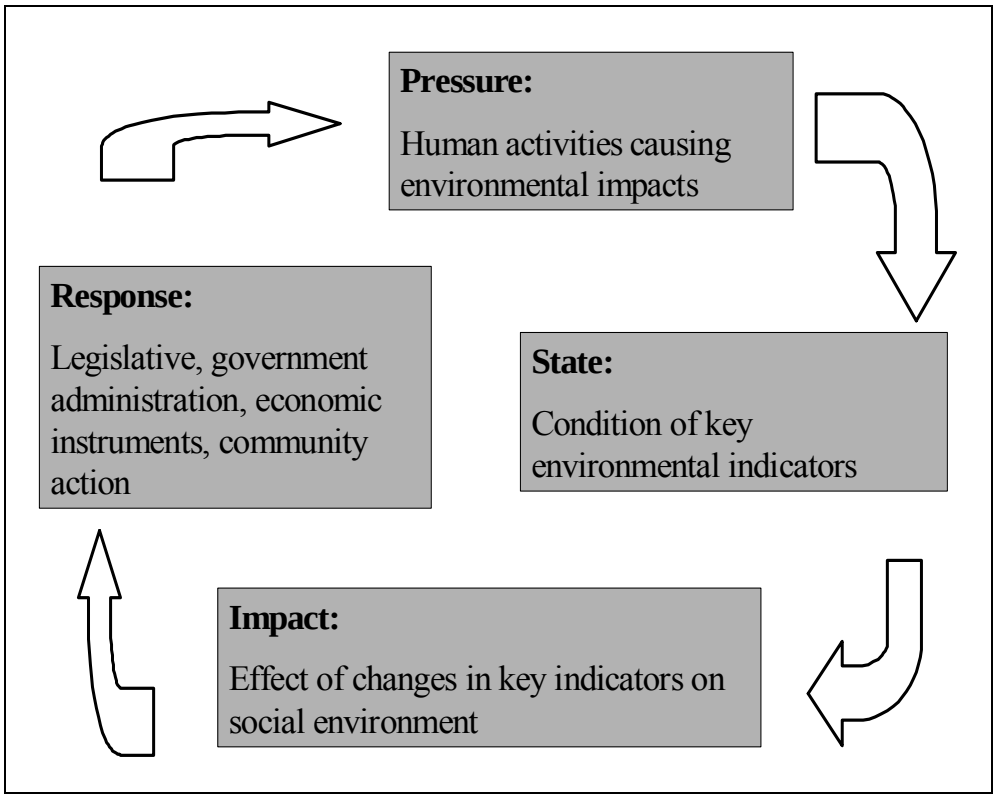
Pressure-State-Impact-Response

In order to articulate as closely as possible with existing monitoring and reporting formats, the approach taken here is based on an adaptation of the *Pressure-State-Response* (P-S-R) framework used in State of the Environment (SOE) reporting. SOE reporting is based on a simple model known as the pressure-state-response (PSR) model. The idea is that once key environmental parameters, or state variables, have been identified it is also important to identify the key pressures (such as industrial discharges) that may lead to changes in each state variable and then to monitor pressure and state variables in tandem. When reporting these

variables, consideration should be given also to the appropriate management responses and, if relevant, these too should be monitored over time. Put more simply, the PSR model is concerned with: What are the key features of this ecosystem? What causes change in those features? What should we do about it?

There are a range of variations and advances on this concept (Casazza et al. 2002). This paper follows the approach utilised by Turner et al. (1998)(Figure 1) which adds one additional question: what are the impacts of changes in state variables on human communities? Expanding the PSR model to include the impacts of changes in environmental state indicators on the social environments makes it possible to begin understanding and managing the coastal zone and other ecosystems as one co-evolving eco-social system while focussing the attention of natural resource managers on those social and economic issues of most direct relevance to NRM and avoiding those issues with little connection to natural resource management practice or outcomes.

Figure 1: Conceptual PSIR Model for an Eco-Social Decision Framework (taken from Lockie & Rockloff, 2004).



As we seek better ways of managing the environment and the impact of human activities we need more integrated approaches to understand the causes and effects of environmental change. Integrating the natural and socio-economic environments provides: an understanding of the pressures and effects of socio-economic change (e.g. population pressure, urbanisation); the ability to assess the human welfare impacts of changes in coastal resource systems; and an insight into the social and institutional aspects of natural resource management responses (Turner, 2000).

The potential of the PSIR model to integrate social, economic and biophysical considerations may be illustrated through reference to a parallel indicator development exercise supported by the Coastal CRC. Scheltinga, Counihan, Moss, Cox and Bennett (2004) have developed and used estuarine, coastal and marine indicators for NRM reporting, based on work already undertaken. Recognising the need for both local relevance and national consistency, Scheltinga et al. (2004) designed an estuarine, coastal and marine indicator package to assist stakeholders to identify and select indictors relevant to a NRM region to satisfy the monitoring needs specified under the Natural Heritage Trust (NHT2) and National Action Plan for Salinity and Water Quality (NAP). These indicators function to monitor the impact of specific regional management actions on the natural resource condition within the coastal zone (specifically the ecosystems (habitats and communities) within the estuarine, coastal and marine biomes (Scheltinga et al, 2004)). Regional NRM bodies and other associated NRM groups are the targeted users of these indicators to assess the performance of their management actions undertaken as part of their regional NRM strategies.

Scheltinga et al. (2004) identified physical, chemical and biological aspects of the environment as major stressors in estuarine, coastal and marine ecosystems. These stressors were defined as "major components of the environment that, when changed by human or other activities, can result in degradation of natural resources" (Scheltinga et al., p. 18). Stressors may be either pressures or states if the P-S-R model is being used (e.g. indicator of the state of the marine environment and an indicator of the stressor on the water quality entering a reef lagoon). Furthermore, these stressors can be: (1) a component of the environment that transfers the impact of a pressure to other parts of the environment through its altered state (e.g. pressure of human activity changing a natural state, such as decline in remnant vegetation); and (2) a stress on the ecosystem caused by the presence of a component in the environment which is not part of the natural/healthy environment (e.g. invasive weed species). Also, physical and chemical stressors have direct and indirect effects. Direct effects of stressors can either be toxic to biota (e.g. release of heavy metals from industry) or directly affect the ecosystems and biota (e.g. altered water flows). Indirect effects of stressors can modify the effects of other stressors, either negatively or positively, through their interactions (e.g. change in pH causes release of heavy metals into estuary) (for further details see Scheltinga et al. 2004, p. 191).

In the processes for selecting indicators suggested by Scheltinga et al (2004, p 10), reference is made to the identification and understanding of relevant estuarine, coastal and marine ecosystems in the region, followed by the identification of relevant physical, chemical and biological stressors. While inclusion of social stressors was considered beyond the scope of Scheltinga et al, it follows that if consideration of social impacts is also included then changes to stressors may also have effects upon populations and their quality of life and, further, that this should also be monitored and inform NRM mitigation strategies.

Outcome and process indicators

Identifying relevant stressors or pressures on populations is, as argued previously, complicated by a general lack of understanding regarding what these are or could be. The concept of adaptive management suggests that this complexity should not be used as justification to set social indicator development aside until perfect knowledge is attained, but that attempts to improve our understanding of social-ecological relationships should proceed alongside attempts to develop appropriate monitoring and reporting frameworks. The shift from *outcome* to *process* monitoring in manufacturing and food industries may provide some clues as to how

to conceptualise social indicators where quantification of the exact relationship between changes in net social welfare and management interventions is not feasible.

Hazard Analysis Critical Control Point analysis — which is widely used in agricultural and food quality assurance programs (Lockie, 1998) — was developed to shift the focus of monitoring activities from the outputs of manufacturing to the processes involved or, more specifically, to the particular points within the manufacturing process where potential most exists for the introduction of quality, safety or other problems. While it is not our intention here to advocate application of HACCP in natural resource management, we would suggest that in many situations it may be useful to shift our focus from monitoring and reporting of net gains or losses in social welfare to monitoring and reporting of those resource management activities most likely to have significant impacts on social welfare. A couple of examples will help to illustrate this point:

- While natural resource-based industries have significant potential impacts on human health, so too do a range of other factors outside the control of resource users and managers such as health behaviours (eg. smoking). Outcome indicators such as aggregate population health statistics may, therefore, prove less useful than process indicators such as changes in emissions and exposure to pollutants.
- Although it seems obvious that the financial viability of farm enterprises will have a significant impact on the ability of farmers to implement improved natural resource management, gross measures of viability such as farm profitability provide little insight into the likely uptake of improved practices due to the large number of confounding and intervening variables. Application of process indicators, however, may help to focus on those aspects of the relationship between viability and implementation most open to the influence of resource managers. Such indicators might include the enterprise level costs and benefits of proposed practices and incentive mechanisms and the distribution of costs and benefits across (sub)regions.

Indicator identification within the PSIR framework

Within the PSIR framework there may be accommodated a potentially infinite array of indicators and relationships between indicators. To begin populating the PSIR model with potential indicator sets in a rational manner it is important to consider each stage of the model as a conceptual framework in its own right comprising elements for which there are sound theoretical and/or empirical rationales for inclusion.

Tables 1 to 3 represent an attempt to synthesise from the literature a set of core values and value dimensions for which more specific indicators may be relevant in a variety of natural resource management contexts. In interpreting and applying these tables as a conceptual framework and, by implication, not as a checklist, it is important to note the following points:

- The values, value dimensions and potential indicators should not be read as exhaustive, universally relevant, or arranged in a fixed order. Rather, they should be seen as a starting point, based on existing research, from which to begin identification of core values, and their corresponding dimensions, prior to selection of specific indicators.
- In developing these tables, an attempt has been made to be as comprehensive as possible of issues identified in the literature while using as few categories as possible. Many of the values included in Tables 1 to 3 have been conceptualised in somewhat different ways and readers should not be restricted to the conceptualisations and language preferred by the authors of this discussion paper.

- These tables are useful for preliminary identification of indicators only. Each indicator must subsequently be evaluated against a variety of criteria including the demonstration of clear relationships with change in natural resource use and condition and responsiveness to changes in management.
- Although monitoring changes in the state of valued attributes is central to the PSIR model, the conceptual tables do not include state variables. In order to focus social indicator monitoring and reporting on those issues that may clearly be related to changes in natural resource use and condition it is proposed that monitoring and reporting only focus on social attributes and values that influence, or are influence by, changes in the state of ecological values. While many social attributes may deserve monitoring in their own right, such a role is generally not that of natural resource management agencies.
- Nevertheless, the conceptual tables do give some consideration to biophysical and economic pressure, impact and response indicators that some may not think relevant to social monitoring or assessment. Given, however, that sustainable natural resource management cannot proceed independently of social considerations it is important to stress the linkages between social, economic and ecological processes and outcomes and to provide some guidance here on how all may be incorporated within the same conceptual framework.

Key references in the construction of these tables included Coakes et al (1999), Flora et al (1997), Lane et al (1997), Lockie et al (2002), Taylor et al (2000) and Walmsley (2002).

An extensive list of sample social indicators identified through a desktop study of natural resource management processes internationally is appended to this paper (see Appendix A).

