

# WET TROPICS

## *Information Needs for Management*



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## **User Guide - Wet Tropics Information Needs for Management**

The preparation of this document followed initial advice and workshops involving Wet Tropics Management Authority (WTMA) staff, the Authority's Scientific Advisory Committee, QPWS, EPA, DNR and Bama Wabu. A draft 'needs' document was considered by the Authority's Board at its November 1999 meeting. The Board approved release of the draft for comment by key stakeholder interests. This consultation phase extended for a period of three months and the document modified in light of the feedback obtained.

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The document comprises 4 sections as follows:

***Section 1: Overview and Rationale***

- ◆ provides an overview of research issues and interests in relation to management of the Wet Tropics World Heritage Area
- ◆ establishes the approach adopted for identification of information needs relevant to the management of the WHA and criteria for prioritisation of research.

***Section 2: Information Needs and Strategic Management Areas***

- ◆ summarises information needs related to specific World Heritage management responsibilities

***Section 3: Key Questions for Management***

- ◆ provides more detailed explanations of management needs and specific questions about which WTMA is seeking sound research and information
- ◆ provides advice and information to research providers about the types of research information important for WTMA to improve its management expertise (eg to assist the Rainforest CRC and other institutions to design their programs of research consistent with the needs of WTMA and other conservation land management agencies)

***Section 4: Priority Research Areas***

- ◆ focuses on WTMA's immediate priorities for research derived by applying the prioritisation process developed under Section 1
- ◆ this list will be the most dynamic section of the document, as in any year it will be strongly influenced newly emerging issues.

## SECTION 1

### Overview & Rationale

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#### 1.1 Introduction

The Wet Tropics of Queensland World Heritage Area is one of the world's most outstanding natural treasures. Managing the Wet Tropics World Heritage Area presents us with the responsibility to transmit to future generations this environmental treasure undiminished by the enjoyment and use of our generation.

Research is recognised as a major and legitimate use of World Heritage areas. The importance of research activities in World Heritage areas is explicitly acknowledged in international conventions such as the World Heritage Convention and the Convention on Biological Diversity. World Heritage areas, due to their high levels of natural integrity, provide us with benchmarks for the measurement of environmental change and the rate of resource consumption. Several national policies, for example the National Strategy for the Conservation of Australia's Biodiversity, recognise the importance of research into such areas as do acts (e.g. *Wet Tropics World Heritage Protection and Management Act 1993*) and statutory documents, such as the *Wet Tropics Management Plan 1998*.

This document is the culmination of an investigation into the major issues, state of current knowledge and the requirements for both strategic and operational level research needed to support management decisions within the Wet Tropics World Heritage Area. In developing this document the Authority has drawn on the views and advice of both land managers and researchers, providing an outline of the management areas and issues the Authority, and others with on-ground management responsibility in the Area, think important in the achievement of on-ground improvements in the conservation management of the Area.

The aim of this document is to assist WTMA focus its priorities and for land managers, researchers and funding bodies to understand WTMA's information and knowledge needs for the foreseeable future. It should also provide a firm basis on which to expand and enhance interactions between research providers and research users in the region.

A major emphasis is on adaptive management research which will:

- test current management practices,
- provide the baseline data necessary to design robust monitoring programs, and
- provide prescriptions for improved management.

Such an emphasis is seen as a means of critically testing and improving our current land management practices while engendering closer collaborative links between research providers and research users.

A strong message from consultations with land managers was that environmental problems are complex and multifaceted. As such they may not always be understood fully by any one academic discipline. Environmental land management problems tend to encompass ecological, technological, economic, cultural, moral, political and administrative issues. Any proposed solution, to be 'operational' must take into account the costs and the benefits of a decision within this wider sciences/humanities context.

Research has been identified as having a number of key roles to play in the protection and management of natural systems within the Wet Tropics, namely:

- ❑ to provide a basic inventory to enable an understanding of the composition, distribution and state of the Area's natural values
- ❑ to understand key ecological processes, and the effects and limits of different impacts and/or management decisions on these processes
- ❑ to provide the knowledge base needed for rational land-use and management decisions, including an evaluation of the environmental, social, cultural and economic costs and benefits of various options
- ❑ to develop methods of prediction, detection, interpretation and rehabilitation in the wake of environmental disturbances of various spatial and temporal scales.

## 1.2 Links to Other Strategies and Plans

This document is designed to support several other Authority plans and strategies including the Wet Tropics Nature Based Tourism Strategy, Wet Tropics Walking Track Strategy and the Daintree Futures Plan.

The document also supports the following Wet Tropics Management Authority Business Plan Outcomes:

- ❑ better scientific knowledge of ecological systems and the status of rare and threatened species and communities and other species of World Heritage significance
- ❑ better scientific knowledge of wildlife populations and ecosystem process
- ❑ better scientific knowledge of ecological and evolutionary processes and the spatial and temporal dynamics of natural systems
- ❑ better scientific knowledge of the social, cultural and economic environment of the Wet Tropics region and their relationship to the management and maintenance of natural ecological and evolutionary processes
- ❑ be actively involved in the development and implementation of the outcomes of programs of research in order to improve its efficiency, relevance, effectiveness, focus and balance.

The wet tropics region is the most populous of northern tropical Australia with around half a million residents. Most of these live within 50km of the World Heritage Area boundaries. FNQ 2010 is an exercise in co-operative regional planning concerned with ensuring the economic prosperity, social well-being and environmental sustainability of the Far North Queensland region. It involves Commonwealth, State and Local Governments, as well as business, tourism, environment, development, primary production, human services and Aboriginal and Torres Strait Islander groups which has responsibility for developing a comprehensive Regional Plan to guide growth and development of the region over the next twenty years.

Many other agencies have planning and management responsibilities within or neighbouring the Area, including local government, the Department of Environment, Department of Natural Resources, Department of Defence and the Department of Main Roads.

***WTMA acknowledges that this is a dynamic document which will require regular revision to ensure it remains relevant. This document provides a basis to guide the current needs for research in the Wet Tropics World Heritage area.***

## 2.0 WTMA Responsibilities & Charter

The Wet Tropics of Queensland World Heritage Area (the Area) was inscribed on the World Heritage list of natural properties on 9 December 1988. The Queensland and Commonwealth governments agreed in 1990 to jointly fund and co-ordinate management of the Wet Tropics World Heritage Area, signing an agreement which established the Wet Tropics Management Scheme and the Wet Tropics Management Authority.

### 2.1 Wet Tropics Management Authority

The Wet Tropics Management Authority was set up to ensure Australia's obligations under the World Heritage Convention in relation to the World Heritage Area are met. The Authority is a body corporate with statutory powers defined under the *Wet Tropics World Heritage Protection and Management Act 1993*. Its primary task is to ensure the implementation of the Primary Goal (see below) for the Area. The Authority does not have day-to-day field management responsibilities. It co-ordinates planning and management by land managers, is responsible for monitoring and reporting on the status of the Area, promoting the goals for the Area and monitoring the effectiveness and efficiency of all actions taken by those with a role in management.

## 2.2 The Primary Goal of Management

The Commonwealth and Queensland Governments agreed on the following Primary Goal which sets the course for management of the Area: *"To provide for the implementation of Australia's international duty for the protection, conservation, presentation, rehabilitation and transmission to future generations of the Wet Tropics of Queensland World Heritage Area, within the meaning of the World Heritage Convention."*

## 2.3 Functions of the Authority

The Authority's functions, as defined under Section 10 of the *Wet Tropics World Heritage Protection and Management Act 1993*, include:

- developing and implementing policies and programs within the Wet Tropics Area;
- making recommendations to Ministerial Council;
- preparing management plans;
- administering funding;
- facilitating and entering into co-operative management agreements;
- rehabilitation; and
- education through the gathering and dissemination of information.

The Authority must, in performing its functions, consider Aboriginal tradition and liaise and co-operate with Aboriginal people concerned with the Area. It must also perform its functions consistent with the objectives and principles of the National Strategy for Ecologically Sustainable Development. The key elements of ESD include:

- integrating the economic, social and environmental concerns and needs of the community
- accounting properly for the economic costs of environmental degradation
- understanding environmental risk and uncertainty.

## 2.4 National Strategy for the Conservation of Biological Diversity

The National Strategy for the Conservation of Biological Diversity (NSCBD) is one of the cornerstones in meeting ESD objectives. The NSCBD stresses "the need to change the way we think, act and make decisions so as to ensure that economic development is ecologically sustainable". This need is in recognition that "now, as never before, human activities are having a significant impact on the fundamental ecological processes of the planet". Recognition of these impacts drives the need for research, knowledge and information.

The NSCBD recognises that:

- the conservation of biological diversity provides significant cultural, economic, educational, environmental, scientific and social benefits for all Australians;
- there is a need for more knowledge and better understanding of Australia's biological diversity;
- there is a pressing need to strengthen current activities and improve policies, practices and attitudes to achieve conservation and sustainable use of biological diversity; and
- we share the earth with many other life forms that have intrinsic value and warrant our respect, whether or not they are of benefit to us.

This document has also adopted the following NSCBD guiding principles:

- biological diversity is best conserved in-situ;
- it is vital to anticipate, prevent and attack at the source the causes of significant reduction or loss of biological diversity;
- processes for and decisions about the allocation and use of Australia's resources should be efficient, equitable and transparent;
- lack of full knowledge should not be an excuse for postponing action to conserve biological diversity. (precautionary principle); and

- the close, traditional association of Australia's indigenous peoples with components of biological diversity should be recognised, as should the desirability of sharing equitably benefits arising from the innovative use of traditional knowledge of biological diversity.

## **2.5 Land management principles**

Consistent with the Primary Goal, the following principles have been developed by the Authority to help guide land management and community relations activities in the Area.

- a. The integrity of the Area is best conserved by protecting as much of it as possible from disturbance and threatening processes.
- b. Planning is to be based on the understanding that the Area is considered by both Parliament and the international community to be of international significance, and that there are likely to be limits to the amount of growth and impact it can absorb without compromising its integrity.
- c. Achieving the Primary Goal for the Area is dependent upon the co-operation and contribution of all levels of government, industry and the community, including conservation groups, resource users, Aboriginal peoples particularly concerned with land in the Area and the Area's neighbours. It is essential that management of the Area does not adversely affect adjoining areas and that activities from these areas do not harm the Area.
- d. It is the intention to ensure that the regional community can continue to participate to the greatest possible extent in the management, protection, presentation, enjoyment and sustainable use of the Wet Tropics World Heritage Area.
- e. In implementing the Wet Tropics Management Plan, the Authority aims to manage any necessary existing or future community infrastructure within the Area to minimise the impact on World Heritage values.
- f. The management of the Wet Tropics Area will specifically respect and protect (as far as legally possible) the areas, sites and other values of cultural heritage significance to Aboriginal people particularly concerned with land within the Area.
- g. In the spirit of co-operation, management approaches should recognise and build on existing systems rather than duplicating them and should resort to additional regulation only where necessary.
- h. Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. Consistent with this, all decisions will be based on the best available knowledge of the Area and, in the absence of information, will err on the side of caution.
- i. Processes for and decisions about the conservation, management and use of the Area should be clear, efficient, equitable and consistent, and must ensure that the use is ecologically sustainable.
- j. Prudent and feasible alternative methods or sites for potentially damaging activities should be explored and used to achieve net reduction in adverse impacts on the Area.

## **2.6 Community Relations Principles**

It has also been acknowledged that we have an obligation to ensure that the Area has a function in the life of the community. To help achieve this, a set of community relations principles has been developed to guide community involvement.

- a. The Area has universal values which must be protected. People from throughout the world have a legitimate interest in ensuring the protection of the Area. Australia should respond to this by developing a successful model for conservation which includes community involvement in management of the Area.

- b. The cultural and natural heritage of the Area should have a function in the life of the community and the local community should be involved in management of the Area.
- c. Management of the Area is based on the shared responsibilities of a wide group of stakeholders. Achieving the Primary Goal requires mutually satisfying partnerships with the many communities of the region, particularly land holders within the Area and neighbours along its boundary. Economic, social and cultural benefits from World Heritage listing should be shared equitably without compromising the Primary Goal.
- d. The rainforest has special meaning for most people in northern Queensland and the regional population's interests, knowledge and attachment to the Area should be acknowledged and respected. This particularly concerns the rainforest Aboriginal peoples whose culture and the rainforest environment are inextricably linked. The Authority will develop a collaborative relationship with Aboriginal peoples.
- e. Trusting relationships should be built through dedication by all parties to openness, active listening, fair dealing and acknowledgment of protocols. Innovation, foresight and a capacity to embrace change must be continually developed in order to move towards the desired future for the Area.
- f. Visitors are welcome to enjoy the Area in ways that maximise their appreciation and inspiration while minimising potential adverse impacts on the natural and cultural environment and surrounding communities. Subject to the provisions of the Wet Tropics Management Plan, or more detailed management plans, access to the Area and the provision of facilities will be based on the principles of equity, with due regard given to ensure that age, gender, race, disability and economic status do not preclude appropriate visitor use and enjoyment of the Area.

## **2.7 General Research Principles**

Research is one of the more important uses of World Heritage areas and most field research leaves little or no perceptible evidence in the landscape. There are some questions that can be addressed only by the manipulation of natural systems. Such experiments are a means of directly comparing management options (for example different road designs or maintenance practices). They help to resolve basic uncertainties about the response of managed ecological systems to human disturbance. Any potential harm to the values or integrity of the Area must be minimised by undertaking experiments in the smallest possible area consistent with statistical requirements and anticipating and taking all possible steps to minimise the impact on the Area, including:

- a. undertaking research in accord with the Precautionary Principle and with relevant legislation;
- b. conducting research in this very special area using best practice procedures in accordance with community values, including consultation with indigenous people;
- c. ensuring compatibility with the management purposes, objectives and management zone provisions of the area in which the research is conducted;
- d. ensuring that the most appropriate area has been selected to both answer the scientific question and to maximise its relevance to management;
- e. ensuring that the area is adequately monitored for evidence of emerging impacts;
- f. ensuring that there is a reasonable expectation that the research will lead to outcomes that are compatible with the management purposes of the area;
- g. establishing what other research projects have been or are being carried out in the vicinity of research site. (Projects in different disciplines may well be found to have some relevance - or may have had some impact that needs to be taken into account. To facilitate this, there is a need to keep up-to-date and accessible registers of researchers, their projects and the locations of their field sites and outputs generated from the research);
- h. exploring options for the movement of research, either away from environmentally sensitive areas, or to develop and use non-invasive techniques such as computer modelling;
- i. paying particular heed to the protection and well-being of rare and threatened animal and plant species;



- j. ensuring research does not compromise the long-term viability of populations, species and ecosystems except in the case of introduced pest species;
- k. paying due attention to the cultural values of the landscape, from both an indigenous perspective and that stemming from the activities of more recent settlers;
- l. minimising the extent of activities carried out, while ensuring the research has the required statistical power;
- m. modifying experimental activities wherever possible to reduce impact on the area;
- n. choosing the most appropriate research methods for the conduct of the study;
- o. ensuring the technical skills and competence of all persons accessing the area;
- p. conducting studies for a period no longer than necessary to achieve the research goals, to minimise disturbance or impact;
- q. acting promptly to reduce impact in case of unforeseen outcomes;
- r. removing all infrastructure at the completion of the study; and
- s. maximising the use and benefits of the research results.

Research organisations in partnership with management agencies should ensure that operating procedures are established which will enable/ensure protocols are set in place to maximise the benefits of field research including:

- lodgement of voucher specimens with the Qld Herbarium, Qld Museum etc.,
- lodgement of spatially referenced field data/raw data at a central source.

For an approved project, the proponent should be obliged to report (during and at the end of the research) on the outcomes, results and implications of the research to the relevant land management authorities.

### **3.0 Research Needs Umbrella**

Research can benefit the conservation and management of natural values in the World Heritage Area in two major ways. Firstly, scientific research is needed to ensure that use and management are such that no natural values are lost or unacceptably degraded. Secondly, scientific research information and knowledge forms the basis for much of the presentation and interpretation of the Area.

Although research, in its broadest sense, includes any process resulting in the collection of information, for the purposes of this document we have adopted the definition used by the EPA: “*Research is the diligent and systematic inquiry or investigation into a subject in order to discover facts or principles*”. Within the context of this review we are chiefly concerned with the undertaking of scientific research projects that lead to better management and conservation of the Wet Tropics World Heritage Area.

Although not directly related to a ‘type’ of research, there was widespread recognition during the consultative process that biological surveys, inventory studies, and all ecological research relies on accurate taxonomy. Without this fundamental descriptive ‘cataloguing’, inventory data is of little value. The Authority recognises that we are facing an increasing shortage of professional taxonomists. There is a need to encourage more taxonomic expertise to the region for biological surveys, environmental impact evaluations and ecological research. New technologies and software development, such as the CSIRO Rainforest Key, are particularly valuable and are considered a basic resource upon which much other research depends.

The consultative process identified three broad, interrelated categories of research needs (Figure 1). This division is in many ways arbitrary, but it does lend itself to a classification based upon the end use of the research. Each category also tends to frame its management questions in different ways and each tends to have a different timeframe for the carrying out and reporting on the research outcomes.

### 3.1 Strategic Research

Two types of strategic research were identified:

- ❑ strategic management research which specifically targets problems and issues of direct concern to land management agencies; and
- ❑ strategic fundamental research which concerns itself with gaining an understanding of complex ecological, social and economic systems, their patterns, processes and function and how they respond to natural and unnatural events. This type of research is vitally important as it provides the basic understanding which underpins all other forms of research.

### 3.2 On-going Research

A characteristic feature of this ‘type’ of research that distinguishes it from other research categories is the replication of measurements or observations over time. Such repeated measurements or observations allow for the identification of fluctuations and trends in a particular attribute of interest over time.

Land management agencies in the region consistently identified the need to develop sets of monitoring indicators relevant to a range of scales and the need to distinguish between natural and human-induced change so that alterations due to management activity can be distinguished from those which have other causes. Management systems must be able to address emerging threats and make appropriate corrections when required.

The Authority has a statutory obligation under the *Wet Tropics World Heritage Protection and Management Act 1993* to monitor, advise and report to Ministerial Council on the state of the Wet Tropics World Heritage Area.

A simple, practical and easily implemented system for reporting on the condition of the Area and evaluating management activity is required. This system should be in a form which is understandable to the community, meaningful to managers and can be incorporated into other management and reporting processes, such as annual reports.

