Australian Government
Department of Sustainability, Environment,
Water, Population and Communities




Threat abatement plan

for the biological effects, including lethal toxic ingestion, caused by cane toads

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Photo credits

FRONT COVER IMAGES (left to right)
Toad aggregation (Ruchira Somaweera, University of Sydney), Calling male (David Nelson, University of Sydney), Cane toad (Damian McRae, DSEWPaC), Metamorph cane toad (David Nelson, University of Sydney)
BACK COVER IMAGES (left to right)
Calling male (David Nelson, University of Sydney), Metamorph cane toad (David Nelson, University of Sydney), Cane toad in leaf litter (Damian McRae, DSEWPaC), Slaty-grey snake with cane toad (Zig Madycki, DSEWPaC)

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CONTENTS

SUMMARY

Rationale

Since the introduction of cane toads (*Bufo marinus*, now revised to *Rhinella marina*) to Australia in 1935, the ecological impact of this animal has aroused considerable concern. Cane toads use potent steroid-derived toxins as chemical defences. The active constituents of these differ from the toxins found in native frogs. All life stages of the cane toad (eggs, tadpoles, metamorphs and adults) are toxic, although toxin types and content change markedly during a toad's lifespan. Toxin levels (and thus, danger to native vertebrate predators) are high in eggs, decrease through tadpole life, are lowest at around the time of metamorphosis, and increase rapidly thereafter. It is difficult to tease apart the effects of cane toads from other threatening processes operating on native species and ecological communities (Shine 2009a). However, there is no scientific evidence that cane toads have caused species extinction. The direct pathway of lethal toxic ingestion of cane toads is the most important cane toad impact.

In 2005, the biological effect of the cane toad was listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999* (Threatened Species Scientific Committee 2005).

Since 1986, the Australian Government has directed at least $11 million dollars to development of a broad-scale means to control cane toads, without success. Community action to manually remove cane toads from the landscape has also been funded. Neither of these endeavours have prevented the continued spread of the pest or significantly limited its impact on Australia's biodiversity. Recognising that it is not currently possible to contain or eradicate cane toads across the nation, a new approach to dealing with their negative impacts is needed. This involves identifying and reducing impacts on key natural assets affected by cane toads, an approach that requires national coordination.

This threat abatement plan (TAP) provides a national strategy to guide investment and effort by the Australian Government, jurisdictions, research organisations and non-government organisations in abating the impacts of cane toads across their known and anticipated range. The TAP will be reviewed in five years.

Objectives for the threat abatement plan

This TAP has three objectives:

- to identify priority native species and ecological communities (including those that are protected matters under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) at risk from the impact of cane toads.
- to reduce the impact of cane toads on populations of priority native species and ecological communities.
- to communicate information about cane toads, their impacts and this TAP.

Implementation of the threat abatement plan

This TAP will be implemented by the Australian Government in conjunction with a broad range of stakeholders. Note that the time-frames listed in this TAP are: short-term, 1–3 years; medium-term, 3-5 years; and long-term, more than 5 years.

1. INTRODUCTION

This threat abatement plan (TAP) has been developed to address the listed key threatening process *The biological effects, including lethal toxic ingestion, caused by Cane Toads (Bufo marinus)* (see listing advice, Threatened Species Scientific Committee 2005) in a feasible, effective and efficient manner. The TAP binds the Australian Government and its agencies in Australia's response to the impact of cane toads and identifies the research, management and other actions needed to address the impacts of this species on Australia's biodiversity.

This plan should be read in conjunction with the two publications: *The ecological impact of invasive cane toads (Bufo marinus) in Australia* (Shine 2009a); and *Cane Toads in Communities - Executive Report* (Bureau of Rural Sciences 2009). These publications provide information on the scope of the cane toad threat and public perceptions of cane toads and their impacts across the known and anticipated range of the species.

1.1 Threat abatement plans

Under section 270 (A) of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the Australian Government:

- develops TAPs
- implements the actions under TAPs that are its direct responsibility
- facilitates the implementation of actions where other groups (e.g. states and territories, industry) share the implementation responsibilities.

The EPBC Act prescribes the process, content and consultation required when making a TAP.

The EPBC Act requires the Australian Government to implement TAPs to the extent to which they apply in areas under Australian Government control and responsibility. In addition, Australian Government agencies must not take any actions that contravene a TAP. Where a TAP applies outside Australian Government areas in states or territories, the Australian Government must seek the cooperation of the affected jurisdictions, with a view to jointly implementing the TAP.

The EPBC Act provides for the protection of Matters of National Environmental Significance, including listed threatened species and ecological communities, listed migratory species, wetlands of international significance, World Heritage properties and National Heritage places (Commonwealth of Australia 2006). A TAP may address threats to these listed matters specifically, as well as more broadly to species and communities under threat from the listed threatening process. As some of these matters may be affected by a specific threat, appropriate Matters of National Environmental Significance may also be addressed in a TAP.

The Department of Sustainability, Environment, Water, Population and Communities prepares a five-year project plan for each TAP and assesses progress on the main strategic actions contained within the TAP on a yearly basis. After five years, each TAP is reviewed to ensure the objectives of the TAP have been achieved.

Mitigating the impact of invasive species is not simply a matter of developing and applying better technical solutions. It also involves the development of better biological and ecological information, as well as understanding and addressing the social and economic factors surrounding the species. The need to move away from attempts at broad-scale cane toad control and eradication to the protection of key biodiversity assets will require the transfer of knowledge on the management of cane toad impacts, as well as support for community effort to limit those impacts.

This new focus, on protection of key assets, is in response to the lack of a method for broad-scale biological control (see 1.2.2). A review of scientific research into the impacts of cane toads on native species informs the initial priority list of “key assets” within this TAP. Scientific findings will continue to inform the priority list and the TAP will also promote the development and use of scientifically proven control measures.

Communication of scientific evidence regarding which species are at risk will be the key factor in this new approach to protecting biodiversity from cane toad impacts.

