



Australian Government

**Great Barrier Reef
Marine Park Authority**



Research Needs for Protection and Management of The Great Barrier Reef Marine Park 2005

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Research Needs for Protection and Management of the
Great Barrier Reef Marine Park
2005

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This document summarises the research needs for protection and management of the Great Barrier Reef Marine Park, current to July 2005. It is intended only as a summary; more complete information and search capabilities, will be available online at:

***[www.gbrmpa.gov.au/corp_site/info_services/science/
research_priorities/index.html](http://www.gbrmpa.gov.au/corp_site/info_services/science/research_priorities/index.html)***

The online version will be revised and updated, and should be referred to for the most current information.

Executive Summary

The research information needed to support management of the Great Barrier Reef has been summarised in the form of 274 Research Questions, organised into 22 Research Themes. Both Themes and Questions are listed in this document. Research Questions have been rated for 'Importance' and 'Urgency' of the information need, and cross-referenced with the National Research Priorities, the GBRMPA's Key Performance Indicators, and key legislative or policy requirements. The process by which these information needs were derived and prioritised is summarised in Attachment A.

The research needs identified here will form the basis of a web-accessible Research Management System, which will integrate the research needs outlined here with existing and planned research activity (including costs and funding sources), the National Research Priorities, researchers, research locations, etc. (Attachment B). This will provide a basis for gap analyses, investment summaries, and other internal and external planning and research management requirements.

Of the 274 Research Questions, 21 are considered critical in importance; of these, most were assessed as relatively urgent, with information, or at least baseline information, needed within one to three years. The critical research questions are:

Effects of Zoning

- *What are the effects of the new Zoning Plan (2003): how effective has it been in protecting coral reefs and inter-reefal habitats and species, especially fish; and what effect has it had on marine park users and regional, state and national communities?*

Water Quality and Pollution

- *How effective is the Reef Water Quality Protection Plan in halting and reversing declining water quality?*
- *What are the relationships between catchment processes, pollutant loads delivered to the marine park, and the impacts on the near-shore marine environment?*
- *What are the critical levels of major water pollutants (nutrients, sediments, agricultural and other chemicals) on marine park ecosystems (coral reefs, seagrass beds, mangroves and pelagic/water column ecosystems): i.e. pollutant load-impact relationships?*

Protection of Threatened Species

- *What are the status and trends in distribution and abundance of dugongs?*
- *What are the direct, indirect and potential impacts of incidental catch in fisheries on dugongs, and methods (e.g. 'pingers') to mitigate those effects?*
- *What are the direct, indirect and potential impacts of Indigenous hunting on dugongs and what level of hunting is sustainable?*
- *What is the status and trends in distribution and abundance of marine turtles?*
- *What are the causes of the rising water table on Raine Island¹, and what are the impacts on breeding turtles and seabirds?*

(¹Raine Island is the world's largest nesting site for green turtles, and the only known nesting site of the endangered Herald Petrel).

Ecologically Sustainable Fisheries

- *What is the risk to elasmobranch (sharks and rays) populations taken in commercial mesh net, line and recreational fisheries (including species and quantities taken)?*
- *How effective are current and planned fisheries management strategies in achieving ecological sustainability?*

Impacts and Mitigation of Climate Change

- *What are the current and predicted impacts of climate change, in combination with other pressures, on marine park species, habitats, and marine park users and regional communities, and how can these be mitigated?*

Managing Diseases and Introduced Pests

- *What are the potential ecosystem impacts and implications of diseases and introductions of marine pest species, and which habitat types and regions are most susceptible?*

Protecting Ecosystem Resilience

- *What management strategies can be used to support or improve ecosystem resilience?*

Understanding and Responding to Community in a Multiple-Use Environment

- *What are community attitudes, perceptions, concerns and needs with respect to the use and management of the GBR?*
- *What are the trends in population growth for Queensland Great Barrier Reef communities and what impact will population growth and associated urban and rural development have on the direct and indirect human demands and pressures on the GBR, community partnerships and community awareness of marine management issues?*
- *What is the annual economic contribution of Great Barrier Reef based and supporting industries to regional, state and national economies?*
- *What are the social, cultural, economic and natural resource management issues relating to Indigenous hunting and fishing in the GBR?*
- *What are the most appropriate ways to enhance fishing, tourism and recreational opportunities whilst minimising impacts on the cultural, ecological and world heritage values of the Marine Park?*

Understanding Biodiversity

- *What are the spatial patterns of biodiversity of major organism groups and habitats in the GBRMP, including inter-reefal and shoal areas?*

Monitoring the Health of Major Habitat Types

- *What are the trends in the condition of major habitat types in the GBRMP and what human and natural factors influence those trends?*

Abbreviations and Definitions

GBR: Great Barrier Reef

GBRMP: Great Barrier Reef Marine Park

GBRWHA: Great Barrier Reef World Heritage Area

GBRMPA: Great Barrier Reef Marine Park Authority

Anthropogenic: caused by humans; relating to or resulting from the influence humans have on the natural world

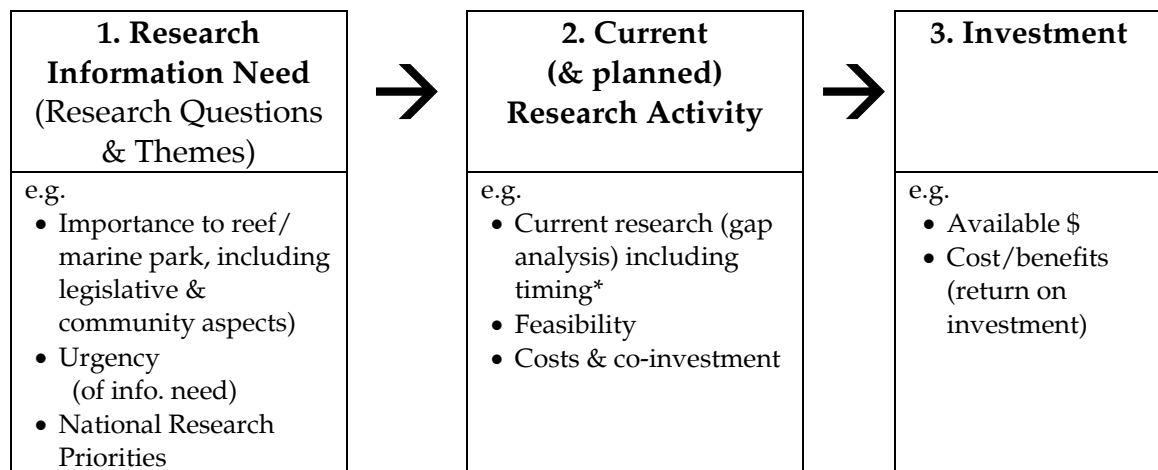
Research for Management

The Great Barrier Reef Marine Park Authority (GBRMPA) is committed to ensuring that the management of the Great Barrier Reef Marine Park (GBRMP) and World Heritage Area (GBRWHA) are based on the best available scientific and other information. This commitment has two main applications. Firstly, the development of management strategies and policies should be informed by good scientific research, where available and relevant. Secondly, where feasible, the best available scientific methods should be used to monitor and assess the effectiveness of management strategies, to fulfil responsibilities for accountability, and to allow ongoing improvement or adaptive management.

The GBRMPA is primarily interested in research on which to base management plans and strategies, and with which to monitor the effects of those management decisions, with a view to:

- Maintaining the conservation, biodiversity and World Heritage values of the Marine Park;
- Ensuring that industries are ecologically sustainable (particularly fishing and tourism);
- Reducing land based impacts on water quality; and
- As far as possible, mitigating the impacts of climate change.

It is important to emphasise that prioritisation of research investment requires consideration of not only the information need, but also existing and planned research activities, feasibility, gap analyses, etc., and resources available for investment:



(*e.g. in 5 yr cycle of dugong survey; was the last survey last year or 4 years ago?).

The purpose of this document is to identify and prioritise information needs only; it does not aim to address other aspects of investment prioritisation. These will be addressed much more effectively by the above management system, which will provide for regular updating and dynamic, rather than static analyses.

The identification of these research needs was based on a detailed consultation with functional and Critical Issues Groups within the GBRMPA, to identify in detail, their research needs (Appendix A). This detailed listing involved updating a previous list, which in turn had been subject to consultation and review by the GBRMPA sections, and by external reviewers and research providers. In identifying the research information needs for the GBRMP, it is clear that there is a need to identify both detailed and specific research questions, and broader, emergent themes or research areas. On this basis, the GBRMPA's Research and Monitoring Coordination Unit collated and integrated the list of detailed 'Research Questions', and organised them into a series of 'Research Themes', which provide an overview. It should be emphasised that there is considerable overlap between themes: i.e. many Research Questions are listed under more than one Theme. For example, analyses of dugong mortality are relevant to protected species, fisheries (dugong may be killed by fishing nets), and water quality (dugong accumulate agricultural pesticides in their tissues).

Research needs were prioritised at the level of Research Questions, not Themes, as the Themes include Questions with a range of priorities. Questions were rated for 'Importance' and 'Urgency' of the information need, and cross-referenced with the National Research Priorities, the GBRMPA's Key Performance Indicators, and key legislative or policy requirements. Details of the prioritisation process are summarised in Attachment A, but it should be noted that 'Urgency' indicates the timeframe over which the information is needed (in some cases, information which is not urgently required does require urgent attention: e.g. to obtain baseline data to assess long-term trends or processes).

Although provided here as a series of structured lists, as an interim measure, this information will form the basis of a web-accessible, research management information system which integrates the research needs for the GBRMP with detailed information on existing and developing research work taking place on, or of relevance to, the Great Barrier Reef, and with other information, such as the National Research Priorities. Where possible, this information will include not only research topics, but also costs and funding sources, participating researchers, research locations, etc. (database design shown at Attachment B). This will provide a dynamic tool for gap analyses, investment summaries, and other internal and external planning and research management requirements. Thus, although the research questions will have associated indices of importance and urgency, information on existing effort (i.e. gap analyses), feasibility, costs and expenditure, expertise available, etc., will all also be important factors in prioritising research effort and investment for the protection of the reef. Those types of information will be included in the research management system being developed, but are not addressed in this document.

It is important to emphasise that research to address natural resource management must be a collaboration between researchers and managers. That is, to adequately address any particular aspect of these information requirements, researchers need not only to choose the topic or research question appropriately, but need to involve reef managers in the design, implementation, interpretation and reporting of the research. In the case of fisheries related research, the GBRMPA Fisheries Issues Group have prepared a detailed prioritisation of research topics for each fishery; that information is available from the Fisheries Issues Group.

Research Themes

The following list provides a broad overview of the information needs of the GBRMP, in the form of research themes and theme descriptions. The themes are the highest level of grouping of research needs and were distilled out of a detailed list of research questions. The themes are *not* listed in any order of priority but are loosely ordered as social and then natural science themes, and the natural science themes grouped as management, threats or issues, status, connectivity, and resilience.

The social science research questions and needs were derived by considering the social science research needs identified by each group, to:

- a) identify the information outcomes that each group is seeking to assist them in marine park planning and management;
- b) define the researchable questions to achieve these outcomes and also frame the social science needs of the Marine Park Authority (MPA) in the language of social science research;
- c) synthesise these outputs (outcomes and questions) into agency wide themes for research.

The process through which the research themes were generated does not lend itself well to ranking the resulting themes according to priority, or importance to management. This is because the themes are derived from grouping questions by content, without reference to priority. Under each theme, there are different numbers of questions with different priority ranking (see below) and different levels of focus.

The GBRMPA has a responsibility to report annually on identified Key Performance Indicators. The following list should be considered with reference to those Indicators, which are listed at the end of this section.

List of research themes

The following themes have been synthesised out of the research questions identified for the GBRMP (descriptions and explanations follow):

Social Science

- *People and Communities in the GBR and Engagement for Reef Management*
- *Impact of governance on resource use and management in the Marine Park*
- *The resilience of social and economic systems in the GBR in the context of uncertainty*
- *The effectiveness of Reef planning and management arrangements*
- *The effects of people and land use activity on marine park resources and the values of the Great Barrier Reef*

Natural Science

- *The effectiveness of marine park planning and management arrangements, including the overall health of the ecosystem, and the effectiveness of the new Zoning Plan (2003) and the Reef Water Quality Protection Plan*
- *Current and predicted impacts of climate change and interactions with other pressures*
- *Status and trends of water quality in the GBRMP and the factors that influence it*
- *Effects of coastal development and land use practices on GBRMP habitats*
- *Impacts of vessels and vessel-based pollution*
- *Threats of diseases, crown-of-thorns starfish outbreaks, invasive species and introduced pests and interactions with other pressures*
- *Status, management and impacts of fisheries*
- *Status, trends and management of protected and other species of conservation concern*
- *Status, trends and threats to biodiversity*
- *Status and management of coral reef eco-systems*
- *Status and management of inter-reefal habitats including soft seabed and shoal country*
- *Status and management of seagrass habitats*
- *Status and management of mangrove habitats*
- *Status and management of islands and cays*
- *The connectivity of ecosystems, habitats and processes in the GBRMP and implications for management*
- *The resilience of habitats and biota to disturbances, anthropogenic impacts and climatic pressures*
- *Research to support the Reef HQ aquaria: closed system studies*

Theme descriptions

Social Science

Research themes represent the strategic directions for social science research required by the GBRMPA to effectively manage the GBR World Heritage Area (WHA). These themes are highly interrelated and undoubtedly overlap with community and industry social research interests elsewhere in coastal Queensland. Where possible and feasible in these cases, the GBRMPA desires to build synergies, partnerships and collaborative arrangements with relevant researchers and institutions to gather information.

People and Communities in the GBR and Engagement for Reef Management

To improve agency engagement with the diverse communities along the GBR on resource use and management and conservation matters, the GBRMPA requires a better understanding of the people and social systems that make up the GBR. Research is required to identify communities of place and interest in the GBR, community relationships to the GBR, history of reef use and patterns of reef-use (including multiple-use). This requires research into the social, economic and cultural characteristics, community relationships and interconnections, capacity issues, knowledge, perceptions, values and attitudes towards sustainable use and management and conservation of resources. It also requires an understanding of institutional arrangements and social processes including the interactions of formal and informal rules on the behaviour and operation of communities and engagement in reef conservation/management issues.

Information to support GBR management would thus include (a) public attitudes towards agency programs, initiatives, and species conservation and management issues in the GBRMP, e.g. shark conservation/use, water quality (b) the social and cultural values of the GBR e.g., newly proclaimed island National Parks and other reef areas and community perceptions of acceptable change to resource condition in these areas and (c) community expectations with respect to the management of the GBRMP.

Impact of governance on resource use and management in the Marine Park

In order to improve the long term effectiveness of institutional arrangements for resource use and management in the Marine Park, there is a need to improve our understanding of the impact, and implications, of formal and informal arrangements in influencing individual and community organisation, behaviour and decision-making. This requires an understanding of the many ways stakeholders and institutions (public and private) manage resource use planning and natural resource management affairs that impact on the GBR. Governance arrangements include formal institutions and regulations at multiple jurisdictional scales, regimes

empowered to enforce compliance, as well as informal arrangements that people and institutions have agreed to be in their interest. They also consists of substantive arrangements (eg: strategic plans) and process arrangements (coordination and integration mechanisms) to accommodate diverse interests and to take cooperative action to govern resource use and management. Understanding the interaction between formal, and informal governance will provide important information on the factors affecting individual behaviour, attitudes, perspectives and values and hence the underlying social dimensions of NRM.

