

Wet Tropics Management Authority Research Strategy 2014-2018

**Improving management by building and
communicating knowledge through collaboration**



**WET TROPICS OF QUEENSLAND
A Learning Landscape**

Front cover photo: Rainforest near Paluma | Credit: Tourism Queensland

Back cover photo: *Licuala ramsayi* fan palm endemic to the Wet Tropics | Credit: Campbell Clarke WTMA



Australian Government



**Queensland
Government**



Research Strategy 2014-2018

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Abbreviations

Act	<i>Wet Tropics World Heritage Protection and Management Act 1993</i>
ATH	Australian Tropical Herbarium
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DRO	Daintree Rainforest Observatory
GBRWHA	Great Barrier Reef World Heritage Area
GIS	Geographic Information System
ILTER	International Long Term Ecological Research Network
IUCN	International Union for the Conservation of Nature
JCU	James Cook University
MTSRF	Marine and Tropical Science Research Facility
NCCARF	National Climate Change Adaptation Research Facility
NCRIS	National Collaborative Research Infrastructure Strategy
NERP	National Environmental Research Programme
OUV-I	Outstanding Universal Value and Integrity (World Heritage values)
QPWS	Queensland Parks and Wildlife Service
Rainforest CRC	Cooperative Research Centre for Tropical Rainforest Ecology and Management
RRRC	Reef and Rainforest Research Centre
SAC	WTMA's Scientific Advisory Committee
TERN	Terrestrial Ecosystem Research Network
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WHA	World Heritage Area
WTMA	Wet Tropics Management Authority
WTQWHA	Wet Tropics of Queensland World Heritage Area

The Wet Tropics: a learning landscape

The Wet Tropics of Queensland World Heritage Area (WTQWHA) is an area of iconic environmental significance with stunning biodiversity, much of it ancient in character and endemic to the region. The World Heritage Area (WHA) is a region of spectacular scenery and rugged topography with fast-flowing rivers, deep gorges and numerous waterfalls. Mountain summits provide expansive vistas of one of the oldest surviving rainforest in the world. The exceptional coastal scenery combines tropical rainforest, white sandy beaches and fringing reefs just offshore; a unique feature on a global scale.

Tropical rainforest dominates the region but there are also significant areas of other vegetation communities including sclerophyll and mangrove forests. The diverse habitats of the WTQWHA provide refuge for numerous species of rare and threatened plants and animals. Species diversity and endemism are exceptionally high, due to ancient biota being isolated for a long time. The Wet Tropics bioregion contains an almost complete record of the major stages in the evolution of plant life and provides refugia for many rainforest species that originated when Australia was part of Gondwana. The Wet Tropics also contains one of the most important living records of the history of marsupials and songbirds.

In addition to these natural values, the region is also culturally rich, comprising the traditional lands of 18 Rainforest Aboriginal tribes who maintain a continuing cultural affiliation with the WTQWHA.

The spectacular and unique features of the WTQWHA, combined with its very high natural integrity, make it of outstanding universal significance and extremely valuable for scientific research. The Wet Tropics region also has the natural assets, research infrastructure and credentials to become an internationally recognised research centre for tropical biodiversity and conservation biology.

Many of the elements to achieve this vision are already in place:

- extensive, accessible, protected, diverse tropical forested landscapes
- located in a country with a stable government, a modern economy, and a safe operating environment
- some of the best and most respected natural area research scientists
- established research infrastructure and supporting services
- a burgeoning nature-based tourism industry
- a high level of political and community support and a sense of identity centred round the region's rainforests and reef.

But there is much to learn. We have barely skimmed the surface of many of the complexities in our ancient forests and their responses to the myriad pressures wrought by human population growth and economic development. We don't know enough about how our ecological, social and cultural systems will respond to changes that are already happening and are likely to accelerate, particularly those associated with climate change.

Research plays a vital role in World Heritage policy and management, contributing knowledge that identifies management issues, informs management practice and evaluates management effectiveness. Research contributes to knowledge about and understanding of the values of World Heritage properties. It contributes to improved policy and management of the Outstanding Universal Value of World Heritage properties and

towards wider community understanding and potential changes in behaviour. Research can reduce uncertainty about values and management strategies, confirm assumptions built into management strategies and play a vital role in monitoring the state of conservation of World Heritage properties. Research conducted in World Heritage properties, or addressing World Heritage themes also builds knowledge relevant to environmental and cultural heritage elsewhere.

This strategy promotes a renewed effort in tropical rainforest research through improved planning, co-ordination, collaboration and communication. The strategy identifies areas of research that will see Australia best equipped to meet its international obligations to protect, conserve, present, rehabilitate and transmit to future generations the natural heritage of WTQWHA.

The Wet Tropics Management Authority (WTMA)'s responses to ongoing and emerging challenges and opportunities require innovative science and technology to:

- deliver a more complete understanding of our ecological, social and cultural systems
- allow better forecasting of the future
- formulate and test mitigation/adaptation measures in the face of global change.

The Wet Tropics of Queensland is a **learning landscape** that provides outstanding opportunities for collaborative research across disciplines such as ecology, climatology, tourism, sociology and economics based on tropical ecosystems.

A comparative advantage of undertaking research which benefits the management of World Heritage properties is that these iconic properties attract considerable attention and can influence the adoption of good management practices elsewhere. UNESCO encourages World Heritage properties to serve as laboratories where monitoring, mitigation and adaptation processes can be applied, tested and improved¹. They also encourage partnerships between relevant organisations in field activities on mitigation and adaptation strategies, methodologies, tools and/or pilot projects.

Well-focussed research is fundamental to effective management of a natural World Heritage area. Research needs to be responsive to the evolving array of challenges faced by natural area land management agencies, with outcomes that can be applied on the ground. WTMA has a long history of supporting solutions-based scientific research and collaborating on research projects with academic institutions, other government agencies and community stakeholders.

This Research Strategy identifies key research topics and tasks, and promotes and encourages research collaboration and partnerships. Working collaboratively will enable better leverage of regional resources and expand the breadth, applicability and capacity of the research undertaken in the Wet Tropics. Collaboration will also foster the transfer of knowledge and continue to build professionalism in Wet Tropics World Heritage management.

This Research Strategy aligns with the *Queensland Research and Development Investment Strategy 2010-2020*² and the Queensland Science and Research Priorities 2014²

¹ The benefits and importance of undertaking research in World Heritage properties are noted in several UNESCO documents. The following may be of particular interest: UNESCO (2007). *Policy document on the impacts of climate change on World Heritage properties (WHC-0716.GA/10)*. <http://whc.unesco.org/document/9281>

² Queensland Science and Research Priorities. <http://www.chiefscientist.qld.gov.au/assets/Queenslandscienceandresearchpriorities.pdf>

Executive summary

WTMA recognises research as being a necessary and valuable component of effective natural area management. Scientific research supports integrated and adaptive management by providing an objective and defensible basis for making decisions and developing policy. Efficient transfer and application of scientific knowledge is crucial to successfully meeting the challenge of transmitting to future generations a resilient WTQWHA in a better condition than we inherited.

Through this Research Strategy, WTMA invites collaboration with research providers to build knowledge of the Wet Tropics bioregion, related environmental and cultural topics, the social and economic importance of the WHA, and how best to conserve and enhance the WTQWHA.

Our research objectives over the next five years (which are described in **Chapter 2**) are to:

- continue to identify priority research topics and questions which will benefit WTQWHA management
- promote appropriate research into World Heritage, conservation land management, environmental, cultural, social and economic issues, across the Wet Tropics bioregion and with a primary focus on the WTQWHA, policy development and operational decision making
- identify, and seek opportunities for, a variety of collaboration and partnership approaches to enable and encourage Wet Tropics natural area land management agencies (including WTMA), and scientists/researchers to work together on World Heritage related projects
- promote increased financial and in-kind support through advocacy, collaboration, and other means, to undertake research relevant and important to the WTQWHA
- build on the outcomes of previous research partnerships with the Rainforest CRC, MTSRF, NERP, TERN and NCARRF
- identify ways in which the WTMA can help facilitate research
- disseminate research findings to communities of interest in an effective and timely way.

Chapter 7 of this Strategy outlines the main research areas that the Authority considers particularly important. It identifies that research is required to improve our understanding of how ecosystems function, to be able to monitor their health, maintain and build their resilience to current and future threats and to be able to use ecosystems sustainably. These needs can be addressed by investing in the following four broad research areas:

- 1. Understanding the Outstanding Universal Value of the Wet Tropics World Heritage Area**
 - 2. Understanding the rainforests (and associated ecosystems) of Australia's Wet Tropics.**
 - Describing Australia's wet tropical diversity
 - Origin, patterns, and maintenance of Australia's wet tropical diversity
 - Functioning of Australia's wet tropical ecosystems
 - 3. Understanding the causes of change to Australia's tropical rainforest ecosystems and how to maintain, restore and monitor their ecological resilience to change.**
 - Human impacts on ecosystems
 - Fragmentation
-

- Invasive species
- Restoration
- Sustainable use

4. Understanding the social drivers of change and the social responses to managing tropical rainforest ecosystems.

- Governance
- Presentation
- Ecosystem services

Chapter 8 of this Strategy outlines our research priorities over the next five years in greater detail and these are summarised in **Appendix 1** of this report. We have categorised our information needs into the four research themes³ described in **Chapter 7** with specific areas of management interest linked to these themes:

1. Understanding the Outstanding Universal Value of the Wet Tropics World Heritage Area

2. Understanding the rainforests (and associated ecosystems) of Australia's Wet Tropics.

- Describing Australia's wet tropical diversity
 - ecological / forest 'health' (EH)
- Origin, patterns, and maintenance of Australia's wet tropical diversity
 - priority species and ecosystems (SP)
- Functioning of Australia's wet tropical ecosystems
 - fire management (FM)

3. Understanding the causes of change to Australia's tropical rainforest ecosystems and how to maintain, restore and monitor their ecological resilience to change.

- Human impacts on ecosystems
 - climate change impacts and adaptation strategies / regional responses (CC)
 - impact mitigation – community infrastructure and activities (IM)
- Invasive species
 - alien and invasive species (AI)
- Restoration
 - wildlife corridors and ecological connectivity (WC)
 - rehabilitation and restoration (RR)
- Sustainable use
 - land use change (LU)

4. Understanding the social drivers of change and the social responses to managing tropical rainforest ecosystems.

- Governance
 - Rainforest Aboriginal cultural studies (AB)
 - giving the WTQWHA a role in the life of the community (CO)
 - adoption – making a difference (AD)

³ These priority research themes are based on UNESCO's *Operational Guidelines for the Implementation of the World Heritage Convention* <http://whc.unesco.org/archive/opguide08-en.pdf>, and the Primary Goal of management as defined in schedule 1 of the *Wet Tropics World Heritage Protection and Management Act 1993* <http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WetTropicsA93.pdf>

- Presentation
 - World Heritage presentation, recreation and tourism (TO)
 - information technology (IT)

- Ecosystem services
 - socio-economic and environmental benefits (environmental goods & services) (SE)
 - supporting economic activity (EA)

Information needs have been identified under each of these four themes and specific areas of management interest. Research questions have been prioritised into Top (.T), High (.H), and Lower Priority (.P).

WTMA hopes that this Research Strategy will help us to build on previous research initiatives and collaborations in the region and attract new research effort and investment into the Wet Tropics.

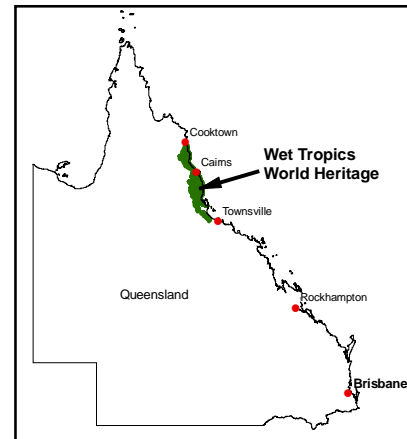
1. Introduction

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

The region

The Wet Tropics of Queensland extends 400 km along the tropical coast of north-east Australia in the State of Queensland between Cooktown to the north and Townsville to its south.

In 2011 the Forests of East Australia (including the Wet Tropics) was added to the list of global biodiversity hotspots⁴⁵ and this is reflected in its inscription under the UNESCO *World Heritage Convention*⁶ for its outstanding universal value and integrity.



Although representing only 0.013 percent of the earth's land surface, the Wet Tropics, for its size, makes a significant contribution to global biodiversity. A 2013 study published in the journal *Science*⁷ identified the Wet Tropics of Queensland World Heritage Area as the sixth most irreplaceable protected area on earth for the conservation of amphibian, bird and mammal species⁸. The Wet Tropics of Queensland World Heritage Area was also ranked globally as the second most irreplaceable natural World Heritage site⁹. These rankings were based on data on 173,000 terrestrial protected areas and assessments of 21,500 species on the IUCN Red List of Threatened Species and highlight the global importance of Australia's Wet Tropics.

In addition to its natural values, the region is also culturally rich, comprising the traditional lands of 18 Rainforest Aboriginal tribes. People have lived in the Wet Tropics for tens of thousands of years. There is a close connection between Rainforest Aboriginal people and the natural environment, involving complex interrelated cultural, social, economic and spiritual relationships. This long continuous connection has been recognised with the National Heritage listing of the Wet Tropics for its Indigenous cultural values.

The natural and cultural assets of the region provide a vital resource for regional tourism, which is the major contributor to the regional economy.

The region is immediately adjacent to Australia's Great Barrier Reef World Heritage Area (GBRWHA) making it a very attractive learning landscape for research. The rainforests of the region have a high level of accessibility

⁴ *Status and Threats in the Dynamic Landscapes of Northern Australia's Tropical Rainforest Biodiversity Hotspot: The Wet Tropics* http://link.springer.com/chapter/10.1007/978-3-642-20992-5_17

⁵ Forests of East Australia: The 35th Biodiversity Hotspot. http://link.springer.com/chapter/10.1007%2F978-3-642-20992-5_16#page-2

⁶ UNESCO World Heritage Convention <http://whc.unesco.org/archive/convention-en.pdf>

⁷ Protected Areas and Effective Biodiversity Conservation <http://www.sciencemag.org/content/342/6160/803.summary>

⁸ Protected area irreplaceability – Wet Tropics of Queensland World Heritage Site: <http://irreplaceability.cefe.cnrs.fr/sites/17757>

⁹ Terrestrial biodiversity and the World Heritage List.

http://www.iucn.org/about/work/programmes/wcpa_worldheritage/resources/publications/?uPubsID=4905

centred round the major urban centre of Cairns. The region also has world class conferencing facilities in both Cairns and Townsville and well established, internationally recognised research infrastructure, including:

- James Cook University (JCU), with campuses in Cairns and Townsville, and several field stations in the region including the Daintree Rainforest Observatory at Cape Tribulation
- Commonwealth Scientific, Industrial and Research Organisation (CSIRO) with laboratories in Cairns, Atherton and Townsville, numerous long term research plots including the TERN 25 hectare superplot at Robson Creek
- Several State Government research establishments at places such as South Johnstone, Cairns, Mareeba and Walkamin.

The region also has capable management institutions, including the Wet Tropics Management Authority (WTMA), the Queensland Department of Environment and Heritage Protection, Queensland Parks and Wildlife Service and the Commonwealth Department of Environment.

The Wet Tropics Management Authority

The *Wet Tropics of Queensland World Heritage Area*¹⁰ (WTQWHA) was inscribed on the UNESCO World Heritage List of natural properties on 9 December 1988.

The Wet Tropics Management Authority¹¹ (WTMA) was established to ensure that Australia's obligations under the World Heritage Convention are met. WTMA is a body corporate with statutory powers defined under the *Wet Tropics World Heritage Protection and Management Act 1993*¹². Its primary task is:

“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.”

WTMA has a coordinating role with specific functions defined in its Act, which include:

- gather, research, analyse and disseminate information on the Wet Tropics area
- advise and report on the state of the Wet Tropics area
- prepare and implement management plans
- develop and implement management policies and programs
- administer funding arrangements in relation to the Wet Tropics area
- enter into arrangements for the provision of rehabilitation and restoration works
- develop public and community education programs
- promote the Wet Tropics area locally, nationally and internationally
- liaise with the governments and authorities of the State, the Commonwealth, other States and the Territories, and international and foreign organisations and agencies.

