Stop The Toad Foundation (Inc)

Report: Field Operations
Dry Season 2006

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Report: Field Operations
Dry Season 2006 (Ver:3)

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- ABN Foundation
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- Skywest

OTHER SUPPORTERS

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- Timber Creek Community Government Council
- Department of Environment and Conservation (DEC)
- Northern Territory Parks and Wildlife Service
- Toll West
- Sally Malay Mining
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- Matso's Brewery
- Kununurra Hotel
- Kingswood Marine
- Slackwater Safaris
- Roebuck Bay Hotel
- Moby Dick Marine
- Air Liquide
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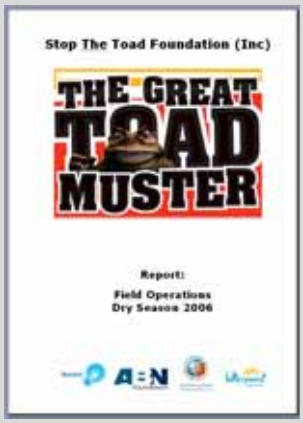


This report summarises and reviews the first year of on-ground cane toad control by the Stop The Toad Foundation whose aim is to KEEP WA CANE TOAD FREE.

The report details the methodical course taken by, and the results of, the Foundation's efforts **to stem the spread of cane toads across the top of Australia, before they reach the Kimberley** region of Western Australia.

While some believe the continued spread of toads in Australia to be an insurmountable problem, until Western Australian's took action there had never been a serious attempt to halt the spread of toads, since their introduction to Queensland more than 70 years ago.

Now, far from being inevitable that cane toads will reach WA, evidence is mounting that there will be real ecological benefits from on-ground toad control operations.

One of the primary goals identified under the Foundation's **Strategic Plan** is:

To implement the most thorough on-ground control operations achievable to slow, and if possible halt, the westward movement of cane toads; and to effectively deal with any (hitch-hiker) outbreaks ahead of the front.

The Foundation conducted a nation-wide **Strategic Forum** video conference in February 2006 involving leading cane toad researchers, experts in feral animal control and people with specific knowledge of the Northern Territory country through which the toads were moving. The aim was to develop an answer to the question: How best to address the issues needed to stop the toad's advance?

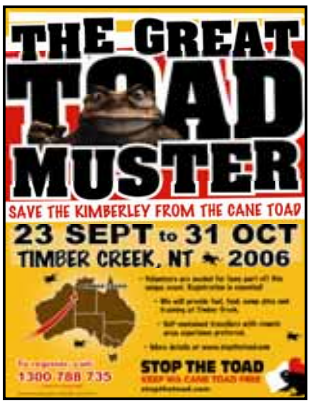
Information gathered in the Strategic Forum established the principles which underpinned the Foundation's Dry Season Strategy (April 2006)

The **Dry Season Strategy** is based on the premise that there is one time of year when cane toads are particularly vulnerable and that an opportunity then exists to drive their numbers down to very low levels. This opportunity is at the end of the Dry Season, when water is at its scarcest in the landscape but temperature, humidity and insect life are on the increase. Toads are no longer invading new country, but are congregated around any remaining water and beginning to be active, as they sense imminent rains and prepare to breed.

At its heart, the Dry Season Strategy is the creation of a 'buffer zone' in the most toad unfriendly areas along the most westerly points of the advancing front. If successful, the buffer zone will need to be cleared each year until a biological solution is found to bring the cane toad under control. This theory forms the basis of the Foundation's cane toad **Control Model**.

Given the remote nature of much of the current toad territory, the Strategy proposed that focussing on-ground control effort within this annual window of opportunity would present the most cost-effective use of resources, especially in light of the fact that it may need to be repeated over a number of years to come.

To trial the Control Model, the Foundation planned, organised and implemented the **Great Toad Muster 2006**. This exercise focussed on identifying the toad populations closest to WA (as the greatest threat) and using repetitive (multiple-night) 'busts' during the Dry Season to remove them as thoroughly as possible.



The primary tasks for cane toad control during the Great Toad Muster 2006 were:

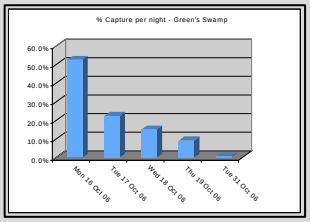
1. Surveillance & Reconnaissance
2. Frontline Depletion (remove all toads from the western edge)
3. Systematic Depletion (removing as many toads as possible eastward of the frontline)

As the Great Toad Muster 2006 was the first event of its type it was also vital to test all underlying theories eg. seasonal timing, repetitive busts; and to evaluate all control techniques and operational methodologies.

The Whirlwind Plains, on Auvergne Station was identified as the best location for the **Primary Buffer Zone** (PBZ) and so became the major focus for the Muster. The area is a floodplain bordered by the Victoria River to the east and north, the Victoria Highway to the south and the Baines River and Pinkerton Ranges to the west.

The PBZ is approximately 550 km^2 in area, consists predominantly of black soils, with gravel ridges on higher ground. Aerial and ground reconnaissance determined that surface water was very restricted across the area during the later stages of the Dry Season. Fifteen major water holes and lagoons were targeted during the Muster.

During the 5½ weeks of the Great Toad Muster 126 volunteers participated. Staff and volunteers completed a total 1,120 days of effort. 48,374 adult and sub-adult toads were removed from the Primary Buffer Zone (PBZ).



Results from the Great Toad Muster 2006 demonstrate that the first component of the STTF's Control Model: (viz) the effective removal of cane toads from the Primary Buffer Zone in late Dry Season 2006, was achieved. This is evidenced by depletion of toad numbers at waterholes that were targeted, and the absence of toads at these locations following first Wet Season rains. This also proved that **multiple night toadbusts in one area can drive local populations close to zero**.

The second component of the Control Model: (viz) the cane toad's inability to invade further than the current most westerly point in the following Wet Season, will only be apparent after the 2006/07 Wet Season. Data obtained during this time will also tell us if toad densities will return to the previous levels.

No cane toad was sighted more than 300 metres from water during the Muster and the vast majority of the toads were found within 10 metres of water. This indicates that the environmental pressure on cane toads to move to water during the dry season is incredibly strong and it now appears certain that they have to do this to survive in the PBZ, and proves the basis of the Dry Season Strategy.

Evidence that the Control Model is effective arrived with heavy rains on the final night of the Muster when a search of the Auvergne Lagoon area revealed no cane toads at all. The absence of toad activity, even following rains, shows that **a significant water body can be completely cleared of cane toads** using these control models.

This was supported by subsequent visits to the Lagoon, including one by the WA Government's DEC with their sniffer-dog in late November. **They did not find a single cane toad.**

STTF consider the 2006 Great Toad Muster to have been an unprecedented success. It is the first known concerted attempt to remove cane toads from an area at landscape scale, and preliminary indications are that it was highly effective.

It is now critically important to return to this area in 2007 to evaluate the degree of that effectiveness and clear the PBZ again. It will also be vital to expand the Muster to include any new areas where frontline toads are identified in the interim.

?

Where to from here?

The Foundation will now focus on its Wet Season strategy.

This includes: A surveillance program to identify the toad frontline along its entire length, a trapping program on the Whirlwind plains, a fencing trial and further development of the Foundation's 'hitch-hiker' strategy.

More information can be found at **www.stopthetoad.org.au**

Auvergne Lagoon field camp from the air 27 September 2006

2 INTRODUCTION

This report summarises and reviews the first year of on-ground cane toad control by the Stop The Toad Foundation whose aim is to KEEP WA CANE TOAD FREE.

The report details the methodical course taken by the Foundation in its efforts to stem the spread of cane toads across the top of Australia, before they reach the Kimberley region of Western Australia.

While some believe this to be a futile response to an insurmountable problem, the Stop The Toad Foundation argues that there has never been a serious attempt to halt the spread of toads since their introduction to Queensland more than 70 years ago.

Much of that part of the Northern Territory the toads are currently advancing across is harsh and inhospitable to toads at the end of the dry season, as water holes dry and temperatures climb. Toads are not well adapted to surviving in these conditions. The Foundation believes that this is the time of year and the place to attempt to halt the advance of cane toads. A strategy has been implemented which takes advantage of the landscape, the climate and the toad's own biology, to hold them back. Surveillance, after the waters of the 2007 Wet Season recede, will give us our first hint of whether this strategy really does have the potential to be that effective.

3 FOUNDATION BACKGROUND

The STOP THE TOAD FOUNDATION (INC) is a not-for-profit organisation incorporated in Western Australia in October 2005 with the primary purpose of preventing the invasion of cane toads into Western Australia. The strategic focus of the Foundation is to alert all Australians to the potential impacts of the cane toad and to try to engage everyone in the protection of Western Australia from the toad's imminent invasion.

The Foundation secured $500,000 of Western Australian Government funding in December 2005 to support cane toad control in the Northern Territory and within Western Australia in the event that populations of toads do establish in this state.

The Foundation has subsequently secured the support of many businesses and philanthropic and funding organisations, the direct involvement of more than 200 volunteers and the general support of thousands of interested people.

Further information on the Stop The Toad Foundation, its objects, and the cane toad threat can be found in the Foundation's Annual Report 2005/06 and other documents at http://www.stopthetoad.org.au/publications/

4 STRATEGIC PLAN

The Foundation's Strategic Plan identifies the following goals in four key areas:

4.1 OPERATIONS AND TRAINING

Primary Goal: *To implement the most thorough on-ground control operations achievable to slow, and if possible halt, the westward movement of cane toads; and to effectively deal with any (hitch-hiker) outbreaks ahead of the front.*

Secondary Goal: *In the advent of cane toads entering Western Australia, to minimise their spread and the harm they do to natural systems and ecological communities.*

4.2 LOGISTICS

Primary Goal: *To deploy the necessary people, machinery, equipment and supplies reliably and cost-effectively - where needed, when needed.*

4.3 INFORMATION

Primary Goal: *To establish and maintain high levels of information flow, to and from the Foundation, which maximise:*

- *intelligence gathering to satisfy our knowledge needs, and*
- *stakeholder awareness, participation and support*

4.4 ADMINISTRATION

Primary Goal: *To develop and operate an administration which effectively supports the work of the Foundation while remaining as lean as possible.*

Coordination meeting in Timber Creek 14 October 2006

5 EARLY STEPS

A number of the key objectives which flow from the goals identified in the Foundation's Strategic Plan were satisfied by the following preliminary steps:

- Appointed Graeme Sawyer to the position of Regional Coordinator. Graeme played a key role in setting up Frogwatch in the Northern Territory in 1991 and led their cane toad project - the catalyst for a change of thinking about cane toad control in Northern Australia. He has been involved in cane toad research, including pioneering work on the use of traps, for more than 5 years and was a member of the National Cane Toad Taskforce.

- Appointed Derek Monks to the position of Operations Manager in Kununurra. With a Bachelor of Science in Biology and Environmental Geography, Derek brought a sound knowledge of the region, its people and environments, and had been a member of the CALM cane toad team.

- Conducted a nation-wide Strategic Forum (via video conference) combining the best available expertise in cane toad ecology/behaviour and control techniques with the best available knowledge of the control area terrain and conditions. The panel's outputs shaped the Foundation's overall strategic planning and particularly the development of the Dry Season Strategy. The panel comprised: Professor Ross Alford & Dr Lin Schwarzkopf (JCU); Dr Mike Bamford (Joint Coordinating Group), Dr Winston Kay, Gordon Graham and Gae Mackay (CALM), Keith Saalfeld & Garry Fischer (NT P&W), Ian Morris (Frogwatch), and Graeme Sawyer (STTF).

- Undertook research which indicated that not all toads in an area are active on a given night and that the manual collection of toads needed to be repeated over multiple nights if an area is to be cleared of toads. This had significant implications for toad control activity and shaped the Foundation's Dry Season Strategy.

- Launched a Dry Season Strategy discussion paper and sought comment from stakeholders. The Strategy subsequently formed the operational basis of the Great Toad Muster which took place in Sept-Oct 2006.

The transcript of the Strategic Forum video conference, the Dry Season Strategy discussion paper and a report on the Auvergne research are available at www.stopthetoad.org.au/publications

6 BACKGROUND TO THE MUSTER

6.1 TOAD FACTS

The cane toad is recognised by the IUCN (the World Conservation Union) and the Global Invasive Species Programme as one of the world's 100 worst invaders. The National Cane Toad Taskforce has recognized growing evidence and concern about the impact of cane toads on Australia's ecosystems. As a result of the acknowledged environmental impacts of cane toads, the species has been listed as a key threatening process in Australia.