The resilience of social and economic systems in the GBR in the context of uncertainty

Climate change is an emerging issue of critical importance to the GBR. It will impact on social systems that rely on the GBR for income and for the achievement of important social and cultural aspirations. It will also affect the resource management practices of individuals and communities now and in the future.

To enhance long-term social and ecological sustainability, we require information on the social and ecological resilience, adaptability and transformability of communities, environments and institutional systems in the GBR. This calls for research on the social dimensions of resilience, and in particular it necessitates research on: (a) the interrelationships between the social and biophysical environments in reef systems, (b) the social, economic and institutional capacity and capability requirements for resilience, adaptability and transformability, and (c) pathways for change to enable social, economic and ecological resilience. The GBRMPA and associated communities require indicators or mechanisms for measuring social economic resilience over time. The Agency also requires partnerships with communities to identify the impact of possible future scenarios on social and economic systems and to identify strategies and arrangements that are appropriate (socially, culturally and politically) for natural resource management in the context of uncertainty.

The effectiveness of Reef planning and management arrangements in achieving outcomes

In order to enable the adaptive improvement of GBRMP planning and management arrangements, the agency requires information that evaluates the efficacy of current and alternative arrangements in maintaining sustainable reef use and the World Heritage values of the GBRMP. This includes understanding the impacts and effects of specific arrangements such as the Representative Areas Program (RAP), the Reef Water Quality Protection Plan (Reef Plan) and other management strategies. This research should consider the effectiveness of different management arrangements in regulating activity to achieve outcomes such as sustainable multiple-use and the conservation of species among other things.

Ideally this research should consider the impacts and effects of planning and management arrangements on communities and social systems, the efficacy of implementation measures and the potential impact alternative management arrangements. For example, research could assess the social and economic barriers and opportunities to implementing proposed management actions under the Reef Water Quality Protection Plan (RWQPP) and related GBRMPA initiatives. Research towards this theme could also consider how individual arrangements manage relationships between the GBRMPA and stakeholder groups, the effectiveness of arrangements in managing communication and coordination, and research could also consider factors such as the different perceptions stakeholders have of GBRMPA roles and responsibilities for management.

The effects of people and land use activity on marine park resources and the values of the Great Barrier Reef.

In order to define management priorities for the GBR, it is imperative that human effects on marine park resources are clearly understood. This requires an understanding of the impacts of current and future resource-use activities on the social, economic and cultural and ecological values in the GBRMP. Examples include the social, economic and cultural impacts of fishing, tourism, and land use intensification adjacent to the GBRMP.

Natural Science

The effectiveness of marine park planning and management arrangements, including the overall health of the ecosystem, and the effectiveness of the new Zoning Plan (2004) and the Reef Water Quality Protection Plan

There is a need to monitor the overall health of the ecosystems, and the effectiveness of specific management strategies, in order to assess their effectiveness and sufficiency, for accountability, and to allow for refinement and improvement: i.e. adaptive management. Recent management initiatives, such as the new Zoning Plan (2003) and the Reef Water Quality Protection Plan have implications for a broad range of stakeholder groups and habitats and require targeted monitoring programs to assess progress towards key objectives. These monitoring programs serve as a 'ground truthing' of the GBRMPA's performance as a management agency.

Current and predicted impacts of climate change and interactions with other pressures

Climate change is expected to have far reaching impacts on all ecosystems within the GBRMP and the industries that depend on them. In the short term, increases in temperature appear certain to result in an increase in the frequency and intensity of mass bleaching of corals and other ecosystem stress events. Recovery of habitats affected by other stresses may be impaired by these climatic changes, and vice versa. If the frequency of these

events increases in the long term, the ability of habitats to recover may be reduced to a point where a permanent shift in the species composition of habitats will occur, often resulting in serious degradation. Climate change may also have a direct effect on species, including iconic species such as turtles, by altering critical environmental parameters and physiological processes. Management strategies include reducing other stressors (such as improving water quality) so that the impacts of climate change are minimised, enhancing the resilience of the GBR system to adapt to changes in climate.

Status and trends of water quality in the GBRMP, and the factors that influence it

Water quality is fundamental to the health of the GBRMP. Declining water quality has diverse and far-reaching impacts on GBR habitats. Major chronic factors contributing to declining water quality include coastal development and runoff from poor land-use practices; potential acute contributors include spills from shipping incidents. Management strategies are directed towards addressing the causes of declining water quality, primarily through the Reef Water Quality Protection Plan. Major information needs include monitoring the effectiveness of the RWQPP, improved and more cost-effective monitoring methods, and more information on the impacts of declining water quality.

Effects of coastal development and land use practices on GBRMP habitats

There is an increasing trend towards urbanization and development of coastal areas in North Queensland. As the coast is developed, pressure on marine habitats increases, particularly habitats adjacent to the coast, through pollution and increased use of marine resources. Research is required on understanding the interactions between activities in the catchments and the marine environment, and ways to minimize impacts. This research must be integrated with relevant social research.

Impacts of vessels and vessel-based pollution

The waters of the GBRMP are heavily used by vessels of all sizes. Shipping traffic is increasing and a wide variety of cargoes are transported. The potential impacts of spillage of these cargoes are not well understood. There have been many ship groundings on coral reefs and the damage caused, though localised, may take decades to recover. Smaller vessels may affect the environment through physical impacts, noise and low level chronic pollution.

Threats of diseases, crown-of-thorns starfish outbreaks, invasive species and introduced pests and interactions with other pressures

Outbreaks of species such as the corallivorous crown-of-thorns starfish and *Drupella* snail can cause extensive damage to reef systems. The extent to which these outbreaks are natural, or result from human activity is not fully

known. Coral diseases have caused massive coral degradation in the Caribbean, and are being observed on the GBR with increasing frequency. The introduction of new marine pests and diseases is a constant threat due to the large volume of shipping that traverses the GBRMP. The status and impacts of pests and diseases that have already been introduced and the control of these pests are not well known.

Status, management and impacts of fisheries.

Fishing is the major extractive activity in the marine park. A wide variety of species are targeted using various methods by the commercial, charter and recreational sectors. Bycatch and direct physical damage may affect many species and habitats besides the target species. Management strategies, including Fisheries Management Plans, and the new Zoning Plan (2003) are aimed at ensuring sustainability of targeted stocks and at reducing effects on other species and habitats. To these ends, more information is needed on stock status and the extent and nature of bycatch and habitat damage caused by fishing gear.

Status, trends and management of protected and other species of conservation concern

Species of particular conservation concern, especially protected and iconic species such as dugongs, turtles and whales, are not only important in their own right, but often also serve as indicators of the health of the marine park. Management of species such as dugong and turtle is complicated as they are protected in most areas, but subject to (limited) hunting in some parts of the marine park. In addition to being affected by a broad range of anthropogenic and climatic stressors, many of them are particularly affected as bycatch of extractive activities. More information is required on the status of these species, their habitats and the factors affecting their conservation status.

Status, trends and threats to biodiversity

Protecting and conserving the extraordinary biodiversity in the marine park is a primary aim of management. Some habitats, such as coral reefs, have been extensively studied, but others are not well known, and we are still some distance from having a full appreciation of the diversity of life in the GBRMP. In order to manage and maintain this biodiversity, there is a need for much better baseline understanding of species and habitat diversity, including knowledge of breeding grounds and nursery habitats, and information on threatening activities and the effectiveness of management strategies.

Status and management of coral reef ecosystems

Coral reefs are the most iconic habitats in the GBRMP, as well as the most intensively studied, diverse and amongst the most sensitive habitats. The reefs of the GBR are of global significance, in terms of biodiversity, extent, and condition; reefs in many other parts of the world have been seriously

degraded by destructive fishing, overfishing, water pollution and mass bleaching. With impending climate change, mass bleaching and other disturbances will dramatically increase the pressure on coral reefs. Management strategies aim to reduce stressors, such as terrestrial runoff and to protect representative sections of coral reef habitats throughout the GBRMP, to improve resilience of the habitat as a whole.

Status and management of inter-reefal habitats including soft seabed and shoal country

Although inter-reefal habitats comprise a very large proportion of the marine park (coral reefs occupy only about 6%), they are much less well studied than better known habitats such as coral reefs. Very little is known about the diversity and abundance of organisms that inhabit these areas and even less about the impacts of human activities such as trawling or water pollution. These habitats are ecologically complex and play important roles in the function of the overall ecosystem, such as maintaining the connectivity between different coral reef habitats, and in various fisheries. To conserve and manage inter-reefal habitats, it is important to understand issues such as how extractive fishing methods may affect not only the biota, but may also modify the seafloor and benthic communities. As for coral reefs, management strategies aim to reduce stressors, such as terrestrial runoff and to protect representative sections of coral reef habitats throughout the GBRMP, to improve resilience of the habitat as a whole.

Status and management of seagrass habitats

Seagrass beds are very important habitats in the GBR, because they support a wide diversity of plants and animals, serve as fishery nurseries, are home and food source to iconic species such as the dugong, and because they play critical roles in sediment and nutrient cycles, often trapping sediment and nutrients. Extensive seagrass beds have only recently been discovered in deep water areas of the GBR lagoon. Seagrass cover and species composition, and the species that depend on them, vary both spatially and temporally, and are influenced by a broad range of natural and anthropogenic factors. Research needs include information on the distribution and dynamics of seagrasses and associated communities, and the effects of human activities on them.

Status and management of mangrove habitats

Mangrove habitats play important roles in the broader ecosystem, as habitats and nursery grounds for commercial and recreational fishery target species, and by trapping sediments, nutrients and pollutants from terrestrial runoff. Mangrove habitats are particularly vulnerable, due to their proximity to coastal developments and because they are directly exposed to both terrestrial and marine stressors. More information is required on the sensitivity of mangroves and the status of species that make up these habitats.

Status and management of islands and cays

GBR islands represent important pockets of isolated terrestrial flora and fauna, are often relatively vulnerable habitats, but sometimes protected from disturbances by their isolation. Islands and cays provide very important nesting sites for seabirds and turtles. More information is needed on the effects of human activities, particularly of tourism and introduced species, on these delicate habitats.

The connectivity of ecosystems, habitats and processes in the GBRMP and implications for management

The connectivity of ecosystems, habitats and processes is profoundly important to the life cycles of many marine organisms, and to the healthy function of many different habitats and the ecosystem as a whole. For example, the supply of coral larvae from other reefs is critical to the ability of coral reefs to recover from large-scale disturbances, such as mass bleaching, cyclone damage or crown-of-thorns starfish outbreaks. The life-cycle of many fishery target species takes them from coastal and estuarine habitats to offshore reefs, and back. In order to protect and maintain these species, habitats and functions, it is crucial to understand and protect their connectivity.

The resilience of habitats and biota to disturbances, human impacts and climatic pressures

The Great Barrier Reef is a complex and dynamic ecosystem, subject to frequent natural disturbances and to significant anthropogenic stresses. The ability of habitats and biota to recover from these stresses and disturbance events is vital to the continued health, function and sustainability of the GBR system. Under natural circumstances, this resilience is often impressive, but may be seriously hampered by ongoing and cumulative human pressures. Unfortunately, different human pressures, such as water quality and over-fishing or climate change, do not affect habitats independently, but often act synergistically, having a combined impact perhaps even greater than their individual impacts. Habitats and biota that are isolated, rare, or slow to recover are particularly susceptible to recurring acute stress events and/or the cumulative affects of multiple pressures. Mitigating these pressures in the Great Barrier Reef will reduce the overall pressure exerted on the system, and thereby improve capacity to resist damage and recover from disturbances, including global phenomena such as climate change. There is a major need to better understand the combined effects of different pressures, and the factors that confer habitat resilience in different circumstances.

Research to support the Reef HQ aquaria: closed system studies

The closed system aquaria of the 'Reef HQ' serve as one of the GBR's most important tools for community education, information and raising awareness. However, the difficulties inherent in maintaining corals and other species in closed systems generates significant challenges and mean there are very few living coral reef exhibits. Research is necessary to improve the capacity and cost-effectiveness of these displays, and may also provide clues to broader threats to the marine park.

GBRMPA Key Performance Indicators

- KPI 1:** The relative numbers of reefs that are 'healthy' compared to 'not healthy' as assessed by the AIMS Long-term Monitoring Program
- KPI 2:** Trends in Chlorophyll *a* concentration in the Great Barrier Reef lagoon.
- KPI 3:** The proportion of fisheries [total fisheries vs. well managed fisheries] with management plans and arrangements that comply with the Commonwealth's guidelines for ecologically sustainable fisheries
- KPI 4:** Trends in number of tourists to the Great Barrier Reef Marine Park and their satisfaction with their experience
- KPI 5:** The number of bioregions with adequate 'no take' zones
- KPI 6:** The number of technical and scientific publications published about the GBR by GBRMPA and the Reef CRC is static or increasing.
- KPI 7:** Public support for increased protection of the GBR

Critical Information Needs

The critical information needs for the GBRMP are represented by the 21 research questions that were ranked as 'critical' in 'Importance' (see Attachment A). These are listed below, along with their 'Urgency' (i.e. the timeframe over which the information is required). Note that in several cases, although a Question involves longer timeframes (e.g. long-term trends or processes), addressing that need will require urgent action to obtain baseline data (e.g. assessment of the new Zoning Plan or the Reef Water Quality Protection Plan). Thus, most of these critical questions are not only critical in importance, but also require urgent research attention.