1.2 Threat abatement plan for cane toads

1.2.1 The threat

History and spread

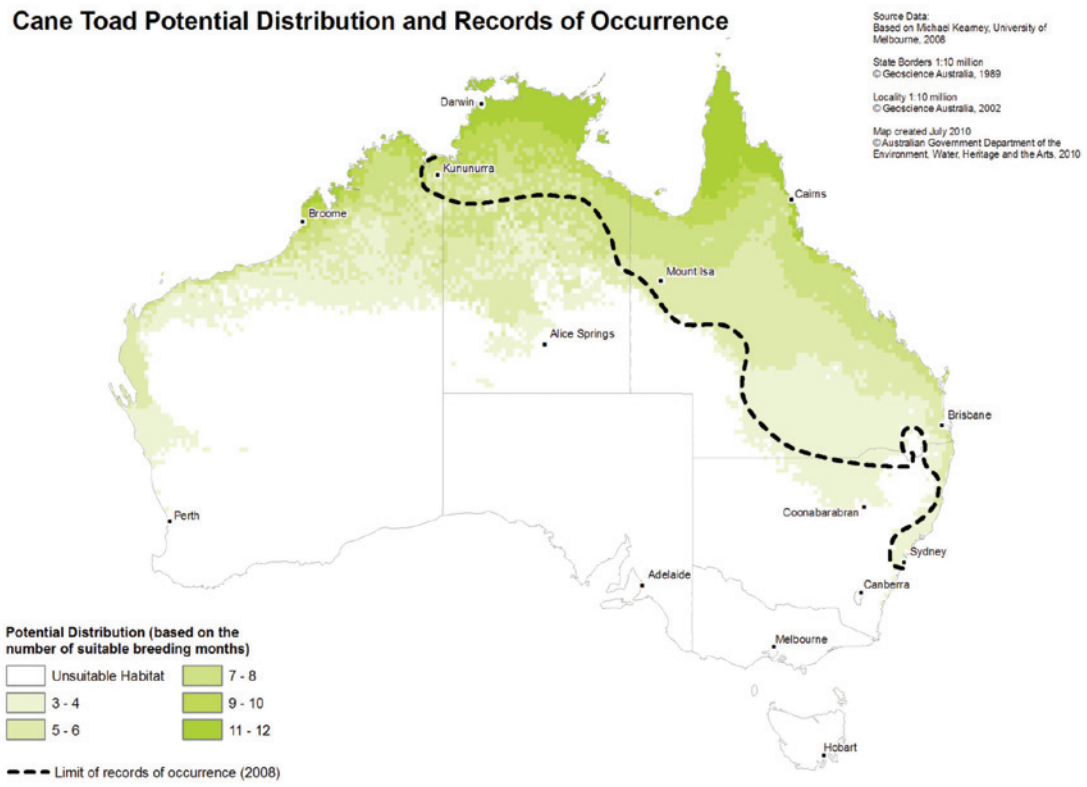
Cane toads were introduced to Australia in 1935 as a means of controlling pest beetles in the sugar cane industry. This is a process that was common to many sugar cane or other crop producing areas of the world (including Puerto Rico, Papua New Guinea and Fiji). At some locations, cane toads failed to establish (e.g. Egypt, where they were introduced in 1937). However, in many others locations cane toads survived and established to become pests. Attempts at cane toad management and control have been most extensive in Australia (Global Invasive Species Database 2009).

The success of cane toads in pest insect control in Australia was never determined, as the use of agricultural chemicals for this purpose became widespread soon after their release (Shine 2009b). Cane toads, however, did become very successful at invading the environments of Australia's north. Since 1935, they have dispersed over 2000 km west from their release site at Gordonvale, Queensland and many hundreds of kilometres to the north and south (Figure 1). Their southern dispersal includes areas considered to be marginal cane toad habitat in arid south-west Queensland and the cooler climates and higher altitudes of northern New South Wales. The black line in Figure 1 indicates records of cane toad occurrence. In south-west Queensland and northern New South Wales in particular, these records do not necessarily indicate established populations.

In the first few decades after cane toads were released in Queensland, they expanded their range at about 10 km per year (Shine 2009b). Since reaching the wet-dry tropics of the Northern Territory, the westward expansion of cane toads has been recorded at around 55 km each year (Phillips et al. 2007).

The New South Wales Key Threatening Process profile for cane toads (DECCW 2006) indicates that their current rate of spread in NSW is approximately 3-4 km per year. However, this may be punctuated by brief spreads of relatively rapid movement often assisted inadvertently by human movement e.g. by "hitch-hiking" with produce or landscaping material.

Figure 1: Map showing potential distribution (shaded areas) and limit of records of occurrence (black line) of cane toads in Australia (based on Kearney et al. 2008)



Ecological impacts

Across their range, cane toads have been implicated in a complex web of direct and indirect impacts on native species and potentially the ecological communities in which these species occur. Assessing cane toad impacts through scientific research is very difficult (Shine 2009a). However, available evidence identifies the direct pathway of lethal toxic ingestion of cane toads as the most important impact. Many native Australian predators have evolved in the absence of prey species with the chemical defences present in cane toads. Consequently, predators are vulnerable to being lethally poisoned when cane toads invade and establish in their areas. No species extinction has ever been attributed to the cane toad, however, research has identified vulnerable predator species and other ecological impacts.

Local population extinctions of the endangered marsupial predator, the northern quoll (*Dasyurus hallucatus*), have been observed following the arrival of cane toads in some areas (Oakwood 2003a, b). Lethal toxic poisoning through ingestion of the cane toad has been identified as the cause of these local extinctions. Several species of goannas, snakes and the blue tongued lizard (*Tiliqua scincoides)* have also been identified as highly vulnerable to lethal poisoning through ingestion of cane toads (Shine 2009a).

Other pathways of cane toad impact on native species have been identified (Shine 2009a) as:

- predation by cane toads (varies, predominantly a minor impact)
- larval competition with frog tadpoles or mosquitoes (minor impact)
- parasite transfer (minor impact)
- competition for terrestrial food (minor impact)
- competition for shelter sites (e.g. usurpation of burrows) (minor impact).

Historically, in the absence of scientific evidence about the complexities of direct and indirect impacts of cane toads, anecdotal information has served to provide guidance on impacts and priorities for managing them.

Cane toads have had an adverse impact on a number of matters of NES and those impacts are expected to continue as they expand their range. For example, cane toads have impacted:

- listed threatened species such as the northern quoll *Dasyurus hallucatus* – an EPBC Act listed endangered species
- Wetlands of International Importance listed under the terms of the Ramsar Convention, including iconic wetlands in Kakadu National Park
- World Heritage properties such as the Wet Tropics of Queensland and the Gondwana Rainforests of Australia.