The Act requires WTMA to perform its functions consistent with the objectives and principles of the *National Strategy for Ecologically Sustainable Development*¹³ which includes:

¹⁰ *Wet Tropics of Queensland World Heritage Area* <http://whc.unesco.org/en/list/486>

¹¹ *Wet Tropics Management Authority* <http://www.wettropics.gov.au>

¹² *Wet Tropics World Heritage Protection and Management Act 1993* <http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WetTropicsA93.pdf>

- 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.

The Act also requires WTMA, in performing its functions, to consider Aboriginal tradition and liaise and co-operate with Aboriginal people concerned with the WTQWHA, and to establish a scientific advisory committee (SAC) whose function is to provide advice to WTMA on:

- scientific research that will contribute to the protection and conservation of the Wet Tropics area
- scientific developments relevant to the protection or conservation of the area.

WTMA's Scientific Advisory Committee played a very important role in determining both the direction and development of this research strategy and will continue to have an important role in advising on its implementation.

WTMA is a scientifically literate organisation that uses high-quality and timely science to support its mission. WTMA staff use their scientific competency to research, analyse and apply existing science to reach conclusions and deliver practical outcomes for policy development. WTMA must be aware of its business context and scientific competency so it can provide fit-for-purpose knowledge to make strategic, tactical and operational decisions that are timely, evidence-based, robust and outcome-driven.

Conservation land managers are increasingly being asked to solve complex policy problems that require significant scientific input. Policymaking must be rigorous and evidence-based and routinely and systematically draw on science. Science provides evidence to stimulate action, clarify ambiguity, identify gaps, improve resilience of decision-making and manage uncertainty. It is also essential for innovation.

Participation of Rainforest Aboriginal people

There are Rainforest Aboriginal communities and groups which have a continuing cultural affiliation with the WTQWHA. This affiliation includes cultural rights and responsibilities to own, access, use and manage environments and resources associated with their traditional estates.

On 9 November 2012 the Wet Tropics World Heritage Area's Indigenous heritage values were included as part of the existing Wet Tropics of Queensland National Heritage Listing.

The listing recognises that Rainforest Aboriginal heritage is unique to the Wet Tropics and is a remarkable and continuous Indigenous connection with a tropical rainforest environment.

The following quote summarises the basis for the listing: *"The Aboriginal Rainforest People of the Wet Tropics of Queensland have lived continuously in the rainforest environment for at least 5 000 years and this is the only place in Australia where Aboriginal people have permanently inhabited a tropical rainforest environment."*

¹³ National Strategy for Ecologically Sustainable Development <http://www.environment.gov.au/resource/national-strategy-ecologically-sustainable-development>

The Aboriginal Rainforest people developed a distinctive cultural heritage determined by their dreamtime and creation stories and their traditional food gathering, processing and land management techniques. Reliance on their traditions helped them survive in this, at times, inhospitable environment. The distinctiveness of the traditions and technical innovation and expertise needed to process and prepare toxic plants as food and their uses of fire is of outstanding heritage value to the nation and are now protected for future generations under national environmental law.”¹⁴

The objective in managing National Heritage places is to identify, protect, conserve, present and transmit, to all generations, their National Heritage values. Indigenous people are the primary source of information on the value of their heritage and the active participation and leadership of Indigenous people in identification, assessment, conservation and management is integral to the effective protection of Indigenous heritage values.

Researchers have an obligation to seek the meaningful involvement of appropriate Rainforest Aboriginal people and their organisations in their research projects. Involvement may vary from a desire to be kept informed about the project, to a requirement for active co-management of the project. Issues to be considered by Rainforest Aboriginal people may include:

- What procedures and processes are proposed to engage Rainforest Aboriginal people throughout the project, and report on the findings and implications of the project at its conclusion?
- Will the project be of benefit to Rainforest Aboriginal people?
- What are the potential impacts of the project on Rainforest Aboriginal estates, environments, resources, cultures, rights, interests or life styles?
- What are the opportunities for training and/or employment of Rainforest Aboriginal people in the project?
- What are the safeguards for the recognition and protection of Rainforest Aboriginal intellectual property rights?
- What is the level of understanding among the researchers about Rainforest Aboriginal cultures, rights and interests associated with the research area?

Some Indigenous organisations have developed or are developing protocols¹⁵ and priorities to assist their people and research organisations to take a strategic approach to addressing issues such as those outlined above. The report documenting the outcomes of the Traditional Owners of the Wet Tropics Strategic Research Directions Workshop held in September 2009 for the Marine and Tropical Science Research Facility (MTSRF) helped to inform the content of this document.

¹⁴ <http://www.environment.gov.au/node/19823>

¹⁵ <http://www.aiatsis.gov.au/files/research/GERAIS.pdf>

2. Research objectives

Research is a necessary and valuable component of effective World Heritage management. Science supports an integrated and adaptive management approach to solving management issues and sets an objective basis for making decisions and policy development. Research is therefore a major and legitimate use of a World Heritage property.

This Research Strategy is part of our response to the challenge of improving the management, protection, understanding, and use of the WHA and its natural and cultural heritage. WTMA aims to foster collaboration between the users of research and the providers of research to build a comprehensive knowledge bank about the WTQWHA from natural, cultural, economic and social perspectives and how best to conserve and enhance these attributes.

The purpose of this Strategy is to:

- assist in the process of knowledge transfer of the values, threats and management of the natural and cultural heritage of the Wet Tropics
- apply this knowledge to improve on-ground management and policy development
- apply this knowledge to obtain additional investment and other support.

This Research Strategy has also been produced to encourage partnerships between WTMA and other interested parties to investigate questions that are currently not well researched or understood by natural area land managers in the region.

This document is the outcome of a review of WTMA's Research Strategy 2010-2014 and provides an outline of the management areas and issues WTMA, and others with management responsibility for the WTQWHA, think important to improve the conservation management of the WTQWHA. It presents WTMA's vision for a more effective strategic approach to securing relevant scientific research. The vision is primarily the result of reflections and discussions held with the SAC, WTMA staff and others. The priorities were also strongly influenced by a review of WTMA's *Wet Tropics Research and Information Needs Report (2000)*¹⁶.

As well as focusing WTMA on our research priorities, the Strategy will assist land managers, researchers and funding bodies to understand our information and knowledge needs for the next five years, and provide a firm basis on which to expand and enhance interactions between research providers and research users in the region.

The relationship between the scientific research community, WTMA and its land management, industry and community partners needs to allow for exchanges, co-evolution, and joint construction of knowledge to enrich decision-making at different scales. This includes two main requirements, that:

- scientific information is relevant to WTMA's policy and on-ground management needs
- WTMA and partner organisations formulate their needs or questions in a way that are accessible for scientists to provide the relevant information.

¹⁶ WTMA (2000). *Wet Tropics Research and Information Needs*. http://www.wettropics.gov.au/site/user-assets/docs/rain_report.pdf

WTMA's major research objectives over the next five years are to:

1. continue to identify priority research topics and questions which will benefit WTQWHA management
2. promote appropriate research into World Heritage, conservation land management, environmental, cultural, social and economic issues, across the Wet Tropics bioregion and with a primary focus on the WTQWHA, policy development and operational decision making
3. identify, and seek opportunities for, a variety of collaboration and partnership approaches to enable and encourage Wet Tropics natural area land management agencies (including WTMA), and scientists/researchers to work together on world heritage related projects
4. promote increased financial and in-kind support through advocacy, collaboration and other means to undertake research relevant and important to the WTQWHA
5. build on the outcomes of previous research partnerships with the Rainforest CRC, MTSRF, NERP and TERN
6. identify ways in which WTMA can help facilitate research
7. disseminate research findings to communities of interest in an effective and timely way.

3. Collaboration, partnerships & best practice

WTMA recognises the critical importance of building professional capacity, using resources to best advantage, and fostering the ongoing interest of researchers, government and the broader community in WTQWHA management issues. WTMA hopes to maintain and build upon our existing long-term relationships with the research community, and will collaborate with researchers to clearly define research questions and identify useful research outcomes, and we are committed to integrating research findings into operational management.

WTMA encourages those with responsibilities for on-ground management within the WTQWHA to initiate adaptive management programs and to identify improvements in operational activities.

WTMA will:

- form partnerships between WTQWHA managers, industry partners and research institutions to increase the base of knowledge which underpins conservation management of the WTQWHA and the broader Wet Tropics bioregion
- form partnerships with international World Heritage property managers, industry partners and research institutions to provide global leadership in World Heritage and tropical landscape management and protection
- foster the role of the Wet Tropics as a living laboratory for global environmental management including of climate change adaptation
- imbue researchers with enthusiasm and respect for the international importance of the WTQWHA and the importance of their research in increasing our knowledge and understanding of its significance and the role of research in improving the management of the WTQWHA
- promote the importance and relevance of science-manager cooperation in the development of adaptive management approaches to improving on-ground operations
- ensure that research is responsive to the needs of the WTQWHA natural area managers by using science to identify solutions for the most significant regional natural area management issues
- promote the open exchange of research findings and dissemination of research outcomes by using a range of communication tools including the WTMA web site, WTMA newsletters and other publications, workshops, seminars, conference presentations and scientific journals
- where appropriate, use its influence and networks, to secure financial and in-kind support and expertise for delivery of the WTMA's research agenda.

Benefits of research collaboration and partnerships

The benefits of partnerships in research are numerous. Some of the many direct and indirect benefits of cooperative research include:

- bringing awareness of research outcomes to potential beneficiaries of the research
- framing of research questions to better answer real life management problems
- increasing the capacity and understanding of WTQWHA managers so that they can proactively address management issues

- increasing the focus of researchers on what are the issues of concern to managers and other potential research beneficiaries
- building upon the knowledge of decades of research already undertaken in the region by universities, CSIRO, the Rainforest CRC, MTSRF, NERP and TERN amongst others, to further investigate Wet Tropics natural area management issues
- encouraging research which can be applied to current and expected management issues
- encouraging integrated approaches to solving environmental/cultural problems
- providing opportunities for graduate and undergraduate students to work closely with WTMA staff on medium-term and long-term projects, to learn about World Heritage management and thus build the next generation of scientists and WTQWHA managers
- securing financial and in-kind support, including contributions of expertise and resources of research partners, government, related sectors, industry and research institutions
- raising the general level of awareness and concern in the community about issues and challenges identified through scientific research about the state of the Wet Tropics.

The science-land manager relationship

The International Union for the Conservation of Nature (IUCN 2010)¹⁷ list three important attributes of effective science-policy interactions:

1. **Salience**, or relevance, reflects the ability to be responsive to conditions and concerns, and to link to issues on which decision-makers focus and over which they have control
2. **Credibility** reflects the believability of produced knowledge to a defined user, i.e. on the extent to which actors perceive the contained facts, theories, ideas, models, causal beliefs, scenarios and options as valid or at least as a better guide to how the world works or how to address a specific issue
3. **Legitimacy** reflects the perceived fairness, political acceptability, transparency and trust in the processes of a science-policy interface, i.e. the perception that its processes have been respectful of stakeholders' divergent values and beliefs, unbiased in its conduct and fair in its treatment of opposing views and interests.

IUCN have also identified four main conditions for an effective science-policy interface which are relevant to this strategy:

- a) building a **common and shared knowledge base** which effectively supports policy, including the promotion of policy-relevant multidisciplinary research and the appropriate integration of non-formal knowledge, observation and monitoring, indicators, models and scenarios, and assessments
- b) providing for an **effective dialogue between science and policy** and other relevant stake- and knowledge-holders, including formal mechanisms of policy advice, processes of early warning and horizon scanning, communication and other aspects of effectively targeting decision makers
- c) providing the fundamental capacity to enable **full engagement in the science-policy interface of all relevant stake- and knowledge-holders**, be it to build the common and shared knowledge base, to communicate more effectively, or to more effectively use the knowledge for policy action/implementation

¹⁷ IUCN (2010). *Enhancing the Science-Policy Interface on Biodiversity and Ecosystem Services*. Information Paper on IPBES – March 2010. http://cmsdata.iucn.org/downloads/ipbes_information_paper.pdf

- d) increasing **synergy and coherence through coordination** of the different actors and activities and, in particular across scales, sectors and disciplines.

In practice, no one-size-fits-all model exists for effective science-land manager interactions.

4. Regional research capacity

The Wet Tropics of Queensland has a mega-biodiverse environment, world-class research capabilities and infrastructure based largely around the two campuses of James Cook University (JCU) and CSIRO laboratories. The region also adjoins a mega-biodiverse marine environment in the Great Barrier Reef with its well-developed research infrastructure.

The region has rapidly developed its research capacity in rainforest ecology and management through Australian Government investment in:

- two rounds of Rainforest CRC funding (1993 – 2006)
- Marine & Tropical Sciences Research Facility (MTSRF) research investment (2006 – 2010)
- National Environmental Research Program (NERP) (2010 - ongoing).
- Terrestrial Ecosystem Research Network (TERN) - FNQ Rainforest Supersite (2009 – ongoing)
- Daintree Rainforest Observatory (previously the Australian Canopy Crane Research Station) (DRO 1998 – ongoing)

WTMA has been an active collaborating research-user partnering in each of these multi-organisation collaborative regional research consortiums.

Governments and regional institutions have invested in a range of research infrastructure including a canopy crane facility and a comprehensive network of long-term rainforest monitoring plots (including the 25 hectare forest dynamics plot at Robson Creek). These have been established to examine long-term dynamic processes in forests and monitor climate change signals and their ecological impacts.

The Daintree Rainforest Observatory facility at Cape Tribulation is one of five Long Term Ecological Research sites in Australia allied to the International Long Term Ecological Research Network (ILTER), and is one of twelve canopy cranes in forests around the world.

A hallmark of the region's rainforest, biodiversity, and conservation biology research in response to the region's challenging environmental issues, has been the collaborative, multidisciplinary approach to discovery, integration and application. This approach was strongly fostered with the commencement of the Rainforest CRC in 1993, and the subsequent establishment of the Cairns campus of James Cook University.

The research programs of the Rainforest CRC, MTSRF and NERP have all focussed on the environment and human interactions with it. The region's scientists have provided national and international leadership in tropical rainforest and conservation biology, climate change and human disturbance ecology. The researchers and their institutions are acknowledged for their successful collaborations with government agencies, industry and the community.

Changing research landscape

The **National Environmental Research Program (NERP)** was established in December 2010 by the Australian Government to replace MTSRF (the Marine and Tropical Sciences Research Facility).

Other recent changes to the region's research landscape include:

In 2007 the **Australian Tropical Herbarium (ATH)** was established in Cairns. ATH is a joint venture between CSIRO, James Cook University, and Queensland Department of Science, Information Technology, Innovation and the Arts (DSITIA). ATH amalgamates the herbarium specimen collections from the Australian National Herbarium previously housed at CSIRO Atherton (QRS), the Queensland Herbarium's Mareeba collection (MBA) and the James Cook University Townsville collection (JCT) to form one of Australia's largest and most diverse collections of tropical plant specimens. Its geographic scope includes Australia's tropics; and related plant groups of Papua New Guinea, the Pacific, and Southeast Asia.

An initiative of the Australian Government Department of Education's Science and Infrastructure Branch is the National Collaborative Research Infrastructure Strategy (NCRIS). Part of this strategy included establishing the **Terrestrial Ecosystem Research Network (TERN) in 2009**. TERN aims to provide a set of dedicated observation sites, standardized measurement methodologies, equipment, data, and information services for ecosystem research and natural resource management across Australia.

As part of TERN, a **FNQ Rainforest Supersite** has been established in the Wet Tropics through co-investment funding from the Queensland Government. The Supersite links specific site-based observations to regional issues of significance. The FNQ Rainforest Supersite builds on more than 40 years of scientific monitoring of the physical and biological status of the rainforests of the Wet Tropics of far north Queensland (FNQ). This includes ecosystem monitoring, vertebrate, invertebrate and higher plant monitoring, carbon and water balance experiments, in stream water quantity and quality measurements and OzFlux energy, carbon and water monitoring. Significant environmental gradients in altitude, temperature and rainfall exist over short distances in the region enabling the monitoring of multiple parameters across a broad range of environments within a compact supersite footprint. The FNQ Rainforest Supersite is divided structurally into two transects, each based around an intensive study site node: the lowland rainforest node is based around Cape Tribulation (the DRO site) and the upland rainforest node is based around the 25 hectare plot at Robson Creek.