	Urgency
<i>Effects of Zoning</i>	
<ul style="list-style-type: none"> • <i>What are the effects of the new Zoning Plan (2003): how effective has it been in protecting coral reefs and inter-reefal habitats and species, especially fish; and what effect has it had on marine park users and regional, state and national communities?</i> 	3-5
<i>Water Quality and Pollution</i>	
<ul style="list-style-type: none"> • <i>How effective is the Reef Water Quality Protection Plan in halting and reversing declining water quality?</i> 	3-5
<ul style="list-style-type: none"> • <i>What are the relationships between catchment processes, pollutant loads delivered to the marine park, and the impacts on the near-shore marine environment?</i> 	1-3
<ul style="list-style-type: none"> • <i>What are the critical levels of major water pollutants (nutrients, sediments, agricultural and other chemicals) on marine park ecosystems (coral reefs, seagrass beds, mangroves and pelagic/water column ecosystems): i.e. pollutant load-impact relationships?</i> 	1-3
<i>Protection of Threatened Species</i>	
<ul style="list-style-type: none"> • <i>What are the status and trends in distribution and abundance of dugongs?</i> 	1-3
<ul style="list-style-type: none"> • <i>What are the direct, indirect and potential impacts of incidental catch in fisheries on dugongs, and methods (e.g. 'pingers') to mitigate those effects?</i> 	1-3
<ul style="list-style-type: none"> • <i>What are the direct, indirect and potential impacts of Indigenous hunting on dugongs and what level of hunting is sustainable?</i> 	1-3
<ul style="list-style-type: none"> • <i>What is the status and trends in distribution and abundance of marine turtles?</i> 	1-3
<ul style="list-style-type: none"> • <i>What are the causes of the rising water table on Raine Island¹, and what are the impacts on breeding turtles and seabirds?</i> 	1-3
<p>(¹Raine Island is the world's largest nesting site for green turtles, and the only known nesting site of the endangered Herald Petrel).</p>	
<i>Ecologically Sustainable Fisheries</i>	
<ul style="list-style-type: none"> • <i>What is the risk to elasmobranch (sharks and rays) populations taken in commercial mesh net, line and recreational fisheries (including species and quantities taken)?</i> 	1-3

- *How effective are current and planned fisheries management strategies in achieving ecological sustainability?* 1-3
- Impacts and Mitigation of Climate Change**
- *What are the current and predicted impacts of climate change, in combination with other pressures, on marine park species, habitats, and marine park users and regional communities, and how can these be mitigated?* >5
- Managing Diseases and Introduced Pests**
- *What are the potential ecosystem impacts and implications of diseases and introductions of marine pest species, and which habitat types and regions are most susceptible?* 1-3
- Protecting Ecosystem Resilience**
- *What management strategies can be used to support or improve ecosystem resilience?* 3-5
- Understanding and Responding to Community in a Multiple-Use Environment**
- *What are community attitudes, perceptions, concerns and needs with respect to the use and management of the GBR?* 1-3
 - *What are the trends in population growth for Queensland Great Barrier Reef communities and what impact will population growth and associated urban and rural development have on the direct and indirect human demands and pressures on the GBR, community partnerships and community awareness of marine management issues?* 3-5
 - *What is the annual economic contribution of Great Barrier Reef based and supporting industries to regional, state and national economies?* 1-3
 - *What are the social, cultural, economic and natural resource management issues relating to Indigenous hunting and fishing in the GBR?* 1-3
 - *What are the most appropriate ways to enhance fishing, tourism and recreational opportunities whilst minimising impacts on the cultural, ecological and world heritage values of the Marine Park?* 1-3
- Understanding Biodiversity**
- *What are the spatial patterns of biodiversity of major organism groups and habitats in the GBRMP, including interreefal and shoal areas?* 1-3
- Monitoring the Health of Major Habitat Types**
- *What are the trends in the condition of major habitat types in the GBRMP and what human and natural factors influence those trends?* 1-3

Themes and Questions

The following list provides a detailed overview of the information needs for the protection and management of the GBRMP, in the form of research questions grouped into themes. The importance ranking for each question was assigned through the process outlined in Attachment A, urgency is also indicated for each question. The grouped questions are not listed in any order of priority and any one question may appear under more than one theme.

The research needs identified here will form the basis of a web-accessible Research Management System, which will integrate the research needs outlined here with existing and planned research activity (including costs and funding sources), the National Research Priorities, researchers, research locations, etc. (Attachment B). This will provide a basis for gap analyses, investment summaries, and other internal and external planning and research management requirements.

Social Science

People and Communities in the GBR and Engagement for Reef Management

Question	Importance	Urgency (years)
• What are the values, beliefs, perceptions and needs that lead people to place direct and/or indirect pressure on species of conservation interest?	H	1-3
• Who is using the GBRMP, where and how, and what impact does this have on key breeding sites for seabird nesting and roosting, high use sites, turtle and dugong and other threatened species?	H	1-3
• What are public attitudes and perceptions towards conservation issues and threats?	H	1-3
• What management and partnership approaches and communication materials (current or proposed) have a positive impact on attitudes and behaviour towards conservation and protection in the WHA?	H	1-3
• What are the social and cultural values of islands and protected species in the Marine Park? What pressures and threats (potential and real) impact on the social and cultural values of the Marine Park?	M	1-3
• What are community perceptions towards change in resource condition and what are socially acceptable limits to change?	H	1-3
• What are the attitudes, values and perspectives of fishers (commercial, recreational, and traditional) towards the GBRMP, resource conservation and use and ecologically sustainable management?	H	1-3
• What is the annual economic contribution of Great Barrier Reef based and supporting industries to regional, state and national economies?	CRITICAL	1-3
• Who is fishing in the marine park, where and how, and what impact does this have on regional fishery resources?	H	1-3
• Who are the stakeholders and communities relevant to the GBRMPA?	H	1-3
• What are community attitudes, perceptions, concerns, and needs with respect to the use and management of the GBR?	CRITICAL	1-3
• What are the geo-political boundaries and other socio-cultural capacity issues at regional and sub-regional scales that are relevant to reef management and GBRMPA-community communication processes?	H	1-3

• What social and economic, cultural and institutional issues within communities are relevant to reef protection, management and community partnerships over the short, medium, long term?	H	1-3
• Who are the people, communities, industries, and stakeholders (e.g. Indigenous, Local, State and International) of interest to water quality issues in the GBRMP?	H	1-3
• What are their attitudes, expectations, perspectives, values, and behaviour with respect to the GBR, reef conservation and water quality and associated resource management issues?	H	1-3
• Who are the stakeholders relevant to or interested in sharks and rays in the GBR (e.g. rec fishers, tourism, Indigenous, general public)?	L	3-5
• What are community attitudes, perceptions and values (e.g. social, economic, cultural) towards shark and rays, including their use and conservation in the GBR?	L	3-5
• What factors influence the development and implementation of interpretive programs and materials by different stakeholders within the GBR tourism industry? How can the GBRMPA work more closely with the GBR tourism industry to enhance their interpretive programs and materials with GBRMP values and GBRMPA messages?	H	1-3
• What research and management protocols are appropriate to support Indigenous engagement and partnerships on issues of Indigenous use of marine resources and cultural heritage, and use of information in management decisions?	H	1-3
• What are Indigenous perceptions, concerns and needs with respect to issues of Indigenous use of marine resources and cultural heritage?	H	1-3
• Who are the people, communities and industry groups using the GBR for tourism and recreational purposes? When, where, and how do people use the GBR for tourism and recreation? What expectations, perceptions etc. do people/communities/industries have regarding the GBR?	M	1-3
• What are stakeholder attitudes to, knowledge and perceptions of compliance and enforcement in the Marine Park?	M	1-3
• Where are sites of high social and cultural value located in the Marine Park? How do communities and social systems value them and what does this mean for incident management?	M	1-3

Impact of governance on resource use and management in the Marine Park

Question	Importance	Urgency (years)
• Who is fishing in the marine park, where and how, and what impact does this have on regional fishery resources?	H	1-3
• What social and economic, cultural and institutional issues within communities are relevant to reef protection, management and community partnerships over the short, medium, long term?	H	1-3
• What are the social, cultural, economic and natural resource management issues relating to Indigenous hunting and fishing in the GBR?	CRITICAL	1-3
• What alternative management strategies and arrangements (e.g. critical approach distances) are suitable for the enhanced protection of seabird nesting and roosting, high use sites, dugongs and turtles, and threatened species?	H	1-3
• How effective are current management arrangements and tools in regulating fisheries resource-use and achieving ecological sustainability of fisheries resources in the GBRMP?	M	1-3

• In the context of uncertainty and the precautionary principle, what alternative management arrangements are more suitable to achieve the ecologically sustainable use and management of fisheries resources in the GBRMP?	H	1-3
• What best management practices are socio-culturally and ecologically appropriate to minimise the impact of fishing?	M	1-3
• What are the institutional arrangements that structure interactions between the different users of the GBR and the resultant multiple-use issues and conflicts in the GBR (e.g. tourism, traditional use, conservation of WHA values)?	H	1-3
• What management arrangements and decision-making mechanisms are appropriate for the GBRMPA to allocate resource access and resource-use rights for tourism multiple-use in the GBRMPA?	M	3-5
• What factors within the tourism industry impact on the implementation of best management practices and other management arrangements within protected areas? What factors influence the dissemination, uptake and implementation of best practice behaviours within GBR recreational user groups and GBR coastal communities?	H	1-3
• What are the social, economic and institutional factors in communities that impact on their ability to implement change?	H	1-3
• What programs and mechanisms are socially and culturally appropriate to improve the delivery of environmental science and associated monitoring tools to the community?	M	3-5
• What formal and informal institutional arrangements (and management strategies) are suitable and necessary to manage resource use and deliver social economic and ecological systems that are resilient and robust over the long term?	H	3-5
• What management actions are required from the GBRMPA and stakeholder groups (e.g. Tourism) to implement change and deliver resilience, adaptability and transformability?	H	3-5
• What institutional arrangements (formal and informal) impact on governance in the tourism industry? What does this mean for industry engagement for reef management? What does this mean for tourism industry resilience?	H	3-5
• What experience in the use and management of common pool resources is relevant to compliance and management in the Marine Park? What alternative models exist and how effective are they in achieving compliance?	M	1-3

The resilience of social and economic systems in the GBR in the context of uncertainty

Question	Importance	Urgency (years)
• What are community perceptions towards change in resource condition and what are socially acceptable limits to change?	H	1-3
• In the context of uncertainty and the precautionary principle, what alternative management arrangements are more suitable to achieve the ecologically sustainable use and management of fisheries resources in the GBRMP?	H	1-3
• What impact do acute perturbations (e.g. cyclones, COTs, bleaching) have on social and economic systems and users?	H	1-3
• What impact do land use and institutional environments have on coral bleaching and ecological thresholds in the GBR? What potential social, economic and cultural impacts will coral bleaching have along the GBR?	M	3-5

- What are the possible future impacts of alternative land use and resource management systems on coral bleaching and ecological thresholds and social and economic systems in the GBR (e.g. Business as Usual, radical land use change, moderate resource use restrictions)? What impact will a changed climate have on land use and social systems in the GBRMP (and catchment areas)? H 3-5
- What practical measures can be used to define socio-economic resilience at a regional or community level in the GBR? H 1-3
- What formal and informal institutional arrangements (and management strategies) are suitable and necessary to manage resource use and deliver social economic and ecological systems that are resilient and robust over the long term? H 1-3
- What are the social, economic and ecological carrying capacities of the GBRMP to sustainably support multiple-use tourism and recreation while maintaining World Heritage Area values and upholding WHA responsibilities? H 1-3
- What are the current and predicted impacts of climate change, in combination with other pressures, on marine park species, habitats, and marine park users and regional communities, and how can these be mitigated? CRITICAL >5

The effectiveness of Reef planning and management arrangements

Question	Importance	Urgency (years)
• What management and partnership approaches and communication materials (current or proposed) have a positive impact on attitudes and behaviour towards conservation and protection in the WHA?	H	1-3
• What factors influence the development and implementation of interpretive programs and materials by different stakeholders within the GBR tourism industry? How can the GBRMPA work more closely with the GBR tourism industry to enhance their interpretive programs and materials with GBRMP values and GBRMPA messages?	H	1-3
• What research and management protocols are appropriate to support Indigenous engagement and partnerships on issues of Indigenous use of marine resources and cultural heritage, and use of information in management decisions?	H	1-3
• What management arrangements and decision-making mechanisms are appropriate for the GBRMPA to allocate resource access and resource-use rights for tourism multiple-use in the GBRMPA?	M	3-5
• What factors within the tourism industry impact on the implementation of best management practices and other management arrangements within protected areas? What factors influence the dissemination, uptake and implementation of best practice behaviours within GBR recreational user groups and GBR coastal communities?	H	1-3
• What programs and mechanisms are socially and culturally appropriate to improve the delivery of environmental science and associated monitoring tools to the community?	M	3-5
• What experience in the use and management of common pool resources is relevant to compliance and management in the Marine Park? What alternative models exist and how effective are they in achieving compliance?	M	1-3
• What are the social, economic and ecological carrying capacities of the GBRMP to sustainably support multiple-use tourism and recreation while maintaining World Heritage Area values and upholding WHA responsibilities?	H	1-3

• What performance indicators are suitable to assess the effectiveness of management actions for the conservation of species of conservation interest (e.g. dugong, turtle, humpback and Dwarf Minke Whales)? How can these performance indicators be implemented?	H	1-3
• What impact do conservation strategies and management arrangements such as RAP have on the social, economic and cultural systems and values of the WHA?	H	1-3
• How effective are conservation strategies and management arrangements (e.g. representative area network) in regulating human behaviour towards the conservation and protection of the ecological and cultural heritage of the GBR? Do they meet legislative requirements and public expectations for management?	H	1-3
• What social and economic performance indicators are suitable to assess the economic status of fisheries resources?	M	1-3
• What social and economic indicators are suitable to assess the performance of GBRMPA compliance and reef management arrangements (e.g. plans of management, reef-wide planning, permits, compliance and enforcement)? What are the capacities and capabilities required to implement them?	M	1-3
• What does the community, and K-12 students, think of and know about the GBRMP? What does this mean for Reef HQ programs?	L	1-3
• How can the efficacy of reef HQ programs and products be evaluated?	M	1-3
• How effective are social and economic management strategies and actions in removing impediments to change and enabling appropriate activities and practices identified in the RWQPP?	H	1-3
• What communication tools are suitable to raise awareness about climate change?	L	1-3
• What programs and processes might be suitable and appropriate for tourism operators to achieve and maintain best practice environmental management standards in the GBR? What benefits and issues are associated with these accreditation programs and process? What national and international experience is relevant?	H	1-3
• What are community and tourism industry perceptions of the efficacy of the GBRMPA resource use and management arrangements in maintaining the ecological and tourism/recreational values of the GBRMPA?	M	1-3
• What processes are appropriate for achieving co management with Indigenous stakeholders?	H	1-3

The effects of people and land use activity on marine park resources and the values of the Great Barrier Reef.

Question	Importance	Urgency (years)
• What are the values, beliefs, perceptions and needs that lead people to place direct and/or indirect pressure on species of conservation interest?	H	1-3
• Who is using the GBRMP, where and how, and what impact does this have on key breeding sites for seabird nesting and roosting, high use sites, turtle and dugong and other threatened species?	H	1-3
• What are the social, cultural, economic and natural resource management issues relating to Indigenous hunting and fishing in the GBR?	CRITICAL	1-3
• What impact do land use and institutional environments have on coral bleaching and ecological thresholds in the GBR? What potential social, economic and cultural impacts will coral bleaching have along the GBR?	M	3-5

• What are the trends in population growth for Queensland Great Barrier Reef communities and what impact will population growth and associated urban and rural development have on the direct and indirect human demands and pressures on the GBR, community partnerships and community awareness of marine management issues?	CRITICAL	3-5
• What are the possible future impacts of alternative land use and resource management systems on coral bleaching and ecological thresholds and social and economic systems in the GBR (e.g. Business as Usual, radical land use change, moderate resource use restrictions)? What impact will a changed climate have on land use and social systems in the GBRMP (and catchment areas)?	H	3-5
• What impact will the projected population of the GBR catchment, and associated land use trends, have on water quality? What impact will population growth have on human demands on the reef, community partnerships and community awareness of marine management issues?	H	1-3
• What is the annual economic contribution of Great Barrier Reef based and supporting industries to regional, state and national economies?	CRITICAL	1-3
• What impact do human activities (e.g. fishing, tourism) have on sharks and rays in the GBR?	M	3-5
• What are the social, economic, cultural and ecological benefits and impacts of tourism and recreation in the GBRMP? What are the benefits and impacts of tourism and recreation in protected areas?	H	1-3
• What are the future trends and drivers impacting on tourism and recreational use of the GBRMP? What are future possible implications for the ecological and cultural values of the GBRMP? What does this mean for future access and use of the GBR for tourism and recreation, and for institutional arrangements for resource-use and management from State and Federal Government perspectives?	H	1-3
• What are the trends in the condition of major habitat types in the GBRMP and what human and natural factors influence those trends?	CRITICAL	1-3

Natural Science

The effectiveness of marine park planning and management arrangements, including the overall health of the eco-system and the effectiveness of the new Zoning Plan (2003) and the Reef Water Quality Protection Plan.