1.2.2 Managing the threat

Since 1986, the Australian Government has directed approximately $11 million to development of a broad-scale means to control cane toads and a further $9 million to other cane toad research and management activities (details in Table 1).

Table 1: Australian Government funding on cane toad research and management 1986 to 2009

Area of expenditure	Funding allocated
Research on impacts	$5,212,518
Research control (long term/biological control)	$11,111,922
Research control (short/medium term control)	$1,303,235
Management	$1,162,117
Community groups	$1,283,234
Education	$44,468
TOTAL	**$20,117,494**

Over $11 million of the Australian Government cane toad funding has been provided for the search for a biological control agent in the toads' native habitat in South America, and research directed at modifying a virus in order to disrupt the development of infected cane toad tadpoles. In 2008, an independent review of the CSIRO's cane toad biological control research (Shannon and Bayliss 2008) resulted in funding for this project being discontinued. The review team found that:

> *'there are still major technical hurdles to be overcome in the development of a self-disseminating genetically modified cane toad control agent. The long term feasibility of the approach is also questionable on several counts including the availability of an acceptable viral vector, the difficulty of generating an appropriate immune response from virally expressed proteins, and the major hurdle of obtaining approval for release. The lack of a national and international risk assessment and management plan for the release of a virally vectored genetically modified organism regardless of exact product specification is also a major deficit and should be an essential part of any further program in this area'.*

To date no broad-scale or biological control has been identified and it is unlikely that such a control could be developed and approved for use before the cane toad will have reached its maximum extent (see Figure 1) and impact. The option for undertaking research into broad-scale biological control of cane toad is subject to there being a significant change to the technical

hurdles identified in the review of CSIRO's cane toad biological control research (Shannon and Bayliss 2008) or some other significant step in 'proof of concept'. This TAP has a five-year operating time-frame and based on currently available information it is not anticipated that such evidence could be provided during its operation.

Community action to manually remove cane toads from the landscape has also received Australian Government funding (approximately $1.3 million from 1986 to 2009). Government agencies in Queensland, New South Wales, Western Australia and the Northern Territory have contributed to cane toad control efforts. However, there is no evidence that these endeavours have prevented the continued spread of the pest or significantly limited its impact on Australia's biodiversity. Community action, while satisfying to local communities, does not have the capacity to make any significant changes to the rate of spread of cane toads or to the densities of cane toads beyond specific local areas. However, where community action is focused on cane toad management to protect assets at a local scale it could help maintain priority biodiversity assets.

A decade of effort around Port Macquarie may have resulted in local eradication from that area. However, the cane toad is likely to be towards the southern limits of its "natural" range in this region of northern New South Wales, and climatic factors may have assisted control efforts. An additional factor in the success of this effort is likely to have been the status of the Port Macquarie infestation as an isolated satellite population (Peacock 2007).

The biological effects, including lethal toxic ingestion, caused by Cane Toads *(Bufo marinus)* (Threatened Species Scientific Committee 2005) was listed as a key threatening process under the EPBC Act in 2005 in response, in particular, to concerns about the impact of cane toads on the northern quoll. At the time of this listing, the then Minister for the Environment and Heritage decided that the development of a TAP would not be an efficient way to abate the threat posed by cane toads.

In 2009, this decision was reviewed by the then Minister for the Environment, Heritage and the Arts. Consultation with colleagues in state and territory governments about the feasibility, effectiveness and efficiency of developing and implementing a TAP to abate the cane toad threat was undertaken, and national coordination emerged as a dominant theme in support of developing a TAP at this time.

This TAP provides a national strategy to guide investment and effort by the Australian Government, jurisdictions, research organisations and non-government organisations in abating the impact of cane toads across their known and anticipated range. This TAP identifies key assets (native species and ecological communities) to be protected, discusses protection methods, and identifies the need to develop humane control methods for cane toads.

Eradication of cane toads is not currently possible. Neither the technologies nor the resources required to contain and eradicate cane toad numbers on a continental scale are available. The timescales required for the development and application of such technologies would mean that cane toads will have reached the extent of their continental impact regardless of the investment made.

Recognising the new information now available about cane toads and their impacts, as well as the failure of past attempts at broad-scale control, this TAP takes the approach of identifying and prioritising the native species and ecological communities under threat from cane toads, and targeting action to protect those assets which have been determined to be of the highest priority.

This approach will focus on achieving positive biodiversity outcomes for species or ecological communities vulnerable to the presence of cane toads. This approach has evolved as the efforts undertaken to date have neither provided a broad-scale control method such as a biological control, nor an effective answer to the expansion of the toads' range through manual removal. Both of these approaches have been proven to be an ineffective use of limited natural resource funds. This new approach will allow for a more effective and efficient use of conservation resources at the national, state, territory and local levels than is occurring under current strategies.

1.2.3 Involvement of stakeholders

The success of this TAP will depend on a high level of **cooperation between all key stakeholders**, including:

- the Australian Government and its agencies
- state and territory conservation and resource management agencies
- local government
- natural resource management agencies and private conservation land management bodies
- research institutes
- industry and entrepreneurs
- Indigenous communities
- other community groups.

The Invasive Animals CRC currently supports a Cane Toad Advisory Group (CTAG). This committee is comprised of Australian Government, state and territory representatives and provides strategic and practical advice on the planning, implementation and delivery of cane toad projects and their outcomes. The CTAG provides a mechanism to focus national and jurisdictional understanding of, and efforts to abate, cane toad impacts and via its links to the Vertebrate Pests Committee will serve as a major coordination point for actions undertaken under this TAP. Major outcomes will be communicated from this group to local government, natural resource management agencies, conservation groups, industry and entrepreneurs, conservation bodies and community groups in each jurisdiction.

Ongoing delivery of awareness and capacity building programs in natural resource management will be required at national, state and regional levels and will make a significant contribution to national implementation of this TAP.

Implementation of some of the objectives of this TAP (e.g. identification and prioritisation of native species and ecological communities) will require specific efforts from the Australian Government and jurisdictions. However, as information is collated, and priorities determined, other stakeholders will have strong locally focused responsibilities for ensuring actions are undertaken to protect biodiversity assets that are impacted by cane toads.