National research networks such as TERN enable the region's researchers to collaborate with other Australian and international researchers to generate, share and apply research findings on a wider basis and increase their sphere of influence¹⁸.

James Cook University has established **The Cairns Institute** as an international research, consulting and training hub. It is a concentration of tropical knowledge and innovation, focussing on human, social and cultural dimensions. The Cairns Institute integrates the expertise and intellectual resources of more than 20 academic disciplines across three campuses in Townsville, Cairns and Singapore.

These changes greatly increase the potential for the region to expand its role as a centre for professional environmental training and learning. The region has the advantage of being a wet tropical environment with a

¹⁸ A good summary of the region's recent collaborative rainforest research directions and examples of research outputs can be found in the following publication: Stork, N.E. & Turton, S.M. (eds) (2008). *Living in a Dynamic Tropical Forest Landscape*. Blackwell Publishing.

modern economy. Its close proximity to the Asia-Pacific region increases its attractiveness as a regional research hub and centre of excellence for tropical ecological research and management with international relevance.

5. Facilitating the research agenda

A major function of WTMA is to encourage strategic research and promote the sharing of knowledge. WTMA is a regionally located and focussed government entity whose defined functions include:

- promotion of the WTQWHA locally, nationally and internationally
- gathering, researching, analysing and dissemination of information on the WTQWHA
- development of public and community education programs
- managing funding arrangements in relation to the WTQWHA
- liaison with the governments and authorities of the State, the Commonwealth, other States and the Territories, and international and foreign organisations and agencies.

WTMA is therefore in an ideal position to facilitate broader collaboration across government agencies and industry sectors and advocate for financial and in-kind support.

WTMA recognises that we need to provide incentives if we are to effectively engage with researchers, and that to best achieve this we need to promote our role as a potential research facilitator, in addition to being a potential user of research. WTMA also needs to promote and increase the visibility of the scientific and technical partnerships and cooperative arrangements we have established over time, and the mutual benefits that have emerged from this collaboration.

Facilitating mechanisms

1. Communicating our information needs

- This Strategy is designed to produce a greater synergy between management (policy and practice) and research by informing researchers and research funders as to where their efforts might best be focussed.

2. Providing resources

- WTMA can increase its role as a communication platform (web site, newsletters, other publications, convening user-focussed seminars/workshops);
- WTMA can provide a wide range of in-kind support, reports and other sources of 'grey literature', office space and facilities, GIS data, services and expertise, staff time and established networks;
- The project structure of WTMA's operations is ideally suited for encouraging student placements, student internships, or other work experience projects.

3. Promotion and recognition

- WTMA is well positioned to act as a champion for particular research proposals, and to more generally promote and support research, researchers and funding applications;
- WTMA can give special recognition to a researcher's body of work which benefits the management of the WTQWHA through the science category of the WTMA Cassowary Awards;

4. Liaison

- WTMA has regional, State, Commonwealth and international links and responsibilities;
- WTMA is well positioned to raise the region's biodiversity and World Heritage agenda/profile, and attract funding, due to the region's outstanding natural significance and the threats to these values.

5. International relevance

- UNESCO has urged World Heritage sites be used as research benchmark sites and to become part of international research networks;
- WTMA is in a position to 'twin' with other World Heritage Areas – this may open new funding opportunities not otherwise available to researchers.

6. Partnership approaches

WTMA must look at a variety of partnership approaches as the best means of influencing the nature and relevance of research being undertaken in the Wet Tropics, the more common of which are outlined below. The choice of approach will be influenced by circumstances.

Approach 1: Research commissioned by WTMA

WTMA commissions research by contracting researchers to tackle specific research questions, in a particular way, over a defined time-frame, outlined in a 'terms of reference' a 'list of deliverables' and 'milestone time-lines'.

In the past, WTMA was a major funding and administering body for natural area research in the region, however WTMA has not operated a formal research funding program since 2006.

WTMA's past research program consisted of three separate initiatives:

1. Research Grants Scheme (short-term contracts) – 1992 to 2006
 - i. established researchers
 - ii. post-graduate student research grants
 - iii. Post-Doctoral Fellowships.
2. Project Gondwana – biophysical inventory (medium-term contracts) - 1996 to 2000.
3. Vegetation mapping of the Wet Tropics bioregion at a scale of 1:50,000 (long-term contract) – 1997 to 2008.

Pursuit of this approach in the future would depend on WTMA securing responsibility for administration of a substantial research investment fund over several years.

Approach 2: Collaborative research programs

Formal collaborative affiliations of this type between WTMA and researchers have been in place for many years, for example, through a long-term collaborative partnership with the Rainforest CRC (1993 – 2006) and more recently through MTSRF (2006 – 2010) and NERP (2010 - present).

Individual projects are coordinated by the Reef and Rainforest Research Centre (for NERP funded projects) or through cooperative research centres in the case of the Rainforest CRC. WTMA's role, as an industry partner, is to assist in project selection; be represented on various Boards, steering committees and project support teams; attend and contribute to workshops and conferences; and review and comment on various reports and other documentation.

Approach 3: Projects initiated by researchers

In this partnership approach, research projects are initiated independently by researchers through their research institutions with input and support from WTMA as an industry partner. Generally, the support of WTMA is sought because there is a requirement for the researcher to prove the practical value of their proposal by accruing matching financial or other forms of in-kind contributions from an industry partner. This form of partnership is very opportunistic and *ad hoc* and difficult for WTMA to budget for in advance.

An example of this type of partnership approach is that WTMA is currently an industry partner organisation in an ARC Linkage project initiated by James Cook University. Linkage Projects support research and development projects which are collaborative between higher education researchers and industry which are undertaken to acquire new knowledge, and which involve risk or innovation. Linkage Project proposals must involve a Partner Organisation from outside the higher education sector. The Partner Organisation must make a significant contribution in cash and/or in-kind, to the project that is equal to, or greater than, the ARC funding.

The advantage of this approach is that it can initiate long-term strategic research alliances between research organisations and the end-users of the research, in order to apply advanced knowledge to problems and/or to provide opportunities to obtain national economic, social or cultural benefits

Approach 4: projects delivered through postgraduate student grants

WTMA recognises the importance of providing research support to postgraduate research students who demonstrate clear evidence of high research potential. Providing modest financial support can greatly improve their research effectiveness, confidence and productivity. Providing top-up-grants to assist student research recognises the importance of attracting, retaining and supporting talented candidates to research degrees, with the longer-term aim of building the region's research capacity. Not only is providing support to postgraduate researchers a very cost-efficient method of undertaking research, it is also recognition of the important contribution postgraduate student researchers are making.

Approach 5: Joint research with affiliated sectors

In this approach, WTMA initiates research projects, in collaboration with other research-user organisations. Examples of this approach include:

- joint visitor surveys and economic studies between WTMA and tourism industry researchers
- design, construction and monitoring of wildlife underpasses and overpasses involving the Queensland Department of Transport and Main Roads, WTMA and researchers.

As the contribution of the WTQWHA to the social, cultural and economic wellbeing of the community becomes more widely appreciated, the opportunity to conduct research with related sectors (e.g. Indigenous, tourism, economic, community service infrastructure providers and local government) increases. This creates the opportunity to spread the cost of the research over several organisations, and increase the relevance of the research findings across different sectors of the regional community.

Approach 6: Projects delivered through volunteers

Community science programs are now lauded for their benefits to the participating individuals, the projects and the host organisations. Baseline research and monitoring projects conducted, or heavily supported by the work of community groups or non-government organisations, can capture large amounts of data.

Community science programs can increase the capacity of organisations for research. They supply labour to collect quantitative statistics from a large number of sites. Successful programs in our region link the work of volunteers to formal scientific programs that monitor the condition of species or ecosystems, for example the Great Barrier Marine Park Authority Reef Monitoring Program, and several large rainforest research projects through Earthwatch.

Recent research projects supported by WTMA involving volunteers have included cassowary dung collections for DNA analysis to develop improved techniques for cassowary population census, the feral 'Deer Watch' project based on community deer sighting information and an important yellow crazy ant surveillance program involving Conservation Volunteers Australia (CVA).

7. Important general areas of research

Regional research capacity

Although not directly related to any specific research area, WTMA recognises the importance of supporting efforts directed at maintaining and strengthening regional research capacity, and the continued development of problem-solving approaches that can be applied to effective and sustainable World Heritage management. This research capacity, and the high quality research outcomes resulting from it, depends upon creating, maintaining and attracting:

- talented researchers
- adequate and up-to-date research infrastructure
- adequate and targeted funding
- good linkages to the best science overseas
- effective linkage to local users of knowledge and expertise
- consistent support over a long time-scale
- effective dissemination and promotion of research success
- successful translation of research resulting in significant environmental, social and economic impacts.

WTMA also recognises that all ecological research relies on accurate taxonomy. We are facing an increasing shortage of professional taxonomists and there is an urgent need to encourage more taxonomic expertise to the region. New technologies and software developments, such as interactive plant identification keys, phylogenetic trees, genetic fingerprinting and aerial surveillance technology are particularly valuable and are now considered basic resource tools for research.

WTMA is also generally supportive of the continuation and expansion of long-term monitoring and inventory programs and of the development and advancement in the disciplines of ecological and predictive modelling, and other forms of spatial and temporal analysis.

Historically, governments have placed much greater emphasis on short-term outcomes. Similarly, much of the research undertaken in universities is carried out by doctoral and post-doctoral researchers employed on a short-term basis and where time is a major constraining factor in the type of research that can be undertaken. Although these studies have provided a rich source of data for the development of ecological theories which underpin ecological science, formulating theories solely on the basis of short-term extrapolation is fraught with danger. Short-term studies need to be supported by long-term data which provides a context for interpretation and helps test the validity and robustness of hypotheses. Modern ecology relies more and more on the development of sophisticated models to predict ecological responses and such models have become valuable tools in the management of our ecosystems but few models have been robustly tested against real, long-term data.

In addition, the complexity of the interaction between short term cycles and longer trends makes interpretation difficult. Long term studies provide an invaluable aid to a better understanding of changes occurring in our ecological systems. Long term studies are also essential for the study of slow processes such as succession and the impact of climate change on natural systems, and in the recording of rare or episodic events

which play a very important role in determining the complex patterns which characterises our ecological landscapes.

What types of research are important?

Research is required to improve our understanding of the World Heritage Area, how ecosystems function, to be able to monitor their health, maintain and build their resilience to current and future threats and to be able to use ecosystems sustainably. These needs can be addressed by investing in four broad research areas:

1. Understanding the Outstanding Universal Value (OUV) of the Wet Tropics World Heritage Area
2. Understanding the rainforests (and associated ecosystems) of Australia's Wet Tropics.
3. Understanding the causes of change to Australia's tropical rainforest ecosystems and how to maintain, restore and monitor their ecological resilience to change.
4. Understanding the social drivers of change and the social responses to managing tropical rainforest ecosystems.

1. Understanding the Outstanding Universal Value of the Wet Tropics World Heritage Area

Research that adds to our knowledge about the attributes of the OUV of the Wet Tropics, relevant to the Area's listed criteria in addition to the identification of additional natural or cultural values is an important obligation.

Key research needs

Increase our knowledge the OUV of the Wet Tropics of Queensland World Heritage Area

- Identify and describe new species of flora and fauna and update OUV attributes of the WTWHA based on new research or on reassessments based on new scientific concepts and understanding.
- Identify and describe appropriate benchmarks and indicators for sustainable monitoring of the integrity and OUV of the WTWHA.
- Establish and maintain permanent and representative networks of monitoring sites across the WTWHA to improve our understanding of natural dynamic processes and to provide early warning of changes in ecological condition which may threaten the viability of OUV.
- Identify, assess and increase our knowledge of the cultural values of the Wet Tropics World Heritage Area.

2. Understanding the rainforests (and associated ecosystems) of Australia's Wet Tropics

Understanding the outstanding universal value, biological diversity, function, and maintenance of Australia's tropical rainforest ecosystems and the long-term Aboriginal association with the region remains the foundation of conserving, managing and presenting these important ecosystems.

The origin and maintenance of biodiversity and the impact of humans on this biodiversity is essential knowledge for their informed management.

Key questions

Describing Australia's wet tropical diversity

- What are the attributes that contribute to the outstanding universal value of Australia's wet tropical rainforest ecosystems?
- What are the patterns of diversity in Australia's wet tropical rainforest ecosystems?

- What factors and processes explain the current patterns and distribution of diversity at the population and species levels?

Origin, patterns, and maintenance of Australia's wet tropical diversity

- How has history influenced genetic and species diversity?
- What factors explain species abundances and richness?
- What is the role of biotic interactions in the structure and function of Australia's wet tropical ecosystems?
- How did Aboriginal occupancy influence the ecology of Australia's wet tropical ecosystems?
- How did diversity originate in natural ecosystems and how can it be maintained in human-impacted landscapes?

Functioning of Australia's wet tropical ecosystems

- How are biodiversity and ecosystem functioning linked in different habitat types?
- What are the characteristics and dynamics of rainforest/open forest boundaries, ecotones and other ecosystem margins and how should these characteristics be incorporated into improved fire management practices?

3. Understanding the causes of change to Australia's tropical rainforest ecosystems and how to maintain, restore and monitor their ecological resilience to change

Invasive species, fragmentation, and climate change threaten many habitats and there is compelling evidence that these threats will increase in the future. Understanding the responses of biodiversity and ecosystems to natural and man-made changes is fundamental to appropriate and timely management intervention.

Research priorities include evaluating the multitude of human impacts on Australia's wet tropical rainforests. Responses of these ecosystems to management strategies designed to conserve and restore them also need to be assessed.

As environmental issues have no borders and require a global approach, research being undertaken in the Wet Tropics is also relevant to many other parts of the world.

Key questions

Human impacts on ecosystems

- What are the levels of environmental change that natural systems can tolerate before fundamental ecological processes are irreversibly altered?
- Where are the areas at highest risk and what options are available to mitigate and/or adapt to environmental change?
- What are the effects of changes in land use and land cover, economic drivers and resource use on the composition, structure, and function of Wet Tropics ecosystems?
- What are the environmental impacts of roads and other infrastructure on the integrity of the WTWHA and what options are available to avoid or mitigate these impacts?
- What and where are the cumulative impacts of past and present developments and how and where should management be directed at improving landscape resilience to counter these impacts?

Fragmentation

- What are the effects of past regional clearing patterns and habitat fragmentation on present and future composition, structure, and function of Wet Tropics ecosystems?
- What are the effects of fragmentation on dispersal, invasive species and the spread of diseases?
- What is the fragmentation; patch size and connectivity thresholds for the maintenance of biodiversity and ecosystem processes?

Invasive species

- What are the effects of invasive weeds, vertebrate and invertebrate pest species and diseases on present and future composition, structure, and function of Wet Tropics ecosystems?
- What are cost-effective approaches to predicting, identifying and eradicating novel invasive species?

Restoration

- What are the biological, social, economic, and political limitations to restoration of tropical ecosystems? How might one overcome these limitations?
- What are achievable, cost-effective techniques for rehabilitating degraded sites and re-establishing natural successional processes, including the restoration of ecological connectivity?

Sustainable use

- How does agricultural and urban land uses impact on biodiversity and ecosystem function at both local and landscape scales and how can they be managed to minimise impacts?
- How is tourist visitation to high biodiversity or environmentally sensitive areas best managed to minimise impacts?

4. Understanding the social drivers of change and the social responses to managing tropical rainforest ecosystems

Studying the social forces that impact rainforest ecosystems is central to their sustained management. Improved understanding of the complex drivers of change both inside and outside Australia's Wet Tropics will contribute to better policies, actions and management for conservation and sustainable use.

Key questions**Governance**

- What is the role of Aboriginal traditional knowledge and community based management in the conservation of Australia's tropical rainforest ecosystems?
- What is the relative effectiveness of conservation policies, management and governance regimes in curtailing habitat degradation in Australia's Wet Tropics?
- How can business and other community and Traditional Owner partners be engaged, benefit from, and contribute to the knowledge and management that is integral to World Heritage protection and management?
- What are the social and economic incentives that may encourage involvement in and support for the WTWHA and its values?