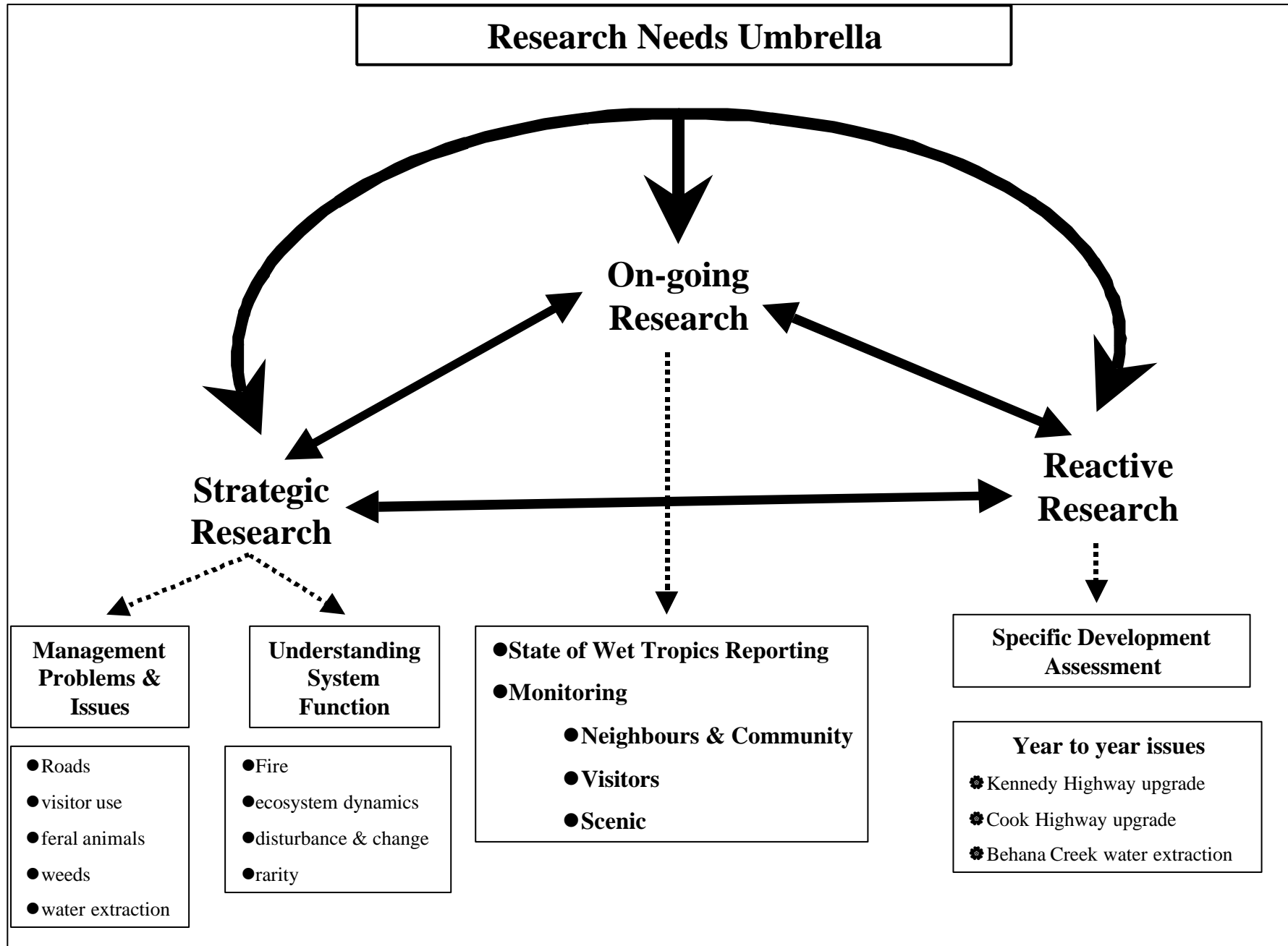
Monitoring systems need to be focused on management objectives. Once there is a departure from the relatively simple question of “what is happening?” to the more challenging questions such as “why is it happening?”, “what will happen in the future?” and “what can we do?”, we are moving beyond monitoring and into the core areas of ecological research where complex experimentation and hypothesis testing is needed to unravel the situation. However, research is needed to establish baselines, to unravel relationships, and to derive robust simple surrogate measures and unambiguous, technically feasible monitoring indicators so that trends in ‘what is happening’ and their responses to management prescriptions can be assessed.

The Authority supports the establishment of a system of permanent reference sites in a representative range of undisturbed habitats where long-term ecological and hydrological research and monitoring can be undertaken and against which the results of monitoring can be tested. Many projects that are critically important for managing the WHA require a long-term commitment. Broad-scale monitoring programs need to be built around a series of long-term studies that are critical to monitoring the health of the Area. There is a need for baseline data to be collected over a long-term timeframe if it is to be useful and to distinguish between natural fluctuations and unnatural trends.

### 3.3 Reactive Research

Each year a number of specific issues arise requiring some form of development assessment. Most applied research on natural ecosystems aims to evaluate the potential impact of human activities, and to manage such activities to reduce adverse impacts. The vulnerability of Wet Tropics ecosystems to increased human impact is not well understood, however, clear and transparent decision-making processes and rigorous impact assessment criteria, guidelines and procedures are required to ensure new developments and activities or modification of infrastructure or facilities do not adversely affect the Area’s natural or cultural environment.

Figure 1. Research Needs Framework



## 4.0 Research Themes

For the purpose of reviewing information needs, this document has grouped related management topics into Research Themes. Three Primary Research Themes provide the framework, and are based on the Primary Goal, the Wet Tropics Management Plan and the range of management issues identified in the Authority's policy document *Protection through Partnerships*.

### Theme 1. Understanding Natural Patterns, Processes and Function

This theme recognises that best-practice environmental management is based on information and knowledge of natural heritage values, their distribution and function. This theme includes the fundamental strategic research which is essential for achieving sustainable use of complex ecosystems.

### Theme 2. Human Activities and Interactions with the Natural Environment

This theme is focused on minimisation of environmental impacts of all forms of human-induced activity and land use on the natural values of the Area. It includes promotion of the integration of environmental, social and economic needs of the community, including ecological goods and services, support for cultural development and improved Aboriginal participation in management.

Due to the diverse nature of Theme 2, several *Secondary Research Themes* were identified to aid in the logical grouping of related topics.

### Theme 3. Repair and Rehabilitation

This theme relates to restoration and rehabilitation of damaged or degraded land, ecological systems and landscapes.

Within each Research Theme a range of Strategic Management Areas (SMAs) have been defined which cover the gamut of land management concerns identified by land management research users in the region (Table 1). Each of the identified management areas are elaborated in greater detail in Section 2 where a brief statement of the significance of the SMA is presented, while Section 3 elaborates the list of objectives that land managers have identified as useful foci for the design of research projects.

**Table 1 List of Strategic Management Areas within each Research Theme**

Primary & Secondary Research Themes	Strategic Management Areas
<b>1.0.0 Understanding Natural Patterns, Processes and Function</b>	1.0.1 monitoring & reporting 1.0.2 natural resource mapping, modelling & assessment 1.0.3 collation & analysis of existing data & information 1.0.4 sites of special scientific interest (SSSI) 1.0.5 biological diversity 1.0.6 genetic diversity and evolutionary history 1.0.7 rarity 1.0.8 ecosystem dynamics 1.0.9 disturbance and change 1.0.10 fire 1.0.11 climate change
<b>2.0.0 Human Activities and Interactions with the Natural Environment</b>  <i>2.1.0 Design &amp; Management of Community Infrastructure</i>	2.1.1 linear service corridors: roads 2.1.2 linear service corridors: powerlines 2.1.3 linear service corridors: walking tracks, pipelines, other services 2.1.4 water infrastructure & extraction 2.1.5 telecommunication facilities

Primary & Secondary Research Themes	Strategic Management Areas
2.2.0 <i>Resource use</i>	2.2.1 drainage 2.2.2 grazing 2.2.3 collecting forest products 2.2.4 bee-keeping
2.3.0 <i>Pest control</i>	2.3.1 environmental weeds 2.3.2 feral animals 2.3.3 diseases
2.4.0 <i>Economics</i>	2.4.1 environmental goods and services
2.5.0 <i>Social</i>	(a) <i>Aboriginal</i> 2.5.1 contemporary Aboriginal issues and aspirations 2.5.2 traditional land management and knowledge (b) <i>Visitation &amp; use</i> 2.5.3 tourism and visitor management 2.5.4 landholders & neighbours 2.5.5 community attitudes 2.5.6 people/wildlife interactions 2.5.7 education, interpretation and presentation 2.5.8 population growth and regional development
3. <b>Repair and Rehabilitation</b>	3.0.1 ecosystem reconstruction, wildlife corridors & ecological linkages

## 5.0 Key Forces for Change

Independently of the procedure described above, consideration was given to identifying the key underlying forces or drivers of pervasive change in the Wet Tropics World Heritage Area. From a long-term strategic perspective, it is considered that programs of research dealing with aspects of these Key Forces for Change are vital for future planning and management of the Area.

Seven SMAs are considered to encapsulate the Key Forces for Change in the Area. The future character of the Area is seen to depend on our management responses to this set of long-term issues, drivers and constraints. These forces are considered to have the highest order of potential pervasive impacts (either positive or negative) on the future character of the Area, and management responses will underpin the rate of change shaped by these forces. Those identified were:

- ecological goods and services;
- infrastructure corridors;
- introduction of invasive pest species;
- tourism & visitor management;
- Aboriginal issues;
- population growth and regional development; and
- climate change.

A brief summary of the rationale for identifying these seven SMAs is given in Table 2. These forces are not discrete entities operating independently and it is recognised that most identified Key Forces will have an influence on other identified Key Forces (Figure 2).

**Table 2. Rationale for selection of Key Forces for Change**

Key Forces for Change	Relevant SMA	Reason/Rationale
Ecological	1.0.1,1.0.2,	Recognition of the value of goods and services provided by natural ecological systems is needed to

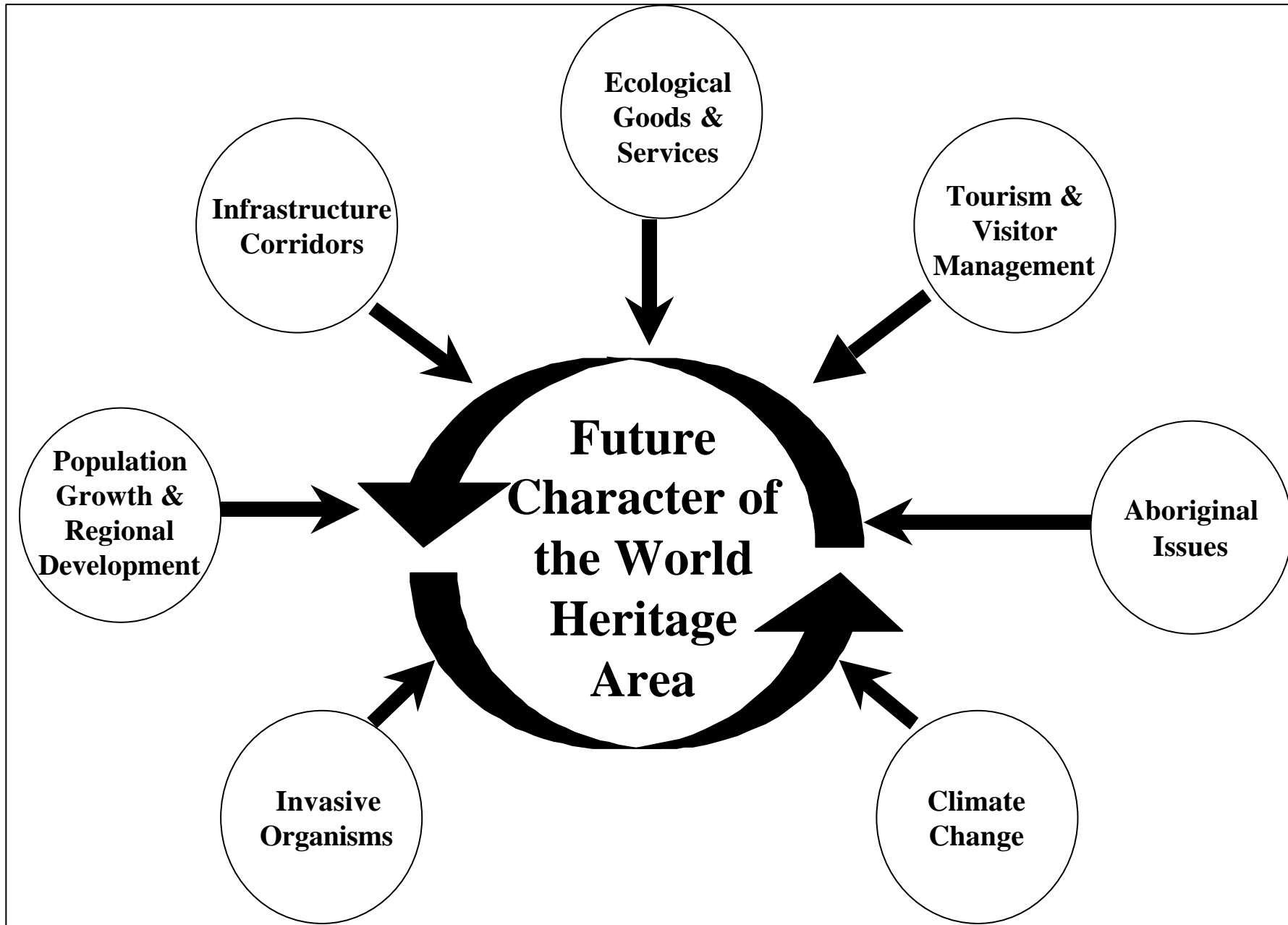
Key Forces for Change	Relevant SMA	Reason/Rationale
goods and services	1.0.3, <b>2.4.1</b>	<p>engender political, community and industry appreciation and support for resourcing world class management of the Area. The integration of the environment into economic frameworks is also seen as a fundamental shift in developing a sustainable future for the Wet Tropics region.</p> <p>World Heritage conservation is a multiple land use. Many essential services are provided by species diversity and healthy ecosystems. These include the regulation of water cycles, the protection of catchments, the provision of clean water, the breakdown of pollutants, nutrient cycling, maintenance of soil fertility, and regulation of climatic systems. There are also a number of productive and consumptive uses of the World Heritage area such as recreation, tourism, education and research.</p>
Infrastructure corridors	1.0.1, 1.0.5, 1.0.6, 1.0.8, 1.0.9, <b>2.1.1, 2.1.2, 2.1.3</b> , 3.0.1	<p>Internal fragmentation and its array of impacts on World Heritage integrity, ecosystems and evolutionary processes are considered a principal threatening process to World Heritage values and their long-term integrity. At the same time there is a need to provide safe, reliable and durable transport infrastructure for presentation purposes and as part of a regional transport network. There is also the on-going need to manage and maintain service corridors associated with a significant high voltage power supply infrastructure network.</p>
Introduction of invasive pest species	1.0.1, 1.0.4, 1.0.8, 1.0.9, <b>2.3.1, 2.3.2, 2.3.3</b> , 3.0.1	<p>Risk of large-scale modification of natural processes and ecosystems by biological invasion is a major area of concern (especially considering overseas experiences). The key principle being espoused is that 'prevention is better than cure'. Environmental weeds in particular are capable of pervasive modifications to natural systems. They include introduced species capable of establishing self-sustaining populations by invading native ecosystems thereby causing major modification to species richness, abundance or ecosystem function. Such plants are generally perennial species capable of displacing at least one vegetation stratum and/or are capable of inducing overt modifications to the function of the system by changing, for example, light, fire or hydrological regimes</p>
Tourism & visitor management	1.0.1, 1.0.8, 1.0.9, 2.4.1, <b>2.5.3, 2.5.4, 2.5.5, 2.5.6</b> , 2.5.7, 3.0.1,	<p>The nature-based tourism industry is a relatively small but regionally significant contributor to the overall economy of the region. Nature-based tourism involves the development of tourism products that go beyond sightseeing to enhance visitors' appreciation and understanding of the scientific and ecological features of the Wet Tropics' natural attractions. It is a philosophy which advances the principles of ecologically sustainable development as well as providing opportunities for sustainable commercial use of the Wet Tropics' natural and cultural assets.</p> <p>The current state of knowledge does not allow the prediction of ecological limits on the effects of tourism with any confidence. There is a need for socio-economic research on the effects of tourism on local communities and for development decisions to take account of social costs and benefits as well as economic and environmental factors.</p> <p>Visitor information (both residents and non residents) is vital to maintaining or improving the quality of visitor opportunities and to formulating strategies to successfully manage current and future visitor demand consistent with the protection of natural and cultural values.</p> <p>The impact of visitors on the Area and the surrounding region is significant. The impact can be positive in terms of enhancing the local economy and increasing appreciation of natural values or it can be negative in terms of its effect on the natural environment and other people.</p>
Aboriginal issues	<b>2.5.1, 2.5.2</b>	<p>Native Title, moving back to country, and protocols for Aboriginal participation in the management of the Area are all emerging issues with widespread implications to our current concepts of management. The preferred approach to both the resolution of competing interests and the facilitation of common management goals is the development of statutory land management agreements.</p> <p>On 3 June 1992, the High Court of Australia rejected the doctrine that Australia was terra nullius at the time of British settlement and recognised the existence of native title. Unlike the rights of private land (ordinary title) holders, the nature, extent and location of the rights of native title</p>

Key Forces for Change	Relevant SMA	Reason/Rationale
		<p>holders is currently unclear. The Wet Tropics Management Plan is a permissible future act under the Commonwealth <i>Native Title Act 1993</i>, as it ensures that native title holders are not more disadvantaged at law than ordinary title holders.</p> <p>Section 211 of the Commonwealth <i>Native Title Act 1993</i> serves to preserve the ability of native title holders to undertake certain activities (such as hunting, fishing, gathering, and cultural or spiritual activities) in an unregulated manner (ie. no permit, licence or authority is required) where that activity is (a) for non-commercial and domestic purposes, and (b) where that activity is not totally prohibited at law or only permitted for specific research, environmental protection, or public health and safety purposes</p> <p>In some circumstances, the exercising of native title rights may be inconsistent with Australia's obligations under the World Heritage Convention to protect World Heritage values. The Authority recognises that the exercise of native title rights also has the potential to enhance the conservation of World Heritage values.</p> <p>Although the Wet Tropics of Queensland World Heritage Area was not listed for its cultural values, research is being undertaken to determine if a case exists for renomination of the Area on the basis of cultural heritage values. Depending on the outcome, the Commonwealth Government may consider the case for the renomination of the Area.</p>
Population growth and regional development	1.0.9, 1.0.1, 1.0.2, 1.0.4, 1.0.5, 1.0.9, 1.0.11, 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.2.1, 2.4.1, 2.5.4, 2.5.5, 2.5.6, <b>2.5.8</b> , 3.0.1	Ultimately, the human population the region has to support and entertain will be the major stressor on the WHA. Population growth inevitably leads to greater demands for energy supplies and their distribution, the upgrading and duplication of transport corridors, increased demands for high quality water supplies for domestic, agricultural and industrial uses and greater demands for recreation and tourism pursuits.
Climate change	1.0.1, 1.0.2, 1.0.5, 1.0.6, 1.0.8, 1.0.9, 1.0.10, <b>1.0.11</b>	The Authority can do very little about this. Some likely manifestations of climate change in the Area include: (a) an increased occurrence in particular forest types of species characteristic of other forest types, (b) changes to forest structure and (c) increases in the number and distribution of pest species taking advantage of stressed and disrupted ecological systems.