The *Cane Toads in Communities* study (Bureau of Rural Sciences 2009) consulted Indigenous groups and the Indigenous Advisory Committee has advised on suitable communication approaches for Indigenous stakeholders.

1.3 Definition of priority native species and ecological communities

For the purposes of this TAP, priority native species and ecological communities are those that have been determined through peer-reviewed research to be highly vulnerable at population level to negative impacts from the presence of cane toads.

At the national level, relevant Matters of National Environmental Significance and the National Reserve System will also be considered. For state and territory agencies, this TAP can guide investment based on state or regional conservation priorities. It will be important that managers assess the impacts of cane toads and allocate adequate resources to achieving effective management at all priority sites (national, jurisdictional, regional, local) and that outcomes are measured and assessed on an on-going basis.

Jurisdictional governments, natural resource management groups and community groups will need to determine more localised priority assets and the means by which they will undertake protection and management actions.

2. OBJECTIVES AND ACTIONS

This TAP has three objectives:

- identify priority native species and ecological communities at risk from the impact of cane toads.
- reduce the impacts of cane toads on populations of priority native species and ecological communities.
- communicate information about cane toads, their impacts and this TAP.

Supporting actions to implement these objectives are listed below.

Objective 1 – Identify priority native species and ecological communities at risk from the impact of cane toads

There are neither the resources nor an appropriate broad-scale control that can be applied to the management of cane toads in a way that would lead to containment and/or eradication of cane toads across their range. However, the Australian Government has a responsibility to manage cane toads on land under its control and where Matters of National Environmental Significance are being impacted by cane toads. Objective 1 addresses the identification of those species and ecological communities at risk from the impact of cane toads.

Ecological communities

There are eight threatened ecological communities listed under the EPBC Act that fall within the current geographic range of the cane toad (Table 2).

Table 2: EPBC Act listed threatened ecological communities within the current cane toad range

Ecological community	EPBC category	Recovery plan comment
Swamp Tea-tree *(Melaleuca irbyana)* Forest of South-east Queensland	Critically Endangered	
Mabi Forest (Complex Notophyll Vine Forest 5b)	Critically Endangered	
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Critically Endangered	
Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin	Endangered	
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	*"considered responsible for a recent abrupt decline in observations of the northern quoll Dasyurus hallucatus".* (McDonald 2010)
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin	Endangered	*"under high population densities, such as those that occur with the hatching of a clutch of toadlets, may have a very deleterious effect on invertebrate populations".* (Fensham et al. 2010)
Weeping Myall Woodlands	Endangered	
Brigalow (*Acacia harpophylla* dominant and co-dominant)	Endangered	

Currently, none of the listing advices for these communities indicate that cane toads are a threat to the community. Further, no other listed ecological communities fall within the predicted future range of cane toads (as shown in Figure 1 Kearney et al. 2008). However, elements of some of the listed communities are impacted, or may in future be impacted, by cane toads as they continue to spread. As shown in Table 2, two of the recovery plans in place for these ecological communities mention cane toads and their possible impacts.

Kearney et al. (2008) used the software package Ozclim (CSIRO, Australia) to derive predictions for changes in monthly maximum and minimum air temperature and relative humidity, as well as mean monthly rainfall by 2050. Under this anticipated climate change scenario for Australia, both expansions and contractions in the potential range of the cane toad and in the length of the toads' breeding season have been predicted for 2050. The southern border of cane toad distribution is predicted to move further south by approximately 100 km and be limited by the opposing influences of increasing air temperature and decreasing humidity on the core body temperature of cane toads. In this scenario, further ecological communities listed under the EPBC Act would fall within the range of cane toads.

Native species and ecological communities on off-shore islands may need to be protected from cane toads. Quarantine or emergency management measures to protect these islands may result in the preservation of endemic island species and ecological communities. Further, it may be possible, under particular circumstances, to protect populations of those species identified as highly impacted on the mainland (Table 3) by preserving populations already present on islands or relocating species from the mainland to islands. Islands known to be free of cane toads and which support populations of species highly impacted by cane toads on the mainland, have been identified (Appendices 1, 2 and 3).

Species

Although many individual animals may succumb to lethal toxic ingestion of cane toads, particularly when toads first appear in a new area, the number of species known to be negatively affected at a population level is small. It is this group that forms the highest priority for action under this TAP. Research is currently being undertaken by several groups (e.g. the University of Sydney, Australian National University) to clarify the impact of toads on certain species such as the northern quoll and goanna species. This research may provide insights into priority species for protection over the life of this TAP.

The ecological impact of invasive cane toads (Bufo marinus) in Australia (Shine 2009a) provides an extensive scientific assessment of the impacts of cane toads on native species. A summary of this assessment, listing those native species for which the level of negative population impact by cane toads is high or moderate is provided (Table 3). This provides an initial assessment of priority for species requiring population level protection. Research is continuing in this area, and the lists may need to be adapted as understanding improves.

Table 3: Current state of knowledge of identified high or moderate negative population level threats to Australian native fauna from the cane toad (modified from Shine 2009a). Lethal toxic ingestion is the most common pathway of impact

Species	Degree of impact	Authority	Pathway for impact
Proteocephalid Tapeworm*	High	Freeland 1993, 2004	Toads destabilise host / parasite equilibrium
Crocodiles			
Freshwater crocodile (in semi-arid landscapes) *Crocodylus johnstoni*	High (location dependent)	Letnic et al. 2008	Lethal toxic ingestion
Goannas			
Varanus spp.	High	Freeland 2004; Griffiths and McKay 2007; Doody et al. 2009; Ujvari and Madsen 2009	Lethal toxic ingestion
Skinks			
Tiliqua scincoides (including subspecies)	High	Price-Rees et al. 2010	Lethal toxic ingestion
Snakes			
Northern death adder *Acanthophis praelongus*	High	Hagman et al. 2009b, Phillips et. al. 2010	Lethal toxic ingestion
King brown snake *Pseudechis australis*	High	G.P. Brown et al. University of Sydney unpublished data	Lethal toxic ingestion
Marsupials			
Northern quoll *Dasyurus hallucatus*	High	Oakwood 2003a, Oakwood 2003b; O'Donnell 2009	Lethal toxic ingestion
Eutherian mammals			
Pale field-rat *Rattus tunneyi*	Moderate	Watson and Woinarski 2003a, Watson and Woinarski 2003b	Unknown

* **NB:** This tapeworm is a parasite of the spotted python *Antaresia maculosa* and has been described to family level only (Proteocephalidae).