Question	Importance	Urgency (years)
• What are the direct, indirect and potential impacts of tourism and recreational activities on dugongs?	L	3-5
• What are the best locations for transit lanes to protect key habitat areas (e.g. Dugong Protection Areas) of dugongs?	L	3-5
• What are appropriate performance indicators for assessing the effectiveness of management actions for the conservation of dugongs?	H	1-3
• What are appropriate performance indicators for assessing the effectiveness of management actions for conservation of Australian Snubfin and Indo-Pacific Humpback dolphins?	M	1-3
• What are appropriate performance indicators for assessing the effectiveness of management actions for the conservation of Humpback and Dwarf Minke whales?	H	1-3
• What are appropriate performance indicators for assessing the effectiveness of management actions for the conservation of turtles?	H	1-3

• How effective are existing management actions aimed at improving turtle breeding, including vegetation restoration, fencing, exclusion and invasive species control?	M	1-3
• How effective are existing management actions aimed at improving seabird breeding, including vegetation restoration, fencing, exclusion and invasive species control?	M	1-3
• What are the effects of marine park zoning on fish populations and fisheries (e.g. target species, prey species and indicator species)?	H	1
• What are the effects of marine park zoning on dispersal and supply of larval fish and benthic organisms (including corals)?	H	1
• What are the short and long-term impacts of shifts in the spatial and temporal distribution of fishing pressure resulting from management strategies ?	H	3-5
• How effective are the temporal and spatial closures to fishing within the GBR Marine Park in achieving ecological sustainability?	H	3-5
• How effective are specific management options for fishing (such as quota systems, gear and vessel restrictions, size limits, trip limits and sex restrictions) in achieving ecological sustainability?	H	3-5
• What are alternative, low risk management options for fisheries resources in the GBR Marine Park?	H	3-5
• What are the threats and risks to soft seabed communities?	H	3-5
• What changes are occurring in island vegetation and how effective are island fire management strategies?	M	3-5
• How effective is the management of high use sites (e.g. camp sites), especially for conserving soils and vegetation?	L	3-5
• What are the risks associated with weeds, feral animals and problem native animals on islands, including consequences of lack of action and priorities for control work?	H	3-5
• What are the most effective techniques to control weed and feral animals in island settings?	H	3-5
• How can natural and human influences on island ecology be best monitored to a) capture causes of change over time, and b) refine management strategies?	M	3-5
• What management strategies can be used to support or improve ecosystem resilience?	CRITICAL	3-5
• What are the cumulative impacts on the environment and stakeholder groups of existing developments (to facilitate more informed decision-making regarding new developments; e.g. aquaculture, marinas, research stations/activities, volume of boats, Indigenous hunting, whale watching)?	H	3-5
• What are the effects of marine park zoning on biodiversity at various spatial and temporal scales?	H	3-5
• What, if any, are the secondary ecological effects of management decisions (e.g. displacement of species, displacement of human use)?	H	3-5
• What are the effects of marine park zoning on inshore and offshore reefal habitats?	H	3-5
• What are the effects of marine park zoning on inter-reefal, soft seabed, and shoal areas?	H	3-5
• How effective is the representative area program and subsequent marine park zoning (against principles of comprehensiveness, adequacy and representativeness)?	H	3-5
• What are the consequences of large-scale processes (e.g. hydrodynamics and reef connectivity) for management strategies (e.g. application of patterns of reef connectivity to the design of marine protected areas), and what are the key knowledge gaps in large-scale processes?	H	3-5

• What new techniques and technologies can be used for management (e.g. test for stress in species, community or ecosystem using photosynthetic efficiency, remote sensing, early warning systems) to reduce impacts from current activities?	L	3-5
• What is the current, overall state of knowledge on the effectiveness of marine park planning and management arrangements including the New Zoning Plan (2003) and the Reef Water Quality Protection Plan (i.e. synthesis and integration of existing data and information)?	H	1-3
• What are the effects of the new Zoning Plan (2003): how effective has it been in protecting coral reefs and inter-reefal habitats and species, especially fish; and what effect has it had on marine park users and regional, state and national communities?	CRITICAL	3-5
• How effective is the Reef Water Quality Protection Plan in halting and reversing declining water quality?	CRITICAL	3-5

Current and predicted impacts of climate change and interactions with other pressures

Question	Importance	Urgency (years)
• What impact is climate change having on marine mammals?	M	3-5
• What impact is climate change having on marine reptiles, especially turtles?	H	3-5
• What effects will climate change have on non-targeted fish species?	M	3-5
• To what extent do climatic events (such as rainfall and global warming) impact on fisheries within the GBR Marine Park?	M	3-5
• What, if any, are the synergistic impacts of temperature and elevated toxicant concentrations to nearshore coral reef species?	M	1-3
• What long-term changes are likely to occur in seagrass habitats as a result of climate change?	H	3-5
• What long-term changes are likely to occur in island systems as a result of climate change?	H	3-5
• What are the implications of interactions, and any synergies, between declining water quality and other broad-scale disturbances (e.g. crown-of-thorns starfish outbreaks, storms, mass bleaching of corals)?	H	1-3
• What are the mechanisms behind bleaching resistance and resilience?	H	1-3
• What long-term changes are likely to occur in coral reef systems as a result of climate change?	H	3-5
• What are the key factors that lead to bleaching and how can these be predicted?	H	1-3
• What are the likely impacts of climate change on local and regional hydrodynamics?	M	3-5
• What data gathering and analysis techniques are most appropriate to assess the impacts of bleaching events and unpredictable disturbances at a range of spatial scales?	M	1-3
• What management strategies can be used to support or improve ecosystem resilience?	CRITICAL	3-5
• What impact is sea level rise likely to have on GBRMP habitats?	M	>5
• To what extent do interactions, and any synergies, between local, regional, and global stressors influence coral bleaching response patterns, associated coral mortality, and the extent and rate of recovery?	H	1-3
• What are the current and predicted impacts of climate change, in combination with other pressures, on marine park species, habitats, and marine park users and regional communities, and how can these be mitigated?	CRITICAL	>5

Status and trends of water quality in the GBRMP and the factors that influence it.

Question	Importance	Urgency (years)
• What are the direct, indirect and potential impacts of pollutants, including bioaccumulation of pollutants, on dugongs?	M	3-5
• What are the direct, indirect and potential impacts of pollutants and bioaccumulation of pollutants on seabirds?	L	3-5
• What are the direct, indirect and potential impacts of diseases on seabirds?	L	>5
• To what extent do anthropogenic changes (such as water quality, wetland destruction and degradation) impact on fisheries within the GBR Marine Park?	H	3-5
• What are the impacts of pesticide toxicity on nearshore coral reef species and their effect on reproduction and recruitment?	H	1-3
• What are ecosystem pollutant tolerances for coral reef ecosystems, for temperature, salinity, nutrients (NO _x), suspended solids, antifoulants, dispersants and pesticides/herbicides?	H	1-3
• What, if any, are the synergistic impacts of temperature and elevated toxicant concentrations to nearshore coral reef species?	M	1-3
• What are ecosystem pollutant tolerances for seagrass ecosystems, for temperature, salinity, nutrients (NO _x), suspended solids, antifoulants, dispersants and pesticides/herbicides?	H	1-3
• How feasible are micro-arrays for detecting chronic pollutant impacts in common GBR coral and seagrass species?	M	1-3
• What is the utility of remote sensing technologies for surveying seagrass meadows, including intertidal, low density meadows, and subtidal meadows in differing water qualities, and including the ability to detect changes at small spatial scales (50x50 m quadrat)?	M	1-3
• What natural and human influences affect the distribution and abundance of mangroves and wetlands?	H	1-3
• What are appropriate risk assessment protocols (dose response relationships) for mangroves for catchment toxicants to develop thresholds for exposure in coastal and estuarine waters and sediments?	H	1-3
• What GBRMP areas have high environmental value and are subject to pollutant inputs (i.e. hydrodynamic modelling, risk assessment/decision support systems)?	H	1-3
• What are the relationships between bioaccumulated compounds and contaminant effects on crabs (including development of suitable biomarkers in mudcrabs e.g. <i>Scylla serrata</i>)?	H	1-3
• What are the relationships between catchment processes, pollutant loads delivered to the marine park, and the impacts on the nearshore marine environment?	CRITICAL	1-3
• What are the implications of interactions, and any synergies, between declining water quality and other broad-scale disturbances (e.g. crown-of-thorns starfish outbreaks, storms, mass bleaching of corals)?	H	1-3
• What water quality risks are associated with the intensification of land uses adjacent to the GBRMP (specifically agricultural, pastoral and urban development)?	H	1-3
• What contribution do urban environments make to the input of pollutants to the GBRMP, including stormwater?	H	1-3
• Model development and validation of nutrient mass balances for the GBRMP (specifically nitrates).	M	1-3
• How effective are sediment biogeochemical indicators, collected at river mouths, for assessing land use change?	H	1-3

• What improvements can be made to make river discharge assessments more reliable under high flow events?	M	1-3
• What passive sampling techniques can be developed for monitoring of target chemicals (including nutrients and pesticides)?	H	1-3
• How can hydrodynamic models of GBR water circulation be used to ensure optimal location of water sampling?	M	1-3
• How can monitoring of water quality characteristics (including sediments and nutrients) be automated (eg. development of robust data loggers) for use in RWQPP Marine Monitoring program?	M	1-3
• What are appropriate biomarkers for detection of anthropogenic pollutants in Barramundi collected from the northern Queensland coast (Torres Strait to Gladstone) and how are they best used?	M	1-3
• What are appropriate risk assessment protocols (dose response relationships for catchment toxicants) for developing thresholds for exposure in coastal and estuarine waters and sediments?	H	1-3
• How do catchment toxicants relate to the distribution and co-occurrence of mangrove dieback in intertidal mudflats along Queensland coast?	H	1-3
• What are pollutant tolerances for inter-reefal ecosystems, for temperature, salinity, nutrients (NO _x), suspended solids, antifoulants, dispersants and pesticides/herbicides?	H	1-3
• What management strategies can be used to support or improve ecosystem resilience?	CRITICAL	3-5
• To what extent do interactions, and any synergies, between local, regional, and global stressors influence coral bleaching response patterns, associated coral mortality, and the extent and rate of recovery?	H	1-3
• What is the current, overall state of knowledge on status and trends of water quality in the GBRMP and the factors that influence it (i.e. synthesis and integration of existing data and information)?	H	1-3
• How effective is the Reef Water Quality Protection Plan in halting and reversing declining water quality?	CRITICAL	3-5
• What are the critical levels of major water pollutants (nutrients, sediments, agricultural and other chemicals) on marine park ecosystems (coral reefs, seagrass beds, mangroves and pelagic/water column ecosystems): i.e. pollutant load-impact relationships?	CRITICAL	1-3

Effects of coastal development and land use practices on GBRMP habitats

Question	Importance	Urgency (years)
• What are the direct, indirect and potential impacts of noise on dugongs?	M	3-5
• What are the direct, indirect and potential impacts of coastal development on dugongs?	M	3-5
• What are the direct, indirect and potential impacts of tourism and recreational activities on dugongs?	L	3-5
• What are the direct, indirect and potential impacts of noise on Australian Snubfin and Indo-Pacific Humpback dolphins?	L	3-5
• What are the direct, indirect and potential impacts of coastal development on Australian Snubfin and Indo-Pacific Humpback dolphins?	M	3-5
• What are the direct, indirect and potential impacts of noise on Humpback and Dwarf Minke whales?	M	3-5
• What are the direct, indirect and potential impacts of coastal development on turtles?	M	3-5
• What are the direct, indirect and potential impacts of noise on seabirds?	L	3-5

• What are the direct, indirect and potential impacts of coastal development on seabirds?	M	3-5
• To what extent do anthropogenic changes (such as water quality, wetland destruction and degradation) impact on fisheries within the GBR Marine Park?	H	3-5
• What, if any, are the synergistic impacts of temperature and elevated toxicant concentrations to nearshore coral reef species?	M	1-3
• What is the utility of remote sensing technologies for surveying seagrass meadows, including intertidal, low density meadows, and subtidal meadows in differing water qualities, and including the ability to detect changes at small spatial scales (50x50 m quadrat)?	M	1-3
• What natural and anthropogenic influences impact the distribution and abundance of seagrass beds?	H	1-3
• What natural and human influences affect the distribution and abundance of mangroves and wetlands?	H	1-3
• What are appropriate risk assessment protocols (dose response relationships) for mangroves for catchment toxicants to develop thresholds for exposure in coastal and estuarine waters and sediments?	H	1-3
• What GBRMP areas have high environmental value and are subject to pollutant inputs (i.e. hydrodynamic modelling, risk assessment/decision support systems)?	H	1-3
• What are the relationships between catchment processes, pollutant loads delivered to the marine park, and the impacts on the nearshore marine environment?	CRITICAL	1-3
• What water quality risks are associated with the intensification of land uses adjacent to the GBRMP (specifically agricultural, pastoral and urban development)?	H	1-3
• What contribution do urban environments make to the input of pollutants to the GBRMP, including stormwater?	H	1-3
• How effective are sediment biogeochemical indicators, collected at river mouths, for assessing land use change?	H	1-3
• What improvements can be made to make river discharge assessments more reliable under high flow events?	M	1-3
• How do catchment toxicants relate to the distribution and co-incidence of mangrove dieback in intertidal mudflats along Queensland coast?	H	1-3
• What is the current, overall state of knowledge on the effects of coastal development and land use practices on GBRMP habitats (i.e. synthesis and integration of existing data and information)?	H	1-3

Impacts of vessels and vessel-based pollution

Question	Importance	Urgency (years)
• What are the direct, indirect and potential impacts of noise on dugongs?	M	3-5
• What are the direct, indirect and potential impacts of pollutants, including bioaccumulation of pollutants, on dugongs?	M	3-5
• What are the direct, indirect and potential impacts of vessel and aircraft traffic on dugongs?	M	3-5
• What are the direct, indirect and potential impacts of tourism and recreational activities on dugongs?	L	3-5
• What are the best locations for transit lanes to protect key habitat areas (e.g. Dugong Protection Areas) of dugongs?	L	3-5
• What is the status of dugongs: anatomy and physiology (e.g. physiological and auditory acuity in species adversely affected by vessels & the effectiveness of 'pingers')?	H	1-3

• What are the direct, indirect and potential impacts of noise on Australian Snubfin and Indo-Pacific Humpback dolphins?	L	3-5
• What are the direct, indirect and potential impacts on Australian Snubfin and Indo-Pacific Humpback Dolphins of vessel and aircraft traffic?	M	3-5
• What are the direct, indirect and potential impacts of noise on Humpback and Dwarf Minke whales?	M	3-5
• What are the direct, indirect and potential impacts of vessel and aircraft traffic on Humpback and Dwarf Minke whales?	M	1-3
• What are the direct, indirect and potential impacts of noise on turtles?	L	3-5
• What are the direct, indirect and potential impacts of vessel and aircraft traffic on turtles?	M	1-3
• What are the direct, indirect and potential impacts of noise on seabirds?	L	3-5
• What are the direct, indirect and potential impacts of pollutants and bioaccumulation of pollutants on seabirds?	L	3-5
• What are the direct, indirect and potential impacts of vessel and aircraft traffic on seabirds?	M	3-5
• What natural and human influences affect the distribution and abundance of mangroves and wetlands?	H	1-3
• What GBRMP areas have high environmental value and are subject to pollutant inputs (i.e. hydrodynamic modelling, risk assessment/decision support systems)?	H	1-3
• What are appropriate biomarkers for detection of anthropogenic pollutants in Barramundi collected from the northern Queensland coast (Torres Strait to Gladstone) and how are they best used?	M	1-3
• What remedial actions are most appropriate for mitigating the impacts of chronic and acute pollution events (e.g. oil spills)?	H	1-3
• What factors should be monitored to determine habitat equivalency and the effectiveness of remedial actions following chronic and acute pollution events?	M	1-3
• What are the most likely short and long-term impacts of local and regional oil and other chemical spills?	H	1-3
• What are the patterns and rates of recovery at sites subject to incidents such as oil spills, ship groundings, cyclones and coral bleaching?	M	1-3
• Which sites are of particular natural and cultural value for protection during acute incidents such as oil spills?	H	1
• What is the current, overall state of knowledge on the impacts of vessels and vessel-based pollution (i.e. synthesis and integration of existing data and information)?	H	1-3

