Marine and Tropical Sciences
Research Facility

THEME 2
Risks and Threats to the Ecosystems

FACT SHEET

Prepared by Toursim Tropical North Queensland

TOURISM TROPICAL NORTH QUEENSLAND

Reef & Rainforest RESEARCH CENTRE

Australian Government
Department of the Environment, Water, Heritage and the Arts

INTRODUCTION

In 2006 the Australian Government established the Marine and Tropical Sciences Research Facility (MTSRF) to develop "world-class public good research" projects that utilize the collaborative efforts of the best Australian tropical environmental researchers. A budget of $40 million dollars over 4 years, was allocated to MTSRF.

All approved projects have to be directly relevant to the conservation and sustainable use of North Queensland's environmental assets, including the Wet Tropics rainforests, the Great Barrier Reef and the connecting coastal regions.

5 major issues, or Themes, of immediate and significant issues were identified
The MSTRF projects are divided into 5 Research Themes:

THEME	DESCRIPTION
Theme 1 Status of the Ecosystems	Understanding the condition, trend and interdependencies of environmental assets of the North Queensland region; developing methods to support ongoing regular assessment and reporting; and developing methods to identify priorities for action. Program 1 – Great Barrier Reef Program 2 – Rainforests & Catchments Program 3 – Torres Strait Program 4 – Species of Conservation Concern
Theme 2 Risks & Threats to the Ecosystem	Understanding the threats to, and their impacts on the environment and hence the North Queensland region, and developing options to mitigate them Program 5i – Marine Program 5ii – Rainforests & Catchments Program 6 – Invasive Pests
Theme 3 Halting & Reversing the Decline of Water Quality	Understanding the causes and effects of changing water quality and water resource use in North Queensland's coastal catchments; developing options for improving practices, reducing risks and mitigating adverse impacts; and developing ways to measure the effectiveness of regulation, management and other actions to halt and reverse declines. This goal supports the objectives of the Australian and Queensland Government's Reef Water Quality Protection Plan (Reef Plan). Program 7 – Water Quality
Theme 4 Sustainable Use & Management of Natural Resources	Understanding the current and potential industry and community uses of biodiversity and natural resources with respect to ecological, social and economic sustainability; and providing information and options to assist North Queensland managers, industries and communities to optimise the use of biodiversity resources and minimise adverse impacts of use where they occur. Program 8 – Great Barrier Reef Program 9 – Rainforests & Catchments
Theme 5 Enhancing Delivery	Increasing the relevance and adoption of research in policy development, management applications and use practices; supporting effective data exchange and adoption of data standards; funding the delivery of relevant reports in the public interest; providing system wide overviews through the integration of biophysical studies of the environmental assets of North Queensland and the integration of social and economic research into these; and providing access to data and knowledge for organisations and the public. Program 10 – Enhancing Delivery

Modified from the MTSRF website: www.rrrc.org.au/mtsrf

As part of Theme 5 (Enhancing Delivery), TTNQ was contracted to facilitate the flow of information from MTSRF to the tourism industry in tropical Queensland (Project 5.10.2) through a series of easy-to-understand Fact Sheets, each one specific to one of the themes. These Fact Sheets set the framework for understanding why this research is important and what the potential impacts are to the environment, our communities and the local tourism industries.

Theme 2: Risks & Threats to the Ecosystem, includes 3 main focus areas:

1. Climate Change: Great Barrier Reef
2. Climate Change: Rainforest and Catchments
3. Understanding Threats and Impacts of Invasive Pests on Ecosystems.

Threats…
physical things that can cause imminent danger
Risks…
levels of probability or chances that the threats will actually cause harm

BRIEF OVERVIEW

An 'ecosystem' is the combination of the ecological community (including plants, animals and micro-organisms) together with its environment (landscape and climate) that interacts and functions as a unit. This term was coined in 1930 by Roy Chapman.

In the Tropical North Queensland region, the main large-scale ecosystems are the rainforests and catchment areas and the Great Barrier Reef.

Maintaining the health and integrity of these ecosystems is not only extremely important to maintaining the ongoing economic, social and environmental well-being of the region, but also to the $2.2 billion nature-based tourism industry that relies on a healthy environment for tours and activities.

Understanding the biotic and abiotic interactions, the threats and the risks facing the system is the first step on learning how to best manage ecosystems. In other words, you need to know how the system works, how it will change as a result of disturbances and how resilient it is to recover from changes before you can set up a management plan to help reduce, stop and reverse the effects. It will also form the framework for models to help predict flow-on effects form specific effects.

