Draft **Cane Toad Strategy for Western Australia**

May 2009

THE GOVERNMENT OF WESTERN AUSTRALIA

The *Draft Cane Toad Strategy for Western Australia 2009-2019* has been prepared by the Western Australian Department of Environment and Conservation (DEC) with input and endorsement from the WA Cane Toad Stakeholder Reference Group.

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This draft Strategy is open for public comment for a six-week period until 25 June 2009. Copies can be downloaded from www.dec.wa.gov.au or hard copies requested from DEC's Kensington office (17 Dick Perry Avenue, Kensington WA 6151, phone 9334 0333) or DEC's Kununurra office (Lot 248 Ivanhoe Road, Kununurra WA 6743, phone 9168 4200).

Front cover: Common planigale (*Planigale maculate*) and a metamorph cane toad. Photo – Jonathan Webb

Back cover: Schoolchildren from Frog Hollow Community School taking part in a DEC educational program. Photo – DEC

FOREWORD

Cane toads pose a real threat to our State's biodiversity.

In an attempt to stop or slow cane toads from entering Western Australia, there has been an unprecedented joint government and community effort, which has involved hundreds of volunteers who have put in thousands of hours alongside wildlife and conservation officers.

Despite this tremendous effort, cane toads are continuing their westward march and the main 'front' is now closer to our border. Already, one toad has been picked up by officials at the border checkpoint east of Kununurra, and toads have been detected in that part of Lake Argyle that extends into the Northern Territory. Irrespective of this, it remains critical that we continue our efforts to combat them.

The *Draft Cane Toad Strategy for Western Australia 2009-19* has been prepared by the Department of Environment and Conservation in consultation with the cane toad stakeholder reference group, which includes community groups such as the Kimberley Toad Busters and Stop the Toad Foundation as well as local and State Government agencies. This strategy focuses on management actions within Western Australia, building on the Operational Cane Toad Strategy, which has been in place since 2005 to direct efforts in an attempt to delay cane toad passage into Western Australia.

In addition, the State Government has recently implemented a range of measures to assist the community in managing the arrival of cane toads. These measures include establishing disposal points in Kununurra, creating a database to record sightings and distributing a series of information brochures and cane toad packs.

The State Government is also continuing to work with researchers to determine the impact that cane toads will have on our native animals and to find an effective control method. However, the Government recognises a coordinated approach is needed to tackle cane toads once they cross the border in numbers.

As part of developing this new strategy for the next decade, the State Government is keen for the broader community to have an opportunity to contribute. The release of this document marks the start of a six-week period during which the community has the opportunity to comment on the strategy and suggest ways in which they believe it can be strengthened.

I encourage you to read the strategy and to make a submission to share your ideas.

Hon Donna Faragher JP MLC
MINISTER FOR ENVIRONMENT; YOUTH

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Purpose and scope of Strategy

This draft Strategy aims to provide an integrated response across the whole community to reduce the impact of cane toads on biodiversity, social and economic values. It outlines measures and governance procedures to be implemented in Western Australia to manage cane toads over the next 10 years. The draft Strategy acknowledges the adaptive nature of managing any invasive species and emphasises collaborative action and the critical role of partnerships between government and community-based organisations.

The Strategy focuses on five objectives (not in any order of priority):

1. To protect biodiversity, social and economic values using appropriate means including targeted manual cane toad control measures.
2. To minimise the likelihood of new populations of cane toads through improved quarantine and surveillance measures.
3. To build control capacity through improved scientific knowledge and biocontrol techniques.
4. To enhance communication, coordination and collaboration of cane toad information and management.
5. To enhance community and industry awareness and understanding of cane toad impacts and management requirements.

Ten key actions will be implemented under the Strategy over the next five years:

i. Continue **research and biological surveys** to identify high value biodiversity assets and potential locations for targeted conservation programs.

ii. Identify and prioritise species at high risk from cane toads and develop and implement **protective management programs.**

iii. Apply best practice **techniques and standards for the short-term control** of cane toads in high value areas, including access to appropriate cane toad **identification**, **euthanasia and disposal** information and support services.

iv. Review and strengthen **quarantine procedures**, including intrastate quarantine inspection/auditing of road, air and ship freight and tourism companies, and strengthening the use of quarantine checkpoints, including mobile checkpoints.

v. Build on awareness of 'hitch-hiker' cane toads and implement procedures to prevent the establishment of satellite populations, including **reporting of cane toad sightings and rapid response measures**.

vi. Facilitate and support appropriate **research into the long-term biological control** of cane toads, including the use of parasitic lungworms and taste aversion learning by native predators.

vii. Support a Stakeholder Reference Group to ensure that relevant State and Federal government agencies and community groups are aware of management and research progress and recommended actions, and relevant groups are able to **contribute and access information** as required.

viii. Build on the existing Freecall **telephone service** to create an integrated information and reporting service, supported by a shared **reporting database and GIS system**.

ix. Review **information** on cane toad impacts, management options, safe handling, identification, reporting, euthanasia and disposal.

x. Build on a cane toad **education program** including demonstration materials, student handouts and a teacher resource kit. The program will address different age groups and audience types, including Aboriginal communities and areas with and without cane toads.

PART 1 – INTRODUCTION

1. CANE TOADS IN AUSTRALIA

Cane toads (*Bufo marinus*) were deliberately introduced into Australia in 1935 in an attempt to control sugar cane pests in Queensland. Cane toads have spread since, both naturally and with human assistance, throughout much of Queensland, northern New South Wales and the 'Top End' of the Northern Territory, impacting upon biodiversity, agricultural, social and cultural values. The movement of the cane toad frontline has increased in pace over time, with the cane toad front now moving at an average rate of approximately 55 kilometres per year in optimal conditions (Phillips *et al.* 2007). The community and government response to the threat posed by cane toads to Western Australia is the first attempt by an Australian State or Territory to take pre-emptive action against toads before they reach its border.

1.1 State Cane Toad Initiative

The Western Australian Department of Agriculture and Food and the Department of Environment and Conservation (DEC) (formerly Department of Conservation and Land Management (CALM)) have been involved in cane toad management activities since 2004. On 11 December 2004, the Western Australian Minister for Agriculture, Fisheries and Forestry and the Minister for the Environment announced the allocation of an additional $600,000 of State funds to the then Department of Agriculture for the management of cane toads.

The Department of Agriculture Western Australia, in conjunction with CALM, were responsible for the implementation of the State Cane Toad Initiative.

In July 2005 the lead role of the State Cane Toad Initiative was transferred to CALM, although the Department of Agriculture and Food (DAFWA) remains involved in the implementation of the State Cane Toad Initiative, primarily in the areas of quarantine and biosecurity (see Section 18).

In September 2005 DAFWA and CALM jointly prepared a draft Western Australian Cane Toad Strategy, which has guided government efforts to date and focused on attempting to delay cane toads' passage to Western Australia. Four key programs have been implemented under the State Cane Toad Initiative:

1. fighting the entry and establishment of cane toads in Western Australia;

2. identifying and protecting biodiversity assets at greatest risk from cane toads;

3. raising community awareness of the cane toad threat; and

4. ensuring effective State-wide coordination of cane toad initiatives.

To support the implementation of the Strategy the State Government provided $900,000 per year for five successive financial years. Actions implemented under this funding include operation of DEC's Kununurra-based Cane Toad Team (focusing on surveillance and control works) and funding to train and support 'Nifty' the sniffer dog (quarantine activities, field-based detection activities and identifying cane toad refuge).

Additional funding has also been provided by the State for specific programs, including biological control research, biological survey, community awareness campaigns and community group activities.

1.2 Consultation process

This draft Strategy has been prepared by DEC with preliminary input from a number of key stakeholders, including DAFWA, the Shire of Wyndham East Kimberley, Kimberley Wildlife Rescue, Kimberley Toad Busters (KTB) and Stop the Toad Foundation (STTF), all of which are members of the Stakeholder Reference Group (see Section 7). This draft document has been released to the broader community for a six-week public comment period.

2. GOALS, OBJECTIVES AND SCOPE

Recognising that the first cane toad to make it across the border from the Northern Territory arrived on 27 February 2009, there is a need to develop and implement a revised cane toad Strategy. The new Strategy recognises that control efforts will need to be refocused to actions within Western Australia.

The goals and objectives of this draft Strategy are:

Goal 1. Minimise the spread and impacts of cane toads. Achieved through:

Objective 1 – Short-term control: to protect biodiversity, social and economic values using appropriate means including targeted manual cane toad control measures.

Objective 2 – Quarantine and surveillance: To minimise the likelihood of new populations of cane toads through improved quarantine and surveillance measures.

Goal 2. Achieve a long-term solution(s) for cane toads. Achieved through:

Objective 3 – Long-term control: to build control capacity through improved scientific knowledge and biocontrol techniques.

Goal 3. Maximise understanding of cane toads, their impacts and management options. Achieved through:

Objective 4 – Coordination: To enhance communication, coordination and collaboration of cane toad information and management.

Objective 5 – Awareness and understanding: To enhance community and industry awareness and understanding of cane toad impacts and management requirements.

This draft Strategy will provide guidance and opportunities for:

- increasing general public awareness;
- community support to minimise the introduction and spread of cane toads;
- improved communication between key stakeholder groups and the wider community;
- coordination and collaboration of management efforts;
- effective use of resources;
- improved data collection and access to information; and
- improved collaboration between research programs.

3. PEST CHARACTERISTICS

1) Ability to utilise a broad range of environmental conditions

Cane toads tolerate a broad range of environmental and climatic conditions. They have demonstrated an ability to occupy many different habitats across Australia, where they eat a wide variety of prey and compete with native species for resources. Toads can move across

rivers, saline mudflats and on flotsam across the sea, as well as along waterways, and even across ranges and seasonally dry rocky terrain.

2) Breeding capacity

Cane toads breed opportunistically, with a far greater reproductive capacity than native frogs. Colonising toads develop rapidly, particularly in the warmer waters of northern Australia, and attain high densities in suitable habitats.

3) Defence mechanisms

Cane toads possess a highly toxic chemical predator defence and many scientific and anecdotal reports exist of deaths of native predators that have attempted to consume cane toads. All life stages (eggs, tadpoles, metamorphs and adults) are generally considered to be highly toxic to vertebrate predators, although there is a short window during the metamorphosis when bufadienolides (cardiotoxic steroids) are completely lacking (Capon and Hayes 2008).

In summary, cane toads possess a number of characteristics that combine to pose a high level of threat to native ecosystems due to their high population densities, ability to occupy many different habitat types, generalist foraging habits, and high toxicity to vertebrate predators.

4. POTENTIAL DISTRIBUTION

CLIMEX modelling suggests that the toad will increase its geographic range throughout coastal and near-coastal regions of tropical Australia to encompass an area of approximately two million square kilometres, including wet coastal areas in eastern and northern parts of Australia (Sutherst *et al.* 1995). Recent predictions by Urban *et al.* (2007) suggest that cane toads are increasing their use of extreme habitats and may be able to survive in more southerly areas including the south-west of Western Australia (Figure 1). This highlights the requirement for thorough quarantine and surveillance systems to prevent the establishment of new southern populations.

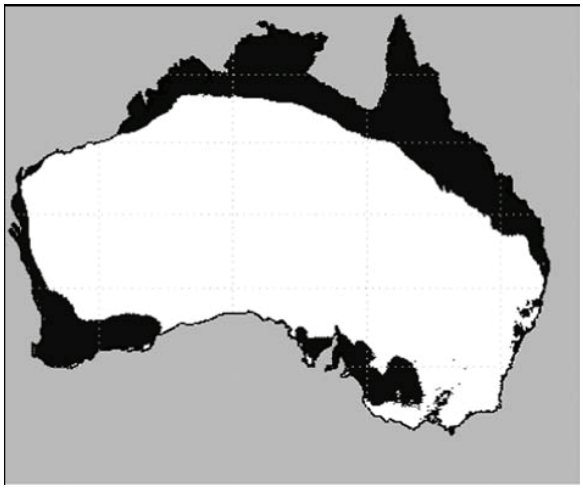

Figure 1. The potential distribution of cane toads on mainland Australia (from Urban *et al.* 2007).

5. FRONTLINE TOADS AND SEDENTARY POPULATIONS

The northern monsoonal climate has had a significant impact on the rate of advance of the cane toad, with the wet season providing ideal conditions for high rates of movement and dispersal into new areas. Movement overland is negligible during the dry season, with toads concentrating around remaining water sources.

Rather than a single, contiguous line, cane toads are moving towards Western Australia through six loosely bounded 'corridors', with the annual distance travelled dependent on the intensity and duration of rainfall.

Research has found significant differences between the rapidly moving frontline toads and sedentary populations that remain behind the front. At the front, the fastest dispersers breed with one another, producing fast-moving offspring. Over remarkably few generations, frontline toads have developed into larger animals with longer legs compared to their bodies, and are more active and very directional in their movements (Phillips *et al*. 2006).

This evolutionary advantage, however, has a downside. Many of the pioneer toads at Fogg Dam in the Northern Territory, particularly the larger, older, longer-legged toads, have severe spinal arthritis (Brown *et al.* 2007). Although further research has indicated that these animals are highly stressed and need to take shorter hops, they nevertheless appear to be able to continue the movement forward at a rapid pace (Phillips *et al.* 2006, Urban *et al.* 2008, Alford *et al.* 2008). It is possible however that because these toads are already stressed they will be more susceptible to additional control measures.

The behaviour of these frontline toads is in contrast to that of long-established cane toad populations. Research on Queensland toads found them to be nomadic and directionless in their movement (Schwarzkopf and Alford 2002), moving slightly less than 10 metres per day on average. Those at the frontline in the Northern Territory may move up to 1.8 kilometres per day when conditions are optimal (Phillips *et al* 2006). Optimal conditions for high rates of cane toad movement are warm, wet, windy nights early in the wet season (Phillips *et al* 2006). These differences may be important in targeting 'weak spots' in the biology of cane toads for future control efforts, and in quantifying the long-term impacts of cane toads.

6. IMPACT OF CANE TOADS

Cane toads have been listed by the Invasive Species Specialist Group of the IUCN[1] as one of the world's 100 worst invasive alien species (Lowe *et al.* 2000). They are perceived by the Australian community as a highly undesirable pest animal, regularly rating as a top pest priority across a wide range of community members (Invasive Animals Cooperative Research Centre T. Peacock, pers. comm.).

Cane toads are considered to impact on tourism, agriculture, Indigenous communities, social amenity and native ecosystems, particularly biodiversity. They potentially impact on native species in three main ways:

(i) toxic ingestion of cane toads by native species;

(ii) predation by cane toads on native species; and

(iii) competition with native species for habitat and resources.

For further information on the impacts of cane toads refer to Appendix 1.

[1] IUCN = the International Union for Conservation of Nature (www.iucn.org)

7. STAKEHOLDERS

A wide variety of stakeholders are impacted by and involved in the management of cane toads. These include Federal, State and local governments, community action groups, agriculture, industry, the tourism and travel sector and the broader community.

The WA Cane Toad Stakeholder Reference Group (SRG) comprises representatives from: the Department of Agriculture and Food WA (DAFWA), the Shire of Wyndham East Kimberley (SWEK), KTB, STTF, Ord Guard Biosecurity Group, Tourism WA, Kununurra Visitor Centre, Rangelands WA, Ord Land and Water and the Kimberley Zone Control Authority. The SRG is chaired by and provided with executive support by DEC.

The role of the SRG is to advise government and facilitate information sharing, with the purpose of fostering ongoing and positive relations between the individual organisations. The SRG has been involved in the development of the draft Strategy and will continue to play a role in the implementation of the final Strategy.

8. COMMUNITY EFFORT IN WESTERN AUSTRALIA

The community response to the threat posed by cane toads to Western Australia is unprecedented, with well-organised and passionately committed community groups working since 2005 to physically prevent the entry of toads into the State. There are two community groups involved in cane toad 'busting': KTB, a Kununurra-based volunteer organisation, and STTF, based in Perth.

The focus of the Kununurra-based KTB has been on regular, frequent volunteer 'toad busting' expeditions at the cane toad front within the Victoria River catchment in the Northern Territory. KTB have successfully helped to raise broader community awareness of cane toad issues, encouraged and enabled the volunteer contributions of many Kimberley residents and have also been involved in ongoing reconnaissance and monitoring activities.

The Perth-based STTF has focused its field-based operations on the trialling of barrier or deflection fencing to assist with the manual collecting or trapping of toads and on an annual dry season 'Great Cane Toad Muster', where volunteers use the toad's requirement for water to collect cane toads manually and dispose of them. STTF has been successful in fundraising for cane toad control, in raising awareness of the cane toad issue across Australia and in the recruitment of volunteers outside the Kimberley region of Western Australia.