Presentation

- What are the key determinants of visitor experience in the Wet Tropics?
- What are the key indicators of visitor behaviour, motivation and understanding and how might these be applied to improve management and education?
- What constitutes best practice techniques for presentation of World Heritage, and what is the role of the tourism industry in this?
- What are the best approaches to developing a strong citizen science and volunteering program to support public engagement in WTWHA management?

Ecosystem services

- What is the economic value of biological diversity? What are the best measures of ecosystem services?
- How is human welfare related to the maintenance of biodiversity and ecosystem services and what are the economic and non-economic “valuations” of these services?
- What is the role of Australia’s tropical rainforests in the global carbon budget and can Australia’s tropical rainforest ecosystems serve as indicators of climate change?
- What are the dynamics of water in Australia’s wet tropical rainforests and what are the impacts of its use on freshwater aquatic biodiversity and ecosystem services?
- What are the intangible values provided by the WTWHA for the local and regional community?

8. Priority research questions 2014-2018

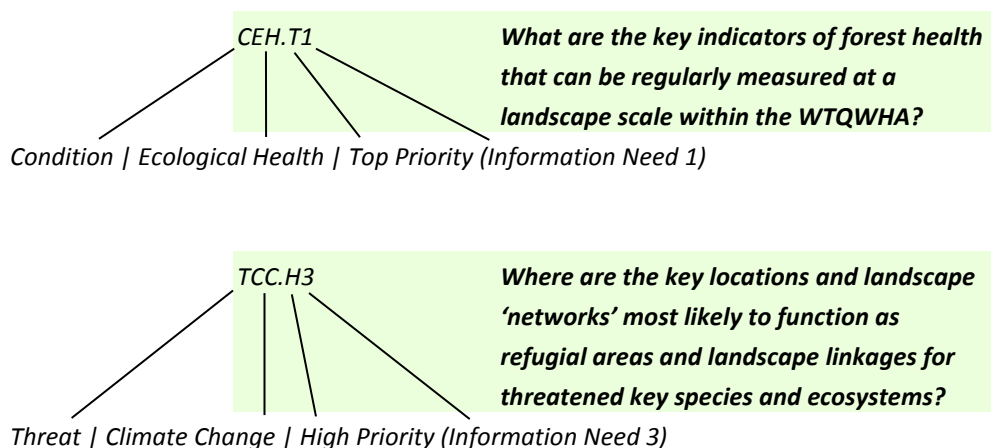
This Research Strategy identifies a small number of specific research questions of fundamental interest and relevance to WTMA, to which we are willing to commit greater resources in championing and supporting (presented below as **TOP PRIORITY research questions (.T)**), and a larger number of more general questions.

Of the general questions the **HIGH PRIORITY research questions (.H)** are those that WTMA has identified as of special interest and/or concern in the short to medium term, while the **LOWER PRIORITY research questions (.P)** are considered to be important but of lesser urgency. These three tiers also provide a broad indication of the scale of resources and time WTMA may be willing to invest in a project.

The scope of projects prompted by the more general questions will be dependent upon the capabilities of the researchers (e.g. student vs. established researcher, full-time vs. part-time research commitment etc.) as well as financial and other resources. Some questions in isolation might be the basis of a small piece of research such as an honours thesis. Others might be scoped or combined in larger-scale projects. WTMA would welcome the opportunity to work collaboratively with researchers to develop projects that meet our needs and increase effectiveness and efficiency across our government and industry partners.

WTMA encourages its research partners to collaborate on long-term strategic issues as well as emerging threats that affect the WTQWHA. The focus of research and the priority topics will change over time with changes in the environmental, community, economic and political landscape, but the following information needs have been identified as priorities in the medium term (3–5 years).

Thirteen categories of management issues have been identified under priority research themes, and information needs have been identified under each of these. Research questions have been prioritised into Top (.T), High (.H), and lower Priority (.P). These have been coded for ease of reference. The first letter refers to the relevant management function, the second and third letter to the relevant category, and the fourth to the priority. The final number is purely for ease of reference where there is more than one question identified for that category and priority.



In addition to the following list of questions, they have also been included as appendices sorted on the basis of 'top priority questions' (Appendix 1), 'high priority questions' (Appendix 2) and 'priority questions' (Appendix 3).

1. Understanding the Outstanding Universal Value of the Wet Tropics World Heritage Area

1a. Increase our knowledge the OUV of the Wet Tropics of Queensland World Heritage Area

What do we wish to achieve?

Research that adds to our knowledge about the attributes of the OUV of the Wet Tropics, relevant to the Area's listed criteria in addition to the identification of additional natural or cultural values is an important obligation.

Understanding the Wet Tropics' Outstanding Universal Value (OUV)

The term Outstanding Universal Value (OUV) is the fundamental cornerstone of World Heritage (including nominations, monitoring and reporting) and is the basis for the protection and management of a World Heritage property. It is defined (in paragraph 49 of the *Operational Guidelines for the Implementation of the World Heritage Convention*¹⁹) as the:

“cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity. As such, the permanent protection of this heritage is of the highest importance to the international community as a whole”

Interpreting Outstanding Universal Value (OUV) and its integrity (OUV-I) and applying it in practice can be difficult, but remains at the heart of the philosophy of World Heritage. There is an ongoing need, and obligation, to improve and update our knowledge of the OUV of the Wet Tropics and to incorporate new scientific evidence, understanding, theories and phylogenetic tools. We need better knowledge and understanding in relation to the four natural World Heritage criterion for which the Wet Tropics was inscribed (criterion vii, viii, ix and x):

(vii) “contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance”:

HIGH priority research questions

CUV.H1 How can the areas of exceptional natural beauty and aesthetic importance of the WTQWHA, considered to be of outstanding universal value (OUV), be identified, located, mapped and described in greater detail as a basis for planning, management, presentation and decisions about development in and around the WTQWHA?

¹⁹ *Operational Guidelines for the Implementation of the World Heritage Convention* <http://whc.unesco.org/archive/opguide08-en.pdf>

OTHER PRIORITY research questions

CUV.P1 How can the superlative natural phenomena displayed by the WTQWHA which are of outstanding universal value (OUV) be identified, located, mapped and described in greater detail as a basis for planning, management, presentation and decisions about development in and around the WTQWHA?

(viii) *“be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features”:*

HIGH PRIORITY research questions

CUV.H2 How can the new understanding and theories of phylogenetics and the evolution of the angiosperms be used to update understanding of the OUV of the Wet Tropics; in particular, the concept and listing of ‘primitive’ or ‘basal’ angiosperms, Gondwanan taxa, species with a nodal position in evolution, and those species of Cretaceous origin and describe those aspects which could be considered to be of outstanding universal value?

OTHER PRIORITY research questions

CUV.P2 What and where are the fossil, geological processes and geomorphologic features and attributes of the WTQWHA which could be considered to be of outstanding universal value?

(ix) *“be outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals”;* and

(x) *“contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation”.*

HIGH priority research questions

CUV.H3 How can the climate sensitivity of species and ecosystems be determined to provide a greater indication of those outstanding universal values which are most susceptible to climate change and identify how much climate change (direction, magnitude, rate, means vs. extremes) is too much in relation to specific values including understanding the climatic thresholds of key species and communities?

CUV.H4 Which species and ecosystems within the WTQWHA are most at risk from threatening processes and how can they be identified and quantified?

2. Understanding the rainforests (and associated ecosystems) of Australia's Wet Tropics

What do we wish to achieve?

Understanding the outstanding universal value, biological diversity, function, and maintenance of Australia's tropical rainforest ecosystems and the long-term Aboriginal association with the region remains the foundation of conserving, managing and presenting these important ecosystems.

The origin and maintenance of biodiversity and the impact of humans on this biodiversity is essential knowledge for their informed management.

2a. Describing Australia's wet tropical diversity

What do we wish to achieve?

We need to improve our understanding of the condition, trend, threats and interdependencies of the natural and cultural environments of the Wet Tropics including methods to support ongoing regular assessment and reporting. We also need to identify those OUV attributes at risk from various threats and identify what management approaches can be adopted to build their resilience.

Ecological / Forest 'Health' (EH)

WTMA is responsible for reporting annually on the state of the WTQWHA to the Queensland and Australian governments, and also to UNESCO on a six yearly cycle. To understand whether and how the 'health' or ecological integrity of the WTQWHA is changing we need to develop improved monitoring tools including methods and opportunities for using remote sensing technology.

TOP PRIORITY research questions

CEH.T1	What are the key indicators of forest health that can be regularly measured at a landscape scale within the WTQWHA?
CEH.T2	Is there proven remote sensing technology able to be used to measure trends in these key indicators either directly or indirectly?
CEH.T3	If not, what alternate approaches could be employed?

Why are these priorities?

WTMA uses a variety of data and information but has not yet identified any practical measure to report on trends in 'health' of the WTQWHA at the 'whole-of-WTQWHA' scale. Remote sensing is the only technology that promises to provide a practical means of reporting on trends in overall WTQWHA 'health' or 'condition' in near real-time and on a regular, repeatable, affordable basis.

Considerations

WTMA has previously commissioned research in this area but several technological hurdles prevented it from being turned into simple routine procedures. Topography, the canopy, and cloud cover pose challenges to interpretation of remote sensing information for the WTQWHA.

HIGH PRIORITY research questions

- CEH.H1 What are the key indicators of forest health that can be used as a basis for assessment and reporting?
- CEH.H2 Is it possible to achieve high resolution mapping and monitoring of change and recovery by remote sensing in a topographically diverse landscape such as the Wet Tropics?
- CEH.H3 What are operational, cost-effective methods for monitoring trends in the ‘condition’ of landscapes, forests and waterways of the WTQWHA at a range of scales, incorporating the monitoring and assessment of risks and threats to the WTQWHA and the impacts of management actions, and how can monitoring results be incorporated into WTMA’s statutory reporting?
- CEH.H4 How can the spatial distribution and magnitude of pressures impacting on the ecological condition of the WTQWHA be identified and mapped, including invasive species, development pressures, habitat fragmentation, wildlife diseases, water quality, upstream land uses and visitor pressures?
- CEH.H5 What are appropriate socio-economic and cultural indicators to describe the effects of changes in the ecological state of the region and changes in its management?

2b. Origin, patterns, and maintenance of Australia’s wet tropical diversity

Priority Species and Ecosystems (SP)

There are several national and state Recovery Plans and Threat Abatement Plans²⁰ which identify research priorities for threatened species and ecological communities. The following research questions are additional to those and of particular relevance to the WTQWHA.

TOP PRIORITY research question

- CSP.T1 What are the condition, trends and projected futures of threatened species including cassowaries and arboreal mammals and other threatened species and ecosystems (including the identification and evaluation of the key threats to them and evaluation of available management options to improve their status)?**

²⁰ National Recovery Plans and Threat Abatement Plans (required under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* <http://www.environment.gov.au/epbc/about/index.html> for threatened species and ecological communities, including the Southern Cassowary), can be found here: <http://www.environment.gov.au/biodiversity/threatened/index.html>
Recovery plans under the *Queensland Nature Conservation Act 1992* <https://www.legislation.qld.gov.au/LEGISLTN/ACTS/1992/92AC020.pdf> can be found here: http://www.ehp.qld.gov.au/wildlife/threatened-species/recovery_conservation_plans.html

Why is this a priority?

The cassowary is classified as endangered in Australia. It is also recognised as a keystone species for seed dispersal in the WTQWHA. Cassowary populations are centred around the Mission Beach, Daintree and Kuranda areas, all of which are contested landscapes in term of development pressures. The cassowary is a high profile species and its survival or otherwise has become somewhat of a 'sustainability' indicator to the regional community. If we have good science to demonstrate that the population is definitely in decline this will give more weight for securing resources and government commitment to implementing impact mitigation measures. Improved understanding of population dynamics will also assist in designing such impact mitigation measures.

Considerations

WTMA and other organisations have already supported cassowary research by CSIRO and techniques for cassowary DNA-profiling have now been proved. CSIRO scientists have the capacity to build on this technology and undertake population dynamics research.

HIGH PRIORITY research questions

- CSP.H1 What aspects of population dynamics, DNA techniques, ecology, physiology, behaviour, and disease research are likely to be the most useful for on-ground recovery of threatened species such as the cassowary?
- CSP.H2 What is the LD50 dose, and what is an appropriate 1080 management strategy to ensure that the Wet Tropics subspecies of the endangered spotted-tailed quoll (*Dasyurus maculatus gracilis*) is not put at further risk from wild dog baiting programs?

OTHER PRIORITY research questions

- CSP.P1 Are there valid surrogacy relationships between vegetation types/regional ecosystems and fauna habitat, and can this be used in the development of habitat mapping and improved predictive capacity especially with respect to threatened and endemic regional fauna?
- CSP.P2 What are the population trends, structure, distribution and genetics for key cassowary populations and what factors are the most likely cause of change for these populations?

2c. Functioning of Australia's wet tropical ecosystems

Fire Management (FM)

Many ecosystems in the Wet Tropics evolved under the influence of fire. Traditional Aboriginal fire management created a mosaic of ecological niches for plants and animals and in so doing influenced patterns of biodiversity. Modern-day changes in landuse and management have disrupted these historical fire patterns and have resulted in changes to fire-adapted ecological communities, particularly in the wet and dry sclerophyll communities along the boundaries of the rainforest. Some of these fire-adapted ecological communities are home to rare and threatened species such as the northern bettong, several species of gliders, and numerous terrestrial orchids.

WTMA recognises the need for land managers to use fire and to exclude fire for different management purposes. Fire, however, is a complex phenomenon and if employed (or excluded) without adequate knowledge, can threaten the biological productivity, biodiversity and sustainability of ecosystems. Because fire regimes affect biodiversity, management actions which affect fire regimes will also affect biodiversity.

In fire-prone landscapes, fire regimes can have a major influence on the composition of vegetation by regulating demographic processes such as mortality, reproduction, germination and survival of plant populations.

Many ecologists have emphasised the complexity of designing appropriate fire regimes for conservation. Although there has been a large increase in ecological knowledge of fire regimes during recent decades, the creation of new fire regimes is still bedevilled by a lack of knowledge. There are many complex and unpredictable biotic responses to fire, making it difficult to arrive at useful generalisations.

Fire is a complex phenomenon but is also a convenient and often necessary tool for the management of ecosystems to maintain biodiversity. This complexity is also reflected in the serious dichotomy in our knowledge: we have quite reasonable levels of understanding of the principles of fire physics, wildfire suppression and prescribed burning technology on one hand, but relatively poor comprehension of the impacts of fire and its role in ecosystem management and the effects of past fire histories and the cumulative effects of fire events, on the other.

The optimal fire regime for a particular ecological community or ecological community state (for example the optimal season, frequency, intensity and extent of burning) varies between ecological communities and varies within the same ecological community depending upon previous fire histories. Consequently, changes to fire regimes play a role in shaping the biodiversity of the Wet Tropics by acting as drivers between ecological community states and types. The conclusion to be drawn is that an appropriate fire regime for many communities depends on the desired management outcomes.

TOP PRIORITY research question

HFM.T1 What are the characteristics of the dynamics of rainforest/open forest edges and other ecosystem boundaries and how should these characteristics be considered when reviewing boundary fire management in response to a changing climate?

Why is this a priority?

A distinctive feature of rainforests in the Wet Tropics is the often abrupt boundary between the rainforest and eucalypt dominated vegetation. In the region, wet sclerophyll forest dominated by tall (>40 metre) eucalypts typically forms a narrow band ranging from 300 metres to less than four kilometres in width along the western rainforest margin. There is evidence that the extent of this forest type has been reduced to half its extent over the last 50 years, largely as a result of conversion to rainforest. Similar claims have been made regarding coastal sclerophyll forests in high rainfall areas being transformed to rainforest at an accelerating rate. There is currently poor understanding of the short and long term dynamic processes involved in this pattern of

ecological change, and a poor appreciation of what constitutes appropriate short and long term management responses to this change.

Considerations

The vegetation dynamics of the rainforest boundary has been the subject of much scientific and management interest. While the rainforest boundaries appear abrupt and stable on short time frames, pollen records show that these boundaries have been expanding and contracting throughout geological history, and the current day expansion is partly a function of climatic amelioration and/or release from fire suppression. A number of researchers report that rainforest is expanding at the expense of eucalypt forest, due to altered changed fire regimes since European settlement.