The first five of the listed Key Forces for Change emerged as particularly significant for the Authority to champion and take a lead role. Population Growth and Regional Development, although recognised as a very powerful driver of environmental change, occurs outside the WHA and therefore is outside the Authority's immediate sphere of influence or responsibility. It has been recognised as a 'whole of government' issue and part of the regional FNQ2010 planning process. Although the Authority is a player in this process, it is not its role to be a lead agency. This information needs document, however, recognises its pre-eminent importance.

Similarly, Global Climate Change, although acknowledged as having the potential for causing major changes to the Wet Tropics is recognised as a national and international issue. Although the importance of modelling different climate change scenarios, particularly where they can be linked to a need to revise management prescriptions is acknowledged, it must also be recognised that the research agenda and priorities for this issue need to be formulated in a context much larger than the Wet Tropics region.

**Figure 2** Key Forces for Change in the Wet Tropics





## 6.0 Information Needs Prioritisation

Brief significance statements for each identified SMA are presented in Section 2 of this document. Section 3 is a more complete and comprehensive listing of information needs, management objectives, key management questions and, where applicable to reactive needs, key locations where the benefits of the research would be immediate. Further identification of Key Locations by land managers is considered important in ensuring the direct relevance of any research project. Focussing research at Key Locations may also provide opportunities for integrated, collaborative research leading to value-added outcomes.

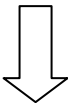
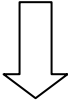
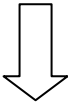
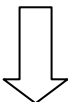
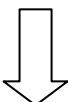
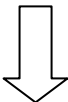
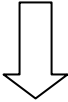
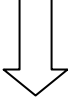
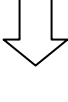
Section 4 of the document summarises the results of land managers' prioritisation of information needs for the WHA. Although all SMAs detailed in Sections 2 and 3 of this report were considered important research areas by at least some research users or research providers, Section 4 was designed to identify immediate needs based on a set of short-listing criteria (Figure. 3). The criteria used were also selected to ensure that the spectrum of management concerns including topical issues, emerging issues, underlying issues and ongoing issues were considered.

**Figure 3.** Short-listing Criteria

- ❑ ***immediacy of concern***  
(i.e. the need to take immediate corrective action to avoid irreversible damage to World Heritage values)
- ❑ ***immediacy of need***  
(e.g. to support priority management projects/programs under WTMA Strategic Plan)
- ❑ ***magnitude of concern***  
(i.e. level of risk, scale of potential impact)
- ❑ ***feasibility of achieving objectives***
  - ❑ what is the underlying cause(s) of the current failure to manage the issue successfully?
  - ❑ is it within the 'sphere of influence' of management?
  - ❑ what form of intervention to improve management is likely to be most successful, and what are the costs, anticipated benefits and risks?
- ❑ ***the applicability of the research across a range of SMAs***

A four phase approach has been taken to focus and prioritise relevant information needs. The approach is shown schematically in Figure 4.

**Figure 4. Information Needs - Prioritisation Process**

Phase	Process	Reference	Detail
• ↓	Identification of general research principles 	2.7	2.7
• ↓	Identification of types of research 	3.0	3.1-3.3 Figure 1
• ↓	Identification of research themes 	4.0	Table 1 Section 2
• ↓	Identification of Strategic Management Areas (SMAs) 	4.0	Section 2 Table 1
• ↓	Identification of management information needs 	Section 3	Section 3
• ↓	Identification of management objectives 	Section 3	Section 3
• ↓	Identification of key management questions 	Section 3	Section 3
• ↓	Identification of Key Forces for Change (KFC) 	5.0	Table 2 Figure 2
• ↓	Short-listing of SMAs 	6.0	Figure 3
•	Priority Research Projects	Section 3	Section 3

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**SECTION 2**

**Information Needs and Strategic Management Areas**

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## Significance of Strategic Management Areas (SMA)

### Understanding Natural Patterns, Processes and Functions

#### 1.0.1 Monitoring & Reporting

Monitoring the conservation of the World Heritage Area is an essential part of its management, and an obligation under the World Heritage Convention and its Operational Guidelines. Monitoring is a process of detecting environmental, social, cultural and economic change with reference to a baseline condition, whilst reporting is a process involving review, evaluation, assessment and presentation of monitoring results. The objectives of monitoring and reporting are to maintain World Heritage values, to enhance management and conservation practices, and to facilitate decision making with regards to preventive actions.

The *Wet Tropics World Heritage Protection and Management Act 1993* requires the Wet Tropics Management Authority to report annually on the State of the Wet Tropics. WTMA is preparing this report consistent with the uniform approach to state of the environment reporting adopted by most Australian governments. This “state-pressure-response” approach is based on the concept of causality: human activities exert pressures on the environment; these change its state or condition; society responds by developing or implementing policies that influence those human activities, and so change the pressures that place natural processes at risk.

Monitoring is the mechanism by which active, direct and accountable assessment of the performance of WTMA policies against actual environmental outcomes can be gauged. Reporting will assist in evaluating the implications of environmental trends and conditions and help assess the relative importance of different environmental issues and in the setting of priorities. Research is required to establish the relationships from which robust, meaningful indicators can be derived. Appropriate management indicators should have the following characteristics:

- correlate strongly with changes in ecological processes or other attribute of interest
- be applicable to a broad range of regional ecosystems
- integrates environmental effects over space and time
- relate unambiguously to an identified issue
- be functionally important
- indicate a response in a measurable way
- provide an indication of widespread change
- have a standard measurement technique
- exhibit low measurement error
- provide an early warning system
- be credible and widely acceptable
- be responsive to short or medium term change
- be capable of being reported simply
- be available and do-able
- be affordable

Useful indicators should be selected to answer the following kinds of questions:

What is the problem and what does it affect?

What is the status of the problem?

How widespread is the problem?

Is the problem getting better or worse and how quickly?

How certain are the scientific conclusions about the problem?

#### 1.0.2 Natural resource mapping, modelling & assessment

A wide range of new and emerging technologies including satellite remote sensing, digital terrain models and radiometrics coupled with GIS offer new methods of land assessment/classification, mapping, and monitoring. These new technologies will increasingly provide powerful prediction and assessment tools in addition to value-adding to other research projects and may provide rapid, accurate and explicit reporting on the state of the Area at the regional scale. The application of computer modelling to classify satellite imagery by land cover type, in conjunction with the assessment of historical trends in land cover change, and analyse relationships between land cover change and socio-economic variables would provide a very useful and powerful reporting tool. The application of such technology to the mapping and modelling of faunal distributions in the Area will also greatly aid our understanding and management.

#### 1.0.3 Collation & analysis of existing data & information

Land managers appreciate that there has been much high quality and potentially useful research undertaken in the region. The establishment of the Rainforest CRC and the Cairns Campus of James Cook University has accelerated the rate of research and increased the range of research disciplines. Land managers are unfamiliar with a large proportion of this research. Often the research, although of a high quality, is not in a form useful for decision makers. An important attribute of research that immediately increases its relevance to management is having it spatially referenced. Land management issues are largely concerned with discrete parcels of land rather than discrete species or processes. Being able to access all the available information relevant to an area would be very useful and the concepts of data and knowledge warehouses appealing. Spatially referencing existing data sets would also have the benefit of enabling these sets to be value-added and incorporated into models, identify knowledge gaps and poorly known areas, and identify a range of issues that should be taken into account in decision making. Similarly, the establishment of a directory of researchers, their research interests, areas of expertise and specialist skills would be a useful resource.

#### **1.0.4 Sites of special scientific interest**

It is recognised that there are parts of the Area which should be managed in special ways due to their intrinsic natural or scientific values. These values could be related to flora, fauna, geological, physiographic or cultural features. They might be of particular scientific interest because they are recognised as type localities for taxonomic species, are benchmark sites for long term monitoring or ecological/evolutionary process research or for other important scientific reasons. Such sites need to be recognised by land managers and planners so that they are protected and explicitly managed for these purposes.

#### **1.0.5 Biological diversity**

Land managers identified the need for biological surveys and inventories, and the incorporation of the results into generally accessible, consistently formatted, spatially referenced, databases. The drawing together, upgrading and supplementing of information on the distribution of species, vegetation types and heritage sites is useful basic information upon which management decisions rely.

The Wet Tropics conserves an extraordinary degree of biological diversity as well as providing the major habitat for numerous threatened species. The Wet Tropics is the only habitat for more than 400 species of plants and 70 species of animals that are regarded as rare, vulnerable or endangered. The Area contains the habitats of 17 per cent of Australia's vascular plant species comprising 65 per cent of Australia's fern species, 21 per cent of Australia's cycad species, 37 per cent of Australia's conifer species and 30 per cent of Australia's orchid species, 36 per cent of Australia's mammal species, including 30 per cent of Australia's marsupial species, 58 per cent of Australia's bat species and 25 per cent of Australia's rodent species, 50 per cent of Australia's bird species (370 species of which 130 principally inhabit closed forests), 25 per cent of Australia's frog species, 23 per cent of Australia's reptile species and 41 per cent of Australia's freshwater fish species.

Research into conservation requirements for biodiversity should be directed at all levels of biological activity, including species, habitats, communities, populations and landscapes. It is vital to maintain diversity and resilience as a basis for alternative futures and for the maintenance of evolutionary processes. The priority order for conservation and research of species, other taxa and species assemblages of plants and animals identified in *Protection Through Partnerships* is:

- endangered and vulnerable;
- monotypic rare and threatened;
- endemic rare and threatened with restricted distributions;
- endemic rare and threatened with a wider distribution;
- non-endemic rare and threatened; and
- primitive and/or endemic.

#### **1.0.6 Genetic diversity and evolutionary history**

Much of the world's humid tropics is of 'recent origin' and subsequently endemism in these areas of species richness is surprisingly low. However, the long-isolated floras of New Caledonia, Madagascar and Queensland's Wet Tropics have exceptionally high levels of endemism. These centres of endemism are significant as diverse gene pools, capturing variation over a very wide evolutionary time span and are potentially significant for new radiations in a world of changing global climates. Many of the endemic species and genera are narrowly restricted within the Wet Tropics and several local centres of endemism have been identified. Many species are restricted to upland areas, divided by altitudinal barriers into two or more disjunct allopatric populations. Current research has identified marked genetic differences between populations of many organisms separated by ecological barriers in the Area. The results show major genetic breaks that represent very distinct evolutionary lineages. Findings from these genetic studies indicate that individual disjunct populations are the evolutionary significant unit of conservation rather than the species *per se*.

#### **1.0.7 Rarity**

The Wet Tropics region has the highest density of rare and threatened plant species in Queensland. Of the 433 species officially listed for the bioregion, 383 are conserved within the World Heritage Area. Of the endangered species, there are 10 orchid species and four

tassel fern species listed; similarly there are eight vulnerable orchid species and a further 4 tassel fern species listed, reflecting not only the loss of habitat in the region but also the impact of illegal collection

There are many rare and/or threatened species among the fauna endemic to the Wet Tropics. Of particular concern is the dramatic decline in population numbers of seven species of frogs endemic to the Wet Tropics. The causes of the declines have not yet been identified. Populations of the Southern Cassowary, *Casuarius casuarius*, have declined as a result of clearing and habitat fragmentation and possibly predation by dogs, competition with pigs and introduced diseases to the extent that the species is considered endangered under both Queensland and Commonwealth legislation. The Southern Cassowary has been postulated as being a 'keystone' species, playing a critical role in the dispersal of the seeds of large-fruited rainforest plants. Although considerable community effort has been directed at cassowary conservation, and into snapshot population surveys, very little research has been undertaken on the ecology and population dynamics of the cassowary. Almost no research has or is being done on threatened plant species apart from some very preliminary studies and surveys on a total of less than 8 species out of the over 400 plant species listed as Rare and/or Threatened for the region.

A substantial proportion of species endemic to the Wet Tropics bioregion are locally common but have geographically restricted ranges. The identification of geographic and taxonomic patterns of rarity in relation to regional history and ecological/environmental factors is important as it addresses fundamental questions about distributions of species' ranges in complex ecosystems and strategic management issues. Such information will provide the basis for improved conservation planning and prioritisation. Research directed towards developing and testing hypotheses to explain constraints on ranges of rare species, including effects of history (especially regional extinctions; cf. neo- vs. paleo-endemics etc.), current environment, ecological interactions, comparison of demography at core vs. periphery of range. Such information is also necessary for the enhanced management of endangered or threatened species.

Basic population ecology research is also an identified need. Determining the key processes and functions that maintain patterns of distribution and abundance is seen as important. In the Wet Tropics a large proportion of all native species are rare. Generally it is not known why they are rare, whether they should be regarded as 'at risk', or how species with chronically low numbers avoid extinction. The opposite population ecology problems arise with invasive introduced pest species, but many of the same types of questions are relevant to their successful management. The increasing number of weed species was identified as posing one of the biggest management problems both at present but particularly in the future.

### **1.0.8 Ecosystem Dynamics**

Biological communities in the Area are extremely rich in species making it difficult to understand processes of interactions and patterns of distribution. Evolutionary and ecological processes alter the composition of biological diversity in time and space. Proper understanding of the mechanisms involved is essential for achieving ecological sustainability in management. Responses of rainforests to both long-term climate change and short-term environmental disturbances must be understood and predictive models of patterns and processes must be constructed for the conservation and rehabilitation of rainforest and for the management of rainforest use.

The dynamics of the Wet Tropics both over ecological time scales (successional sequences, revolutionary) and geological time scales (evolutionary) are understood much better than previously due to recent advances in genetic and dating techniques and in spatial and temporal modelling and GIS, however the research needs to be translated into prescriptions for long-term management.

The ecological processes of pollination and seed dispersal is poorly understood. Much is made of the importance of flying foxes and cassowaries for dispersal of seed and the role of bats, birds and invertebrates in pollination. Can those species most important for rainforest pollination/seed dispersal be identified and prioritised for conservation management, especially those that are being affected by processes outside rainforests such as cassowaries and flying foxes?

### **1.0.9 Disturbance and change (Quaternary and Contemporary)**

It is important if valid predictions of the consequences of activities are to be made that the responses of species and ecosystems to natural and artificial disturbances are understood both spatially and temporally. For example, how do rare species respond to natural and human-induced disturbances? how do these responses relate to phylogenetic and landscape history? which species or community types are resilient to disturbance and why? which types of species or communities require active management intervention as opposed to benign neglect? These responses need to include both ecological and evolutionary dimensions, i.e., changes in distribution & abundance, population dynamics, gene flow and selection regimes and include such things as the effects of fragmentation, edge processes, impacts of introduced weeds and ferals particularly at the interface of rainforest and agricultural lands.

### **1.0.10 Fire**

Fire research was consistently identified as one of the most important on-ground land management needs. One of the most significant variables in open forest/woodland ecosystems is the fire regime. Fire may be either a natural event or a management tool used to maintain landscape diversity of particular vegetation types, and sometimes to control weeds. Its use as a management tool is important because it has had a long-standing association with the vegetation and on a wide range of biota.

Ecologically significant changes to the rainforest/open forest boundary have taken place over the last 50 years with large areas of wet sclerophyll forest types, in particular, being progressively converted to rainforest. Presently, wet sclerophyll forests occur as a discontinuous strip up to 4 km wide along the western margin of the rainforest and occupy approximately 54,000 ha which is only half the extent identified from airphotos taken in the 1940's. It is a matter of urgency to find out which biota are dependent upon wet sclerophyll forest types and how threatened they are by the rapid trend toward rainforest. The yellow-bellied glider and the tropical bettong are two candidates for concern but there may be less obvious species of plant and animal which are involved. Clearly the main source of managerial power lies in fire control and there is strong evidence that current vegetation changes, of considerable conservation significance, may be manipulated by control of fire.

Research is needed to identify optimal burning regimes for the maintenance and regeneration of sclerophyll communities, especially wet sclerophyll forests and for assessing the effects of altered fire regimes, cattle grazing, and the spread of exotic grasses and weeds (changing fuel loads and dynamics) in sclerophyll forests. Research is needed relating the role of fire in maintaining, enhancing, decreasing or modifying habitat diversity, and the ecological effects of fuel-reduction burning. An assessment of the use of fire as a management tool for controlling problematic weeds such as pond apple or the use of fire as a management tool for manipulating the habitat of the endangered northern bettong are also required.

### **1.0.11 Climate change**

There is growing evidence that increases in atmospheric concentrations of 'greenhouse' gases will result in additional rapid warming of the earth's surface. This is likely to lead to climatic changes, including increased temperatures, sea level rises and altered rainfall regimes. The extent, pattern and timing of such changes remains uncertain. The ability of species and ecosystems to adapt to climate changes is affected by the rate of change and the likely increases in the frequency of extreme climatic events rather than by a general trend. The stresses caused by these extreme abnormal events could prove to be very powerful selection forces resulting in the elimination of certain species from certain environments, increases in occurrence in particular forest types of species characteristic of other forest types, changes to forest structure or environmental disruptions which are more favourable to such changes and increases in the numbers and distribution of pest species taking advantage of stressed and disrupted ecological systems.

## **Human Activities and Interactions with the Natural Environment**

### **Design and management of community infrastructure**

Internal fragmentation occurs when natural habitats are dissected and wildlife populations subdivided by linear clearings. Presently 0.22% of the Area has been directly impacted by the clearings associated with the network of powerlines and roads. When artificial lakes, railways and cableways are included, 0.46% of the Area has been directly impacted by linear infrastructure clearings. Species most likely to be affected by severance of forest links are those with large home ranges, poor dispersal abilities, patchy distributions or arboreal specialists. Habitat fragmentation may have major impacts on the dispersal of young, particularly in territorial species. An artificial barrier suddenly alters historic natural patterns of gene flow among populations which may have serious consequences for the long-term preservation of evolutionary diversity.

#### **2.1.1 Linear service corridors: roads**

Roads in the Area provide access for conservation management and research, access for private land owners, access to public utilities and access for visitors to enjoy and appreciate the Area's recreational and heritage values. Some of these roads are part of a regional network linking urban areas and major highway systems throughout northern Queensland.

Most of the roads within the Area were built to service past logging operations. Following the cessation of logging many of the minor roads and snig tracks have become over-grown or fallen into disrepair, some of these can be successfully managed by benign neglect, however, it is likely that a significant proportion should be actively decommissioned and rehabilitated.

Roads and traffic can harm World Heritage values, occupying and fragmenting large areas of habitat otherwise available for wildlife, contributing to erosion, sedimentation and pollution of land and stream habitats, and encouraging the spread of weeds, diseases and feral animals. Several components of a road act as a barrier to wildlife movement including its width, both the exposed bare road surface and the altered verge habitat in addition to the noise, movement, dust, emissions, and lights associated with traffic. Roads are also a significant source of mortality for wildlife. For some species, particularly those that are large or rare, road kills can have a significant effect on their conservation status. This is the case with the cassowary where collisions with vehicles are a major cause of their decline. In areas such as Mission Beach, for example, there are at least three adult cassowaries are killed by vehicles annually.

WTMA's Road Access Strategy does not propose any new roads for the Area. However, transport studies indicate it is likely there will be demands for significant upgrading of the Kennedy, Bruce, Captain Cook and Gillies highways and several other roads within the next 10 years to cope with the expected increases in regional traffic levels.