In 2007 the Invasive Animals Cooperative Research Centre (IACRC) was commissioned by the State Government to review the community on-ground cane toad control operations in the Kimberley, in order to inform decision-making on future investment in on-ground activities. At the time of the report, there was no definitive evidence that physical removal of cane toads had slowed the movement of toads towards Western Australia, although the biomass of toads at the frontline had no doubt been diminished (Peacock 2007). This draft Strategy recognises that community groups have a significant role to play in the delivery of any cane toad control measures as well as education and public awareness campaigns.

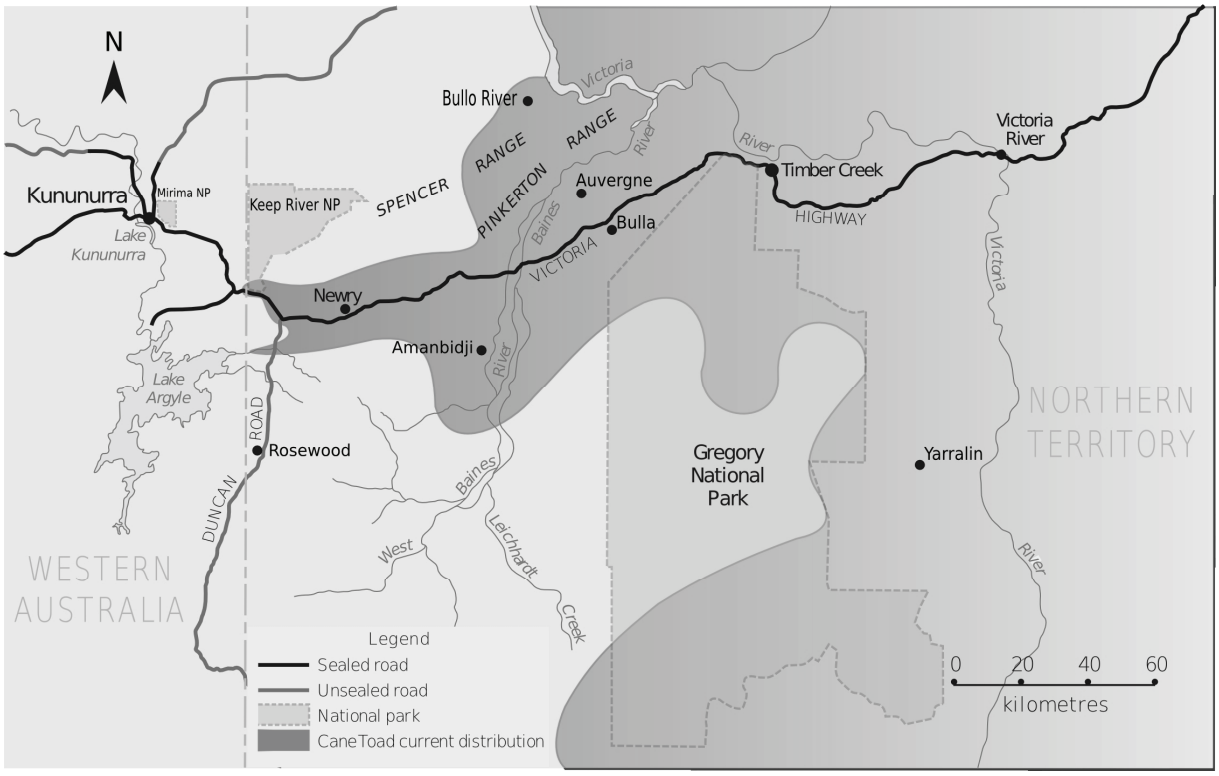

Figure 2. Frontline location of cane toads, as at 28 February 2009. Compiled by DEC based on data from DEC and KTB on-ground operations.

8.1 Elsewhere in Australia

Community effort against the 'arrival' of cane toads has generally been at a significantly smaller scale and duration than that achieved by volunteer groups in Western Australia. A notable exception is the south eastern frontline of cane toads, where the New South Wales Department of Environment and Climate Change has been instrumental in coordinating a community participation program. Cane toads were present in small numbers in a disjunct population at Port Macquarie from 1996 to 2006, but appear to have been eradicated following an intensive program of volunteer toad musters (S. Crocetti, pers. comm.). This implies that eradication of a discrete population may be possible when populations are at the edge of their climatic range.

9. DEC FOCUS TO DATE

DEC is working cooperatively with the Northern Territory Government, KTB and STTF against the westward movement of cane toads, and has a five person surveillance and control team based in Kununurra to undertake on-ground operations. Over the past year the team has:

- undertaken surveillance to identify the extent and spread of cane toads in the Victoria River District in the Northern Territory;
- deployed and serviced cane toad traps, and collected cane toads by hand;
- responded to reported sightings of cane toads in Western Australia and the Northern Territory; and
- continued with the trial of a detection sniffer dog inspecting vehicles for hitch-hiker toads at the Western Australia/Northern Territory border checkpoint.

DEC has also contributed funding to a number of research programs focusing on impacts and long-term control measures (see Section 19).

10. COOPERATIVE MANAGEMENT

Effective and efficient management of pest animals requires cooperative and integrated efforts from all involved parties. Peacock (2007) stated that this is best achieved through all parties, including DEC, working from a common strategy or 'battle plan'.

The Western Australian Government established the position of State Cane Toad Initiative Community Coordinator as a result of the IACRC review. This position will foster and promote cooperation and a coordinated approach among the various stakeholders involved in cane toad control operations to deliver the best value for the State's investment.

The establishment of the SRG will further foster this collaborative approach, bringing together all key parties to share information and to develop strategies in an integrated and ongoing manner.

PART 2 – PLAN OF ACTION

11. OUTLINE OF GOALS, OBJECTIVES AND ACTIONS

Goal 1: Minimise the spread and impacts of cane toads	
Objective	**Actions**
1. To protect biodiversity, social and economic values using appropriate means including targeted manual cane toad control measures.	Continue **research and biological surveys** to identify high value biodiversity assets and potential locations for targeted conservation programs. Identify and prioritise species at high risk from cane toads and develop and implement **protective management programs.** Apply best practice **techniques and standards for the short-term control** of cane toads in high value areas, including appropriate cane toad **identification, euthanasia and disposal information and services.**
2. To minimise the likelihood of new populations of cane toads through improved quarantine and surveillance measures.	Review and strengthen **quarantine procedures**, including intrastate quarantine inspection; auditing of road, air and ship freight and tourism companies; and strengthening of quarantine checkpoints, including the option of mobile inspections. Raise awareness of hitch-hiker cane toads and implement procedures to prevent the establishment of satellite populations, including **reporting of cane toad sightings and rapid response measures**.
Goal 2: Achieve a long-term solution(s) for cane toads	
Objective	**Actions**
3. To build control capacity through improved scientific knowledge and biocontrol techniques.	Facilitate and support appropriate **research into the long-term biological control** of cane toads, such as the use of parasitic lungworms and taste aversion learning by native predators.
Goal 3: Maximise understanding of cane toads, their impact and management options	
Objective	
4. To enhance communication, coordination and collaboration with regard to cane toad information and management.	Support a Stakeholder Reference Group to ensure that relevant government agencies and community groups are aware of management and research progress and recommended actions, and relevant groups are able to **contribute and access information** as required. Build on the existing Freecall **telephone service** to create an integrated information and reporting service, supported by a shared **reporting database** and **GIS system.**
5. To enhance community and industry awareness and understanding of cane toad impacts and management requirements.	Develop a cane toad **education program** including demonstration materials, student handouts and a teacher resource kit. The program will address different age groups and audience types, including Aboriginal communities and areas

	with and without the presence of cane toads.
	Review written **information** and produce complementary material for dissemination via stakeholder groups, information packs and websites. Information to include cane toad impacts, management options, safe handling, identification, reporting, euthanasia and disposal.

12. COMMUNITY AWARENESS AND UNDERSTANDING

Promoting coordinated community awareness and understanding of cane toads and their potential impact in Western Australia has a number of objectives:

- to provide information on cane toad identification, impacts, control methods and quarantine measures that will ensure the public receive up to date, accurate and consistent messages;
- to ensure the community know which organisations can be called for reporting suspected sightings, identification information and on the ground assistance;
- to increase the capacity of the community to correctly identify cane toads (and hence decrease 'accidental' killing of native frogs);
- to increase community ownership and involvement of the cane toad issue;
- to ensure that the community is interacting with and controlling cane toads in a safe and appropriate manner;
- to ensure community members feel prepared for the arrival of cane toads; and
- to increase awareness of cane toads across the State, so as to prevent establishment of satellite populations and to ensure any hitch-hiker toads found outside their existing range are dealt with in a timely and effective manner.

12.1 Targeted community information

Information produced regarding cane toads is most effective when targeted to specific audience types, in terms of both content and the medium used.

Kimberley

It is likely that the arrival of cane toads into settled areas of the Kimberley will create an increased level of uncertainty and anxiety from residents regarding impacts and control methods; consequently information needs to be readily accessible. Schools, community cane toad groups, local government, tourism networks, relevant State Government agencies, local media, and local natural resource management groups can all act as conduits for information. As such, the member organisations of the SRG will be integral to the development and distribution of information on cane toads. Note that many of the communities likely to be impacted by cane toads in the north of Western Australia are Aboriginal communities, and material will also need to be developed appropriate to information requirements of Indigenous people.

Broader public

Some of the community information on cane toads will need to be promoted at a State-wide level, in order to ensure any hitch-hiker toads found outside their existing range are dealt with in a timely and effective manner. Having a consistent and State-wide reporting and information system for suspected cane toad sightings is an essential component of this (see Section 12.7).

Schools

School programs are an important component of awareness-raising by educating future leaders in protection of the environment. Children can also convey messages back to their parents. Both DEC and community groups provide informal school-based educational sessions, however, these programs could be better supported and further developed (see Section 12.5).

Tourism and travellers

People traversing areas with cane toads need to be aware of the potential for their vehicles, trailers and camping equipment to harbour and transport cane toads to new areas. Quarantine checkpoints and information on 'checking your load' will be used to minimise human-assisted movement of cane toads. Tourism distribution networks (e.g. local visitor centres, Tourism WA electronic newsletter to over 3,000 industry operators and key players) are well established and could potentially be used to distribute such information. A regional holiday planner is also produced annually for each of the State's five Regional Tourism Organisations, and should be used to contain warnings and general information on cane toads. Similarly, individual tourism businesses could be used to distribute cane toad extension material (e.g. station stays, caravan parks, hotels, and camping areas).

Transport and other industry groups

The transportation sector (trucking, shipping, air freight) and other industry groups such as agriculture are also potential vectors for the movement of cane toads. For example, horticultural produce is freighted out of the Ord River Irrigation Area, and ships from Darwin regularly dock at remote Kimberley coastal ports. Information specific to these sectors will need to be developed, to raise awareness and reduce the likelihood of accidental movement of cane toads to other areas of Western Australia (see Section 18 for further discussion on surveillance and quarantine processes).

12.2 Extension material

A variety of cane toad extension material is available in Western Australia (see Appendix 2). Although the list appears extensive, there is a lack of cane toad information to support educational programs and quarantine awareness purposes. Development of material to address these gaps is discussed further in Sections 12.5 and 18 and in Tables 1 and 2 below. There are several other areas where extension materials should be updated to meet community needs prior to the arrival of cane toads in settled areas of the Kimberley (e.g. the cane toad Pest*note*).

To avoid confusing the public, those parties producing materials should cooperate to jointly produce and distribute key information (while acknowledging the ability of organisations to produce their own material where desired). The SRG is the ideal medium to help develop the content of extension material for the east Kimberley at least – this could be easily adapted for use elsewhere. As the lead government agency, DEC will fund the production of information material as recommended in this draft Strategy and as determined necessary by the SRG. Table 1 gives an indicative list of the type of material that may be suitable for development as part of an extension package (excluding schools-based educational material, see Section 12.5).

Table 1: Suggested set of extension material for Western Australia.

Items marked with an asterix acknowledge similar products developed by the NSW Department of Environment and Climate Change, which could be used as a template.

	Suggested extension material
General awareness/ control information	- general brochure on cane toad impacts, identification, management and contacts - cane toad life cycle fact sheet* - distribution, spread, past and current control efforts fact sheet - managing cane toads in your backyard fact sheet - protecting children and pets - safe handling and euthanasia of cane toads - trapping cane toads fact sheet - cane toad control research fact sheet - general cane toad impacts, identification, management and contacts poster - DAFWA/DEC cane toad Pest*note* - community group brochures - cane toad general information display stand - culturally appropriate information package with general information, developed for indigenous communities - Front counter enquiry package – consisting of relevant items to assist staff from stakeholder organisations with enquiries from the public
Identification	- cane toad/native frog ID fridge magnet (with contact details) - cane toad/native frog calendar - 'Hear a cane toad's call' MP3 file on relevant websites* - 'Frog or toad?' fact sheet* - 'Don't kill me!' photos, descriptions and frog calls (for websites) of Kimberley native frog species fact sheet* - green tree frog/cane toad/KTB bookmark - native frog stickers
Quarantine	- 'Help stop the spread of cane toads' pamphlet (potentially different pamphlets developed for various target groups) - 'Stop the toad, check your load' flier*
Information enquiries and reported sightings	- all extension material to contain contact details and information and reporting line telephone number

Many of the items in the table above would be suitable for insertion into a revised information kit (see Section 16.3), to be distributed to quarantine points, residents and businesses in areas where cane toads are likely to arrive in the near future. Most of the items would also be suitable for downloading from relevant websites.

12.3 Signs

A number of signs regarding State quarantine requirements and cane toads were installed in 2005 on all of the major (sealed and unsealed) roads leading into Western Australia. A number of general information poster-boards and signs were also placed in and around Kununurra in 2005. It is recommended that key stakeholders collaboratively review the signs and posters currently in place in the east Kimberley, and replace them with new material focusing on cane toad impacts, identification, and what to do/who to contact in the event that a cane toad is sighted.

Signs or posters should be placed at strategic locations within towns prior to the arrival of cane toads. Information bays on town perimeters, public open space (e.g. boat ramps), remote Aboriginal communities, 24-hour roadside rest areas and remote tourism destinations (e.g. entries to Gibb River Road, Purnululu National Park, Mitchell River National Park) are also potential sites for cane toad signage.

12.4 Websites

Numerous websites provide the public with information (with varying degrees of completeness and accuracy) on cane toads. Websites of note include those of:

- IACRC (www.invasiveanimals.com/invasive-animals/cane-toads/index.html);
- Cane Toads in Oz (www.canetoadsinoz.com);
- KTB (www.canetoads.com.au);
- STTF (www.stopthetoad.org.au);
- DAFWA (www.agric.wa.gov.au);
- DEC (www.dec.wa.gov.au/canetoads); and
- Frog Watch NT (www.frogwatch.org.au).

Online information on cane toad impacts, control methods and research outcomes needs to be kept up to date to be of maximum value. It is also recommended that member organisations of the SRG link their websites to other relevant websites and to documents such as this draft Strategy.

12.5 Education programs

School-based education programs on cane toads in Western Australia have been relatively informal. Kimberley Wildlife Rescue conducts educational sessions to local school children and Aboriginal communities several times per year. Staff from DEC's Kununurra office also organise activities with students in the east Kimberley area, with a focus on cane toad impacts, life cycle, identification, safety, and detection using 'Nifty' the cane toad sniffer dog. KTB give cane toad presentations to schools and community groups around Western Australia. These presentations are aimed at raising awareness about the threat impacts that the cane toads toad poses to Western Australia's biodiversity, education about cane toad identification, their impacts, the risk of hitch-hiker toads and how to go toad busting with the KTB (S Boulter pers comm.). STTF also has an education program in place and deliver to schools and industry across the State.

There is an opportunity to develop a more cohesive approach to cane toad education in the Kimberley. Any products developed could easily be transferred for use to other areas in the State. The New South Wales Department of Environment and Climate Change has an excellent schools-based program (and teacher resource book) called 'Trap that Toad'. An abbreviated and modified version of this book, along with suitable demonstration materials,

would be a valuable addition to the communications toolkit currently available to volunteers and staff involved in cane toad education in Western Australia. The educational program needs to be linked to the State Education Curriculum, to enable teachers to use the material during class time.

Table 2: Indicative package of schools-based educational material

	Suggested educational material
Visual support material	- stuffed and rubber cane toads - laminated photo cards of native frogs, cane toads, cane toad prey and cane toad predators - identification and life cycle posters
Student handouts	- 'Cane toad or native frog?' activity sheet to do with guest presenter - information kit with fridge magnet, brochure, sticker, bookmark and fact sheets - the 'cane toad story'
Teacher resource book	- workbook containing student/teacher activities such as: background information for teachers, interesting facts page, colouring in and puzzle activities, life cycle activity, frog or toad ID activity, native frogs activity, spread of cane toads map, cane toad quiz, cane toad impacts activity, cane toads and frog calls (on low cost MP3s), what can you do? activity. - curriculum links - cane toad poster - further information/contact details

12.6 Cane toad forums

A number of national cane toad research forums have been held (a CSIRO workshop on biological control in Brisbane in 2004; an IACRC/CSIRO invasion and control workshop in Brisbane in 2006; and an IACRC control research forum in Darwin in 2008). These workshops facilitate information sharing between scientific and research organisations around Australia, and provided an opportunity for management agencies and community groups to learn of advances in knowledge of cane toad impacts and control.