Table 1. Conceptual framework for identification of potential indicators of social and community health and wellbeing for coastal resource management – Pressure/driving force indicators

Core values	Dimensions	Potential indicators	Context specific indicator examples
Natural conditions	Natural resource supply	Resource availability	Surface water availability
		Resource capability	Soil types and distribution
Community values and aspirations	Intrinsic values	Baseline standards	Formal and informal water quality standards
		Resource/biodiversity conservation	Marine protected areas
		Community identity	Sense of place
		Indigenous cultural values	Protection of cultural sites
		Aesthetic values	Visual amenity of coast, waterways, recreation areas and town
	Use values	Community aspirations	Preferred development paths
		Disposition to change	Understanding and attitudes to existing resource uses
Development and economic activities	Resource demand	Population growth	Population density and resource consumption
		Tourism	Visitor numbers and resource consumption
		Industrial use	Post-mining land rehabilitation
		Infrastructure development	Development projects and industry
		Leisure and recreation	Intensity of use of recreational activity (land and water based)
		Structural adjustment	Changes in land/coastal use
		Transport	Road usage and development
	Pollution	Point source pollution	Discharges including location, type and load of materials
		Diffuse source pollution	Discharges including location, type and load of materials
	Anthropogenic return to natural assets	Resources available for reuse	Return flows to surface or groundwater
Legal and policy frameworks	Legislative	Compliance	Prosecutions
		Property rights/resource access regimes	Leasehold land requirements Native Title obligations
	Policy development and implementation	Funding/resources	Annual expenditure of government funds on national, regional and local-scale programs for resource management

Table 2. Conceptual framework for identification of potential indicators of social and community health and wellbeing for coastal resource management – Human welfare impact indicators

Core values	Dimensions	Potential indicators	Context specific indicator examples
Public health	Environmental health	Population health indicators and distribution	Aboriginal health
			Infant mortality rate
		Exceedences of pollution guidelines	Exceedences of guidelines for water, air and food quality
		Incidence of disease	Prevalence of pollution-related health problems
			Number of water/air/food borne disease outbreaks
	Mental health	Ability to Cope	Levels of substance abuse, gambling, depression, domestic violence
	Safety	Occupational health and safety	Reported accidents
			Days lost
		Freedom from violence	Domestic and family violence
			Assault
		Road safety	Fatigue-related accidents
Community structure and welfare	Human capital	Education and training	Education levels
			Informal training opportunities
		Employment	Employment structure and occupational mobility
		Capacity for change	Participation in key decisions that affect NRM
			History of innovation in NRM
	Community composition	Demographic composition and change	Population structure
			Displacement and circular migration
	Quality of life	Human development	Human Development Index
		Cultural amenity	Expression of cultural heritage
		Housing	Availability, adequacy and affordability of housing
		Crime	Recorded crime rates
		Standard of living	Household income and debt
		Community services	Access to community infrastructure
	Equity and stratification	Income distribution	Income by occupational group, gender, ethnicity, age etc
			Level of transient work population
		Poverty	Number of poorest members in the population
Social capital	Networks	Community participation	Volunteering for community-building activities
			Membership of community groups
			Attendance at public meetings, local government etc
			Community activism
		Organisational relationships	Durability of organisational networks
			Diversity of organisational networks

	Norms and trust	Acceptance of diversity	Diversity of group membership
			Harmony between cultural groups
		Acceptance of controversy	Management of conflict
		Flexibility and responsiveness	Historical response to change
Economic viability	Economic resilience	Economic diversity	Enterprise mix and inter-relationships
		Small business	Shop occupancy levels
			Stability of small business
	Economic activity	Gross product	Gross regional product and gross domestic product per capita
Resource sustainability	Intra-generational equity	Resource access	Recreational amenities/opportunities (and access for disabled)
		Resource degradation	Perceived quality of coastal landscape
	Inter-generational equity	Depletion of non-renewable resources	Energy availability
Psychosocial wellbeing	Community identity	Community attachment	Sense of pride
	Understanding of change	Disposition to change	Attitudes and practices to waste disposal and recycling
		Awareness	Knowledge of key causes and effects of NRM problems

Table 3. Conceptual framework for identification of potential indicators of social and community health and wellbeing for coastal resource management – Response indicators

Core values	Dimensions	Potential indicators	Context specific indicator examples
Effectiveness	Organisational efficacy	Implementation of planned actions	Environmental flow objectives
	Stakeholder efficacy	Uptake of organisational advice	Implementation of best management practice
Institutional learning and capacity	Planning	Planning processes in place at appropriate scale	Number of (sub)regions covered by an effective integrated ecosystem management framework
		Planning processes linked to program implementation	Changes in resource management in response to planning processes
	Monitoring and Evaluation	M&E linked to program implementation	Trends in people's attitudes and actions derived from surveys
	Public participation	Clear processes for participation in democratic governance	Marine network participation Access to decision-makers
	Consistency and integration in application of policy	Integration of management	Plans/maps with integration of uses by different stakeholders

Conceptual framework for preliminary indicator assessment

Before moving to the results of this research, it is important to stress that the focus of the research on identifying indicators raises a number of additional issues such as cost, data availability, ease of interpretation and so on. The SMART filter (Table 1) adapted by Taylor et al (2000) draws together a considerable literature on criteria for indicator selection and is used here to highlight the range of issues that must be considered in the development of monitoring programs. While the list of criteria incorporated in the SMART filter is relatively comprehensive, no assessment is offered of the relative importance of each criteria.

Table 4. Modified SMART filter criteria

Simple	Easily interpreted
	Easily monitored
	Industry acceptance
	Professional acceptance
	Appropriate for community use
Measurable	Mapable
	Statistically verifiable, reproducible and comparable
	Able to be aggregated
	Able to be combined with others to form indices
	Responsiveness to change in management
	Able to show trends over time
Accessible	Regularly monitored
	In use by managers
	Cost-effective
	Consistent with other data sources (eg. ABS, SCARM & ABARE)
Relevant	Related to a highly valued natural resource management factor
	Linked to regional NRM policies and goals
	Linked to State and national processes (e.g. SOE, SCARM)
Timely	Early warning of potential problems / highlights future needs or issues

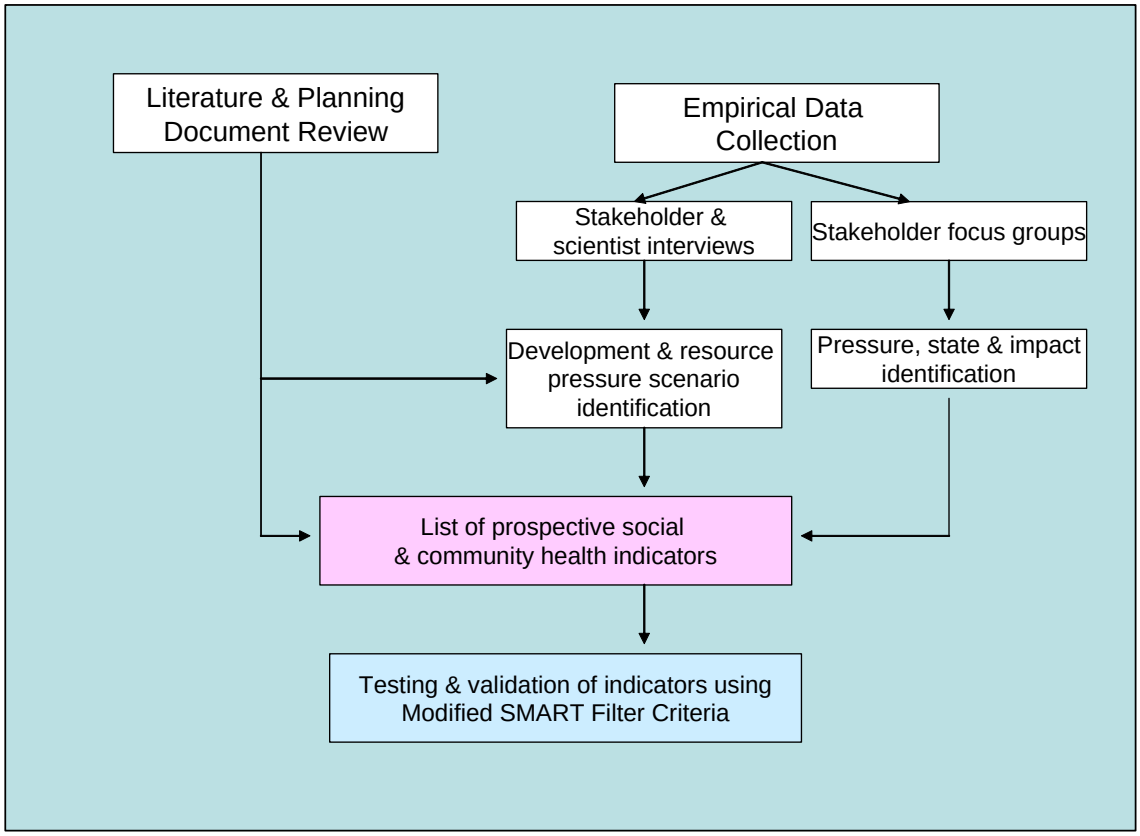
Source: Taylor et al. (2000)

Chapter 3

RESEARCH METHODS AND STUDY AREAS

The development of this discussion paper was informed by a research process that sought to identify a range of preliminary data relevant to the conceptual framework detailed in the previous chapter. More specifically, a combination of literature review and stakeholder consultation was used to develop a preliminary list of potential indicators relevant to natural resource management in the Fitzroy and Port Curtis catchments consistent with the PSIR framework (see Figure 2).

Figure 2: Method for identifying resource use pressures and social and community health indicators in coastal catchments.



1) Literature and planning document review

A literature review was conducted to compile all accessible information on social and community indicators and indicator frameworks used in environmental and natural resource management. An annotated bibliography was compiled and is available to download from the Coastal CRC and Centre for Social Science Research (Central Queensland University) websites. A list of indicator sub-headings/themes is given in Appendix B as a guide.

The literature has been used to assist in the development of an indicator selection process (Chapter 3), compilation of a comprehensive list of prospective indicators of social and community health relevant to coastal resource management and the validation of social and

community indicators (see Chapter 4). Appendix C provides a complete list of the documents used to inform this study.

2) Collection of empirical data

Focus groups and semi-structured telephone interviews were used to provide empirical data for this report. Both techniques of data collection are discussed in subsequent sections below.

Stakeholder focus groups

Focus groups in the two coastal catchment study areas were undertaken over a nine month period. The focus groups consisted of stakeholders from different resource sectors, organisations, levels of government, representative peak bodies and communities. Snowball sampling was employed to access focus group participants through Coastal CRC stakeholder contact lists, regional NRM and Landcare groups and peak producer organisations in each coastal catchment

In total there were twelve focus groups, with six in each coastal catchment study area. Participants attending the focus groups were organised into one of the following six areas based on their background and knowledge. These six areas were:

- Industry
- Government
- Conservation and natural resource management groups
- Tourism, resource user, regional and economic development
- Indigenous
- Community services and education

Each focus group meeting was two hours in duration, conducted in either Gladstone (Port Curtis catchment) or Rockhampton (Lower Fitzroy catchment) and facilitated by CRC researchers, with the exception of the Indigenous stakeholder focus group meetings. For these two focus group meetings, individuals who were well known and involved in Indigenous organisations were employed to undertake the task of facilitation. When possible the focus group discussions were tape recorded and later transcribed.

The focus groups were used as a mechanism of engaging participants in an interactive discussion on key aspects of the coastal zone and waterways. In particular, the purpose was to derive information to further understanding of pressures, conditions, impacts and responses to current and future resource change. Preliminary outcomes from the biophysical indicator research, involving the Environmental Protection Agency and Coastal CRC, in the form of a draft integrated indicator framework for monitoring and reporting was also explored with the focus groups.

Key stakeholder and scientist interviews

Interviews with key stakeholders from the above-listed stakeholder interest areas were conducted to identify key resource pressures from development paths for a 20 year future. Only those individuals who had not previously participated in the stakeholder focus groups were contacted. This enabled additional information to be collected that may not have been discussed in the focus groups. Scientists engaged in coastal zone, estuarine and waterway

research for the Coastal CRC in the Fitzroy and Port Curtis catchments were interviewed for their scientific knowledge and expertise on current and future resource pressures.

The telephone interviews with stakeholders and scientists used a semi-structured interview format, and a number of questions were posed to explore with participants most likely development paths over the next 20 years. Information was collected on the following:

- types and level of resource use pressure
- threats to the ecological and social health of the coastal zone
- strategies to manage pressures and resulting threats
- risks (i.e. what might derail this development path)
- distribution of costs and benefits among stakeholders
- other relevant issues

Furthermore, participants were asked to consider two alternate development path scenarios of: (1) a more conservative development path; and (2) a high level development path. For context, developments that would impact either on water quality or environmental flows in the Port Curtis and Fitzroy coastal zone were targeted.

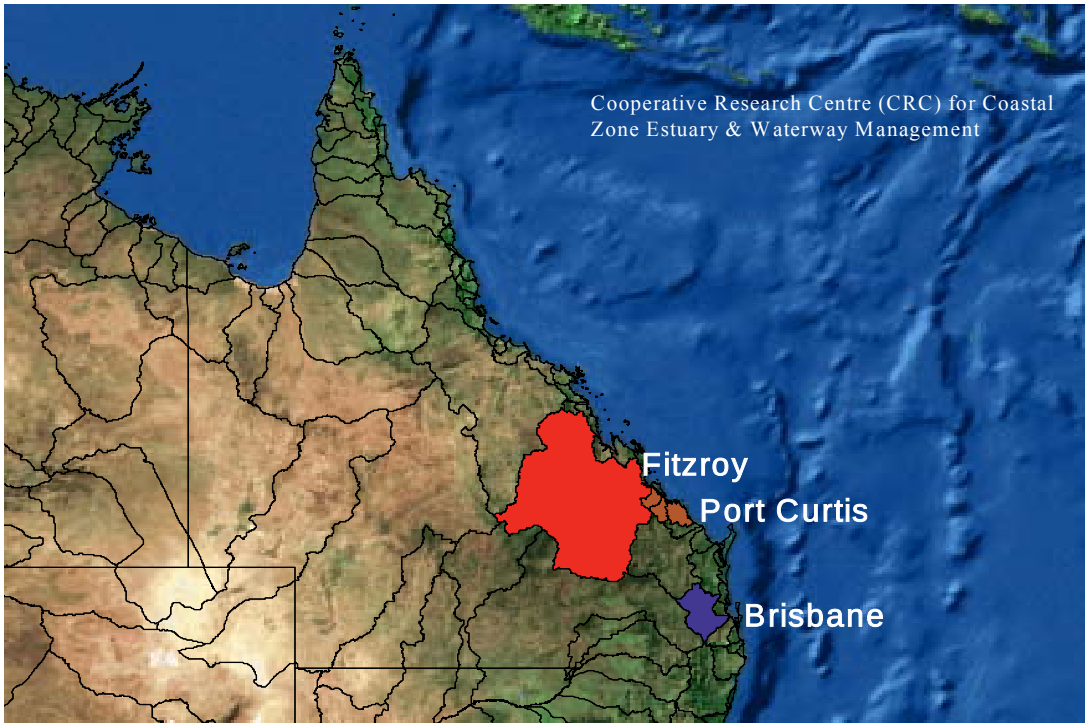
Testing and validation of prospective indicators using the Modified SMART Filter Criteria

All empirical data transcripts and the indicator literature were analysed for prospective social and community health indicators for the Fitzroy and Port Curtis catchments. Lists of prospective indicators were generated following this process. A preliminary assessment of those suggested for the Fitzroy and Port Curtis catchments by stakeholders was undertaken using the Modified SMART Filter Criteria (see Table 1) was then performed to offer a preliminary assessment of their suitability and usefulness for monitoring and reporting on coastal resource change. The indicators emerging from this preliminary assessment will be assessed for validity in greater detail in the next stage of this research. These are presented and discussed in more detail in the next chapter.