Bufo marinus

Cane toads are both aggressive predators and highly toxic prey when eaten by other animals. All life stages are toxic, including the eggs, tadpoles, metamorphs and adults. Any animal without an evolutionary exposure to the toad's bufotoxin will succumb, which unfortunately means most of our unique Australian fauna. They have a deadly impact on anything that bites them. As well as being toxic to predators, cane toads have a voracious appetite, feeding on a broad variety of prey items including insects; small reptiles and frogs. They even eat chicks and eggs of ground-nesting birds. They out-compete native species for food and shelter sites and can deplete resources so severely that their impacts on ecosystems are serious.

In the Northern Territory there is evidence of localised extinctions of northern quolls (*Dasyurus hallucatus*) and severe population declines (90%) of large predatory reptiles such as the varanid (monitor) lizards. Reports of deaths of freshwater crocodiles, water birds, freshwater fish and turtles are accumulating. Anecdotal evidence suggests the impact may be more severe and widespread than evidence gathered to date suggests. Long term impacts could be very broad.

Cane toads are very adaptable and can infiltrate urban areas, grasslands, woodlands, sand dunes, coastal heath, mangroves and the margins of rainforest.

They are prolific breeders, with large females producing up to 30,000 eggs at a time. The eggs are capable of surviving in freshwater systems and brackish systems with salinity levels up to 15 ‰ (approx. half seawater).

Cane toads also have a drive to invade new landscapes, with an initial wave of toads moving across the landscape as a front, colonising suitable habitats at the expense of native fauna. The cane toad front tends to be comprised of large animals in large numbers creating major ecosystem disruption. Following colonisation of an area by toads, in time, there appears to be a general reduction in size, number and health of toads, allowing some native species to re-establish.

While these ecosystems will never be the same again, it is expected that reducing the impacts of the initial wave may have benefits in rate and scale of ecosystem recovery, after the front has passed. If the initial front could be eradicated, it is unknown how this will impact on the subsequent progression of the front but preliminary indications from studies at Ringwood station and around Darwin in the Northern Territory give rise to the possibility that disrupting this invasion front limits the subsequent build up of cane toads.

Cane toad rehydrating through skin

Toads require access to water at least every 4 days. Given the extended dry seasons experienced in the Northern Territory and the Kimberley this is a weakness that can be exploited.

6.2 THE SEARCH FOR A PLAN

FrogWatch's work following the cane toad invasion across the NT and their cane toad trapping study at Ringwood Station, 150km south of Darwin provided insights into toad ecology and behaviour in the wet/dry tropical region. Graeme Sawyer and Ian Morris were the architects of the research and their work has led to a rethink on the possibility of controlling cane toads or at least minimising their impact on natural ecosystems in areas with distinct dry Season - Wet Season climate.

The harsh dry cracking clay landscape of the Whirlwind Plains

Graeme Sawyer's early involvement in toad control activity in the Victoria River District in 2005 gave him insight to the specific issues of toad movement through these landscapes. He conjectured that the naturally hostile nature of some areas (eg. cracking clay soil plains) and other natural barriers (eg. Pinkerton Ranges) may lend themselves to a 'control zone' approach to cane toad movement. The ability of cane toads to persist in areas such as Whirlwind Plains is dependant on their ability to access sufficient moisture during the protracted dry season.

The hot temperatures and high evaporation rates also mean that cane toads food and water requirements are high, perhaps making long term refuging, as seen in cooler climates, not feasible in the warmer tropical areas. There is some evidence that toads are inactive in the cold periods in the early to mid dry season in the region but not to the degree experienced in colder climates.

The Pinkerton Ranges form an almost continuous vertical barrier north of the Whirlwind Plains

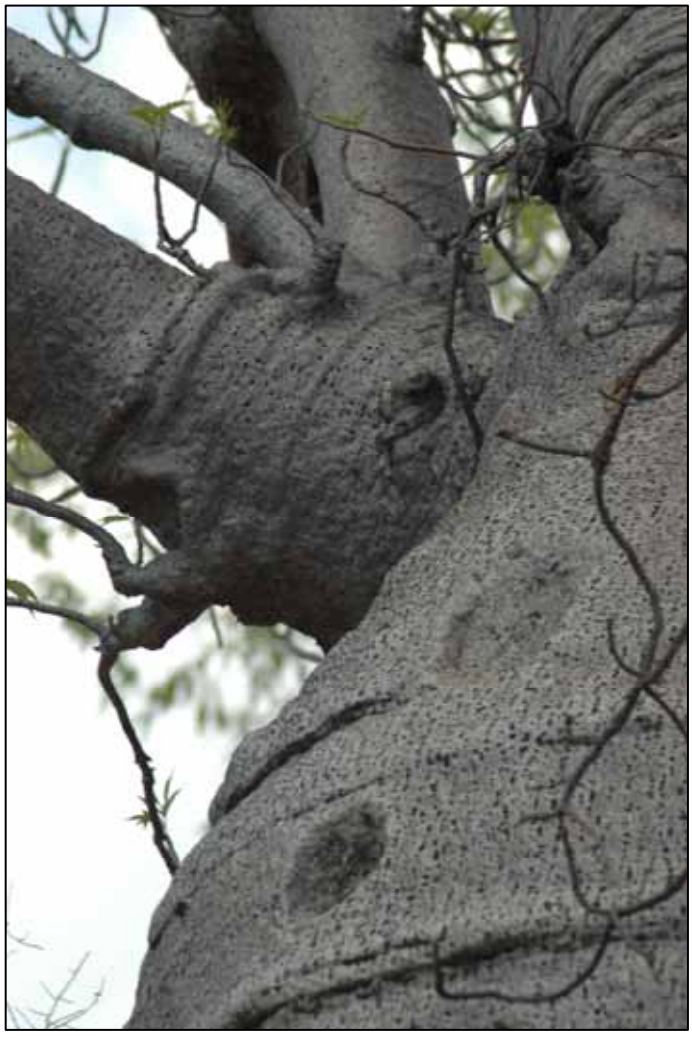
The Foundation conducted a nation-wide video conference in February 2006 involving leading cane toad researchers, experts in feral animal control and people with specific knowledge of the Northern Territory country through which the toads were moving (see p3). The purpose was to bring together information on:

- the ecology/biology/behaviour of the cane toad
- the terrestrial and aquatic environments that the front is passing through
- land tenure and legislative settings
- past experience of cane toad control measures
- studies and other resources which may assist

The aim was to develop an answer to the question: How would you best go about stopping the toad's advance? Matters of cost-effectiveness and safety for participants were also considered.

Information gathered in the Strategic Forum confirmed, informed and consolidated many of Graeme Sawyer's observations and experiences, and established the principles which underpinned the Foundation's strategic plan:

- draft Cane Toad Hitchhiker Threat Rapid Response Operational Plan (released for stakeholder comment in March 2006)
- draft Cane Toad Barrier Fencing Trial (released for stakeholder comment in March 2006)
- draft Dry Season Strategy (released for stakeholder comment in April 2006)



7 THE DRY SEASON STRATEGY

The Dry Season Strategy proposed that there is one time of year when cane toads are particularly vulnerable and that an opportunity exists to drive their numbers down to very low levels. This is at the end of the Dry season, when water is at its scarcest in the landscape but temperature, humidity and insect life are on the increase. Toads are no longer invading new country, but are congregated around any remaining water and beginning to be active, as they sense imminent rains and prepare to breed.

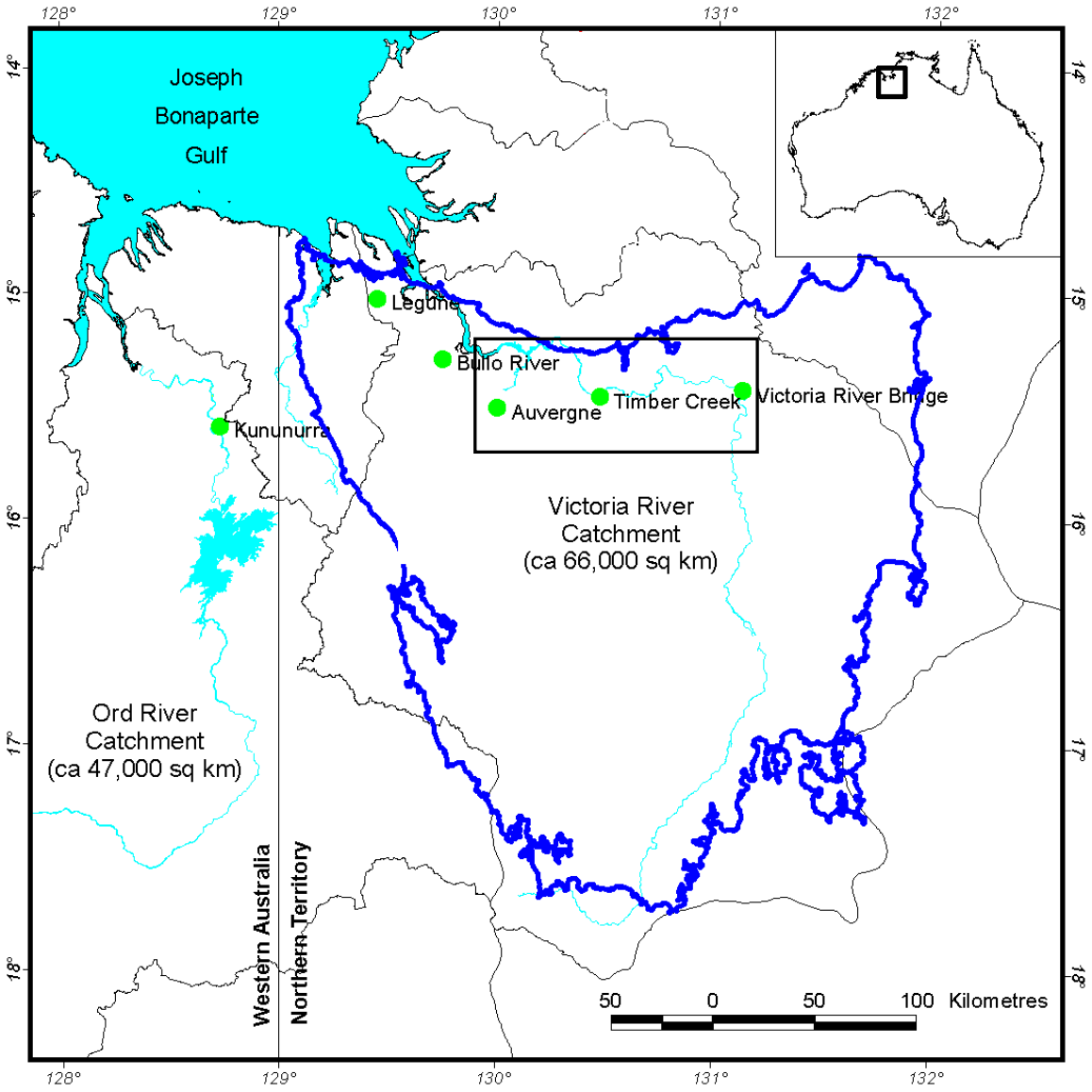
At this time, toads will be found only in very close proximity to water, and in fact are usually found right on the perimeter of it. They tend to be out in the open and are easily captured.

To test the approach, it was demonstrated that toad populations around a specific water body could be driven to very low levels at this time of year. The reduction was achieved by trapping and hand-capture of toads on multiple, consecutive nights. This approach presents an opportunity to clear toads from water bodies in a 'sweep' across the landscape. The aim is to clear the front and push it as far east as possible before the rains arrive and toads become free to move westward once again.