Several community-initiated forums to discuss the management of cane toads have been held since 2004. The first major forum was the East Kimberley Cane Toad Forum facilitated and organised by Kimberley Specialists in Research Inc, with assistance from Andrew Storey. This was held in Kununurra in March 2005. This was quickly followed by the Perth forum, Keeping Cane Toads out of WA, organised by the Conservation Council of WA and held in June 2005. These forums have led to increased community awareness and interest in working to prevent the advancement of the cane toad frontline towards Western Australia; the creation of cane toad community action groups, including KTB and STTF; and the commencement of regular, volunteer toad busting activities.

Given the development and release of this draft Strategy, the 27 February 2009 arrival of the first cane toad in Western Australia, and the collaboration of the SRG, it may be appropriate for another community forum or information session to be held in Kununurra in 2009. This would provide an opportunity for key stakeholder groups and the broader east Kimberley community to share information on the current status of cane toad management ahead of their anticipated arrival in Kununurra. Similar forums in other towns in the Kimberley may be needed as the cane toad front advances.

12.7 Information and reporting line

Suspected cane toad sightings can be reported to a Freecall 1800 number that is directed to DAFWA's Pest and Disease Information Service (PaDIS). DAFWA has kept statistics on the number of calls regarding cane toads made to the 1800 084 881 reporting and information line:

- 1 June 2005 to 1 June 2006 166 calls
- 1 June 2006 to 1 June 2007 134 calls
- 1 June 2007 to 1 June 2008 74 calls

Statistics have also been kept by DEC since July 2006 on the number of calls made directly to DEC or forwarded on via the PaDIS information and reporting line:

- 1 July 2006 to 30 June 2007 86 calls
- 1 July 2007 to 30 June 2008 47 calls

Note that east Kimberley residents may also be directly contacting the volunteer group KTB rather than using the information and reporting line. Overall, the vast majority of sightings have turned out to be native frogs, illustrating the importance of providing visual identification information and a telephone-based identification service. Also of note, is that nearly all of the calls made originate from the south-west of Western Australia, where members of the public were concerned they may have found a hitch-hiker cane toad. The provision of a telephone-based identification service remains essential for fielding the number of calls about suspected cane toads that are received across the State and in particular hitch-hiker toads. This service needs to be continued without the need to transfer or refer calls and adequate resources need to be provided to ensure that PaDIS can continue to provide this information and reporting telephone service.

	Community awareness and understanding actions	Responsibility	Priority/ Time frame
1	Inform the public according to the type of target audience the need for community surveillance and action, and publicise any significant findings or progress.	DEC, DAFWA, community groups	Ongoing
2	Use a variety of mediums (information displays, brochures, fact sheets, posters, signs, newsletters, school visits, newspaper inserts, targeted send-outs, websites) to raise public awareness of issues such as toxicity, personal/pet safety, frontline movement, identification, avenues for spread, control measures and animal ethics issues.	DEC, DAFWA, SWEK, Kununurra Visitor Centre and community groups	High/ ongoing
3	Review the available extension material (Appendix 2) and determine additional material required as listed in Table 1.	DEC, with SRG input	High/ under way
4	Investigate production of joint extension material with SWEK, DAFWA, DEC and community groups.	DEC, with SRG input	High/ early 2009
5	Develop an information package for Indigenous communities, using the recent Northern Territory DVD as a reference point.	DEC, with input from Indigenous representatives	Medium/ mid 2009
6	Produce a set of information sheets for specific industry, transportation and tourism groups, to minimise accidental movement of cane toads to other areas of Western Australia.	DEC and DAFWA	Medium/ mid 2009

	Community awareness and understanding actions	Responsibility	Priority/ Time frame
7	Review the name, location and content of DEC's cane toad webpages.	DEC	High/ under way
8	Update the information on the DAFWA cane toad webpages.	DAFWA	Medium/ early 2009
9	Develop a school-based education package on cane toads, including visual support materials, student handouts and a teacher resource book.	DEC, with SRG input	Medium/ mid 2009
10	Hold a community cane toad forum in Kununurra during 2009 prior to the arrival of cane toads, and progressively throughout the Kimberley ahead of the cane toad front.	DEC, SWEK (and other shires), community groups	Medium/ 2009
11	Advertise on all relevant extension material, newsletters and media releases the existence and purpose of the Freecall 1800 cane toad reporting and information line.	DEC, DAFWA, SWEK, Kununurra Visitor Centre and community groups	Medium/ ongoing

13. COORDINATION AND IMPLEMENTATION

13.1 Stakeholder roles and coordination

The effective management of any invasive species requires a collaborative approach across land tenure and organisational boundaries. The establishment and ongoing functional operation of the SRG is critical to the development and implementation of this Strategy, and a high level of participation by member groups will result in a more cohesive and effective community, scientific and government response to cane toads in Western Australia.

DEC's State Cane Toad Initiative Community Coordinator is based in Kununurra and will be responsible for coordinating implementation of action items of the final Strategy. The position also supports and assists community groups involved in on-the-ground cane toad control activities. Facilitating information exchange and cooperative activities is an essential component of this.

All individuals and groups are encouraged to provide feedback to DEC or members of the SRG (see Section 7) regarding the management of cane toads in Western Australia. On completion of the consultation process for the draft Strategy, the SRG will provide DEC with ongoing advice on the management of cane toads and continue to facilitate the exchange of information between groups involved in cane toad management.

13.2 Information management

The difficulty in accessing information on cane toad research was raised as a significant issue at the 2008 cane toad forum in Darwin. Improved access to information regarding on-the-ground control operations, research into control efforts and policy developments would be beneficial to all parties. The website www.feral.org.au is currently a good source of information, holding over 40 cane toad documents. However, the website was created by the former Pest Animal Control CRC (replaced by the IACRC, see Section 12.4) and does not contain the outcomes of recent research or all documents of relevance to Western Australia. As a consequence, it is important that the State Government cane toad webpages are kept

up to date. It is further recommended that a formal cane toad research/community group information exchange medium (such as a mailing list via which member groups could circulate research/control 'updates') is established.

13.3 A National Cane Toad Plan

'The biological effects, including lethal toxic ingestion, caused by cane toads (*Bufo marinus*)' is listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). However, unlike most other listed threatening processes, a national threat abatement plan was not developed. At the time of listing, the Threatened Species Scientific Committee (TSSC) felt that due to initiatives already in place (e.g. research into biological control, public awareness campaigns, and the Natural Resource Management Council's June 2005 '*Review of the impact and control of cane toads in Australia with recommendations for future research and management approaches*'), a threat abatement plan was not warranted. The TSSC did, however, state that a national approach was considered essential. The Commonwealth Government is currently reviewing this decision and considering whether a national threat abatement plan is warranted. Western Australia has supported the preparation of such a plan.

The national Cane Toad Advisory Group (CTAG) was formed in June 2007. The membership of this group includes representation from each of the relevant States and Territories, World Wildlife Fund (WWF), the IACRC and Department of the Environment, Water, Heritage and the Arts. The advisory group reports to the Vertebrate Pests Committee of the IACRC and was formed to provide strategic and practical advice on the planning, implementation and delivery of cane toad projects and their outcomes, although development of a national strategy is not part of the Terms of Reference. Under the 'Caring for Our Country' funding initiative, the Commonwealth has identified its interest in supporting projects to reduce the impacts of cane toads. It has specified the following targets for 2009-10 investments in its Caring for Our Country Business Plan 2009-10.

- *To undertake 1500 community volunteer days of cane toad control in 2009-10, particularly in areas that will slow the southern and westward migration of cane toads.*
- *To research the development of feasible, sustainable control measures and/or management and eradication solutions for the cane toad menace in 2009-10.*

	Coordination and implementation actions	Responsibility	Priority/ Time frame
12	Establish the Stakeholder Reference Group (SRG), to act as an information sharing forum on cane toad management issues and as an advising body to DEC.	DEC	High/ completed
13	Support the position of the State Cane Toad Initiative Community Coordinator, to promote a coordinated approach among stakeholders involved in cane toad control operations.	DEC and SRG	High/ ongoing
14	Maximise the ability of user groups to contribute to the provision of, and gain access to, appropriate information on biodiversity, cane toad impacts, cane toad population dynamics and cane toad control, in order to track progress being made, adapt control measures and implement new control techniques.	DEC and SRG	High/ ongoing
15	Ensure an ongoing exchange of information between the SRG and the national Cane Toad Advisory Group (CTAG) on strategic direction and progress, coordination of activities	DEC and SRG	Medium/ ongoing

	Coordination and implementation actions	Responsibility	Priority/ Time frame
	and utilisation of available expertise.		
16	Facilitate and conduct community forums and stakeholder workshops to ensure ongoing awareness and education, coordination and information exchange between groups, and maintenance of collaborative relationships.	DEC and SRG	High/ ongoing
17	Provide support to community groups to investigate additional sources of funding and resources, including the Federal 'Caring for Our Country' program.	DEC and SRG	Medium/ ongoing
18	Investigate the establishment of a formal medium for information exchange on cane toad research between various community groups and government agencies.	DEC and SRG	Medium/ ongoing
19	Contribute to any processes initiated to develop a National Cane Toad Strategy.	DEC, with input from SRG	High/ to be determined

14. IDENTIFICATION

The accurate identification of cane toads, to ensure native frogs are not mistakenly killed, is a significant issue. It is essential that the community is adequately supported with identification material and services to ensure toads are correctly identified.

Adult cane toads can potentially be confused with a number of native frogs especially species from genera *Limnodynastes, Cyclorana, Neobatrachus*, *Notaden* and *Uperoleia*, found in northern Australia. In the Kimberley, the frog most commonly confused with the cane toad is the giant frog (*Cyclorana australis)*, due to its size and brownish appearance. However, the giant frog, and all other native frog species, can be readily distinguished from the cane toad by a number of distinctive features (see DAFWA Pest*note* 01/2005 Cane Toads (www.agric.wa.gov.au) or KTB's definitive table, 'Is it a native frog or a cane toad?' (www.canetoad.com.au) for further information).

Metamorph cane toads are significantly more difficult to identify than adults, and may be confused with native frog species such as those of the *Uperoleia* genus. Particular care needs to be taken when volunteers are busting metamorph cane toads and native species are present (see Section 20).

Cane toad tadpoles are very difficult to distinguish from the tadpoles of some native frog species, so expert advice should always be sought prior to removing tadpoles. Cane toad tadpoles are comparatively small and black in colour, and often form dense congregations. Cane toad eggs are readily distinguished from the eggs of native frogs, as they lay one-millimetre-long black eggs in unusual long strands held together by a clear jelly-like substance.

In residential areas where cane toads may eventually establish themselves, and where it is possible a significant number of people will want to destroy cane toads but will not be confident in their ability to accurately identify them, the provision of accessible identification and disposal points is essential. This is discussed further in Section 16.4.

	Identification actions	Responsibility	Priority/ Time frame
20	Raise awareness of the need to accurately distinguish cane toads from native frogs through mediums such as posters, websites and MP3 files.	DEC and SRG	High/ under way
21	Produce extension material focusing on identification of cane toads and native frog species, including products such as fridge magnets, calendars, fact sheets, brochures and bookmarks.	DEC and SRG	High/ under way
22	Advertise the existence of the Freecall information and reporting line on all cane toad extension material.	DEC	High/ ongoing
23	Establish identification and disposal points at each town centre likely to require this service.	DEC and SRG	High/ under way

15. MANUAL CONTROL OPTIONS

Over the past four years, Western Australia has seen an unprecedented effort by community groups and the State Government to delay the movement of cane toads from the Northern Territory into Western Australia. This effort is widely acknowledged as having resulted in a greater understanding of the behaviour, ecology and control of the cane toad, knowledge that can be utilised in the future management of cane toads (Peacock 2007; KTB 2008, STTF 2006, 2007; R. Shine pers. comm.).

Research has shown that despite the massive community effort and significant financial investment by the State Government, the forward movement of the cane toad front has not significantly slowed (Peacock 2007) and is still moving at about 50 kilometres per year (Peacock, 2007).

The groups involved in cane toad control efforts have demonstrated a willingness to revise their control efforts when techniques or priorities are amended as new knowledge becomes available. The recommendations in this section provide some guidance as to where resources should be focused for optimal outcomes in the future.

15.1 Hand collection

All groups involved in cane toad control efforts in the Victoria River Catchment have a strong focus on manually picking up cane toads as part of their control approach. Field experience has shown that hand collection of cane toads is the most effective and efficient way of manually removing cane toads, with more animals being removed in a given time period than can be removed using other manual methods such as traps (E. Kruger, pers. comm.). The use of fencing may result in hand collection being more effective, with volunteers able to remove more toads from a given area in a shorter time frame and with less effort (STTF 2008 Muster report).

Since 2005, almost half a million cane toads have been removed from the landscape by volunteer groups and DEC staff, with the vast majority of these being hand collected. Millions of metamorphs and eggs have also been destroyed.

While the numbers described above reflect impressive achievements, further analysis is required to quantify the actual benefits of the removal program on biodiversity and other values, and to determine how knowledge gained from these endeavours can best guide future actions. All three groups involved in manually removing cane toads are doing so with a broad objective of reducing the impacts of cane toads on biodiversity values. However, no meaningful quantitative data are currently available on how on-the-ground measures have benefited local populations of native species.

There is evidence that, at a local level, manual control efforts can decrease cane toad numbers in the short term. However, no data have been collected on the impact on native species at the population level. The long-term benefits (in terms of biodiversity protection) are likely to be negligible. Modelling work completed in Queensland, which may not be directly comparable to Western Australia, estimated that for a regional population of one million cane toads, 330,000 cane toads would need to be removed per year before there would be any impact on the abundance of the species (calculated as the maximum sustainable yield) (J.M. Hero, 2005). It is unlikely that these numbers could be removed each year on an ongoing basis. Further modelling is required to estimate the impact of removing frontline cane toads versus those from sedentary populations such as in Queensland.

Due to the extremely high fecundity of cane toads, numbers recover quickly to pre-harvesting levels, and manual removal of toads would need to be sustained in perpetuity to be an effective control measure (J.M. Hero, 2005). Additionally, and while it will obviously vary with individual species, it is unclear at what point a reduction in toad population densities results in a meaningful decrease of biodiversity impacts, especially given that predators may be able to detect and eat toads even when toads are present at very low densities. Whether this (unknown) level of control can be sustained with the limited resources available is an additional factor.

Many in the community believe that positive outcomes are achieved by manual collection of cane toads: localised suppression of cane toads, community participation, increased knowledge of cane toad movement and biology, and perhaps most significantly raised public awareness and understanding of cane toad impacts and management. Manual removal of cane toads is encouraged in areas where it is most likely to be effective in the long-term protection of high value areas (e.g. islands; see also Section 17). In addition to toad busting and raising awareness, community volunteers could in the future conduct structured cane toad monitoring and surveillance activities, monitor local wildlife, and become involved in research trials for new biological control methods.

15.2 Trapping

Extensive trapping work by DEC has illustrated a number of issues with the use of traps, including:

- maintenance and servicing of traps in remote areas;
- damage by fire, theft, vandalism, stock and wildlife;
- non-target species being caught;
- the effectiveness of traps being limited by the need to position traps in or very close to water; and
- the ineffectiveness of traps for toad suppression when toads are at low densities (e.g. at the frontline), as only a small percentage of the population is captured.

DEC recognises that cane toad traps may play a role as a surveillance tool at and ahead of the main front and be required by community members as a tool to keep toads out of

backyards. To maximise their effectiveness a combination of lights, baits and acoustics is recommended.

15.3 Fencing

There have been calls from the wider community for the construction of a barrier fence along catchment boundaries to prevent the western movement of cane toads. The intention of the fence is to buy time until a more permanent solution to cane toads can be developed, but issues to be resolved include:

- potential damage by fire, storms, stock, native wildlife and fallen trees;
- the resources required to construct, maintain and continuously patrol a fence, often in rugged terrain in remote locations, would be significant, with no guarantee of its effectiveness;
- such a fence would have to be located to avoid watercourses, wetlands and floodplains, as wherever water flowed through or over a fence, particularly during the wet, tadpoles and juvenile cane toads would get through;
- major rivers that have cane toads in their catchments (e.g. Victoria River) will transport cane toads to, and along, the coast, allowing satellite populations to establish (e.g. toads have already colonised all of the Sir Edward Pellew Island group in the Gulf of Carpentaria, Northern Territory); and
- the unknown impacts of a large-scale fence on native fauna.

Barrier fencing may play a role at strategic sites that are identified to be of special significance, such as mound springs. A number of issues remain, however, and these are discussed further in Section 17.