Research study areas

The research reported in this discussion paper was undertaken in the Lower Fitzroy and Port Curtis coastal catchments of Central Queensland (Figure3). The Lower Fitzroy coastal zone is part of the much larger Fitzroy catchment adjacent to the Port Curtis catchment. While these two coastal zone areas share many similar geographical features, such as being coastal catchments whose water enters the Great Barrier Reef (GBR) Lagoon, they differ dramatically socially and economically. These differences are elaborated in the following chapter.

Figure 3: Location map of the Fitzroy and Port Curtis catchments in Central Queensland of Australia



Chapter 4

IDENTIFICATION OF POTENTIAL SOCIAL AND COMMUNITY HEALTH INDICATORS FOR THE FITZROY AND PORT CURTIS COASTAL CATCHMENTS

This chapter presents and discusses the results obtained following analysis of the interview data with stakeholders and interest groups and following the compilation of social indicator literature. The first section outlines some current and future resource pressures identified from the literature and by stakeholders for the Fitzroy and Put Curtis regions, as well as those identified following interviews with stakeholder groups. Subsequent sections present potential indicators identified from the literature review and interviews. The chapter finishes with a final set of indicators following application of the SMART filter.

Current and Potential Resource Use Pressures For the Fitzroy and Port Curtis Coastal Catchments

Both regions have different resource use pressures because of the different activities occurring in these regions. Hence, the current and future pressures are described separately and briefly for each. It is important to note that this discussion paper makes no claims as to the likelihood that these particular resource use pressures will eventuate or the accuracy of their alleged environmental impacts. Further, no mention is made here of the multiple initiatives underway to ameliorate and/or avoid negative impacts arising from these and other resource use pressures, or of the secondary social and economic benefits that might arise from these initiatives. These pressures have been identified from the literature and from stakeholder interviews solely for illustrating the possible links, should they eventuate, to social welfare and change.

Port Curtis Coastal Catchment

The Port Curtis Coastal catchment comprises the Port Curtis Estuarine Areas, Calliope and Boyne Rivers. The smaller Port Curtis catchment has a population of approximately 43,000 people (Queensland Government 2003) and is a major industrial centre and deepwater port facility with a land area of approximately 44,800 km^2. The main land uses are heavy industry (port facilities, metal refining, chemical and mineral production, coal/mineral/petroleum extraction and power generation), mining of the Stuart oil shale reserve, forestry, grazing and horticulture. Other activities include urban development, commercial fishing and recreational activities such as fishing and boating. Other key land uses include national parks, State owned lands, major urban centres and rural residential areas. Noted environmental features include the World Heritage listed Great Barrier Reef, mangrove areas, a deepwater harbour and two river systems (Boyne and Calliope Rivers). While the human population is relatively small it is increasing. There is a diverse range of resource uses and activities conducted in the coastal zone and in close proximity to the town and urban area.

The region is an excellent venue for boating enthusiasts with its proximity to the Great Barrier Reef. Both recreational and commercial fishing have significantly increased in recent times due to population growth. Not surprisingly then, there have been significant increases in boat

ownership over recent times too and this trend is likely to continue. Boating and anchoring put increased pressure on inshore and offshore coral reefs, coastal and estuarine waters and indigenous traditional owner culture. Furthermore, with population increases and development, there are likely to be more shipping movements leading to more maritime pollution incidents and safety hazards with port use. Water traffic is likely to lead to saturation and to impact on industry.

Land clearing disturbs a range of natural habitats, and it is predicted that this will continue. For example, with Gladstone Port Authority's clearing permit and continued development it is likely that there will be more intertidal wetland clearing, and mangrove clearing resulting in fish habitats being threatened. A new airport for Gladstone is likely to impact on mangrove areas and buffer zones will decrease. Even though the public prefer bush between the suburbs, land clearing is continuing.

There is an increase in dredging and extraction on coastal and estuarine waters with sand mining on the beaches and dune systems, and dredging of the harbour and sea. Placing of spoil has the potential to cause benthic disturbances and increase water turbidity, all of which can adversely affect marine biodiversity and seagrass beds in particular. This trend is likely to continue in the future.

There are a range of development and economic activities on the coast including residential, industrial, port, infrastructure, and tourism developments. Curtis Island holds significant potential for future development including to currently undeveloped areas which could lead to another set of pressures. For example, with increasing fringing development, the town is more spread out, there are costs associated with infrastructure, and more empty shops and offices, and more pressures on water quality arising from storm water and development.

Fitzroy River Coastal Catchment

The Fitzroy coastal catchment includes the Fitzroy River, Capricorn Coast and Central Queensland. The catchment is dominated by agriculture (grazing, dryland cropping, irrigated cotton and horticulture) and by mining (coal production of 100 million tonnes/year, magnesite, nickel and historically gold and silver) and covers approximately 142,500 km^2 (Great Barrier Reef Marine Park Authority 2001). There are many weirs along the river and tributaries, but only one major dam with a second planned. Issues of concern for the river include: suspended sediment, nutrients, flooding and blue green algae (Coastal CRC 2002). The Lower Fitzroy coastal catchment has an approximate population of 84,500 people (Livingstone Shire Council 2004, Rockhampton City Council 2004). The coastal area includes Keppel Bay which supports a major scallop, prawn and fish industry. Inland from the coast, the estuary hinterlands have been generally cleared for grazing and urban development, except for a considerable area of near pristine marine wetlands near the southern mouth (Coastal CRC, 2002). The Capricorn Coast is a major tourist centre and it attracts visitors to the Keppel Islands.

Similar to the Port Curtis region, the impacts from recreation and tourism are increasing. For example, Cooroman Creek has seen an increase in recreational use, resulting in erosion to islands caused by the wave action from boats. In the future, there are likely to be more boat ramps arising from the increase in boats and people using the waterways and to increased potential for oil spills.

Problems alleged to arise from over-fishing have reduced the viability of the fishing industry and increased pressures on fish stocks. This has contributed to government intervention via the establishment of no-take zones throughout the GBR, and increased tensions between recreational and commercial fishers. However, this management decision is likely to place pressure elsewhere such as on the river systems, as people have better equipment and more reliable boats to find fish.

The most extensive land use in the Fitzroy catchment is cattle grazing which has resulted, consequently, in substantial alteration to vegetation and ground cover across the catchment. While the contribution of grazing to erosion and salinity across the catchment is highly variable and subject to some debate, the role that grazing has played in land clearing and reclamation has certainly contributed, in turn, to low surface cover along the Fitzroy River, loss and fragmentation of terrestrial and wetland habitat, and loss of cultural sites. Riparian and flood plain modification also have occurred and it is believed by some that a proposed 5000 head cattle feedlot may threaten estuarine and marine biodiversity and integrity.

Water provision is an issue in parts of the catchment with competition for water among agricultural industries increasing. Growing urban populations and/or development arising from industry on the coast are also increasing demand. Waste disposal from irrigation, chemical contaminants, increased sediment, pesticide and nutrient inputs, run-off and marine incursion require management to reduce pressure on water quality in the Fitzroy River and, where this has not happened, are promoting secondary problems such as algal blooms.

Empirical data on social and community health indicators for the Fitzroy and Port Curtis Coastal Catchments

As indicated previously, a range of consultation and data collection methods were used to elicit from stakeholders in the Fitzroy and Port Curtis catchments their perceptions on resource use pressures and core values for consideration in the development of integrated social and environmental monitoring programs. This process elicited a large number of prospective values and indicators that are summarised in Tables 5 to 10 using the framework outlined in Tables 1 to 3. Tables 5 to 7 represent stakeholders' perceptions of pressures, values and indicators relevant to Port Curtis and Tables 8 to 10 those perceptions relevant to coastal management in the Lower Fitzroy.

Table 5. Stakeholder identified pressure/driving force indicators – Port Curtis

Core values	Value dimensions	Potential Indicators	Context specific indicator examples
Natural conditions	Natural resource supply	Resource availability	Secure water supply
		Resource capability	
Community values and aspirations	Intrinsic values	Baseline standards	Water quality
			World Heritage listing
		Resource/biodiversity conservation	Retention of bush and protection of fauna
			Curtis Island protected from development
			World heritage area – global value
		Community identity	Sense of community and community identification
			Social interaction
			Environmentally aware community
			Community pride
		Indigenous cultural values	Maintenance of cultural values and lifestyle
			Traditional hunting rights
			Protection of cultural sites
			Retention of oral history
		Aesthetic values	Uniqueness of coastal area
			Visual aesthetics of town
			Visible waste/rubbish
			Visual aesthetics pollution level at beaches, islands, Police Creek, Barney Point
			Wilderness experience
			Recreational amenity of waterways and coast.
			Environmental amenity value
			Industry located away from town
	Use values	Community aspirations	Recreational fishing use of harbour
			Secure employment
			Employment opportunities for younger generation
			Support for low income or working families
			Service industry in community
			Affordable lifestyle available (housing, gathering places etc)
			Retention of professionals
			Equitable distribution of wealth
			Green areas for recreation
			Buffer zones between urban and industry
			Unique coastal area of Gladstone
		Disposition to change	Limit to town size
Development and economic activities	Resource demand	Population growth	Population size and composition
			Level of suburban/housing development
			Growth rate of town
		Tourism	Tourism growth (domestic and international)
		Industrial use	Level of recreational and commercial fishing (harvest number, fishing licences)

		Infrastructure development	Amount of land reclamation
			Geographical expansion and location of industry activities to estuary and urban centre
			Loss of cultural sites to development
			Level of land clearing
		Leisure and recreation	Usage of islands for recreation (leisure opportunity).
			Satisfaction of recreational fishers / fish catch
			Number and quality of public coastal and waterway recreational areas (areas accessible with/without boat)
		Structural adjustment	Level of landscape change: rural to semi-rural to urban
		Transport	Access to road infrastructure
			Number of boats per population base
	Pollution	Point source pollution	
		Diffuse source pollution	
	Anthropogenic return to natural assets	Resources available for reuse	
Legal and policy frameworks	Legislative	Compliance	
		Property rights/resource access regimes	Traditional hunting rights
	Policy development and implementation	Funding/resources	

Table 6. Stakeholder identified human welfare impact indicators – Port Curtis

Core values	Value dimensions	Potential Indicators	Context specific indicator examples
Public health	Environmental health	Population health indicators and distribution	Hospital waiting list/times
			Bulk billing facilities
			Adequacy of health facilities – location and access
		Exceedences of pollution guidelines	Cost of water processing for human consumption
			Toxin level in seafood, fish and marine vertebrates
		Incidence of disease	Incidence of blue-green algae outbreak
			Health of traditional foods (e.g. turtles, oysters)
			Prevalence of health problems associated with industrial pollution effects (subjective well-being)
	Mental health	Ability to Cope	Depression and support services for women
	Safety	Occupational health and safety	
		Freedom from violence	Domestic and family violence (reporting, arrests, detention)
		Road safety	
Community structure and welfare	Human capital	Education and training	
		Employment	Age of workforce
		Capacity for change	
	Community composition	Demographic composition and change	Percentage of workforce new residents
	Quality of life	Human development	
		Cultural amenity	Retention of Aboriginal oral history
		Housing	Housing availability
			Number and size of rural property blocks
			Availability of short term housing
			Number of extended family sharing common residence
			Number of people per residence
			Quality/condition of housing
		Community services	Access and level of after school care
			Availability of Daycare
			Availability of schools and education
			Level of community services per population base
			Level of support services for women
			Aged care facilities
		Crime	
		Standard of living	Cost of living – (cost of rental and housing sale prices)
	Equity and stratification	Income distribution	Distribution of wealth
			Lifestyle affordability (access to gathering places etc)
		Poverty	Distribution of low income group, infrastructure and services
			Support for low income and working families