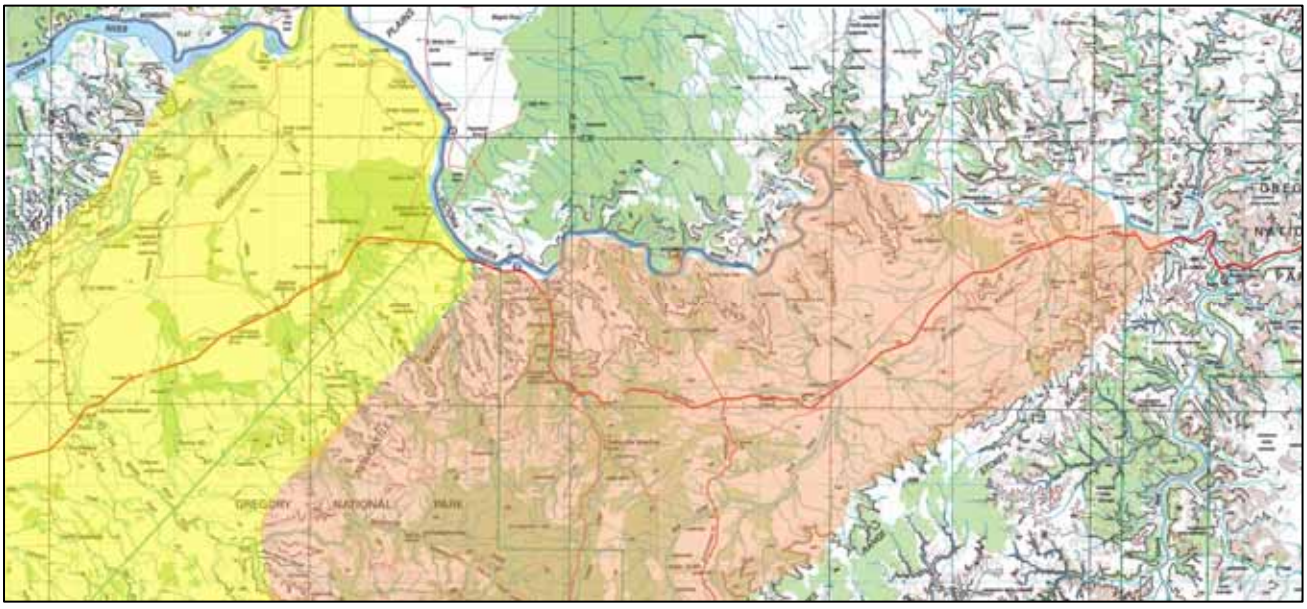
At its heart, the Dry Season Strategy is the creation of a 'buffer zone' in the most toad unfriendly areas along the most westerly points of the advancing front. If successful, the buffer zone will need to be cleared each year until a biological solution is found to bring the cane toad under control. To enable prioritisation, the buffer zone was divided into the Primary Buffer Zone (PBZ) and the Secondary Buffer Zone. This zoning is displayed on the map below, the PBZ is the western most of the two, of the highest control priority and the subject of the Muster.

It was expected (given the remote nature of much of this country) that focussing on-ground control effort within this annual window of opportunity may present the most cost-effective use of resources, especially in light of the fact that it may need to be repeated over a number of years to come.

The landscape is so dry at this time of year that fires are common

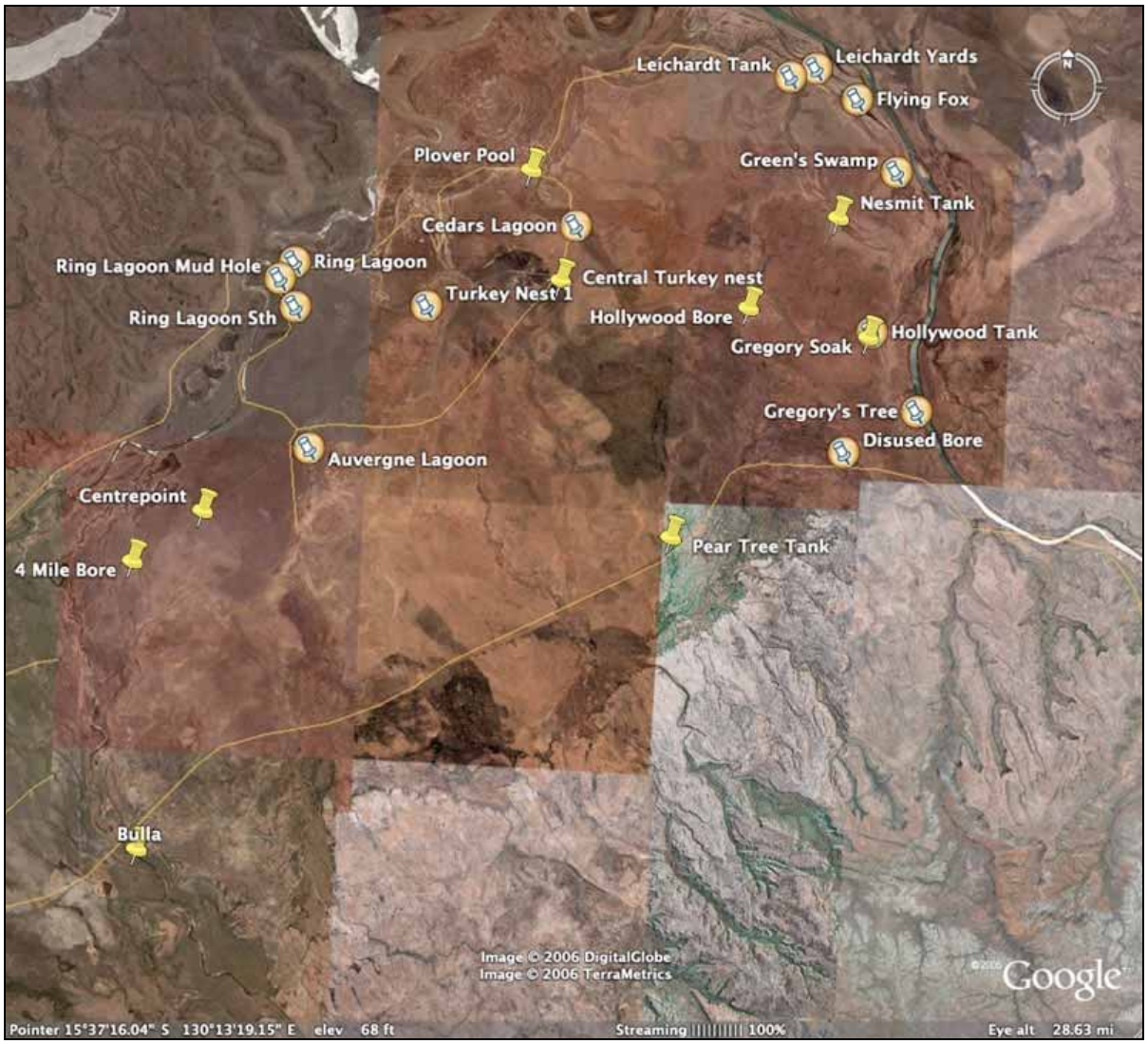


The frontline in the NT could be as big as Tasmania. The Foundation's focus was on buffer zones defined on the leading edge of the front in the boxed area (see below)

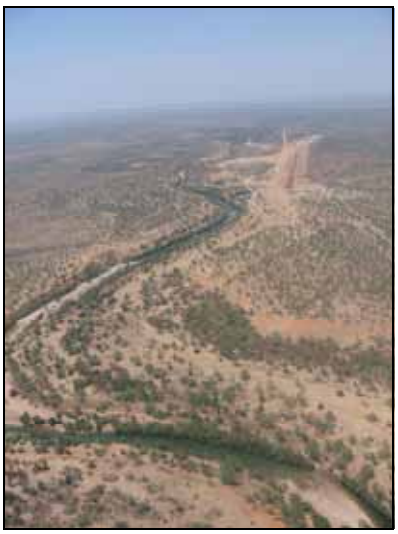


The first priority was to clear the Primary Buffer Zone (yellow), working from west to east and if time allowed, to clear the Secondary Buffer Zone (pink).

The Dry Season Strategy proposed to start on the westernmost leading edge of the known current infestation and to work back towards the east. The basic principal is that the toads closest to the WA border take the highest priority, as they are of the greatest threat to the toad free integrity of WA. The closest toads to WA (approximately 100km) are within walking distance for individual toads, as they are believed to live for 5 years or more and appear to be able to travel up to 50 km per year in the Victoria River District (VRD).



Targets within the Primary Buffer Zone



7.1 THE AUVERGNE STUDY

Based on observations in the vicinity of Gregory's Cairn and Alpha and Sandy Creek in February and March 2006, Graeme Sawyer predicted that there would be significant numbers of toads in the area of the Auvergne Lagoon.

Auvergne Lagoon

The Foundation conducted a reconnaissance of the Lagoon and nearby turkey nest on June 18 to confirm whether there were toads in the area. The Auvergne Lagoon is a section of the Auvergne Lagoon Creek system where water remains after the plains have dried up and the creek has stopped flowing. Toads were confirmed in significant numbers.

An exercise was organised in the area over the four nights (and days) June 28 – July 1 2006 in which 571 cane toads were removed. This exercise tested a theory that multiple, consecutive night toadbusts on an area were required to be effective in reducing toad populations. Visits to this area subsequent to the initial busts lent weight to the theory, with fewer toads recorded.

A report on this event is available from www.stopthetoad.org.au/publications

7.2 ADDITIONAL PREPARATIONS

The strategy involved the use of hand collection and trapping to maximise the impact on toad numbers. Throughout 2006 the Foundation had established a trap building program which engaged more than 400 students across more than 20 schools state-wide, resulting in components for more than 200 trap bodies. These are mainly Perspex finger trap doors.

To facilitate effective trapping in the target area, the Foundation provided financial support through the Northern Land Council's 'Caring For Country Unit' to Elaine Watts, the coordinator of the Mulayee Aboriginal Women Rangers, Timber Creek. The young women in her care have also been involved in surveillance, water audits and mapping of vegetation and soil types to define areas where cane toad control was most likely to be effective, drawing on the expertise of the local indigenous traditional owners and stockmen.

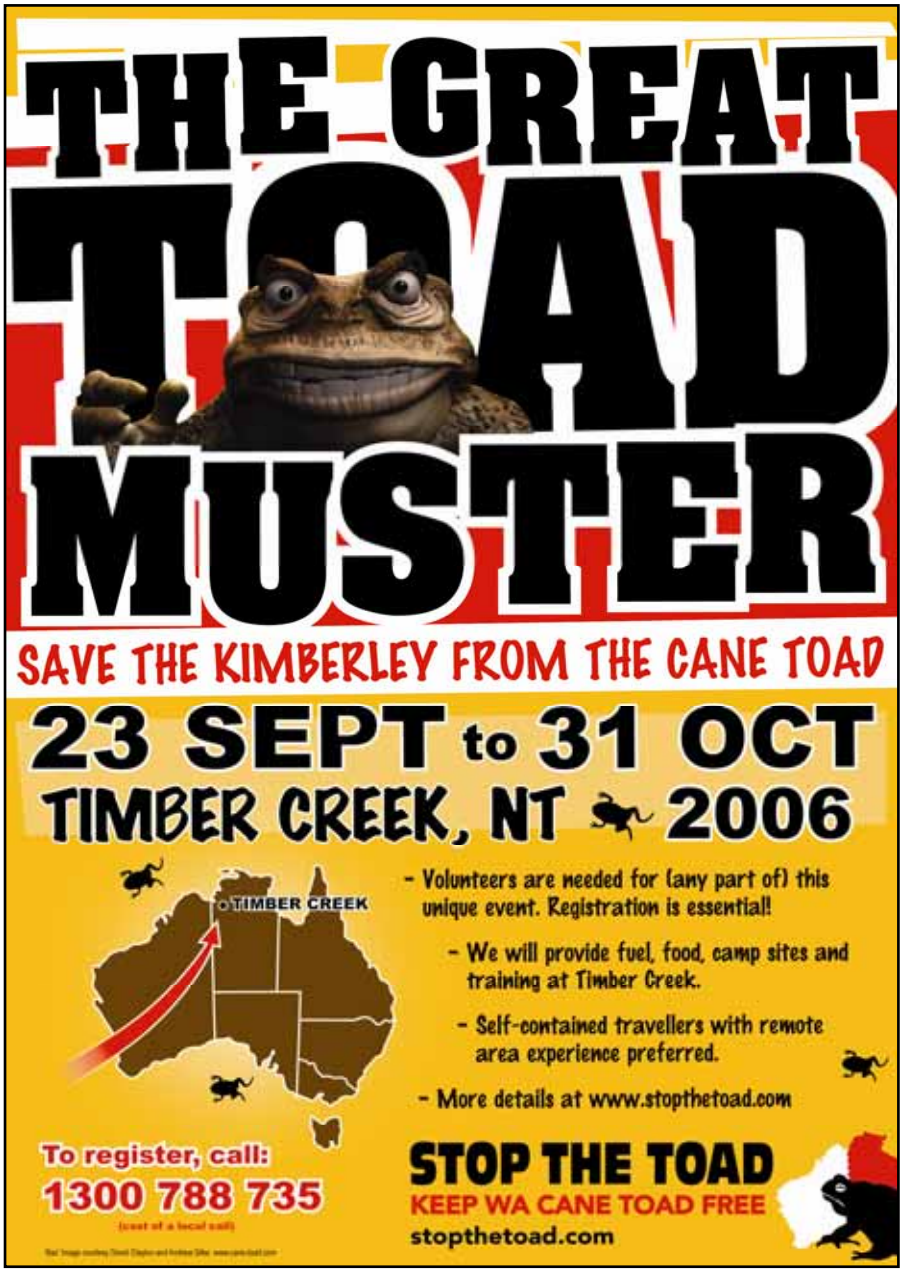
Intelligence on the location of toads in the region came from a variety of sources including regular reports from the Department of Environment and Conservation (DEC) cane toad teams in Kununurra, pastoralists, local Kununurra and Timber Creek people, as well as the Foundation's own field observations.