HIGH PRIORITY research questions

HFM.H1 What are the criteria that need to be developed to identify key areas for fire management and other areas where expansion of rainforest is actually a desirable/natural outcome?

OTHER PRIORITY research questions

HFM.P1 In light of the impact of climate change on ecosystems, how can WTQWHA on-ground land managers optimise their fire management while meeting biodiversity and cultural heritage conservation, recreational availability, and requirements for community safety?

HFM.P2 What are the 'best' fire management regimes (for the protection of the Area's outstanding universal value and its integrity) for key vegetation types or locations?

HFM.P3 How can traditional ecological knowledge be incorporated to effectively involve Aboriginal people in fire management programs?

3. Understanding the causes of change to Australia's tropical rainforest ecosystems and how to maintain, restore and monitor their ecological resilience to change

What do we wish to achieve?

We need to improve our understanding of the threats to, and their impact on, the Wet Tropics environment, develop options to mitigate them, and methods to identify priorities for action.

3a. Human impacts on ecosystems

Climate Change Impacts and Adaptation Strategies / Regional Responses (CC)

Climate change poses a significant threat to the Wet Tropics, particularly to species adapted to cool upland areas and isolated mountain tops, and many endemic species are predicted to decline significantly in range due to even slight increases in temperature. In 1997 the World Heritage Centre identified the WTQWHA as at particularly high risk from climate change.

We need predictions on the likely impacts of changing climate on key species, habitats and ecosystems, better understanding of how they might adapt, and to identify key species and ecosystems that are under most threat. To be able to mitigate the effects of climate change, we need to identify key climate-buffered, stable refugia and landscape links, and develop guidelines for the design of landscape connectivity incorporating refugia to allow for movement of organisms and persistence of gene pools.

TOP PRIORITY research questions

TCC.T1	How resilient are different WTQWHA species and ecosystems to climate change and what management actions can be undertaken to maintain/improve ecosystem 'resilience' in the face of climate change?
TCC.T2	Where are the key locations and best landscape configurations most likely to function as refugial areas and landscape linkages for key threatened species and ecosystems?
TCC.T3	When and where is landscape connectivity a bad choice in relation to the maintenance and stability of refugial areas?

Why are these priorities?

A better understanding of the impacts of climate change would enable WTMA to encourage land managers and land use planners to focus on these areas to mitigate ongoing impacts and build the resilience of such networks and refugial areas.

Considerations

The principle of increasing landscape connectivity is strongly supported and promoted by WTMA as a means of improving regional environmental resilience to a range of pressures such as clearing, fragmentation and climate change, and as a way of increasing access to a fragmented resource-base by wildlife, and mitigating the effects of population isolation and fragmentation. However, there may be special cases where climatically stable refugial areas with high levels of local endemism and highly specialist species, may be destabilised, and the resident species disadvantaged, by habitat invasion resulting from well-meaning but ill-conceived corridor design.

HIGH PRIORITY research questions

- TCC.H1 What are the short-term and long-term environmental, economic and social costs and benefits associated with particular climate change adaptation options and their likely effectiveness in the Wet Tropics?
- TCC.H2 How will climate change impact on the natural and cultural environments of the WTQWHA and what is the level of spatial and temporal confidence associated with these predictions?
- TCC.H3 Where are the key locations and landscape ‘networks’ most likely to function as refugial areas and landscape linkages for threatened key species and ecosystems?

OTHER PRIORITY research questions

- TCC.P1 How can climate change models and their underlying relationships and assumptions be tested and improved by the strategic collection of environmental and ecological data sets through the establishment of monitoring systems to enable early detection of climate change impacts on key species and ecosystems?
- TCC.P2 Which species are likely to be the best indicators of the effects of climate change on natural communities?
- TCC.P3 How will climate change and its primary impacts interact with other threats such as clearing, fragmentation, fire, weeds, feral animals, declining water quality, urbanisation and other land uses to impact on the outstanding universal values of the WTQWHA, including identification of those which have the greatest potential for substantial impact?
- TCC.P4 Under what circumstances and which places in the landscape could improving landscape connectivity result in negative ecological outcomes?
- TCC.P5 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?
- TCC.P6 How does the WTQWHA contribute to greenhouse gas emissions, sequestration and storage?
- TCC.P7 How resilient are key sectors of local industry, notably tourism and visitor services, with respect to the environmental impacts of climate change?

Impact Mitigation – Community Infrastructure and Activities (IM)

The provision of necessary community infrastructure is the main reason for permitting ongoing human disturbances within the WTQWHA, and managers are eager to minimise such disturbance.

For example, the presence of a road alters hydrology, fragments habitat and results in road-kill. Some native animals avoid roads, resulting in wildlife populations becoming isolated and causing a disruption to seasonal movements and genetic interchange. Roads are also a source of stream pollution and increased sediment load, while road culverts, causeways and bridge footings often result in the fragmentation of aquatic habitats and the altering of stream flow patterns. The habitat fragmentation impacts of a road can be amplified by road use which results in noise, vibration, movement, dust, emissions, and lights, each of which can interfere with wildlife activities and behaviour.

The clearings associated with power transmission lines typically have greater fragmentation and edge effect impacts than roads and can result in the intrusion of non-forest habitats (usually tall exotic grasslands or shrublands) into native forests which act as conduits for weeds, feral animals, wind and fire into the interior of the forest. Dams, weirs and culverts impact on aquatic ecosystems by causing changes in natural flow regimes as a result of water extraction and supply; by modifying or destroying habitats; by acting as barriers to the movement of plants and animals; by decreasing water quality and quantity; and increasing colonisation by introduced and exotic animal and plant species.

Guidelines relating to the design, construction and maintenance of these activities have been produced for the purpose of avoiding or mitigating undesirable impacts on the environment, but managers are always keen to keep strengthening them. We need information on ways to:

- Completely avoid particular impacts;
- Control the effects of unavoidable impacts; and
- Alleviate the effects of particular threats.

TOP PRIORITY research question

TIM.T1 What is the effectiveness of impact mitigation strategies and on-ground practices in restoring or maintaining ecological processes and function with respect to community infrastructure (e.g. roads, power supply and distribution, communications, water storage and water supply) design, construction, maintenance and use?

Why is this a priority?

As part of an adaptive management approach and to ensure that on-ground improvements are being achieved, it is important that researchers collaborate with WTMA, its on-ground managers and with infrastructure providers to monitor and provide feedback to continually improve design, construction and maintenance practices.

Considerations

Essential services supplied by community infrastructure are important for regional development but the construction and maintenance of infrastructure also impacts significantly on the condition of the natural environment, particularly where cleared corridors are required through rainforests.

HIGH PRIORITY research questions

- TIM.H1 What impacts do high altitude, low traffic presentation roads (e.g. Mt Lewis; Mount Edith-Kauri Creek Circuit Road) have on locally restricted endemic wildlife and what are appropriate design, maintenance and management considerations?
- TIM.H2 How can mountain-top sites within the WTQWHA be classified with respect to their ecological and evolutionary significance, vulnerability to disturbance and irreplaceability?
- TIM.H3 What impacts does the provision of community infrastructure have on water quality and on the ecological functioning of freshwater aquatic ecosystems?

OTHER PRIORITY research questions

- TIM.P1 What are suitable indicators for quantifying and monitoring grazing impacts?

3b. Invasive species

Alien and Invasive Species (AI)

Alien and invasive species are a major threat to the integrity of the WTQWHA and to rural industries in the region. Managers need to identify the best practices for prevention or control of pest species in the Wet Tropics, the implications of using these methods, and the habitat types and subregions that are most susceptible to invasive species, including better maps of current and projected distribution of spread, trends, and impacts at scales relevant to local and regional management.

Science is a critical element underpinning biosecurity. It can have an enormous input to managing risks and uncertainties, and ultimately the effectiveness of any decision. It can provide key information for many questions and can help determine which questions should be asked. We need better methods to identify, assess and prioritise organisms that are most likely to emerge as pests, weeds and diseases including the range of factors that influence emerging pests, weeds and diseases. Research is also required to minimise the risk of entry, establishment or spread of pests and disease invasions.

To successfully eradicate, control, or mitigate the impact of established pests we need to:

- Understand the movement of invasive species through complex natural and human modified environments
- Develop effective and integrated approaches to managing established pests
- Improve the understanding of the life history/ecology of pests and the invaded system

- assess current and future costs, both to the environment and the economy, of invasive species.

We require better tools for the risk analysis of pathways by which high priority pest organisms enter the Wet Tropics and, once established, are disseminated. Particular needs are for new and improved tools and models to better understand and manage:

- the inanimate pathways associated with the entry of specific invertebrate groups (such as tramp ants)
- pathways to predict the potential natural and human mediated spread of high priority pest organisms after their initial establishment
- the relative risks between pathways

We require diagnostic tools, and aligned taxonomic research, that enable rapid identification of high priority risk organisms including their taxonomy. Particular needs are new/improved diagnostic tools for:

- priority arthropods (such as yellow crazy ant and other tramp ant species)
- pathogens (such as phytophthora, myrtle rust)
- aquatic species.

Our surveillance systems are under increasing demand and we need to better understand, and increase, the efficacy of both existing and new surveillance tools and systems. Particular needs in the area of efficacy of surveillance are:

- Methods to evaluate the effectiveness of current approaches to surveillance including tools and systems.
- Assessment of the sensitivity and specificity of tools for detecting pests and pathogens.
- Developing more effective approaches to targeted surveillance, considering the application of detection tools and the design of sampling schemes. This is particularly important for the detection of pests and pathogens at low densities.
- Social research to improve the acceptability to and active engagement from, the general population.
- Methods for proving the absence of pest, weed and disease organisms.

Key pests are successfully controlled using a variety of control tools; however some of these tools (e.g. toxins) are increasingly unacceptable. We need more control options which are humane, socially and culturally acceptable and minimise impacts on non-target species and the environment. Particular needs are research into more effective and acceptable management options for:

- vertebrate pests
- invertebrate pests
- plant pests
- plant diseases including myrtle rust and phytophthora
- use in the freshwater environment.

A critical research need is to better understand and quantify the actual and potential impacts of pests and diseases on ecosystems, i.e. more of a systems approach to risk.

TOP PRIORITY research questions

TAI.T1 What is the realised and potential ecological impact of yellow crazy ants on the OUV and integrity of the WTQWHA and how effective is the management regime being employed to eradicate them from the Wet Tropics?

Why is this a priority?

Yellow crazy ants have recently been found in the Wet Tropics World Heritage Area in a restricted area around Mount Peter near Edmonton while a smaller outbreak in the Kuranda district is only a short distance from the World Heritage Area. These ants are on the World Conservation Union's list of '100 of the World's Worst Invasive Alien Species' and fit the stereotype of a rapacious marauding invader. Where yellow crazy ants flourish, little else does. They can remove nearly all insect life, leaving none for other animals, and kill small animals such as lizards and bird chicks.

The Wet Tropics World Heritage Area is at grave risk, for the ants' preferred habitat is moist lowland tropical forest. Yellow crazy ants demonstrate the power of numbers and the benefits of social cooperation. They are able to dominate large areas by forming super-colonies with multiple nests and multiple queens and extend over several hundred hectares. The boundary of a super-colony has been found to be able to advance by 3 metres a day in some environments.

The adults eat nectar and honeydew and feed their brood on animals killed or scavenged. They don't sting but squirt formic acid, which blinds and debilitates their prey. Their great numbers allow them to overwhelm animals far exceeding them in size. Yellow crazy ants farm sap-sucking bugs for their honeydew (excreted sugary liquid) and protect them from predators. The build-up in bugs and sugar encourages the growth of sooty mould, which can severely compromise tree health and is sometimes fatal.

Considerations

The Wet Tropics Management Authority is managing a yellow crazy ant eradication program in the hope of removing this threat before the risk escalates. We need a research package that will inform the Wet Tropics Yellow Crazy Ant Eradication Program on the efficacy of its eradication approach, on the effectiveness of different chemical baits, toxins and hormones (the current control methods) and explore alternative methods. The program to be effective requires life-history information to optimise the timing of bait delivery, and efficient surveillance techniques in rugged rainforest situations, and monitoring of both the impacts of the yellow crazy ant infestation and the effectiveness of the management regime being employed to eradicate them.

TAI.T2 **Where should investment in pest animal research and management be directed and focussed, considering the relative risk posed to the ecology and outstanding universal values and integrity (OUV-I) of the WTQWHA?**

Why is this a priority?

Current pest animal research and management is largely focussed on pig control and more recently on wild dogs and the pest fish, tilapia. However, there has recently been a proliferation of newly emerging pest animals (especially invertebrates) establishing in the region, including various tramp ant species (such as the yellow crazy ant and the electric ant), feral bees (Asian honeybee), feral worms (*Pontosclex corethrurus*) and deer (rusa, fallow and chital). Other pests, for example rabbits and foxes, have also been expanding their ranges. Many of these pests also have the potential to have a significant impact upon rural economies. Natural area managers need to be better informed of the relative potential risks posed by these introductions.

Considerations

Socio-economic costs and benefits of both pests and their management is an important additional factor. For example, the environmental damage caused by feral pigs is recognised nationally as a key threatening process. There is widespread and high level community concern regarding pig damage to both the environment and rural industries in the region and increasing concern regarding the role of feral pigs in the spread of diseases of wildlife, domestic stock, and humans. Pig numbers are such that control measures designed to reduce numbers by killing need to be intensive and continuous. The response to the pig issue has diverted much of the region's protected area pest animal resources for many years.

TAI.T3 Where are there identifiable, vulnerable, high-susceptibility areas where weeds and pest animals have the potential to become major drivers impacting the ecological health of particular communities, ecosystems or regions of the WTQWHA that should be the focus for keeping pest, pathogen and/or weed free?

Why is this a priority?

If we knew which areas are most vulnerable, then it allows land managers to more strategically focus pest and weed control / hygiene activities in these areas. The vulnerability of an area may be related to its interactions with climate change impacts, the significance of the site in terms of its OUV-I (e.g. mountain tops and centres of local endemism), or particular vegetation types and their susceptibility to pest attack.

Considerations

Traditionally pest control has targeted specific pest species rather than targeting susceptible parts of the landscape. This change in emphasis will become more important when considering the interacting effects and impacts of climate change.

HIGH PRIORITY research questions

- CAI.H1 Which weed species cause, or are likely to cause, the greatest environmental harm, where are the key areas of susceptibility and what are their environmental impacts?
- CAI.H2 Are current infrastructure management/maintenance hygiene prescriptions appropriate and/or adequate with respect to potential weed and disease risks?

CAI.H3 What are the impediments and management barriers to effective feral pig control in the Wet Tropics?

CAIH4 Is the distribution and prevalence of *Phytophthora cinnamomi* within the WTQWHA increasing or decreasing: what factors drive change in distribution and virulence, and which of these are susceptible to management intervention?

OTHER PRIORITY research questions

CAI.P1 What are the cost/benefits of different control measure options and is it possible to develop effective, species specific, and environmentally safe control methods (with an emphasis on the yellow crazy ant, feral pig, tilapia and feral deer)?

CAI.P2 What criteria should be used to prioritise expenditure on prevention, control, eradication or containment of weeds considered to pose a major threat to natural environments in the region?

CAI.P3 What criteria should be used to prioritise expenditure on prevention, control, eradication or containment of vertebrate and invertebrate pests considered to pose a major threat to natural environments in the region?

CAI.P4 What are the ecological and evolutionary impacts associated with the translocation of native species outside their natural range including fish stocking and tree planting?

CAI.P5 What plant and/or soil diseases or pests are, or could potentially be, associated with tree planting activities and what risk do they pose?

3c. Restoration

What do we wish to achieve?

We need to improve our understanding of the current and potential uses of the WTQWHA with respect to the maintenance, improvement and sustainable use of biodiversity and ecosystem function. More information is needed to assist WTMA, infrastructure agencies and communities, to plan effectively for sustainable land management, and to identify options for improving practices, reducing risks, and mitigating adverse impacts, and to measure the effectiveness of actions designed to halt and reverse declines.

The following priority research questions are additional to the research priorities identified in regionally relevant national Recovery Plans and Threat Abatement Plans²¹.