### **2.1.2 Linear service corridors: powerlines**

Electricity facilities and the maintenance of corridors of slashed vegetation beneath them, in addition to networks of access tracks for line maintenance have substantial impacts on World Heritage values. Powerlines cover 1316ha of the Area. The width of a powerline clearing is thought to form an effective barrier to the movement of most non-flying terrestrial and arboreal rainforest fauna. Powerline clearings are a major cause of weed and pest intrusions into forested areas and also provide a conduit for fire into rainforested areas. Powerline corridors occupy areas of habitat otherwise available for wildlife and encourage the spread of weeds, diseases and feral animals. The corridors also fragment or divide habitats and can prevent animal movement, particularly that of arboreal mammals (e.g. possums). This in turn can make animals with small populations vulnerable, lead to a long-term reduction in animal species viability and reduce the dispersal of seeds and pollen by animals. Research indicates that, especially in closed forest situations, the wider the corridor clearings and reduced canopy connections, the greater the impacts on flora and fauna. Studies have shown that the impact of wide clearings is not confined to the clearing itself, but extends as a wide band of low integrity forest along its length which may extend over 200 metres into the rainforest thereby potentially impacting 12,960 ha of the World Heritage Area.

As the resident and tourist population of northern Queensland continues to grow, so will the demand for electricity supplies to service urban areas. Demand management and alternative power sources may assist in reducing the number of powerlines and facilities in the Area.

### **2.1.3 Linear service corridors: walking tracks, pipelines, other services**

Currently, most detailed presentation and enjoyment of the WHA is based on visitor access by foot along tracks and pathways, both at mass-tourism sites and in more remote settings. Local recreational use also is based on paths and trails. These demands will increase, particularly as many of the outstanding natural values of the area are located close to rapidly-growing centres of population. There are very few published studies on the impacts and effects of such developments and their use in the Area - both with respect to direct impacts and to associated or transferred effects. The Authority is currently in the process of finalising a Walking Track Strategy for the region which will identify a number of specific information needs. There has been much debate regarding the need, desirability and feasibility of constructing and maintaining a 'long distance' walking track in the Area, much research is required before an informed decision on such an issue can be made.

### **2.1.4 Water infrastructure and extraction**

Water impoundments are major landscape modifiers. They result in the direct loss of both terrestrial and aquatic habitats through drowning and introduce water barriers to terrestrial fauna movement. Impoundments isolate upper tributaries from their downstream reaches and tributaries. As a consequence of a reduction in the frequency of channel maintenance flows, streams below impoundments are not capable of maintaining their characteristic geometry and channels may become choked with sediments and aquatic plants. Reductions in flow rates also result in substantial reductions of productive riffle habitats. The degree of seasonality and predictability of flow, and the timing of key flow events, are of critical importance to the ecological functioning of aquatic ecosystems in the Area. Fish also have well defined seasonal (flow-related) cues for spawning and movement.

While rainfall in the region is very high, it is also distinctly seasonal and unreliable. There are three dams in the Area, Copperlode Falls Dam, Paluma Dam and Koombooloomba Dam. The first two supply the urban water requirements of the Cairns and Townsville region while Koombooloomba provides a water source for hydroelectric power generation. Ten Local Authorities have 27 weirs within the Area with associated pipelines, access roads and powerlines. Recent figures indicate that per capita water consumption ranges from 560 litres/person/day to 1,000 litres/person/day in the region. This consumption rate is expected to increase to cater for the increasing water needs of a growing urban and visitor population, expansion of irrigated agriculture and demands from industry.

Presently there are no generally accepted methodologies for assessing the instream flow requirements of any Australian river affected by flow regulation or stream diversions. The dynamic nature of Wet Tropics streams, the diversity of life forms and the requirements of a functional aquatic ecosystem will make the concept of minimal acceptable environmental flows very difficult to define.

Many people living near the World Heritage boundary use the rivers and streams of the Area for their water supply. Within the Area there are 71 private surface water extraction sites, but most of this water is pumped to properties outside the Area. The *Water Resources Act 1989* regulates the taking, use and diversion of surface water. The extent of ground water (sub-artesian) extraction in the Area is unknown and there are no restrictions under the *Water Resources Act 1989*. Water storage, diversion and extraction can alter the natural flow of the Area's rivers and streams, possibly leading to change in the aquatic environment and harming World Heritage values. There are limits to the amount of water that can be extracted before the health of a stream is affected.



Groundwater extraction from the tableland's basalt aquifer is another area of concern as it is thought to be vital for the recharge of many of the higher order stream tributaries which originate in the WHA. Many of these tributaries have very high biodiversity values and many, due to their spatial separation may be very significant ecological and evolutionary units.

### 2.1.5 Telecommunication facilities

There are 22 public and private telecommunications facilities in the Area. They include microwave and radio repeaters, marine and aeronautical safety radio repeaters and beacons, fibre optic cables, meteorological and radar installations and radio and TV broadcast systems. An aerial cableway provides access to the top of Mt Bellenden Ker for maintenance of communications equipment and another provides access from Kareeya power station to Koombaloo dam intake.

These facilities can create a range of problems for the Area's natural systems:

- it is technologically desirable for such facilities to be built on mountain tops (e.g. to increase transmission range), but mountain tops are often the last refuges of rare, restricted and ancient species of plants and animals;
- siting such facilities on ridgelines and peaks can affect the scenic beauty of a landscape vista. The Area's beautiful scenery is a drawcard for millions of visitors who travel to the region each year; and
- these facilities may require access roads or cableways. The area around the facilities may also need to be cleared extensively to allow for maintenance.

## Resource Use

### 2.2.1 Drainage

Water relations are basic to all biological processes, and alterations to hydrological systems are likely to have the potential for major direct and indirect impacts on the natural values of the Area. The threat is likely to be manifestly more immediate in the coastal lowlands especially in parts of the Area characterised by swamp or poorly drained communities. A number of such communities have been identified as 'endangered' or 'of concern' regional ecosystems.

### 2.2.2 Grazing

While grazing of domestic stock is generally incompatible with the goals of World Heritage Area management, the Authority respects the existence of grazing tenures issued over land prior to World Heritage listing. There are 37 grazing properties consisting of 10 pastoral holdings, 20 special leases, 5 annual occupation licences and 5 stock grazing permits issued by the Department of Natural Resources. The term of these tenements is variable. Under present arrangements, 17 special leases will continue beyond the year 2000, with the longest to continue to the year 2037. The leased lands in the Area often adjoin and/or are part of adjacent pastoral areas. Grazing tenement boundaries often include extensive rainforest areas unsuitable for grazing of stock. In some circumstances, grazing activities can assist with World Heritage management (e.g. fire management). Recently renewed leases and permits within the Area have included only open forest (i.e. land suitable for grazing) in the lease or permit. The conditions of the leases vary with regard to public access rights and other management activities.

Graziers often assist management of the Area by keeping a watch over the land, fighting inappropriate fires and controlling weeds. However, cattle grazing may damage the Area's biological diversity through introduction of weeds and diseases, trampling vegetation and increasing soil erosion. Graziers may also prefer fire management arrangements which encourage the growth of grasses at the expense of forest regrowth. For these reasons, cattle grazing is not always a land use which is compatible with the World Heritage requirements of protection, conservation, rehabilitation and presentation. Little is known of the range and intensities of ecological impacts caused by grazing or of acceptable cattle grazing carrying capacities for different ecosystems. It is also not known what impacts the sudden removal of cattle grazing may have on ecological systems which have been subjected to this activity for long periods of time. Detailed criteria for dealing with lease renewals and/or proposed boundary amendments need to be developed.

### 2.2.3 Collecting forest products

Commercial, recreational, scientific, educational and traditional use of plants and animals can affect the Area. Collecting firewood can have significant impact through the removal of animal habitat, trampling vegetation, creation of access tracks and interfering with the natural decomposition rate of forest products into the soil. The state forests in the Area are a significant source of seeds for tree planting programs on both private and public land. The Community Rainforest Reforestation Program and the Wet Tropics Tree Planting Scheme obtain significant proportions of their seed from the Area. Commercial permits are also granted within the state forests and timber reserves. State forests in the Area provide a significant source of genetic material for tree planting programs.

Both the direct and indirect ecological impacts of collecting and use of forest products is presently unknown. Also unknown are the potential long-term impacts of the translocation of genetic material from one area to another through revegetation programs and the commercial distribution of seeds, seedlings and cuttings.

#### **2.2.4 Bee-keeping**

The beekeeping industry is an essential part of the State's primary production system. A number of horticultural crops grown in North Queensland depend on honey bees for successful cross pollination. The success of the expanding horticultural industry in North Queensland is dependent on an adequate supply of honey bees to provide these pollination services. Beekeeping relies on native flora, particularly eucalypts, for over 90% of its production resource. There are some localities within and adjoining the Area which have been identified by the beekeeping industry as important. These localities are on the western fringe of the area, outside rainforest, in sclerophyll forests. The industry asserts continued access to these areas is critical to maintain its success in North Queensland and that such success is vital to the adequate supply of bees for pollination in the area. The prime requirement of beekeepers in periodically locating bees in these areas is for the rebuilding of vigour in bees which have been utilised for pollinating of horticultural crops. Beekeeping usually involves the migration of bees from site to site, depending on the availability of food resources, so apiary sites are unlikely to be occupied all the time. There is still a need however, to keep tracks open for truck access, a need for a clear area around the hives to protect them from fire, and there may be social impacts due to incompatibility between recreational use and bees.

The ecological impact of managed honey bees on native flora and fauna is a matter of debate. Scientific opinion is presently divided as to the extent of the impact of bees on natural ecosystems, however, areas of concern include:

- increased hybridisation of native plant species (and therefore a loss of genetic diversity);
- competition for nectar supplies with birds, native insects and nectar-feeding bats, leading to their long-term decline;
- possibility of disease transmission; and,
- reduced pollination of some native plants, especially those adapted to pollination by birds.

## **Pest Control**

### **2.3.1 Environmental weeds**

Environmental weeds are introduced, invasive plant species capable of establishing self-sustaining populations within native communities or ecosystems and are capable of causing major modification to species richness, abundance or ecosystem function. Many have the ability to displace at least one vegetation stratum and/or are capable of inducing overt modifications to the function of the system by changing, for example, light, fire or hydrological regimes. These attributes are major threats particularly to locally restricted endemic plant and animal species and communities.

Most management effort to date has been directed at pond apple while the most concerted strategic control effort has gone into *Thunbergia* in the past and now *Harungana*. Unfortunately, the list of environmental weeds gets bigger every year as new problems continually emerge. We do not understand the issue well enough to identify most problem species before they get out of hand.

It is accepted that the Wet Tropics will never be totally free from the effects of weeds and that new weed problems will continually arise through importation, translocation or existing benign plants becoming weedy following changes in surrounding land use or climate. Similarly, existing weed problems will not disappear in the short to medium term, even with unlimited resources and the immediate implementation of the best management systems available. A strong input from research into identifying new and potential weed problems, assessing their impact, and dealing with them effectively will be essential if the integrity of the Area is to be maintained.

### **2.3.2 Feral animals**

Invasive animal species are introduced species which become established in natural ecosystems and act as agents of change thereby threatening native biodiversity. Evolutionary isolated biological systems, which characterise the Area, are especially vulnerable to biological invasions. Habitat modification through selective feeding, trampling damage, rooting, predation on, competition with, or disturbance of the Area's natural systems are the major threatening processes acting on many of the Area's threatened species. In addition, invasive animal species may also act as hosts, vectors or amplifiers of diseases and parasites that can affect native wildlife or human health.

Most research effort to date has gone into feral pig, papaya fruit fly and palm leaf beetle research all of which also have impacts on the agricultural community. Only very limited research has been of an ecological nature. The pig issue has eclipsed all other feral animal issues in the Wet Tropics, as the public perceive it as being our major feral animal problem. Recent interest has been shown in the feral fish *Tilapia*. Invertebrate pest species research is almost non-existent but is considered a very important area for research. In

many instances invasive invertebrate species could interfere with basic ecological processes at an early stage in the natural web of ecological interactions. At present we do not understand the ecology of pest animals very well and this is reflected in our inability to either identify or manage the problem adequately.

### 2.3.3 Diseases

Diseases are an insidious but very real and immediate threat to the natural values of the Area. An extensive sampling of rainforest sites affected by patch deaths in the region found *Phytophthora cinnamomi* on 41 percent of 128 sampled. In a seven year period to 1981, a total of 3,019 soil samples were analysed and *P. cinnamomi* was isolated from 33 percent of samples. In October 1999 many small patches of rainforest 'dieback' were located in the vicinity of Tully Falls and in the Koombaloo area. What has caused these forest deaths, what has triggered this phenomenon, how widespread it is, or what area of forest is potentially at risk, is unknown but is a major concern, as is how management should respond to such events.

Disease has also been implicated as the threatening process causing the disappearance of seven upland stream dwelling frogs in the Area. The most promising culprit has been identified as a chytrid fungi. If this is shown to be the primary causal agent then at last research can be directed at treating the problem rather than at trying to identify the problem, and/or identifying which other species are potentially at risk.

There is concern at the prevalence and possible virulence of mycobacterial infections observed from autopsied road killed cassowaries. The concern is whether the observed infections are unnatural and whether it could reduce the survivorship (particularly of young birds) or vigour of these long-lived, endangered birds.

Currently there is no information on natural background levels or disease loads of native wildlife in the Area.

## Economics

### 2.4.1 Environmental goods and services

Ecosystem goods and services represent the benefits human populations derive, directly or indirectly, from ecosystem functions. The services of ecological systems and the natural capital stocks that produce them are critical to the functioning of the Earth's life-support system. They contribute to human welfare, both directly and indirectly, and therefore represent part of the total economic value of the planet.

Because ecosystem services are not fully 'captured' in commercial markets or adequately quantified in terms comparable with economic services and manufactured capital, they are often given too little weight in policy decisions. This neglect may ultimately compromise the sustainability of human uses in the region. It can be instructive to estimate the 'incremental' or 'marginal' value of ecosystem services, that is, the estimated rate of change of value compared with changes in ecosystem services from their current levels, given different development scenarios. This is a relatively new science, but it is important that the right sort of information is collected and presented in a form useful for ecologists, economists, policy makers and the general public.

Being a new science, we acknowledge that there will be many conceptual and empirical problems inherent in producing estimates of economic worth, however, it is essential in order to: make the range of potential values of the services of ecosystems more apparent; establish at least a first approximation of the relative magnitude of wet tropics ecosystem services; set up a framework for further analysis; stimulate additional research and debate.

The WHA provides a wide range of goods and services including the maintenance of environmental processes, a wide range of resource uses, provides enjoyment, aesthetics, ethical and moral values.

## Social

### 2.5.1 Contemporary Aboriginal issues and aspirations

The Authority supports research that may assist the Commonwealth Government in establishing whether there is a case for World Heritage listing of the Area on the basis of its cultural values as well as its natural values. There is growing support for increased Aboriginal involvement in managing the Area. This has been acknowledged by the Queensland Government. For example, the preamble of the *Wet Tropics World Heritage Protection and Management Act 1993* states: "It is also the intention of the Parliament to acknowledge the significant contribution that Aboriginal people can make to the future management of cultural and natural heritage within the Area, particularly through joint management agreements".

The Authority has undertaken a Review of Aboriginal Involvement in Management of the Area at the direction of Ministerial Council. The Review involves 14 Terms of Reference, based on two main themes:

- recognising Aboriginal people's aspirations; and
- identifying ways of better meeting these aspirations through the evaluation of existing and potentially new mechanisms of involvement.

### **2.5.2 Traditional land management and knowledge**

The Authority is committed to meaningful Aboriginal involvement in management of the Area. Research on ethno-ecology and traditional land management in collaboration with the Aboriginal community will lead to a shared expertise and a common language in which to resolve conflicting perspectives on land management.

### **2.5.3 Tourism & visitor management**

Tourism is now the region's biggest industry with recreation based on the Wet Tropics World Heritage Area contributing \$670 million annually in direct and indirect income (Driml, 1994). The tourism industry is recognised as an ambassador for the Area and a major presenter of its attributes. Through interpretation, education and opportunities for involvement in its protection, visitors will become ambassadors for the values of the Area by fostering greater understanding and appreciation of this remarkable environment and the need to protect it.

The region has a well-developed service infrastructure concentrated within a relatively small area and functions as a major national and international destination point. The Wet Tropics of Queensland World Heritage Area, with about 4.7 million visits annually (Wet Tropics Management Authority Visitor Monitoring Survey, 1993) and the Great Barrier Reef, also a World Heritage site, are the major attractions for visitors who significantly boost the region's population at any given time.

A comprehensive understanding of visitor expectations, attitudes, motivation, satisfaction levels and behaviour is critical to effective visitor management, both in terms of maximising the opportunities to present World Heritage values, and, through sound management, to minimise biophysical impacts on World Heritage values. The goal is to ensure that visitation remains a quality experience for visitors as well as a benefit to the culture, economy and environment of the region. Maintenance of the Area's values and the attractiveness of these attributes is a necessary precondition.

#### ***Biophysical carrying capacity***

Carrying capacity is an indicator measure of the relative fragility of a site and identifies changes in its robustness to support a variety of visitor uses and activities. It is necessarily a composite measurement of the quality, quantity and sensitivity of a site's environmental and/or World Heritage value assets. The aim of researching biophysical carrying capacities is to be able to estimate safe limits of visitor numbers doing the most common range of activities on a site. This number could theoretically be enhanced or raised through management intervention/site hardening etc., or lowered through degradation and accumulated impacts.

#### ***Limits of acceptable change (LAC)***

There are benefits and disadvantages in having people visit the Area. Positive aspects include the money that flows into the local economy. Tourism and recreation based on the Area were found to contribute \$670 million annually in direct and indirect income to the Cairns and Townsville regions. This figure included \$377 million in direct expenditure made up of \$92 million direct expenditure in the Area and a further \$285 million. This calculation was based on tourists spending one night before and one night after their trip in the adjacent area (Driml, 1994). Although it is hard to quantify in economic terms, there are many other benefits of visitor use, such as enhancing appreciation of the natural world and providing opportunities for relaxation and social interaction.

The disadvantages of tourism can include trampling or clearing of vegetation; disturbance to animals; reduction in water quality; alterations in the landscape in an attempt to attract or please the majority of visitors; perceptions of crowding and congestion that reduces the quality of the experience for some visitors; disruption of local residents (e.g. many tour buses using a route through a suburban street); conflict between activities (e.g. canoes and motor boats on the same river); increased community costs to service visitors; and higher costs of living due to increased land and goods prices (e.g. the cost of housing in Cairns has increased dramatically with increased levels of tourism).

### **2.5.4 Landholders and neighbours**

Understanding the values and motivations of landholders and neighbours can provide the key to the management of significant conservation issues affecting the World Heritage Area, particularly those concerned with edge effects. It can provide the key to further understanding the motivation or incentive to conserve biodiversity on private lands. It can enhance the effectiveness of management in refining strategies along the World Heritage boundary. It provides a platform of understanding to better inform the development of partnership approaches.