8 THE GREAT TOAD MUSTER

Planning for a major on-ground toad control event flowed directly from the Strategic Forum, the Dry Season Strategy discussion paper, the feedback received on it, and from the subsequent reconnaissance work undertaken.

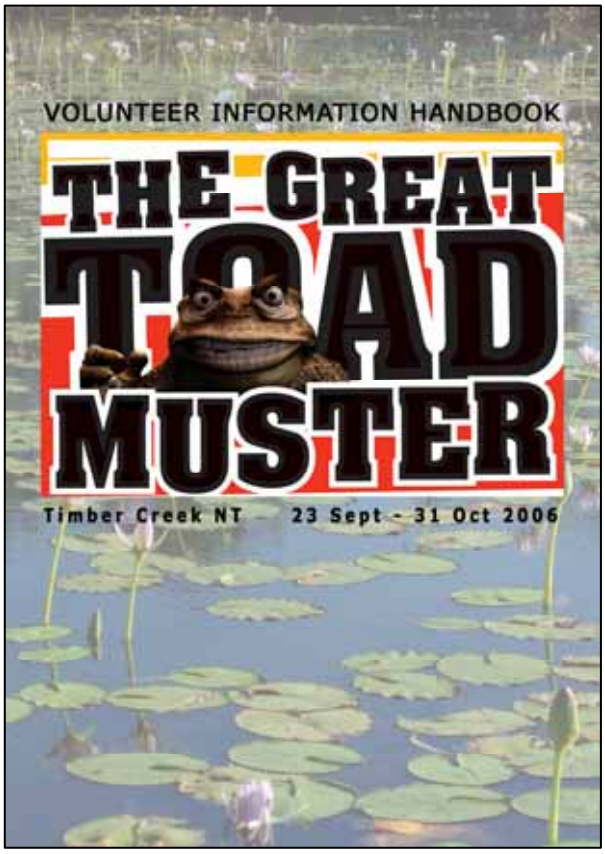
In the absence of any confirmed toad reports from further west, or north of the Pinkerton Ranges or from any southerly areas of more immediate concern, the Foundation defined its Primary Buffer Zone as being sited on the Whirlwind Plains (including Auvergne Lagoon and nearby water) with the Secondary Buffer Zone adjoining on its south/eastward side, back to the Victoria River.

The Foundation confirmed its commitment to its Dry Season Strategy as the most cost effective approach to cane toad control and set a five and a half week period from 23 September to 31 October 2006 as the term for its first Great Toad Muster.



The Great Toad Muster was promoted through the distribution of flyers and posters, an email campaign and through advertising in key regional centres in the north of Australia.

The Muster was planned and organised by the Stop The Toad Foundation and we received close cooperation from the Department of Environment and Conservation (DEC) Cane Toad Team through their team Leader Errol Kruger. The DEC team played a key role in the Baines River Pinkerton Ranges corridor and in ongoing follow up work in the area.



A volunteer information handbook was developed to help people prepare for participation in the event.

It included information on toads, the Foundation's approach to toad control, what to bring, how to get there and what to expect.

The handbook is available from www.stopthetoad.org.au/publications

Channel 7 film crew in Timber Creek 16 October 2006

8.1 MUSTER OBJECTIVES

The primary objective of the 2006 Great Toad Muster was cane toad control. To achieve this, the central tasks were:

4. Surveillance & Reconnaissance methods
5. Frontline Depletion
6. Systematic Depletion

As the Great Toad Muster 2006 was the first event of its type, it was vital to evaluate:

7. Appropriateness of timing (season)
8. Effectiveness of repetitive busts
9. Control Model
10. Control Techniques
11. Efficient deployment of people and equipment
12. Occupational health and safety
13. Care for the environment

8.1.1 SURVEILLANCE AND RECONNAISSANCE

The aims of the surveillance and reconnaissance task were:

- To establish the location of cane toad populations in the Primary Buffer Zone (PBZ).
- To determine the location of the frontline (the western extent) of cane toads in the PBZ.
- To assess which control tactics and techniques were most useful in each main location.
- To provide information on access, opportunities and risks at each location to inform the field operations planning and management processes.

8.1.2 FRONTLINE DEPLETION

Once the location of the cane toad frontline had been determined, the aims of frontline depletion task were:

- To drive cane toads numbers at locations along the frontline to as close to elimination as possible.
- To reduce the proportion of adult (breeding size) cane toads in the populations that remain at frontline locations with the aim of minimising breeding potential on the frontline prior to breeding
- To reduce the numbers of eggs, tadpoles, metamorphs and sub-adults where breeding had already occurred

8.1.3 SYSTEMATIC DEPLETION

Whilst concentrating on the frontline was seen as important, it was also critical to target the remainder of the designated control zone to achieve a systematic depletion of cane toad numbers across the zone. The aims of the systematic depletion task were:

- To reduce the overall number of cane toads at as many locations as possible across the designated control area.
- To conduct systematic depletion activities in a west to east direction.

8.1.4 TIMING EVALUATION

The underlying assumption for the timing of the Great Toad Muster was that the late dry season was the best time to attempt toad control. This was based on past observations and experience. To evaluate whether the dry season/early build was an optimal time of year to undertake this type of cane toad control exercise. The aim was:

- To confirm whether cane toads were mainly concentrated on remnant, receding water bodies
- To determine if cane toads were present in open areas away from the remaining waterbodies
- To assess how vulnerable toads were to trapping and mustering in these locations.

8.1.5 REPETITIVE BUSTS EVALUATION

Preliminary work earlier in the dry season suggested that single visitations to waterholes to remove toads would not be adequate to deplete toad numbers. Because toads only need to

rehydrate every ~4 days, potentially only 25% of toads in the vicinity of a waterhole would be observed in any one night. Therefore, the aim of this task was:

- To show whether a single night of toad removal would significantly deplete toad numbers at a waterbody
- To evaluate whether multiple nights of successive cane toad control on a given body of water would be necessary to deplete toad densities to a level where the population could be regarded as effectively removed.

8.1.6 CONTROL MODEL EVALUATION

The ultimate aim of the Great Toad Muster was to effectively push back the toad frontline to the east and thereby establish a buffer zone to be maintained in subsequent years using the same approach, thereby preventing the westward progression of cane toads in that area.

This model relied on:
a) the effective removal of cane toads from the Primary Buffer Zone in late dry 2006, and,
b) the inability of cane toads to invade further than the current most westerly point in the following Wet Season.

Assessment of the toad's ability to invade past the current westerly frontline over the coming Wet Season could only be assessed once the Wet Season is over, however, to enable this assessment, the aim was:

- To collect comprehensive data during the Muster on numbers of toads removed and locations from where removed to allow temporal comparisons to be made following the 2006/07 Wet Season.

8.1.7 CONTROL TECHNIQUES EVALUATION

The toolbox of cane toad control techniques consist primarily of hand capture, trapping and physical barriers (fencing). During the Muster we will employ hand capture and trapping with some trials of the use of short, temporary fences used as corrals to assist with hand capture efforts. This extensive block of field time will provide opportunities for insight into the practicalities and the subtleties of the control techniques.

- To evaluate the strengths and weakness of different cane toad control techniques
- To assess the appropriateness of different cane toad control techniques for different toad busting scenarios

8.1.8 EFFICIENT DEPLOYMENT OF PEOPLE AND EQUIPMENT EVALUATION

Very considerable distances are involved in operating in the Primary Buffer Zone. The western edge is 70km west of Timber Creek, a small Northern Territory township, and 150km east of Kununurra (Western Australia), the nearest major settlement. Moving people and equipment into (and around) this landscape is both costly and time consuming.

The seasonal window of opportunity at the heart of the Dry Season Strategy is both narrow and variable. When toad activity will begin and when rains will make the landscapes inaccessible cannot be known definitively.

For these reasons it was essential to:

- evaluate the extent to which deployments made the most efficient use of time, vehicles, fuel, etc. and resulted in the highest possible net tactical advantage over the toads.

8.1.9 Occupational health & safety evaluation

It is a moral and legal obligation that the STTF provide a safe and healthy work environment for its staff and volunteers. This is especially critical during the Muster whilst working with people from differing backgrounds, covering a huge range in age, experience, fitness and abilities working in demanding, remote and potentially dangerous country. The aim of this task was:

- To evaluate the extent to which STTF ensured a safe working environment for volunteers in the field

8.1.10 Care for the Environment

The battle to stop Cane Toads is primarily an action in defence of the natural environment of Western Australia. Direct cane toad control activities are prolonged and intensive and carry with them the potential to harm the environments being worked in. To address this potential, the Foundation established the following environmental aims:

- To heed quarantine laws and principles;
- To minimise physical damage from plant and equipment;
- To avoid polluting the land and waters;
- To return the country to its previous condition when cane toad activities have ceased.

Larry Johns presents a weed information session

8.2 MUSTER IMPLEMENTATION

8.2.1 SURVEILLANCE AND RECONNAISSANCE

Surveillance and reconnaissance had several elements. By day, helicopter surveillance was used to identify remaining surface water in the landscape. Creek lines could be followed by air to detect billabongs set back off roads and major water bodies as well as disused pastoral water points. Clearly visible water and areas which appeared to still hold moisture (eg. soaks) were recorded on GPS and this data later collated. Daytime ground visits by 4WD and quad bike to locations identified from the air were used to confirm the presence or absence of water; to look for signs of toad populations (such as tadpoles, metamorphs and toad prints) and to assess water points for night time access and toad control.

Night visits to these locations were used to help confirm the presence of cane toads (a nil result not being conclusive proof of the absence of cane toads). Further assessment could be made of:

a) the scale of cane toad populations present,
b) likely useful control methods, and
c) any management concerns for hand collection teams.

GPS units were used to mark new water points as well as details of access (eg. roads and gates), as navigation at night time is often confusing when dead reckoning.

Volunteers complete an aerial surveillance exercise in the Slingair helicopter

8.2.2 *FRONTLINE DEPLETION*

The cane toad frontline was considered to represent the greatest 'threat' to Western Australia, being the closest populations of cane toads to the state. Once the frontline was determined by reconnaissance, these locations received the most intensive treatment.

This took the form of assigning multiple teams to muster each water body and surrounds. Using more teams encouraged more thorough search by reducing time pressures. These multiple teams were often supported by personnel on quad bikes transporting full bags of toads back to vehicles, and supplying fresh spotlight batteries and drinking water. Day time searches were also conducted for tadpoles and metamorphs. Tadpoles were captured with scoop nets and metamorphs were sprayed with a weak bleach solution from hand mistspray bottles.

8.2.3 *SYSTEMATIC DEPLETION*

Having dealt with the highest priority locations on the frontline, focus was then turned to reducing the overall toad numbers across the broader control area. Using teams of workers in more mobile configurations enabled multiple locations to be worked on a given night. The intensity of control efforts was less but the area of land that had cane toad control implemented was larger.

Traps were deployed at isolated waterholes once they had been busted in consecutive nights to continue 'mop-up' of toad populations after hand collection has ceased. Although traps generally caught few toads, their effectiveness can not be over-stated, as these were the few residual toads not taken by hand mustering.

8.2.4 *TIMING EVALUATION*

The Dry Season Strategy outlines an expectation that during the latter part of the Dry Season and during the build-Up (till significant rains come) the high evaporation rates and drying of the landscape will play on the toad's water dependency to force concentration of toads at the remaining water bodies. These expectation were tested by analysis of cane toad capture data and field observations of; the absence of cane toads around dry water points; the restriction of cane toads to the vicinity of water points that still contain surface moisture or free water. In some instances cane toad populations at some water bodies appeared to be greater than the available refuge sites.

NB: Rains, humidity and other environmental variables which impact toad behaviour need to be considered beside human variables such as 'comfort' working in different locations and general effects on fatigue, morale, etc.

8.2.5 *REPETITIVE BUSTS*

The Dry Season Strategy also outlines the notion that not every cane toad in a location will leave its refuge to forage or rehydrate on every night. As a result, a single visitation to a specific location will only capture a proportion of resident toads. From this it is hypothesised that conducting toad control exercises on a location on successive nights will expose a high percentage of the toad population to those control efforts and thereby capture a grater number of toads, and increase the efficacy of the control works. This can be tested by analysing cane toad capture data for locations where control effort was uniform in intensity and technique and sustained over a period of days.

8.2.6 CONTROL MODEL EVALUATION

The ultimate aim of the Great Toad Muster was to effectively push back the toad frontline to the east and thereby clear all toads from the buffer zone. This model relied on the effective removal of cane toads from the designated buffer zone and the inability of cane toads to invade further than the previous year. To enable this assessment comprehensive data were collected during the Muster to record numbers of toads removed, locations from where removed, and changes in numbers taken from each location over time as an indication of remaining populations. These data would be used after the 2006/07 Wet Season to assess the toad's ability to reinvade and to build-up densities.