The northern quoll is the only species listed in Table 3 (above) that is also listed under the EPBC Act (as Endangered). Significant actions have taken place to protect the northern quoll through the Northern Territory's *Island Arks* program, as a result of documented decline of the species with the arrival of cane toads (Rankmore et al. 2008). This program has provided 'insurance populations' of the species on two toad-free islands. While the program has been highly successful in establishing populations of northern quolls on the islands, it has not yet attempted to reintroduce any individual animals to their original habitats.

Species, for which there is suspicion, but not scientific certainty, of negative population level impacts, on a national scale, caused by cane toads, have also been identified (Table 4). The draft national recovery plan for the spotted-tailed quoll (*Dasyurus maculatus*) (Long and Nelson 2010) has identified the potential threat of cane toads on the northern subspecies of this species, although research is inconclusive. Research into possible impacts is recommended under this draft recovery plan. Any such research would inform the priority list under this TAP.

Table 4: Current state of knowledge on uncertain negative population-level threats to Australian native fauna from the cane toad (modified from Shine 2009a)

Species	Type of impact	Degree of impact	Authority
Dragons (Agamidae)			
Frilled lizard *Chlamydosaurus kingii*	Lethal toxic ingestion	Reports inconsistent	van Dam et al. 2002; T. Madsen pers. comm.
Birds			
Rainbow bee-eater *Merops ornatus*	Usurpation of burrows	unknown	Boland 2004

Future research may require other species to be added to this list, or the list at Table 3.

Recommended actions and priorities

Action	Priority
Action 1.1 Identify native species, ecological communities and off-shore islands currently known to be at high to moderate risk. (Largely completed).	High priority, short term because currently underway
Action 1.2 Identify the ways in which cane toads impact the native species and ecological communities listed in 1.1 (Largely completed).	High priority, short term because currently underway
Action 1.3 Where impact is unknown but may be high, establish and support research to further understand the impact of cane toads on the native species and ecological communities. Where appropriate, research ways to assist with the recovery of priority native species and ecological communities. (Has commenced).	Medium priority, medium term
Action 1.4 Develop a prioritisation tool to guide allocation of resources for protection of native species and communities. Apply it to native species and ecological communities identified: first from Action 1.1, then from Action 1.3.	Low priority, medium term

The criteria to be used in the prioritisation tool (Action 1.4) will include:

- protection of cane toad-free off-shore islands, particularly those that currently support populations of native species identified in Table 3 (Appendices 1, 2 and 3 contain a preliminary list of islands known to fall within this category)
- protection of those species identified in Table 3
- capacity to add species when evidence of impact becomes clear (e.g. species listed under Table 4)
- Matters of National Environmental Significance.

Performance indicators

- Lists showing off-shore islands and the EPBC Act listed ecological communities and species at risk from the impacts of cane toads developed by the Cane Toad Advisory Group (CTAG) and the Vertebrate Pest Committee (VPC), agreed by VPC and made available to all stakeholders within 12 months of the making of this TAP.
- Scientific evidence, endorsed by the CTAG and VPC, is gathered for those species for which high impact from cane toads is currently suspected, but not yet confirmed within 18 months of the making of this TAP.
- Research, which improves scientific understanding of impacts on native species and ecological communities; improves understanding of recovery measures; and which informs resourcing agreements between the Australian Government and affected jurisdictions is endorsed by the VPC as it becomes available.
- Prioritisation tool for allocation of resources to ecological communities/species developed and agreed by the CTAG and the VPC within 24 months of the making of this TAP.
- Prioritisation tool applied at a national level and application encouraged at jurisdictional, regional and local levels within 6 months of the prioritisation tool being agreed by the VPC.

Objective 2 – Reduce the impact on populations of native species and ecological communities

Under Objective 1, actions to determine the priorities for the application of resources to the management of cane toads and their impacts will be developed. Listings and mapping of threatened ecological communities and species will be undertaken. The Australian Government will address those ecological communities and species that are on land under its control or are Matters of National Environmental Significance, in cooperation with state and territories. These listings and maps will also enable stakeholders to determine state, regional and local priorities and apply appropriate resources to their protection.

The purpose of Objective 2 is to promote effective tools that can be used to reduce the impact of cane toads on native species. The tools will cover all aspects of cane toad management at the planning and response stages, and be broadly applicable.

Use of these tools and guidelines will be the responsibility of all stakeholders, in particular those with land and water management responsibilities in areas identified as being of priority for protection against cane toads. The Australian Government will be monitoring the uptake of management actions in each of the identified priority areas. Where the Australian Government and state/territory governments have mutual obligations (e.g. some Ramsar Wetlands) negotiation of appropriate actions and funding of management actions will be undertaken.

While the purpose of this TAP is not to develop specific cane toad control tools, such as poisons, research is underway that could result in a larger toolkit becoming available over the life of this TAP. These could include:

- development and registration of a humane lethal spray for toads
- use of a larval alarm pheromone to manage cane toad populations within water bodies (Hagman and Shine 2009c; Hagman et al. 2009a)
- use of a parasitic nematode of cane toads (*Rhabdias pseudosphaerocephala*) identified as present in established populations of Australian cane toads (Dubey and Shine 2008; Shine 2009b)
- development of better traps.

As such tools become available, information about them will be included on the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) cane toad webpage.

The Australian Government is a signatory to the Australian Pest Animal Strategy which includes as one of its principles that 'Where there is a choice of methods, there needs to be a balance between efficacy, humaneness, community perception, feasibility and emergency needs'.