Social capital	Networks	Community participation	Social interaction
			Level of shift work in workforce
		Organisational relationships	
	Norms and trust	Acceptance of diversity	Cultural harmony (within and between cultures)
			Location of Aboriginal community (cohesiveness)
		Acceptance of controversy	Gender relations in the community
		Flexibility and responsiveness	
Economic viability	Economic resilience	Economic diversity	Retention of professionals
			Loss of economic income due to out of region social activities (shopping)
			Number of out of region workers (outside Port Curtis/Gladstone) Investment outside Port Curtis region
		Small business	Shop occupancy levels in town versus new development
			Stability of small business enterprises
	Economic activity	Gross product	
Resource sustainability	Intra-generational equity	Resource access	Public access areas to river, islands and foreshore for use
			Range and use of leisure opportunities
			Availability of fish
			Security of water supply
		Resource degradation	Change in physical features from development e.g. sand composition from dredging
			Level of boat usage (measure of damage to marine environment)
	Inter-generational equity	Depletion of non-renewable resources	
Psychosocial wellbeing	Community identity	Community attachment	Connectedness of community - Long and short term residents
	Understanding of change	Disposition to change	Environmental ethic/attachment by community
			Attitudes towards waste disposal, recycling etc
		Awareness	Environmental awareness

Table 7. Stakeholder identified response indicators – Port Curtis

Core values	Value dimensions	Potential Indicators	Context specific indicator examples
Effectiveness	Organisational efficacy	Implementation of planned actions	Water quality measures
	Stakeholder efficacy	Uptake of organisational advice	Reduced impacts from household activities
Institutional learning and capacity	Planning	Planning processes in place at appropriate scale	
		Planning processes linked to program implementation	Level and type of infrastructure development with development projects and industry
	Monitoring and Evaluation	M&E linked to program implementation	
	Public participation	Clear processes for participation in democratic governance	
	Consistency and integration in application of policy	Integration of management	

Table 8. Stakeholder identified pressure/driving force indicators – Lower Fitzroy

Core values	Value dimensions	Potential Indicators	Context specific indicator examples
Natural conditions	Natural resource supply	Resource availability	Water flows
		Resource capability	
Community values and aspirations	Intrinsic values	Baseline standards	Social equality
			Water quality
		Resource/biodiversity conservation	Freshwater flows
			Species diversity
			Habitat/nursery areas
			Coastal system integrity
			Retention of natural bush areas
			Wading bird habitat
			Inter-tidal areas
			Wetlands and waterways, beach/dune ecosystem
			Critical habitat areas
		Community identity	Community/social responsibility
		Indigenous cultural values	Maintenance of cultural values
			Traditional hunting rights
			Protection of cultural sites
			Protection of Native Title rights
		Aesthetic values	Clean and green values
			Clean, unpolluted foreshore and beaches
			Public area (boat ramp, beach) amenity condition
	Use values	Community aspirations	Affordable rent and housing
			Managed economic growth
			Equity in water use and allocation
			Beach access and use
			Affordable fish and seafood
			Local fishing industry
		Disposition to change	
Development and economic activities	Resource demand	Population growth	Water use per capita
		Tourism	Tourism attractiveness
		Industrial use	Number of commercial fishing operations
			Commercial fishing effort
		Infrastructure development	Level/rate of industrial development
		Leisure and recreation	Number of boat ramps
			Use of recreational amenity (boat ramps)
			Level of recreational use of waterways & coast (river flows and level of sedimentation)
			Recreational fishing effort

		Structural adjustment	
		Transport	Access to public transport
			Transport corridors
			Connected to coastal zone growth
	Pollution	Point source pollution	Cost of sewage disposal
			Cost of stormwater disposal
			Volume of waste per population
		Diffuse source pollution	
	Anthropogenic return to natural assets	Resources available for reuse	Level of water recycling by industry
Legal and policy frameworks	Legislative	Compliance	
		Property rights/resource access regimes	Commercial fishery restrictions (legislation changes, access to resource and areas)
			Distribution of water rights
	Policy development and implementation	Funding/resources	

Table 9. Stakeholder identified human welfare impact indicators – Lower Fitzroy

Core values	Value dimensions	Potential Indicators	Context specific indicator examples
Public health	Environmental health	Population health indicators and distribution	Profile of community health, egg obesity levels Community health – prevalence of diseases, illness
		Exceedences of pollution guidelines	Cost of water treatment for human consumption
		Incidence of disease	
	Mental health	Ability to Cope	
	Safety	Occupational health and safety	
		Freedom from violence	
		Road safety	
Community structure and welfare	Human capital	Education and training	
		Employment	
		Capacity for change	Change in associated fisheries industry – boat maintenance etc.
	Community composition	Demographic composition and change	Number of shift workers, miners, retirees, rural Distribution in coastal areas, urban: rural ratio Composition of Indigenous community Level of cultural diversity
	Quality of life	Human development	
		Cultural amenity	Visual amenity
		Housing	Affordability of rent and housing
		Community services	Service provision Counselling Women's health Location and proximity to community support services
		Crime	
		Standard of living	Employment opportunities Household income and debt
	Equity and stratification	Income distribution	Distribution of wealth Affordability of coastal housing and lifestyle
		Poverty	
Social capital	Networks	Community participation	Community activism Participation in decision-making
		Organisational relationships	
	Norms and trust	Acceptance of diversity	Community diversity

		Acceptance of controversy	
		Flexibility and responsiveness	
Economic viability	Economic resilience	Economic diversity	Level of economic growth (regional/shire) Economic value of seafood industry
		Small business	
	Economic activity	Gross product	Economic value of seafood industry
Resource sustainability	Intra-generational equity	Resource access	Availability of fish and seafood Affordability of fish and seafood Cost of water Access to water within and across regions
		Resource degradation	Demand for water
	Inter-generational equity	Depletion of non-renewable resources	
Psychosocial wellbeing	Community identity	Community attachment	Community stability (egg. Turnover of property ownership)
	Understanding of change	Disposition to change	Use of alternative energy sources Level of water recycling by industry Recycling behaviour Water efficiency Level of social support for illness prevention
		Awareness	Public awareness Community/social responsibility

Table 10. Stakeholder identified response indicators – Lower Fitzroy

Core values	Value dimensions	Potential Indicators	Context specific indicator examples
Effectiveness	Organisational efficacy	Implementation of planned actions	Level of management intervention
	Stakeholder efficacy	Uptake of organisational advice	Water efficiency measures (water use per capita) Changes in social attitudes Level of community awareness
Institutional learning and capacity	Planning	Planning processes in place at appropriate scale	
		Planning processes linked to program implementation	Level/amount of management intervention/action
	Monitoring and Evaluation	M&E linked to program implementation	Tourism attractiveness
	Public participation	Clear processes for participation in democratic governance	Participation in environmental decision-making
	Consistency and integration in application of policy	Integration of management	

Preliminary assessment of social and community health indicators

A number of observations may be made regarding the values, pressures and indicators identified by stakeholders in the Lower Fitzroy and Port Curtis catchments. First, the conceptual framework outlined in this paper suggests there remain significant gaps in the identification of potential indicators for use in any reasonably comprehensive monitoring and reporting program. Second, while the presentation of suggested values and indicators in the tabulated form used here does not specify the relationships between individual resource use pressures, their impacts on valued ecological or social attributes, and management responses, development and implementation of an effective monitoring and reporting framework requires these relationships to be explored and validated. Application of the proposed PSIR model would require, therefore, that users break down the components of the conceptual tables on the basis of individual ecological state variables and their associated linkages with social pressures, impacts and responses. Following this process, it is possible that individual social indicators shown to have multiple links to valued ecological assets and management interventions may be identified and used as focal points for indicator reporting. However, reporting social indicators in this manner potentially draws attention away from the need to identify those indicators most clearly related to changes in natural resource management as opposed to monitoring and reporting on valued social attributes in their own right.

While this paper does not attempt to identify and test a comprehensive set of social indicators for the Fitzroy or Port Curtis catchments, it is important to illustrate the utility of those criteria for indicator selection synthesised in the SMART filter, which is applied in this section to a

random selection of those indicators suggested by stakeholders in the Fitzroy and Port Curtis (see Tables 11 to 13). Tables 11 to 13 also comment on whether the suggested indicators are outcome or process indicators.

Table 11. Preliminary evaluation of suggested pressure indicators

Suggested pressure indicators	Process or outcome indicator	Simplicity	Measurability	Accessibility	Relevance	Timeliness	Preliminary assessment
Water quality	O	●●●	●●●	●●	●●●	●●●	Promising. Potential issue with public communication.
Retention of bush and protection of fauna	O	●●●	●●●	●●●	●●●	●●●	High public support. Visible outcome.
Sense of community and community identification	O	●●	●●	●	●●●	●●	Requires greater specification and original data collection such as sample surveys unless proxy indicators used such as participation in community events.
Protection of cultural sites	O	●●●	●●●	●	●●●	●●●	Inadequate data. Data concentrated on sites where development underway (eg. mines) providing poor basis for future planning.
Recreational amenity of waterways and coast	O	●●	●	●	●●●	●●	Highly valued outcome but highly subjective and poorly defined.
Green areas for recreation	O	●●●	●●	●●●	●●●	●●●	Highly valued outcome. More specification required of what sorts of green areas are required and their accessibility for different groups, eg. disabled.
Population size and composition	O	●●●	●●●	●●●	●●	●●	No linear relationship between population growth and resource demand. Must be interpreted in context of housing requirements, recreational demands etc.
Tourism growth	O	●●●	●●	●●●	●●	●●	As above.
Level of recreational and commercial fishing	O	●●●	●●	●●	●●●	●●●	Highly relevant to community aspirations and values.
Amount of land reclamation	O	●●●	●●●	●●	●●●	●●●	Need to link to uses of land following reclamation.
Community/social responsibility	O	●	●●	●●	●●●	●●	Requires clarification and development of proxy indicators such as implementation of widely accepted practices. May require original data collection.
Protection of Native Title rights	O	●	●	●	●●●	●●	Important to natural resource managers but inadequately defined due to ongoing legislative and judicial processes.
Water use per capita	O	●●●	●●●	●●●	●●	●●●	Direct feedback on community behaviour. May not reflect greatest users of potable water.
Level/rate of industrial development	O	●●	●●	●	●●●	●●●	Needs greater specification in terms of resource requirements.

Table 12. Preliminary evaluation of suggested social impact indicators

Suggested impact indicators	Process or outcome indicator	Simplicity	Measurability	Accessibility	Relevance	Timeliness	Preliminary assessment
Adequacy of health facilities	O	●	●●	●●●	●	●●	Inadequately defined Poor linkages with NRM
Toxin level in seafood	O	●●●	●●●	●●	●●●	●●●	Promising
Prevalence of health problems associated with industrial pollution	O	●●●	●●●	●	●●●	●●	Data accessibility may be problematic Disaggregating effects of industrial pollution from other factors difficult
Depression and support services for women	O	●●●	●●●	●	●	●●●	Indirect relationships with NRM
Domestic and family violence	O	●●●	●●●	●●●	●	●●●	Indirect relationships with NRM
Age of workforce	O	●●●	●●●	●●●	●●	●●●	Some issues involved in disaggregating NRM from other effects
Retention of Aboriginal oral history	O	●	●	●	●●●	●●	Important to NRM. May be recast as process indicator.
Distribution of wealth	O	●●●	●●●	●●●	●●	●●●	Main issue disaggregating effects of NRM. Process indicators may be more useful, i.e. equity impacts of NRM interventions.
Social interaction	O	●●●	●	●	●●●	●●●	Poorly defined. May be more useful to find proxy indicators such as participation in NRM groups, volunteering in community events.
Cultural harmony	O	●	●	●	●●●	●●	Highly subjective in definition and difficult to measure. NRM specific process indicators may be more relevant.
Public access to river	O	●●●	●●	●●●	●●●	●●●	Promising
Security of water supply	O	●	●●	●	●●●	●●	Important to NRM but inadequately defined. May need to disaggregate at level of specific stakeholders and consider process indicators such as procedural fairness of allocation mechanisms.
Attitudes towards waste disposal, recycling etc	O	●●●	●●●	●	●●●	●●	Requires original data collection through sample survey or similar instrument.

Table 13. Preliminary evaluation of suggested response indicators

Suggested response indicators	Process or outcome indicator	Simplicity	Measurability	Accessibility	Relevance	Timeliness	Preliminary assessment
Changes in social attitudes	O	●●●	●●●	●●	●●	●●	No necessarily direct relationship between attitudinal and behavioural change. Requires original data collection.
Level/amount of management intervention/action	O/P	●●	●●	●●	●●●	●●●	Where requiring original data collection this would be undertaken by agencies using research.
Tourism attractiveness	O	●●	●●	●●	●●	●●	Inadequately defined. May require original data collection.
Participation in environmental decision-making	O/P	●●●	●●	●●	●●●	●●●	Highly relevant to much NRM. Levels of participation easily monitored. Impact of NRM beyond immediate participants less clear.
Implementation of water quality measures	O	●●	●●	●●	●●●	●●●	Measures may involve dispersed populations and not be easily monitored. Participation in specific incentive schemes easily monitored.
Reduced impacts from household activities	O	●●	●●	●●	●●●	●●	Needs more detailed specification. May be difficult to determine where impacts are long-term and/or diffuse.
Level and type of infrastructure development with development projects and industry	O	●●●	●●	●●	●●●	●●●	Subject to some uncertainty due to ever changing business environment and commercial-in-confidence nature of some planning.