8.2.7 EFFICIENT DEPLOYMENT OF PEOPLE AND EQUIPMENT EVALUATION

Evaluating the extent to which deployments made the most efficient use of time, vehicles, fuel, etc. and resulted in the highest possible net tactical advantage over the toads is a challenge.

However, once the rate of depletion of toads at sites in the PBZ was established it was possible to do this. Simply by recording the numbers of toads captured at a site, along with the number of people engaged in hand capture and the number of hours of effort, a toads/person/hr index was derived. This catch per unit of effort approach had useful application in evaluating deployment efficiencies across multiple night busts. It enabled a practical assessment of when and where to deploy resources to maximum effect. Targets on the western edge of the PBZ would be allowed to drop to very low toads/person/hr ratings in the endeavour to clean waterbodies completely but for more easterly targets where the aim was to drive landscape populations down as low as time and resources allowed, it was vital to keep this index high.

8.2.8 OCCUPATIONAL HEALTH AND SAFETY

As part of its risk management planning the Foundation had identified a broad range of occupational health and safety (OH&S) issues that had the potential to negatively impact staff and volunteers in the field. Strategies for minimising risk and preparing for emergencies were considered. These included:

1) training for staff in advance of the Muster (eg. First Aid).
2) planning (eg. reducing night travel)
3) awareness raising of dangers and mitigation measures for volunteers through:
    a. introductory packages,
    b. induction sessions,
    c. daily briefings and
    d. other training

8.2.9 CARE FOR THE ENVIRONMENT

Western Australia has strict quarantine laws. Protocols and practices were developed that were consistent with border checkpoint bio-security requirements as well as the potential to spread weeds, pests and disease within the Northern Territory.

Toad control is an intensive exercise. At it's the peak the Muster had over 40 volunteers and staff in the field at once using several 4WD vehicles, quad bikes, traps and fencing structures. Most of the activity was conducted on a pastoral station and existing station roads were used almost exclusively.

The district weeds officer provided advice and information sessions on identifying and managing weeds for staff and volunteers. Particular attention was paid to weeds which had the potential to be transported to the Kimberley on vehicles, and clothing. Vehicles which had been in the field were cleaned prior to east-west border crossings.

Volunteer activities were coordinated and controlled closely through a team structure. Camp sites were selected in consultation with land managers and with local impact in mind.
Avoiding pollution is a challenge with such a large group of people. Toilets and other sanitation issues were planned carefully with deep pit latrines dug well away from water bodies. Food and other wastes were disposed of at Timber Creek's council tip site. Chemicals and petroleum products were carefully stored and only accessed by authorised personnel. Litter was carefully controlled with rules, supervision and clean-up sessions.

A weak solution of chlorine was used to destroy metamorph toads on the perimeter of waterbodies when found. This was considered to be low impact as it was delivered directly to the target (on land) during daytime when chlorine can be expected to boil off within (2 hours).

Cane toad control activities are continuing in the Northern Territory and are likely to for several years to come. For now, all physical structures, excepting those traps that remain in place, have been fully decommissioned.

All vehicles travelling back to WA were cleaned of weed seeds

8.2.10 CANE TOAD CAPTURE

The primary methodology of cane toad control was hand capture, backed up by trapping. Below is outlined the general process of capture, transport, euthanasia, counting and disposal of toads. This process has become known as 'toad busting'

Hand capture involves small teams (4 – 8 people) that drive to pre-selected control locations arriving just before or soon after dusk. Using powerful spotlights the teams form 'skirmish' lines that radiate out from the water body and 'sweep' the shore line. The line of search typically extends 50 to 100m out from the shore. This depends on a range of factors, but primarily the practicalities of access and vegetation.

When observed or found in traps, toads are picked-up and placed in heavy duty plastic bags. The bags are then carried until 'full' usually until they become uncomfortable heavy). Care was taken not to overload bags as too many toads results in mass toxin discharge. Bags are sealed at the top (capturing as much air as possible) and used to transport the captured toads back to base/field camp at the end of the evenings work. When back at camp the toads are euthanized by opening the bags, filling the bags with CO2 gas, and then resealing the bags. This is the approved process for euthanizing toads, as agreed by DEC. Bags are then left sealed till morning (a minimum of 1hr is needed to ensure full euthanasia).

In the morning the bags are opened, toads removed, categorised as male, female or sub-adult and totals in each category recorded. All toads below 80mm in length were classed as sub-adults because it is not possible to positively determine the sex of these toads. Metamorphs or toads below 20mm in length were kept separate and were not included in the count. After counting the toads were taken to burial pits for disposal.

Records were kept of the location captures were made, the number of each category of toad captured, the number of workers, the duration of the effort and any incidental observations that might give insight into improved control methods or the impact of cane toads (ie. dead native fauna).

Gassing

Counting

Burial

8.3 MUSTER OUTCOMES

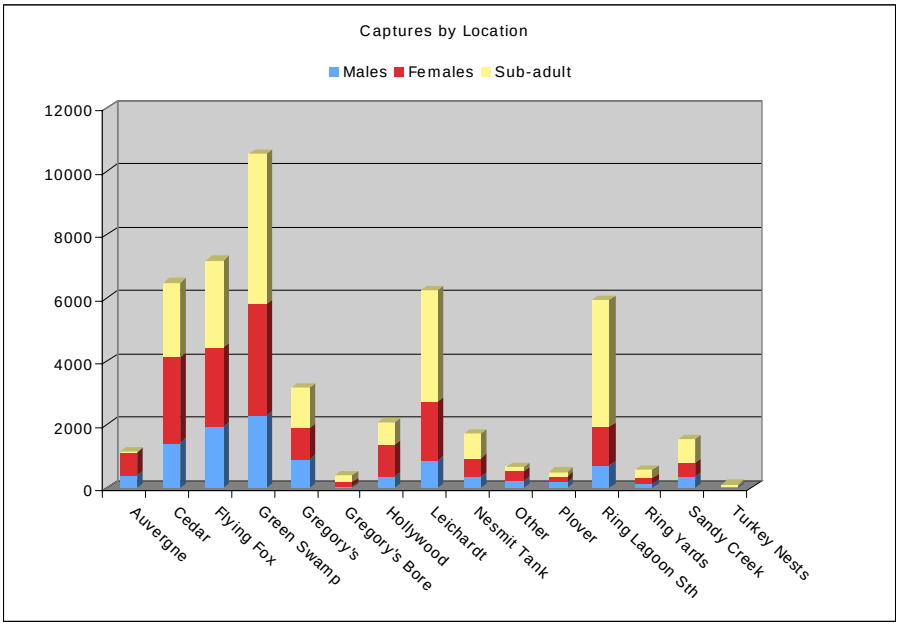
8.3.1 THE PRIMARY BUFFER ZONE

The Whirlwind Plains, on Auvergne Station was identified as the best location for the Primary Buffer Zone and therefore the primary focus for the Muster. The area is a floodplain bordered by the Victoria River to the east and north, the Victoria Highway to the south and the Baines River and Pinkerton Ranges to the west. The control zone is approximately 550 km^2 in area, consists predominantly of black soils, with gravel ridges on higher ground. Aerial and ground reconnaissance determined that surface water was very restricted across the area during the later stages of the Dry Season. Fifteen major water holes and lagoons were identified and 'busted' during the period, although some of these receded and dried during the muster. Results of the toad muster activities are detailed below.

8.3.2 CANE TOAD CAPTURE DATA

Capture effort was variable across the locations as there was not the same number of people involved in the collection of toads on each night at each location. This reflected varying numbers of volunteers at different stages of the Muster, as well as the need to spread people across different locations at different times.

During the 5½ weeks of the toad muster a total of 48,374 adult and juvenile toads were removed from the control zone. The following graph shows the capture details for each of the major locations across the area of the Muster showing the number of toads taken from each location.



There was significant variation in the numbers of toads at the different locations and the shoreline of the locations had no real bearing on the numbers of toads in the area. It appears that the vegetation type and other physical attributes had no real bearing either. Other aspects such as proximity to other water bodies and water courses may be an explanation but a more detailed analysis over coming months will be required to reveal this.

Some of the locations such as Cedars and Leichardt are water storage earth tanks, square in shape and approximately 80 metres square yet they had high concentrations of cane toads.

Natural systems such as Flying Fox and Green's Swamp also had high concentrations of toads and were in the section of the floodplain that held the most cane toads. Leichardt was also in the same region.

Most of the sub-adult cane toads were more than 40mm in length. There were surprisingly few very young cane toads or tadpoles across the area, which is perhaps an indication that cane toads find the conditions quite difficult during the dry season. In the Top End of the NT some breeding has been recorded in every month of the year but this does not appear to be the case in the Whirlwind Plains/Auvergne region.

8.3.3 AUVERGNE LAGOON

The opportunity was taken during the Great Toad Muster to revisit Auvergne Lagoon to reassess the effectiveness of mustering conducted earlier in the year. In late June/early July 2006 nearly 600 toads were removed from the lagoon, with 144 toads taken from a 1.2 km transect along the lagoon. This transect comprised approx. 20% of the total shoreline of the lagoon. Follow up visits yielded only 7 toads from the transect on the 7th Aug and 3 toads on the 9th August. During the Great Toad Muster only 27 toads were taken from the transect, with an additional 462 taken from the rest of the lagoon. After the third night no further toads were captured on the transect.

Overall 1,135 toads were captured on the lagoon complex during the muster, bringing the tally for the year to 1,685, with numbers dropping sharply after 4 nights but with small numbers being found after that. This certainly suggests that toad numbers had been significantly depleted on the transect and on the lagoon as a whole, and numbers on the transect remained lower compared with the remainder of the lagoon following the initial mustering in July.

Auvergne Lagoon - note dense stands of Barringtonia actangula and floating rafts of aquatic vegetation that can provide safe refuges for toads.

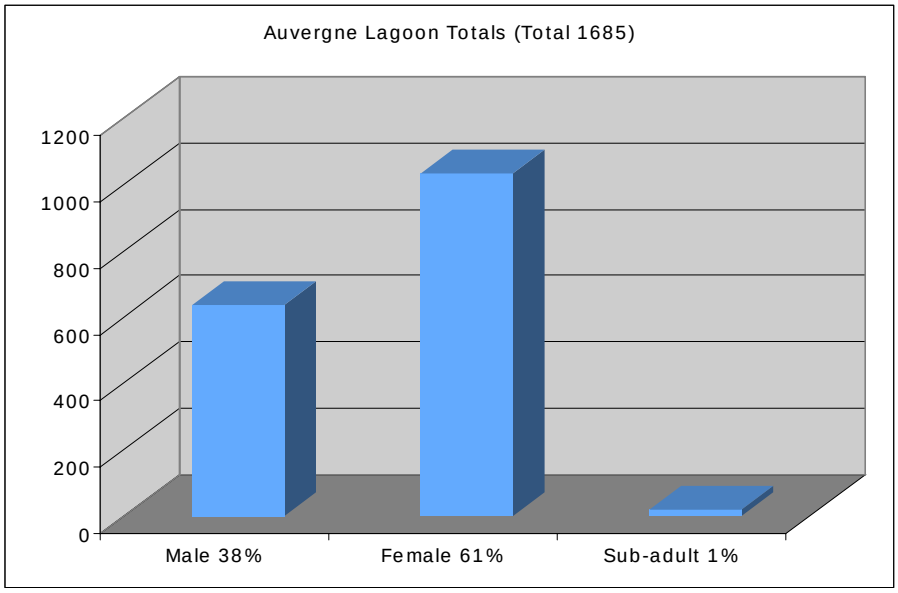
It has been reported that toads become more active as soon as the first Wet Season rains come, with toads seeming to appear from no where in areas previously believed not to support many toads. This was observed and reported by volunteer groups at the start of the 2005/06 Wet Season in the Victoria River Roadhouse area. Fortuitously, there were localised, heavy rains over the control zone on the last few days of the 2006 Great Toad Muster. This provided an opportunity to determine if toads appeared in areas previously thought to be cleared. On the final night of the Muster, after heavy rain, a search of the Auvergne Lagoon area revealed no cane toads at all. The absence of toad activity following rains suggests that a significant water body can be cleared of cane toads using these control models. This was further supported by a visit to the area by the WA Government's DEC cane toad team in late November. Nifty the sniffer-dog was part of the team and they spent several hours at the lagoon at night, and found no cane toads.

Auvergne Lagoon was populated by mostly adult cane toads with little evidence of breeding even though toads had been at the site for at least 6 months. Visits to the site on October 13 and October 31 found no cane toads at all. It is possible the system was cleared of mature cane toads. There were most likely some metamorphs still in the area at the end of the Muster. Control work had been carried out but they were difficult to find in reeds in one section of the system.

At Auvergne Lagoon there were virtually no sub-adult toads and toads had not bred in the area to a significant degree.