There are many threats facing the marine, rainforest and catchment areas, but scientists recognise **climate change** and **invasive pests** as two of the worst, due to the broad-scale impacts and potential irreversible damage they can cause.

A Catchment Area…
is a topographic region in which all of the underground and surface water (from rivers, streams and run-off) drains down to a common outlet (e.g. river or lake) before draining out to sea. Also called *drainage basins* or

Biotic…
Refers to something in the environment that is alive, (e.g. animals, plants, bacteria)
Abiotic…
Refers to nonliving things in the environment (e.g. light, water, heat, rock,

CLIMATE CHANGE

TERMINOLOGY

Issues relating to climate change can be very confusing, especially since there are a lot of different terms being used in the media to describe different aspects of it. The key terms to remember are **'the greenhouse effect'**, **'global warming'** and **'climate change'**.

The Greenhouse Effect is a natural phenomenon whereby naturally-produced greenhouse gases form a 'blanket' high in the earth's atmosphere that traps energy and warmth. This is a very important process - without it, the earth's temperature would be an estimated -18ºC! The most common greenhouse gases are carbon dioxide, methane, nitrous oxide & water vapour. These gasses are naturally produced by decaying plants, the air we breathe out and natural forest fires.

Global Warming is NOT a natural event. The earth's increased air and ocean temperatures are the result of excess greenhouse gases accumulating in the atmosphere. More greenhouse gases in the atmosphere is like adding more 'blankets' that traps more warmth. Over time, the earth's average temperature rises and throws the delicate and complex climate system off-balance. The source of most of the excess greenhouse gases is burning of fossil fuels (coal, oil & gas) for energy and transportation.

Climate Change refers to any long-term significant change in the "average weather" that a given region experiences over a time frame of decades to millions of years. This includes a range of measurable variables, including average temperature, precipitation (rain & snow fall) and wind speed and direction.

Today, the term 'climate change' is commonly used to refer to climate changes thought to be associated with human activities over the past century. Although global warming is only part of the bigger environmental issue of climate change, it may be a main driver of the present climate changes.

PREDICTIONS FOR TROPICAL NORTH QUEENSLAND

As temperatures rise, it can trigger off a series of environmental changes, including changes in rainfall patterns, a rise in sea level, which in turn will have a wide range of impacts on plants, wildlife and humans.

Climate change models vary, but overall, it is predicted that Tropical North Queensland will experience an increase in average temperature, more rainfall during wet seasons, longer and harsher dry seasons and more intense, stronger cyclones (but fewer of them). Scientists agree that climate change will have significant impacts on all environments and associated flora & fauna, including the rainforest and catchment areas and the Great Barrier Reef.

MAJOR IMPACTS

For the local tourism industry, the main concerns with climate change focus on the impacts to the key natural assets of rainforests, lowland forests, catchment areas, coastal communities (e.g. mangroves) and the reef. Climate change can have devastating impacts .

Greenhouse Gasses!
The biggest man-made contributor to the greenhouse effect is carbon dioxide
77% from burning fossil fuels
22 % the result of deforestation.
1% from manufacturing activities (e.g. concrete, steel & aluminium).

But it is only a few degrees!
Scientists say that the earth's temperature could rise by as much as 6ºC.
That may not sound like much, but just think:
During the last ice age, the average temperature was only 7 ºC cooler than today!

Moving Up
Some animals are unable to adapt to warmer temperatures, and must physically move from their normal 'home area' to another location in search of cooler temperatures. The Pika, a small mammal that lives in the mountains of eastern Asia, the Middle East, and North America is going extinct in North America because they cannot go any higher on the mountains.
In the Wet Tropics, scientists have worked out that one extra degree pushes an animal's habitat 200 metres up the mountain.
This is why many scientists fear that some rainforest animals will run out of places to go if it warms too much.