In the absence of a specific natural resource management problem to apply the SMART filter criteria against, this assessment must be regarded as illustrative only. Nevertheless, it does illustrate the complexity involved in selecting robust indicators that provide data on which natural resource managers might act. One of the most common problems with the suggested indicators is the difficulty raised repeatedly through this discussion paper of untangling the lines of causality between natural resource use and condition, social outcomes and management interventions. Again, this is not because these relationships do not exist but because it is extremely difficult to find straightforward indicators of these relationships that are based either on existing data or inexpensive to collect, easy to interpret, and responsive to management.

This preliminary evaluation also brings us back to the concept of process indicators, very few of which were suggested by stakeholders during the initial consultations outlined in this paper. While process indicators would not resolve all the measurement difficulties highlighted by this evaluation, they may enable some progress within an adaptive management framework. Distribution of wealth, for example, might be reconceptualised as distribution of the costs and benefits of NRM programs among target communities. Retention of Aboriginal oral history and cultural identity may be recast as contribution of NRM programs to cultural identity, and so on.

Chapter 5

CONCLUSION

The continued currency of sustainability as a framework for economic development, coupled with increasing pressure from consumers, shareholders and trade regulators for evidence that products have not caused environmental or social harm, are only likely to deepen pressure for demonstrable improvements in environmental and social performance. Nevertheless, development of useful and reliable social indicators raises a number of challenges for natural resource managers. These include substantiation of the relationships between changes in resource use and condition and indicators of social and community health and well-being; collection of suitable social and economic data from primary and secondary sources to inform indicators; and demonstrating the value and practicality of indicators and their associated monitoring systems to natural resource managers, policy makers, planners, community members and other stakeholders.

Preliminary assessment of values and indicators identified by Fitzroy and Port Curtis stakeholders suggests that while these offer a useful insight into those components of the coastal community and ecosystem that are valued by stakeholders there remains a need to deepen our understanding of how changes in natural resource management practice may extend positive benefits to those most affected by social impacts. In the absence of such understanding, it is unlikely that indicators will be developed that actually are responsive to the sorts of management actions that natural resource managers and agencies are able to implement. To this end, the next phase of this research will be focussed on refining and testing the process for identifying and testing prospective social indicators identified through stakeholder consultation and desktop review using social impact assessment and other methods.

More specifically, this discussion paper will be used to provide feedback to relevant stakeholders and to work with them to:

- define more carefully the goals of social indicator monitoring and reporting;
- link this more closely to specific programs of natural resource management such as the reporting responsibilities of regional groups under the National Action Plan for Salinity and Water Quality and Natural Heritage Trust Mark II; and,
- focus identification and testing of indicators more carefully on specific changes in natural resource use and condition.

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APPENDIX A

Table A1. Potential pressure/driving force indicators - Natural conditions

Dimension	Potential Indicators	Definition	Rationale	Data Sources
Natural resource supply	Energy sources	The sources of energy for industry, services, transport, households and energy conversion, and the amount of energy from each source. Sources to be classified as: (a) renewable (solar, hydro, wind, wood, others), and (b) non-renewable (coal, gas, petroleum, others).	Generating and consuming energy inevitably produces wastes. Different sources of energy have different environmental consequences. For example, burning fossil fuels releases a range of gases and particles, but the mix of gases is different for natural gas, various grades of coal and petroleum. By contrast, using solar cells does not release gases or particles, but the manufacture of the cells may have environmental consequences.	Data to support this indicator will be available through the ABS environmental accounting project.
	Climate	Levels of precipitation and evaporation.		
	Surface water availability	The quantity of surface water available is reflected in the mean annual runoff (MAR), which is the amount of water that reaches the river after evaporation and soil absorption.		
	Geology			
	Topography			
	Catastrophic events	For example, droughts and floods.		

Table A2. Potential pressure/driving force indicators – Community values and aspirations

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Intrinsic values	Recreational opportunity and use	Recreation is measured by the number of visitors to local, state, and federal parks and other natural recreation areas; the number of recreational fishing and shellfishing permits issued within the county; and membership in local chapters of non-governmental organizations.	These are aligned with habitat and ecosystem appreciation. Appreciation is any activity in which the participant is directly acting to preserve or conserve natural resources and/or benefits directly from such activities. In some systems, the force of appreciation may conflict with other socio-economic forces, such as exploitation or development. Over time, the balance of these potentially conflicting forces may shift, as the demographics and socio-economics of local communities change.	
	Investment on waterfront revitalization	Public dollars invested in waterfront communities for waterfront revitalization.		
	Habitat allocation	Measures include percent of total wetted area devoted to recreation or conservation (e.g., public shellfish beds, marine parks), and percent of adjacent shoreline (including islands) in habitat set-asides (parks, refuges, wilderness areas, and natural areas).	Appreciation is any activity in which the participant is directly acting to preserve or conserve natural resources and/or benefits directly from such activities. In some systems, the force of appreciation may conflict with other socio-economic forces, such as exploitation or development. Over time, the balance of these potentially conflicting forces may shift, as the demographics and socio-economics of local communities change.	
	Investments in habitat protection and restoration	Includes purchase of protected areas and conservation easements, construction of artificial reefs, installation of mooring buoys.		
	Itinerant population	Proportion of "second" or vacation homes	Appreciation is any activity in which the participant is directly acting to preserve or conserve natural resources and/or benefits directly from such activities. In some systems, the force of appreciation may conflict with other socio-economic forces, such as exploitation or development. Over time, the balance of these potentially conflicting forces may shift, as the demographics and socio-economics of local communities change.	
	Economic development/ resource use and efficiency	Proportion of development projects taking place on "brownfield" land as opposed to "greenfield" land.		
Use values				

Table A3. Potential pressure/driving force indicators - Development and economic activities

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Resource demand	Changes in land use	Area of each land-use, described under a standard classification.	This indicator is a direct measure of the pressure. Different land-uses are a major reason for differences in environmental condition. Land management practices associated with different uses have varying effects on the ecological functions, attributes and integrity of the land.	Although there is some monitoring in all jurisdictions, Australia lacks a satisfactory national land use map. NLWRA is expected to correct this.
	Changes in coastal use	The length or area of the coast used for structures associated with activity.	The coast is heavily used for a variety of activities (eg, aquaculture, marinas, navigation channels) that can affect coastal ecosystems. The length or area of the coast physically changed for each activity is the best measure of its extent.	Some data are available in most jurisdictions.
	Catchment development	The nature and types of land uses in the coastal river and stream catchments for estuaries, lagoons and bays.	This indicator will document changes in land use patterns. The frequency, duration, and components of river and stream runoff have significant control over sediment and water quality conditions in estuaries, lagoons, and bays.	
	Areal Modification Index	Percent of total wetted area under current modification.	Habitat alteration is the intended and unintentional change in native habitat as a result of human activity (eg, diking, and filling, overwater structures). As the areal modification index rises, the functional abilities of the biological and bio-physical system become increasingly compromised.	
	Areal Culture Index	Percent of total wetted area devoted to shellfish aquaculture.	Habitat alteration is the intended and unintentional change in native habitat as a result of human activity. Increases in the amount of area devoted to shellfish aquaculture can have beneficial effects on the socio-economic system and system health and neutral or negative effects on biological integrity, depending on the extent of culture.	
	Water demand	The amount of water required by all water use sectors, including the mining, agriculture, industry, domestic, and environmental sectors.	Water for the environment and drinking water are both considered basic needs and given priority in terms of water allocation. Sectoral water demand may be particularly important when considering policy development or catchment management issues. As with the supply of water, both surface and groundwater demands should be taken into account.	
	Surface water extraction versus availability	The ratio of water use compared to catchment yield. Water extraction to be disaggregated by use and source.	There is a need to allocate water to the environment and to extractive uses. Knowing how much water is extracted and the uses to which it is put is essential for understanding its allocation. Water extraction can only be properly evaluated when the availability of water is also taken into account.	Some data relevant to this indicator are available in all jurisdictions.
	Domestic water access	Population without access to piped water on site	This has implications for the control of water consumption as well as for future infrastructure development.	
	Disturbance of marine habitat	Area of marine habitat subject to: (a) trawling, (b) anchorage sites, (c) dredging (including dredge spoil dump sites), (d) navigation channels, (e) exploration, and (f) mining.	A number of human activities disturb marine habitats, with potentially damaging effects on benthic ecosystems. The nature and severity of effects on marine habitats depends on the type of disturbing activity. A distinction is therefore made between different types of activity.	Some data are available in all relevant jurisdictions.

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Total seafood catch	The total catch of fish (excluding aquaculture) disaggregated into: (a) commercial fish catch (by species where possible), (b) discarded catch, (c) landed bycatch, and (d) estimated recreational and subsistence catch.	The harvesting of fish, crustaceans and molluscs from the marine environment is a major human activity affecting marine biodiversity. Total fish catch gives an estimate of the magnitude of pressure from harvesting biomass from the marine environment. While stock assessments are available for some major commercial fisheries, there are few other measures to provide clues to the health of other fish stocks.	Reasonable data are available on commercial fish catch. Estimating recreational fish catch is more difficult but is underway in several jurisdictions. By-catch figures are also being developed.
	Investments in manufactured capital	Manufactured capital assets depreciate and require investment to maintain. Investments will be targeted at fishing fleets and development of new technologies (often a joint effort between market and public organizations) and the infrastructure needed to support industrial use of marine resources.	When capital assets, and hence the productive capacity for humans to meet their objectives and fulfil aspirations, are threatened, society can respond in a number of ways. All responses, however, can fundamentally be viewed as investment decisions by market, public or civil society organizations. Investments by the market and public sectors in manufactured capital fall within the realm of traditional economic theory and there are many expenditure-based indicators that can be used to track these types of investment.	
	Energy use	Quantity of energy used in total, and in total as a percentage of GDP/GSP, for each of the following sectors: (a) industry (manufacturing, mining, agriculture, and construction), (b) services, (c) transport, (d) households, and (e) energy conversion.	Energy is fundamental to the operation of modern urban environments; it is central to the provision of goods and services, to production in industry, to mobility, to comfort, and to liveability in the domestic context. It inevitably produces wastes which can be harmful to the environment. This indicator shows changes in the patterns of energy use. Less use will generally be environmentally beneficial.	Data to support this indicator will be available through the ABS environmental accounting project. Raw data are collected by a number of agencies such as ABARE and ABS.
	Public transport use	The number of trips made by public transport, by type.	The environmental effects of transport depend strongly upon the mode of transport used. Cars are generally the most, and walking and cycling the least, environmentally damaging modes of transport. Public transport is intermediate in its environmental effects. It is assumed that increased public transport use indicates reduced car use. Although this indicator is an imperfect measure of access to services, it is the best available measure.	Some relevant data are available from the Census. In some cities this is supplemented by additional surveys.
	Vehicle ownership per household			
	Population growth		Population growth and economic development are closely interrelated and both have a direct effect on the quantity and waste produced and on the type of land use that the environment is experiencing.	
	Residential density	Total resident population divided by the area of land within built residential zones.	Residential density strongly influences the environmental functioning of a human settlement. Low residential densities encroach on non-urban land and are associated with high energy and resource use. High residential densities can exacerbate pollution in large urban centres.	Data to support this indicator are available from the ABS, and State and Territory planning agencies.

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Population distribution and number of people per dwelling	The absolute and percentage changes in population and number of households. Changes should be reported by location of the settlement (i.e., whether coastal or inland) and by settlement size (i.e., large, medium or small settlements).	Settlements with growing populations are generally expanding, and therefore place additional pressure on the environment through development and increased human activity. Conversely, settlements with declining populations may lack the resources to address existing and emerging environmental concerns. The consequences of population growth or decline depend upon the location and size of the settlement. Changes in number of household are as significant as shifts in population, because of the effect on demand for land and other resources.	This indicator is monitored across all jurisdictions by the ABS and State and Territory planning authorities.
	Catchment population as a proportion of the maximum sustainable population		There is a certain minimum amount of water required for development, which can be expressed on a per capita basis (1000 m^3/yr). If there is not enough water for the size of the population, development will not be possible and subsistence will predominate.	
	Visitor numbers	Annual numbers of visitors, by reason of visit and length of stay, relative to the resident population.	The effective size of the human population in each settlement depends upon the number of visitors and the resident population. Visitors make additional, and slightly different, demands on environmental and non-environmental resources to residents. The extent to which visitors draw upon resources and affect the environment depends on the length of stay and the nature of visit.	Data relevant to this indicator are available in all jurisdictions.
	World Heritage Area tourism	Number of tourists visiting Australia's two marine World Heritage sites (Shark Bay and the Great Barrier Reef) and estimates of the annual tourism fees, levies and direct charges contributed by users of the two sites.	This indicator is designed to measure tourism pressure on Shark Bay and the Great Barrier Reef. It may also be appropriate to track tourism at marine sites near other World Heritage sites (such as South West Tasmania).	
	Accommodation numbers	Numbers of hotels, B&Bs, guest houses, and bed spaces.		
Pollution	Discharges from point sources	The location and number of point source discharges into inland waters, estuaries, lagoons, bays, and coastal waters, including the types and loads of materials discharged.	Point sources (eg, sewage outfalls, urban stormwater drains, industrial outfalls) discharge a variety of loads and pollutants to inland and coastal water systems. This indicator is a direct measure of the pressure.	Data are available in all jurisdictions. The availability of data will improve as reporting through NPI is implemented.
	Maritime pollution incidents	Number of pollution incidents reported to AMSA.	Shipping accidents (eg, groundings, ship-to-ship collisions), oil spills resulting from other sources such as pipe lines, as well as losses of oil, cargo, and other materials from ships during routine operations may have a major impact on a highly sensitive habitat or sensitive species.	This indicator is monitored by AMSA.
	Fuel consumption per transport output	Megajoules of fuel consumed per passenger kilometre or ton kilometre for each major transport mode, together with the total fuel consumption and passenger/freight kilometres travelled for each mode. This indicator should be reported by fuel type (petrol, unleaded petrol, diesel, LPG, natural gas, electric vehicles, and ethanol).	Transport is a major consumer of energy, and source of greenhouse gases and air pollutants. The energy consumed per unit of transport output is a measure of the efficiency of energy use by this sector. Lower energy consumption is likely to be environmentally beneficial.	Data necessary to calculate this indicator are available from the ABS, although it may be necessary to use vehicle kilometres travelled for private transport and passenger kilometres travelled for public transport.