Exclusion fencing has been identified as an effective method of removing cane toads from specific strategic water bodies (STTF annual report 2007 and 2008). This type of temporary fencing relies on the requirement of cane toads to re-hydrate and minimises the effort taken to collect large numbers of toads from these water bodies.

Another type of fencing that has been trialled is deflection fencing, where a barrier is set up that directs toads towards traps.

15.4 'Sniping'

The use of low calibre (0.17 or 0.22 cal.) air rifles (sniping) has been reportedly successfully used as a 'mop-up' tool to remove small numbers of cane toads that have remained after conventional manual methods have been used. Due to safety, animal welfare and legal reasons, sniping should only be considered in very limited circumstances where eradication is highly probable and safety procedures are in place.

15.5 Detector dogs

In 2006, DEC commenced a trial on the potential use of cane toad detection dogs as part of the State Cane Toad Initiative. The use of a trained Belgian Malinois ('Nifty') has three main purposes:

1. quarantine and biosecurity, a joint project with DAFWA, as cane toads are a declared pest species under the *Agriculture and Related Resources Protection Act 1976* (ARRP Act);
2. monitoring and surveillance in the field; and
3. responding to cane toad sightings.

Nifty's duties have varied between quarantine inspection of vehicles and consignments at the State border checkpoint and in Kununurra, and monitoring projects at the cane toad frontline. New areas are searched for the presence of cane toads when DEC receives reports from the public of possible sightings. Nifty has also assisted the New South Wales Department of Environment and Climate Change with an isolated population of cane toads in the Port Macquarie area, and may be available to other states if requested to assist in the detection of cane toads. Nifty has demonstrated that the main value of detector dogs is in closed area searches (freight at transport depots) and for vehicle inspections at the border checkpoint rather than searches in the field.

It is important to note that the use of a detector dog involves a substantial time requirement and personal commitment from the dog's handler. A DEC review of the cane toad detector dog program in mid 2007 concluded that the major cost differences between a detector dog and conventional techniques were in the feeding and keeping costs of the dog and for the equipment and trap maintenance costs respectively. DEC is continuing the use of Nifty for cane toad quarantine purposes across the Kimberley. However, there are presently no plans to expand the detector dog program with the training of additional dogs.

15.6 Spray-on pesticides

Pestat Pty Ltd has reportedly developed a spray (HopStop®) that anaesthetises and then humanely kills cane toads. The product is intended for commercial sale as a method of household cane toad control. One of the components in the mixture reputedly acts as an anaesthetic, causing the animals to become sleepy and immobile shortly after treatment. Once immobilised, another of the components kills the animal (Pestat 2007).

The process of registering HopStop® for sale as a spray can product is likely to be a detailed and lengthy one and issues posed by its potential use in Western Australia will be addressed during this process.

	Manual control actions	Responsibility	Priority/ Time frame
24	Continue in the short term with the current focus on frontline reconnaissance, survey and removal of cane toads, and providing support to community groups involved in frontline cane toad removal.	DEC	High/ 2008/09 wet season
25	Aim to ensure that DEC and community groups involved in frontline cane toad removal are sharing information about cane toad control operations and location of the frontline to ensure that resources are being allocated as effectively as possible.	DEC and community groups	High/ ongoing
26	Investigate potential avenues for focusing future efforts on: manual collection in high value/high risk areas; cane toad and native fauna monitoring and surveillance activities; assisting in trials for new biological control methods; awareness raising and educational tasks; and providing support to the community for cane toad management.	DEC, community groups, SWEK and other shires when appropriate	Medium/ early 2009
27	Continue current focus of DEC's trapping program for surveillance and monitoring purposes, incorporating the use	DEC	High/ ongoing

	of attractants (e.g. lights, baits and acoustics) as appropriate.		
28	Provide information for local residents on the use of traps to capture cane toads found in residential areas.	DEC, SWEK (and other shires when relevant), community groups	Medium/ mid 2009
29	Further investigate the use of wildlife gateways in barrier fencing used for specific objectives to minimise impacts on the movement of native fauna.	DEC and community groups	High/ mid 2009
30	Further investigate the use of barrier fencing as a tool to assist in the manual capture of cane toads to protect high value/high risk assets.	DEC and community groups	High/ mid 2009
31	Continue the use of Nifty the detector dog with a focus on quarantine, and investigate ways in which her role can be expanded once cane toads are present in Western Australia.	DEC and DAFWA	High/ early 2009

16. TOAD-BUSTING BY LOCAL COMMUNITIES

16.1 Permits and authorisation

Enquiries have previously been made regarding the permits or authorisation required for community groups to undertake cane toad surveillance and control work on a variety of land tenure types, including DEC-managed public conservation reserves, other government lands, Indigenous-managed lands and privately managed land. DEC is able to grant permits for access to DEC-managed land only. As part of the *Conservation and Land Management Act 1984* a Regulation 4 authority with appropriate conditions listed, including Regulation 18 authority to hunt non native species on DEC-managed land is needed and is available to community groups from the relevant DEC office.

As cane toads are an introduced species, DEC's approval to catch cane toads on private land or on land under the control of shires or other State Government agencies is not required. In this instance community groups need to seek the approval of the relevant landowner or managing authority to conduct toad-busting activities.

Any activities additional to toad-busting conducted on DEC-managed lands, such as conducting scientific research, require additional permits from DEC. The taking (removal, capture) of native flora or fauna requires DEC permits irrespective of the land tenure. Further advice is available from the relevant DEC Wildlife Officer.

Cane toads are a declared pest under the ARRP Act for the following categories: A1 (Entry prohibited), A2 (Subject to eradication in the wild) and A3 (Keeping prohibited). This means that its entry into Western Australia by people is prohibited, it is subject to eradication in the wild and its keeping is prohibited. With the 27 February 2009 arrival of cane toads into Western Australia this classification is to be revised. Further details are available from DAFWA.

16.2 Safe handling of cane toads

To minimise the potential for poisoning of people or animals, it is essential to provide information to the community on the safe handling and management of cane toads. Adult cane toads produce bufotoxins from glands on their shoulders, which can exude, and even squirt in extreme cases, toxins when provoked. Bufotoxins are absorbed through body tissues, such as the eyes, mouth and nose and can cause rapid death from heart failure in most small animals when ingested – even animals that 'mouth' a cane toad can be affected. Bufotoxins are also poisonous to humans. If swallowed, the toxin may affect the heart, blood pressure and breathing, and cause paralysis.

DAFWA's 'Cane Toad Frequently Asked Questions' webpage outlines a number of measures that need to be followed to minimise occurrences of poisoning by cane toads (see Appendix 3). DAFWA's cane toad webpage also provides advice on the management of domestic pets that could potentially be poisoned by cane toads.

16.3 'Toad-busting' kits

Many people will want to capture and remove cane toads found within the area in which they live. It is important that the appropriate resources are provided to ensure that the community is able to do so safely and effectively. DEC has developed the Cane Toad Pack, which contains identification information, disposable gloves, safety information, disposal and local contact details, and is available at selected locations.

16.4 Cane toad disposal points

Some people will not be comfortable with identifying and particularly humanely killing cane toads themselves. The establishment of disposal points for cane toads, where suspected cane toads can be identified and appropriately euthanased and disposed of, is essential.

One or two disposal points per town is generally considered adequate. Local DEC offices, shire offices/depots and specialist community organisations may be suitable locations for disposal points. For the town of Kununurra, three disposal or drop off points have initially been installed for the collection of live cane toads, these are located at the DEC depot on Ivanhoe Road, the SWEK depot on Bandicoot Drive and the Kimberley Vet Centre. These drop off points have signage that can be used to identify the animal and contact phone numbers if the person is unsure of identification. Drop off points are available to the public seven days a week, 24 hours a day, with cages checked every Monday and Friday by DEC officers. If cane toads are removed from the drop off points, DEC officers will humanly euthanase the animal and dispose of it at the Shire of Wyndham East Kimberley land fill site.

16.5 Cane toad traps

Some residents of towns where cane toads are present will want to use cane toad traps. These people need to be provided with information about the correct use of traps, including provision of shade and water for animals in the trap, regular checking of traps, correct identification of cane toads and safe manual handling of toads.

16.6 Involving Indigenous communities

The impact of cane toads on indigenous communities has been documented over time as cane toads have moved across the northern areas of Australia (van Dam *et al.* 2002). Many communities have identified the reduction and, in some cases, the complete loss of some

traditional bush tucker. Cultural ceremonies have also been modified to reflect these losses (see Appendix 1).

As cane toads move towards Western Australia, it will be the outlying communities that will come into first contact with cane toads and there is a need to ensure that communities are prepared for this contact. Educational presentations are already being provided to communities and many Indigenous people are involved in the community efforts to try to stop the westward advance of the cane toad.

Aboriginal people have been engaged in the effort to control cane toads as part of the programs run by both KTB and STTF, and there is potential to formalise this initiative as part of a broader Indigenous employment and training program. For example, as part of the native title consent determination over the lands of the Mirriuwung-Gajerrong (MG) people, DEC and the Mirriuwung-Gajerrong Corporation have joint responsibility for six conservation areas in the east Kimberley, and a formal training program is in place to provide long-term training and employment for MG people in the management of this land. This trainee program could provide an appropriate model for future Indigenous employment in land management, including cane toad control.

	Toad busting by local communities actions	Responsibility	Priority/ Time frame
32	Develop culturally appropriate information materials on the safety risks and safe handling of cane toads, for wide distribution throughout communities with the potential to be impacted by cane toads.	DEC, with input from SRG	High/ under way
33	Develop and distribute 'toad-busting kits' for use by local community members.	DEC, with input from SRG	High/ under way
34	Ensure that people issued with traps are aware of the correct use of traps, safe handling techniques, identification and disposal.	DEC, SWEK, community groups	High/ mid 2009
35	Establish two or three cane toad disposal points in Kununurra, and identify other towns or communities that may require a similar service as the cane toad front advances. A holding facility at one of the disposal points at least should also be considered for use after hours.	DEC, SWEK and other relevant shires, Kununurra Veterinary Centre.	High/ completed
36	Consider the development of a cane toad management program as part of a broader Indigenous land management strategy.	DEC,	High/ early 2010

17. PROTECTION OF BIODIVERSITY

17.1 Baseline and impact monitoring

Cane toads have been identified as potentially impacting on a number of industries, including tourism and agriculture. Appendix 1 outlines specific impacts that have been documented throughout Australia. Further investigation into these impacts in a Western Australian context is warranted.

In the northern part of Western Australia a significant investment in surveying biodiversity values, including 20 Kimberley islands between 2006 and 2009 (DEC 2008) is being done. The aim of the surveys is to gain a better understanding of the biota, to identify islands that

may require specific management actions to protect values from cane toads, and to identify islands that may be suitable locations for 'at risk' species translocation programs. Biological survey and monitoring work is also being conducted in the east Kimberley with similar objectives.

Within the east Kimberley biodiversity programs the following specific actions are carried out:

- frog call surveys are conducted during the wet season along main roads and key wetland areas;
- acoustic monitoring towers have been installed at Point Springs Nature Reserve and Parry Lagoons Nature Reserve;
- Lake Argyle biodiversity benchmarking survey;
- radio telemetry work on large predators (specifically large pythons); and
- various inventory trapping exercises throughout the east Kimberley.

Monitoring and benchmarking surveys are designed to measure population trends over time and should be a long-term and regular undertaking. DEC will continue the current east Kimberley monitoring program for native predators and frogs once cane toads are present in the region; ongoing monitoring to determine the level of impact on individual species is an essential part of the management response to cane toads.

17.2 Species at risk

There does not appear to be any evidence that cane toads have caused or contributed to the extinction of any Australian species (DEWHA 2006), although toads may exacerbate environmental stresses from other threatening processes (e.g. fire). It has been documented, however, that many species experience rapid and significant population decreases following cane toad invasion (see Appendix 1) and that in some instances this can lead to localised extinctions. Anecdotal reports from areas where cane toads have been present for a significant period of time suggest that predator populations appear to recover (potentially through a learning process of avoidance, see Section 19.4), however, this has not yet been adequately documented and may not always occur. Vertebrate predator species that are likely to be at high risk from cane toads in Western Australian include northern quolls, freshwater crocodiles and frog-eating reptiles such as pythons and goannas.

Highest-risk species are likely to be those species with restricted ranges (e.g. the threatened land snails of the east Kimberley). Trials conducted by DEC and the University of Sydney on land snails of several genera and sizes found in the Ningbing Range (which contains several critically endangered taxa) indicate that most species were eaten by cane toads (D. Pearson, pers. comm.) and hence may be at risk. Native fish may directly interact with cane toads. Crossland (2001) has found however that most barramundi and sooty grunter learn to avoid *B. marinus* tadpoles with minimal trauma. It is therefore anticipated that the toads are unlikely to have a significant negative impact on wild populations of these species through direct toxic effects (M.R. Crossland 2001). Further investigation is required for other species of native fish.

The identification of native species likely to experience population-level impacts from cane toads is part of the process to investigate whether any species (or their habitats) will require management intervention for recovery or conservation. Potential management strategies include:

- physical protection (e.g. fencing) of habitat critical for high risk species (see Section 17.4);

- translocation of individuals from high risk populations to cane toad free areas (see Section 17.5);
- ensuring adequate knowledge of the genetics of high risk species (see Section 17.6) and retaining examples of species (as sustainable populations) in managed environments such as zoos and wildlife sanctuaries; and
- assisting native predators with learning to avoid cane toads, by developing a taste aversion from a non-lethal dose (see Section 19.4).

All of the options listed above are substantial endeavours that would require significant additional research, planning and resources prior to implementation, and may not be logistically feasible or possible to deliver on the ground.

17.3 Critical habitat

Protecting native fauna from the impact of cane toads will be very difficult to achieve at a landscape scale, given the nature of cane toad invasion and the natural dynamics of fauna across the landscape. The use of the nematode lungworm (see Section 19.3) and assisting predators to learn to avoid cane toads through taste aversion (see Section 19.4) may offer some protection, although this will depend on their successful application at a landscape scale.

Given the short-term uncertainty, the focus therefore needs to be directed to identifying habitat sites that are critical to the ongoing viability of specific species or populations of a given species. A number of such critical habitat sites will be identified through the Kimberley Islands Biological Survey. Island surveys will be completed in 2009 with results available the following year.

Other areas in the east Kimberley that are considered critical habitat and, as such, potentially require additional conservation management against the impacts of cane toads include:

- limestone features, including the Ningbing Ranges, where a number of geographically restricted land snails occur;
- habitat of remnant northern quoll populations; and
- high value biodiversity sites including the Ord River, Parry Lagoons Nature Reserve, Point Springs Nature Reserve, Prince Regent Nature Reserve and Mitchell River National Park.

Identifying sites of high biodiversity value is only the first step in the assessment of critical habitat: whether values present in each area will be impacted by cane toads must also be assessed. An assessment process is required that identifies:

- species vulnerability and causes;
- the degree of difficulty and cost in managing populations;
- areas that could be easily protected and may represent some biodiversity value; and
- areas that represent specific community interests (such as Lily Creek Lagoon and the freshwater crocodiles).

17.4 Biodiversity asset protection

A framework for decision-making is required in order to determine where resources need to be directed into the protection of a specific species or habitats from the impact of cane toads. Factors that would influence this decision-making are:

- vulnerability;
- likelihood of threat;
- feasibility of protection; and
- aesthetic appeal/tourism values.

Areas in the east Kimberley considered to have particular importance as high biodiversity sites or assets are listed in Section 17.3. These areas and high risk species need to be considered in conjunction with the criteria listed above to develop a biodiversity asset protection matrix. This matrix may be expanded to other parts of the State, given the potential for viable populations of cane toads to establish in the south-west of Western Australia and could guide the prioritisation of species, sites and habitats that may require management intervention.

Fencing of localised areas will be investigated as one of a number of strategies to protect key biodiversity assets. Fencing of habitat critical to the survival of geographically restricted camaenid land snails has been mentioned as an option to trial the efficacy of fencing to prevent cane toads invading key habitat. However, establishing fencing in cracking black clays and managing the impacts of cattle, fire and seasonal inundation/access issues would be extremely difficult. Fencing trials may also provide information on the viability of fencing as a biodiversity asset protection tool for use at a wider level.

A key role of DEC is to maintain and, where land has been degraded, to enhance the resilience of biodiversity through improving land management of reserves and unallocated Crown land. In the past five years DEC and other organisations have begun to improve the management of existing key threatening processes such as introduced herbivores and extensive wildfire. The goal of this management is to increase the integrity of vegetation systems and native fauna populations. Cane toads prefer to move through more open countryside, so the retention of native vegetation may reduce their movement as well as encourage larger and more resilient native fauna populations.