Fragmentation is one of the major threats to the integrity of the WTQWHA. Queensland's *Vegetation Management and Other Legislation Amendment Regulation (No.1) (2004)*²² restricts broad-scale clearing of native vegetation, but historical land-clearing, particularly on the level and gently undulating lands of the coastal lowlands and the upland Tablelands has resulted in these landscapes being highly fragmented. Fragmentation increases the vulnerability of the WTQWHA to disturbance and decreases its

²¹ National Recovery Plans and Threat Abatement Plans (required under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* <http://www.environment.gov.au/epbc/about/index.html> for threatened species and ecological communities, including the Southern Cassowary), can be found here: <http://www.environment.gov.au/biodiversity/threatened/index.html>

Conservation Plans under the *Queensland Nature Conservation Act* can be found here: http://www.ehp.qld.gov.au/wildlife/threatened-species/recovery_conservation_plans.html

²² Queensland Government (2004). *Vegetation Management and Other Legislation Amendment Regulation (No.1) (2004)* <http://legislation.govnet.qld.gov.au/LEGISLTN/SLS/2004/04SL063.pdf>

resilience to threats such as weeds, feral animals and climate change. Rehabilitation efforts focused on restoring connectivity are therefore critical to increasing the resilience of Wet Tropics ecosystems.

Wildlife corridors and ecological connectivity (WC)

TOP PRIORITY research question

HWC.T1 What are achievable, cost-effective techniques for rehabilitating degraded sites and re-establishing natural successional processes, including the restoration of ecological connectivity in infrastructure corridors?

Why is this a priority?

Establishing corridors across a contested landscape has many challenges and costs. It is important to have a reasonable level of research information available to know what is required to ensure a rehabilitation corridor will fulfil its intended ecological function.

Considerations

At this stage it is uncertain how to achieve the most effective habitat connectivity e.g. does connecting the landscape by rehabilitation with a preferred food source encourage wildlife movement or will it result in occupation and territorial behaviour inhibiting connectivity? Consideration also needs to be given to aquatic corridors that are currently fragmented (by dams, barriers, culverts, etc.) that may affect threatened and endemic aquatic species.

HIGH PRIORITY research questions

HWC.H1 What constitutes critical patch size thresholds and corridor widths for wildlife associated with different landscape types?

HWC.H2 By applying existing knowledge and trialling different designs, demonstrate how to design and rehabilitate a wildlife corridor to achieve improved habitat connectivity for identified species of World Heritage significance, and in particular the cassowary?

OTHER PRIORITY research questions

HWC.P1 What evidence is there that wildlife corridors are achieving their intended purposes at a landscape scale?

HWC.P2 Are riparian corridors fulfilling their functional roles and how important are width and overall connectivity in achieving desired ecological outcomes?

Rehabilitation and Restoration (RR)

TOP PRIORITY research question

HRR.T1 What constitutes the best ecological restoration practices and what are their costs and benefits in environmental, social and economic terms?

Why is this a priority?

We need this information to assist in implementing cost-effective, ecologically functional restoration projects. An adaptive management approach to utilising research and monitoring data to refine and improve the ecological outcomes of our investment in restoration important. Ecological outcomes will be influenced by the purpose of the restoration project such as improving connectivity for wildlife movement, ‘buffering’ significant ecosystems from adjacent land uses impacting on the WHA, re-establishing threatened ecosystems, increasing available habitat for targeted species of wildlife or screening infrastructure which impacts on significant scenic amenity of the WHA amongst others.

Considerations

Net costs and benefits (both economic and ecological) of any offsetting option need to be taken into account.

HIGH PRIORITY research questions

- HRR.H1 What are the options for enhancing or accelerating large-scale natural regeneration of abandoned, previously cleared areas?
- HRR.H2 What are the best practice designs for creating refuge habitats as a proactive response to shifts in climate zones due to climate change?
- HRR.H3 How can we effectively prioritize the most important large-scale ecological restoration projects that could be undertaken in the Wet Tropics?
- HRR.H4 What are the options for undertaking large-scale land rehabilitation and forest restoration following the decommissioning of redundant infrastructure (e.g. powerlines or roads)?

OTHER PRIORITY research questions

- HRR.P4 What are the preferred or priority areas for undertaking World Heritage ‘offset’ ecological restoration activities?
- HRR.P4 What options are available for planting and/or screening exposed rock faces, steep road batters and shotcrete batters following road construction, maintenance or repair?

3d. Sustainable use

Land Use Change (LU)

There are many direct and indirect ecological impacts related to population growth and associated urban and rural development including habitat loss, modification and fragmentation. Far North Queensland (FNQ) has one

of the fastest rates of population growth in Queensland. The regional population doubled from around 111,000 in 1976 to over 220,000 by 2006. As at 30 June 2011 the resident population was 252,233 persons. Projections released in 2011 indicate that by 2016 the expected population of FNQ will be between 268,044 and 285,070 persons. By 2031 this is expected to change to between 307,028 and 372,597 persons²³. This will increase demand for resources such as land, water, recreational opportunities, and agricultural products, which in turn will increase external pressures on the WTQWHA. Although over 85% of the WTQWHA is protected area estate (national park), the remainder, and most of the surrounding landscape, falls under a range of different land tenures. While people may be attracted to live in the region in part because of its outstanding natural values, changes in land use surrounding the WTQWHA will inevitably put more pressure on those values.

The *Far North Queensland Regional Plan 2009-2031*²⁴ aims to ensure this growth is sustainable and protects areas of significant environmental value (including the WTQWHA and the GBRWHA). WTMA is keen to ensure that planning decisions are guided by the best available environmental science.

HIGH PRIORITY research questions

- TLU.H1 What are the fragmentation, patch size and connectivity thresholds for maintenance of biodiversity and ecosystem processes?
- TLU.H2 What is the impact on water quality and on aquatic wildlife within the WTQWHA (in particular endangered amphibians and endemic freshwater fish) of agricultural chemicals used upstream of the WTQWHA?

OTHER PRIORITY research questions

- TLU.P1 Which Wet Tropics landscapes and ecosystem processes are most at risk from changing land uses?
- TLU.P2 What is the comparative biological and ecological importance of regrowth, modified, disturbed and/or fragmented vegetation?
- TLU.P3 What are the impacts on water quality and local and regional water resource demands arising from land use change?
- TLU.P4 What impacts does groundwater extraction have on the condition of vegetation and freshwater aquatic communities in the WTQWHA?
- TLU.P5 What are the assessment and planning needs for sustainable native vegetation and biodiversity conservation at various planning scales?
- TLU.P6 How can ecosystem goods and services be defined and quantified as a framework for the application of incentive mechanisms with respect to development activities?

²³ Population and Dwelling Profile, Far North Queensland, Office of Economic and Statistical Research, Queensland Treasury and Trade. <http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0CC4QFjAB&url=http%3A%2F%2Fwww.gqso.qld.gov.au%2Fproducts%2Fprofiles%2Fpop-housing-profiles-reg-planning%2Fpop-housing-profiles-fng.pdf&ei=NfMwU7oTj86SBebZgZgM&usq=AFQiCNF0sRqFFROC1JG92hXcw3dQXU5jLA&bvm=bv.63587204,d.aGc>

²⁴ Queensland Government (2009) *Far North Queensland Regional Plan 2009-2031*. <http://www.dip.qld.gov.au/regional-planning/regional-plan-3.html>

4. Understanding the social drivers of change and the social responses to managing tropical rainforest ecosystems

4a. Governance

Rainforest Aboriginal Cultural Studies (AB)

Rainforest Aboriginal people have occupied, used and been intimately connected to their lands in the WTQWHA since time immemorial. Eighteen to twenty Aboriginal tribal groups continue to live in and around the WTQWHA and sustain their traditional cultural knowledge and connections to country. Conservation of the WTQWHA is inextricably linked with that of Aboriginal culture and spiritual values.

The long term special associations of Rainforest Aboriginal people with the land in the WTQWHA are recognised in the preambles of both State and Commonwealth legislation designed to direct management and protection of the Area. The preamble of the *Wet Tropics World Heritage Protection and Management Act 1993*²⁵ states:

"It is also the intention of the Parliament to acknowledge the significant contribution Aboriginal people can make to the future management of cultural and natural heritage within the Area, particularly through joint management agreements."

The *Wet Tropics World Heritage Area Regional Agreement 2005*²⁶ provides for cooperative management between 18 Aboriginal tribal groups, WTMA and the Australian and Queensland governments, and WTMA remains committed to ensuring appropriate involvement of Aboriginal people in management of the WTQWHA.

The following quote summarises the basis for the listing: *"The Aboriginal Rainforest People of the Wet Tropics of Queensland have lived continuously in the rainforest environment for at least 5 000 years and this is the only place in Australia where Aboriginal people have permanently inhabited a tropical rainforest environment.*

*The Aboriginal Rainforest People developed a distinctive cultural heritage determined by their dreamtime and creation stories and their traditional food gathering, processing and land management techniques. Reliance on their traditions helped them survive in this at times inhospitable environment. The distinctiveness of the traditions and technical innovation and expertise needed to process and prepare toxic plants as food and their uses of fire is of outstanding heritage value to the nation and are now protected for future generations under national environmental law."*²⁷

²⁵ *Wet Tropics World Heritage Protection and Management Act 1993* <http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WetTropicsA93.pdf>

²⁶ *Wet Tropics World Heritage Area Regional Agreement 2005* http://www.wettropics.gov.au/rah/rah_pdf/regional_agreement.pdf

²⁷ <http://www.environment.gov.au/node/19823>

TOP PRIORITY research questions

CAB.T1	What are the aspirations and interests of Rainforest Aboriginal people in the use and joint management of different parts of the WTQWHA, and what systems of management can be developed to facilitate Aboriginal co-management of the WTQWHA?
CAB.T2	How can Wet Tropics Rainforest Aboriginal culture be documented, consistent with objectives of the Wet Tropics Regional Agreement?

Why are these priorities?

WTMA is committed to supporting increased meaningful involvement by Rainforest Aboriginal people in the management of the WTQWHA and recognises the need to work with Rainforest Aboriginal people in keeping with the principles of self-determination. In the spirit of reconciliation and improved management of the WTQWHA, we are taking positive steps to assist Rainforest Aboriginal people to achieve their aspirations to manage the Area.

Considerations

*The Queensland Nature Conservation Act 1992*²⁸ and the *Wet Tropics World Heritage Protection and Management Act 1993*²⁹ require the Environmental Protection Agency/Queensland Parks and Wildlife (QPWS) and WTMA to perform their functions, as far as practicable, in consultation and cooperation with Rainforest Aboriginal people.

Mechanisms for achieving greater Aboriginal involvement in management are provided under legislation such as the *Aboriginal Land Act (Queensland) 1991*³⁰, the *Native Title Act (Commonwealth) 1993*³¹, *Wet Tropics Management Plan (Queensland) 1998*³² or where land is owned by Aboriginal peoples (e.g. DOGIT, freehold/private, etc). Mechanisms can range from information sharing and consultation arrangements between Aboriginal people and land management agencies through to joint-decision making power.

HIGH PRIORITY research questions

CAB.H1	How can Aboriginal capacity building and engagement in natural resource management be improved and implemented?
CAB.H2	What are culturally important attributes of the WTQWHA and where are they located (cultural mapping)?

OTHER PRIORITY research questions

CAB.P1	What is the status of traditional ecological knowledge as it applies to plants, animals, habitats, ecological processes, landscape function and caring for country in the Wet Tropics and how can it best be recorded, integrated and used in a culturally appropriate way?
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²⁸ *The Queensland Nature Conservation Act 1992* <http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/N/NatureConA92.pdf>

²⁹ *Wet Tropics World Heritage Protection and Management Act 1993* <http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WetTropicsA93.pdf>

³⁰ *Aboriginal Land Act (Queensland) 1991* <http://legislation.govnet.qld.gov.au/LEGISLTN/CURRENT/A/AborLandA91.pdf>

³¹ *Native Title Act (Commonwealth) 1993*

[http://www.comlaw.gov.au/ComLaw/Legislation/ActCompilation1.nsf/0/E2786B9A17728077CA25770D0019F960/\\$file/NativeTitle1993_WD02.pdf](http://www.comlaw.gov.au/ComLaw/Legislation/ActCompilation1.nsf/0/E2786B9A17728077CA25770D0019F960/$file/NativeTitle1993_WD02.pdf)

Native Title Act (Queensland) 1993 <http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/N/NativeTitleQA93.pdf>

³² *Wet Tropics Management Plan (Queensland) 1998* <http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WetTropMgmtP98.pdf>

- CAB.P2 What information is needed for the assessment and documentation of the case for recognition of Rainforest Aboriginal cultural heritage for international World Heritage listing?
- CAB.P3 How can traditional Aboriginal ecological knowledge systems be applied in better management of the WTQWHA?
- CAB.P4 What is the potential for tourism as a vehicle for increasing involvement of rainforest Aboriginal people in the management of the WTQWHA?

Giving the WTQWHA a Role in the Life of the Community (CO)

World Heritage managers have an obligation, outlined in UNESCO's Operational Guidelines for the Implementation of the World Heritage Convention³³ to "adopt general policies to give the heritage a function in the life of the community". A systematic approach to understanding community expectations and residents' experience of the WTQWHA will help develop on-ground programs that increase appreciation of the WTQWHA and improve community satisfaction and support.

TOP PRIORITY research question

TCO.T1 How can business (particularly the tourism industry) and other community and Traditional Owner partners be engaged, benefit from, and contribute to the knowledge and management that is integral to WTQWHA protection and management?

Why is this a priority?

Industry, Traditional Owner and community benefits are an important *raison d'être* for WTMA. WTMA needs to know not only how to engage the community but also to show that this engagement is occurring and that benefits are derived from the engagement.

Considerations

Engagement models, for example those related to the cassowary as a focal species, are important to understand and to quantify the economic benefits that flow from such engagement.

HIGH PRIORITY research questions

- TCO.H1 What are community attitudes, knowledge levels, perceptions, expectations, concerns, needs and levels of support with respect to the use and management of the WTQWHA?
- TCO.H2 How can traditional knowledge or traditional resource management techniques be amalgamated with mainstream or western-based management practice which is generally based on science and government policy?

OTHER PRIORITY research questions

- TCO.H3 How can we best promote the value of the WTQWHA to the community?

³³ Operational Guidelines for the Implementation of the World Heritage Convention <http://whc.unesco.org/archive/opguide08-en.pdf>

- TCO.H4 What are the reasons behind people's use and appreciation of the WTQWHA and what disparities exist between different demographics or segments of the population?
- TCO.H5 How can WTMA best enhance community understanding and enjoyment of the WTQWHA?
- TCO.H6 How can WTMA understand, evaluate, document and promote the educational benefits of the WTQWHA?

Adoption – Making a Difference (AD)

What do we wish to achieve?

We want to improve our understanding of how effective research findings are in terms of their influence on (uptake, adoption, contribution to) regional World Heritage conservation, policy, and management practices; and in building community knowledge, awareness and support.

TOP PRIORITY research question

SAD.T1 **How can social and ecological science be integrated into World Heritage conservation policy and management in order to build long-term social and environmental sustainability and resilience in the Wet Tropics?**

Why is this a priority?

There is growing recognition among conservation managers of the need to incorporate the findings from both the ecological sciences with those of the social sciences. Contributions from both the ecological and social sciences are important in ecosystem-based management approaches in order to build long-term resilience and sustainability. We need to better understand how to turn scientific knowledge into effective real-world conservation actions that are supported by the community.

Considerations

Complex environmental challenges require multi-disciplinary, collaborative, approaches to managing them. Relevant, timely, and well-focussed research has a crucial role to play in informing management decisions and actions, and managers need to ensure that findings can be applied to conservation policy and practice.

HIGH PRIORITY research questions

- SAD.H1 What evidence is there that the findings from research and monitoring programs are influencing land management agencies in the region and what are the barriers to knowledge transfer?
- SAD.H2 What evidence is there that the partnerships and cooperative arrangements between WTMA and the research provider community are achieving desired outcomes?

OTHER PRIORITY research questions

- SAD.P1 What is the uptake of research recommendations by WTMA and other agencies with a role in managing the WTQWHA?

- SAD.P2 What evidence is there that research topics and grant applications are representing and responding to on-ground management challenges and issues?