Climate Change Variable	Potential Impacts in Rainforests & Catchment Areas	Potential Impacts in Marine & Reef Environments
Warmer Temperatures	▪ Shifts in the extent and spatial distribution of forest habitats ↘ forests unable to tolerate warmer temperature will shift to cooler areas and/or die-off ↘ forests that prefer warmer climes will expand ▪ Changes in forest composition as heat tolerant species dominate ▪ Changes in animals biodiversity as heat intolerant animals migrate to cooler areas ▪ Habitat loss	▪ Increased frequency & intensity of coral bleaching events ▪ Increased coral stress and diseases ▪ Reduced coral reproduction and egg viability ▪ Increased algal blooms, resulting in reduce water visibility ▪ Increased macro algae growth, potentially overgrowing coral ▪ Increase diseases in other marine invertebrates ▪ Reduction in fish growth and size
More Rainfall	▪ Shifts in the extent and spatial distribution of forests depending on wet condition tolerance ↘ Areas of increased rainfall will favour some rainforest types ↘ Areas of decreased rainfall will favour other drier forests	▪ Increased coral bleaching in shallow waters as a result in increased freshwater concentrations ▪ Increased nutrient and sediment loading as larger flood plumes carrying nutrients and freshwater to reefs farther out
Stronger Cyclones	▪ Greater disturbance, damage and possible fragmentation ▪ Loss of habitat ▪ Fauna mortality ▪ Possible shift in diversity (more disturbance can result in higher diversity)	▪ Increased structural reef damage ▪ Increase breakage, abrasion and smothering of corals and benthic (bottom-dwelling) communities.
Sea level Rise	▪ Loss of coastal habitats, especially beaches and mangroves.	▪ Island habitat loss – including sea turtle nesting sites ▪ Deeper water coral death due to reduced sunlight penetration ▪ Seagrass habitat loss
Increased Ocean Acidity		▪ Weakened skeletons of corals, echinoderms, mollusca and crustaceans due to disrupted calcification processes ▪ Reduced reproductive success of marine organisms

THE PAST IS A POOR INDICATOR OF THE FUTURE…

Some people argue that high temperatures have occurred before, without the detrimental impacts that are being predicted for the near future. In fact, 3000 – 6000 years ago temperatures in this region were about 1.5ºC warmer than today, but despite the high temperatures, the plants and animals survived. So, what's different – why is THIS temperature change going to have a bigger impact? There are several reasons.

Back then:

- the temperature change occurred over a much longer time. It took about 2000 to 3000 years to heat up, not just 50 – 100 years like the present situation
- the animals and habitats did not have to contend with the added stresses caused by man's activities (e.g. land clearing, pesticides, diseases, poor water quality). Many scientists think that these ongoing stresses have reduced overall well-being and health of many animals.
- The environment was not fragmented by land clearing and development. This allowed animal and plant communities to respond to global climate change by migrating to other areas better suited for their survival. Fragmentation reduces the ecosystem's resilience to climate change.

INVASIVE PESTS

‘Invasive Pests’ are considered non-indigenous plants, animals or micro-organisms that spread into new areas and become so abundant that they become economically, environmentally and ecologically harmful. Native species can be classified as invasive pests if they spread into and overtake new ranges previously not occupied.

‘Introduced Species’, or exotic species, are non-indigenous plants, animals or micro-organisms that have been introduced, either accidentally or deliberately, to new locations. Introduced species might become invasive pests if they can out compete native species for resources (e.g. nutrients, light, physical space, water or food).

‘Feral animals’ are domestic animals (livestock or pets) that have been released or escaped and gone wild. Like Introduced species, they may out-compete native species and become invasive pests.

What makes invasive pests so dangerous is that they are able to ‘take over’ and out-compete native species. They do this because they have one or more specific traits that give them the ‘edge’ (competitive advantage) over native species. These traits can be physical, behavioural of ecological.

Physical and behavioural traits are called species-based mechanisms.

These traits allow the pests to:

- grow and reproduce more rapidly than native species
- reproduce both asexually (vegetatively) and sexually
- reach sexual maturity at a young age,
- produce lots of offspring or seeds,
- disperse offspring or seeds over great distances,
- tolerate of a wide range of environmental conditions,
- alter growth form (morphology) and behaviour to suit changing environmental conditions (phenotypic plasticity)
- survive on a range of food types
- produce toxins that inhibits growth in other plants(chemical competition or allelopathy)
- adapt to human environments and impacts.

Additionally, the state of the ecosystem also plays a role in whether these animals become pests or not. Normally, in a healthy ecosystem, the available resources and the demand for those resources by living organisms is in equilibrium and every species fills a role, or niche, to help maintain this balance. If this balance is disturbed by the introduction of a new species, which fills an unfilled niche or creates a new one, the entire equilibrium of the ecosystem can be thrown off balance. This can result in devastating environmental outcomes.

MAJOR IMPACTS

Invasive pests cause severe and lasting impacts at several levels within an ecosystem, affecting the ecology, the economics and potentially the health of humans.

- **The ecology -** they reduce native species biodiversity directly by predation, and indirectly by diluting the gene pool by hybridisation (genetic pollution) and out-competing for food, water, nutrients and living space.
- **The economics -** they impact the agriculture and forestry industries by reducing yield and the tourism and recreational industries by degrading natural scenic habitats and reducing local native species populations that the tourists pay to visit.
- **Human health -** they cause health concerns by fouling waterways, introducing toxins and diseases that harm humans, livestock and food crops.