17.5 Islands and other refuges

As identified above, the translocation of individuals from high risk wildlife populations to cane toad free areas is one potential strategy to protect key biodiversity assets against cane toad impacts. Approximately 60 northern quolls have been translocated from mainland Northern Territory to toad-free Astell and Pobasso islands as a safeguard against advancing cane toads (DEWHA 2005). This program has also attempted to improve quarantine measures on islands to reduce the chance of cane toad invasion and so maintain the biodiversity on the islands (see Section 18).

The Kimberley Islands Biodiversity Survey will identify which ‘at risk’ species occur on islands, and hence act as potential refugia. An indirect product of the survey is the knowledge of whether any islands are suitable locations to accommodate ‘at risk’ species for translocation programs. Mainland sites may also have the potential to act as refuges for priority species, where they may not be colonised by cane toads because of natural geographical barriers. Another example is peninsulas that have a constricted neck and bounded by inaccessible terrain (i.e. cliffs), where fencing may be an option. These areas need to be identified for the Kimberley and other parts of the State in advance of the cane toad front.

Within the scientific community there is some concern about the use of islands for translocation programs, given the impacts this may have on existing island biodiversity. Translocation programs are time and resource consuming, with no guarantees that

populations will successfully establish. DEC will not proceed with any translocation programs unless the species at risk requires such action as an essential component of its conservation and impacts on translocation sites can be demonstrated.

Additionally, strict quarantine protocols would be required for Kimberley islands to minimise the potential for human-assisted movement of cane toads. These protocols would apply all users of the islands including mining companies, Indigenous people and scientists (see Section 18).

17.6 Genetic diversity

Although the ecological impacts of cane toads may decrease with time, it is possible that some native predators will experience a genetic bottleneck, resulting in significant loss of genetic variability with possible consequences of reduced long-term population viability. This is only likely to be of concern if the reduction is profound and long lasting and small populations become reproductively isolated from each other.

	Protection of biodiversity actions	Responsibility	Priority/ Time frame
37	Discuss with other relevant agencies appropriate means to monitor the impacts of cane toads on other industries.	SRG	Medium/ ongoing
38	Continue to locate and map the current extent of the toad in its westward spread, and monitor the rate of spread.	DEC and community groups	High/ ongoing
39	Continue the current east Kimberley monitoring program for species at risk to measure changes in abundance prior to and after the presence of cane toads, and determine the level of population recovery in the long term.	DEC, with community involvement	High/ ongoing
40	Analyse the results of the Kimberley biological survey and other relevant research conducted in the Kimberley and Northern Territory to contribute to the ongoing development of a biodiversity asset protection matrix to guide resource allocation.	DEC	High/ 2009
41	Analyse the results of the Kimberley biological survey and other relevant information to identify areas of critical habitat that will require specific protection measures.	DEC	High/ 2009
42	Evaluate the feasibility (cost, potential locations, benefit) of protecting critical habitat for geographically restricted or threatened species, such as the land snails of Ningbing Range, with fencing and manual cane toad control programs.	DEC	High/ early 2009
43	Analyse the results of the Kimberley Islands Biological Survey and other relevant research to investigate the role that islands might play in the conservation of species at risk.	DEC	Medium/ mid 2009
44	Assess the risk of cane toads invading offshore islands and devise mitigation strategies for islands at risk (transport of freight/food etc).	DEC	High/ 2009
45	Identify areas on the mainland that may be used as refugia for species at risk or in trials of cane toad exclusion zones.	DEC	Medium/ mid 2009

46	Develop a biodiversity asset protection matrix for the east Kimberley that can be replicated for other regions if necessary.	DEC	Medium/ mid 2009

18. PREVENTING THE ESTABLISHMENT OF NEW CANE TOAD POPULATIONS

18.1 Quarantine

The cane toad is currently a declared animal under ARRP Act for the following categories: A1 (Entry prohibited), A2 (Subject to eradication in the wild) and A3 (Keeping prohibited). As such, it is illegal to knowingly bring cane toads into Western Australia or to keep a cane toad without authority. Landowners with cane toads found on their property are also required to eradicate the animal(s) – in practice, however, anyone who finds a cane toad is strongly encouraged to report this to the cane toad Freecall number so that the relevant departments can then take action. These requirements under the declaration need to be reviewed, given the presence of cane toads within Western Australia. The main purposes of the *Biosecurity and Agriculture Management Act 2007* (BAM Act), which is replacing the ARRP Act, are to prevent new animal and plant pests (weeds and vermin) and diseases from entering Western Australia and to manage the impact and limit the spread of those already present in the State. Under the BAM legislation all existing Acts and regulations have been reviewed, updated and gathered into a single regulatory scheme. The review of the current cane toad pest listing is likely to involve a public consultation process and may result in a different declaration for northern parts of the State than for the remainder of Western Australia. Further information is available at www.agric.wa.gov.au/content/pw/bamb_info.htm.

Quarantine WA (part of DAFWA) provides inspection and certification services for the interstate movement of items of quarantine concern. DEC currently provides partial funding to DAFWA to enable Quarantine WA officers to check for cane toads at the Eucla and Kununurra 24 hour State border road checkpoints. All vehicles travelling into Western Australia are required to stop for inspection, where quarantine inspectors monitor private travellers' goods to prevent the uncontrolled entry of risk materials into the State. Inspection staff operate under a standard protocol for dealing with cane toads or suspected cane toads at the road checkpoints, which includes health and safety issues, inspection, identification, euthanasia and reporting processes. The continuation of cane toad inspections at the State border road checkpoints will be reviewed once cane toads are established in Western Australia.

A manifest on all road freight vehicles travelling into Western Australia indicates which freight is regarded as quarantine risk material (QRM). Any QRM is directed to registered premises for unloading, and QRM is set aside for inspection by Quarantine WA officers. Registered premises can be targeted for cane toad awareness raising and checking, and procedures put in place for rapid response should cane toads be detected.

Non-QRM freight (the vast majority of freight) is of concern, as checkpoint inspection may not adequately consider the origin of the goods and the likelihood of toads hitch-hiking within the contents. Clearly, repeat occurrences of undetected hitch-hikers in non-QRM freight could lead to the establishment of new populations of cane toads. Pathway analysis is needed to identify potential entry points for cane toads, with preventative management of those pathways significantly more efficient than post incursion management.

Numbers of cane toads (both alive and dead) intercepted at and beyond the State border checkpoints have remained very low. Since 2000, three cane toads have been intercepted at the Kununurra checkpoint (two in pot plants and one handed in), four cane toads have been

located in Kununurra (all found either at caravan parks or truck depots) and eight cane toads have been located throughout the remainder of the State as a result of goods (mostly food) being freighted into Western Australia or via the interstate travel of individual people).

In every instance where a confirmed cane toad is reported in Western Australia, DEC staff (with assistance from DAFWA) conduct surveillance and awareness-raising activities to ensure that no additional cane toads were brought into Western Australia at the same time and subsequently escaped. It is important to engage in these follow-up exercises to ensure the risk of a cane toad incursion is minimised as much as possible.

Detailed records of reports and incursions need to be kept on a centralised database, in order to identify patterns and to allow for follow-up surveillance of these areas. It appears that these activities may not be occurring on a sufficiently regular basis, particularly the need for quarantine staff to liaise with interstate exporters in toad-infested areas regarding inspection requirements prior to loading and for follow up surveillance after a cane toad is found. Additional resourcing to meet cane toad inspection requirements may be needed.

It is likely in the 2008/09 wet season, with the cane toad front moving close to the border, an increased number of cane toads will be sighted by travellers along the Victoria Highway. It has been reported that some people have been encouraging travellers along the highway to collect any cane toads they see and deposit them at the border checkpoint. However, the checkpoint does not currently have the capacity to euthanase and dispose of large numbers of cane toads on-site or to hold live cane toads. As long as travellers have the capacity to correctly identify and euthanase cane toads, they should be encouraged to do so at the location the cane toad is found.

A number of other roads could act as vectors for cane toad movement into the Kimberley region of Western Australia, notably the unsealed Buntine and Duncan roads. Signage was placed on these roads in 2005 to raise awareness of travellers and minimise inadvertent human-assisted movement of cane toads. It is unlikely a manned checkpoint at these locations would be logistically or financially viable, given the remoteness of the sites and the low volume of traffic (particularly during the wet season). Maintenance of signage and use of other awareness raising material for travellers is a more feasible option.

The establishment of a quarantine checkpoint south of Broome (in the arid zone where population modelling indicates cane toads could not become established as breeding populations, see Section 4) has been previously suggested, to minimise the potential for cane toads to inadvertently be transported from the Kimberley to south-western Western Australia. The construction of a quarantine facility would cost in the vicinity of $2 million, plus ongoing operational costs of approximately $700,000 per year (G. Pickles, DAFWA, pers. comm.). The establishment of alternative temporary road blocks to check vehicles for cane toads have a number of legal and occupational health and safety issues regarding the stopping of vehicles on the open road, without the ideal safety infrastructure (pull over lanes etc). An alternative to this is the development of an unmanned or honour system checkpoint, which could consist of a ‘cane toad pull over bay’ with information boards to raise awareness for the potential for new populations of cane toads to establish further south in the State, pamphlets and a disposal facility (which would require regular and frequent checking).

The establishment of a mobile or random quarantine checkpoint service, which conducts random checks on vehicles and facilities in high risk, priority areas, is considered a possible option. Such inspections could be done under the auspices of the ARRP Act declaration for cane toads and could potentially use existing DEC resources (e.g. the cane toad sniffer dog).

Intrastate and interstate rail, ship and air traffic (both commercial freight and domestic/tourist) all pose a risk in terms of movement of undesirable pests such as cane toads. For example, barges from Darwin regularly dock at remote coastal ports such as Kalumburu. These barges

are subject to standard quarantine protocols in the Northern Territory. Communities at remote locations in northern Western Australia need to be provided with appropriate information and support from Quarantine WA to allow communities to minimise the entry of high-risk items. Additional cane toad information sessions could also be provided to staff in remote tourism locations (such as Faraway Bay, Kimberley Coastal Camp, the proposed Berkeley River development) and to the Kimberley coastal cruising industry. Entry roads to remote tourism destinations require cane toad awareness signage (e.g. Gibb River Road, Kalumburu Road).

Quarantine WA officers currently check facilities such as airports, ship ports, train stations and areas where freighted QRM is unloaded or stored. A review of these processes will be required once cane toads are present in northern Western Australia, as non-QRM from cane toad infested areas is currently not inspected. A declaration or certification system specific to cane toads may be appropriate. Wyndham port and produce freighted out of the Ord River Irrigation Area are two examples where a review and upgrade of quarantine processes will be required. Any changes to quarantine processes will be based on an assessment of the level of risk posed and the likely benefit gained from changing an existing quarantine process.

Islands in the Kimberley will require a high level of protection from cane toads, and hence strict quarantine protocols. Accompanying education for mining companies, tourism ventures and Aboriginal people will also be required.

The authorised importation and keeping of cane toads in Western Australia is subject to a strict approval and management process, managed by DAFWA. The ARRP Act and existing policy in this area restricts the import of cane toads to high security public facilities for research or educational purposes in order to minimise biosecurity risks. DAFWA manage this process through a departmental work instruction and potential institutional importers should contact DAFWA to discuss the requirements and procedures for importing.

18.2 Surveillance processes

A surveillance system was established in 2005 to monitor areas of the State where cane toads may accidentally become established, with a focus on areas where tourists arriving from cane toad affected areas are likely to camp (e.g. water bodies, traveller resting bays, caravan parks, roadside stops). The surveillance system relies on awareness-raising material alerting travellers to the risks posed by cane toads, and of the presence of DEC staff, Quarantine WA staff, community action groups, and the cane toad information and reporting telephone line so that members of the public know what to do in the event they find a cane toad in a cane toad free area.

Any suspected cane toad sighting in Western Australia ahead of the main front can either be reported to the cane toad information and reporting telephone line, to DAFWA or to the nearest DEC office. Assistance will be provided to ascertain the identification of the animal and, where necessary, DEC staff will then conduct a field visit to locate the animal, confirm identification, and remove, euthanase and dispose of the animal appropriately. Statistics on reported and confirmed sightings and actions taken will be recorded on a standardised cane toad database used by all agencies and organisations.

The surveillance system appears to be working well to date, with the four known finds of cane toads (both alive and dead) in the Kununurra area being readily reported by members of the Kununurra community to KTB, Kimberley Vet Centre, DEC or DAFWA. Suspected sightings of cane toads elsewhere in the State have been reported to the cane toad information and reporting line or to DEC or DAFWA, and no satellite populations of cane toads are known to have established in Western Australia. Ensuring that no populations establish ahead of the main front will remain a key priority for Western Australia. Individual

hitch-hiker cane toads are not able to breed in new locations, as both a male and a female are needed for external fertilisation to occur. However repeat, undetected and unmanaged hitch-hiker cane toads are clearly of concern.

The surveillance process will be enhanced further through the development and distribution of new extension material, advertising the information and reporting telephone line, and greater media attention and general publicity of the cane toad issue once they are present in Western Australia.

	Preventing the establishment of new cane toad populations actions	**Responsibility**	**Priority/ Time frame**
47	Review the declaration of cane toads under ARRPA/BAMA once breeding populations of cane toads are established in Western Australia.	DAFWA	When required
48	Provide an enhanced level of cane toad awareness information and vehicle inspection at the Kununurra road checkpoint over the 2008/09 wet season.	DAFWA and DEC	High/ early 2009
49	Conduct pathway analyses and risk assessment to identify potential sources and likelihood of human assisted cane toad movement within Western Australia.	DAFWA	High/ early 2009
50	Identify intrastate quarantine processes and procedures that will need creating or strengthening once cane toads are present in Western Australia, particularly for road, ship and air freight and the tourism/travel industry.	DAFWA	High/ early 2009
51	Assess the risk posed by non Quarantine Risk Material (QRM) that is or will be transported from cane toad infested areas into cane toad free areas, and strengthen quarantine inspection and auditing processes accordingly.	DAFWA	High/ early 2009
52	Investigate the requirement/cost benefit of creating additional road checkpoints to minimise the possibility of satellite populations of cane toads becoming established in southern Western Australia.	DAFWA	High/ early 2009
53	Establish a mobile/random checkpoint facility for use ahead of the cane toad front.	DEC and DAFWA	High/ early 2009
54	Broaden the future use of Nifty, the cane toad sniffer dog, to conducting quarantine work at tourism and freight targets in and around Kununurra and Wyndham, and as part of the mobile facility.	DEC	Medium/ early 2009
55	Create a joint database to record cane toad sightings, presence and removal via a coordinated data collection and GIS system, linked to the Freecall reporting system.	DEC, DAFWA and community groups	High/ early 2009
56	Eradicate individual cane toads that are detected across the State ahead of the main front.	DEC	Ongoing

57	Manually remove any satellite toad populations discovered ahead of the main front.	DEC and community groups	Ongoing
58	Raise awareness of the surveillance network to monitor areas in the State where cane toads may accidentally become established and implement rapid-response control operations to deal with reports of toads elsewhere in the State.	DEC, with input from DAFWA	High / ongoing

19. RESEARCH ON CANE TOAD CONTROL

Manual control methods to prevent the movement of cane toads into Western Australia, whilst playing a role in temporary mitigation and increasing knowledge of cane toad behaviour, ecology and control, are unlikely to be sustainable on a large scale in the longer term. Cane toads reproduce at a very rapid rate – a female can produce up to 35,000 eggs in a single clutch, twice a year, although there is high mortality of tadpoles and metamorphs (DEWHA 2005). Consequently, unless a very high proportion of cane toads are consistently removed from a site, breeding and recolonisation occurs so rapidly that any population decrease is short-lived (see Section 15.1).

A long-term solution or combination of solutions is required to minimise the impact of cane toads. Significant resources have been put into research since the mid 1980s to find a suitable biological control agent for cane toads. Outcomes of this research have been varied; a summary of the main areas of research is provided below.

19.1 Genetic and immune control options

Genetic research has focused on a number or areas:

- viruses from Venezuela (the central area of the evolutionary origin of the *Bufo* genus) that would control cane toads found in Australia, were not pursued as they also killed Australian frogs in laboratory tests (Shannon and Bayliss 2008);
- mechanisms to disrupt the development of cane toad tadpoles into metamorphs by using an infectious recombinant virus; tadpoles were exposed to cane toad genes that are normally expressed later in development and inducing an auto-immune response to interfere with normal development (Pallister *et al*. 2008);
- Ribonucleic acid interference (RNAi), which results in disrupted protein production;
- exploitation of the properties of the Na+ K+-ATPase enzyme in toads, which is involved in ion transport across membranes and is a factor in the resistance of cane toads to their own toxin (Pallister *et al*. 2008); and
- adapting the 'daughterless' technology pioneered in fish for application to the cane toad by developing a gene that would ensure all cane toad offspring are male (Koopman 2006).

The control of cane toads by the release of sterile males or the release of males that produce sterile offspring has also been proposed by Mahoney and Clulow (2006). Sterile males would be produced, by rearing triploid hybrids with uneven chromosome numbers, and released into the wild to compete for and mate with wild females.