Recommended actions and priorities

Action	Priority and timeframe
Action 2.1 Focus management of cane toad impacts by Australian Government agencies on designated high priority native species and ecological communities, and seek cooperative action on priorities by jurisdictions and other stakeholders**.**	High priority, short term
Action 2.1.1 Implement and monitor emergency management of canetoad impacts for **known** high priority native species and ecological communities (as designated in Table 3) using currently available tools and techniques (e.g. trapping, fencing of small areas, manual removal from designated sites)	High priority, short term
Action 2.1.2 As new species and communities are added to the list of priority native species and ecological communities via a peer reviewed process, implement or adjust management of cane toad impacts, using available tools and techniques. Additional tools and techniques will become available with the registration of toxins for euthanasia of captured toads and development of other impact management or cane toad control techniques. Codes of practice and standard operating procedures for cane toad control will provide guidance on these techniques.	Medium priority, medium term

Recommended actions and priorities (Continued)

Action 2.2 Prepare guidelines, including codes of practice and standard operating procedures, that can be applied to both emergency responses and on-going management for high priority native species and ecological communities for endorsement by the VPC.	Medium priority, medium term
Action 2.2.1 Australian Government to prepare and implement management plans, (including identifying and addressing gaps in management techniques and tools) for designated high priority species and ecological communities on land managed by Australian Government agencies.	Medium priority, medium term
Action 2.2.2 Provide the guidelines for emergency and on-going cane toad management to all stakeholders. Liaise with responsible jurisdictions/agencies to encourage the preparation and implementation of such plans in their areas of responsibility. Where mutual obligations exist the Australian Government will work cooperatively to prepare such plans.	Medium priority, medium term
Action 2.2.3 Australian Government to monitor the development and implementation of guidelines and cane toad management plans for designated high priority species and ecological communities.	Medium priority, medium to long term
Action 2.2.4 Australian Government to monitor the literature about the spread and impact of the cane toad and review/amend guidelines and develop new management plans as required.	Medium priority, medium to long term
Action 2.3 Establish guidelines for humane management actions to control cane toads for VPC and Animal Welfare Committee endorsement.	Medium priority, medium term
Action 2.3.1 Distribute guidelines to all Australian Government agencies with land management responsibilities.	Medium priority, medium term
Action 2.3.2 Australian Government to seek cooperative adoption of guidelines by states/territories including incorporation in state based regulations as appropriate.	Medium priority, medium term

Performance indicators

- Australian Government agencies advised of this TAP, the designation of high priority species and ecological communities, and their management responsibilities within six months of the TAP being made.
- Application of this TAP by Australian Government agencies is monitored by these agencies and DSEWPaC over the life of the TAP.
- Jurisdictions and stakeholders are advised of this TAP, the national high priority species and ecological communities and the jurisdictions'/stakeholders' management responsibilities within six months of the TAP being made.
- Management plans agreed with relevant stakeholders (state/territory governments) for each of those species impacted by cane toads at a population level within eighteen months of this TAP being made.
- Responses of jurisdictions and other stakeholders are monitored throughout the life of the TAP.
- Additional advice is provided to all stakeholders within six months of new species and ecological communities being identified and agreed or removed from the list of priority species.
- Guidelines for emergency and on-going management plans are developed and agreed by VPC within two years of the TAP being made.
- Guidelines are provided to all stakeholders within three months of being agreed by VPC.
- Preparation of plans across all land tenures for high priority species and ecosystems are monitored by the Australian Government on an on-going basis across the life of the TAP.
- Humane management actions (standard operating procedures and codes of practice for humane treatment of cane toads) are developed and agreed by the VPC within two years of the TAP being made.

Objective 3 – Communicate information about cane toads, their impacts and this TAP

Australians are concerned about the impact of cane toads on the environment. However, community concern is highest when cane toads incursion is recent or imminent and fades over time as the community adjusts to living with cane toads in the environment (Bureau of Rural Sciences 2009). The initial very high level of concern leads to high expectations that environmental agencies will take action to avert the impact of toads.

This TAP acknowledges:

- there are no “magic bullets” that the Australian Government can provide that will eradicate or reduce the cane toad population across Australia
- there are competing conservation requirements for limited conservation funding generating a need to prioritise any allocation of cane toad management funds to those efforts most likely to conserve biodiversity (over $20 million has been provided by the Australian Government to address the impact of cane toads since 1986 with limited success)
- it is clear that, in some cases, other established invasive species, or human activity, are the cause of native species extinctions
- actions to support priority species and threatened ecological communities from the impact of cane toads across Australia must be prioritised, with priority being given to those species that would be most affected at a national population level and ecosystems where multiple complex changes may occur
- there remains a need for tools to help all stakeholders at national, state/territory, regional and locals levels to effectively implement and manage cane toad impacts.

While the primary responsibility for managing established pests lies with the states and territories and landholders, all stakeholders can play significant roles in reducing the impacts of cane toads. However, to empower stakeholders to take actions that collectively reduce the worst impacts of cane toads it is necessary to communicate:

- the strategic approach detailed in this TAP
- the key priority species and ecosystems that need protection
- guidelines designed to enable action to be undertaken effectively
- standard operating procedures and codes of practice to ensure the humane treatment of cane toads.

State agencies and community groups have produced significant high quality communication materials relating to cane toads. These groups present this material to stakeholders and the general public through regular newsletters and media releases. A number of networks of conservation groups and researchers with an interest in cane toads already exist. These networks can form a link in a communications strategy for this TAP including communications in regard to developments in toad control methods.

Recommended actions and priorities

Actions	Priority and timeframe
Action 3.1 Implement a one-stop-shop webpage on the DSEWPaC website with links to jurisdictional and stakeholder information on cane toads and including information on: • the threat cane toads pose to biodiversity • management actions to limit this threat • guidelines for cane toad management • information to help identify cane toads from other amphibians • codes of practice and standard operating procedures • management plans (as they are developed) for areas designated as high priority.	Medium priority, ongoing
Action 3.2 Encourage monitoring, evaluation and reporting on cane toad management actions is maintained and communicated to stakeholders.	Medium priority, ongoing
Action 3.3 Ensure Australian Government fact sheets and other communications material on cane toads are current and reflect the strategy developed in this TAP.	Medium priority, ongoing

Performance indicators

- Webpage on the DSEWPaC website holds appropriate information and linkages within 12 months of the Minister making this TAP.
- All co-funded or Australian Government-funded cane toad projects include reporting of cane toad management actions, and monitoring of results, and are made available to the public within six months of the completion of the project.
- Cane toad fact sheets and other communications material are revised and made available to the public within 12 months of the Minister making this TAP.
- Threat abatement plan priorities are communicated directly to communities and stakeholders that have expressed concern and interest in cane toad control within three months of any request.