### **2.5.5 Community attitudes**

An understanding of community attitudes towards the World Heritage Area assists in the management of conservation issues that involve community considerations. It can further assist in the effective targeting of management messages to the community. It allows the Authority to measure whether the World Heritage Area has a "function in the life of the community".

### **2.5.6 People/wildlife interactions**

Increasing demands on nature-based tourism pursuits will inevitably result in increased direct interactions between people and wildlife. Some human behaviours may be detrimental to the wellbeing of the wildlife concerned. Some activities alter animal behaviour - feeding may cause animals to associate people with food, which may subject them to risks of collision with vehicles or attacks by dogs. Such association and conditioning may also result in a level of expectation resulting in aggressive behaviour to humans who do not provide a "free feed".

Frequent spotlighting at a site may also have impacts, as may visits to features such as golden bowerbird bowers during their breeding season.

The management of domestic animals such as dogs and cats may also be a significant wildlife issue in parts of the Area.

### **2.5.7 Education, interpretation & presentation**

Information and interpretation is an important part of the Authority's responsibility to present the values of the Area to local, national and international communities. Presentation of the Area also occurs in a number of ways which do not involve visitation such as books and film. Interpretation centres run and managed by local community groups are an important component of the Authority's strategy of information dissemination.

Well designed environmental education programs can be one of the most important methods of management available. A community which is well informed of the natural, cultural and economic values of the Area and aware of how certain activities and processes could threaten those values is more likely to be supportive of management activities.

### **2.5.8 Population growth & regional development**

Australian Bureau of Statistics Census data (1981-1996) indicates the regional population of the 13 Local Government Areas increased from 253,818 in 1981 to 374,814 in 1996. The regional population in the decade 1986-96 increased by 29.67 percent. The figures also show a large increase in visitation. For example, the number of visitors recorded in Cairns/Mulgrave on census night rose from 10,563 in 1986 to 24,400 in 1996. The growth in both population and visitor numbers will result in an increase in the intensity of a range of pressures on the Area. The extent to which visitors draw upon resources and affect the environment depends upon the length of the stay and the nature of the visit. Coordinated regional planning will be necessary to reduce impacts of population growth. Population growth inevitably leads to greater demands for energy supplies and their distribution, the upgrading and duplication of transport corridors and increased demands for high quality water supplies for domestic, agricultural and industrial uses. Increases in population will place greater demands on the Area for recreation and tourism pursuits particularly with regards to access issues such as scenic drives and walking tracks. It is important to recognise that the region will change through time and across space under alternative population growth scenarios and to anticipate and plan appropriately.

It is also recognised that large lengths of the major rivers are outside the WHA and that the state of many of the streams within the WHA will be dependent upon what is happening outside. Similarly, it is not known at this stage how ecologically interconnected are the habitats inside and outside of the WHA. This is particularly the case for coastal habitats. There is a strong possibility that partially migratory and nomadic species use upland and coastal habitats seasonally or on an irregular basis. Many of them (both vertebrate and invertebrate) are likely to be pollinators and dispersers. Declines in their populations due to habitat loss in an area they migrate to has the potential to affect the dynamics of forest systems elsewhere.

## **Repair and Rehabilitation**

### **3.0.1 Ecosystem reconstruction, wildlife corridors & ecological linkages**

The maintenance and rehabilitation of the natural integrity of World Heritage values is a key principle for managing the Area. The focus should be on the rehabilitation of disturbed landscapes while developing processes and techniques that minimise environmental impact and permit the reconstruction of stable and self-sustaining ecosystems in the long-term.

Much revegetation is focussed on the creation of corridors between fragments, especially given the finding that the genetic structure of some isolated populations differs from that in the main forest. To help with the design and justification of these corridors it would be useful to know whether the targeted species actually use the corridors and whether they increase the likelihood of survival of species in the fragments.

## SECTION 3

### Key Questions for Management

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## Information needs, and key management objectives and questions most relevant to identified SMAs

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
1.0.1	<b>Monitoring and reporting</b>	<p>To develop operational methods for monitoring the condition of rainforests and waterways through a combination of field based sampling with GIS, remote sensing, and spatial modelling.</p> <p>To establish the relationships required to identify useful, robust indicators and other surrogate measures of change and to identify thresholds, natural fluctuations and variability inherent in such relationships.</p> <p>To develop performance indicators against which to measure the adequacy of policy and management arrangements in achieving biological diversity conservation objectives.</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> to develop systems not only for monitoring of potential impacts, but also to assess effectiveness of management procedures, and to develop early warning systems of environmental change</li> <li><input type="checkbox"/> to document patterns of change or lack of change in order to establish a baseline for understanding the impact of such change or lack of it on natural communities, ecosystems and ecological processes</li> <li><input type="checkbox"/> to develop monitoring protocols involving standardised sampling designs and techniques for testing management regimes and strategies</li> <li><input type="checkbox"/> to develop biological diversity indicator groups to reveal the impacts of environmental disturbance</li> <li><input type="checkbox"/> to accelerate research into new, cost-effective methods of monitoring</li> <li><input type="checkbox"/> to integrate monitoring with an ecological research program aimed at improving our understanding of long-term and event-driven ecological processes</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what are suitable indicators and monitors of ecosystem health and dynamics?</li> <li><input type="checkbox"/> how can large scale, cost effective methods for monitoring be developed for: <ul style="list-style-type: none"> <li>• forest clearing</li> <li>• forest disturbance/recovery</li> <li>• extent and severity of edge effects</li> <li>• structural modification</li> <li>• alterations to drainage/hydrological patterns</li> <li>• invasions by weeds &amp; diseases</li> <li>• invasions by exotic animals</li> <li>• rates of change due to fire regimes</li> <li>• presentation success</li> <li>• landholder &amp; neighbour levels of satisfaction and support</li> <li>• visitor satisfaction</li> </ul> </li> <li><input type="checkbox"/> what needs to be considered in the development of cultural indicators?</li> </ul>	
1.0.2	<b>Natural resource mapping, modelling and assessment</b>	<p>To provide an overall, up-to-date vegetation coverage of the region at a suitable scale for planning.</p> <p>To detect and monitor changes in land condition through time using remotely sensed data.</p>	<p><b>Vegetation mapping</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to complete a program of high resolution vegetation mapping for the Wet Tropics biogeographic region</li> <li><input type="checkbox"/> to develop descriptive keys which identify and categorise the inherent diversity of vegetation</li> </ul>	<p><b>Vegetation mapping</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the controlling 'state factors' determining the distribution and pattern of vegetation communities in the region?</li> <li><input type="checkbox"/> how intact and unimpacted by human disturbances is the area?</li> </ul>	<p><b>Vegetation mapping</b></p> <ul style="list-style-type: none"> <li>• On a regional basis based on IBRA Wet Tropics bioregion</li> </ul>



Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations	
		<p>community types in the region</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to systematically assess the integrity of vegetation types across the region</li> <li><input type="checkbox"/> to identify relative conservation significance of different vegetation community types</li> <li><input type="checkbox"/> to identify generic and specific management prescriptions for different identified vegetation types</li> <li><input type="checkbox"/> to identify, analyse, refine and map wet tropics regional ecosystems</li> </ul> <p><b>Remote sensing of standing biomass</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop and apply techniques for remote sensing of forest structure, height and biomass</li> <li><input type="checkbox"/> to develop rapid and reliable methods for mapping, monitoring and assessment purposes</li> </ul> <p><b>Modelling</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop vegetation mapping and predictive modelling techniques</li> <li><input type="checkbox"/> to map and model the patterns of distribution of target Wet Tropics fauna</li> <li><input type="checkbox"/> to undertake a program of rainforest soil mapping or to identify the determinants of soil type formation to enable predictive regional modelling of soil types</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what are the conservation significance of different mapping units?</li> </ul> <p><b>Remote sensing of standing biomass</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> is it possible to achieve high resolution mapping &amp; monitoring of change and recovery by remote sensing?</li> </ul> <p><b>Modelling</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> can predictive models be developed to analyse and assess the impacts of human activities on the ecology of terrestrial riparian and aquatic systems on a landscape ecological basis?</li> </ul>	<p><b>Remote sensing of standing biomass</b></p> <ul style="list-style-type: none"> <li>• previously logged areas of known history</li> <li>• cyclone damaged areas</li> <li>• forest 'edges'</li> </ul>	
1.0.3	<b>Collation &amp; analysis of existing</b>	To capture the mass of existing data and knowledge relevant to	<ul style="list-style-type: none"> <li><input type="checkbox"/> to collate, analyse and model using existing research information and data</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> is it feasible to develop a data &amp; information warehouse for the region?</li> </ul>	

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
	<b>data</b>	<p>the management of the Area that is presently inaccessible or not incorporated into information systems.</p> <p>To develop a directory of researchers and other experts.</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> to value add and make, or increase, accessibility and usefulness of diverse existing data</li> <li><input type="checkbox"/> to get existing data and information into packages useful for management</li> <li><input type="checkbox"/> to develop better ways of presenting data and information to increase its relevance and applied usefulness</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> are there data ownership/copyright issues involved in increasing the accessibility of previous research data and information?</li> <li><input type="checkbox"/> is it feasible to provide standard sets of digital, cartographically correct base maps for general use and compatibility?</li> </ul>	
1.0.4	<b>Sites of Special Scientific Interest (SSSI)</b>	To plan for the recognition and protection of sites of special scientific interest.	<ul style="list-style-type: none"> <li><input type="checkbox"/> to identify areas of special scientific interest by reason of flora, fauna or geological or physiographic features</li> <li><input type="checkbox"/> to develop a network of special scientific interest sites which might include: <ul style="list-style-type: none"> <li>• benchmark sites</li> <li>• type locations</li> <li>• unique features or attributes</li> <li>• ecologically fragile</li> </ul> </li> <li><input type="checkbox"/> to establish scientific criteria for identifying biologically significant key areas, critical habitat, important corridors, habitat mosaics and biological refugia</li> <li><input type="checkbox"/> criteria for the identification and configuration of areas for acquisition</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> where are the areas or sites of particular scientific interest and/or concern?</li> <li><input type="checkbox"/> what measures are needed to ensure effective conservation of SSSIs?</li> </ul>	
1.0.5	<b>Biological diversity</b>	To provide the knowledge and understanding of Wet Tropics biological diversity essential for its effective conservation and management.	<ul style="list-style-type: none"> <li><input type="checkbox"/> to elucidate the patterns of biological diversity at the level of the gene, the species, and the ecosystem across the Wet Tropics landscape</li> <li><input type="checkbox"/> to identify processes and categories of activities that have or are likely to have adverse impacts on</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> where are the ecosystems and habitats that contain high diversity, large numbers of endemic or threatened species, or that are representative, unique or associated with key evolutionary or other biological processes?</li> </ul>	

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
			<p>the conservation of any aspect of biological diversity</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to identify which species and habitats most merit investment in protective measures</li> <li><input type="checkbox"/> to identify the most important, effective, and efficient actions that need to be taken to conserve biodiversity</li> <li><input type="checkbox"/> to undertake inventory into the taxonomy, geographic distribution and evolutionary relationships of Wet Tropics organisms (priority being given to lesser known groups including aquatic plants, non-vascular plants, key invertebrate groups, micro-organisms)</li> <li><input type="checkbox"/> to document the freshwater biota associated with the main types of catchments and its modification due to known disturbances</li> <li><input type="checkbox"/> to gain an understanding of the interactions between surface hydrology and groundwater and biological diversity</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> which components require urgent protective measures?</li> <li><input type="checkbox"/> what are the relative conservation status of plant communities/ecosystems within the Wet Tropics biogeographic region?</li> </ul>	
1.0.6	<b>Genetic diversity and evolutionary history</b>	To better plan to protect vulnerable areas of high evolutionary significance.	<ul style="list-style-type: none"> <li><input type="checkbox"/> to fulfil the Authority's obligations to identify and protect World Heritage values</li> <li><input type="checkbox"/> to establish from an evolutionary perspective the relative conservation values of specific populations and areas</li> <li><input type="checkbox"/> to determine critical habitat areas and important biological refugia within the Area</li> <li><input type="checkbox"/> to identify genetically vulnerable areas and critical</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> can evolutionary significant units, genetically endangered or vulnerable areas, critical natural wildlife corridors, and important biological refugia within the region be defined and identified?</li> <li><input type="checkbox"/> where are natural genetic discontinuities located and can distinct genetic provinces be determined?</li> <li><input type="checkbox"/> what protocols are needed before we</li> </ul>	<ul style="list-style-type: none"> <li>• mountain tops and summit areas</li> <li>• vicinity of clearings associated with linear infrastructure</li> <li>• Kuranda/Macalister Range area</li> </ul>

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
		<p>natural corridors and barriers across the landscape</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to identify and classify evolutionary significant mountain-top habitats</li> <li><input type="checkbox"/> to understand the effects of fragmentation by contrasting the consequences in genetic diversity of long-term natural fragmentation with those of recent fragmentation due to clearing for various purposes and of various sizes</li> </ul>	<p>move plants and animals between genetic provinces?</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> can refugial areas be identified? what are the implications of such identification with regards revegetation projects, fire management etc?</li> <li><input type="checkbox"/> are there genetic units which will be lost through climate change?</li> <li><input type="checkbox"/> what are the techniques for saving them?</li> </ul>	<ul style="list-style-type: none"> <li>• Daintree lowlands</li> </ul>
1.0.7	<p><b>Rarity</b></p> <p>To better understand the management requirements of different categories of rare taxa and to better and more explicitly prioritise management action.</p> <p>To prepare management strategies and guidelines in an appropriate cultural and scientific framework to control or alleviate threatening processes affecting threatened species and communities - not necessarily confined to those on national or state lists but considered regionally significant.</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> to identify the distribution of key threatened species</li> <li><input type="checkbox"/> to address specific research issues raised in recovery plans for endangered and vulnerable species in the region</li> <li><input type="checkbox"/> to identify the habitat requirements and natural controlling factors limiting distribution or abundance</li> <li><input type="checkbox"/> to identify threatening processes, their prioritisation and techniques for their management in relation to threatened species and communities</li> <li><input type="checkbox"/> to develop monitoring procedures for threatened species</li> <li><input type="checkbox"/> to develop predictive models based on a classification of vulnerability and/or rarity which identifies species and communities likely to be of concern in the future</li> </ul>	<p><b>Patterns and causes of rarity</b> (risk assessment)</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what common syndromes/characteristics result in natural groupings of rare species?</li> <li><input type="checkbox"/> what are the relative roles of natural processes vs. human induced changes in the typology and vulnerability of rare species?</li> <li><input type="checkbox"/> are there nodes of rare species and are they at risk from common sets of threatening processes?</li> </ul> <p><b>Ecology of rarity</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what ecological functional role do rare species have in ecosystems?</li> <li><input type="checkbox"/> what are the controls on population numbers and density?</li> <li><input type="checkbox"/> are there common sets of ecological</li> </ul>	<ul style="list-style-type: none"> <li>• cassowary management plan areas</li> <li>• northern bettong recovery plan areas</li> <li>• mahogany glider recovery plan area</li> </ul>

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations	
		<p><b>Patterns and causes of rarity</b> (risk assessment)</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop a robust, targeted decision making model for strategic species management</li> <li><input type="checkbox"/> to identify the relative contributions of long-term evolutionary and ecological processes and recent human changes that contribute to the vulnerability of species or communities</li> <li><input type="checkbox"/> to improve understanding of patterns and causes of rarity in the context of biogeographic history, extinctions, current environmental attributes, and ecological interactions</li> </ul> <p><b>Ecology of rarity</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to identify classes of rare species that are the most susceptible/sensitive to disturbance and change</li> </ul> <p><b>Predictive modelling</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop the capacity to predict the geographic distribution of rare species</li> </ul>	<p>parameters leading to observed geographic patterning of rarity?</p> <p><b>Predictive modelling</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the key processes that determine patterns of rarity?</li> <li><input type="checkbox"/> is our understanding of species ecological needs sufficient to develop robust predictive models?</li> </ul>		
1.0.8	<b>Ecosystem dynamics</b>	To develop a predictive understanding of the dynamics of rainforests, sclerophyll forests and wetlands applicable to their conservation, management, rehabilitation and sustainable use.	<ul style="list-style-type: none"> <li><input type="checkbox"/> to discover the determinants of vegetation community types and composition</li> <li><input type="checkbox"/> to examine the dynamics of rainforests in different time scales and in relation to boundary communities (e.g. rainforest/wet sclerophyll)</li> <li><input type="checkbox"/> to identify and interrelate key changes in the characteristics and composition of rainforest biota and soil following disturbances of different types, scales and intensities</li> <li><input type="checkbox"/> to develop predictive models of ecological changes resulting from a range of natural and human-</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what are the functional roles of key vertebrates and invertebrates in forest dynamics?</li> <li><input type="checkbox"/> what criteria are needed for establishing baseline environmental flows and the significance of natural fluctuations to flow patterns in Wet Tropics' water courses?</li> <li><input type="checkbox"/> which species are most important for rainforest pollination, seed dispersal and other ecological services?</li> </ul>	

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
			<p>induced disturbances</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to define the underlying natural dynamics and environmental variability</li> <li><input type="checkbox"/> to provide scientific and technical support for rainforest rehabilitation</li> </ul>		
1.0.9	<b>Disturbance and change</b>	To understand determinants, processes, rate and direction of ecological succession in different ecosystems following disturbance.	<ul style="list-style-type: none"> <li><input type="checkbox"/> to better understand natural systems' tolerance to disturbance</li> <li><input type="checkbox"/> to define the impacts of human activities on Wet Tropics ecosystems and World Heritage values</li> <li><input type="checkbox"/> to document and interrelate changes in the characteristics and composition on Wet Tropics' biota and soil following disturbances of different types, scales and intensities</li> <li><input type="checkbox"/> to provide information on the dynamic functioning of complex Wet Tropics' ecosystems</li> <li><input type="checkbox"/> to establish inventories of the condition and extent of wetlands, floodplains and riparian ecosystems</li> <li><input type="checkbox"/> to develop broadscale models to relate changes in forest distribution to changes in climate, fire regimes and landscape settings</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> which taxa and/or functional groups are favoured or threatened by disturbance of different types and scales?</li> <li><input type="checkbox"/> what methods can be used to assess and monitor the rate and distribution of native vegetation clearing - both past and present patterns?</li> <li><input type="checkbox"/> what are appropriate environmental impact assessment methodologies that enable conservation impacts to be determined?</li> </ul>	
1.0.10	<b>Fire</b>	<p>To better plan for the maintenance of natural values through the correct use of fire as a management tool.</p> <p>To develop prescribed burning practices that take account of the</p>	<p><b>Fire management</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop ecologically and evolutionary based fire management programs</li> <li><input type="checkbox"/> to understand the role of fire in maintaining habitat diversity</li> </ul>	<p><b>Fire management</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the 'best' fire management regimes (for the protection of natural heritage values) for key vegetation types or areas?</li> <li><input type="checkbox"/> can criteria be developed for the</li> </ul>	<ul style="list-style-type: none"> <li>• wet sclerophyll forests</li> <li>• areas proposed for prescribed burning by land management</li> </ul>