Threats of diseases, crown-of-thorns starfish outbreaks, invasive species and introduced pests and interactions with other pressures

Question	Importance	Urgency (years)
• What are the direct, indirect and potential impacts of diseases on dugongs?	L	3-5
• What are the direct, indirect and potential impacts of disease on Australian Snubfin and Indo-Pacific Humpback dolphins?	M	3-5
• What are the direct, indirect and potential impacts of disease on Humpback and Dwarf Minke whales?	L	>5
• What are the direct, indirect and potential impacts of disease on turtles?	M	3-5
• What are the risks associated with weeds, feral animals and problem native animals on islands, including consequences of lack of action and priorities for control work?	H	3-5

• What are the most effective techniques to control weed and feral animals in island settings?	H	3-5
• What is the ecology of <i>Pisonia</i> forests of the Capricorn/Bunker Group, including their interactions with scale insects: what are the causes of <i>Pisonia</i> death (e.g. Tryon Island forest)?	H	1-3
• What are the mechanisms leading to crown-of-thorns starfish and <i>Drupella</i> outbreaks and their subsequent decline?	H	1-3
• How could any human contribution to crown-of-thorns starfish and <i>Drupella</i> outbreaks be predicted and/or controlled?	H	1-3
• What is the status of marine pest species currently established in the GBRMP?	H	1
• What are the potential ecosystem impacts and implications of diseases and introductions of marine pest species, and which habitat types and regions are most susceptible?	CRITICAL	1-3
• What vectors exist for marine pest introductions and how can the risk associated with each vector be best minimised?	H	1-3
• What is the epidemiology of diseases that infect corals on the GBR?	H	1-3
• What are the potential impacts and implications of coral transplantation?	M	1-3
• What is the current, overall state of knowledge on threats of diseases, crown-of-thorns starfish outbreaks, invasive species and introduced pests and interactions with other pressures (i.e. synthesis and integration of existing data and information)?	H	1-3
• What threatens populations of Proserpine rock wallaby especially impacts of ingesting weed species: risk assessment?	H	1-3

Status, management and impacts of fisheries.

Question	Importance	Urgency (years)
• What are the direct, indirect and potential impacts of incidental catch in fisheries on dugongs, and methods (e.g. 'pingers') to mitigate those effects?	CRITICAL	1-3
• What is the status of dugongs: anatomy and physiology (e.g. physiological and auditory acuity in species adversely affected by vessels & the effectiveness of 'pingers')?	H	1-3
• What are the direct, indirect and potential impacts of incidental catch in fisheries on Australian Snubfin and Indo-Pacific Humpback dolphins, and methods (e.g. 'pingers') to mitigate those effects?	H	1-3
• What are the direct, indirect and potential impacts of incidental catch in fisheries on Humpback and Dwarf Minke whales, and methods (e.g. 'pingers') to mitigate those effects?	M	3-5
• What are the direct, indirect and potential impacts of incidental catch in fisheries on turtles?	H	1-3
• What are the effects of marine park zoning on fish populations and fisheries (e.g. target species, prey species and indicator species)?	H	1
• What are the effects of marine park zoning on dispersal and supply of larval fish and benthic organisms (including corals)?	H	1
• What are the key biological parameters and life cycles of exploited fisheries resources in the GBR Marine Park: identification of critical sites (such as spawning sites) and critical times (such as spawning events)?	H	3-5
• What are the key biological parameters and life cycles of exploited fisheries resources in the GBR Marine Park: determination of age, growth characteristics, fecundity and frequency of spawning?	H	3-5

- What are the key biological parameters and life cycles of exploited fisheries resources in the GBR Marine Park: assessment of fishing mortality of exploited species, including the discard mortality of species caught but not retained? H 3-5
- What is the temporal and spatial distribution of fishing activities in the GBR Marine Park, with respect to: quantification of species taken by different fishing sectors? H 3-5
- What is the temporal and spatial distribution of fishing activities in the GBR Marine Park, with respect to the degree of regional depletion of fisheries resources? H 3-5
- What is the temporal and spatial distribution of fishing activities in the GBR Marine Park, with respect to the incidental take of non-target (i.e. by-product and bycatch) species in fisheries? H 3-5
- What are the short and long-term impacts of shifts in the spatial and temporal distribution of fishing pressure resulting from management strategies ? H 3-5
- How can the validity and accuracy of the information used for fishery assessment be verified through at-sea observer programs? H 3-5
- How can the validity and accuracy of the information used for fishery assessment be verified through fishery-independent surveys? H 3-5
- How accurate and valid are the assessments on the status of exploited fisheries resources in the GBR Marine Park? H 3-5
- What are appropriate performance measures which accurately assess the status of fisheries resources in the GBR Marine Park? H 3-5
- What are appropriate limit reference points for species, species assemblages and ecosystems, which indicate if the sustainability of fisheries in the GBR Marine Park is being exceeded? H 3-5
- How effective are the temporal and spatial closures to fishing within the GBR Marine Park in achieving ecological sustainability? H 3-5
- How effective are specific management options for fishing (such as quota systems, gear and vessel restrictions, size limits, trip limits and sex restrictions) in achieving ecological sustainability? H 3-5
- What are alternative, low risk management options for fisheries resources in the GBR Marine Park? H 3-5
- What species of conservation concern (i.e. dugong, turtles, dolphins, whales, sea snakes and syngnathids) are at risk from fishing activities in the GBR Marine Park, how great is that risk and what is the recovery from such impacts? H 3-5
- What highly vulnerable species are at risk from fishing activities in the GBR Marine Park, how great is that risk and what is the recovery from such impacts? H 3-5
- In assessing the environmental impacts of fishing and fisheries-related activities in the GBR Marine Park, what is the ecological role of species or species assemblages within the GBR ecosystem? H 3-5
- In assessing the environmental impacts of fishing and fisheries-related activities in the GBR Marine Park, what is the rate of recovery of species or species assemblages impacted within the GBR ecosystem? H 3-5
- How can bycatch mitigation devices (e.g. hoppers, BRDs, TEDs and 'pingers') be improved to reduce the bycatch of incidental species and the impact of fishing? H 3-5
- How can fishing methods and fishing practices be improved to minimise the environmental impact of fishing in the GBR Marine Park? H 3-5
- To what extent do climatic events (such as rainfall and global warming) impact on fisheries within the GBR Marine Park? M 3-5
- To what extent do anthropogenic changes (such as water quality, wetland destruction and degradation) impact on fisheries within the GBR Marine Park? H 3-5

• What are the relationships between bioaccumulated compounds and contaminant effects on crabs (including development of suitable biomarkers in mudcrabs e.g. <i>Scylla serrata</i>)?	H	1-3
• What are appropriate biomarkers for detection of anthropogenic pollutants in Barramundi collected from the northern Queensland coast (Torres Strait to Gladstone) and how are they best used?	M	1-3
• What management strategies can be used to support or improve ecosystem resilience?	CRITICAL	3-5
• What is the current, overall state of knowledge on the status, management and impacts of fisheries (i.e. synthesis and integration of existing data and information)?	H	1-3
• What are the most appropriate ways to enhance fishing, tourism & recreational opportunities whilst minimising impacts on the cultural, ecological and world heritage values of the Marine Park?	CRITICAL	1-3
• What are the effects of the new Zoning Plan (2003): how effective has it been in protecting coral reefs and inter-reefal habitats and species, especially fish; and what effect has it had on marine park users and regional, state and national communities?	CRITICAL	3-5
• How effective are current and planned fisheries management strategies in achieving ecological sustainability?	CRITICAL	1-3
• What is the risk to elasmobranch (sharks and rays) populations taken in commercial mesh net, line and recreational fisheries (including species and quantities taken)?	CRITICAL	1-3

Status, trends and management of protected and other species of conservation concern

Question	Importance	Urgency (years)
• What are the direct, indirect and potential impacts of incidental catch in fisheries on dugongs, and methods (e.g. 'pingers') to mitigate those effects?	CRITICAL	1-3
• What are the direct, indirect and potential impacts of noise on dugongs?	M	3-5
• What are the direct, indirect and potential impacts of pollutants, including bioaccumulation of pollutants, on dugongs?	M	3-5
• What are the direct, indirect and potential impacts of diseases on dugongs?	L	3-5
• What are the direct, indirect and potential impacts of coastal development on dugongs?	M	3-5
• What are the direct, indirect and potential impacts of Indigenous hunting on dugongs and what level of hunting is sustainable?	CRITICAL	1-3
• What are the direct, indirect and potential impacts of vessel and aircraft traffic on dugongs?	M	3-5
• What are the direct, indirect and potential impacts of tourism and recreational activities on dugongs?	L	3-5
• What are the best locations for transit lanes to protect key habitat areas (e.g. Dugong Protection Areas) of dugongs?	L	3-5
• What is the status of dugongs: anatomy and physiology (e.g. physiological and auditory acuity in species adversely affected by vessels & the effectiveness of 'pingers')?	H	1-3
• What are the status and trends in distribution and abundance of dugongs?	CRITICAL	1-3
• What is the status of dugongs: movements/behavioural patterns?	H	3-5
• What is the status of dugongs: life history parameters?	H	3-5

• What are appropriate performance indicators for assessing the effectiveness of management actions for the conservation of dugongs?	H	1-3
• What are the direct, indirect and potential impacts of incidental catch in fisheries on Australian Snubfin and Indo-Pacific Humpback dolphins, and methods (e.g. 'pingers') to mitigate those effects?	H	1-3
• What are the direct, indirect and potential impacts of noise on Australian Snubfin and Indo-Pacific Humpback dolphins?	L	3-5
• What are the direct, indirect and potential impacts of disease on Australian Snubfin and Indo-Pacific Humpback dolphins?	M	3-5
• What are the direct, indirect and potential impacts of coastal development on Australian Snubfin and Indo-Pacific Humpback dolphins?	M	3-5
• What are the direct, indirect and potential impacts on Australian Snubfin and Indo-Pacific Humpback Dolphins of vessel and aircraft traffic?	M	3-5
• What are the direct, indirect and potential impacts of tourism and recreational activities on Australian Snubfin and Indo-Pacific Humpback Dolphins?	L	3-5
• What is the status of Australian Snubfin and Indo-Pacific Humpback dolphins: especially genetic structure of populations?	M	3-5
• What is the status of Australian Snubfin and Indo-Pacific Humpback dolphins: migratory/behavioural patterns?	M	3-5
• What is the status of Australian Snubfin and Indo-Pacific Humpback dolphins: historic information on population fluctuations?	M	3-5
• What is the status of Australian Snubfin and Indo-Pacific Humpback dolphins: distribution and abundance (including long term trends and the identification of areas of higher population density)?	H	1-3
• What are appropriate performance indicators for assessing the effectiveness of management actions for conservation of Australian Snubfin and Indo-Pacific Humpback dolphins?	M	1-3
• What is the status of Humpback and Dwarf Minke whales: genetic structure of populations?	L	3-5
• What is the status of Humpback and Dwarf Minke whales: migratory/behavioural patterns?	M	3-5
• What is the status of Humpback and Dwarf Minke whales: historic information on population fluctuations?	L	3-5
• What is the status of Humpback and Dwarf Minke whales: distribution and abundance (including long term trends and the identification of areas of higher population density)?	H	1-3
• What are the direct, indirect and potential impacts of incidental catch in fisheries on Humpback and Dwarf Minke whales, and methods (e.g. 'pingers') to mitigate those effects?	M	3-5
• What are the direct, indirect and potential impacts of noise on Humpback and Dwarf Minke whales?	M	3-5
• What are the direct, indirect and potential impacts of disease on Humpback and Dwarf Minke whales?	L	>5
• What are the direct, indirect and potential impacts of vessel and aircraft traffic on Humpback and Dwarf Minke whales?	M	1-3
• What are the direct, indirect and potential impacts of Tourism and recreational activities on Humpback and Dwarf Minke whales?	H	3-5
• What are appropriate performance indicators for assessing the effectiveness of management actions for the conservation of Humpback and Dwarf Minke whales?	H	1-3
• What impact is climate change having on marine mammals?	M	3-5
• What are the direct, indirect and potential impacts of incidental catch in fisheries on turtles?	H	1-3
• What are the direct, indirect and potential impacts of noise on turtles?	L	3-5

• What are the direct, indirect and potential impacts of disease on turtles?	M	3-5
• What are the direct, indirect and potential impacts of coastal development on turtles?	M	3-5
• What are the direct, indirect and potential impacts of Indigenous hunting on turtles?	H	1-3
• What are the direct, indirect and potential impacts of vessel and aircraft traffic on turtles?	M	1-3
• What are the direct, indirect and potential impacts of tourism and recreational activities on turtles?	L	3-5
• What level of turtle hunting is sustainable?	H	1-3
• What impact is climate change having on marine reptiles, especially turtles?	H	3-5
• What is the status of turtles: anatomy and physiology, (e.g. physiological and auditory acuity in species adversely affected by vessels & 'pingers')?	M	1-3
• What is the status and trends in distribution and abundance of marine turtles?	CRITICAL	1-3
• What is the status of turtles: movements/behavioural patterns?	H	3-5
• What is the status of turtles: life history parameters?	H	3-5
• What are appropriate performance indicators for assessing the effectiveness of management actions for the conservation of turtles?	H	1-3
• How effective are existing management actions aimed at improving turtle breeding, including vegetation restoration, fencing, exclusion and invasive species control?	M	1-3
• What are the direct, indirect and potential impacts of noise on seabirds?	L	3-5
• What are the direct, indirect and potential impacts of pollutants and bioaccumulation of pollutants on seabirds?	L	3-5
• What are the direct, indirect and potential impacts of diseases on seabirds?	L	>5
• What are the direct, indirect and potential impacts of coastal development on seabirds?	M	3-5
• What are the direct, indirect and potential impacts of Indigenous hunting (incl. egg collecting) on seabirds?	L	3-5
• What are the direct, indirect and potential impacts of vessel and aircraft traffic on seabirds?	M	3-5
• What are the direct, indirect and potential impacts of tourism and recreational activities on seabirds, and what are critical approach distances from key breeding sites and high use sites?	M	1-3
• What level of seabird egg collecting is sustainable?	L	3-5
• What are the major threats (including climate change) to declining seabird populations in the far northern and southern GBRWHA?	H	1-3
• What impact is food availability having on seabird populations?	H	3-5
• How effective are existing management actions aimed at improving seabird breeding, including vegetation restoration, fencing, exclusion and invasive species control?	M	1-3
• What is the status and condition of protected and iconic fish populations?	H	1-3
• What is the status and condition of non-targeted fish populations?	M	3-5
• Does the condition of protected, iconic and non-targeted fish populations reflect changes in pressures and consequent shifts in GBR trophic webs?	H	1-3
• What are the key threatening processes, their impacts, and the critical issues for the conservation of threatened elasmobranch species (grey nurse shark, great white shark, whale shark, freshwater sawfish) in the GBRMP?	M	3-5
• What effects will climate change have on non-targeted fish species?	M	3-5
• What are the effects of marine park zoning on dispersal and supply of larval fish and benthic organisms (including corals)?	H	1