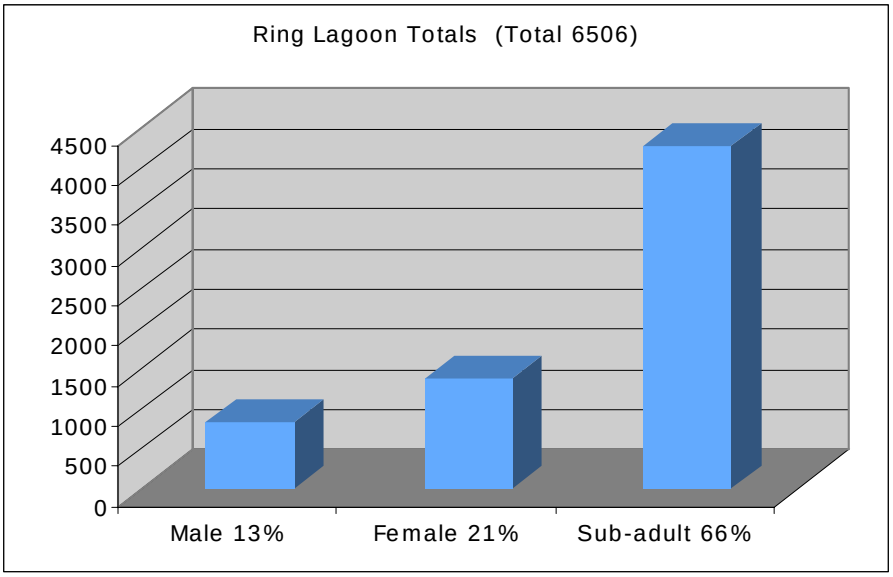
During the July visit to Auvergne Lagoon there were some metamorph toads in one location, which were attacked by the group. There were less than 5 toads found in the 40mm size range during the Great Toad Muster indicating that the impact from the earlier visit was significant.

During the September – October visit there were two areas with tadpoles and some very young metamorphs. It is interesting to note that in an area with over 1500 cane toads and very suitable habitat, little breeding took place from June to September.



8.3.4 *RING LAGOON*

Ring Lagoon was the most westerly waterbody and had a large number of toads and an especially high number of sub adults as a percentage of the population.



At Ring Lagoon there were not as many toads overall as there were on the eastern side of the PBZ, there were less toads in the 80 to 100 mm size range but large numbers in the 30 to 80mm size. The high population percentage of sub-adults could indicate a relatively new population and may also suggest that breeding occurred as early as 2005/2006 Wet Season.

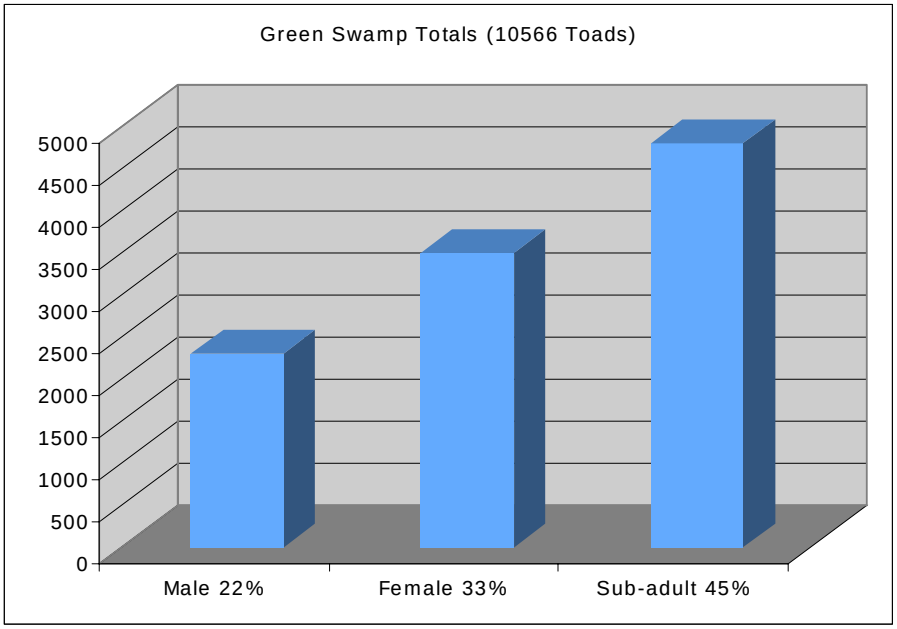
There were also less toads in total on the Ring Lagoon system (6506) when compared to places like Green Swamp (10566). The total was very different when you consider that Flying Fox (7297), Green's swamp (10566) and Leichardt (6233) are all grouped together in one area of the region.

8.3.5 *CEDARS LAGOON*

A small wetland (80 metres square) that held a large number of cane toads. During the day, Sunday 8th, 594 cane toads were collected around the edge of the water. An additional 1,615 toads were collected that night. After this toads were no longer evident in numbers around the water body during the day. Evidence suggests that the toad population in this area was greater than there were refuge spots for them, as there were large numbers of cane toads out in broad daylight around the waters edge. The following night an additional 2,175 toads were collected around the location.

8.3.6 *GREEN SWAMP*

This location also had toads visible during the day, mainly refuging in cattle footprints. A large number of people (40) participated on the first night this location was worked. The area had water and wet mud in the centre of an area of clear ground that made the hand collection of cane toads relatively easy. The rapid decline in numbers at this location might be attributed to the vegetation structure and large effort on the first night.



The sex and age profile of toads captured from Green Swamp shows a larger proportion of adult (over 80mm) toads than found in capture data from Ring Lagoon. One possible explanation is that cane toads have been present at Green Swamp for longer than at Ring Lagoon. If Green Swamp has had toads for 2 breeding seasons then the higher percentage of adults may be due to the maturing toads recruited from the first round of breeding adding to adult population percentage. Whereas, if Ring Lagoon has had toads present for only one breeding season the higher proportion of sub-adult 30mm-80mm) toads may be due to insufficient time for the toads to mature and add to the proportion of adult toads in the capture profile. Some weight is given to this conjecture by the considerable distance between Green Swamp and Ring Lagoon (around 30km). Ring Lagoon is well west of Green Swamp and therefore likely to have received cane toads after Green Swamp.

8.3.7 *FLYING FOX*

Flying Fox is a natural system and appears to be a major Dry Season refuge area. It also has some of the most difficult busting areas due to extensive thickets of *Barringtonia acutangula* (Freshwater mangrove) on some sections.

The numbers of cane toads taken from some of the locations was very significant and confirms that the principles of the planning were correct. Indications are that the environmental pressure on cane toads to move to water during the Dry Season is incredibly strong and it appears they have to do this to survive. No cane toads were found more than 300 metres from water. This supports evidence from Ringwood Station

It is also interesting to look at the cane toads on the western side of the Baines River. The DEC cane toad team concentrated on that area between the Baines River and the Pinkerton Range and found very small numbers of cane toads, approximately 160 toads for the week.

This area is just 2.6 km from Ring Lagoon where we removed 6,500 cane toads. Based on distance, the numbers there would be expected to have been much higher than they were, indicating that the river itself may be a significant barrier to cane toad movement.

This also raises the question of whether the cane toads are crossing the Victoria River in significant numbers. More work needs to be done to determine this and the fencing project planned for the Gregory's tree road will help to shed some light on this issue.

The confluence of the East and West Baines Rivers

9 DISCUSSION

9.1 SURVEILLANCE & RECONNAISSANCE

The Great Toad Muster was conducted in the PBZ and whilst we were aware that there were significant numbers of toads in the areas, the extent of the infestation was a surprise.

We now have a data set from the area that is unique and it will be very important to redo the exercise next year to provide answers to some very significant questions about cane toad numbers and the reinfestation of areas that have been cleared of cane toads. This will help to answer some important questions about the management of cane toad impacts as well as control possibilities and strategies for reducing migration.

The Pinkerton' Range is a significant barrier and with some man made enhancements it could be even more significant. There are some sections along the Vic River area at the end of the range where some control work should be targeted.

The Baines River, notably downstream of the East and West Baines confluence, appears to present some level of barrier to toad movements. Ring lagoon has had toads for at least 1 year (and perhaps longer based on the relative numbers of males females and sub-adults within the population) but they have not crossed the river in significant numbers. DEC work between the Baines River and the Pinkerton Range show small numbers of toads by comparison. Further reconnaissance to the west of the East Baines River has detected no toad populations any further west than those at Auvergne Lagoon and Ring Lagoon.

Cane toads have been in the region of Auvergne lagoon for a significant period of time and this is a key indicator that the process of reconnaissance is still a problem yet this should not be the case as it is reasonably easy to do. It requires people being in places at night and during the dry being able to respond to environmental changes such as unseasonal rains and temperature spikes.

9.2 FRONTLINE DEPLETION

Water bodies on the northern side of the Baines would have been worth addressing with the resources we were wielding during the Muster. DEC efforts have only yielded a few hundred toads from these locations and it would be interesting to know whether this is a function of population sizes (as it appears), or effort.

9.3 SYSTEMATIC DEPLETION

The Muster saw an intense and sustained cane toad control effort targeted at a large portion of the Primary Buffer Zone. The Great Toad Muster was the first event of its type and beyond cane toad control itself it served to as a proving ground for control techniques and concepts as well the practicalities of mounting such a field campaign.

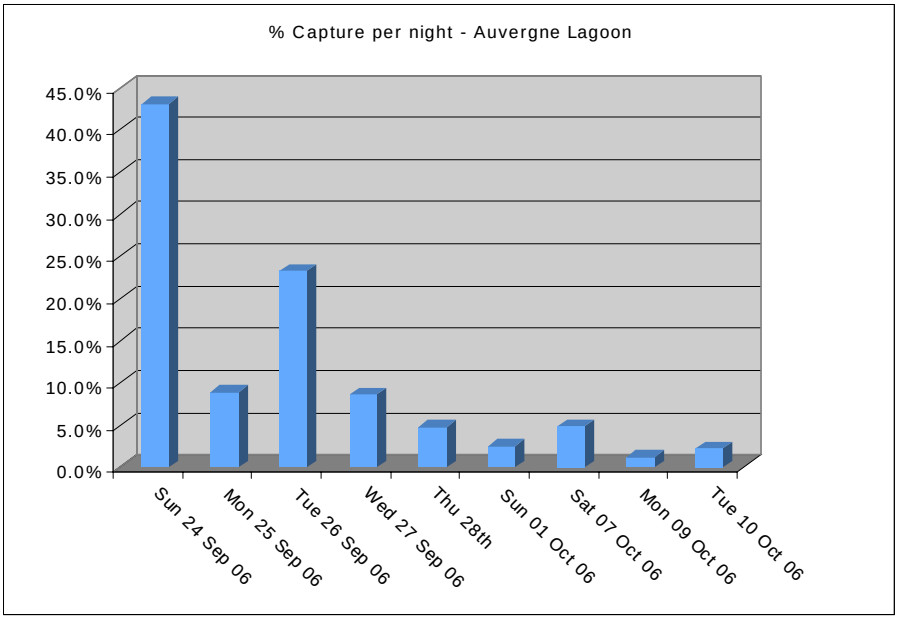
There were areas, identified as lower priority targets that did not get addressed, or did not get fully addressed. Sections of Alpha Creek and Sandy Creek between the Victoria Highway and the major Station roads some 10 – 15km to the north were identified as having persisting surface water and likely to contain cane toad populations. This section of Sandy Creek did receive some attention in the latter stages of the Muster. However the difficulties of terrain and access limited this work, as did time constraints. Some known targets on this section did not receive any control effort or visitation to confirm water or toad status. Similar targets on Alpha Creek received no visitation at all.

Alpha Creek, Pear Tree Creek and Sandy Creek to the south of the Victoria Highway all contained persisting water bodies and significant likelihood of cane toad populations. Once again, time constraints and difficulties of access prevented visitation during the Muster.