However, modelling work by McCallum (2006) shows that sterile male release can achieve control, but only if about 300 times more sterile adult males are released each year than the

number in the population, an estimation that significantly limits the feasibility of it as a control method.

The ability to progress the development of biological control agents has been hindered by a lack of knowledge of cane toad genetics and proteins (Australian Genome Alliance 2006). Since 2006 the Western Australian Government has invested in the Australian Cane Toad Genome Project, to determine the complete genome sequence of the cane toad. It is hoped this research will help focus control efforts, but is likely to take many years. An extensive program of laboratory, enclosure and field trials, requiring significant investment in time and funding, would be necessary to test the feasibility of any biocontrol measures.

Additionally, ensuring there is no risk of unintended damage to native fauna by genetic or immune control measures is paramount. *Bufo* species, some of which are endangered, are found throughout the world, including Indonesia. Australia would need to be certain of the benefits to be achieved against the potential risks posed to other species, and whether these risks can be adequately managed.

19.2 Chemical ecology

The possibility of identifying alarm pheromones of cane toad tadpoles and attractant pheromones emitted by adults, and using these to interfere with the normal development or behaviour of the species, has been suggested at successive research forums on cane toads (Hyatt and Robinson 2004, Alford 2005, Tyler 2006). A precedent exists for feasible application of this type of technology – the salmon industry in the Great Lakes (USA) was reportedly saved when pest lampreys were controlled with the use of pheromones, by attracting the animals into ditches leading away from the lakes, allowing for eradication operations (M. Tyler, noted in Hyatt and Robinson (2004)). The extraction of pure parotoid secretions from female cane toads has revealed a male attractant (sex pheromone) (M. Tyler, pers. comm.). However, there have been no trials to demonstrate a behavioral response to the attractant pheromone.

Research by the University of Sydney has discovered an alarm pheromone in cane toad tadpoles which, when introduced into cane toad tadpole populations, accelerates the metamorphosis process. This results in decreased tadpole recruitment and survival, and in the development of smaller toads (Hagman and Shine 2008a). Laboratory and field trials have tested the response of cane toad tadpoles and metamorphs to a range of chemical stimuli. It was found that filtered fluids from crushed cane toad tadpoles contained scent cues that elicited strong avoidance by cane toad tadpoles (Hagman and Shine 2008a).

Clarification was needed as to whether these isolated cane toad alarm pheromones would impact negatively upon native frog species. In further laboratory trials (Hagman and Shine 2008b), minor behavioral responses to cane toad alarm pheromones were detected in six native Australian frog species. Native tadpoles either ignored the stimulus, or tended to approach it rather than avoid it.

These results are encouraging for the potential use of toad-specific chemicals to manipulate the behaviour of cane toad tadpoles in the field, without posing significant negative effects on native Australian frogs. The development of a synthetic alarm pheromone could potentially have future application in attracting cane toads for either trapping purposes, or to deter the animals from sensitive water bodies. The feasibility of the latter would be restricted to small, contained waterways, rather than broadscale control. It is most likely that the potential control methods developed from this research would be best applied as part of a combination of control measures.

The chemical composition, variability and the relative/absolute toxicity of Australian cane toads was examined by the University of Queensland's Institute for Molecular Bioscience

(Capon and Hayes 2008). A comprehensive chemical analysis of the cane toad cardiotoxic steroids (bufadienolides) was undertaken, across all life stages, and using specimens from eastern and western extremes of the cane toad colonised areas of Australia (KTB supported this research with the provision of 500 frozen cane toads from the Northern Territory). Of particular note, the research found:

- replenishment rates for bufadienolides following a predatory attack are slow (measured in weeks);
- cane toad eggs possess a rich diversity of bufadienolides, quite different from those found in the adult toad, even though the eggs lack any glandular structures capable of bufadienolide biosynthesis;
- as eggs develop, bufadienolides levels diminish to a point where later stage tadpoles contain minimal levels of bufadienolides (i.e. are non-toxic). Growing metamorphs develop a parotoid gland and the levels and diversity of bufadienolides become similar to that of adult toads; and
- bacteria present within the parotoid gland and oviduct are capable of chemically modifying cane toad bufadienolides.

From these observations, it appears that bufadienolides play an important role in cane toad survival across all life stages, and that this process is influenced by specialist bacteria. Capon (pers. comm.) hypothesised that cane toad bacteria diversify the chemical composition of the toxic secretions, allowing for greater ecological effect in (a) protecting adult toads by broadening the effectiveness of the cardiotoxic effect against a diverse array of Australian native predators, and (b) by enhancing the survival of eggs and tadpoles and possibly pathogenic fungi and bacteria.

Further research to gain a more detailed knowledge of the relationship between cane toads, bufadienolides and bacteria and to isolate, identify and evaluate the cane toad alarm pheromone is warranted, as the potential exists to reveal new strategies for minimising the environmental impact of cane toads (R. Capon, pers. comm.).

19.3 Lungworms

Parasitic nematode lungworms are known to be present in Australian populations of cane toads and in native Australian frogs, and are potentially a tool that could be used to reduce the fitness and number of cane toads at the invasion front.

Research has confirmed that lungworms can significantly reduce viability of metamorph cane toads (Kelehear 2007). Further work is required to determine whether the parasite can affect toad populations rather than just individual toads, and to ensure that native frog species are not at risk as a result of greater exposure to the lungworm.

Rhabdias lungworms are difficult to identify from morphology alone. Research by the University of Sydney has been ongoing into the identification, location and origin of these lungworms, based on DNA sequence analysis. Results to date indicate that the lungworm found in Australian cane toads is *R. pseudosphaerocephala*, an introduced species most probably brought in with the original toad introduction (Dubey and Shine 2008).

DEC is providing funding to the University of Sydney for this research program over a two-year period. DNA sequencing methods will be used to identify which lungworm taxa occur in frogs and cane toads in north-western Australia and experiments will evaluate the ability of cane toad lungworms to infect native frogs. The effectiveness of lungworm infection in reducing cane toad fitness; and field-based trials to infect wild populations of cane toads, will analyse survival, growth and recruitment rates of juvenile cane toads.

Investigations conducted by a Dutch research student supported by KTB found a lungworm, initially identified as *R. hylae,* in cane toads located 80 kilometres behind the cane toad front (Groffen 2008). The lungworm was subsequently confirmed to be *R. pseudosphaerocephala.* The work involved sampling of 54 sites behind the westerly moving front of cane toads. The survey results showed that up to 80 per cent of cane toads were infected with the lungworm in areas such as Victoria Bridge, whereas lower infection densities of 20 per cent existed at more westerly sites such as Dingo Springs (J. Groffen, pers. comm.), which are closer to the frontline.

It is hoped that the introduced lungworm does not infect native frog species and that it could be used as a control measure. In laboratory trials, the lungworm results in high mortality rates in metamorphs and reduces the fitness of adult cane toads (Shine pers. comm.). The University of Sydney is also researching parasites that are endemic in native frogs that may assist in the control of toads. Such a control method has the advantage of being able to spread the parasite through the distribution of cane toad faeces, rather than via live cane toads.

19.4 Taste aversion learning

Various vertebrate species (quolls, snakes, large lizards, monitors and freshwater crocodiles, see Section 6.1) that eat cane toads are at risk, with anecdotal reports of initial population mortality rates of up to 95 per cent. Even when large numbers of cane toads are removed, many predators still die, as they only need to encounter one large cane toad to receive a lethal dose. There is some evidence to suggest that predator foraging behaviour can change to reduce their vulnerability to cane toads. For example, laboratory trials with common planigales (*Planigale maculata*) have demonstrated that small carnivorous marsupials learn to avoid eating toads (Webb *et al.* 2008). Further observations using native frog and cane toad skin secretions painted onto crickets, suggest that 'cane toad aware' planigales used chemical rather than visual cues to assess prey palatability – the addition of cane toad scent caused some of the predators to sniff and reject otherwise preferred prey (Webb *et al*. 2008).

It has been proposed that 'teaching' native fauna to avoid toads by using either small 'teacher toads' ahead of the cane toad front, or by distributing low toxicity baits may stimulate taste aversion learning. These techniques would give predators a non-lethal dose of cane toad toxin, thereby permitting their survival and encouraging their avoidance of cane toads in future encounters (Webb *et al.* 2008; R. Shine pers. comm.). 'Teacher toads' would be male, sterile, infected with lungworms, and sourced from slow-moving genetic stock to slow their dispersal. Despite the potential value of such a technique, reservations have been expressed about the introduction of cane toads, even to areas immediately ahead of the cane toad frontline.

Webb *et al.* (2008) outlined several key steps in the development of low toxicity baits. First, the chemical that predators respond to as a result of aversion learning would need to be identified, synthesised and incorporated into low toxicity baits. Secondly, trials would need to be conducted to confirm that captive predators that consume the baits subsequently display an aversion to live toads. Baits could then be deployed in the field at strategic trial sites, targeting small populations of especially vulnerable fauna. Webb *et al.* (2008) highlighted the need for further research on whether taste aversion learning is retained for longer time periods (more than 28 days) and whether subsequent attacks on cane toads by 'forgetful' predators result in fatal or near fatal outcomes.

	Research on cane toad control actions	Responsibility	Priority/ Time frame
59	Promote awareness and possible synergies between various research programs conducted across Australia, and assist with projects that align with the intent of this Strategy.	DEC and SRG	High/ ongoing
60	Maintain awareness of new developments in various research programs into genetic and immune control options, and investigate the application of results or further funding requirements where appropriate.	DEC and SRG	Medium/ ongoing
61	Investigate the possible application of pheromones (particularly in combination with other control measures) and determine further funding priorities and requirements.	DEC and SRG	High/ early 2009
62	Support and facilitate further research into the identification of parasitic lungworms; impacts on native frog species and the impact of lungworms on cane toad survival, growth and recruitment in laboratory and field situations.	DEC, community groups, SRG	High/ ongoing
63	Investigate the potential of using low toxicity baits to stimulate taste aversion learning in native predators, dependant on results of laboratory work, support and facilitate field-based trials.	DEC, in collaboration with research organisations	High/ mid 2009
64	Investigate ways in which community groups can participate in, and contribute to, research programs, such as data collection, conducting necropsies, the provision of cane toad samples and the dissemination of control techniques.	DEC, with community groups and research organisations	High/ ongoing

20. EUTHANASIA AND ANIMAL ETHICS

The *Animal Welfare Act 2002* and accompanying regulations govern the treatment and welfare of animals in Western Australia. The Act provides standards for animal care and use, protects animals from cruelty and safeguards the welfare of animals used for scientific purposes. The Act is administered by the Department of Local Government and Regional Development through local government. Where cane toads are encountered in Western Australia all parties involved in the control of cane toads are required to comply with the Animal Welfare Act, the Wildlife Conservation Act and the Agriculture and Related Resources Protection Act (or, when fully operational, the BAM Act).

All control programs in Western Australia must consider the ethical treatment of cane toads, as cane toads require the same level of consideration from an ethics perspective as domestic, exotic and native animals. Control and euthanasia are to be conducted humanely, be target specific, and cause no suffering to target or non-target animals. In order to achieve this, the people undertaking these activities must be competent and where necessary licensed to do so.

It is important to note that across Australia misidentification of native frogs as cane toads is common. This continues to occur even in areas that cane toads have inhabited for many years. It is essential that members of the public are completely certain of the identification of the animal they have captured prior to euthanasing it. People encountering a suspected toad in Western Australia are strongly encouraged to restrain the animal (in a bag or container with air holes) and report it to DEC's cane toad reporting and information line (see Section 12.7) *before* attempting to kill the animal. Advice should immediately be given on how to

confirm whether the animal is a cane toad. This will hopefully minimise the chances of native frogs being mistaken for cane toads and killed, while helping to ensure that toads found in areas previously free of the pests are adequately detected and euthanased.

Alternatively, people can transport suspected cane toads to their local DEC office (or other facilities where suitably experienced people are located, such as veterinary clinics). In areas outside the recognised distribution of cane toads, live cane toads can also be collected by DEC or Quarantine WA officers (i.e. hitch-hiker toads ahead of the cane toad front).

For most species of vertebrates there are a number of methods of humane euthanasia that can be used. The most appropriate method is dependent on the age or stage of development of the toads, the facilities or equipment available and the skill level of the person undertaking the euthanasia. Ethical euthanasia rather than cost should determine the choice of method.

These guidelines also include sections on the euthanasia of a range of native and introduced animals and draws on research and advice from key sources such as the American Veterinary Association and the Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART). The current acceptable method for euthanasing amphibians is stunning and decapitation or stunning followed by pithing (ANZCCART 2001; American Veterinary Medical Association (AVMA) 2007). The following discussion relates to methods that have not been endorsed by groups such as ANZCCART or are still under consideration or testing.

Euthanasia via hypothermia (cooling and then freezing the cane toad) has previously been recommended by the Western Australian Government and other jurisdictions managing cane toads as an appropriate method for people to kill cane toads. Freezing alone is unacceptable as a form of euthanasia for vertebrates. Thus. cooling to 3-4ºC for at least 60 minutes, then deep freezing at -20ºC for at least 24 hours has been deemed acceptable by the Department of Local Government and Regional Development. The practicality of this method for use in the field, and specifically in situations where large numbers of toads, metamorphs or tadpoles have to be euthanased means that this method has serious limitations. It should be noted that this method is not recognised as humane by ANZCCART (2001).

The suitability of using of carbon dioxide to euthanase large numbers of toads needs further clarification, as results of informal trials in the laboratory and field situations have identified conflicting results (S Brett, pers. comm.; P. Mawson, pers. comm.).

Other trials using a range of topically applied chemicals (i.e. to the skin) indicated that many chemicals advocated in the common literature and on websites (including benzocaine, lignocaine and alcohol) have not been demonstrated to provide effective or humane euthanasia of cane toads (P. Mawson, pers.comm).

DEC has also trialled the use of modified nail guns (pneumatic and butane gas cylinder powered) to euthanase cane toads, and found the method to be both instantaneous and resulting in the humane death of toads, with no damage to associated tissue or the parotoid glands.

A common household antiseptic applied to the skin of toads has been used by some people to kill adult and metamorph cane toads. This method appears to be as humane as others that were tested by DEC. It is important from DEC's perspective that endorsement from ANZCCART and local government (under the Animal Welfare Act) to use this antiseptic should be sought. The application of the antiseptic to treat water bodies supporting tadpoles should not be used because it contains alcohol, synthetic soaps, pine oil and other chemicals that alone or in combination could be highly damaging to other aquatic animals.

The antiseptic is highly toxic to native frog species. Due to the level of difficulty in accurate identification at the metamorph stage, residual and non-target impacts have not been determined. DEC recommends against spraying diluted antiseptic on metamorphs as part of control efforts except in selected sites which includes areas away from water bodies and riparian areas where it can be administered by suitably skilled people who can accurately identify cane toads.

Application of any other product (such as bleach, salt, vinegar, and domestic pesticide sprays) does not result in a certain, timely or humane death of cane toads, and is strongly recommended against. Some researchers and private companies have been involved in the development of a spray can pesticide specific to cane toads (see section 15.6), which could, in future, be widely available as a retail product, however, no such product has yet been registered for commercial use.

Community groups involved in toad-busting activities are required to euthanase and dispose of cane toads in far greater numbers than other people. The current methods of euthanasia and disposal predominantly used by these community groups (in the Northern Territory) are either (a) gassing with carbon dioxide followed by burying or (b) placing the toads in a bag and applying antiseptic followed by burying.

	Euthanasia and animal ethics actions	Responsibility	Priority/ Time frame
65	Produce information material outlining the necessity of correct identification of cane toads prior to euthanasing them, and advertising the role of DEC's cane toad reporting and information line in identification.	DEC	High/ early 2009
66	Conduct further trials on the use of carbon dioxide as a means of euthanasing large numbers of cane toads.	DEC	High/ early 2009
67	Review animal ethics recommendations and develop in consultation with the community groups procedures for appropriate methods of euthanasia.	DEC, with the SRG	High/early-mid 2009
68	Advertise the presence of identification and disposal points in the towns where these facilities are established.	DEC, with SRG input	High/ ongoing
69	Produce information material outlining recommended and non-acceptable methods of euthanasing and disposing of cane toads, targeted at both residential communities and toad busting groups.	DEC, with SRG input	High/ early 2009

21. RESOURCING AND BUDGET

Unprecedented levels of resources and effort from both community and government have been directed towards slowing the movement of cane toads towards Western Australia. KTB and STTF have both accessed State and Federal funding, in addition to private donations and volunteer time, to generate a substantial increase in awareness across the community of cane toads and their impacts, and to mobilise thousands of volunteers to manually remove cane toads.

To date, the State Government has provided approximately $750,000 to STTF and $494,225 to KTB for community cane toad initiatives. In addition to this, the Minister for Environment has recently confirmed the State Government is providing KTB with $1.2 million through DEC, for their field based and community support activities, over a four-year period.