HOW INVASIVE PESTS GOT HERE

Although it is believed that Aboriginal people did not bring any exotic plants or animals into Australia when they arrived over 50,000 years ago, European explorers and early settlers certainly did.

Some plants, that are now pest weeds, were deliberately brought for crops, pastures gardens or as ornamentals. Others arrived accidentally in animal feed or in pot plant soil.

Some animals, that are now classified pest animals, were released into the wild deliberately for sport, beauty and biological control, while others escaped captivity and managed to survive and thrive on their own.

More recently, the introduced pest problem has increased due to international trade of cargo through commercial ports and international airports. A majority of the introduced pests in the last 30 years are thought to have come from Asia (see Table below).

CONTROLLING INVASIVE PESTS

There is no 'best way' to get rid of invasive pests. A range of methods need to be used depending on habitat, type of plant or animal and their ability to adapt to introduced pressures. However, there are dangers involved all methods of removal and sometimes eradication attempts can lead to unpredictable environmental harm as a result of altering local food chains and population dynamics. The most commonly used control methods are chemical, mechanical and biological.

Chemical – the use of chemicals to kill off and prevent the spread of invasive species. With plants, this usually this involves direct application of the chemical to the plants or the area that the plant lives. With insects, it can involve the use of attractant pheromones to lure mate-seeking insects into traps.

Pros: *can be very effective in both large and small areas.*
Cons: *can harm native species, can contaminate land and waterways, target species may develop resistance to the chemicals*

Mechanical – the physical removal of pests by hand or machinery, including hand pulling, mowing, burning, hunting, trapping and constructing physical barriers (e.g. nets, fences).

Pros: *good for controlling small populations, is target specific, minimizes harm to non-invasive plants and animals and surrounding environment.*
Cons: *is labour intensive & costly, native species can be accidentally removed, usually require repeated treatments to ensure success*

Biological –biological controls involve either modifying the biology of the pest directly, or using another animal or organism to attack the pest. Methods include releasing predators, parasites, or diseases to kill or reduce reproductive output of targeted pests, and interfering with reproductive productivity by making pests infertile or introducing sterile males to mate with females, which results in "dead" eggs or eggs that will develop into sterile adults (used mainly with insects & fish).

Pros: *is chemical free, can have highly successful results.*
Cons: *newly introduced pest can become invasive pests themselves (e.g. cane toad), released species may not be able to survive, species do not have the anticipated effect/impact.*

IF NOTHING IS DONE…

If appropriate mitigation steps are not taken, the resulting outcomes for both land and marine based tourism industries could be severe.

Visitor reactions to habitat degradation and loss of key tourism destinations, including scenic lookouts, swimming holes, and coral reefs, could lead to **reduced local visitation**, **poor media coverage** and **loss of regional marketing power**.

EXAMPLES OF INVASIVE PESTS

METHOD OF INTRODUCTION	REASON FOR INTRODUCTION	AUSTRALIAN EXAMPLES	IMPACTS
Intentional	**Sport** *Several animals were purposely introduced into the Australian landscape for recreational hunting.*	European Red Fox Introduced into Victoria in 1850.	▪ Implicated in the decline of over 19 native mammals, and the extinction of up to 9 species
		Rabbit Ten pairs were introduced into Victoria in 1859 as game	▪ Compete with other native animals that eat grass (e.g. bettong, pademelons)
	Biological Control *Exotic animals were released into the environment to control specific pests – however, in many cases, the experiment failed and the 'controller' became a bigger pest.*	Cane Toad About 100 toads were introduced into North Queensland in 1935 to eat cane beetles that were depleting sugar cane crops	▪ Eating populations of small native frogs and reptiles ▪ Poisoning native snakes that try to eat them
		Mynah bird Introduced into North Queensland in 1862 to control insects	▪ Out-compete native birds for food and nesting sites
	Beautification *Acclimatization Societies purposely introduced exotics to help make Australia look more like 'home' (Britain)*	Deer Introduced in 1906 into NSW	▪ Destroy native plants ▪ Transit dangerous diseases like foot-and-mouth disease to native mammals
		English sparrow Introduced into Australia between 1863 and 1870	▪ Competes for food resources ▪ Kill small native birds, smash eggs ▪ Compete for nesting sites
		Oleander (plant)	▪ Competes for resources (sunlight, moisture, nutrients) ▪ Prevents native plant growth by poisoning the surrounding soil
	Food Source *Early sailors made a special effort to plant trees that would provide food for following explorers*	Coconut trees	▪ Out competes native coastal trees for space and sunlight