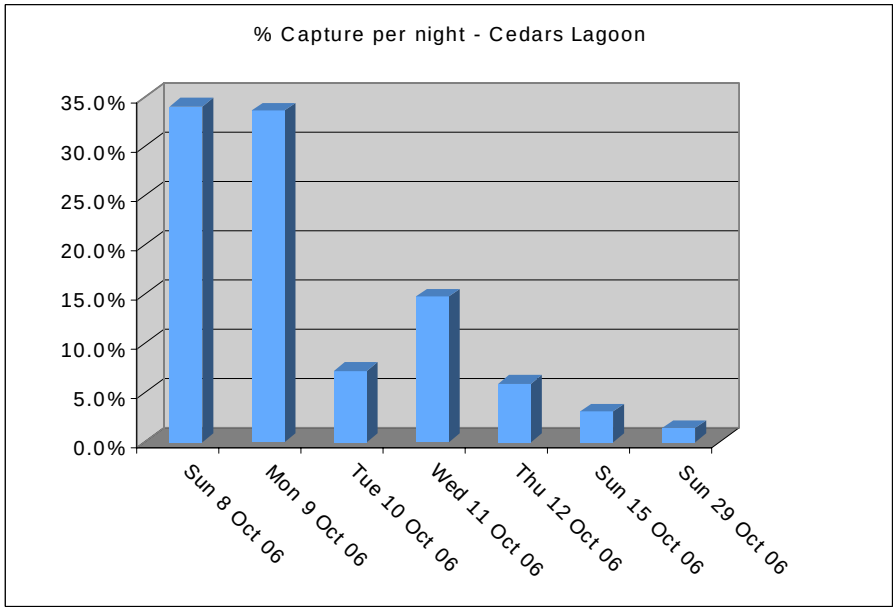
9.4 EFFECTIVENESS OF REPETITIVE BUSTS

The following graphs show the importance of multiple successive busts at the same location to really deplete toad numbers. The following plots show the percentage of the total capture for each site that was caught on each night. They show the importance of successive night busts to make a significant impact on the toad numbers at a given location.

9.4.1 AUVERGNE LAGOON



9.4.2 CEDARS LAGOON



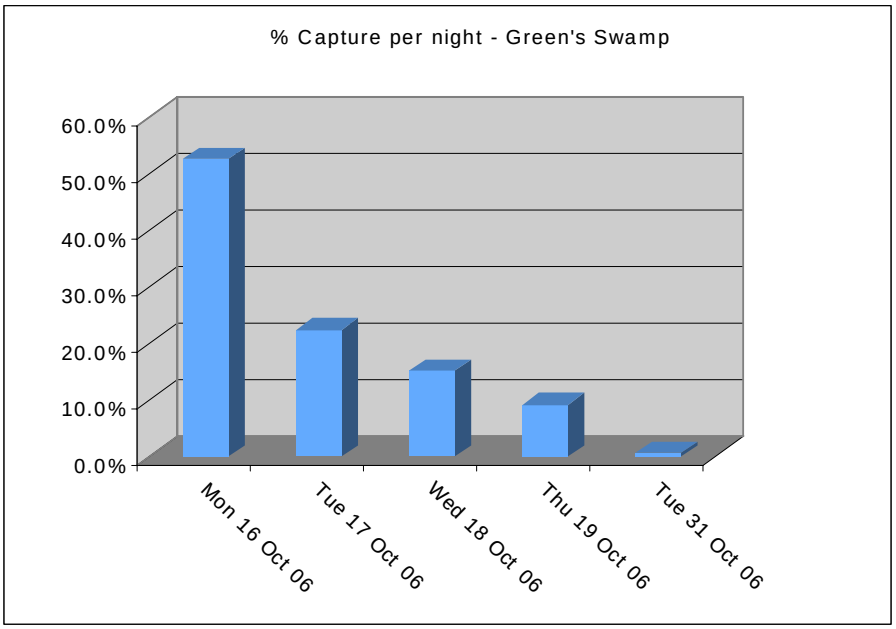
The experiences from Cedars lagoon provide interesting information about refuge options in the PBZ. Poor refuge options for cane toads mean they are more vulnerable to toad busting. There were large numbers of cane toads visible during the day in and around the water at Cedar Lagoon. There were limited refuge options in the area and this appeared to be the cause. This was confirmed after 594 toads were removed from the area during daylight on Sun 8th October. That night a haul of 1,615 was taken from the lagoon area. On the following day only a handful of toads were found in the water indicating that refuge spots could hold the remaining toads. That night a further 2,175 toads were removed.

Even in such good conditions we did not manage to exceed 35% of the total number of toads taken on a given night. This again highlights the need for repeated visits to the same locations.

9.4.3 GREEN'S SWAMP

Green's Swamp probably provided the most favourable conditions for toad busting of any location. The structure of the area, significant bare ground areas around limited water bodies combined to make the toads visible and vulnerable.

It is interesting that even with such favourable conditions and 40 people involved in the bust at one location on the first night we only just managed to get 50% of the toads at the location.



9.5 CONTROL TECHNIQUES EVALUATION

9.5.1 TOAD BUSTING

Toad busting (hand-collecting) activity has reached high levels of efficiency.

A better understanding of when cane toad 'refuging' behaviour begins and what the triggers are for this could allow for an earlier start to the Muster in future years.

We need to continue to refine the toad busting model to see if greater numbers of cane toads can be removed per unit of effort by careful matching of people numbers with the terrain and densities of cane toads in an area (see 8.2.7)

Strategies such as deploying attractants like ground lights to concentrate toads may be effective in helping increase the capture rate for small toads and warrant experimentation next year.

The development of specialised reconnaissance and clean-up crews proved vital to the overall efficiency of Muster effort and essential to complete eradication at target sites.

9.5.2 TRAPS

Research near Darwin (Ringwood) shows a significant impact on toad populations from trapping during the late dry season.

Some traps were constructed during the Muster and deployed during the period. Indications were positive with several captures of many toads in a single night and one capture of 88 toads over 3 nights in one trap. An average of 21.2 toads were caught per trap per night during our trials.

There was enough evidence from the limited trap work done to indicate that the patterns observed at the Ringwood trap trials could potentially be replicated in this area if the traps are appropriately set up, placed and maintained.

9.5.3 BARRIERS

A barrier fence was trialled reducing the toad's ability to escape from an advancing line of toad busters. It was partially effective and the question of how barriers may be able to be used to concentrate toads or to channel toads into traps warrants further study. Barrier techniques are unlikely to be universally applicable but it may be feasible to develop a bank of materials and structures with experienced people assessing locations for suitability.

Trialling a barrier fence at Green's Swamp

9.5.4 SNIPING

There were some areas that were very difficult to toadbust due to the landscape, vegetation and/or the behaviour of cane toads. This was particularly the case in areas of freshwater mangrove (Barringtonia acutangula) thickets. In some areas it was difficult for people to move freely and cane toads could often escape deep into the thickets, hollows and logs or into water, making them impossible to reach.

Noise and movement of people often triggered an escape response from the toads in these areas, more so than in open spaces when a crouch response was more common.

It was decided to trial an air rifle to shoot cane toads as a solution to this problem and as part of the process of final clean-up, once the vast majority of toads had been removed by conventional toad busting.

We trialled this process on the Auvergne Lagoon complex.

14 large cane toads were collected from the Barringtonia thicket on the eastern side of the main section of Auvergne Lagoon on one night late in the Muster when toad numbers were very low and no toads were collected on the western (more open) side of that section. All were very large adults and 10 were large females.

In another example on the northern section the teams repeatedly reported a cane toad jumping into the water and escaping each night. It was thought to be the same toad. A toad was shot in that area during one of the clean-up runs in that section and no other toads were reported from that spot after this event.

The sniping trial is considered to have been a key tool in completely eradicating toads from Auvergne Lagoon and the inclusion of a sniper in clean up crews is concluded to be an effective tool in final clean-up and in dealing with difficult areas such as thickets and where toads escape to water.

Safety concerns

The process of using an air rifle to kill cane toads has dangers associated with it. These include the use and transport of a firearm in the field, as well as the issue of ricochets (especially with low velocity ammunition being used into or near water).

The associated risks of injury need to be managed by ensuring operators are appropriately qualified and through additional training and appropriate operational procedures in the field.

It should be noted that:

1) Graeme Sawyer (Regional Coordinator) was our sniper and that he has appropriate licences, has done the appropriate training course with the NT Government for feral animal control, and is a qualified range safety officer.
2) No hand collection teams were working at sites on nights when the firearm was employed and sniping was done with a single partner.

Methodology

Cane toads were shot as soon as practicable after they were sighted. A stable rest was used whenever available but it was often necessary to shoot from an 'offhand' position and often in a cramped situation. Fortunately distances were short, allowing reasonable accuracy and consistency. A rest should be used where practicable, followed by a sitting or kneeling position

Cane toads hit in the correct spot exhibit a characteristic and clear response where the body stretches forward quickly and then relaxes into a limp stretched out position with the legs stretched straight out to the rear. Once shot, the cane toad's body can be retrieved, by using sticks or similar to reach into difficult places.

It is recommended that a partner always be involved in the process to minimise risk and to maximise cane toad sightings. Approvals from land owners is essential.

9.6 CONTROL MODEL

The capture of 48,734 cane toads over the period indicates that the model underlying 'toadbusts' is significant as a cane toad control factor and the underlying principles of the STTF model (that toads have to refuge near water and that successive night toad busts in one area are the best model for removal), are in fact confirmed.

No cane toad was sighted more than 300 metres from water and the vast majority of the toads were found within 10 metres of water.

Some specific sites in the area give further insight into the impact of the model. In particular the case study on Auvergne Lagoon is of interest. The Lagoon is approximately

3.5 km's in length and is fenced to keep stock away from the water which means there is more vegetation around the water providing more cover for toads.

The Auvergne lagoon area is a section of the Auvergne Lagoon Creek system where water remains after the plains have dried up and the creek has stopped flowing. It is in the area 15 35 29.94 S 130 06 45.15 E and can be viewed at Google earth http://www.googleearth.com.

The night's catch

9.7 A COMPARISON OF LOCATIONS ACROSS THE PRIMARY BUFFER ZONE

Cane toads have continued to show the same movement patterns as they have across the NT and are moving more rapidly along the river corridors as they move closer to WA. This is confirmed by the densities of toads near the river and the fact the toads are further west along the Victoria River corridor than they are along the highway.

Cane toads are known to keep moving longer into dry periods when they are following a watercourse than when travelling cross country.

Based on population profiles (sex and size capture data), there is conjecture that locations at the eastern end of the PBZ, such as Flying Fox and Green Swamp, have had toads present for 18 months to 2 years. It is not possible to judge this with certainty, however, toads were found in much greater numbers than anyone expected and it is likely that toads have been present for longer than expected.

9.8 DID WE CONTROL CANE TOADS?

Why cane toads move across the landscape is not well understood. Diverse opinions exist as to the nature and cause of this movement. The net westward movement of cane toads is the only certainty.

Some studies suggest that cane toads move randomly and some indicate quite directional movement. Lots of myths such as “cane toads only move along roads” thrive in this uncertainty. The sex and age profile of toads captured from Green’s Swamp shows a larger proportion of adult (over 80mm) toads than found in capture data from Ring Lagoon. One possible explanation is that cane toads have been present at Green’s Swamp for longer than at Ring Lagoon. If Green’s Swamp has had toads for 2 breeding seasons then the higher percentage of adults may be due to the maturing toads recruited from the first round of breeding adding to adult population percentage. Whereas, if Ring Lagoon has had toads present for only one breeding season the higher proportion of sub-adult 30mm-80mm) toads may be due to insufficient time for the toads to mature and add to the proportion of adult toads in the capture profile. Some weight is given to this conjecture by the considerable distance between Green Swamp and Ring Lagoon (around 30km). Ring Lagoon is well west of Green Swamp and therefore likely to receive cane toads after Green’s Swamp. It also gives rise to the question of what is driving cane toad movement.

If the reason for movement is population pressure then the dramatic removal of toads from the Auvergne floodplain system will become a critical factor in slowing toad numbers and it will not make the final mop up of cane toads (the effort to get the last one) such a priority.

If in fact the removal of the vast bulk of toads from an area would remove pressure from the remaining few to migrate the toad busting efforts would be able to be greatly extended from what we have achieved during this event.

If on the other hand cane toads are going to move anyway it is necessary to try to “get the last toad” in an area. This means keeping resources in an area much longer and dramatically reducing numbers of toads being caught per unit of effort.

Teams ready to leave Timber Creek for the night’s work 14 October 2006

10 CONCLUSIONS

STTF consider the 2006 Great Toad Muster to have been an unprecedented success. It is the first known landscape-scale attempt to control cane toads, and preliminary indications are that it was highly effective. The Muster was also conducted in a safe and responsible manner, with no negative occupational, health and safety issues arising. Appropriate strategies were set in place to train and oversee volunteers.

Evidence that the Control Model is effective arrived with heavy rains on the final night of the Muster when a search of the Auvergne Lagoon area revealed no cane toads at all. The absence of toad activity, even following rains, suggests that a significant water body can be cleared of cane toads using these control methods. Further support for this can be taken from a visit to the area by the WA Government DEC cane toad team, in late November. They spent several hours at the lagoon at night and could not find a single cane toad.

10.1 Surveillance & Reconnaissance

The surveillance and reconnaissance approach to the Muster identified the western most populations of cane toads. It thereby determined where the current toad front existed and enhanced our ability to target those toads of greatest threat to WA. The combination of helicopter, quad bike and 4x4 vehicles identified remaining waterholes and assisted in the safe and rapid access to most target locations in the control zone.