• What is the temporal and spatial distribution of fishing activities in the GBR Marine Park, with respect to the incidental take of non-target (i.e. by-product and bycatch) species in fisheries?	H	3-5
• What species of conservation concern (i.e. dugong, turtles, dolphins, whales, sea snakes and syngnathids) are at risk from fishing activities in the GBR Marine Park, how great is that risk and what is the recovery from such impacts?	H	3-5
• What highly vulnerable species are at risk from fishing activities in the GBR Marine Park, how great is that risk and what is the recovery from such impacts?	H	3-5
• How can bycatch mitigation devices (e.g. hoppers, BRDs, TEDs and 'pingers') be improved to reduce the bycatch of incidental species and the impact of fishing?	H	3-5
• How can fishing methods and fishing practices be improved to minimise the environmental impact of fishing in the GBR Marine Park?	H	3-5
• What is the condition of key inshore and island fringing reef benthic and fish communities?	H	3-5
• What are threshold levels of coral-algal-herbivore abundance that lead to stable phase-shifts?	H	3-5
• What controls herbivorous fish abundance on GBR reefs?	H	1-3
• How do populations and communities of non-reef organisms connect and what factors affect that connectivity at ecological and evolutionary levels?	M	3-5
• What is the current, overall state of knowledge on the status and management of non-targeted and protected species (i.e. synthesis and integration of existing data and information)?	H	1-3
• What are the effects of the new Zoning Plan (2003): how effective has it been in protecting coral reefs and inter-reefal habitats and species, especially fish; and what effect has it had on marine park users and regional, state and national communities?	CRITICAL	3-5
• What are the risks associated with visitor interactions with whales?	L	1-3
• What threatens crocodile populations and what threats do they pose for visitors: risk assessment?	L	1-3
• What is the status of pied imperial pigeon populations?	L	1-3
• What is the risk to elasmobranch (sharks and rays) populations taken in commercial mesh net, line and recreational fisheries (including species and quantities taken)?	CRITICAL	1-3
• What threatens populations of Proserpine rock wallaby especially impacts of ingesting weed species: risk assessment?	H	1-3
• What is the status and condition of pelagic communities in the GBR?	H	3-5

Status, trends and threats to biodiversity

Question	Importance	Urgency (years)
• What impact is climate change having on marine mammals?	M	3-5
• What is the status and condition of protected and iconic fish populations?	H	1-3
• What is the status and condition of non-targeted fish populations?	M	3-5
• Does the condition of protected, iconic and non-targeted fish populations reflect changes in pressures and consequent shifts in GBR trophic webs?	H	1-3
• What are the key threatening processes, their impacts, and the critical issues for the conservation of threatened elasmobranch species (grey nurse shark, great white shark, whale shark, freshwater sawfish) in the GBRMP?	M	3-5

• In assessing the environmental impacts of fishing and fisheries-related activities in the GBR Marine Park, what is the ecological role of species or species assemblages within the GBR ecosystem?	H	3-5
• In assessing the environmental impacts of fishing and fisheries-related activities in the GBR Marine Park, what is the rate of recovery of species or species assemblages impacted within the GBR ecosystem?	H	3-5
• What are ecosystem pollutant tolerances for seagrass ecosystems, for temperature, salinity, nutrients (NO _x), suspended solids, antifoulants, dispersants and pesticides/herbicides?	H	1-3
• How do populations and communities of non-reef organisms connect and what factors affect that connectivity at ecological and evolutionary levels?	M	3-5
• What factors can cause changes in local and regional connectivity and what are the implications of these, both for biodiversity, and GBR-dependent industries?	H	3-5
• What are the spatial patterns of biodiversity of major organism groups and habitats in the GBRMP, including inter-reefal and shoal areas?	CRITICAL	1-3
• What are the effects of marine park zoning on biodiversity at various spatial and temporal scales?	H	3-5
• What data are required to refine estimates of the sustainable tourism carrying capacity of both individual sites and major habitat types?	M	1-3
• What if any, species and/or populations are at risk but not currently recognised as such?	M	1-3
• What is the current, overall state of knowledge on the status, trends and threats to biodiversity (i.e. synthesis and integration of existing data and information)?	H	1-3

Status and management of coral reef eco-systems

Question	Importance	Urgency (years)
• In assessing the environmental impacts of fishing and fisheries-related activities in the GBR Marine Park, what is the ecological role of species or species assemblages within the GBR ecosystem?	H	3-5
• In assessing the environmental impacts of fishing and fisheries-related activities in the GBR Marine Park, what is the rate of recovery of species or species assemblages impacted within the GBR ecosystem?	H	3-5
• What is the condition of key inshore and island fringing reef benthic and fish communities?	H	3-5
• What are the dynamics of coral recovery/recruitment, algal assemblages and interactions on disturbed inshore reefs?	H	1-3
• What is the status and condition of GBR coral reefs and coral reef communities and how is it changing (trends)?	H	1-3
• What are threshold levels of coral-algal-herbivore abundance that lead to stable phase-shifts?	H	3-5
• What controls herbivorous fish abundance on GBR reefs?	H	1-3
• What are the impacts of pesticide toxicity on nearshore coral reef species and their effect on reproduction and recruitment?	H	1-3
• What are ecosystem pollutant tolerances for coral reef ecosystems, for temperature, salinity, nutrients (NO _x), suspended solids, antifoulants, dispersants and pesticides/herbicides?	H	1-3
• What, if any, are the synergistic impacts of temperature and elevated toxicant concentrations to nearshore coral reef species?	M	1-3
• How stable are coral reef communities and how do they recover after different disturbances?	H	1-3

• How feasible are micro-arrays for detecting chronic pollutant impacts in common GBR coral and seagrass species?	M	1-3
• What GBRMP areas have high environmental value and are subject to pollutant inputs (i.e. hydrodynamic modelling, risk assessment/decision support systems)?	H	1-3
• What are the mechanisms behind bleaching resistance and resilience?	H	1-3
• What long-term changes are likely to occur in coral reef systems as a result of climate change?	H	3-5
• What are the key factors that lead to bleaching and how can these be predicted?	H	1-3
• What impact is sea level rise likely to have on GBRMP habitats?	M	>5
• What are the patterns and rates of recovery at sites subject to incidents such as oil spills, ship groundings, cyclones and coral bleaching?	M	1-3
• What is the epidemiology of diseases that infect corals on the GBR?	H	1-3
• What are the potential impacts and implications of coral transplantation?	M	1-3
• What are the trends in condition of high use dive sites, and what are the impacts of human activity?	M	1-3
• What are the major effects of artificial reefs on surrounding benthic and pelagic ecosystems, including fish populations?	H	1-3
• What are the trends in the condition of major habitat types in the GBRMP and what human and natural factors influence those trends?	CRITICAL	1-3
• How do trends in the condition of major habitat types in the GBRMP compare to similar systems globally, and what factors could be influencing any differences?	M	1-3
• What major factors determine the condition of major habitat types in the GBRMP?	H	3-5
• What are the effects of marine park zoning on inshore and offshore reefal habitats?	H	3-5
• What are the environmental and social/cultural values of different sites, particularly inshore areas (e.g. fringing reefs, seagrass beds and mangroves), and what are the threats to those values?	L	3-5
• What data are required to refine estimates of the sustainable tourism carrying capacity of both individual sites and major habitat types?	M	1-3
• What is the current, overall state of knowledge on the status and management of coral reef eco-systems (i.e. synthesis and integration of existing data and information)?	H	1-3
• What are the most appropriate ways to enhance fishing, tourism & recreational opportunities whilst minimising impacts on the cultural, ecological and world heritage values of the Marine Park?	CRITICAL	1-3
• What are the effects of the new Zoning Plan (2003): how effective has it been in protecting coral reefs and inter-reefal habitats and species, especially fish; and what effect has it had on marine park users and regional, state and national communities?	CRITICAL	3-5
• What are the critical levels of major water pollutants (nutrients, sediments, agricultural and other chemicals) on marine park ecosystems (coral reefs, seagrass beds, mangroves and pelagic/water column ecosystems): i.e. pollutant load-impact relationships?	CRITICAL	1-3
• What is the status and condition of pelagic communities in the GBR?	H	3-5

Status and management of inter-reefal habitats including soft seabed and shoal country

Question	Importance	Urgency (years)
• In assessing the environmental impacts of fishing and fisheries-related activities in the GBR Marine Park, what is the ecological role of species or species assemblages within the GBR ecosystem?	H	3-5
• In assessing the environmental impacts of fishing and fisheries-related activities in the GBR Marine Park, what is the rate of recovery of species or species assemblages impacted within the GBR ecosystem?	H	3-5
• What are the threats and risks to soft seabed communities?	H	3-5
• What are pollutant tolerances for inter-reefal ecosystems, for temperature, salinity, nutrients (NOx), suspended solids, antifoulants, dispersants and pesticides/herbicides?	H	1-3
• What impact is sea level rise likely to have on GBRMP habitats?	M	>5
• What are the patterns and rates of recovery at sites subject to incidents such as oil spills, ship groundings, cyclones and coral bleaching?	M	1-3
• What are the major effects of artificial reefs on surrounding benthic and pelagic ecosystems, including fish populations?	H	1-3
• How do populations and communities of non-reef organisms connect and what factors affect that connectivity at ecological and evolutionary levels?	M	3-5
• How do populations connect and what factors affect that connectivity at ecological and evolutionary levels: benthic reef organisms?	H	3-5
• What is the status of and trends in inter-reefal habitats and pressures/issues/threats for inter-reefal soft seabed habitats?	H	1-3
• What are the trends in the condition of major habitat types in the GBRMP and what human and natural factors influence those trends?	CRITICAL	1-3
• How do trends in the condition of major habitat types in the GBRMP compare to similar systems globally, and what factors could be influencing any differences?	M	1-3
• What major factors determine the condition of major habitat types in the GBRMP?	H	3-5
• What are the effects of marine park zoning on inter-reefal, soft seabed, and shoal areas?	H	3-5
• What is the current, overall state of knowledge on the status and management of inter-reefal habitats including soft seabed and shoal country (i.e. synthesis and integration of existing data and information)?	H	1-3
• What are the most appropriate ways to enhance fishing, tourism & recreational opportunities whilst minimising impacts on the cultural, ecological and world heritage values of the Marine Park?	CRITICAL	1-3
• What are the effects of the new Zoning Plan (2003): how effective has it been in protecting coral reefs and inter-reefal habitats and species, especially fish; and what effect has it had on marine park users and regional, state and national communities?	CRITICAL	3-5
• What is the status and condition of pelagic communities in the GBR?	H	3-5

Status and management of seagrass habitats

Question	Importance	Urgency (years)
• What are the direct, indirect and potential impacts of pollutants, including bioaccumulation of pollutants, on dugongs?	M	3-5
• In assessing the environmental impacts of fishing and fisheries-related activities in the GBR Marine Park, what is the ecological role of species or species assemblages within the GBR ecosystem?	H	3-5
• In assessing the environmental impacts of fishing and fisheries-related activities in the GBR Marine Park, what is the rate of recovery of species or species assemblages impacted within the GBR ecosystem?	H	3-5
• What are ecosystem pollutant tolerances for seagrass ecosystems, for temperature, salinity, nutrients (NO _x), suspended solids, antifoulants, dispersants and pesticides/herbicides?	H	1-3
• How feasible are micro-arrays for detecting chronic pollutant impacts in common GBR coral and seagrass species?	M	1-3
• What long-term changes are likely to occur in seagrass habitats as a result of climate change?	H	3-5
• What is the utility of remote sensing technologies for surveying seagrass meadows, including intertidal, low density meadows, and subtidal meadows in differing water qualities, and including the ability to detect changes at small spatial scales (50x50 m quadrat)?	M	1-3
• What is the status and condition of GBR seagrass communities and how is it changing (trends)?	H	1-3
• What natural and anthropogenic influences impact the distribution and abundance of seagrass beds?	H	1-3
• What refinements to data gathering and analysis techniques could best improve monitoring and management of seagrass beds?	M	1-3
• What GBRMP areas have high environmental value and are subject to pollutant inputs (i.e. hydrodynamic modelling, risk assessment/decision support systems)?	H	1-3
• What impact is sea level rise likely to have on GBRMP habitats?	M	>5
• What are the patterns and rates of recovery at sites subject to incidents such as oil spills, ship groundings, cyclones and coral bleaching?	M	1-3
• How do populations and communities of non-reef organisms connect and what factors affect that connectivity at ecological and evolutionary levels?	M	3-5
• What are the trends in the condition of major habitat types in the GBRMP and what human and natural factors influence those trends?	CRITICAL	1-3
• How do trends in the condition of major habitat types in the GBRMP compare to similar systems globally, and what factors could be influencing any differences?	M	1-3
• What major factors determine the condition of major habitat types in the GBRMP?	H	3-5
• What are the environmental and social/cultural values of different sites, particularly inshore areas (e.g. fringing reefs, seagrass beds and mangroves), and what are the threats to those values?	L	3-5
• What is the current, overall state of knowledge on the status and management of seagrass habitats (i.e. synthesis and integration of existing data and information)?	H	1-3
• What are the critical levels of major water pollutants (nutrients, sediments, agricultural and other chemicals) on marine park ecosystems (coral reefs, seagrass beds, mangroves and pelagic/water column ecosystems): i.e. pollutant load-impact relationships?	CRITICAL	1-3
• What is the status and condition of pelagic communities in the GBR?	H	3-5

Status and management of mangrove habitats

Question	Importance	Urgency (years)
• To what extent do anthropogenic changes (such as water quality, wetland destruction and degradation) impact on fisheries within the GBR Marine Park?	H	3-5
• What controls herbivorous fish abundance on GBR reefs?	H	1-3
• What is the structure and condition of mangroves as indicated by airborne and satellite image data sets and how are these datasets best used for mapping and monitoring mangrove ecosystem health?	M	1-3
• What are the historical (1940-1990s, in decadal increments) distributions of <i>Avicennia</i> and other mangrove populations, based on wood growth rings, aerial photography and assessments of mangrove health (i.e. sub-lethal condition) using satellite imagery?	M	1-3
• What natural and human influences affect the distribution and abundance of mangroves and wetlands?	H	1-3
• What are appropriate risk assessment protocols (dose response relationships) for mangroves for catchment toxicants to develop thresholds for exposure in coastal and estuarine waters and sediments?	H	1-3
• What GBRMP areas have high environmental value and are subject to pollutant inputs (i.e. hydrodynamic modelling, risk assessment/decision support systems)?	H	1-3
• How do catchment toxicants relate to the distribution and co-occurrence of mangrove dieback in intertidal mudflats along Queensland coast?	H	1-3
• What impact is sea level rise likely to have on GBRMP habitats?	M	>5
• What are the patterns and rates of recovery at sites subject to incidents such as oil spills, ship groundings, cyclones and coral bleaching?	M	1-3
• How do populations and communities of non-reef organisms connect and what factors affect that connectivity at ecological and evolutionary levels?	M	3-5
• What are the trends in the condition of major habitat types in the GBRMP and what human and natural factors influence those trends?	CRITICAL	1-3
• How do trends in the condition of major habitat types in the GBRMP compare to similar systems globally, and what factors could be influencing any differences?	M	1-3
• What major factors determine the condition of major habitat types in the GBRMP?	H	3-5
• What are the environmental and social/cultural values of different sites, particularly inshore areas (e.g. fringing reefs, seagrass beds and mangroves), and what are the threats to those values?	L	3-5
• What is the current, overall state of knowledge on the status and management of mangrove habitats (i.e. synthesis and integration of existing data and information)?	H	1-3
• What are the critical levels of major water pollutants (nutrients, sediments, agricultural and other chemicals) on marine park ecosystems (coral reefs, seagrass beds, mangroves and pelagic/water column ecosystems): i.e. pollutant load-impact relationships?	CRITICAL	1-3