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Solid waste generation and disposal	Solid waste generated per year split into: (1) quantity and percentage disposed to landfill or incinerated, and (2) quantity and percentage diverted from waste disposal facilities (reused, recycled or reprocessed) and reported for three waste streams recognised in the NSWCS (municipal, commercial and industrial, and building and demolition).	Minimising the amount of waste generated is an accepted strategy for dealing with land, air or water pollution. Recycling is a key strategy for managing waste streams, with reduction of waste to landfill a major aim. This indicator is a direct measure of the pressure.	Hazardous wastes are reported by NPI. Monitoring is currently patchy, but this is improving as the AWD is implemented.
	Total liquid waste discharged as a proportion of supply		Liquid waste generation depends on industrial and agricultural processes as well as the population size. The more liquid waste that is discharged into the system, the more pressure is exerted on the system to maintain itself.	
	Waste water treatment	The number of waste water treatment plants, together with the volume of waste water released to inland, coastal and estuarine waters, disaggregated according to the level of treatment or filtration used.	Treatment of waste water to primary, secondary or tertiary levels exerts different (progressively lessening) pressure on the receiving water environment. Treatment of waste water is a significant societal response to water quality concerns. The volume of water released is a less precise measure than the actual quantities of pollutants (pathogens, nutrients etc) but it is much more readily measured. Actual quantities of pollutants should be reported where available.	This indicator is monitored in all jurisdictions, at least to the level of number of waste water treatment plants. Data on emissions from waste water treatment plants will be reported through NPI.
	Point source pollution	Reduction in phosphorus loads discharged from sewage treatment plants and other point sources.		
	Population without access to toilet facilities		This has implications for waste disposal and pollution potential in the catchment, as well as future infrastructure development.	
Anthropogenic return to natural assets	Compensatory Expenditures	The total expenditures, in dollars spent, on eradication and mitigation.	Habitat alteration is the intended and unintentional change in native habitat as a result of human activity. It can occur as a side effect of intentional species introduction. Increasing effort, and expense, is put into eradication or at least control of these species when results are detrimental. When habitat alteration is intentional, but also detrimental, the compromise is often mitigation, or the required creation of new or improved habitat for species negatively affected by the original activity.	

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Waste water reuse	Waste water re-use, expressed as a percentage of total waste water discharged.	Waste water re-use can reduce the need for abstractions, thereby helping to conserve Australia's water resources. The reuse of water is also important in diverting nutrients and other pollutants that may otherwise enter waterways. Waste water re-use is an important response both to water quality and water quantity issues. The re-use indicator should be considered in association with the water use to catchment yield indicator in inland waters.	Local government, water utilities, and waste water authorities have information on re-use. Where EPA licences are issued to water boards to allow re-use, there are reporting requirements included in the licence that will provide information on re-use volumes. The Water Account Project (by ABS) has sought data on the volume of treated effluent transferred to other users for reuse.
	Anthropogenic water supply	The amount of water available for use, including return flows.	In many countries in the world, the natural water supply in a catchment needs to be supplemented with water from outside. In most cases this is due to the development in a catchment outstripping the water resource availability. Importation of water (eg, interbasin transfer or desalinization of seawater) has a negative effect on the water supply in one catchment, while fulfilling a need in another catchment.	
	Area revegetated	The area revegetated by species or genus, in hectares per annum, disaggregated into areas revegetated using local vegetation or other vegetation, and the purpose of the revegetation.	Revegetation is a significant societal response to processes threatening biodiversity. Native vegetation clearing is a major threat to biological diversity. While revegetated areas do not have the same environmental benefits as uncleared land, they restore many ecological values.	Some data are available in most jurisdictions through the NHT and the ABS's agricultural survey and census.
	Environmental flows	Removal or modification of structures impeding fish migration and flows for fish movement, and improvement in operating strategies.		
	Beach stabilization	The number of beach rehabilitation/ nourishment and stabilization (including hard stabilization) programs in estuaries, lagoons and bays, and on the open coast; the nature and cost of these programs; and data recorded per km of coastline.		

Table A4. Potential pressure/driving force indicators - Legal and policy frameworks

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Legislative	Land reclamation policy (on mangrove conversion and agricultural privatization)		Mangrove conversion to aquaculture affects the resilience of the livelihood system dependent on the mangrove resource. The poorer households who are more dependent on mangroves are affected by mangrove loss while the richer households benefit from conversion. The ability of the community to maintain sustainable common property management of the remaining mangrove and fishing areas is undermined by the changes in property rights and changes in inequality brought about by externally driven enclosure and conversion. There is enhanced conflict in the community over remaining resources, leading to non-cooperative exploitation of the mangrove fisheries. Conversion increases income inequality within the population, thereby reducing the likelihood of cooperative action within a heterogeneous group.	
	Security of tenure	Includes status of length, exclusivity, enforceability and transferability.		
	Land use policy	Existence of non-confiscatory land use policy.		
	Property rights	Existence of property rights for exploited nontimber forest products (eg, fuel wood).		
	Land tenurial prerequisite policy	Whether or not it discriminates against forestry.		
	Transparency	Transparent system of concession allocation.		
	Clarity of property rights	Existence of a clear ministerial decree and forest agreement for forest concession. (FMU is implemented on the basis of legal title on the land, recognized customary rights, or clear lease agreements).		
Policy development and implementation	Great Barrier Reef management	Annual allocation of funds from government sources to the GBRMPA and the Queensland Department of Environment for management of the Great Barrier Reef, and to Australian scientific institutions for research on the Great Barrier Reef.	Tracking of funds from government sources to GBRMPA and the Queensland Department of Environment for the management of the Great Barrier Reef, and to scientific institutions for research on the Great Barrier Reef accounts for their allocation on a yearly basis.	

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Commonwealth and State Government marine management	Annual expenditure of the Commonwealth Government and State funds on (national,) regional and local-scale programs for coastal and marine management, including in the environment, conservation and resource sectors. It includes funds raised by government authorities in the form of levies and charges to offset changes in consolidated revenue outlays.	Funds allocated to environment, resource, and conservation sectors will be measured. The total funds include money raised by governing authorities through levies and other charges. This indicator will monitor the Commonwealth and State Governments' monetary responses to changing issues in coastal management.	
	Coastal management program competitive grants			
	Human resources	Total number of employees and contract workers in relevant management agencies.		
	Investments in social capital—state capacity	Investments in the legal and institutional infrastructure that comprises macrolevel social capital. Examples are investments to increase fisheries governance capacity by enhancing communications within and between government departments ('horizontality' initiatives), aligning policies, building core capacity (investments in infrastructure and technology), and improving organizational effectiveness.		
	Investments in institutions—operational situations	Investments in better information, monitoring and enforcement.	These investments can be made at low cost relative to investments needed for higher-level institutional change. Enforcement costs can escalate rapidly and become prohibitively expensive, however, if local social norms are not congruent with formal rules. Thus, investments in monitoring and enforcing existing rules are important for successful resource management, but are not alone sufficient for long-run sustainability. Most public agencies closely track expenses devoted to monitoring, compliance and enforcement. When publicly available, this data provides the basis for indicators of investment in operational-level institutions. Fishers and other resource users may also contribute significant in-kind and financial resources to self-monitoring. In self-governing or artisanal fisheries, however, indicators of these investments may be more difficult to develop because much of the monitoring activity may be a 'byproduct' of routine fishing activities.	

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Investments in institutions— collective choice situations	A response to threats against capital assets is to change the formal rules governing behaviours or outcomes that are required, prohibited or permitted by law. Indicators at this level focus on the costs of activities such as the development of management plans, publication of rule changes and costs associated with legislative change.	Because changing rules is a higher-level process, societal investments aimed at changing the formal rules-in-use will be more expensive than simply increasing monitoring and enforcement. At the collective choice level, it is also possible for government, NGOs or other 'norm entrepreneurs' to effectively invest in norm-seeding activities that seek to change the informal rules-in-use.	
	Investments in institutions— constitutional situations	If sustainability outcomes consistently fail to meet broad societal expectations, there may be increasing calls for political changes about the rule-setting process itself. Constitutional level rules about the articulation of stakeholder interests are those that refer to selecting and representing stakeholders for the governance process. Aggregation rules deal with the transformation of diverse stakeholder interests into actions, often specifying the timing or frequency of meetings and technical rules about voting procedures needed to resolve conflicts. At this level, appropriate indicators of investment relate to resources dedicated to litigation, political lobbying and core investments in strategic decision-making processes by public, private and civil society organizations.	Constitutional level change is more expensive again relative to lower level changes that simply devote more resources to enforcement or shift management orientation. Data is likely to be much more difficult to come by at this level and in-kind contributions to the process very important.	
	Precautionary economics policy	Whether or not reserve funds are available for damage (performance bond).		
	Precautionary economics policy	Whether or not anticorruption provisions are in place.		

Table A5. Potential human welfare impact indicators – Public health

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Health	Infant mortality rate	The number of children who died before completing their first year of life (number of deaths/1,000 births).		Secondary data are available from statistics agencies and community profiles.
	Nutritional levels	Prevalence of undernourishment and vitamin A deficiency.	Chronic household hunger represents the capacity of society to feed its people on a continuing basis. Vitamin A deficiency was chosen as an indicator primarily because, considering other micronutrient deficiencies, iron deficiency is a complex issue that arises from multiple sources and is difficult to address, and iodine deficiency is not as widespread and has a well-known technical solution: iodizing salt.	
	Disease outbreaks	Number of outbreaks per year of disease associated to contaminated marine water, fish, and other species.		Data are available in health and mortality statistics and hospital records.
	Mortality (including young children) and morbidity associated with poor outdoor air quality	Incidence of mortality/morbidity due to acute respiratory or cardiovascular disease (young children >1 month and <1 year).		Data are available in health and mortality statistics and hospital records.
	Morbidity associated with contaminated drinking water	Acute physician/emergency room/ hospital admissions for gastrointestinal, neurological (lead), reproductive illnesses, and cancer.		Data available in epidemiological studies.
	Morbidity associated with contaminated recreational water	Physician/emergency room/hospital admissions for gastrointestinal illnesses, upper respiratory tract, eye, ear, nose or throat infections, and skin ailments.		Data available in local public health units and hospital records.
	Exceedences of the maximum residue levels in food and produce	The number of samples of rural produce and food which exceeds the Maximum Residue Levels (MRL) for contaminants is a surrogate for land/water contamination.	There is public concern and interest over the use of chemicals in agriculture and their residues in foods and other produce. This indicator also applies to foods taken from the freshwater and marine environments. Data on residue levels will also provide some information on the movement of these contaminants through the food chain.	There are ongoing national programs that monitor residues in all relevant jurisdictions. Some states also have monitoring schemes.
	Exceedences of drinking water quality guidelines	Drinking water quality for reticulated water supplies and proportion of the population with access to drinking water systems, by settlement type (i.e., by major cities, other (coastal) cities, inland rural towns and remote settlements).	Access to quality drinking water is an important aspect of the environment as experienced by the inhabitants of human settlements. The Australian Drinking Water Guidelines (1996) are an accepted standard against which to evaluate the quality of drinking water.	Some data are available in all jurisdictions.
	Exceedences of groundwater quality guidelines	Salinity and nitrate levels in groundwater.	Salinity is a major water quality limitation on the environmental values (including potential beneficial uses) of groundwater. It is generally only necessary to monitor nitrate levels where health issues are important. Rising nitrate levels suggests that the aquifer is being polluted from point or diffuse sources.	Some data are available in all jurisdictions. The Guidelines for Groundwater Protection are used to indicate significant levels of change for a range of environmental values.