3. DURATION, IMPLEMENTATION AND EVALUATION OF THE PLAN

3.1 Duration of the plan

This TAP reflects the fact that threat abatement will be ongoing, as there is no prospect for national eradication of cane toads.

This TAP must be reviewed by the Minister at intervals of not longer than five years. The Minister's scientific advisory committee, the Threatened Species Scientific Committee, will be provided with annual updates of actions taken under this TAP.

3.2 Cost of the plan

Funding for TAP actions, along with a range of other responsibilities under the EPBC Act, to be undertaken by the Australian Government, is provided to the Department of Sustainability, Environment, Water, Population and Communities via the Australian Government budget each year. At the time of writing this TAP (2010-11 financial year), this funding sits under Outcome 1 of the Department's budget:

> *"The conservation and protection of Australia's terrestrial and marine biodiversity and ecosystems through supporting research, developing information, supporting natural resource management, regulating matters of national environmental significance and managing Commonwealth protected areas."*

This budget outcome is allocated to a wide variety of actions including biodiversity conservation, the *Caring for our Country* initiative, the *Australian Biological Resources Study Strategic Plan 2007–2011*, assessment of Commonwealth-managed and all export fisheries, protection of cetaceans as well as development and implementation of individual TAPs.

Over the financial years 2008/2009 and 2009/2010, $2 million of funding under *Caring for our Country* was allocated to both the development of this TAP and a set of projects designed to meet the *Caring for our Country* business plan targets on cane toads. This TAP sets a new approach to the management of cane toads that focuses on the protection of high priority areas and high priority species which will be more effective, efficient and feasible than the broad-scale approaches used in the past.

Where possible, actions under this TAP will be facilitated through existing internal budget allocations where an existing responsibility for biodiversity protection already exists (e.g. the National Reserve System). Departmental funding relating to the delivery of EPBC Act activities will be used to fund actions that fall outside these existing responsibilities (e.g. development and application of the prioritisation tool). It is not possible to assign costs to each element of the TAP at the time of writing this TAP.

Investment in many of the TAP actions will be determined by the stakeholders, in particular the states and territories. It is not possible to quantify either the uptake of actions or the funding that may be provided by each of the affected jurisdictions. This will be a matter of negotiation (e.g. one tool or resource, funded solely by one jurisdiction, may be shared with other jurisdictions in return for a discounted cost to use or access a different tool or resource).

In addition to funding provided directly by the Australian Government and the jurisdictions, TAP actions are often enacted via existing intergovernmental mechanisms such as the VPC. Funding for these mechanisms is incorporated in normal organisational administrative costs and is not able to be detailed on the basis of costs of an individual TAP.

The total cost of implementation of this TAP, therefore, cannot be quantified at the time of its writing. However, the Australian Government is committed to undertake all the actions listed within the five-year life of this TAP.

This TAP provides a framework for undertaking targeted priority actions. Budgetary and other constraints may affect the achievement of the objectives of this TAP and, as knowledge changes, proposed actions may be modified over the life of the TAP. Australian Government funds may be available to implement key national environmental priorities, such as relevant actions listed in this TAP and actions identified in regional natural resource management plans.

3.3 Implementing the plan

In order to successfully implement this TAP, DSEWPaC will:

- implement the TAP as it applies to Commonwealth land and act in accordance with the provisions of the TAP
- maintain its strong links with state and territory agencies and with local and regional bodies that are responsible for the management of cane toads
- seek stronger coordination of national action on cane toads under the auspices of the VPC and draw on expertise from CTAG, state and territory agencies and non-government organisations
- encourage involvement of key stakeholders and experts in cane toad related research and management.

In relation to Australian Government responsibilities, the EPBC Act requires the Director of National Parks to protect, conserve and manage biodiversity and heritage in Commonwealth reserves and conservation zones and to contribute to these factors in areas outside Commonwealth reserves and conservation zones. Collaboration between all stakeholders is required for the successful implementation of this TAP. Local governments assist in delivering state and territory priorities at a local and regional level and consequently may be involved in the management of specific assets as part of jurisdictional actions.

Research priorities for managing the impacts of cane toads should focus on: identification of priority biodiversity assets at risk from the impact of cane toads; mechanisms for the protection of those assets found to be of a high priority; and preparation of appropriate tools for stakeholders to use to mitigate the negative impacts of cane toads. All research and monitoring results will be provided to stakeholders via the DSEWPaC cane toad webpage within the timeframes set under Objective 3.

3.4 Evaluating and reviewing the plan

Section 279 of the EPBC Act provides for the review of this TAP at any time and requires that the TAP be reviewed at intervals of no longer than five years. If evidence is found that the objectives and actions recommended in the TAP need to be updated or modified to prevent species or ecological communities becoming threatened, or that the effectiveness of the TAP can be improved, it can be revised within five years of the release of this TAP. Annual reports on the implementation of the TAP will be provided to the Threatened Species Scientific Committee.

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APPENDICES

Appendix 1 Queensland Islands with no record of cane toads, but holding populations of those native species determined to be highly impacted (at the population scale) in the presence of cane toads (i.e. species listed in Table 3). Data collated in 2010.

	Acanthophis praelongus Northern death adder	Pseudechis australis King brown snake	Tiliqua scincoides intermedia Northern blue-tongue lizard	Varanus gouldii Gould's goanna	Varanus indicus Mangrove monitor	Varanus mertensi Merten's water monitor	Varanus panoptes Yellow-spotted monitor	Varanus semiremex Rusty monitor	Varanus scalaris Spotted tree monitor	Varanus tristis Black-headed monitor
BADU ISLAND	X				X				X	
BOIGU ISLAND					X					
CAP ISLET					X					
CARLISLE ISLAND							X			
CLIFF ISLAND NATIONAL PARK								X		
COMPIGNE ISLAND				X						
COONANGLEBAH (DUNK) ISLAND	X									
COQUET ISLAND										
DARNLEY ISLAND					X					
DAUAN ISLAND					X					
DENHAM ISLAND		X								
DOWAR ISLET					X					X
EBORAC ISLAND	X									
FLINDERS ISLAND				X			X			X