Status and management of islands and cays

Question	Importance	Urgency (years)
• What are the causes and impacts on breeding turtles and seabirds of the rising water table on Raine Island?	CRITICAL	1-3
• What changes are occurring in island vegetation and how effective are island fire management strategies?	M	3-5
• How effective is the management of high use sites (e.g. camp sites), especially for conserving soils and vegetation?	L	3-5
• What are the risks associated with weeds, feral animals and problem native animals on islands, including consequences of lack of action and priorities for control work?	H	3-5
• What are the most effective techniques to control weed and feral animals in island settings?	H	3-5
• What is the ecology of <i>Pisonia</i> forests of the Capricorn/Bunker Group, including their interactions with scale insects: what are the causes of <i>Pisonia</i> death (e.g. Tryon Island forest)?	H	1-3
• What long-term changes are likely to occur in island systems as a result of climate change?	H	3-5
• How can natural and human influences on island ecology be best monitored to a) capture causes of change over time, and b) refine management strategies?	M	3-5
• What impact is sea level rise likely to have on GBRMP habitats?	M	>5
• What are the patterns and rates of recovery at sites subject to incidents such as oil spills, ship groundings, cyclones and coral bleaching?	M	1-3
• How do populations and communities of non-reef organisms connect and what factors affect that connectivity at ecological and evolutionary levels?	M	3-5
• What are the natural and cultural values of islands particularly, island National Parks?	M	3-5
• What is the current, overall state of knowledge on the status and management of islands and cays (i.e. synthesis and integration of existing data and information)?	H	1-3
• What threatens populations of Proserpine rock wallaby especially impacts of ingesting weed species: risk assessment?	H	1-3
• What is the status of pied imperial pigeon populations?	L	1-3

The connectivity of ecosystems, habitats and processes in the GBRMP and implications for management

Question	Importance	Urgency (years)
• Does the condition of protected, iconic and non-targeted fish populations reflect changes in pressures and consequent shifts in GBR trophic webs?	H	1-3
• What are the effects of marine park zoning on dispersal and supply of larval fish and benthic organisms (including corals)?	H	1
• What are the dynamics of coral recovery/recruitment, algal assemblages and interactions on disturbed inshore reefs?	H	1-3
• What are the short and long-term impacts of broad-scale environmental disturbances, under different frequency scenarios (eg. cyclones, tsunamis, COTS outbreaks)?	M	1-3
• What are the potential impacts and implications of coral transplantation?	M	1-3

• What are the major effects of artificial reefs on surrounding benthic and pelagic ecosystems, including fish populations?	H	1-3
• How do populations and communities of non-reef organisms connect and what factors affect that connectivity at ecological and evolutionary levels?	M	3-5
• To what extent do interactions, and any synergies, between local, regional, and global stressors influence coral bleaching response patterns, associated coral mortality, and the extent and rate of recovery?	H	1-3
• How do populations connect and what factors affect that connectivity at ecological and evolutionary levels: benthic reef organisms?	H	3-5
• What can integration and further analysis of existing data sets tell us about ecological connectivity?	H	1-3
• What factors can cause changes in local and regional connectivity and what are the implications of these, both for biodiversity, and GBR-dependent industries?	H	3-5
• What are the effects of marine park zoning on biodiversity at various spatial and temporal scales?	H	3-5
• What are the consequences of large-scale processes (e.g. hydrodynamics and reef connectivity) for management strategies (e.g. application of patterns of reef connectivity to the design of marine protected areas), and what are the key knowledge gaps in large-scale processes?	H	3-5
• What is the current, overall state of knowledge on the connectivity of ecosystems, habitats and processes in the GBRMP and implications for management (i.e. synthesis and integration of existing data and information)?	H	1-3

The resilience of habitats and biota to disturbances, anthropogenic impacts and climatic pressures

Question	Importance	Urgency (years)
• What impact is climate change having on marine reptiles, especially turtles?	H	3-5
• Does the condition of protected, iconic and non-targeted fish populations reflect changes in pressures and consequent shifts in GBR trophic webs?	H	1-3
• What are threshold levels of coral-algal-herbivore abundance that lead to stable phase-shifts?	H	3-5
• How stable are coral reef communities and how do they recover after different disturbances?	H	1-3
• What long-term changes are likely to occur in seagrass habitats as a result of climate change?	H	3-5
• What are the implications of interactions, and any synergies, between declining water quality and other broad-scale disturbances (e.g. crown-of-thorns starfish outbreaks, storms, mass bleaching of corals)?	H	1-3
• What are the mechanisms behind bleaching resistance and resilience?	H	1-3
• What long-term changes are likely to occur in coral reef systems as a result of climate change?	H	3-5
• What are the key factors that lead to bleaching and how can these be predicted?	H	1-3
• What data gathering and analysis techniques are most appropriate to assess the impacts of bleaching events and unpredictable disturbances at a range of spatial scales?	M	1-3
• What are the key local and regional processes and factors that confer ecosystem resilience?	H	1-3

• What are the major threats to local and regional factors that influence the resistance and resilience of communities?	H	1-3
• What should form the major criteria when identifying resilient areas?	H	1-3
• What management strategies can be used to support or improve ecosystem resilience?	CRITICAL	3-5
• What are the patterns and rates of recovery at sites subject to incidents such as oil spills, ship groundings, cyclones and coral bleaching?	M	1-3
• What are the short and long-term impacts of broad-scale environmental disturbances, under different frequency scenarios (eg. cyclones, tsunamis, COTS outbreaks)?	M	1-3
• What are the cumulative impacts on the environment and stakeholder groups of existing developments (to facilitate more informed decision-making regarding new developments; e.g. aquaculture, marinas, research stations/activities, volume of boats, Indigenous hunting, whale watching)?	H	3-5
• To what extent do interactions, and any synergies, between local, regional, and global stressors influence coral bleaching response patterns, associated coral mortality, and the extent and rate of recovery?	H	1-3
• What is the current, overall state of knowledge on the resilience of habitats and biota to disturbances, anthropogenic impacts and climatic pressures (i.e. synthesis and integration of existing data and information)?	H	1-3

Research to support the Reef HQ aquaria: closed system studies

Question	Importance	Urgency (years)
• What environmental factors affect recruitment and survival of captive coral reef species?	L	1-3
• How can life support technology suitable for the captive maintenance of coral reef communities be improved?	L	1-3
• What is the current, overall state of knowledge on research to support the Reef HQ aquaria: closed system studies (i.e. synthesis and integration of existing data and information)?	L	1-3

Attachment A

Process Used to Determine Research Priorities for the Protection and Management of the Great Barrier Reef 2005

Introduction

This document summarises the process used by the Great Barrier Reef Marine Park Authority (GBRMPA) to determine research priorities for the Great Barrier Reef Marine Park. It also details a process for integrating identified research needs with current and planned research activity, to assist in allocating priorities for research investment.

The research priorities were based upon review, by GBRMPA scientists and managers, of the 'Research Priorities for the Management of the Great Barrier Reef Marine Park and the World Heritage Area 2001' (Green et al. 2001). This update took into account emerging issues, and improved structure and integration. Key issues considered included: Importance to the protection of the Great Barrier Reef; National Research Priorities; Legislative and policy imperatives; Community interest; and relative urgency.

Identification of Research Information Needs:

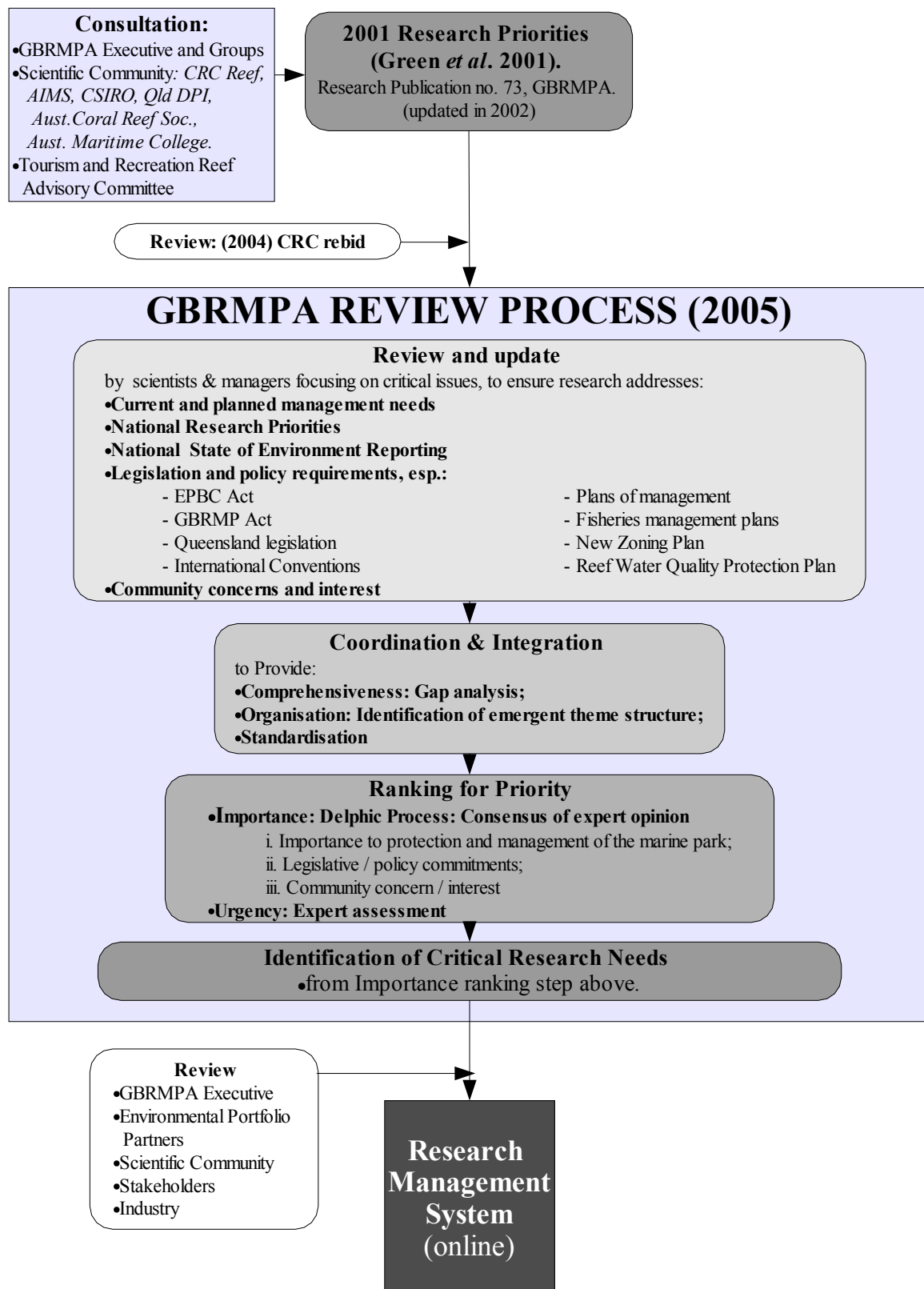
The Research Themes and Questions identified in the main document comprise a significant update and evolution of previously identified research needs, which were themselves the result of careful compilation, consultation and review (Diagram 1).

In 2001, the GBRMPA published a list of research needs 'Research Priorities for the Management of the Great Barrier Reef Marine Park and World Heritage Area 2001'. (Research Publication 73: Green et al. 2001; published also on the GBRMPA's external web site). That list was derived from extensive consultation, including with staff of the GBRMPA, a range of the scientific community (including the Cooperative Research Centre for the Great Barrier Reef World Heritage Area, the Australian Institute of Marine Science, the Australian Coral Reef Society, CSIRO, Qld DPI, and the Australian Maritime College), and the GBRMPA's Tourism and Recreation Reef Advisory Committee. The list was updated in 2002, based on informal review and discussion with the wider scientific and stakeholder communities, and on further consultation with the Critical Issues and other Groups within GBRMPA. In 2004, the GBRMPA Groups reviewed their research needs in the context of the rebid for the CRC Reef Research Centre.

The present Research Themes and Questions are based on substantial revision and evolution of the previous list, to address the following needs:

- Comprehensive review and update by the Critical Issues Groups and other sections of GBRMPA, to ensure the list comprehensively addresses the *current* needs for protection and wise use of the Great Barrier Reef Marine Park;

Diagram 1: Identification and Priority of Research Information Needs



- Consideration of links to National Research Priorities, National State of the Environment Reporting, the GBRMPA's Key Performance Indicators, International Conventions, The Environment Protection and Biodiversity Conservation (EPBC) Act 1999, and other legislative and policy requirements or commitments.
- Synthesis to provide a single 'reef-wide' / agency-wide list (removing overlaps and duplication in questions identified by different groups within the GBRMPA; improving standardisation in terms of detail and style);
- Re-expression of specific information needs as 'Research Questions' (to denote their status as an information need; these were previously expressed as 'Tasks', which were more prescriptive and risked pre-empting innovation in methods etc.);
- Identification of emergent 'Research Themes' to provide structure, organisation and synthesis to the list of very detailed and specific questions; whilst
- Maintaining the valuable detail and specificity of the 'Research Questions' (required to avoid ambiguity in interpretation by researchers);
- Clarification of priority into Importance and Urgency (the timeframe over which the information is required);

The resultant Themes and Questions, and their associated priorities, were then again reviewed by GBRMPA scientists and managers. Further feedback will be sought through consultation with stakeholders, research providers and Environment portfolio partners.

Prioritisation of Research Information Needs

Analysis by GBRMPA's Research Reference Group¹ concluded that the priority of information needs is best described in terms of two factors:

- i. the *importance* of the information to the protection and use of the marine park; and
- ii. the *urgency*, or time frame over which the information is required to be effective and lead to outcomes.

Given that 'Importance' and 'Urgency' are relevant in different contexts, they were not combined into any single priority rating.

The prioritisation of information needs reported here was conducted without constraints imposed by factors such as research feasibility or similar factors, to avoid circularity of logic (e.g. to give a problem low priority, because it is not currently considered feasible, would pre-empt the potential for new methods or technologies to be applied). The prioritisation was done at the detailed level of specific Research Questions, rather than for the emergent Themes. This reflects the need for prioritisation at the specific level, and the

¹ Research Reference Group includes representatives of the relevant Critical Issues and other Groups, natural and social science experts from the Research and Monitoring Coordination Unit, and the Director of the Science, Technology and Information Group, Dr David Wachenfeld, who was a co-author of the 2001 listing (Green et al 2001), and Editor of the 1998 State of the Great Barrier Reef World Heritage Area Report.

fact that the Themes were defined to synthesise the *overall* content of the detailed questions, and not their priority. That is, each Theme includes Questions of a wide range of priorities, and those priorities cannot be effectively summarised or ‘averaged’.