The State Government has also invested in a number of awareness raising, research and cane toad control initiatives, as outlined in the dot points below and Appendix 4.

- DEC has supported a five-member cane toad surveillance and control team based in Kununurra since July 2005 (previously operated by DAFWA from December 2004). The regional cane toad budget also supports the State Cane Toad Initiative Community Coordinator position that commenced November 2008. This operational program requires a large proportion of the $600,000 per annum DEC Kimberley Region cane toad budget.
- 'Nifty' the detector dog. Training and purchase costs were about $10,000, with an annual operational cost of approximately $1,500 and considerable, out-of-hours staff time.
- The State Government allocated $500,000 for a cane toad awareness program in 2005/06. The 'Help Us Fight an Alien Invasion' campaign ran in television, print and radio media in 2006.
- The State ($4.3 million) and Commonwealth ($2.7 million) governments announced a joint $7 million, four-year program to undertake a biological survey of islands near the Kimberley coast in November 2006.
- Since 2005, the State Government has funded additional human resources for the border quarantine checkpoints near Kununurra and at Eucla as part of the State Cane Toad Initiative. Expenditure to date for these services has been approximately $400,000.
- The State has contributed $60,000 towards a $500,000 Australian Research Council-funded project by the University of Sydney to determine the impact of cane toads on a variety of native fauna.
- DEC has allocated $130,000 to for a Principal Research Scientist to investigate the impact of cane toads on native fauna in the east Kimberley as part of the State Cane Toad Initiative.
- Funding of $300,000 over two years has been provided towards a University of Sydney research project investigating the potential role of nematode lungworms in the control of cane toads.
- $926,932 has been provided to the Australian Cane Toad Genome Program by Professor Grant Morahan from the WA Institute for Medical Research (WAIMR).

The State Government has allocated $750,000 per annum to DEC for the State Cane Toad Initiative for the period 2006/07 to 2009/10. As outlined above, the State Government has also committed to fund KTB $1.2 million through DEC, for four years from 2008/09, to support field and community-based management actions.

The 2007 Peacock report recommended that support for community effort continue to be provided on the basis that community groups are able to make a positive contribution towards management outcomes for cane toads, despite the difficulties in achieving an objective of stopping the forward movement of cane toads. However, Peacock also stated that community groups should not be supported financially to the level where resources were diverted from promising research into long-term control of cane toads. The State Government seeks, through this draft Strategy, to find a balance between supporting communities with information and tools to manage cane toads in the short term, and finding longer term management solutions for cane toads.

	Resourcing and budget actions	Responsibility	Priority/ Time frame
70	Continue to provide funding and support to appropriate cane toad management actions and research programs.	DEC/State Government	Ongoing
71	Provide support to groups to access State and Commonwealth funding sources for cane toad management programs.	DEC, with SRG input	Ongoing
72	Ensure that expenditure of State funds is open and accountable, with the State cane toad program and State funded community programs providing an annual report to the SRG of expenditure and actions implemented.	DEC and community groups	High/ each financial year

22 EVALUATION OF STRATEGY

22.1 Adaptive management

Adaptive management is an approach that involves learning from management actions, and using that learning to improve the next stage of management (Holling, 1978).

This draft Strategy forms the beginning of the adaptive management process including an annual review and the documentation of any changes. Given the nature of cane toad management issues (e.g. rapid movement of the frontline, changing awareness and acceptance of cane toads within the east Kimberley environment, and progress and changes to research programs), it is important that the final Strategy undergoes continual review and consolidation and that old versions of the Strategy be kept as evidence of progress on the cane toad issue.

22.2 Performance measures

The following measures will form part of the review reporting process.

Performance indicator	Time frame
Final State Cane Toad Strategy released	Mid 2009
Release of new publication material	January to June 2009
Develop a protocol for cane toad incident reporting	March 2009
Development of a State-wide communication plan	March 2009
Community forum in Kununurra	Mid 2009
Gaps and funding constraints identified in intrastate quarantine and steps commenced to address these	June 2009

East Kimberley and State-wide community awareness raising activities planned	2009
Coordinated approach to the delivery of educational information developed and implemented	June 2009
Development of protocols for animal ethics	June 2009
Review Strategy and actions within to identify new developments and management requirements	May 2010 and every year after this
Investigate the use of fences to protect key biodiversity areas and identify opportunities to embed the maintenance of these to regional operations and/or Indigenous employment programs	June 2009
Develop a biodiversity asset protection matrix for the east Kimberley that can be replicated for other regions if necessary	June 2009
Identify opportunities to use data collected through biodiversity education programs to give an indication of abundance of high risk species living in urban areas of the east Kimberley and implement strategies for management and protection of these	June 2010
Identify other threatening processes impacting on high risk species and develop management strategies to build the resilience of ecosystems	June 2010
Review the progress of biological control research and identify the feasibility of long-term outcomes	Dec 2009 and every year after this
Review the SRG's role in contributing to the delivery of actions identified in the Strategy and promotion of information exchange, coordinated effort and collaboration between stakeholders	June 2009 to be reviewed on a continual basis
Review current research activities, identify gaps in research programs and make recommendations	June 2010

22.3 Review of Strategy

The final Strategy will cover a 10-year planning period and provide 10 key actions for implementation in Western Australia over the next five years in order to achieve these

objectives. DEC, with input from the SRG, will conduct an annual review of progress made in delivery of actions in the Strategy. The State Cane Toad Initiative Community Coordinator will be responsible for producing an annual report as a result of this review process, which will be publicly available. The review will highlight progress being made and any changes which need to be implemented within the Strategy. The Strategy adopts an adaptive management approach, where management actions are continually open to review given outcomes achieved and new knowledge gained. A major review of the Strategy will also occur after the first five years, to determine whether the objectives and key actions of the Strategy remain valid.

	Evaluation of Strategy Actions	Responsibility	Priority/ Time frame
73	Report on progress against action items and objectives of the State Cane Toad Strategy on an annual basis	DEC, with SRG input	High/ on an annual basis
74	Complete a major review of the State Cane Toad Strategy after five years, subject to public comment.	DEC, with SRG input	High/ after five years

Appendix 1: Impact of cane toads

Impacts on biodiversity

Somewhat surprisingly, comparatively little quantitative data have been produced on the impacts of cane toads since their introduction in the 1930s. Some of the more recent research undertaken to quantify the impacts of the cane toad on biodiversity include:

- targeted surveys of the northern quoll in Kakadu National Park (Oakwood 2003);
- monitoring of the calling activity of frogs in the Roper River Valley and in Kakadu National Park (Grigg *et al*. 2003);
- resurvey of sites from an earlier broad-scale vertebrate fauna survey of Kakadu National Park (Watson and Woinarski 2003 a + b);
- numerous studies on the impacts of cane toads on goannas;
- research on impacts on freshwater crocodiles;
- numerous studies on the susceptibility of reptiles and snakes to cane toad toxin; and
- research conducted in the Northern Territory by DEC and the University of Sydney on the impact of a suite of east Kimberley fauna predating on cane toads.

(i) Toxic ingestion of cane toads

As discussed in Section 3 of this document, the cane toad is toxic in almost all of its life stages: eggs, tadpoles, metamorphs and adult toads. Cane toads possess poison glands (known as parotoid glands) on each shoulder, from which a toxin is released when they are threatened. If ingested, this venom can cause elevated heart rate, excessive salivation, convulsions and paralysis, which can result in death for many native species (McRae *et al.* 2005). The toxin produced by cane toads can also be absorbed through predator body tissues including the eyes, mouth and nose, so that even gripping a toad in the mouth may cause death.

Studies completed in Kakadu National Park (Oakwood 2003) demonstrated that local extinction of the northern quoll (*Dasyurus hallucatus*) occurred following cane toad invasion. Significant declines in northern quoll populations have previously been reported in targeted quoll surveys (Braithwaite and Griffiths 1994) and in broad fauna surveys completed in the Northern Territory (Watson and Woinarski 2003 a + b), where declines were considered to be a direct result of lethal ingestion of cane toad toxin.

The Commonwealth Government acknowledged that remaining mainland populations of northern quolls found in the 'Top End' are expected to disappear over the next 10 years (DEWHA 2005). It is considered likely that this will also occur for many of the Kimberley mainland populations, although not in the next 10 years and not in the Pilbara, where northern quolls also occur (D. Pearson, pers. comm.). It has been estimated that the disappearance of these populations will constitute a further 30 per cent decline in the pre-toad distribution of the species (DEWHA 2005). With the exception of some island locations, an almost total cane toad colonisation of the northern quoll's range is expected. It will be difficult to accurately determine the impact of cane toads on the northern quoll in Western Australia given two factors: the species has already disappeared from much of the east Kimberley; and there are limited data on northern quoll populations. It is uncertain to what degree the species may recover from the initial population declines in the long term (see Section 17).

More recent work (Webb *et al.* 2008) on smaller marsupials such as the common planigale (*Planigale maculata*) investigated the response of these species to encounters with cane toads. While some planigales died after attacking cane toads, most individuals survived and rapidly learned to avoid cane toads. This research suggests possible ecologically based control measures that warrant further investigation (see Section 19).

Previous work (Begg *et al*. 2000, Catling *et al*. 1999, Doody *et al*. 2004) on the impact of cane toads on freshwater crocodiles (*Crocodylus johnstoni*) has reported the death of individuals but with no change in overall abundance. Letnic *et al*. (2008) attempted to quantify the impact of cane toads by monitoring numbers of freshwater crocodiles found in the Victoria River, before and after the arrival of cane toads. They reported massive mortality of freshwater crocodiles during the passing of the invasion front, with counts declining by as much as 77 per cent, with intermediate sized, or sub-adult animals most affected. These numbers were supported by anecdotal reports from pilots, rangers, tour operators and the public of multiple freshwater crocodile deaths in the upper semi-arid reaches in the Gulf of Carpentaria and in the Katherine region. In contrast, in areas in Queensland where cane toads have been present for many years, there is little evidence that cane toads have caused freshwater crocodile mortality. Letnic *et al.* (2008) suggested that cane toad and freshwater crocodile encounters were more likely in a semi-arid environment as cane toads needed to return to water sources to rehydrate. Hence the impact of cane toads on freshwater crocodiles may increase with increasing aridity, with potential flow-on effects within riparian and aquatic ecosystems.

Several field studies have documented declines in populations of goannas and monitors (*Varanus* spp) due to the presence of cane toads. Doody *et al*. (2004) reported a 64 per cent decrease in survival of yellow-spotted monitors (*Varanus panoptes*) in a seven-month period following cane toad invasion. Griffiths and McKay (2007) attributed a 77 per cent drop in yellow-spotted monitor numbers in the 12 months following invasion to cane toads, although they detected no decline in Mitchell's water monitor (*V. mitchelli*) or Merten's water monitor (*V. mertensi*) numbers over the same period. Ujvari and Madsen (2008) radio-tracked yellow-spotted monitors before and after the arrival of cane toads and concluded that at least 90 per cent of native adult male goannas succumbed to cane toads. Up to 85 per cent of all Australian species of *Varanus* could potentially be at risk, based on their diet, distribution and susceptibility to the cane toad toxin (Smith and Phillips 2006). Doody *et al.* (2006) noted flow-on effects from the decline in goannas and monitors such as increased survival rates of freshwater turtle eggs on which they feed.

Anecdotal evidence exists of severe population declines of Gould's sand monitor (*Varanus gouldii*), Merten's water monitor, yellow-spotted monitor and the spotted tree monitor (*Varanus timorensis*) occurring in Queensland in almost immediate response to cane toad colonisation (Burnett 1997). Eight of the 20 monitor species whose distributions overlap potential cane toad distribution were considered to be at high risk from cane toads due to their micro habitat preferences, distribution and diet (Burnett 1997).

Preliminary data from an intensive radio tracking study of goannas, initiated in September 2002 in Kakadu National Park, indicates an initial mortality rate of 50-70 per cent following the arrival of cane toads. It was estimated that at least a 50 per cent decline occurred in populations of yellow-spotted monitor over a seven-month period (late Oct 2003 to late May 2004) coincident with the arrival and establishment of cane toads (Holland 2004). The author reported that most goannas died following attempted ingestion of cane toads.

Anecdotally, there are reports of recovery of goanna populations occurring a significant period of time after cane toad invasion. Little quantitative data exist on whether or not recovery of goanna populations is likely to occur in the Northern Territory as has been anecdotally reported as occurring in Queensland. Some species are known to persist in

areas of Queensland that have had cane toads present from a few to many decades but there are no quantitative data on pre-toad population sizes.

Work by the University of Sydney at Fogg Dam is continuing investigations into the strong selection pressures cane toads are placing on a variety of frog-eating predators, regarding both the evolution of bufotoxin resistance and changes to foraging behaviour.

Phillips *et al.* (2003) stated that most individuals of frog-eating snakes would probably die after ingestion of cane toads, in a study that identified 49 snake taxa potentially at risk from cane toads (30 per cent of all Australian snake species). Most Australian snakes have a low tolerance to cane toad toxin, with a small number of exceptions, such as keelbacks (*Tropidonophis mairii*) and slaty-grey snakes (*Stegonotus cucullatus*). Some snake species possess a low resistance to the toxin but have a small relative head size and thus could only ingest small, less toxic toads (Phillips *et al.* 2003).

Research by Phillips and Shine (2006) found surprisingly rapid adaptive responses in Australian black snakes (*Pseudechis porphyriacus*) following invasion of cane toads. Snakes from toad-infested areas were shown to have increased resistance to toad toxin and a decreased preference for toads as prey. Separate laboratory experiments suggested that these changes were not attributable to learning by individual snakes or to acquired resistance, but that black snake behaviour and physiology had rapidly evolved in fewer than 23 snake generations (Phillips and Shine 2006).

Smith and Phillips (2006) examined species distributions and concluded that 85 per cent of goanna species and 59 per cent of dragon lizards were potentially at risk from cane toads. The authors tested 11 species of reptile for resistance to the cane toad toxin and although a high level of variation was found within species, all species (with the exception of saltwater crocodiles *Crocodylus porosus*) that appeared to be very resistant to the toxin were easily capable of consuming a cane toad large enough to cause death.

Crossland (1997) and Crossland and Alford (1998) documented the ingestion of cane toad tadpoles by three species of native tadpoles (*Litoria* spp.) resulting in high rates of mortality, with a fourth species unaffected. Detailed data on the impact of ingesting cane toads by native frog species are not available.

Similarly, while it is known that 100 per cent mortality of a particular species of freshwater snail occurs from ingestion of cane toad eggs or tadpoles (Crossland and Alford 1998), there have been no studies to assess population impacts on this group.

'The biological effects, including lethal toxic ingestion, caused by cane toads (*Bufo marinus)*' has been listed as a key threatening process under the EPBC Act. It is acknowledged that the northern quoll, goannas, freshwater crocodiles and some snake species have been severely impacted at the population level due to their predation of cane toads. These impacts appear severe in the short term, however further research is required to determine the long term population impacts on these species. Currently only anecdotal evidence is available regarding population recoveries of a few species.

(ii) Predation by cane toads

While larval cane toads are algal, detritus and suspension feeders, metamorph, juvenile and adult cane toads feed on a wide variety of small prey items, predominantly ground dwelling arthropods. Cane toads are thought to consume approximately 200 food items per night, far more prey than most native frogs ingest in the same period (DEWHA 2005). The bulk of the diet is usually ants, beetles and termites, although they can eat anything that fits in their

mouth including a wide variety of insects, frogs, small reptiles, mammals and birds (DEWHA 2005).

Investigations completed by community groups working on the cane toad frontline have discovered that cane toads consume large quantities of invertebrates, with dissected toads containing centipedes, spiders, scorpions, cockroaches, native frogs, crabs and a wide variety of beetles (STTF 2007). One dead female toad examined by STTF during the 2007 muster was found to have 19 frogs *(Litoria inermis)* in its stomach.

A study undertaken in the western Gulf of Carpentaria in the Northern Territory reported that the abundance of beetles was significantly lowered in the short term by colonising toads compared to cane toad-free sites (Catling *et al*. 1999). A number of other studies (Freeland *et al*. 1986, Werren 1993) investigating the diet of cane toads, have found it to include a wide variety of invertebrates including beetles, ants, termites, snails, earthworms, centipedes, scorpions and spiders.

Invertebrates particularly at risk from cane toads are likely to be those species with restricted ranges. There is the potential for severe impacts on populations of threatened land snails of the east Kimberley. Ongoing trials conducted by DEC and the University of Sydney on a number of land snails of several genera and sizes found at the Ningbing Range indicate that all species (including several critically endangered taxa) are potentially palatable to cane toads (D. Pearson, pers. comm). Further work will examine potential encounter rates between toads and land snails in their rocky limestone habitat (see Section 17.2).