METHOD OF INTRODUCTION	REASON FOR INTRODUCTION	AUSTRALIAN EXAMPLES	IMPACTS
Accidental / Thoughtlessness	**Set Free** *Some domestic animals that are released into the wild manage to survive, and can proliferate to become pests.*	Fish (e.g. tilapia, carp, archerfish) Mainly from dumping out aquariums or overflowing garden ponds	▪ Out competes native fish for food ▪ Foul waters with their excessive waste ▪ Spread disease and parasites to native fish
	Cargo supplies *Many animals and plants 'stow away' in cargo carried by ships and planes and are released when they are unloaded in port.*	European Rats Often 'jump ship' when they are shipwrecked or dock in port.	▪ Hunt native animals – implicated in the decline and extinction of some native birds, lizards and snails. ▪ Compete with native animals for food resources ▪ Destroy some native plants.
		Killer bees	▪
		Yellow Crazy Ant Discovered in the tropical north Australia in 1988. Comes West Africa, India or China.	▪ Displaces native ants ▪ kills invertebrates, reptiles, baby birds and small mammals. ▪ Disrupts ecology in rainforest habitats
	Food Crops *Some food crops that are intentionally brought to Australia escape and become pests themselves.*	European Bees Brought to Australia to pollinate introduced European crops.	▪ Out compete native bees for space in hollows of trees to make their hives ▪ Deplete food resources (nectar) needed by native bees
	Ship Ballast Water *Over 170 exotic marine pests have been introduced into Australian waters since the beginning of European settlement, over 200 years ago. These include fish, crabs, shrimp, snails, clams, worms, seaweed, bacteria and toxic algae. Many of the pests in the past 30 years have come from Asia.*	Black striped mussels Found in Darwin Harbour in 1999	▪ Blocks water pipes
		Japanese Seaweed Introduced from woodship carrier from Japan	▪ Out competes & displaces native seaweeds for space & sunlight
		Northern Pacific Starfish Introduced into Tasmania in the 1980's	▪ Destroy native shellfish crops
		Asian Green mussels Found in Cairns Harbour in 2001	▪ Forms thick mats on seafloor ▪ Can clog water pipes
		Toxic Microalgae From all over the world	▪ Poisons shellfish & fish ▪ Health issue - can cause human fatalities

RELEVANT MTSRF RESEARCH

The Marine and Tropical Sciences Research Facility (MTSRF) is part of an Australian Government initiative to *"develop collaborative, public benefit research between Australia's best tropical environmental researchers to support the conservation and sustainable use of North Queensland's environmental assets - the Wet Tropics rainforests, the Great Barrier Reef and the connecting coastal regions".*

The Reef and Rainforest Research Centre (RRRC) is contracted to administer the MTSRF Research Programme in North Queensland.

There are 5 main themes of study:

Theme 1 Status of ecosystems
Theme 2 Risks and Threats to the Ecosystems
Theme 3 Halting & Reversing decline in water quality
Theme 4 Sustainable use and management of natural resources
Theme 5 Enhancing Delivery

Theme 2, Risks & Threats to the Ecosystems, includes three projects:

Project Number	Project Name	Main Objectives	Research Providers
Project 5i	Climate Change: Great Barrier Reef	To identify specific information gaps of direct relevance and importance to users of the Great Barrier Reef and management agencies. To model possible futures for the GBR for forecasted climate variations; To create an early warning and assessment system; To evaluate of the resilience of coral reef ecosystems to climate change; To create a set of tools for management to help manage climate change impacts.	CSIRO AIMS UQ JCU CQU
Project 5ii	Climate Change: Rainforest and Catchments	To identify potential climate change impacts on n North Queensland's tropical forests, To determine management options for how to mitigate negative impacts. To develop a way to identification risks and threats posed by climate change To determine resilience or lack of resilience of different terrestrial ecosystems	CSIRO JCU
Project 6	Understanding Threats and Impacts of Invasive Pests on Ecosystems	To identify current and potential risks of invasive marine species in the GBR. To identify knowledge gaps and critical research needs To identify mitigation measures to control invasive pests.	JCU CSIRO DPI&F FNQ NRM

Acronyms: AIMS (Australian Institute of Marine Science), ANU (Australian National University), CSIRO (Commonwealth Scientific & Industrial Research Organisation), DPI&F (Department of Primary Industries & Fisheries), GU (Griffith University), JCU (James Cook University), NRM (National Resource Management), UNSW @ ADFA (University of New South Wales Australian Defence Force Academy), UQ (University of Queensland)