Importance of Information Need:

In essence, rating the importance of the research need involves answering the question:

‘How important is this information to the future protection of the Great Barrier Reef?’.

There are three main criteria to answering this question:

1. ‘Importance to GBR’ Risk Analysis: What are the risks to the future of the marine park (or WHA) associated with not obtaining this information? This risk analysis includes direct and indirect risks, and must consider both the potential consequences, and their likelihood.

As part of that criterion:

2. Are there specific policy or legislative imperatives or values to obtaining the information?

(Based on detailed matrix cross-referencing Questions with relevant Acts, National Research Priorities² (sample page at Attachment C); assuming that most or all relevant policy or legislation is directed to protection of the reef, this criterion constitutes a subset of the first);

3. Is the information need of particular concern or interest to the broader community and stakeholders of the reef?

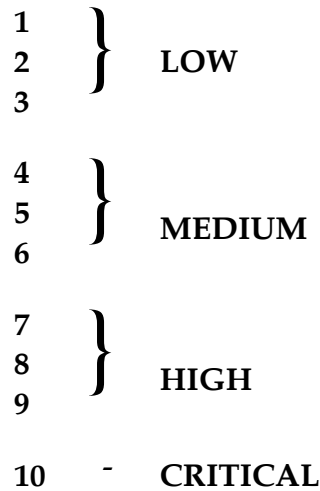
(This reflects the value of engendering stewardship of the reef, in turn facilitated by addressing questions of significance to the community).

The Research Questions were rated for importance using a ‘Delphic’ process (i.e. consultation and consensus of expert opinion), involving a range of experienced members of both policy and science management sections of the GBRMPA (The Research Reference Group). This assessment drew on priorities allocated by Critical Issues and other Groups within their areas of expertise, and calibrated those priorities to provide an overall, agency/reef-wide perspective. This prioritisation, along with the Questions and Themes themselves, is to be further reviewed through consultation with stakeholders, research providers and Environment portfolio partners.

Each Question was rated as ‘Critical’, ‘High’, ‘Medium’ or ‘Low’, based on scores between 1-10 (Diagram 2: i.e. ratings will only be presented as the 4 categories, to avoid inappropriate emphasis on small differences, but scoring 1-10 allows more discrimination).

² Virtually all of the information required for management of the GBRMP is relevant to the first National Research Priority: – ‘An Environmentally Sustainable Australia’, in particular 1.5: ‘Sustainable use of Australia’s biodiversity’ but also including 1.7: ‘Responding to climate change and variability’. Some requirements are also relevant to Priority #4.3 – ‘Safeguarding Australia: Protecting Australia from invasive diseases and pests’.

Diagram 2:



The scoring process involved:

1. 'Importance to Reef' risk assessment: Initial consensus score of 1-10; then:
2. Legislative or policy relevance: Score increased by 1 (or in extreme cases) 2 'bonus points' if considered to have legislative or policy application or value; and/or
3. Community value: 1 (-2) 'bonus points' if of particular significance to the broader community.

The maximum score was ten; thus, a question may be critical simply in terms of importance to the reef, or because of its combined importance and legislative and/or community significance.

Urgency or Timeframe of Information Need

'Urgency' refers to the time-span over which the information is *needed* in order to contribute to management and protection of the GBRMP; note that some less urgent questions, such as those about long-term trends or processes, may still require urgent data collection as baselines for those long-term trends. Note also that Urgency is used to refer to the information need, and does not necessarily indicate the time a research project might require to address that need.

Each Question was rated, as 0-1 yrs, 1-3 yrs, 3-5 yrs or >5 yrs, by GBRMPA Critical Issues or other Groups with specific expertise in the relevant area. Because the ratings are not relative, they did not need to be compared across the entire list (in contrast to the Importance).

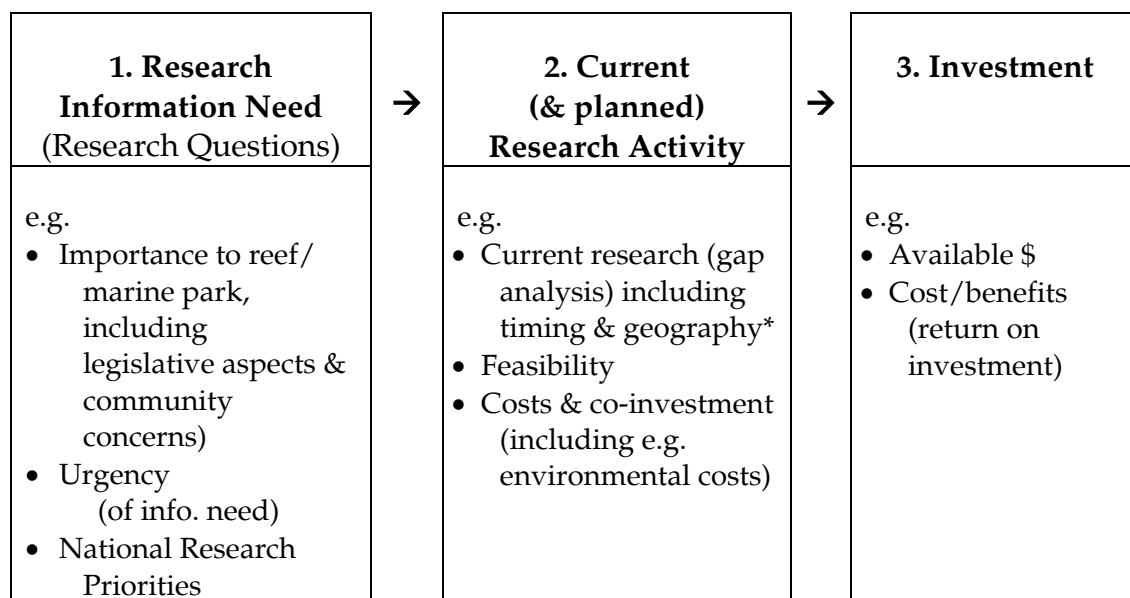
Combination of Research Information Priorities with Research Activities

Prioritisation of overall research investment involves i. the initial prioritisation of the information need, and ii. subsequent integration with information about research activities, costs, feasibility, etc. (Diagram 3).

Detailed information on both research information needs (1) and activities (2) form the basis of a web-accessible ‘Research Management System’ being developed by the GBRMPA’s Research and Monitoring Coordination Unit. This system will integrate the research needs outlined in the main document, with existing and planned research activity, including costs and funding sources, researchers, research locations, etc. (database design shown at Attachment B; also shows relationships with National Research Priorities, legislative instruments, State of the Environment Reporting, Key Performance Indicators, etc.). This will provide a tool for internal and external planning and management of research, such as overall investment prioritisation (either general or circumstance-specific), gap analyses and summarising existing investment.

Development of priorities for overall research investment essentially involves scaling the priority of the need by a wide variety of factors that influence the return on investment or cost/benefit analysis. Cost analysis may be complex, and influenced not only by direct costs, but factors such as the potential for co-investment, or social or environmental costs of the research itself (e.g. research which requires fishing in green zones). Benefit analysis will primarily involve factors that may reduce the benefits (e.g. constraints on feasibility, timeliness, limitations in time or spatial scales of results). That is, practical issues may make a Question a lower priority for investment, but are unlikely to make an unimportant question a high priority.

Diagram 3:



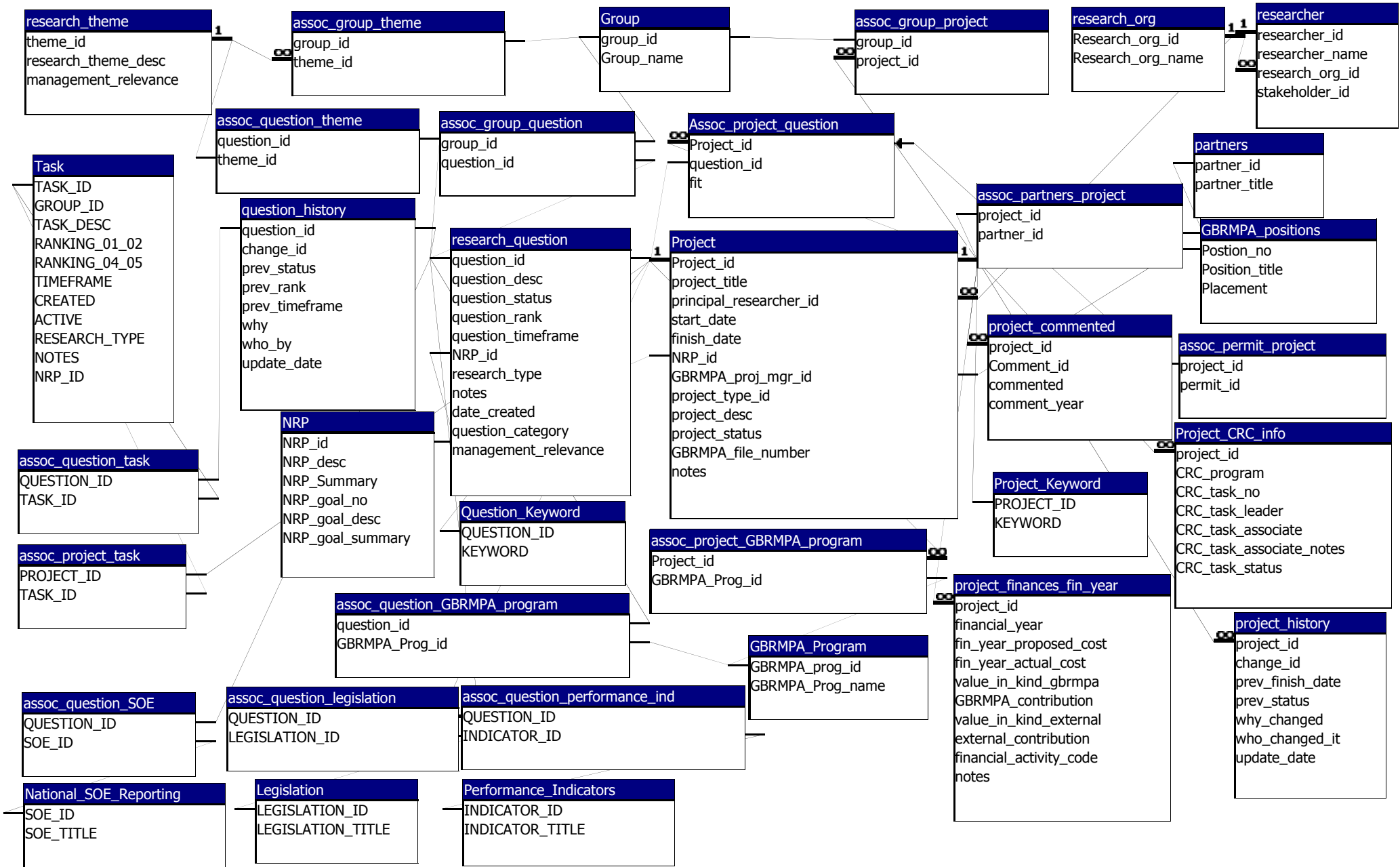
(*e.g. in 5 yr cycle of dugong survey; was the last survey last year or 4 years ago? Is all available information relevant only to part of the marine park?).

Many of these considerations cannot be assessed *a priori* but will be specific to particular funding and other circumstances. For example, costs, co-investment and feasibility may vary considerably among research providers, and investment decisions may involve iterative discussions to develop research plans which maximise return on investment for both providers and users. The implementation of a database-driven Research Management System will facilitate such analyses, by allowing i. compilation of the necessary range of information in a flexible structure; and ii. extensive exploration of cost and benefits, in an efficient and interactive manner, for a wide range of specific circumstances.

Reference

Green, A., Oliver, J., Wachenfeld, D. (2001). Research Priorities for the Management of the Great Barrier Reef Marine Park and World Heritage Area 2001. Research Publication 73, Great Barrier Reef Marine Park Authority, 28pp.

Attachment B: Database Design



Attachment C: Sample matrix showing Research Questions cross-referenced with policy and legislation.

ID	Research Question	Research Reference Group Rank	GBRMPA ACT	EPBC ACT: World Heritage	EPBC ACT: National Heritage	EPBC ACT: Wetlands of International Importance	EPBC ACT: Listed threatened species and communities	EPBC ACT: Listed migratory species	EPBC ACT: Marine Environment	EPBC ACT: Additional matters to national environmental significance	National Research Priority: An environmentally sustainable Australia	National Research Priority: Safeguarding Australia	National Research Priority: Promoting and Maintaining Good Health	National State of the Environment Reporting: Atmosphere	National State of the Environment Reporting: Biodiversity	National State of the Environment Reporting: Coasts and Oceans	National State of the Environment Reporting: Inland waters	National State of the Environment Reporting: Land	National State of the Environment Reporting: Natural and Cultural Heritage	RWQPP	new Zoning Plan	Plans of Management	Old Fisheries Management Plans	Key Performance Indicators
144	What are appropriate risk assessment protocols (dose response relationships for catchment toxicants) for developing thresholds for exposure in coastal and estuarine waters and sediments?	H									X		X		X	X	X	X		X				X
145	How do catchment toxicants relate to the distribution and co-occurrence of mangrove dieback in intertidal mudflats along Queensland coast?	H		X					X		X				X	X	X	X		X				X
146	What are pollutant tolerances for inter-reefal ecosystems, for temperature, salinity, nutrients (NOx), suspended solids, antifoulants, dispersants and pesticides/herbicides?	CRITICAL									X					X	X	X		X				X
147	What are the mechanisms behind bleaching resistance and resilience?	H									X					X	X	X						X
148	What long-term changes are likely to occur in coral reef systems as a result of climate change?	H									X		X		X	X	X	X						X
149	What are the key factors that lead to bleaching and how can these be predicted?	H									X					X	X							X
150	What are the likely impacts of climate change on local and regional hydrodynamics?	M									X				X	X								X
151	What data gathering and analysis techniques are most appropriate to assess the impacts of bleaching events and unpredictable disturbances at a range of spatial scales?	M									X					X	X							X
152	What are the key local and regional processes and factors that confer ecosystem resilience?	H									X		X			X	X							X
153	What are the major threats to local and regional factors that influence the resistance and resilience of communities?	H									X	X	X		X	X				X				X
154	What should form the major criteria when identifying resilient areas?	H									X	X	X		X	X				X				X
155	What management strategies can be used to support or improve the resilience of major habitats in the GBRMP?	CRITICAL		X							X	X	X		X	X	X			X	X	X		X
156	What impact is sea level rise likely to have on GBRMP habitats?	M									X	X	X		X	X	X			X				X
157	What are the patterns and rates of recovery at sites subject to incidents such as oil spills, ship groundings, cyclones and coral bleaching?	M									X		X		X	X	X							X
158	What are the short and long-term impacts of broad-scale environmental disturbances, under different frequency scenarios (eg. cyclones, tsunamis, COTS outbreaks etc.)?	M									X			X	X	X	X							X
159	What are the mechanisms leading to crown-of-thorns starfish and Drupella outbreaks and their subsequent decline?	H	X								X	X	X		X	X				X				X



Photo Karl Borgelt

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