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Exceedences of surface, marine and estuarine water quality guidelines	Percentage exceedences of water quality guidelines for a suite of microbiological, bacterial and chemical water quality parameters relating to protection of aquatic ecosystems, primary contact recreation, irrigation, and stock watering. (Exceedences to be reported separately for each use.)	The maintenance of the environmental values of water is a critical environmental issue. Since there are regional variations in the environmental values of water and baseline environmental conditions, this indicator allows for variation in the parameters measured and frequency of measurement for each water body. Water quality guidelines should be used to indicate significant levels of change for a range of environmental values.	Water quality is widely monitored in all jurisdictions. It is expected that the revised ANZECC water quality guidelines/forthcoming NEPM will be applied incrementally over the next few years.
	Freshwater algal blooms	Incidence of freshwater algal blooms.	Algal blooms are a potential surrogate indicator of eutrophication or high nutrient load. Algal bloom events are indicative of algal species outbreaks which directly threaten biodiversity, water quality and human health.	Regular monitoring is undertaken for some reservoirs in most jurisdictions. There are various State and Territory committees, which coordinate the implementation of strategies for the control of algal blooms.
	Algal blooms in estuarine and marine environments	The frequency of algal blooms, and dominant species of algae responsible for them.	Algal blooms degrade recreational amenity and fisheries, can be toxic, affect natural ecosystems, and have major consequences for tourism. Algal bloom events are indicative of algal species outbreaks which can directly threaten biodiversity, water quality and human health.	Algal blooms are monitored in some jurisdictions, however at present this is mostly on an ad hoc basis which makes comparison across jurisdictions difficult.
Safety	Forest management health and safety	Whether or not forest managers cooperate with public health authorities regarding illnesses related to forest management.		
	Forest management health and safety	Whether or not forest employers follow ILO working and safety conditions and take responsibility for forest-related health risks of workers.		
	Quality of public access experience	Description of the usability of the public access points and state of surrounding environment.		
	Perception of security	Local people feel secure about access to forest resources.		

Table A6. Potential human welfare impact indicators – Community structure and welfare

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Human capital	Education	The average number of years spent in school of the adult population.		Secondary data are available from statistics agencies and community profiles.
	Educational attainment	Percentage of the population in a given locale that has completed a certain level of formal training.	(What this indicator misses is informal, on-the-job training that is common in industrial settings; bush skills that may be critical to survival in a subsistence economy; and entrepreneurial skills, which may be important to succeed in small businesses that characterize the tourism industry. Also, it may miss other skills (such as quality of local leadership) that contribute to a community's ability to adapt to changing economic conditions.)	Secondary data are available from statistics agencies and community profiles.
	Access to education	Percentage of children with access to primary education.		
	Access to education	Percentage of youth with access to secondary, technical, and university education.		
	Environmental education	Whether or not children are educated (formally and informally) about natural resource management.		
	Employment and training opportunities	Whether or not opportunities exist for local and forest-dependent people to receive employment and training from forest companies.		
	Job experience			
	On-the job skills training			
	Employment	Percentage of active population employed (total, employees, self-employment, and gender differentiated).		
	Unemployment		Unemployment has long been used as a measure of community wellbeing and as a performance indicator for local, regional, provincial and national economies.	Secondary data are available from statistics agencies and community profiles.
	Unemployment levels (seasonal)			
	Capacity for change	Capacity to participate in key decisions that affect NRM and primary production and agro-enterprises.		
	Capacity for change	Community capacity to influence political decisions that affect the community.		
	Capacity for change	Participation on final consumer price (community gate price/final consumer price of most important selected commodities).		
	Capacity for innovation	Capacity to innovate in agriculture, agro-enterprises, and NRM.		

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Capacity for management	Capacity to manage agro-enterprises, local agricultural research committees, community organizations, consortia, and farms.		
Community composition	Population age structure		Sustainable communities have "normal" age distributions (i.e., those that reflect national or regional trends). One would have to question the sustainability of communities with very few young adults, or communities where only retired people with considerable assets can afford property.	Secondary data are available from statistics agencies and community profiles.
	Displacement migration and circular mobility	Displacement migration may be caused by a deleterious state of affairs in the home locality (such as loss of assets) and often has negative impacts on social infrastructure in both sending and receiving areas. Circular mobility is stimulated by the demand to move caused by attractive circumstances elsewhere, often in urban areas.	Population displacement is often an indicator of the breakdown of social resilience. Displacement and coping strategies represent an extreme manifestation of vulnerability. Coping strategies are involuntary short-term actions taken by households when faced with extreme external stress. They almost invariably lead to a different subsequent state of vulnerability to future difficult situations. Circular and seasonal migration is an important aspect of social stability because it is a strategy for risk spreading at the household level and because of its relationship to resource dependency.	
Quality of life	Human Development Index	The HDI allows the comparison of life quality, using information on income, health and education level.	The index ranges from 0 to 1.0, the higher the value the better development achieved by a given population (HDI >0.8=high, HDI between 0.5 and 0.8=medium, and HDI <0.5=low). High development is associated with better sanitary conditions and waste management.	Secondary data are available from statistics agencies and community profiles.
	Low median income		This indicator, relative to that of the state, is a proxy indicator of economic well being. Societal well being (quality of life) is a blend of economic well being and measures of social stability (eg, average education level attained, crime and divorce rates).	
	Divorce rate		Societal well being (quality of life) is a blend of measures of social stability (eg, average education level attained, crime and divorce rates) and economic well being.	
	Crime rate	The number of recorded violent crimes per year.	Societal well being (quality of life) is a blend of measures of social stability (eg, average education level attained, crime and divorce rates) and economic well being.	Secondary data are available from statistics agencies and community profiles.
	Community amenity	Percentage of population with access to safe and adequate quantity of drinking water.		
	Community amenity	Percentage of population with proper sanitation facilities.		
	Availability of affordable housing			

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Real estate values		Rising real estate values could be an important contributor to poverty and low income in tourism based communities. Most tourism community jobs are low wage and seasonal. As tourism communities become more popular and more desirable places to live, real estate prices (and associated property taxes) may be driven up, resulting in further financial strain for local retirees on fixed incomes or long-term residents who are struggling to make the transition to the new economy.	
Equity and stratification	- Gini Coefficient - Theil Index	Frequently used indicators of income distribution which take into consideration the average familiar income per capita of a given region.	In developing countries, income level of the population relates directly with the lack of proper sanitary conditions and is directly responsible for the poor environmental quality conditions in which this population lives.	
	Income comparisons	Farm and household income comparisons by wellbeing group and by gender.		
	Total earnings		Measure of regional economic performance. System-dependent economic performance is measured using indicators of natural resources earnings (e.g., timber harvest, commercial fishing, appreciation-related employment, natural resource management) and employment within those sectors, relative to overall regional earnings and employment.	
	Total employment		Measures regional economic performance. System-dependent economic performance is measured using indicators of natural resources earnings (e.g., timber harvest, commercial fishing, appreciation-related employment, natural resource management) and employment within those sectors, relative to overall regional earnings and employment.	
	Aboriginal employment rates			
	Poverty	Percentage of poorest inhabitants of a given area.		Secondary data are available from statistics agencies and community profiles.
	Distribution of benefits	Whether or not mechanisms for sharing economic benefits from forest use are seen as fair by local communities.		
	Fair wages	Whether or not wages and other benefits in forest companies conform to national and/or ILO standards.		

Table A7. Potential human welfare impact indicators – Social capital

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Networks	Community stewardship	Number of people involved in stewardship organizations and activities.		
	Community stewardship	Businesses participating in stewardship activities.		
	Community stewardship	Participation in volunteer activities that protect/restore and enhance coastal resources.		
	Coastal care community groups	Number of 'Coastcare' and allied groups, membership size in each group and the annual costs of programs administered by them.	The extent of local citizens' participation in these groups is a direct measure of their concern and knowledge of coastal issues in their community.	
	Level of involvement	Level of personal involvement in community groups.		
	Local organizational efficacy	Whether or not local stakeholders meet with satisfactory frequency, representation of local diversity, and quality of interaction.		
	Charitable donations			
	Media interest in tourism and health	Percentage of positive and negative media coverage.		
	Newspaper circulation			
	Information access	Proportion of population with internet access.		
	Partnerships	Evidence of functional public-private partnerships		
Norms and trust	Acceptance of controversy	Whether or not level of conflict is acceptable to stakeholders.		
	Conflict mediation	Whether or not application of conflict mediation activities is successful.		
	Conflict resolution	Whether or not means of conflict resolution functions without violence.		
	Acceptance of diversity	Whether or not the contribution of all stakeholders are mutually respected and valued at the generally satisfactory level.		
	Collaborative actions by user groups			
	A functioning buffer zone	Level of conflict at FMU boundary.		
	A functioning buffer zone	Local level of respect for FMU boundary.		
	A functioning buffer zone	Level of concessionaire's efforts to protect FMU boundaries.		

Table A8. Potential human welfare impact indicators – Economic viability

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Economic resilience	Diversity of the natural resource base		Dependency on a narrow range of natural resources can increase the variance of income and hence decreases its stability. Resource dependency can be risky for commercialized activities due to the boom and bust nature of markets for the outputs from resource use and to the threat of technological innovation. Environmental variability can increase the risk of being dependent on particular resources, through extreme natural events or from the impact of pests and diseases on agricultural systems.	
	Income sources	Types of income sources (eg, on/off farm, agricultural/nonagricultural).		
	Economic diversity index			
	Land tenure situation	Percentage of farmers who own land, mean farm size.		
	Diversity of product use	Diversification of total forest product utilization (products used/known potential products).		
Economic activity	Gross domestic product per capita (GDP/inhab)		GDP per capita characterizes the economic activity (wealth) of a population. The higher the income concentration, the higher the number of poor population and the worse the quality of life of the population, including sanitary conditions.	Secondary data are available from statistics agencies.
	Gross geographic product per capita		Growth in the production of goods and services is a basic determinant of how the economy fares, as well as the level of development in a catchment. GGP measures income growth, and is an important indicator of consumption patterns and the use of renewable resources.	
	Investment in public assets			
	Real estate values		Often real estate values reflect the health of the local economy. Highly fluctuating real estate values in resource-dependent communities would be seen when faced with downturns or upturns in the resource based commodity economy. Fluctuating real estate prices would be a sign of community instability and might offer a challenge to sustainability for some places. Rising real estate values might also be an important contributor to poverty and low income in tourism based communities. Most tourism community jobs are low wage and seasonal. As tourism communities become more popular and more desirable places to live, real estate prices (and associated property taxes) may be driven up, affecting fixed income local retirees or struggling long-term residents financially.	Secondary data are available from statistics agencies and community profiles.

Table A9. Potential human welfare impact indicators – Resource sustainability

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Intra-generational equity	Resource access	Number of accessible (including for the disabled) public recreational amenities/opportunities.		
	Public access enhancement	Infrastructure to enhance and protect public access to the shore including rights of way, boardwalks, and signage programs.		
	Recreational opportunity	Percentage of (deteriorated) urban waterfronts revitalized.		
	Urban green space	Area of urban land devoted to parks, gardens, recreation and other open spaces relative to total urban area. This indicator should be disaggregated into publicly accessible space and nonpublicly accessible space (such as school grounds and some golf courses).	The amount, location and quality of green space in urban areas influence the quality of the urban environment for residents. Green space offers recreational opportunities and contributes to the aesthetics of the environment. This indicator is a direct measure of the condition, and satisfies all selection criteria except ease of interpretation.	Some data are available, mainly from special purpose studies.
	Perceived quality of coastal landscape			
	Total value of extracted marine resources relative to total regional earnings	For estuarine resources, this is a simple proxy indicator and should be for both commercial and recreational resources.	Biological and physical processes of estuarine systems can affect quality of life factors such as sense of place or community, views and scenery or aesthetics, and recreational opportunities. Communities which are succeeding financially and socially, and retain a socio-economic connection to the estuary may treat the system differently than communities which are struggling and/or which have lost that connection.	
	A functioning buffer zone	Existence of economic development authority in buffer zone.		
	A functioning buffer zone	Existence of a legal boundary between village area and forest concession area.		
	Perception of fairness	Whether or not access to forest resources is perceived locally to be fair.		
	Traditional resource access	Whether or not ownership and use rights to resources (inter- and intra-generational) are clear and respect preexisting claims.		
	Effective local management in controlling maintenance of and access to forest resources	Rules and norms of resource use are monitored and enforced.		
Inter-generational equity				

Table A10. Potential human welfare impact indicators – Psychosocial wellbeing

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Community identity	Future orientation	Whether or not people link their own and their children's future with management of forest resources.		
	Rates of in-migration and out-migration		A population that is stable in numbers but that experiences rapid turnover may exhibit higher rates of social pathologies such as crime, divorce, substance abuse, and spousal abuse. Rapid turnover in a local population prevents bonds from developing that foster social cohesion and ultimately community capacity.	Secondary data are available from statistics agencies and community profiles.
Understanding of change	Knowledge of key causes and effects of NRM problems			
	Knowledge of key causes and effects of agricultural production, processing, and marketing relationships			
	Awareness of sustainability issues and Local Agenda 21			
	Use of new school curricula on ICM topics			
	Public opinion on environmental issues			
	Environmental education efficacy	Whether or not forest managers can explain links between relevant human culture and the local forest.		
	Environmental awareness	Whether or not people recognize the need to balance number of people with natural resources use.		
	Environmental values	Whether or not destruction of natural resources by local communities is rare.		
	Environmental values	Whether or not spiritual links to the land are maintained by people.	People link their own and their children's future with management of forest resources.	
	Conservation license plate sales			

Table A11. Potential response indicators – Effectiveness

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Organizational efficacy	Catchment management programs	Number and nature of formally implemented catchment management programs covering coastal river and stream catchments.	This is based on the rationale that the frequency, duration, and components of river and stream runoff have significant control over sediment and water quality conditions in estuaries, lagoons, and bays. This indicator will be designed to measure changes in catchment management program implementation efforts.	
	Effective implementation of the management plan			
	General progress in strategies and plans for ICM			
Stakeholder efficacy	State of satisfaction of population		Public opinion often influences the behaviour of people. The level of cooperation of the community in natural resource management and conservation depends, along with other factors, on their satisfaction with resource management in their area.	
	Agreements established	Number of interim agreements with stakeholder groups.		
	Changes in the behaviour of institutions and interest groups	Collaborative planning and decision making through task forces, commissions, civic associations, etc.		
	Uptake of BMP	Percentage adoption of BMP (eg, more efficient irrigation techniques).		
	Uptake of BMP	Percentage of resource managers using agreed best practice by resource sector and/or catchment, if relevant.		
	Uptake of organizational advice	Number of participants in water trading and volume of water traded.		
	Changes in behaviours directly affecting resources of concern	Elimination of destructive fishing practices and over-harvesting.		
	Changes in behaviours directly affecting resources of concern	Land use practices that reduce contamination of water, sustain fresh water inflows to estuaries.		