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
	fire responses of different ecosystems, natural patterns of succession, and the role of fire in the maintenance of biological diversity.	<ul style="list-style-type: none"> <li><input type="checkbox"/> to establish the ecological effects of fuel reduction burning</li> <li><input type="checkbox"/> to understand the effect of exotic grass invasion of sclerophyll forest on the timing and intensity of fires</li> <li><input type="checkbox"/> to establish a series of long-term monitoring plots to study regeneration and recovery at selected fire sites and other areas</li> </ul> <p><i>Wet sclerophyll ecology</i></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to discover the determinants of vegetation types and composition in the vicinity of sclerophyll/rainforest boundaries</li> <li><input type="checkbox"/> to evaluate the status and dynamics of key faunal populations and to discover the determinants of critical faunal habitat and the role of fire within wet sclerophyll forests</li> <li><input type="checkbox"/> to formulate management options for the conservation of wet sclerophyll forests</li> <li><input type="checkbox"/> to assess the social attitudes towards wet sclerophyll forest and the effects of grazing and the use of fire</li> </ul>	<ul style="list-style-type: none"> <li>identification of key areas for fire management and other areas where expansion of rainforest is actually a desirable/natural outcome?</li> <li><input type="checkbox"/> can species be used to monitor success of fire management practices (e.g. bettongs)?</li> <li><input type="checkbox"/> how do we maintain understorey biodiversity?</li> <li><input type="checkbox"/> how do we determine the optimal pattern and size for mosaic prescribed burns?</li> <li><input type="checkbox"/> how do we involve Aboriginal people and 'traditional' burning programs?</li> <li><input type="checkbox"/> what are the effects on the ecological, spatial and temporal dynamics of non-rainforest communities and the role of fire in the maintenance of community structure and faunal habitats?</li> </ul>	agencies
1.0.11	<p><b>Climate change</b></p> <p>To predict and model the impact of accelerated climate change on the range, distribution and invasiveness of environmental weed species.</p> <p>To predict and model the impact of climate change on ecosystem</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> to support research into the potential impacts of climate change on World Heritage values</li> <li><input type="checkbox"/> to investigate the range and physiological tolerances of selected species and populations</li> <li><input type="checkbox"/> to develop predictors of the responses of ecosystems and species to climate change</li> </ul>	<p><b>Weeds</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> is the postulated disruption to ecological systems likely to provide a greater opportunity for pest species invasions?</li> <li><input type="checkbox"/> which pest species are predicted to be favoured by the changes likely to be wrought by accelerated climate change?</li> </ul>	

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
	boundaries.	<input type="checkbox"/> to undertake research into the secondary effects of climate change such as altered fire proneness, conditions that might favour the spread of feral animal pests, weeds or pathogens	<input type="checkbox"/> which areas or ecological community types are likely to be affected?  <b>Ecosystem boundaries</b> <input type="checkbox"/> which ecosystem types are threatened by climate change?  <b>Rehabilitation</b> <input type="checkbox"/> what design aspects and species selections need to be incorporated into rehabilitation projects to ensure that altitudinal and latitudinal buffers or corridors exist through the landscape? (Such considerations are important to allow for the movement of organisms in the event of shifts in 'climatic zones' and to ensure sufficient genetic variation is incorporated so that these links can act as refuges)	
2.1.1	<b>Linear Service Corridors: Roads</b>	<b>Roads</b> <input type="checkbox"/> to study examples of both successful and unsuccessful road engineering practices and identify those where (i) the engineering practice is poor because of a lack of understanding of fundamental landscape and/or ecological principles; (ii) the interrelationship with the various biological or ecological parameters is poorly understood; (iii) the existing engineering practice is incompatible with aesthetic/tourist values or the desired character of an area  <input type="checkbox"/> to develop methods of prescribing engineering design and construction practice to (i) completely avoid a particular impact; (ii) control the effects of	<b>Roads - barrier</b> <input type="checkbox"/> what are the range of impacts different classes of roads and vehicle tracks have on different groups of wildlife? <input type="checkbox"/> what aspects of road design contribute to its faunal barrier effect? <input type="checkbox"/> what design features reduce the barrier effect?  <input type="checkbox"/> what aspects of roads and road verges impact, both positively and negatively, on presentation and visitor experiences?	<b>Roads - barrier</b> <b>Major Roads:</b> <ul style="list-style-type: none"> <li>• East Evelyn Road</li> <li>• Kuranda Range section of the Kennedy Highway</li> <li>• Palmerston</li> </ul> <b>Minor Roads:</b> <ul style="list-style-type: none"> <li>• Mt Lewis Rd</li> <li>• South Johnstone network</li> <li>• ACB/Danbulla</li> </ul>



Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
		<p>an unavoidable impact; (iii) attenuate the effects of a particular threat</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop a classification of access based on robust ecological criteria</li> <li><input type="checkbox"/> to predict and alleviate impacts on ecological, aesthetic and other values of roads</li> </ul> <p><b>Roads - barrier</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to field test the implementation of 'best practice' road management and maintenance approaches and assess success or otherwise of different approaches (a learning by doing exercise)</li> <li><input type="checkbox"/> to develop assessment, classification and management options for Wet Tropics 'ghost' roads and tracks</li> <li><input type="checkbox"/> to develop a management strategy for the 6,500 km of logging roads and tracks no longer in use in the Area</li> <li><input type="checkbox"/> to undertake a thorough economic assessment of the costs and benefits of maintaining the existing road network to an acceptable, high environmental standard</li> </ul> <p><b>Roads - traffic</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to undertake an assessment of the range and intensities of traffic impacts on Wet Tropics wildlife</li> <li><input type="checkbox"/> to gain an understanding of traffic volumes and activity patterns correlated to risk to different</li> </ul>	<p><b>Roads - traffic</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> which species are susceptible to road kill and when?</li> <li><input type="checkbox"/> what are the traffic activity patterns on different roads and how do they correlate with susceptible species activity patterns?</li> <li><input type="checkbox"/> to what extent are use patterns and traffic volumes predicted to change?</li> <li><input type="checkbox"/> what is the relative impact of noise, dust, lights on the avoidance behaviour of different wildlife?</li> <li><input type="checkbox"/> what aspects of traffic amplify the barrier effects of a road?</li> </ul>	<ul style="list-style-type: none"> <li>• 'Quaid' Road</li> <li>• Cape Trib-Bloomfield Rd</li> <li>• Creb Track</li> </ul> <p><b>Roads - traffic</b></p> <ul style="list-style-type: none"> <li>• East Evelyn Road</li> <li>• Kennedy Highway</li> <li>• Cook Highway</li> <li>• Palmerston Highway</li> <li>• Daintree - Cape Trib. Rd</li> <li>• El Arish-Mission Beach Rd</li> </ul>

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations	
		<p>groups of wildlife</p> <p>to develop criteria for decisions regarding seasonal (or other) road closures, imposing limits on vehicle numbers etc.</p>			
2.1.2	<p><b>Linear Service Corridors: Powerlines</b></p>	<p>To develop 'best practice' approaches to design, maintenance and other management practices to:</p> <p>(i) completely avoid particular impacts;</p> <p>(ii) control the effects of unavoidable impacts;</p> <p>(iii) attenuate the effects of particular threats.</p>	<p><b>Powerlines - barriers</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to identify and assess options for mitigating the wildlife barrier effects of powerline clearings</li> <li><input type="checkbox"/> to review and improve the Quesi code for maintenance of powerline clearings</li> <li><input type="checkbox"/> to undertake an audit of electricity infrastructure and to identify areas suitable for rehabilitation, strategic wildlife corridors and ecological linkages</li> </ul> <p><b>Powerlines - conduits</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to identify and assess options for eliminating the role of powerline clearings as dispersal corridors for invasive plant and animal pests and fire intrusion</li> </ul>	<p><b>Powerlines - barriers</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> how formidable, are the wildlife barriers resulting from powerline clearings?</li> <li><input type="checkbox"/> what options are there for rehabilitating under powerline clearings?</li> <li><input type="checkbox"/> what would be a strategic approach to ameliorating known adverse impacts of powerline clearings and associated infrastructure disturbances?</li> </ul> <p><b>Powerlines - conduits</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what role do powerline clearings play as dispersal corridors for invasive plant and animal pests and fires?</li> </ul>	<p><b>Powerlines - barriers</b></p> <ul style="list-style-type: none"> <li>• Palmerston</li> <li>• Chalumbin-Woree</li> </ul> <p><b>Powerlines - conduits</b></p> <ul style="list-style-type: none"> <li>• Palmerston</li> <li>• Chalumbin-Woree</li> </ul>
2.1.3	<p><b>Linear Service Corridors: walking tracks, pipelines, other services</b></p>	<p>To better manage the network of existing walking tracks through the adoption and monitoring of 'best practice' track design and maintenance.</p> <p>To examine the issue of a long distance walking track</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> to develop a world class network of walking tracks and trails</li> <li><input type="checkbox"/> to optimise the detailed presentation and enjoyment of the WHA</li> <li><input type="checkbox"/> to identify the range of impacts associated with walking tracks, their design and use</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what are the range and intensities of environmental impacts associated with different existing walking tracks and their use?</li> <li><input type="checkbox"/> what are useful indicators for prioritising maintenance schedules?</li> <li><input type="checkbox"/> is there a need for considering the construction of a long distance walking track in the region?</li> <li><input type="checkbox"/> what are the costs and benefits of a range</li> </ul>	<p>refer to Wet Tropics Walking Track Strategy and Wet Tropics Nature Based Tourism Strategy</p>

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
				<p>of options in the design and siting of a long distance track?</p> <p><input type="checkbox"/> what is the environmental and economic feasibility of constructing and maintaining a long distance walking track?</p>	
2.1.4	<b>Water infrastructure and extraction</b>	To make informed decisions which will ensure the maintenance of the quality, diversity and natural values of aquatic ecosystems within the Area and in downstream areas	<p><input type="checkbox"/> to assess potential impact on water quality and ecology of different types of water resource developments</p> <p><input type="checkbox"/> to assess environmental flow requirements for defined water quality and ecological outcomes</p> <p><input type="checkbox"/> to identify important aquatic ecosystems and their key natural values</p> <p><input type="checkbox"/> to monitor their condition in relation to known sources of impact</p> <p><input type="checkbox"/> to develop methods of prescribing engineering design and construction practice to (i) completely avoid a particular impact; (ii) control the effects of an unavoidable impact; (iii) attenuate the effects of a particular threat</p>	<p><input type="checkbox"/> what are the World Heritage values of freshwater aquatic ecosystems of the Area?</p> <p><input type="checkbox"/> how can you define an environmental flow necessary to maintain natural World Heritage values?</p> <p><input type="checkbox"/> what are the range of impacts associated with alterations to flow patterns?</p>	
2.1.5	<b>Telecommunication facilities</b>	To minimise the number of telecommunication sites within the Area and minimise the impact of existing facilities.	<p><input type="checkbox"/> to have a net reduction in the impact of communications facilities within the Area</p>	<p><input type="checkbox"/> can mountain top sites be classified in the Area with respect to their ecological and evolutionary significance, vulnerability to disturbance and irreplaceability?</p> <p><input type="checkbox"/> is it feasible for towers to accommodate multiple user needs?</p>	

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
				<input type="checkbox"/> are there feasible alternative sites external to the Area that are suitable?	
2.2.1	<b>Drainage</b>	To better plan to protect areas and species vulnerable to altered drainage patterns.	<input type="checkbox"/> to identify and classify the ecological impacts of alterations to natural hydrological processes	<b>altered drainage/ hydrology</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> how much drainage is being carried out within the region and where?</li> <li><input type="checkbox"/> are there adverse environmental impacts to the WHA from external drainage activities?</li> <li><input type="checkbox"/> quantify and predict future impacts</li> <li><input type="checkbox"/> can cause and effect be established?</li> <li><input type="checkbox"/> what impact is drainage having on patterns of ground-water quantity and quality?</li> <li><input type="checkbox"/> what ecological impacts are changes to aquifers having?</li> <li><input type="checkbox"/> where and which ecosystems are being affected?</li> <li><input type="checkbox"/> what options if any are there to mitigate impacts?</li> </ul>	<ul style="list-style-type: none"> <li>• Coastal lowlands</li> <li>• Atherton basalt aquifer</li> </ul>
2.2.2	<b>Grazing</b>	<p>To permit grazing where it is compatible with the natural values of the Area and does not conflict with other management intents.</p> <p>To include specific requirements regarding fencing, fire</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> to identify and quantify cattle grazing impacts and management options</li> <li><input type="checkbox"/> to establish general guidelines and conditions for permits/leases</li> <li><input type="checkbox"/> to ensure that grazing only occurs on land where it</li> </ul>	<b>Cattle grazing</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> what is the effect of cattle grazing/management practice interactions with fire dynamics?</li> <li><input type="checkbox"/> what ecological impacts would cessation of grazing have on areas that have been</li> </ul>	

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
		management, weed control and stocking rates on all permits and/or leases.	<p>contributes to World Heritage management</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to establish the contemporary interrelationship between grazing and ground cover composition and biomass</li> <li><input type="checkbox"/> to establish the contemporary interrelationship between grazing and fire and the effects of different stocking rates and land management practices</li> <li><input type="checkbox"/> to establish the range and intensity of ecological impacts attributable to cattle grazing in different parts of the Area</li> <li><input type="checkbox"/> to predict the impacts of the sudden removal of grazing from an area</li> </ul>	<p>managed for grazing for long periods?</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the range of impacts of grazing and what are their interactions with fire, soil type, terrain, runoff and weeds?</li> <li><input type="checkbox"/> what role does grazing play in the distribution of undesirable pest species?</li> <li><input type="checkbox"/> what are suitable indicators for quantifying and monitoring grazing impacts?</li> <li><input type="checkbox"/> are there acceptable cattle carrying capacities for certain community types?</li> <li><input type="checkbox"/> what are the cost/benefits to the grazier in changing or adopting the way they traditionally manage their cattle to reduce environmental impacts?</li> </ul>	
2.2.3	<b>Collecting forest products</b>	To ensure collection of flora and fauna, whether for conservation, scientific purposes or for Aboriginal use, occurs in an ecologically sustainable and culturally appropriate manner.	<ul style="list-style-type: none"> <li><input type="checkbox"/> to base decisions on sound scientific advice</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what constitutes ecologically sustainable seed collection?</li> <li><input type="checkbox"/> are there generic guidelines which can be developed for seed collection based on sets of character syndromes shared by different groups of plants?</li> <li><input type="checkbox"/> what are appropriate protocols for the collection of forest products for scientific purposes?</li> <li><input type="checkbox"/> what ecological role do tree falls along roads have, and how should such timber be disposed?</li> </ul>	

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2.2.4	<b>Bee-keeping</b>	To have bee-keeping in the region managed to minimise the impacts on World Heritage values.	<input type="checkbox"/> to determine the likelihood, persistence and impact of feral hives becoming established within the Area <input type="checkbox"/> to determine the likelihood of increased hybridisation of native plant species by introduced honey bees <input type="checkbox"/> to determine whether competition for nectar supplies with birds, native insects and nectar-feeding bats, is likely to lead to their long-term decline <input type="checkbox"/> to assess the possibility of disease transmission to native bees in the Area <input type="checkbox"/> to assess the likelihood of reduced pollination of some native plants, especially those adapted to pollination by birds	<input type="checkbox"/> how far do exotic bees travel? <input type="checkbox"/> how prevalent are feral hives in the Area? <input type="checkbox"/> how persistent are feral hives in the Area? <input type="checkbox"/> what impact are feral bees having on native bees? <input type="checkbox"/> what are the potential impacts of feral bees on the ecology of different ecosystems?	
2.3.1	<b>Environmental weeds</b>	<p>To develop an environmental weed risk assessment system for the Wet Tropics.</p> <p>To establish an ecologically based, logistically and economically feasible system for identifying priorities for weed prevention, eradication, containment or control.</p> <p>To identify potential ecological impacts and present and potential distribution ranges of high priority environmental weeds.</p>	<p><b>Risk assessment and prioritisation</b></p> <input type="checkbox"/> to develop a robust decision making model for strategic weed management <input type="checkbox"/> to develop a targeted approach, which will facilitate: <ul style="list-style-type: none"> <li>• collation of relevant reference materials</li> <li>• focus on a small proportion of the enormous pool of potential weeds</li> <li>• enhances probability of early detection &amp; response</li> <li>• enables pro-active contingency planning &amp; swift response</li> <li>• facilitates preparation of public awareness materials</li> </ul>	<p><b>Risk assessment and prioritisation</b></p> <input type="checkbox"/> is it possible to develop explicit biogeographic/ historical and biological/ ecological criteria to assess the potential environmental threat posed by a wide range of presently occurring or likely introductions to the region? <input type="checkbox"/> what criteria should be used to prioritise expenditure on prevention, control, eradication or containment of environmental weeds - both existing and those considered to pose a major threat to natural environments in the region?  <p><b>Ecology</b></p>	

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
		<p><b>Ecology</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to understand the population dynamics and effective control of weed species</li> <li><input type="checkbox"/> to identify the most susceptible aspects of the ecology of target environmental weed species to be exploited in their management</li> <li><input type="checkbox"/> to gauge the potential impact of high priority environmental weeds on World Heritage values and biodiversity</li> </ul> <p><b>Control</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop specific and integrated control methods</li> <li><input type="checkbox"/> to investigate and develop novel control methods including practical alternatives to the use of herbicides</li> </ul> <p><b>Strategies</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to take a pro-active approach to weed management</li> <li><input type="checkbox"/> to identify methods and strategies for eradicating or controlling weeds and preventing new outbreaks without detrimental effects on non-target plants and animals</li> <li><input type="checkbox"/> to develop simple keys and identification kits</li> <li><input type="checkbox"/> to raise the public profile and importance of environmental weeds</li> <li><input type="checkbox"/> to coordinate management responses and control efforts</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what is its mode of growth?</li> <li><input type="checkbox"/> what is its rate of population increase?</li> <li><input type="checkbox"/> what is its climatic range and distribution?</li> <li><input type="checkbox"/> does it have undesirable traits?</li> <li><input type="checkbox"/> what is known of its reproductive and dispersal biology?</li> </ul> <p><b>Control</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> have control techniques been developed elsewhere?</li> <li><input type="checkbox"/> is there a need for chemical control trials?</li> <li><input type="checkbox"/> are there non-chemical control options?</li> </ul> <p><b>Strategies</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the best management options?</li> <li><input type="checkbox"/> how can we involve the public (e.g. volunteers, community groups, tourist industry) in weed management strategies?</li> <li><input type="checkbox"/> how do we ensure favourable ecological successions once weeds are removed?</li> </ul>	