4b. Presentation

World Heritage Presentation, Recreation and Tourism (TO)

Nature-based tourism is the mainstay of the North Queensland economy, with visits to tourism sites in and around the WTQWHA estimated to be about 5 million per year. In order to protect both the integrity of the WTQWHA and the tourism industry itself, tourism in the area must be ecologically sustainable. WTMA also has an obligation under the World Heritage Convention to present the OUV of the Wet Tropics to locals and visitors. Much useful information to improve the management of the WTQWHA can be gained through periodic visitor surveys aimed at assessing the effectiveness of tourism, and WTQWHA management, in achieving a ‘matching’ of visitor needs with tourism experiences.

HIGH PRIORITY research questions

- MTO.H1 What are the key determinants of visitor experience at WTQWHA recreation sites?
- MTO.H2 What are the key indicators of visitor behaviour, motivation and understanding and how might these be applied to improve management?

OTHER PRIORITY research questions

- MTO.P1 How can visitor perceptions of scenic and aesthetic importance be assessed and how might this information be used in impact assessment?
- MTO.P2 What constitutes best practice techniques for presentation of the WTQWHA, and what is the role of the tourism industry in this?
- MTO.P3 What are best practice techniques for design, construction and maintenance of nature-based visitor facilities within the context of a wet tropical environment?
- MTO.P4 What are the impacts on rainforest wildlife of visitor – wildlife interactions and can better wildlife viewing techniques be developed to mitigate adverse visitor impacts?
- MTO.P5 What particular issues are relevant to international visitors to the Wet Tropics and how could this be adopted in management?

Information Technology (IT)

New technologies are constantly emerging that enable land managers to increase their knowledge and improve management practices. The opportunities for using existing and emerging technologies, including web-based approaches, in WTQWHA management, interpretation and education, are immense, but not without cost.

HIGH PRIORITY research questions

SIT.H1 How successful are WTMA's current programs, and how can WTMA and its research and development partners work together to use new technologies to maximise access/exposure benefits and minimise cost? Which new technologies are available to WTMA and how can they best be applied to operational systems?

4c. Ecosystem services**Socio-economic and Environmental Benefits (Environmental Goods & Services) (SE)**

The WTQWHA provides many direct and indirect benefits to the community in the form of environmental goods and services. The most important of these services are those which are essential for life and those which prevent, limit, minimise or correct environmental damage to water, air and soil. There is also a growing recognition of the importance to society that environmental goods and services provide for the health, social, economic, cultural, spiritual, educational, recreational or medicinal needs of human societies.

The majority of the region's rivers feed into the Great Barrier Reef lagoon, and water quality is a key threat to the integrity of GBRWHA values³⁴.

The WTQWHA is also a sanctuary from urban pressures, a place for exploration, and provides the community with a sense of place, cultural identity and spiritual nourishment. Although placing a financial value on these services is complex and contentious, they are nevertheless of enormous value to the regional economy, and to community health and wellbeing.

TOP PRIORITY research questions

MSE.T1 What are the environmental goods and services provided by the WTQWHA to the community (across a range of parameters) and what socio-economic contributions and benefits do they provide to the community?

Why is this a priority?

There is a need to demonstrate the importance of the WTQWHA, not only as a place to enjoy for its intrinsic Outstanding Universal Value, but also the benefits it bestows on the community in terms of water, erosion-control, filtration, natural resources, Aboriginal health, and tourism.

Considerations

A better understanding of the nature, scale and range of environmental goods and services could also assist in developing incentive mechanisms with respect to development activities and better inform the concept of ecological offsets.

³⁴ Queensland Government (2009). Reef Water Quality Protection Plan. <http://www.reefplan.qld.gov.au/about/rwqpp.shtm>

HIGH PRIORITY research questions

- MSE.H1 What are the environmental goods and services provided by the WTQWHA for the regional community and the GBRWHA?
- MSE.H2 How does the WTQWHA support the regional nature-based tourism and recreational industry, and regional economic activity through employment and investments and how can this information be used in advocacy, policy development and planning?
- MSE.H3 How sensitive is the economic contribution of the WTQWHA to land management options?

OTHER PRIORITY research questions

- MSE.P1 What are the relative financial and economic values of key Wet Tropics' species (particularly the Cassowary), habitats and regional water resources?
- MSE.P2 What is the role of the WTQWHA in maintaining economic prosperity, social health and community wellbeing?
- MSE.P3 What are the environmental goods and services provided by the WTQWHA with respect to conservation benefits for the Great Barrier Reef?

Supporting Economic Activity (EA)

What do we wish to achieve?

We need to better understand the current and potential community uses/benefits of the WTQWHA, its biodiversity and natural resources, with respect to ecological, social and economic sustainability. We need information and options to assist managers, industries and communities to minimise adverse impacts of use where they occur.

Tourism has been the fastest growing industry in North Queensland for the last three decades and makes a significant contribution to the local economy. Nature-based tourism is the main drawcard. Protection of the WTQWHA is essential to the sustainability of the local tourism industry, and tourism contributes significantly to political and community support for protection of the Great Barrier Reef and Wet Tropics rainforests.

HIGH PRIORITY research questions

- MEA.H1 How does the WTQWHA support the regional tourism and recreation industries, and how does this relate to regional economic activity through employment and investments and how can this information be used in advocacy, policy development and planning?
- MEA.H2 How sensitive is the economic contribution of the WTQWHA to management and planning decisions?

OTHER PRIORITY research questions

MEA.P1 What socio-economic value does the tourism industry derive from the WTQWHA and what are the flow-on benefits to the regional community and economy?

9. Actions

Identifying these research questions is only one step in the process of meeting WTMA's information needs. We also need to communicate our priority research needs, foster partnerships, provide a range of incentives and other services, initiate or promote projects, collaborate as a research partner, disseminate major findings, and assist in securing financial and in-kind support. To further our research objectives, WTMA will:

1. Communicate WTMA's research strategy and priorities

WTMA will encourage research institutions and industry sector partners to undertake research that addresses strategic WTQWHA management issues. WTMA will promote research partnerships to investigate environmental, management, cultural, social and economic issues as outlined in this strategy.

2. Establish partnerships and promote investment to support Wet Tropics research

WTMA will participate cooperatively and facilitate collaboration on research projects that benefit the management of the WTQWHA. WTMA will promote, advocate, and champion investment into its priority research areas and research partnerships. Support may include providing letters of support or commitments as industry partners. Investment may be in the form of seed funding to initiate a new area of enquiry, co-investment or in-kind support for projects conducted through formal government or non-government grant schemes.

3. Facilitate research through a range of supportive mechanisms

WTMA will undertake to provide a range of supportive mechanisms and services to assist researchers in undertaking their studies, such as promoting the region as an outstanding location for tropical ecosystem research projects. WTMA will also offer a range of incentives to attract research interest by providing services such as the identification of collaboration opportunities and relevant research questions, a brokering service to help link people together, assistance with logistical needs, provision of office accommodation as appropriate, access to reports and other 'grey' literature, GIS data, products, services and expertise, work experience or supervision of in-house student projects and financial support subject to budgetary constraints.

4. Disseminate and adopt research findings

WTMA will improve its dissemination of research findings, knowledge and information on the management of the WTQWHA through its website and other publication resources. WTMA's website has the potential to develop into a focal point to connect, share and develop knowledge and resources relevant to the WTQWHA. A well designed and managed web-based focal point will encourage researchers to make their knowledge available.

10. Key Performance Indicators

The following set of indicators will be used as a basis for reporting on progress towards the achievement of the WTMA's research objectives and evaluating the impact of this Strategy. Indicators have been organised under four main groupings based on the Actions identified in the previous section.

Action 1: Communicate WTMA's research strategy and priorities

Objective	Key performance indicators
1. Identify priority research topics and questions which will benefit WTQWHA management.	1a. Priority research topics reviewed annually to ensure priorities remain current.
2. Promote appropriate research into World Heritage, conservation land management, environmental, cultural, social and economic issues, across the Wet Tropics bioregion and with a primary focus on the WTQWHA, policy development and operational decision making.	2a. Numbers of significant research projects addressing Wet Tropics research priorities. 2b. Number of scientists with permits to undertake research in the WTQWHA. 2c. Evidence or examples of the research strategy being influential in attracting research investment to the region.

Action 2: Establish partnerships and promote investment to support Wet Tropics research

Objective	Key performance indicators
3. Identify, and seek opportunities for, a variety of collaboration and partnership approaches to enable and encourage Wet Tropics natural area land management agencies (including WTMA), and scientists/researchers to work together on world heritage related projects.	3a. Number of WTMA collaborative research partnerships with key organisations. 3b. Evidence of researcher/WTMA partnerships, including collaborative development of research proposals and in-kind support.
4. Promote increased financial and in-kind support through advocacy, collaboration and other means to undertake research relevant and important to the WTQWHA.	4a. Number of industry partner commitments from WTMA. 4b. Examples of WTMA financial investment or in-kind support for research projects. 4c. Examples of how the Research Strategy has been used in the formulation or justification of research funding proposals.
5. Build on the outcomes of previous research partnerships with the Rainforest CRC, MTSRF, NERP and TERN.	5a. Examples of research which builds on outcomes from previous WTMA research partnerships.

Action 3: Facilitate research through a range of supportive mechanisms

Objective	Key performance indicators
6. Identify ways in which WTMA can help facilitate research (e.g. through knowledge brokering, information sharing, project facilitation and capacity building).	6a. Number of researchers using WTMA office facilities. 6b. Evidence of use of WTMA library of grey literature and GIS resources. 6c. Number of students undertaking work experience, training or supervision at WTMA.

Action 4: Disseminate and adopt research findings

Objective	Key performance indicators
7. Disseminate research findings to communities of interest in an effective and timely way (e.g. research findings used by Wet Tropics land managers and other key stakeholders in evidence-based decision making).	7a. Number of technical and scientific publications about the Wet Tropics and the Wet Tropics of Queensland World Heritage Area in particular. 7b. Number of forums for land managers and other key stakeholders, to promote research and its findings, and provide an opportunity to consider the implications of this work for policy and practice. 7c. Examples of where research findings have been applied in making evidence-based decision-making, policy and planning, and on-ground management practice. 7d. Evidence of WTMA knowledge transfer being effective in informing key stakeholders of solutions-based research findings.

Appendix 1

A summary of identified research questions

A summary of our identified priority research questions are listed below. The management context, what we wish to achieve and why these questions are a priority are described in **Chapter 8**.

A summary of the TOP PRIORITY research questions

Understanding the rainforests (and associated ecosystems) of Australia's Wet Tropics.

Ecological/forest 'health'

- What are the key indicators of forest health that can be regularly measured at a landscape scale within the WTQWHA? Is there proven remote sensing technology able to be used to measure trends in these key indicators either directly or indirectly? If not, what alternate approaches could be employed?

Priority species and ecosystems

- What is the condition, trends and projected futures of threatened species including cassowaries and arboreal mammals and other threatened species and ecosystems (including the identification and evaluation of the key threats to them and evaluation of available management options to improve their status)?

Fire Management

- What are the characteristics of the dynamics of rainforest/open forest edges and other ecosystem boundaries and how should these characteristics be considered when reviewing boundary fire management in response to a changing climate?

Understanding the causes of change to Australia's tropical rainforest ecosystems and how to maintain, restore and monitor their ecological resilience to change.

Alien and invasive species

- What is the realised and potential ecological impact of yellow crazy ants on the OUV and integrity of the WTQWHA and how effective is the management regime being employed to eradicate them from the Wet Tropics?
- Where should investment in pest animal research and management be directed and focussed considering the relative risk posed to the ecology and outstanding universal values and integrity (OUV-I) of the WTQWHA?
- Where are there identifiable, high-susceptibility areas where weeds and pest animals have the potential to become major drivers impacting the ecological health of particular communities, ecosystems or regions of the WTQWHA that should be the focus for keeping pest and/or weed free?

Impact mitigation – community infrastructure and activities

- What is the effectiveness of impact mitigation strategies and on-ground practices in restoring or maintaining ecological processes and function with respect to community infrastructure (e.g. roads, power supply and distribution, communications, water storage and water supply) design, construction, maintenance and use?

Climate change impacts and adaptation strategies/regional responses

- How resilient are different WTQWHA species and ecosystems to climate change and what management actions can be undertaken to maintain/improve ecosystem 'resilience' in the face of climate change?
- Where are the key locations and best landscape configurations most likely to function as refugial areas and landscape linkages for key threatened species and ecosystems?
- When and where is landscape connectivity a bad choice in relation to the maintenance and stability of refugial areas?

Wildlife corridors and ecological connectivity

- What are achievable, cost-effective techniques for rehabilitating degraded sites and re-establishing natural successional processes, including the restoration of ecological connectivity in infrastructure corridors?

Rehabilitation and restoration

- What constitutes the best ecological restoration practices and what are their costs and benefits in environmental, social and economic terms?

Understanding the social drivers of change and the social responses to managing tropical rainforest ecosystems

Rainforest Aboriginal cultural studies

- What are the aspirations and interests of Rainforest Aboriginal people in the use and joint management of different parts of the WTQWHA and what systems of management can be developed to facilitate Aboriginal co-management of the WTQWHA?
- How can Wet Tropics Rainforest Aboriginal culture be documented, consistent with objectives of the Wet Tropics Regional Agreement?

Giving the WTQWHA a role in the life of the community

- How can business (particularly the tourism industry), community and Traditional Owner partners be engaged, benefit from and contribute to the knowledge and management that is integral to WTQWHA protection and management?

Socio-economic & environmental benefits (ecological goods & services)

- What is the value of the goods and services provided by the WTQWHA across a range of parameters and what socio-economic contributions and benefits do they make to the community?

Adoption – making a difference

- How can the ecological and social dimensions of World Heritage conservation policy and management be linked to build resilience and long-term sustainability in the management of the WTQWHA?

A summary of the HIGH PRIORITY research questions**Understanding the Outstanding Universal Value of the Wet Tropics World Heritage Area**

Understanding the Wet Tropics' outstanding universal values

- How can the aesthetic and scenic features and attributes of the WTQWHA, considered to be of outstanding universal value (OUV-I), be identified and described in greater detail as a basis for decisions about development in and around the WTQWHA?
- How can the new understanding and theories of phylogenetics and the evolution of the angiosperms be used to update understanding of the OUV-I of the Wet Tropics; in particular, the concept and listing of 'primitive' or 'basal' angiosperms, Gondwanan taxa, species with a nodal position in evolution, and those species of Cretaceous origin and describe those aspects which could be considered to be of outstanding universal value?
- How can the climate sensitivity of species and ecosystems be determined to provide a greater indication of those outstanding universal values which are most susceptible to climate change and identify how much climate change (direction, magnitude, rate, means vs. extremes) is too much in relation to specific values including understanding the climatic thresholds of key species and communities?
- Which species and ecosystems within the WTQWHA are most at risk from threatening processes and how can they be identified and quantified?

Understanding the rainforests (and associated ecosystems) of Australia's Wet Tropics.

Ecological/forest 'health'

- What are the key indicators of forest health that can be used as a basis for assessment and reporting?
- Is it possible to achieve high resolution mapping and monitoring of change and recovery by remote sensing in a topographically diverse landscape such as the Wet Tropics?
- What are operational, cost-effective methods for monitoring trends in the 'condition' of landscapes, forests and waterways of the WTQWHA at a range of scales, incorporating the monitoring and assessment of risks and threats to the WTQWHA and the impacts of management actions, and how can monitoring results be incorporated into WTMA's statutory reporting?
- How can the spatial distribution and magnitude of pressures impacting on the ecological condition of the WTQWHA be identified and mapped, including invasive species, development pressures, habitat fragmentation, wildlife diseases, and visitor pressures?
- What are appropriate socio-economic and cultural indicators to describe the effects of changes in the ecological state of the region and changes in its management?

Priority species and ecosystems

- What aspects of population dynamics, DNA techniques, ecology, physiology, behaviour and disease research are likely to be the most useful for on-ground recovery of threatened species such as the cassowary?

Fire management

- What are the criteria that need to be developed to identify key areas for fire management and other areas where expansion of rainforest is actually a desirable/natural outcome?

Understanding the causes of change to Australia's tropical rainforest ecosystems and how to maintain, restore and monitor their ecological resilience to change

Alien and invasive species

- Which weed species cause, or are likely to cause, the greatest environmental harm, where are the key areas of susceptibility and what are their environmental impacts?
- Are current infrastructure management/maintenance hygiene prescriptions appropriate and/or adequate with respect to potential weed and disease risks?
- What are the impediments and management barriers to effective feral pig control in the Wet Tropics?
- Is the distribution and prevalence of *Phytophthora cinnamomi* within the WTQWHA increasing or decreasing: what factors drive change in distribution and virulence, and which of these are susceptible to management intervention?