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Proportion of fishers participating in M&E activities	Percentage of fishers in different segments of the industry who follow the requirements of recording and reporting landings, hailing in (report by radio their estimated landings by species prior to docking), submitting to dockside monitoring by third party monitors, carrying on-board independent observers and/or installing 'black box' vessel tracking gear.	The primary activities at this level—gathering information, monitoring fishing activities and enforcement of formal or informal rules— are costly and government, resource users or some combination of the two may bear these fishery management transaction costs. From a monitoring perspective, the interest is in how changes in the quality of information, monitoring intensity and enforcement of existing institutions will change actor incentives and behaviour and help achieve management objectives. In general, if a threat of detection and punishment is not credible, individual behaviour is unlikely to change significantly even with formal rules in place. It is also possible, however, that behaviour will still not change if the formal rules do not coincide to some degree with social norms; if regulations are imposed from outside and/or fishers feel that the formal rules are illegitimate or unfair, there may actually be incentives to violate those rules.	
	Investments in natural capital	Projects or programs that protect or improve important habitat, directly enhance the production of target species, or engage in predator control are all types of investments in natural capital.	When capital assets, and hence the productive capacity for humans to meet their objectives and fulfil aspirations, are threatened, society can respond in a number of ways. All responses, however, can fundamentally be viewed as investment decisions by market, public or civil society organizations. Investments in natural capital may sometimes be problematic due to our limited understanding of ecosystem dynamics. Indicators of investments in these activities should account for time, in-kind contributions of supplies and equipment, and for direct financial contributions from market, public and civil society organizations.	
	Investments in human capital	It is now widely recognized that human capital can be developed through investments in the training, education and health of workers. Other non-traditional investments such as the documentation and dissemination of local ecological knowledge are also clearly investments in human capital.	When capital assets, and hence the productive capacity for humans to meet their objectives and fulfil aspirations, are threatened, society can respond in a number of ways. All responses, however, can fundamentally be viewed as investment decisions by market, public or civil society organizations. Data on many of investments in human capital can be tracked using conventional sources such as census surveys. Investments by civil society organizations in human capital may be as, or more, important than public sector investments for some fisheries.	
	Investments in social capital—community capacity	These include investments in social structural variables (e.g., communications, social networks, venues for dispute resolution), norm-seeding (e.g., awareness and stewardship campaigns) and leadership-building activities (e.g., mentoring programs).	When capital assets, and hence the productive capacity for humans to meet their objectives and fulfil aspirations, are threatened, society can respond in a number of ways. All responses, however, can fundamentally be viewed as investment decisions by market, public or civil society organizations. Public and civil society organizations have become increasingly aware of the importance of investments of social capital over the past decade. Indicators of investments in social capital should take into account all three aspects of microlevel community capacity building (bonding, bridging, and linking).	
	Human resources	Education and training programs for coastal and marine affairs.		

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Waterfront revitalization	Amount of citizen time and dollar donations to waterfront revitalization activities.		
	Waterfront revitalization	Number of volunteers contributing time to activities associated with waterfront revitalization.		
	Waterfront revitalization	Private sector economic investment in waterfront communities.		
	Effectiveness of resource management structures and strategies ensured	Understanding of MPA rules and regulations by the community.		
	MPA compliance by resource users with management plans enhanced	Number of stakeholders involved in surveillance, monitoring and enforcement.		

Table A12. Potential response indicators – Institutional learning and capacity

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Planning	Changes in land management in response to planning processes	The area of land managed under best-practice guidelines as specified in planning processes.	Different land-uses are a major reason for differences in environmental condition. Land management practices associated with different uses have varying effects on the ecological functions, attributes and integrity of the land. Changes in land use are expected to continue.	Although there is some monitoring in all jurisdictions, Australia lacks a satisfactory national land use map. NLWRA is expected to correct this.
	Establishment of catchment management agency		If a management agency has been established, management in that area will be catchment specific.	
	Community sensitivity	Whether or not policy and forest planning are based on the history and characteristics of community.		
	Cultural sensitivity	Whether or not forest management plans reflect care in handling human cultural issues.		
	Ecosystem-social integration	Whether or not management planning involves all stakeholders and takes into account all the components and function of the forest such as timber production, ecology and well-being of local population.		
	Management objectives are clearly and precisely described and documented	Objectives are clearly stated in terms of the major functions of the forests, with due respect to their spatial distribution.		
	Availability of a comprehensive forest management plan	Whether or not the plan looks beyond the second cutting cycle.		
	Availability of a comprehensive forest management plan	Whether or not maps of resources, management, ownership and inventories available.		
	Coordinating mechanisms for coastal and marine affairs			
	Planning and management mechanisms	Description of the authority to enact laws and ordinances to protect public health, safety and welfare.		
	Preparation of coastal profiles			
	Use of coastal indicators			
	Coordinating mechanisms for coastal and marine affairs			

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
Monitoring and evaluation	Environmental flows objectives	Number of waterways for which environmental flow provisions have been established and for which environmental flow provisions are being met.	Environmental flows aim to ensure a supply of water adequate to maintain ecosystem function in inland water systems. Work to establish environmental flow provisions only began recently and it is therefore important to monitor progress. Where environmental flow provisions have been established, it is important to monitor whether they are being met.	Some data are available in most jurisdictions. Data availability will improve in all jurisdictions as COAG water reform guidelines are implemented.
	Fishing effects on non-target biodiversity	Number of fisheries management plans (State and Commonwealth) that contain effective indicators for monitoring the level of, and extent of reduction in, impacts on non-target organisms, and the number of such indicators.	These indicators may include direct and indirect measures of impacts on nontarget biodiversity (eg, an inventory of epibenthic fauna in trawling grounds may provide a direct measure, while trawl bycatch amounts may provide an indirect measure).	
	Community attitudes and actions	Trends in people's attitudes and actions, derived from longitudinal surveys.	The attitudes and actions of individuals are an important factor in their impact on the environment (as individuals or as members of households). Surveying community attitudes is an important feedback mechanism for analysing the effectiveness of environmental policies, programs and education, as well as for judging support for initiatives. This indicator is a measure of individual people's attitudes and some of their individual actions in response to their perception of the condition of the environment and the pressures upon it.	The ABS has undertaken regular surveys of people's views and practices since 1992. This work can be supplemented by other ABS surveys and by ad hoc surveys by other organizations.
	Continuous forest inventory	Continuous forest inventory plots established and measured regularly.		
	Safety	Working groups are protected (e.g. from fire, encroachment and premature reentry).		
	Plan revision	Results from monitoring and research and other new scientific and technical information are incorporated into the implementation and revision of the management plan.		
	Available human resources and equipment for surveillance and monitoring			
	Clearly defined enforcement procedures			
Public participation	Marine network participation	Participation (number on the mailing list) in MCCN by IMCRA subregion and Marine Region, documented consistently each year.	Monitoring mailing list numbers will show the changes in the public awareness of, interest in, and support for coastal issues over time.	
	Level of forum establishment in the catchment		Establishing water forums allow participative management in the catchment. They are viewed as essential to the successful establishment of catchment management agencies.	
	Participation in courses	Number of participants in property management plan courses.		

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Extent of participation in training and Landcare.			
	Access to decision-makers	Capacity of community members to gain access to decision-makers in private and government organizations.		
	Existing channels and mechanism for participation in democratic governance			
	Information access	Updated plans, baseline studies and maps are widely available, outlining logging details like cutting areas and road construction, with timing.		
	Information access	Baseline studies of local human systems are available and consulted.		
	Stakeholder rights	Management staff recognizes the legitimate interests and right of other stakeholders.		
	Community access to political decision making			
	Effective and equitable representation and participation of coastal resources stakeholders in Management ensured	Degree of stakeholder participation in management of the MPA		
	Level of satisfaction of stakeholders with participation			
	Training	Amount and quality of training provided to resource users to participate in MPA management		
	Training	Amount and quality of training provided to community organization to participate in MPA management		
		Mechanisms for public opinion on coastal and marine environmental issues.		
Consistency and integration in application of policy	Consistent management plan		A catchment management strategy for each catchment must be in harmony with the national water strategy and should set the principles for allocating water taking into account the protection, use, development, conservation, management, and control of water resources in the catchment.	
	Adoption of regional growth strategy			

Dimensions	Potential Indicators	Definition	Rationale	Data Sources
	Integration of management	Number of regions covered by an effective integrated ecosystem management framework that includes environmental performance indicators for assessing and reporting on ecosystem attributes related to the various responsibilities of the three levels of government and the activities of the private sector. This indicator attempts to link effort with outcomes on the ground.	This indicator assumes that ocean and coastal management will fall within an overarching national management framework, while proceeding on a hierarchical and regional basis. The indicators and sectoral objectives will be evaluated based on their relevance to their respective regions' and subregions' ecosystems.	
	Effective instruments for inter-sectoral coordination on land use and land management exist.			
	Plans/maps showing integration of uses by different stakeholders.			
	Effectiveness of legal structures and strategies for management ensured	Existence and compatibility of legislation with needs of the MPA management plan.		

Acronyms:

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
AMSA	Australian Maritime Safety Authority
ANZECC	Australia and New Zealand Environment and Conservation Council
AWD	Australian Waste Database
BMP	Best Management Practices
COAG	Council of Australian Governments
EPA	Environmental Protection Agency
FMP	Fisheries Management Plan
FMU	Forest Management Unit
GBRMPA	Great Barrier Reef Marine Park Authority
HDI	Human Development Index
ICM	Integrated Coastal Management
ILO	International Labor Organization
IUCN	World Conservation Union
MCCN	Marine and Coastal Community Network
NEPM	National Environment Protection Measures
NHT	Natural Heritage Trust
NLWRA	National Land and Water Resources Audit
NPI	National Pollutant Inventory
NSWCS	National Solid Waste Classification Scheme
PFE	Permanent Forest Estate

APPENDIX B

Summary of indicator subheadings/themes from the literature

social indicators
community health indicators
resilience indicators
sustainability indicators
indicators in environmental management
indicators in environmental and NRM planning
indicators in baseline assessment
indicators in impact assessment of change in resource use
indicators and frameworks for tracking and monitoring changes in:

- resource use
- resource condition
- resource management activities

indicators in performance evaluation
indicators in project and plan evaluation
indicators and alternative approaches in monitoring
indicators and alternative approaches in informing decision making
evaluation and criteria to test indicators

APPENDIX C

Documents reviewed to inform resource pressure scenarios

Curtis Coast Regional Coastal Management Plan
2003/2004 Government, Industry, Tourism and Regional Development, Community Services and Education, Conservation and NRM, and Indigenous FGDs (Port Curtis)
State Coastal Management Plan – Queensland's Coastal Policy (Curtis and Capricorn Coast Regions)
Calliope River Information Report
Historical Coastlines
CRC Central Queensland Information Paper, Volume 6: Fitzroy Catchment
2003/2004 Government, Industry, Tourism and Regional Development, Community Services and Education, and Conservation and NRM FGDs (Fitzroy)
2004 Fitzroy NRM Region FGD
Central Queensland Strategy for Sustainability 2 (Draft)
CQ A New Millennium – Central Queensland Regional Growth Management Framework