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
2.3.2	<p><b>Feral Animals</b></p>	<p><b>Vertebrate pests: risk assessment &amp; prioritisation</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop a robust decision making model for strategic vertebrate pest management</li> <li><input type="checkbox"/> to develop a targeted approach. which will facilitate: <ul style="list-style-type: none"> <li>• collation of relevant reference materials</li> <li>• enhances probability of early detection &amp; response</li> <li>• enables pro-active contingency planning &amp; swift response</li> <li>• facilitates preparation of public awareness materials</li> </ul> </li> </ul> <p><b>Vertebrate pests: ecology</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to identify potential ecological impacts and present and potential distribution ranges of high priority vertebrate pest species</li> <li><input type="checkbox"/> to identify the most susceptible aspects of the ecology of target vertebrate pest species to be exploited in their management</li> <li><input type="checkbox"/> to gauge the potential impact of high priority vertebrate pest species on World Heritage values and biodiversity</li> </ul> <p><b>Vertebrate pests: control</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop specific and integrated control methods</li> </ul> <p><b>Vertebrate pests: strategies</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop an optimal strategic approach to pest animal management</li> <li><input type="checkbox"/> to take a pro-active approach to pest animal management</li> </ul>	<p><b>Vertebrate pests: risk assessment &amp; prioritisation</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what species should we be concerned about?</li> <li><input type="checkbox"/> what criteria should be used to prioritise expenditure on prevention, control, eradication or containment of vertebrate pests considered to pose a major threat to natural environments in the region?</li> </ul> <p><b>Vertebrate pests: ecology</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the environmental impacts of these vertebrate pest animals?</li> <li><input type="checkbox"/> which vertebrate pests cause, or are likely to cause, the biggest problems and where are the key areas of susceptibility?</li> </ul> <p><b>Vertebrate pests: control</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> is it possible to develop effective, target specific, environmentally safe control methods?</li> <li><input type="checkbox"/> is effective control possible by relying on increasing death rate methods or should the emphasis be on techniques to reduce birth rates?</li> </ul> <p><b>Vertebrate pests: strategies</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the range of cultural issues that need to be considered in vertebrate pest control programs?</li> <li><input type="checkbox"/> what control strategies will work and be ecologically and publicly acceptable?</li> </ul>	<p><b>Vertebrate pests</b></p> <ul style="list-style-type: none"> <li>• stratified to account for major regional environmental variation</li> </ul> <p><b>Feral pig monitoring system</b></p> <ul style="list-style-type: none"> <li>• DNR/Wet Tropics Management Authority feral pig trapping area</li> </ul>



Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
	<p>especially those based on fertility control and pheromone affects.</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> to raise the public profile and importance of vertebrate pests</li> <li><input type="checkbox"/> to coordinate management responses and control efforts</li> </ul> <p><b>Feral pig: ecology, behaviour &amp; ecological</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to derive relationship between pig populations and impact assessment (refer pig monitoring)</li> <li><input type="checkbox"/> to understand the diet, social structure and behaviour of the feral pig as a basis for optimising control programs</li> </ul> <p><b>Feral pig: impacts</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to establish baseline impact assessment levels</li> <li><input type="checkbox"/> to understand the direct and indirect environmental impacts of feral pigs to optimise the location of control activities</li> <li><input type="checkbox"/> to have the basic information required for contingency planning in case of a human or livestock disease outbreak</li> <li><input type="checkbox"/> to prepare contingency plans for environmentally important areas</li> </ul> <p><b>Feral pig monitoring system</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to establish a population level monitoring system</li> <li><input type="checkbox"/> to establish the relative performance of the pig trapping program</li> </ul> <p><b>New technologies</b></p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what are the cost/benefits of control measures?</li> <li><input type="checkbox"/> what strategic direction should we follow?</li> <li><input type="checkbox"/> how do we educate the community on these issues?</li> <li><input type="checkbox"/> can we enlist volunteers for control programs - if so, what protocols are needed?</li> </ul> <p><b>Feral pig: ecology, behaviour &amp; ecological</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the major components of the diet of feral pigs in natural areas, and how does it vary seasonally?</li> <li><input type="checkbox"/> what are the timing and extent of movement patterns and what triggers this behaviour?</li> <li><input type="checkbox"/> are pig densities and damage correlated with certain recurring habitat attributes/features?</li> </ul> <p><b>Feral pig: impacts</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> can direct environmental damage caused by pig diggings, predation etc be quantified?</li> <li><input type="checkbox"/> can indirect impacts such as competition effects and vectors/amplifiers of diseases be quantified?</li> </ul>	

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
		<ul style="list-style-type: none"> <li><input type="checkbox"/> to approach the long-term population control of feral animals through the reduction in birth rates rather than by short-term approaches which rely on increasing death rates</li> <li><input type="checkbox"/> to investigate the 'chemical language' of pigs and its potential as a tool in the control of basic behavioural processes including population dynamics</li> <li><input type="checkbox"/> to investigate the feasibility and desirability of new and emerging technologies to design pig specific vaccines capable of a) fertility control and/or b) lactation inhibition</li> <li><input type="checkbox"/> to investigate the feasibility of designing pig attractant and pig repellent pheromones</li> </ul> <p><b>Invertebrate pests: risk assessment and prioritisation</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop an invertebrate pest risk assessment system for the Wet Tropics</li> <li><input type="checkbox"/> to establish an ecologically based, logistically and economic feasible system for identifying priorities for invertebrate pest prevention, eradication, containment or control</li> <li><input type="checkbox"/> to determine the extent of the invertebrate pest problem</li> <li><input type="checkbox"/> to determine relative levels of concern</li> <li><input type="checkbox"/> to develop a robust decision making model for strategic invertebrate pest management</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what options are available for rapid response pig eradication if feral pigs were implicated with harbouring serious human diseases or livestock diseases such as 'foot and mouth'</li> </ul> <p><b>Feral pig monitoring system</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> is the feral pig population increasing?</li> <li><input type="checkbox"/> is the pig trapping program successful in reducing pig numbers?</li> <li><input type="checkbox"/> is the pig trapping program benefiting and reducing impact levels within the WHA?</li> </ul> <p><b>New technologies</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> is a bait delivered, pig specific, environmentally safe method of immunocontraception technically feasible?</li> <li><input type="checkbox"/> is an environmentally safe method of lactation inhibition a more viable alternative to contraception and is it an ethical approach?</li> <li><input type="checkbox"/> can technology be used to create a better, target animal specific bait?</li> <li><input type="checkbox"/> can pheromone research into behaviour modification lead to: <ul style="list-style-type: none"> <li>• improved trap success (attractants)</li> <li>• ability to repel pigs from limited areas</li> <li>• ability to modify reproductive</li> </ul> </li> </ul>	

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
		<p><input type="checkbox"/> to develop a targeted approach. which will facilitate:</p> <ul style="list-style-type: none"> <li>• collation of relevant reference materials</li> <li>• focus on a small proportion of the enormous pool of potential invertebrate pests</li> <li>• enhances probability of early detection &amp; response</li> <li>• enables pro-active contingency planning &amp; swift response</li> <li>• facilitates preparation of public awareness materials</li> </ul> <p><b>Invertebrate pests: ecology</b></p> <p><input type="checkbox"/> to identify potential ecological impacts and present and potential distribution ranges of high priority invertebrate pest species</p> <p><input type="checkbox"/> to identify the most susceptible aspects of the ecology of target invertebrate pest species to be exploited in their management</p> <p><input type="checkbox"/> to gauge the potential impact of high priority invertebrate pest species on World Heritage values and biodiversity</p> <p><b>Invertebrate pests: control</b></p> <p><input type="checkbox"/> to develop specific and integrated control methods</p> <p><b>Invertebrate pests: strategies</b></p> <p><input type="checkbox"/> to determine the most appropriate strategy for the Wet Tropics World Heritage Area</p> <p><input type="checkbox"/> to develop simple keys and identification kits</p> <p><input type="checkbox"/> to coordinate management responses and control efforts</p>	<p>behaviour</p> <p><b>Invertebrate pests: risk assessment and prioritisation</b></p> <p><input type="checkbox"/> can systems be developed to identify and distinguish between environmental, agricultural, nuisance (&amp; combinations) pest species?</p> <p><input type="checkbox"/> which species could impact on food webs and ecological interactions at early stages - thereby disrupting many ecological processes (e.g. exotic earthworms, ants etc)?</p> <p><b>Invertebrate pests: strategies/ contingencies</b></p> <p><input type="checkbox"/> which species presently have contingency/Ausvet plans or equivalent?</p> <p><input type="checkbox"/> are such existing plans relevant and/or acceptable to natural areas or areas with rugged terrain and limited access?</p>	

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations	
2.3.3	<p><b>Diseases</b></p>	<p>To develop an exotic plant and animal disease risk assessment system for the Wet Tropics.</p> <p>To establish an ecologically based, logistically and economic feasible system for identifying priorities for exotic plant and animal disease prevention, eradication, containment or control.</p> <p>To identify potential ecological impacts and present and potential distribution ranges of high priority exotic plant and animal diseases.</p> <p>To develop exotic plant and animal disease control strategies and contingencies.</p> <p>To intensify research effort into presently identified disease concerns.</p> <p>To identify the impacts of human habitation on disease transmission to surrounding native and introduced animals</p>	<p><b>Risk assessment and priorities</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop an exotic (&amp; endemic) disease inventory for the WHA</li> <li><input type="checkbox"/> to develop a robust decision making model for strategic disease management</li> <li><input type="checkbox"/> to develop a targeted approach. which will facilitate: <ul style="list-style-type: none"> <li>• collation of relevant reference materials</li> <li>• focus on a small proportion of the enormous pool of potential diseases</li> <li>• enhances probability of early detection &amp; response</li> <li>• enables pro-active contingency planning &amp; swift response</li> <li>• facilitates preparation of public awareness materials</li> </ul> </li> </ul> <p><b>Ecologic impact</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to gauge the potential impact of high priority exotic diseases on World Heritage values and biodiversity</li> <li><input type="checkbox"/> to identify the most susceptible aspects of the ecology of target exotic diseases to be exploited in its management</li> <li><input type="checkbox"/> to identify the potential role of feral and native animals as vectors and amplifiers of exotic animal and human diseases</li> <li><input type="checkbox"/> to investigate the potential role of feral, native and domestic animals as vectors and amplifiers of endemic diseases</li> </ul>	<p><b>Risk assessment and priorities</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the natural background disease loads in native plants and animals?</li> <li><input type="checkbox"/> what are the disease loads in feral fauna and flora?</li> <li><input type="checkbox"/> what is the role of feral animals in the transmission of zoonoses</li> <li><input type="checkbox"/> what is the level of risk or concern?</li> </ul> <p><b>Ecologic impact</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> would we be able to identify a faunal collapse in an area due to an exotic disease given the cryptic nature of most of our faunal wildlife?</li> </ul> <p><b>Strategies</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> are there potential problem areas which should be monitored?</li> <li><input type="checkbox"/> is there a need to develop disease management protocols or contingency plans?</li> </ul> <p><b><i>Phytophthora cinnamomi</i></b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> is <i>Phytophthora cinnamomi</i> endemic to the region or to parts of the region?</li> <li><input type="checkbox"/> has its distribution and prevalence increases/decreased since Brown's surveys (20 years ago)?</li> </ul>	<p><b><i>Phytophthora cinnamomi</i></b></p> <ul style="list-style-type: none"> <li>• Brown's network of <i>Phytophthora</i> sites (possible focus: Mt Lewis, Wallaman Falls, Tully Falls, Mt Windsor and Black Mt Road</li> </ul> <p><b>Amphibian diseases</b></p> <ul style="list-style-type: none"> <li>• upland rainforest streams (&amp; preserved museum specimens of the missing frogs)</li> </ul> <p><b>Mycobacterial infections in cassowaries</b></p> <ul style="list-style-type: none"> <li>• Mission Beach (plus cassowary kills)</li> </ul>

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
		<p><b>Control options</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop specific and integrated control/management methods</li> </ul> <p><b>Strategies</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to take a pro-active approach to exotic disease management</li> <li><input type="checkbox"/> to develop hygiene protocols</li> <li><input type="checkbox"/> to coordinate management responses and control efforts</li> </ul> <p><b><i>Phytophthora cinnamomi</i></b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to determine whether or not <i>P. cinnamomi</i> is endemic and a natural part of the dynamics of the rainforests</li> <li><input type="checkbox"/> to determine current distribution and status in Wet Tropics</li> <li><input type="checkbox"/> to evaluate present/potential risk and whether it is a key threatening process</li> <li><input type="checkbox"/> to identify biotic and abiotic controls/triggers of survival and virulence</li> </ul> <p><b>Amphibian diseases</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to determine whether chytrid fungi is a primary or secondary causal agent in frog decline in the region</li> <li><input type="checkbox"/> to determine whether chytrid fungi is endemic or epidemic in the region</li> <li><input type="checkbox"/> to determine an appropriate management response</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what triggers <i>Phytophthora cinnamomi</i> to cause dieback?</li> <li><input type="checkbox"/> are the triggers natural or caused by human activities?</li> <li><input type="checkbox"/> are current infrastructure management/maintenance prescriptions appropriate?</li> </ul> <p><b>Amphibian diseases</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> is chytrid fungi the causal agent of the recent, rapid frog extinctions and declines in the Wet Tropics?</li> <li><input type="checkbox"/> is chytrid fungi associated with Wet Tropics' frogs endemic?</li> <li><input type="checkbox"/> how should management respond to such a disease?</li> </ul> <p><b>Mycobacterial infections in cassowaries</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> how prevalent is the disease in cassowaries?</li> <li><input type="checkbox"/> what type/s of mycobacteria is/are involved?</li> <li><input type="checkbox"/> could this disease reduce the survival of cassowaries?</li> </ul>	

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
		<p>to such a disease</p> <p><b>Mycobacterial infections in cassowaries</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to establish the prevalence, pattern and virulence of mycobacteria infections in cassowaries, its means of spread and extent of concern</li> </ul>		
2.4.1	<p><b>Environmental Goods &amp; Services</b></p> <p>To identify, quantify and value non-market and market environmental attributes and resources:</p> <p><i>1. maintenance of the environment</i></p> <ul style="list-style-type: none"> <li>• carbon</li> <li>• water cycles</li> <li>• water quality</li> <li>• regional climates &amp; microclimates</li> <li>• flood mitigation</li> <li>• groundwater recharge</li> </ul> <p><i>2. utilitarian uses</i> visitation</p> <ul style="list-style-type: none"> <li>• genetic resources</li> <li>• scientific research</li> <li>• education</li> <li>• horticultural</li> <li>• pharmaceutical products</li> <li>• energy (hydro)</li> </ul> <p><i>3. personal enjoyment</i></p> <ul style="list-style-type: none"> <li>• enjoyment &amp; aesthetic values</li> <li>• leisure activities (scenic</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> to develop assessment processes which allow the full costs and benefits of proposals to be quantified in standard units, and which will allow direct comparisons of different scenarios and options</li> <li><input type="checkbox"/> to develop methods and gain information which will create opportunities to foster community/industry/political support to achieve primary goal</li> <li><input type="checkbox"/> to development of effective and long-term conservation incentive mechanisms</li> <li><input type="checkbox"/> to develop methods for evaluating economic implications of changes in ecological function and provision of ecological goods and services in relation to use</li> <li><input type="checkbox"/> to develop methods to collate and apply economic, environmental and social data in a coherent manner for cost-benefit and related analyses</li> <li><input type="checkbox"/> to develop an approach to environmental economics based on scientific research and knowledge, including resource accounting and the long-term social benefits and costs</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> how do we measure economic/social benefits and disbenefits to communities from WHA and tourism?</li> <li><input type="checkbox"/> can robust methods for evaluating economic implications of changes in ecological function and provision of ecological goods and services in relation to use be developed?</li> <li><input type="checkbox"/> what are the full range of goods and services provided by the WHA?</li> </ul>	<ul style="list-style-type: none"> <li>• Kuranda Range road upgrade options</li> <li>• Cook Highway upgrade options</li> <li>• Daintree lowlands</li> <li>• Cairns water supply options</li> </ul>

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
	<p>views, bushwalking, bird watching, camping etc)</p> <p>4. <i>ethics</i></p> <ul style="list-style-type: none"> <li>• ethical/moral values</li> <li>• intrinsic natural values &amp; importance</li> <li>• cultural and historic values</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> to develop a comprehensive inventory of goods and services provided by the World Heritage Area</li> <li><input type="checkbox"/> to evaluate the role of native arthropods in providing ecological services such as pollination of native and agricultural plants and biological control of pests</li> <li><input type="checkbox"/> to assess the role of different vegetation types in the regulation of water in the region</li> <li><input type="checkbox"/> to develop conceptual models which can identify the changes in ecological services in response to different types and intensities of use</li> <li><input type="checkbox"/> to quantify the ecological and economic significance of ecosystem services</li> <li><input type="checkbox"/> to provide an interpretation of the costs and benefits - environmental, social and economic of use/change and any remedial actions</li> <li><input type="checkbox"/> to provide information to assist in rationale debate by quantifying the full costs/benefits of any proposal</li> </ul>		
2.5.1	<p><b>Contemporary Aboriginal issues and aspirations</b></p>	<p>To ensure that the informed views of Aboriginal people regarding socio-cultural impacts of proposals are obtained and incorporated into decision making and planning.</p>	<p><b>Contemporary Aboriginal issues and aspirations</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to identify both the positive and negative impacts of people 'moving back to country'</li> <li><input type="checkbox"/> to provide for the meaningful participation of Aboriginal people in the management of the Area</li> <li><input type="checkbox"/> to achieve genuine and sustained goodwill and cooperation between WTMA, management agencies and Aboriginal people</li> </ul>	<p><b>Contemporary Aboriginal issues and aspirations</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the aspirations and interests of Aboriginal people in the use and joint management of different parts of the WHA?</li> <li><input type="checkbox"/> what are the cultural values of the Area and where are they located?</li> </ul>

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
			<ul style="list-style-type: none"> <li><input type="checkbox"/> to better understand the cultural, social and biophysical impacts of rainforest usage on both natural and cultural heritage values</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> how do you balance and protect rights of resource users, indigenous peoples and the 'public interest'?</li> <li><input type="checkbox"/> how do you balance the intent of recognition and the exercise of rights while protecting natural values?</li> </ul>	
2.5.2	<b>Traditional land management and knowledge</b>	To recognise within the planning and management framework cultural values and to ensure that the interests of Aboriginal people are recognised.	<ul style="list-style-type: none"> <li><input type="checkbox"/> to undertake oral history research as a matter of urgency</li> <li><input type="checkbox"/> to undertake research on ethno-ecology and traditional land management, in collaboration with the indigenous community leading to shared expertise and a common language in which to resolve conflicting perspectives on land management</li> <li><input type="checkbox"/> to identify and assess Aboriginal traditional land management practices and the potential use of these practices in managing the Area</li> <li><input type="checkbox"/> to identify Aboriginal knowledge of the distribution, status and conservation aspects of plants and animals and, where appropriate, use this information in management strategies</li> <li><input type="checkbox"/> to recognise and increase understanding and conservation of the Area's cultural values and ensure the interests of Aboriginal people particularly concerned with the land are reflected in the conservation</li> <li><input type="checkbox"/> to encourage culturally appropriate research with or by Aboriginal people, focused on traditional ecological knowledge and its relevance to</li> </ul>		



Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
			<p>conservation management</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to apply the knowledge and practices in ways that ensure equitable sharing of the benefits arising from their use</li> </ul>	
2.5.3	<p><b>Tourism &amp; visitor management</b></p>	<p>To determine biophysical and psycho-social carrying capacities and the limits to acceptable change as related to visitation and use.</p> <p>To better understand the expectations of visitors to the WHA and to gauge the extent to which those expectations are met through management of the Area.</p>	<p><i>Biophysical carrying capacity</i></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to establish key indicators that are relevant to monitoring the impact of visitation and use</li> <li><input type="checkbox"/> to better understand the social and biophysical impacts of rainforest visitation and usage on natural and cultural heritage values and on the nature and quality of visitor experiences</li> <li><input type="checkbox"/> to develop measures of 'biophysical carrying capacity' of different environment types taking into account both resistance to impact and resilience after impact</li> </ul> <p><i>Social/behavioural carrying capacity</i></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop measures of 'social/behaviour carrying capacity' of different environment types taking into account both socio-psychological and situational variables</li> <li><input type="checkbox"/> to monitoring the social impact of particular visitor activities and facilities to understand broad trends in recreation participation</li> </ul> <p><i>Limits of acceptable change (LAC)</i></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to develop measures of 'limits of acceptable change' of different environment types taking into account both biophysical indicators and experiential indicators</li> </ul>	<p><b>Carrying capacity</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> how can biophysical and social carrying capacities be determined for different sites, areas or facilities?</li> <li><input type="checkbox"/> what are the biophysical and social carrying capacities of identified visitor sites in the Area?</li> <li><input type="checkbox"/> can 'World Heritage focussed' marketing strategies be developed which influence visitor demography, perceptions and behaviour?</li> </ul> <p><b>Impacts of visitation and use</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what information is needed to link nature and extent of use with impacts on the environment?</li> <li><input type="checkbox"/> can consistent techniques for assessing/quantifying biophysical impacts be developed?</li> <li><input type="checkbox"/> how do we measure and monitor impacts on local communities and specific interest groups?</li> <li><input type="checkbox"/> what is required to establish monitoring programs for 'visitor experience' at key sites?</li> </ul> <ul style="list-style-type: none"> <li>• Visitor sites identified in the Wet Tropics Management Plan</li> <li>• Sites identified in the 'Nature-based Tourism Strategy'</li> <li>• Opportunities identified in 'Walking Track Strategy'</li> </ul>

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
		<ul style="list-style-type: none"> <li><input type="checkbox"/> to identify document and analyse the nature of biophysical, social and cultural impacts of rainforest visitation and usage</li> <li><input type="checkbox"/> to develop monitoring procedures involving standardised data sets and methodologies for assessing change and reciprocal interactions over time</li> </ul> <p><b>Visitor Use</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to gain a sound knowledge of visitor attributes and the magnitude and relative distribution of recreational use of the WHA, resulting in better management prescriptions</li> <li><input type="checkbox"/> to gain a better understanding of environmental impacts of recreational use in the WHA resulting in better management prescriptions</li> <li><input type="checkbox"/> to understand the pattern of visitor use of the World Heritage Area and the causal factors for such a pattern.</li> <li><input type="checkbox"/> to better understand the relationship between visitor behaviour and impacts on the World Heritage Area.</li> <li><input type="checkbox"/> to understand the relationship between residents and visitors in sharing the World Heritage Area.</li> <li><input type="checkbox"/> to develop strategies for mitigation of adverse existing and potential impacts on cultural and natural heritage values, and nature and quality of visitor experience</li> <li><input type="checkbox"/> to develop strategies for maximising the positive benefits of rainforest visitation and use</li> </ul>		

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
			<ul style="list-style-type: none"> <li><input type="checkbox"/> to develop key indicators which cover the six broad categories of ecological, aesthetic, experiential, social, cultural and economic indicators</li> <li><input type="checkbox"/> to undertake surveys of visitors and other people and to collect and analyse visitor use data: <ul style="list-style-type: none"> <li>• to identify visitor profiles</li> <li>• to identify market segments</li> <li>• to identify visitor information requirements</li> <li>• to identify recreation needs</li> <li>• to identify preferences and expectations</li> <li>• to identify travel patterns</li> <li>• to identify satisfaction levels</li> <li>• to identify attributes that contribute to visitor satisfaction</li> </ul> </li> <li><input type="checkbox"/> to identify information requirements of visitors during each phase of a recreation trip (e.g. pre-planning, travel to, on-site, travel back, recollection)</li> </ul>		
2.5.4	<b>Landholders &amp; neighbours</b>	To improve management through meaningful partnership arrangements and to give the WHA a function in the life of the community.	<ul style="list-style-type: none"> <li><input type="checkbox"/> to develop a demographic profile of World Heritage private landholders and neighbours</li> <li><input type="checkbox"/> to understand the motivation of landholders and neighbours in the context of the threats and opportunities posed by the World Heritage Area</li> <li><input type="checkbox"/> to identify the expectations of landholders and neighbours towards World Heritage management</li> <li><input type="checkbox"/> to provide advice on the strategic direction of any review of World Heritage boundaries</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what are the positive cultural, social and economic roles of the WHA in the regional community and beyond?</li> <li><input type="checkbox"/> in what reciprocal ways are the community having an active role in caring for the Area?</li> </ul>	

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations	
		<ul style="list-style-type: none"> <li><input type="checkbox"/> to identify the key issues of concern and possible strategies to deal with those concerns</li> <li><input type="checkbox"/> to establish current attitudes to domestic pets and their perceived interactions with native wildlife</li> <li><input type="checkbox"/> to establish current attitudes to weed control</li> </ul> <p>to establish current attitudes to the use of chemical including pesticides</p>			
2.5.5	<b>Community attitudes</b>	To improve management by understanding community attitudes to the Area with respect to general and specific issues.	<ul style="list-style-type: none"> <li><input type="checkbox"/> to understand at a regional level the awareness of the World Heritage listing, the level of support and the relative depth of that support, and the degree of relative importance the community places on the conservation of rainforest</li> <li><input type="checkbox"/> to understand at a national level the awareness of the World Heritage listing, the level of support and the relative depth of that support, and the degree of relative importance the community places on the conservation of rainforest</li> <li><input type="checkbox"/> to further measure the likelihood of people visiting the World Heritage Area in the future and their motivation for doing so</li> <li><input type="checkbox"/> to find out in practical terms the level of trade-off the community is prepared to accept in order to achieve conservation outcomes</li> <li><input type="checkbox"/> to understand the level of sub-regional variation in response to conservation management measures and the reasons for such variations</li> <li><input type="checkbox"/> to understand the pattern of use of the World Heritage Area and sensitivity to tourism</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what is involved in the development of a process of social impact assessment?</li> <li><input type="checkbox"/> what would constitute fair and equitable triggers for determining different levels of social assessment?</li> </ul>	

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
			<input type="checkbox"/> to quantify the level of community benefits and costs from the World Heritage Area		
2.5.6	<b>People/wildlife interactions</b>	To reduce negative impacts on wildlife from inappropriate interactions with wildlife.	<input type="checkbox"/> to increase community awareness of appropriate interactions with wildlife <input type="checkbox"/> to increase community appreciation of native wildlife <input type="checkbox"/> to develop better management prescriptions to reduce conflicts between wildlife and humans <input type="checkbox"/> to increase the public's understanding of and involvement in research and monitoring <input type="checkbox"/> to develop the communities' skills in research and monitoring processes	<input type="checkbox"/> what are the range of impacts on endangered wildlife resulting from access, tourism and research? <input type="checkbox"/> what are the range of impacts resulting from human feeding of wildlife? <input type="checkbox"/> how can we engender community assistance in an overall monitoring program? <input type="checkbox"/> what are the range of impacts resulting from artificial feeding of wildlife (eg cassowaries) <input type="checkbox"/> how can fruit bats be deterred from orchids? <input type="checkbox"/> what are the range of impacts resulting from spotlighting, its intensity and frequency on a range of species ? <input type="checkbox"/> what are the range of impacts on social behaviour and breeding success resulting from regular viewing of golden bowerbird bowers?	
2.5.7	<b>Education, interpretation and presentation</b>	To assist in the development of an informed community with a good understanding of the values of the Area which is supportive of and actively involved in	<input type="checkbox"/> to develop and promote a minimum impact code for visitors	<input type="checkbox"/> how successful in achieving the Authority's aims has been the approach of local community run and managed interpretation centres?	

Strategic Management Area (SMA)		Information Need	Management Objectives	Key Management Questions	Key Locations
		management activities to conserve these values.		<input type="checkbox"/> what is the relative importance of pre-visit, off-site and on-site interpretation materials and messages?	
2.5.8	<b>Population growth and regional development</b>	To pro-actively plan for projected patterns of increase in population and the potential demands that this and evolving land use changes may place on the Area.	<input type="checkbox"/> to predict human demands and impacts on World Heritage values <input type="checkbox"/> to create an integrated regional framework for planning and management at the bioregional level to assist in pro-active decision making <input type="checkbox"/> to develop models for the prediction of vegetation, soil and land properties and qualities <input type="checkbox"/> to develop inferential rule-based systems to interpret the probability of occurrence of specific attributes in data sparse environments, with particular attention to rainforest fauna, species of concern or pest distributions <input type="checkbox"/> to develop predictive models to extrapolate the spatial domain of reliability (confidence) of other research projects - e.g. where can the results of various studies be extrapolated to <input type="checkbox"/> to develop a spatial-demographic model of human population growth in the region and associated demands on rainforest services <input type="checkbox"/> to connect analyses of population growth with models predicting consequent demands on rainforest goods and services	<input type="checkbox"/> what and where are human uses predicted to impact on the Area? <input type="checkbox"/> how can the Authority play a key role in input into regional planning exercises?	
3.0.1	<b>Ecosystem reconstruction, wildlife corridors</b>	To establish an ecologically based, logistically and economically feasible system for identifying	<input type="checkbox"/> to enhance the rehabilitation of damaged landscapes using ecologically and geologically sound processes with a particular emphasis on	<b>Establishing regional priorities</b> <input type="checkbox"/> how do we identify key regional priorities?	<b>Ecology</b> <ul style="list-style-type: none"> <li>• East Evelyn Road</li> </ul>

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
<p><b>and ecological linkages</b></p>	<p>priorities for rehabilitation efforts, especially linear infrastructure clearings and disturbances.</p> <p>To determine the relative costs and benefits of different approaches to ecological rehabilitation, especially of linear infrastructure clearings and disturbances.</p> <p>To assess the ecological and economic performance of rehabilitation projects.</p>	<p>habitat re-establishment, defragmenting, decommissioning, presentation enhancement, slope stabilisation and the re-establishment of connectivity</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> to adopt and implement suitable technologies and guidelines for rehabilitation and restoration of degraded rainforest, open forest, wetland, riparian and river systems</li> <li><input type="checkbox"/> to develop protocols for selecting priority areas for regeneration and rehabilitation of degraded rainforest, riparian and river systems</li> <li><input type="checkbox"/> to establish the requirements for ecologically functional wildlife corridors and habitat linkages</li> <li><input type="checkbox"/> to identify the most suitable techniques for vegetation rehabilitation (e.g. replanting, direct seeding, stock exclusion, weed control, fire management)</li> <li><input type="checkbox"/> to identify the most suitable techniques for habitat reconstruction to provide habitat structure and resources for forest/riparian wildlife</li> <li><input type="checkbox"/> to provide fundamental scientific understanding of rehabilitation processes</li> <li><input type="checkbox"/> to understand landscape evolutionary processes and application of these principles to reconstruction of disturbed sites</li> <li><input type="checkbox"/> to establish the requirements for ecologically sound decommissioning of obsolete infrastructure, especially roads, tracks, powerline clearings and old mine sites</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what criteria should be used in selecting projects/areas?</li> </ul> <p><b>Ecology</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the key ecological processes and design elements that need to be considered?</li> <li><input type="checkbox"/> are constructed wildlife corridors effective and self-sustainable?</li> <li><input type="checkbox"/> what design criteria (widths, species, logs, rocks, water features etc) need to be considered for specific wildlife?</li> <li><input type="checkbox"/> What protocols should be adopted for the inclusion of rare and threatened species in plantings?</li> </ul> <p><b>Strategies &amp; approaches</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> what are the relative costs/benefits (ecological &amp; economic) of narrow linear corridor verses 'big patch' projects?</li> <li><input type="checkbox"/> what is the potential for the introduction of undesirable soil or plant pests and diseases? what hygiene protocols etc need to be implemented?</li> <li><input type="checkbox"/> When are alternatives to direct tree planting, such as direct seeding and natural regeneration (e.g. cattle exclusion fencing, weed management) realistic options?</li> </ul> <p><b>Monitoring</b></p>	<ul style="list-style-type: none"> <li>• temporal and spatial sequence of documented rehabilitation sites</li> <li>• Donaghy's corridor</li> <li>• Peterson Creek corridor</li> <li>• Massey Creek corridor</li> <li>• Walter Hill Range corridor</li> </ul> <p><b>Strategies &amp; approaches</b></p> <ul style="list-style-type: none"> <li>• temporal and spatial sequence of documented rehabilitation sites</li> <li>• sites specifically incorporating different design, establishment, maintenance or methodological features</li> </ul> <p><b>Monitoring</b></p> <ul style="list-style-type: none"> <li>• temporal and spatial sequence of documented</li> </ul>

Strategic Management Area (SMA)	Information Need	Management Objectives	Key Management Questions	Key Locations
		<ul style="list-style-type: none"> <li><input type="checkbox"/> to quantify the roles of the riparian zone under different conditions, including determination of required riparian strip width for a range of essential ecological processes</li> <li><input type="checkbox"/> to assess aquatic habitat distribution in streams, and development of appropriate biological and physical techniques for aquatic habitat restoration</li> <li><input type="checkbox"/> to develop practical strategies and techniques for management of invasive species</li> <li><input type="checkbox"/> to develop site-species matching models</li> <li><input type="checkbox"/> to establish ecological criteria for monitoring or assessing the effectiveness of rehabilitation projects</li> <li><input type="checkbox"/> to investigate novel/innovative methodologies</li> <li><input type="checkbox"/> to establish ecological principles relating to restoration of complex rainforest systems</li> </ul> <p><b>Ecological restoration of wetlands</b> to identify key ecological processes for management of temporary and permanent wetlands</p>	<ul style="list-style-type: none"> <li><input type="checkbox"/> what are appropriate indicator sets for monitoring progress of projects and tracking the restoration of ecosystem function?</li> <li><input type="checkbox"/> how successful have existing plantings been (with respect to original purpose) and what aspects should be adopted or avoided?</li> </ul> <p><b>Ecological restoration of wetlands</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> how is it possible to restore hydrological and ecological processes following drainage to parts of a wetland?</li> <li><input type="checkbox"/> how should the decommissioning of a drain through a wetland be accomplished and its progress monitored?</li> </ul>	<p>rehabilitation sites</p> <ul style="list-style-type: none"> <li>• Donaghy's corridor</li> <li>• Peterson Creek corridor</li> <li>• Massey Creek corridor</li> <li>• Walter Hill Range corridor</li> </ul> <p><b>Wetlands</b></p> <ul style="list-style-type: none"> <li>• Wyvuri Swamp</li> </ul>



## Section 4

### WTMA Priority Information Requirements (next 3 - 7 years)

Strategic Management Area (SMA)	SMA No.	Priority Project or Information Need
monitoring and reporting	1.0.1	as identified and detailed in the State of Wet Tropics indicator reports
natural resource mapping, modelling and assessment	1.0.2	a) complete a program of high resolution vegetation mapping of the entire bioregion b) develop methods for remote sensing of standing biomass for mapping, monitoring and assessment purposes
fire	1.0.10	a) develop prescribed burning practices that take account of the differential fire response of different ecosystems, natural patterns of succession and the role of fire in the maintenance of biological diversity with particular initial emphasis on wet sclerophyll forests and Northern Bettong habitat
linear service corridors - roads	2.1.1	a) adaptive management research for the development and assessment of methods for prescribing engineering and design construction practice to: completely avoid a particular impact; control the effects of unavoidable impacts; and attenuate the effects of particular threats. Immediate focus should be directed at the: <ul style="list-style-type: none"> <li>◆ Kuranda Range</li> <li>◆ East Evelyn</li> <li>◆ Captain Cook Highway</li> <li>◆ Mission Bch- El Arish</li> </ul> b) develop a classification of access based on robust biophysical/ecological criteria of the Area's road and track network to determine their future management
linear service corridors - powerlines	2.1.2	a) adaptive management research for the development and assessment of methods for prescribing engineering and design construction practice to: completely avoid a particular impact; control the effects of unavoidable impacts; and attenuate the effects of particular threats. Immediate focus should be directed at the: <ul style="list-style-type: none"> <li>◆ South Johnstone/Palmerston line</li> <li>◆ Chalumbin/Woree line</li> </ul>
environmental weeds	2.3.1	a) develop a robust decision making model for strategic weed management b) understand the population dynamics and effective control of prioritised weed species c) develop specific and integrated control methods
feral animals	2.3.2	a) develop a robust decision making model for strategic vertebrate and invertebrate pest management b) identify potential ecological impacts and present and potential distribution ranges of vertebrate and invertebrate pest species prioritised in (a) above

Strategic Management Area (SMA)	SMA No.	Priority Project or Information Need
		c) identify the most susceptible aspects of the ecology of target pest species to be exploited in their management d) develop specific and integrated control methods
diseases	2.3.3	a) assess the impact, extent and environmental controls on the expression of forest dieback ( <i>Phytophthora spp</i> ) in areas of recent outbreak b) determine whether chytrid fungi is the causal agent in the decline and/or disappearance of seven endemic Wet Tropics frog species and, if so, develop management prescriptions c) develop an exotic disease inventory of existing and potential problems and develop a robust decision making model for strategic disease management d) identify the potential role of feral, domestic and native plants and animals as vectors and amplifiers of disease e) gauge the potential impact of exotic diseases on WH values and identify the most susceptible aspects of their ecology to be exploited in their management
environmental goods and services	2.4.1	a) develop a comprehensive inventory of the environmental goods and services provided by the WHA b) develop methods for evaluating the economics of ecological function changes and the provision of environmental goods and services in relation to use so that the full costs and benefits of proposals can be quantified. Initial case studies: <ul style="list-style-type: none"> <li>◆ Daintree Futures</li> <li>◆ Kuranda Range options</li> <li>◆ Water supply</li> </ul>
contemporary Aboriginal issues and aspirations	2.5.1	a) identify aspirations b) identify cultural values c) identify mechanisms for achieving both conservation goals and indigenous aspirations
tourism and visitor management	2.5.3	as per actions and information requirements identified in the Wet Tropics Nature Based Tourism Strategy and Wet Tropics Walking Track Strategy
community attitudes	2.5.5	a) identify community attitudes and levels of support b) develop a Social Impact Assessment processes
ecosystem reconstruction, wildlife corridors and ecological linkages	3.0.1	a) identify key regional and WHA priorities b) develop best practice methods for ecological restoration

**for more detailed descriptions refer to Section 3**