Impact mitigation – community infrastructure and activities

- What impacts do high altitude, low traffic presentation roads (e.g. Mt Lewis; ACB Roads) have on locally restricted endemic wildlife and what are appropriate design, maintenance and management considerations?
- How can mountain-top sites within the WTQWHA be classified with respect to their ecological and evolutionary significance, vulnerability to disturbance and irreplaceability?
- What impacts does the provision of community infrastructure have on water quality and on the ecological functioning of freshwater aquatic ecosystems?

Climate change impacts and adaptation strategies/regional responses

- What are the short-term and long-term environmental, economic and social costs and benefits associated with particular climate change adaptation options and their likely effectiveness in the Wet Tropics?
- How will climate change impact on the natural and cultural environments of the WTQWHA and what is the level of spatial and temporal confidence associated with these predictions?
- Where are the key locations and landscape 'networks' most likely to function as refugial areas and landscape linkages for threatened key species and ecosystems?

Wildlife corridors

- What constitutes critical patch size thresholds and corridor widths for wildlife associated with different landscape types?
- By applying existing knowledge and trialling different designs, demonstrate how to design and rehabilitate a wildlife corridor to achieve improved habitat connectivity for identified species of World Heritage significance, and in particular the cassowary?

Rehabilitation and restoration

- What are the options for enhancing or accelerating large-scale natural regeneration of abandoned, previously cleared areas?
- What are the best practice designs for creating refuge habitats as a proactive response to shifts in climate zones due to climate change?
- How can we effectively prioritize the most important large-scale ecological restoration projects that could be undertaken in the Wet Tropics?
- What are the options for large-scale rehabilitation following decommissioning of redundant infrastructure (e.g. powerlines or roads)?

Landuse change

- What are the fragmentation, patch size and connectivity thresholds for maintenance of biodiversity and ecosystem processes?
- What is the impact on water quality and on aquatic wildlife within the WTQWHA (in particular endangered amphibians and endemic freshwater fish) of agricultural chemicals used upstream of the WTQWHA?

Understanding the social drivers of change and the social responses to managing tropical rainforest ecosystems

Rainforest Aboriginal cultural studies

- How can Aboriginal capacity building and engagement in natural resource management be improved and implemented?
- What are culturally important attributes of the WTQWHA and where are they located (cultural mapping)?

World Heritage presentation, recreation and tourism

- What are the key determinants of visitor experience at WTQWHA recreation sites?
- What are the key indicators of visitor behaviour, motivation and understanding and how might these be applied to improve management?

Giving the WTQWHA a role in the life of the community

- What are community attitudes, knowledge levels, perceptions, expectations, concerns, needs and levels of support with respect to the use and management of the WTQWHA?
- How can traditional knowledge or resource management techniques best be incorporated with mainstream or western-based management practice which is generally based on science and government policy?

Socio-economic & environmental benefits (ecological goods & services)

- What are the ecological goods and services provided by the WTQWHA for the regional community and the GBRWHA?
- How does the WTQWHA support the regional nature-based tourism and recreational industry, and regional economic activity through employment and investments and how can this information be used in advocacy, policy development and planning?
- How sensitive is the economic contribution of the WTQWHA to land management options?

Supporting economic Activity

- How does the WTQWHA support the regional nature-based tourism and recreational industry, and regional economic activity through employment and investments and how can this information be used in advocacy, policy development and planning?
- How sensitive is the economic contribution of the WTQWHA to land management options?

Adoption – making a difference

- What evidence is there that the findings from research and monitoring programs are influencing land management agencies in the region and what are the barriers to knowledge transfer?
- What evidence is there that the partnerships and cooperative arrangements between WTMA and the research provider community is achieving desired outcomes?
- How successful are WTMA's current programs and how can WTMA and its research and development partners work together to use new technologies to maximise access/exposure benefits and minimise cost? Which new technologies are available to WTMA and how can they be best applied to operational systems?

A summary of the OTHER PRIORITY research questions**Understanding the Outstanding Universal Value of the Wet Tropics World Heritage Area**

Understanding the Wet Tropics' outstanding universal values

- How can the superlative natural phenomena displayed by the WTQWHA which could be considered to be of outstanding universal value (OUV-I) be identified and described in greater detail?

- What are the fossil, geological and geomorphologic features and attributes of the WTQWHA which could be considered to be of outstanding universal value be identified and described?

Understanding the rainforests (and associated ecosystems) of Australia's Wet Tropics.

Priority species and ecosystems

- Are there valid surrogacy relationships between vegetation types/regional ecosystems and fauna habitat, and can this be used in the development of habitat mapping and improved predictive capacity especially with respect to threatened regional fauna?
- What are the population trends, structure, distribution and genetics for key cassowary populations and what factors are the most likely cause of change for these populations?

Fire management

- In light of the impact of climate change on ecosystems, how can WTQWHA on-ground land managers optimise their fire management while meeting biodiversity and cultural heritage conservation, recreational availability, and requirements for community safety?
- What are the 'best' fire management regimes (for the protection of the Area's outstanding universal value and its integrity) for key vegetation types or locations?
- How can traditional ecological knowledge be incorporated to effectively involve Aboriginal people in fire management programs?

Understanding the causes of change to Australia's tropical rainforest ecosystems and how to maintain, restore and monitor their ecological resilience to change.

Alien and invasive species

- What are the cost/benefits of different control measure options and is it possible to develop effective, species specific, and environmentally safe control methods (with an emphasis on the feral pig, tilapia and feral deer)?
- What criteria should be used to prioritise expenditure on prevention, control, eradication or containment of weeds considered to pose a major threat to natural environments in the region?
- 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?
- What are the ecological and evolutionary impacts associated with the translocation of native species outside their natural range including fish stocking and tree planting?
- What plant diseases or pests are, or could potentially, be associated with tree planting activities and what risk do they pose?

Impact mitigation – community infrastructure and activities

- What are suitable indicators for quantifying and monitoring grazing impacts?

Climate change impacts and adaptation strategies/regional responses

- How can climate change models and their underlying relationships and assumptions be tested and improved by the strategic collection of environmental and ecological data sets through the establishment of monitoring systems to enable early detection of climate change impacts on key species and ecosystems?
- Which species are likely to be the best indicators of the effects of climate change on natural communities?
- How will climate change and its primary impacts interact with other threats such as clearing, fragmentation, fire, weeds, feral animals, declining water quality, urbanisation and other land uses to impact on the outstanding universal values of the WTQWHA, including identification of those which have the greatest potential for substantial impact?
- Under what circumstances and which places in the landscape could improving landscape connectivity result in negative ecological outcomes?
- 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?
- How does the WTQWHA contribute to greenhouse gas emissions, sequestration and storage?
- How resilient are key sectors of local industry, notably tourism and visitor services with respect to the environmental impacts of climate change?

Wildlife corridors and ecological connectivity

- What evidence is there that wildlife corridors serving their intended purposes at a landscape scale?
- What are the functional implications of riparian corridors with respect to width and connectivity?

Rehabilitation and restoration

- What are the preferred or priority areas for undertaking World Heritage 'offset' ecological restoration activities?
- What options are available for planting and/or screening exposed rock faces, steep road batters and shotcrete batters following road construction, maintenance or repair?

Landuse change

- Which Wet Tropics landscape and ecosystem processes are most at risk from changing landuses?
- What is the comparative biological and ecological importance of regrowth, modified, disturbed and/or fragmented vegetation?
- What are the impacts on water quality and local and regional water resource demands arising from land use change?
- What impacts does groundwater extraction have on the condition of vegetation and freshwater aquatic communities in the WTQWHA?

- What are the assessment and planning needs for sustainable native vegetation and biodiversity conservation at various planning scales?
- How can ecosystem goods and services be defined and quantified as a framework for the application of incentive mechanisms with respect to development activities?

Understanding the social drivers of change and the social responses to managing tropical rainforest ecosystems.

Rainforest Aboriginal cultural studies

- What is the status of traditional ecological knowledge as it applies to plants, animals, habitats, ecological processes, landscape function and caring for country in the Wet Tropics and how can it best be recorded, integrated and used in a culturally appropriate way?
- What information is needed for the assessment and documentation of the case for recognition of Rainforest Aboriginal cultural heritage for national and international listing?
- How can traditional Aboriginal ecological knowledge systems be applied in better management of the WTQWHA?
- What is the potential for tourism as a vehicle for increasing involvement of rainforest Aboriginal people in the management of the WTQWHA?

World Heritage presentation, recreation and tourism

- How can visitor perceptions of scenic and aesthetic importance be assessed and how might this information be used in impact assessment?
- What constitutes best practice techniques for presentation of the WTQWHA, and what is the role of the tourism industry in this?
- What are best practice techniques for design, construction and maintenance of nature-based visitor facilities within the context of a wet tropical environment?
- What are the impacts on rainforest wildlife of visitor – wildlife interactions and can better wildlife viewing techniques be developed to mitigate adverse visitor impacts?
- What particular issues are relevant to international visitors to the Wet Tropics and how could this be adopted in management?

Giving the WTQWHA a role in the life of the community

- How can we best promote the value of the WTQWHA to the community?
- What are the reasons behind people's use and appreciation of the WTQWHA and the variation between different demographics or segments of the population?
- How can WTMA best enhance community understanding and enjoyment of the WTQWHA?
- How can WTMA understand, evaluate, document and promote the educational benefits of the WTQWHA?

Socio-economic & environmental benefits (ecological goods & services)

- What are the relative financial and economic values of key Wet Tropics' species (particularly the Cassowary), habitats and regional water resources?
- What is the role of the WTQWHA in maintaining prosperity together with social health and wellbeing?
- What are the ecological goods and services provided by the WTQWHA with respect to conservation benefits for the Great Barrier Reef?

Supporting economic activity

- What is the socio-economic value of the WTQWHA for the tourism industry and their flow-on benefits to the regional community and economy?

Adoption – making a difference

- What is the uptake of research recommendations by WTMA and other agencies with a role in managing the WTQWHA?
- What evidence is there that research topics and grant applications are representing and responding to on-ground management challenges and issues?

Appendix 2

WEB RESOURCES

Organisations & Entities

Australian Government

Commonwealth Scientific, Industrial and Research Organisation (CSIRO) <http://www.csiro.au/>

CSIRO Ecosystem Sciences Division <http://www.csiro.au/en/Organisation-Structure/Divisions/Ecosystem-Sciences.aspx>

CSIRO Atherton Laboratory <http://www.csiro.au/places/Atherton.html>

CISRO Townsville: Australian Tropical Sciences and Innovation Precinct
<http://www.csiro.au/Organisation-Structure/Divisions/Ecosystem-Sciences/ATSIP.aspx>

Department of Environment <http://www.environment.gov.au/>

National Climate Change Adaptation Research Facility (NCCARF) www.nccarf.edu.au/

Terrestrial Biodiversity Network (TBN)
<http://www.nccarf.edu.au/networks/terrestrial-biodiversity-network>

National Collaborative Research Infrastructure Strategy (NCRIS) <http://www.education.gov.au/national-collaborative-research-infrastructure-strategy-ncris>

National Environmental Research Program (NERP) <http://www.environment.gov.au/topics/science-and-research/national-environmental-research-program>

Australian Tropical Herbarium (ATH) <http://www.ath.org.au/>

Great Barrier Reef Marine Park Authority (GBRMPA) <http://www.gbrmpa.gov.au>

International Long Term Ecological Research (ILTER) <http://www.ilternet.edu/>

International Union for Conservation of Nature (IUCN) www.iucn.org/

James Cook University (JCU) <http://www.jcu.edu.au>

Daintree Rainforest Observatory <http://www.jcu.edu.au/canopycrane/>

The Cairns Institute www.jcu.edu.au/cairnsinstitute/about/

Centre for Tropical Biodiversity and Climate Change www.jcu.edu.au/ctbcc/

Cooperative Research Centre for Tropical Rainforest Ecology and Management (Rainforest CRC)
<http://www.jcu.edu.au/rainforest/>

Reef and Rainforest Research Centre (RRRC) www.rrrc.org.au/

Marine & Tropical Sciences Research Facility (MTSRF) <http://www.rrrc.org.au/publications.html>

Terrestrial Ecosystem Research Network (TERN) <http://www.tern.org.au/>

Queensland Government

Department of Environment and Heritage Protection (EHP) <http://www.ehp.qld.gov.au/>

Department of National Parks, recreation, Sport and Racing <http://www.nprsr.qld.gov.au/>

Department of Science, Information Technology, Innovation and the Arts (DSITIA) <http://www.qld.gov.au/dsitia/>

United Nations Educational, Scientific and Cultural Organisation (UNESCO) <http://www.unesco.org/new/en/unesco/>

UNESCO World Heritage Centre: <http://whc.unesco.org/>

UNESCO World Heritage List: Wet Tropics of Queensland World Heritage Area (WTQWHA)
<http://whc.unesco.org/en/list/486>

Wet Tropics Management Authority (WTMA) <http://www.wettropics.gov.au>

WTMA's Scientific Advisory Committee (SAC) <http://www.wettropics.gov.au/scientific-advisory-committee.html>

Legislation & Publications

Australian Government

Environment Protection and Biodiversity Conservation Act 1999 <http://www.environment.gov.au/epbc/about/index.html>

National Recovery Plans and Threat Abatement Plans (under the EPBC Act)
<http://www.environment.gov.au/biodiversity/threatened/index.html>

Native Title Act (Commonwealth) 1993

[http://www.comlaw.gov.au/ComLaw/Legislation/ActCompilation1.nsf/0/E2786B9A17728077CA25770D0019F960/\\$file/NativeTitle1993_WD02.pdf](http://www.comlaw.gov.au/ComLaw/Legislation/ActCompilation1.nsf/0/E2786B9A17728077CA25770D0019F960/$file/NativeTitle1993_WD02.pdf)

National Strategy for Ecologically Sustainable Development

<http://www.environment.gov.au/about/esd/publications/strategy/index.html>

IUCN (2010). *Enhancing the Science-Policy Interface on Biodiversity and Ecosystem Services.* Information Paper on IPBES – March 2010. http://cmsdata.iucn.org/downloads/ipbes_information_paper.pdf

Queensland Government

Aboriginal Land Act (Queensland) 1991

<http://legislation.govnet.qld.gov.au/LEGISLTN/CURRENT/A/AborLandA91.pdf>

Far North Queensland Regional Plan 2009-2031. <http://www.dip.qld.gov.au/regional-planning/regional-plan-3.html>

Native Title Act (Queensland) 1993

<http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/N/NativeTitleQA93.pdf>

Nature Conservation Act 1992 <http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/N/NatureConA92.pdf>

Queensland Research and Development Priorities and Objectives.

<http://www.chiefscientist.qld.gov.au/research-and-development/about-priorities.aspx>

Wet Tropics Management Plan (Queensland) 1998

<http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WetTropMgmtP98.pdf>

Wet Tropics World Heritage Protection and Management Act 1993

<http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/W/WetTropicsA93.pdf>

Stork, N.E. & Turton, S.M. (eds) (2008). *Living in a Dynamic Tropical Forest Landscape.* Blackwell Publishing. – available for purchase (hard copy and online version) through <http://au.wiley.com/WileyCDA/WileyTitle/productCd-1405156430.html>

UNESCO

Operational Guidelines for the Implementation of the World Heritage Convention

<http://whc.unesco.org/archive/opguide08-en.pdf>

Policy document on the impacts of climate change on World Heritage properties (WHC-0716.GA/10) 2007.

<http://whc.unesco.org/document/9281>

World Heritage Convention 1972. <http://whc.unesco.org/archive/convention-en.pdf>

Wet Tropics Management Authority (WTMA)

Maps of the Wet Tropics region <http://www.wettropics.gov.au/maps>

State of the Wet Tropics Reports <http://www.wettropics.gov.au/annual-reports>

Wet Tropics Conservation Strategy 2004 <http://www.wettropics.gov.au/conservation-strategy>

Wet Tropics Research and Information Needs 2000. www.wettropics.gov.au/site/user-assets/docs/rain_report.pdf

Wet Tropics World Heritage Area Regional Agreement 2005 <http://www.wettropics.gov.au/regional-agreement>



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