A study of ground-nesting rainbow bee-eaters (*Merops ornatus*) (Boland 2004) found that cane toads were one of the most significant sources of mortality of chicks. Cane toads destroyed 33 per cent of nesting attempts by blocking the nest entrance, or by eating fledglings and eggs. When cane toads were removed from the nests and placed up to 1.2 kilometres away from the nest sites, 75 per cent returned to the same burrow overnight or within two or three nights. Toads were less likely to return to the nest with increasing release distance. This behaviour suggests that cane toads have homing abilities and use olfactory cues to locate prey, and may have implications for other species that have young in ground-level nests or dens, such as the red-cheeked dunnart (Boland 2004).

Crossland (1998) investigated predation by cane toad tadpoles and two native frog tadpoles (those of the ornate burrowing frog *Limnodynastes ornatus* and the desert tree frog *Litoria rubella*) on the eggs, hatchlings and larvae of native frogs. Laboratory experiments showed that neither small nor large cane toad tadpoles were significant predators of native frog eggs, hatchlings or tadpoles. However, large ornate burrowing frog tadpoles and, to a lesser extent, tadpoles of the desert tree frog were significant predators of native frog eggs and hatchlings, but not of native tadpoles. The author suggested that native tadpoles were likely to have a greater impact on the survival of early life stages of native frogs due to predation than were cane toad tadpoles.

(iii) Competition

Despite a lack of quantitative data, available information indicates that cane toads compete with native species such as ground frogs for key resources including food. Catling *et al*. (1999) has found that cane toads caused a significant longer-term reduction in the abundance of small lizards, possibly by reducing invertebrate food supply.

Competition in the tadpole stage can be significant for some native frogs, with Crossland (1997) finding ornate burrowing frog tadpoles absent in ponds where cane toad tadpoles were present. As direct predation was not observed, the superior competitive ability of cane

toad tadpoles, rather than predation of early life stages of the species, has been inferred as the causal factor.

A study of native frog species from the Darling Downs area of southern Queensland, involving competition trials, found that cane toad tadpoles may affect the growth of native anuran tadpoles under some circumstances. Trials conducted in artificial ponds indicated that cane toad larvae reduced the growth of three native species: the spotted grass frog (*Limnodynastes tasmaniensis*), scarlet-sided pobblebonk *(Limnodynastes terraereginae*), and holy cross toad (*Notaden bennettii*) (Williamson 1999).

Research at Fogg Dam (Greenlees *et al.* 2007) examined whether the presence of cane toads reduced the rate or activity level of native giant burrowing frogs (*Cyclorana australis*). Results showed that although the frogs were less active if cane toads were present, the overall effect on their feeding rate was small. The authors suggested that on hot humid nights in the tropics, the number of insects was sufficiently high to avoid effective competition between frogs, or between frogs and cane toads.

It appears that cane toads are more likely to have an adverse impact on terrestrial ground frogs or larger frog species due to competitive interaction and, in some circumstances, high densities of cane toad tadpoles in isolated pools could out-compete native aquatic vertebrates and invertebrates for food resources (DEWHA 2005). In northern Australia, competition between cane toads and native species for food is likely to be highest near permanent water bodies during the dry season. The dry season congregation of toads at water sources has assisted community groups in their physical cane toad removal operations (see Section 15). However there are limited quantitative data to adequately support a conclusion on such impacts.

Other impacts

Cane toads will potentially impact on industries such as agriculture and tourism, on Indigenous communities and on social values of the broader community. Specific impacts include:

- dangers posed to people unfamiliar with cane toads, who may handle the animals without knowledge of their toxic nature;
- visual impacts, particularly in areas of high visitor/tourism use;
- consumption of introduced dung beetles (Lever 2001);
- consumption of honeybees (Tyler 1994);
- consumption of the toads themselves by some human immigrants and by Indigenous people (Tyler 1975);
- mouthing of toads creating a risk of death to domestic animals, including cats and dogs (Lever 2001);
- pollution of bore holes, water holes and drinking troughs (Freeland 1984);
- blocking of drains by toads, and their subsequent death and decomposition providing a fertile breeding ground for insect pests (Freeland 1984);
- pollution of swimming pools and the expense of making them toad-proof (Freeland 1984); and
- costs to human health; the eggs of some human parasites found in human faeces remain viable after passage through toads (Freeland 1984) and cane toads are known to transmit diseases such as salmonella (van Dam *et al.* 2002).

Tour operators in both the Northern Territory and the Kimberley region of Western Australia have raised concerns about potential impacts on visitor numbers once cane toads become present in an area; many tourists are known to express deep concerns about the impact of cane toads, especially for iconic areas (particularly World Heritage sites and national parks) such as Purnululu National Park. Cane toads are generally viewed by the public as unattractive, potentially poisonous and often present in large numbers. They are at odds with a wilderness or outback experience, a major theme of tourism in northern Australia.

In a preliminary risk assessment of impacts on Kakadu National Park, van Dam *et al.* (2002) believed that cane toads were unlikely to have a negative impact on tourism income. It is not known whether a substantial decrease in tourism occurred following the arrival of cane toads in Kakadu or any other key tourist attractions in the Northern Territory. However, in Queensland where cane toads have been present for many decades, there has been no noticeable impact on tourism levels (Northern Territory Tourist Commission 2003).

The cane toad can potentially result in impacts on Indigenous cultural values by:

(i) causing declines in bush tucker species such as goannas;

(ii) causing the alteration of traditional ceremonies; and

(iii) possible effects on sacred sites.

van Dam *et al.* (2002) noted that there have been instances in the Northern Territory where traditional ceremonies were modified to request spirits to replenish important food or iconic species that have declined since the arrival of cane toads.

Appendix 2: Awareness raising information currently available in WA

(excludes periodic sources of information that require updating such as newsletters and general promotional material such as t-shirts, bumper stickers etc).

	DEC	DAFWA	KTB	STTF
General awareness	- 'Watch out for cane toads' FAQ DL brochure - 'Help us fight an alien invasion' DL brochure and A4 PDF flyer - 'Help us fight an alien invasion' poster - 'Watch out for cane toads' information kit – contains the above three items plus the Pest*note*, fridge magnet and sticker - 2009 cane toad brochures including information on children and pets, safe handling, how to keep toads out of your backyard, cane toad identification - The Cane Toad Pack – information kit containing plastic gloves, magnet, native frog stickers, four brochures listed above.	- Cane toad Pest*note* No. 01/2005 - Cane toads frequently asked questions webpage - Webpage 'Advice to Western Australians on the humane killing of cane toads	- KTB 'You Can Help Keep Western Australia Cane Toad Free!' Glove Box Brochure - KTB Guidance and Management Strategy for Eradication, Control and Management of Cane Toads (*Bufo marinus*) in Kununurra and the Kimberley - Fact Sheet #2: Cane Toad WA/NT Frontline Corridors - Fact Sheet #3: KTB Wet and Dry Season Toad busting Strategy - KTB Children's bookmark: Green tree frog or cane toad - KTB Poster: Saving Kimberley Biodiversity - KTB Poster: Building Communities – Our Volunteers - KTB toad busting map: Areas of KTB NT toad busting operations as the cane toads approach Western Australia - DVD (2008) on junior Aboriginal Toadbusters, uploaded onto You Tube - DVD (2006) on general toad busting - KTB Poster: What's in your Backyard? Kimberley biodiversity awareness campaign. - Kimberley Toad Busters Field and Safety Manual - KTB insert to the Kununurra Visitor Centre 2009 Glove Box Guide	- STTF DL brochure - annual 'The Great Toad Muster' poster - 'The Great Toad Muster' DVD

Identification	- Spot the difference / native frogs A4 flyer - Native frog series of six stickers - Native frog and cane toad magnet	- Cane toad Pest*note* No. 01/2005	- Fact Sheet #1: Recognising a cane toad - KTB Poster: Cane Toad Aware: Don't confuse our native toads with the cane toads poster - Is it a Native Frog or a Cane Toad? KTB definitive table. - Native Frogs 2009 calendar - Native Frogs 2009 playing cards - Native Frog identification cards	- Travellers pack – including toad identification, safe handling of toads and disposal information.
Website	www.dec.wa.gov.au/canetoads	www.agric.wa.gov.au/aboutus/canetoadfinalmarch.htm	www.canetoads.com.au/	www.stopthetoad.org.au www.frogwatch.org.au/

In addition to the material listed above, the Kimberley Land Council and the Australian Government's Envirofund jointly produced a 'Cane Toads in the Kimberley' booklet that outlines information for Indigenous communities on cane toad and native frog identification, cane toad impacts and safety when handling cane toads.

Appendix 3: Safe handling of cane toads

The following steps should be followed when handling cane toads (adapted from DAFWA 2005):

- Cane toads should only be killed by persons who take precautions not to place themselves or others at risk from exposure to the cane toad poison.
- Take pets away from the vicinity and make sure that children are supervised.
- Thoroughly wash hands after touching a cane toad (or native frog).
- Wear rubber gloves, safety glasses and have a plastic bag or a lidded container (with air holes) ready to hold the cane toad.
- Carefully pick up the cane toad by a back leg or use a broom or similar to 'sweep' the toad into a container. Alternatively, place a hand inside a plastic bag and use the covered hand as a glove to firmly pick up the toad. Pull the bag over the toad with your other hand and secure the toad inside by tying the top of the bag.
- Cane toad carcasses are still toxic so they should be disposed of carefully - either by burial in a location where it cannot be dug up by other animals, especially pets; or by incineration.
- People can transport suspected cane toads in bags or containers (with air holes) to DEC offices for identification, humane euthanasia and appropriate disposal.
- If cane toad toxin is squirted onto the skin or into the eyes, first aid should be immediately performed. The toxin can cause pain and severe irritation to the eyes, or temporary visual disturbances.

First aid treatment includes irrigating (washing with a lot of water) the eyes, mouth and nose if they have been exposed to toad venom. Seek medical attention if symptoms persist. If toxin is squirted into the mouth, the patient should be taken immediately to the emergency department of the nearest hospital. Additional information on cane toad poisoning is available from the Poisons Information Line on 13 11 26 anywhere in Australia, 24 hours a day, seven days a week.

Appendix 4: Summary of Government funding for cane toads

Financial year	Commonwealth	State	Lotterywest	Description
2004/05		$600,000		State Cane Toad Initiative • DEC cane toad field team, funding grant to Kimberley Specialists, funding to WA Quarantine and Inspection Service (WAQIS) road checkpoints, communications
2005/06		$900,000		State Cane Toad Initiative • DEC cane toad field team, detector dog, funding grants to KTB and STTF, funding to WAQIS road checkpoints, communications
	$600,000			Matching Commonwealth funding for State Cane Toad Initiative
		$500,000		Public awareness campaign • Print, radio and television information on cane toad impacts, identification and management
		$500,000		Grant to STTF • Trust fund established to fund community group cane toad actions
	$79,000			Grant to KTB
2006/07		$900,000		State Cane Toad Initiative • DEC cane toad field team, detector dog, funding grants to KTB and STTF, funding to WAQIS road checkpoints, corporate relations, funding specific research proposals
	$2,700,000	$4,300,000		Kimberley Islands Biological Survey (2007-2010)
	$274,000	$350,000		Australian Cane Toad Genome Project
		$60,000		University of Sydney research impacts of cane toads on native fauna
			$50,000	Lotterywest grant to STTF
	$225,000			Grant to KTB
	$69,011			Purchase of KTB bus
	$1,800			GVEHO grant to STTF
2007/08		$900,000		State Cane Toad Initiative • DEC cane toad field team, detector dog, funding grants to KTB and STTF, funding to WAQIS road checkpoints, communications, funding specific research proposals, including $300,000 over three years for nematode lungworm research
		$500,000		Australian Cane Toad Genome Project
		$240,000		Grant to KTB • Toadbusting costs
		$100,000		Grant to STTF • Toadbusting costs
			$169,225	Lotterywest grant to KTB
2008/09		$900,000		State Cane Toad Initiative • DEC cane toad field team, community coordinator position, detector dog, funding to WAQIS road checkpoints, communications, funding specific research proposals
		$76,932		Australian Cane Toad Genome Project
		$339,500		KTB field operations
	$150,000			STTF 2009 muster
2009/10		$750,000		State Cane Toad Initiative
		$340,000		KTB field operations
Sub totals	$4,098,811	$12,255,932	$219,225	
TOTAL	**$16,573,968**			

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ACRONYMS

ANZCCART	Australian and New Zealand Council for the Care of Animals in Research and Teaching
ARRP Act	Agriculture and Related Resources Protection Act
AVMA	American Veterinary Medical Association
CALM	Department of Conservation and Land Management
CLIMEX	Predictive software package developed by CSIRO
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTAG	Cane Toad Advisory Group
DAFWA	Department of Agriculture and Food Western Australia
DEC	Department of Environment and Conservation
DEWHA	Department of the Environment, Water, Heritage and the Arts
EPBC Act	Environment Protection and Biodiversity Conservation Act
GIS	Geographic information system
GVEHO	Grants to Voluntary Environment and Heritage Organisations program
IACRC	Invasive Animals Cooperative Research Centre
IUCN	International Union for Conservation of Nature
KTB	Kimberley Toad Busters
MG	Mirriuwung-Gajerrong
MP3	Digital audio format
PaDIS	Pest and Disease Information Service
QRM	Quarantine risk material
SRG	Stakeholder Reference Group
STTF	Stop the Toad Foundation
SWEK	Shire of Wyndham East Kimberley
TSSC	Threatened Species Scientific Committee
WAQIS	Western Australian Quarantine and Inspection Service

GLOSSARY

Biocontrol (or biological control)
The control of a pest by the introduction of a natural enemy or predator, usually bacteria, viruses or insects, or by biological products such as hormones.

Biodiversity
The variability among living organisms and the ecosystems of which those organisms are a part which includes:
(a) diversity within native species and between native species; and
(b) diversity of ecosystems; and
(c) diversity of other biodiversity components.

Biodiversity components include native species, habitats, ecological communities, genes, ecosystems and ecological processes.

Biodiversity asset
Threatened taxa and ecological communities, or significant ecosystems or taxa.

Biological survey
Inventory of the species that occur in a particular area by systematic scientific investigation.

Biosecurity
The protection of the economy, environment and human health from the negative impacts associated with entry, establishment or spread of exotic pests, weeds and diseases.

Biota
All life, including plants, animals and fungi.

Bufadienolides
One of the two groups of steroid chemicals present in the venom produced by members of the genus *Bufo* that are known to be cardioactive toxins.

Bufotoxins
The other of the two groups of steroid chemicals present in the venom produced by members of the genus *Bufo*. Sometimes used more generically to mean the toxins produced by members of the genus *Bufo*.

Colonising toads
The first cane toads to arrive in an area where they have not previously occurred.

Disposal facility
An official location where members of the public can take suspected cane toads, have them properly identified, and destroyed and disposed of if necessary.

Euthanasia
In the context of pest management, euthanasia refers to the killing of a pest animal in a manner that minimises any pain or suffering.

Fecundity
The number of offspring produced by an individual, fertility.

Genera
Plural form of genus.

Genetic bottleneck
A severe reduction in population size resulting in a decrease in the genetic variability within a population.

Genome
The complete set of genetic material of an organism.

Genus
A principal taxonomic category that ranks above species and below family.

Hitch-hiker toads
Cane toads that stow away in freight, vehicles or personal belongings and are unintentionally transported over long distances.

Invasive species
Species introduced deliberately or unintentionally outside their natural habitats where they have the ability to establish themselves, invade, out-compete native species and take over the new environment.

Metamorph (contraction of metamorphling)
The life stage of a frog or toad that occurs immediately following metamorphosis from the tadpole stage.

Parotoid gland
Hypertrophied cutaneous glands situated behind the tympanum that are characteristic of most members of the anuran family, Bufonidae, but are also found in some members of the anuran family, Hylidae.

Pheromones
A chemical substance produced and released by an animal that affects the behaviour or physiology of conspecifics (others members of the same species).

Pithing
To kill an animal by destroying the brain with a sharp metal instrument.

Quarantine
The system of measures that are used to manage risks of the entry and establishment of pests, weeds or diseases that threaten animal, plant or human health.

Radio telemetry
A method for collecting biological data, especially movement data, whereby an electronic device that transmits VHF radio waves is attached to or implanted within a subject animal.

Refugium (or refuge)
An area in which a population of organisms can survive a period of unfavourable conditions or which offers protection from a threatening process.

Refugia
Plural form of refugium.

Resilience (of ecosystems)
The capacity of an ecosystem to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks.

Species
A group of organisms that:
(a) interbreed to produce fertile offspring; or
(b) possess common characteristics derived from a common gene pool; and includes
(c) a sub-species.

Stakeholder
A person, group of people, organisation or government with a share or an interest in an issue.

Taxon
A group or category, at any level, in a system for classifying organisms

Taxa
Plural form of taxon.

Threatening process
A process that threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community.

Toad busting
A community activity involving the collection and destruction of cane toads in a particular locality.

Translocation
Movement or removal to a different place or habitat.

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