	Acanthophis prarelongus Northern death adder	Pseudechis australis King brown snake	Tiliqua scincoides intermedia Northern blue-tongue lizard	Varanus gouldii Gould's goanna	Varanus indicus Mangrove monitor	Varanus mertensi Merten's water monitor	Varanus panoptes Yellow-spotted monitor	Varanus semiremex Rusty monitor	Varanus scalaris Spotted tree monitor	Varanus tristis Black-headed monitor
FRIDAY ISLAND				X	X					
HOOK ISLAND				X						X
HORN ISLAND				X						X
INGRAM ISLAND								X		
KESWICK ISLAND							X			
LLOYD ISLAND								X		
MAER ISLAND					X					X
MOA ISLAND				X					X	
MORETON ISLAND				X						
MORNINGTON ISLAND	X	X	X	X					X	X
NORTH KEPPEL ISLAND				X						
PRINCE OF WALES ISLAND		X		X	X					X
RESTORATION ISLAND				X						
STANLEY ISLAND					X		X			X
ULUI ISLAND					X				X	X
WAEIR ISLET					X					
WARRABER ISLET									X	

Appendix 2 Islands in the Northern Territory with no record of cane toads with no record of cane toads, but holding populations of those native species determined to be highly impacted (at the population scale) in the presence of cane toads (i.e. species listed in Table 3). Data collated in 2010.

	Dasyurus hallucatus Northern Quoll	Acanthophis praelongus Northern death adder	Pseudechis australis King Brown	Tiliqua scincoides intermedia Northern blue-tongue lizard	Varanus acanthurus Ridge-tailed monitor	Varanus glebopalma Black-palmed monitor	Varanus gouldii Gould's goanna	Varanus indicus Mangrove monitor	Varanus mertensi Merten's water monitor	Varanus panoptes Yellow-spotted monitor	Varanus scalaris Spotted tree monitor	Varanus tristis Black-headed monitor
ASTELL ISLAND	X											
BATHURST ISLAND		X	X	X			X		X	X	X	X
BICKERTON ISLAND			X	X			X		X			X
BROMBY ISLET					X							
CHANNEL ISLAND	X											
COTTON ISLAND												X
CROKER ISLAND										X	X	
DARCH ISLAND										X		
DJEERGAREE ISLAND					X	X						
DORCHERTY ISLAND										X		
DRYSDALE ISLAND										X		
EAST VERNON ISLAND											X	
FIELD ISLAND (KARDANGARL)										X		
GRANT ISLAND											X	
GROOTE EYLANDT	X	X	X	X	X	X	X	X	X	X	X	X
GULUWURU ISLAND					X	X						

	Dasyurus hallucatus Northern Quoll	Acanthophis praelongus Northern death adder	Pseudechis australis King Brown	Tiliqua scincoides intermedia Northern blue-tongue lizard	Varanus acanthurus Ridge-tailed monitor	Varanus glebopalma Black-palmed monitor	Varanus gouldii Gould's goanna	Varanus indicus Mangrove monitor	Varanus mertensi Merten's water monitor	Varanus panoptes Yellow-spotted monitor	Varanus scalaris Spotted tree monitor	Varanus tristis Black-headed monitor
ILYAUGWAMAJA ISLAND	X											
INGLIS ISLAND	X				X			X				
JIRRGARI ISLAND			X		X		X					
LAWSON ISLAND										X	X	
MARCHINBAR ISLAND	X		X		X	X			X	X		
MCLUER ISLAND											X	X
MELVILLE ISLAND			X	X	X		X	X	X		X	X
MOOROONGGA ISLAND		X		X							X	
MUNGWARNDUMANANJA ISLAND	X											
NORTH EAST CROCODILE ISLAND												X
NORTH EAST ISLES	X											
NORTH WEST CROCODILE ISLAND											X	
PERON ISLAND NORTH										X		
POBASSOO ISLAND	X		X		X					X		
PROBABLE ISLAND			X								X	
RARAGALA ISLAND			X		X	X						
RAPUMA ISLAND											X	
VALENCIA ISLAND											X	
WIGRAM ISLAND			X			X						
WINCHELSEA ISLAND	X					X	X		X			
YABOOMA ISLAND								X		X	X	

Appendix 3 Islands in Western Australia with no record of cane toads, but holding populations of those native species determined to be highly impacted (at the population scale) in the presence of cane toads (i.e. species listed in Table 3). Data collated in 2010.

	Dasyurus hallucatus Northern Quoll	Acanthophis praelongus Northern death adder	Pseudechis australis King Brown	Varanus acanthurus Ridge-tailed monitor	Varanus glauerti Kimberly RocK Monitor	Varanus glebopalma Black-palmed monitor	Varanus gouldii Gould's goanna
ADOLPHUS ISLAND	X						
AUGUSTUS ISLAND	X			X	X		
BATHURST ISLAND						X	
BERTHIER ISLAND	X						
BIGGE ISLAND	X	X					
BOONGAREE ISLAND	X					X	X
BYAM MARTIN ISLAND					X	X	
CAFFARELLI ISLAND	X						
CAPSTAN ISLAND	X						
CARLIA ISLAND	X		X				
CHAMPAGNY ISLAND					X		
CORNEILLE ISLAND			X	X			
FENELON ISLAND			X				
GIBBINGS ISLAND					X	X	
HEYWOOD ISLAND					X		
HIDDEN ISLAND	X		X		X	X	
IRVINE ISLAND			X				
KATERS ISLAND						X	
KOOLAN ISLAND	X					X	

	Dasyurus hallucatus Northern Quoll	Acanthophis praelongus Northern death adder	Pseudechis australis King Brown	Varanus acanthurus Ridge-tailed monitor	Varanus glauerti Kimberly Rocl Monitor	Varanus glebopalma Black-palmed monitor	Varanus gouldii Gould's goanna
LACHLAN ISLAND				X		X	
LONG ISLAND			X		X		
MIDDLE OSBORNE ISLAND					X		
PASCO ISLAND					X		
PURRUNGUNGKU ISLAND	X						
SAINT ANDREW ISLAND					X		
SIR FREDERICK ISLAND	X				X		
SIR GRAHAM MOORE ISLAND			X	X	X		
SOUTH WEST OSBORNE ISLAND					X	X	
SUNDAY ISLAND			X		X		
UWINS ISLAND	X				X		
WOLLASTON ISLAND	X						

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