10.2 Frontline Depletion

The major objective of frontline depletion was successfully achieved in the control zone, with population numbers in waterholes along the frontline effectively removed.

10.3 Systematic Depletion

The secondary objective of the systematic depletion of toads from the control zone was achieved to a greater extent. Populations of toads at the 15 major waterholes in the control zone were effectively removed. However, there were some inaccessible creeklines with residual water which could not be accessed, and these might have supported toad populations that were not eradicated. Greater numbers of vehicles and volunteers would allow additional time to be spent accessing these remoter areas.

10.4 Appropriateness of timing (season)

The timing of the Great Toad Muster appeared to be appropriate, being in the late Dry Season, when many water holes were receding or drying, with temperatures climbing above 40^{o}C. It was anticipated that these conditions would place toads at a high stress level. During the Muster, no toads were found greater than ~ 300 m from any waterhole, with the majority within 10 m of water, and with most toads along the waters edge. The very high densities of toads at some small waterholes, and with many toads at these locations in the open during the day, suggests over-crowding, with the limited preferred shelters occupied. This suggests that all toads in the landscape crowd into the remaining waterholes, making this the best time of the year for on-ground control.

10.5 EFFECTIVENESS OF REPETITIVE BUSTS

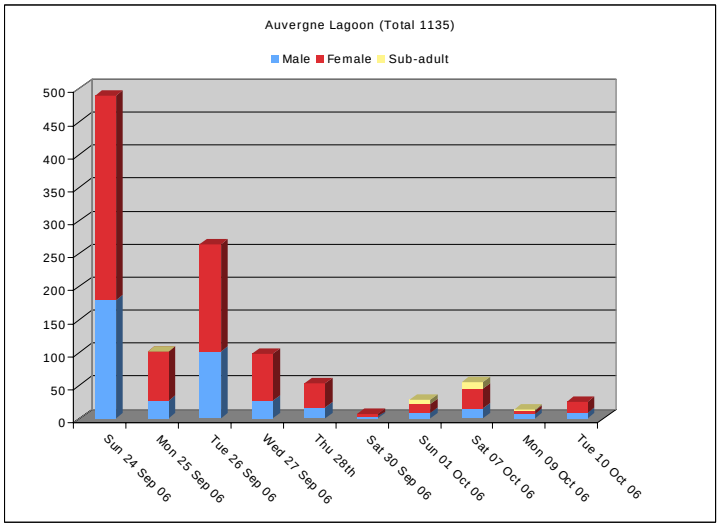
The Muster demonstrated the importance of repetitive toadbusts to really deplete toad numbers. Auvergne Lagoon was used for initial trials in July, with follow-up busting in August and again in October during the Muster. Results show repetitive busting to be highly effective at lowering toad numbers with 4 – 5 nights needed at a location to deplete numbers to the point where the population is all but eradicated. Complete clean-up is also achievable but more specialised effort is needed to completely eradicate toads from a waterhole (see 9.5).

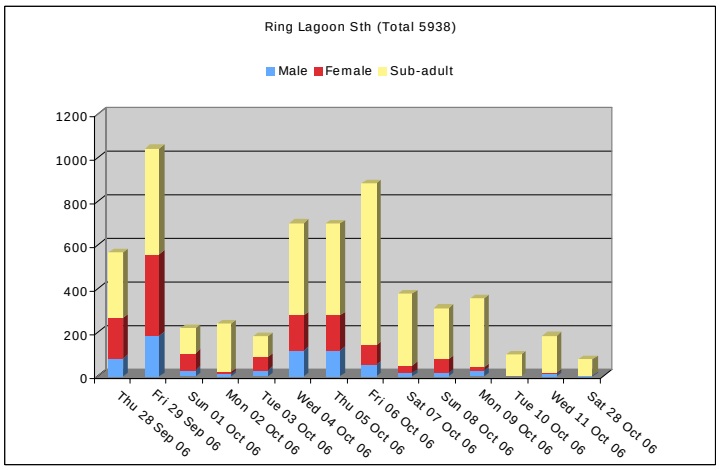
10.6 CONTROL MODEL

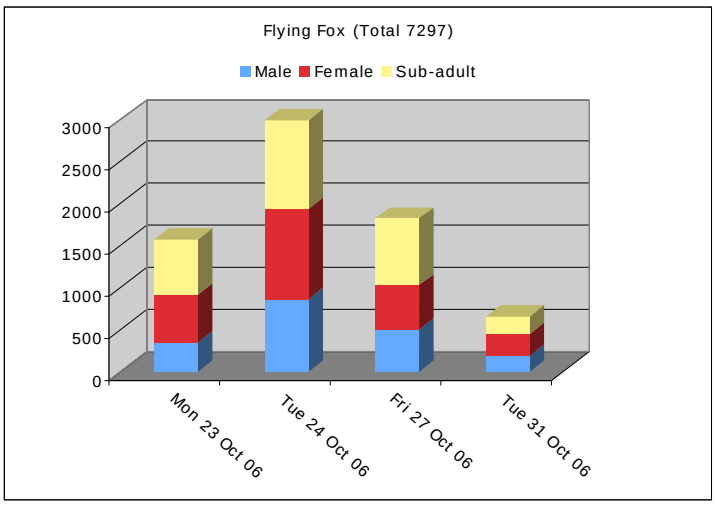
Results from the Great Toad Muster 2006 demonstrate that the first component of the Control Model, population removal from the control zone, was achieved. This is evidenced by depletion of toad numbers at waterholes that were targeted, one location revealing an absence of toads following first Wet Season rains. The second aspect of the Control Model will only be apparent after the 2006/07 Wet Season. It is not known whether toads will invade to the same westerly point as the 2006 frontline by the end of the 2007 Wet Season, and it is not known if densities will return to the same levels over the ensuing Wet Season.

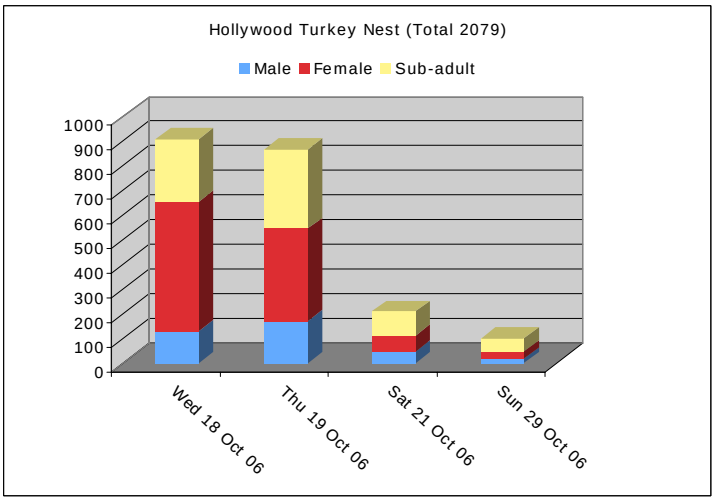
The first part of the Control Model has been achieved. It is now critical to continue reconnaissance and on-ground control in the early Dry Season 2007 to determine the effects the Great Toad Muster has had on the advance of the toads. If toad control has been effective, then the opportunity exists to repeat the exercise in 2007 on a larger scale and potentially establish a permanent buffer zone to keep WA cane toad free!

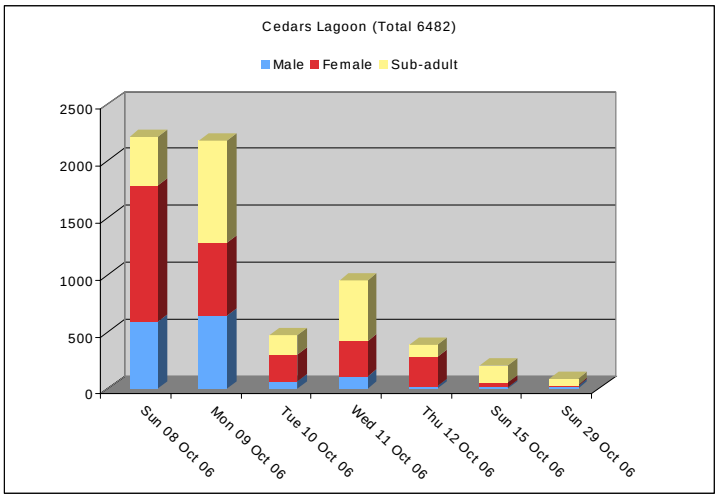
11 APPENDIX 1 - TOAD CAPTURE RESULTS








Hollywood Turkey Nest (Total 2079)
Male
Female
Sub-adult
1000
900
800
700
600
500
400
300
200
100
0
Wed 18 Oct 06
Thu 19 Oct 06
Sat 21 Oct 06
Sun 29 Oct 06


Cedars Lagoon (Total 6482)
Male
Female
Sub-adult
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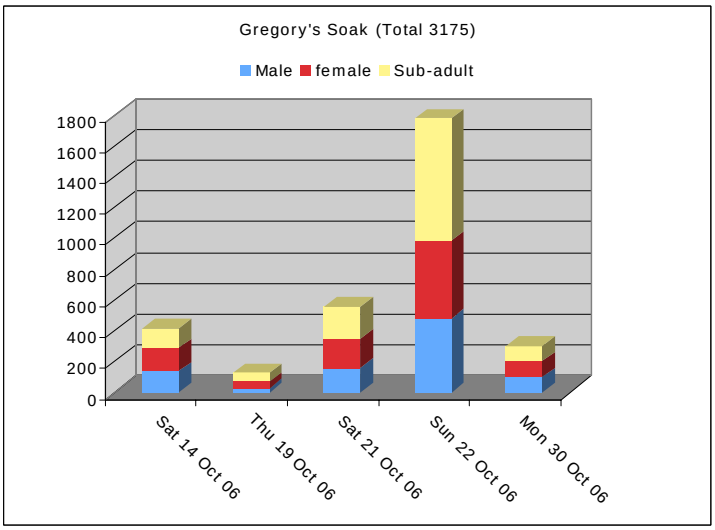
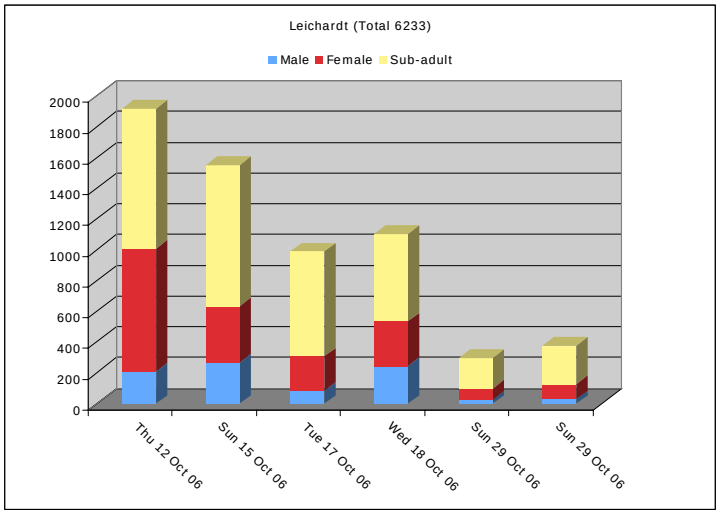
2000
1500
1000
500
0
Sun 08 Oct 06
Mon 09 Oct 06
Tue 10 Oct 06
Wed 11 Oct 06
Thu 12 Oct 06
Sun 15 Oct 06
Sun 29 Oct 06


Gregory's Soak (Total 3175)
Male
female
Sub-adult
1800
1600
1400
1200
1000
800
600
400
200
0
Sat 14 Oct 06
Thu 19 Oct 06
Sat 21 Oct 06
Sun 22 Oct 06
Mon 30 Oct 06



Closing days - Great Toad Muster 2006

12 APPENDIX 2 - WILDLIFE IMPACTS

A Whip snake was found at Auvergne Lagoon writhing and knotted up seemingly in pain. The animal died soon after it was discovered. An autopsy revealed a small cane toad metamorph in the stomach of the snake.

Goanna carcasses were common across the area but only one live goanna was seen during the period of the toad bust and it appeared to be in the process of dying as it was unable to move its limbs and was very sick. It was found at Cedar Lagoon.

There were also a significant number of shells of long necked turtles in the water as well as some on land. Local indigenous people commented there appeared to be many more than usual.

Cane toads were in very high concentrations in some area and the impact on native species utilising the same food supply were potentially significant. Whilst we do not have good information on this the numbers of species like *litoria inermis*, native frogs which congregate on water late in the Dry Season, their numbers seemed to be much higher at Auvergne Lagoon than at other locations such as Ring Lagoon and locations in the east of the control zone. We also found *litoria inermis* in the stomach contents of a number of the cane toads we autopsied.

In areas where there is such a significant reduction in surface water and significant refuge periods massive numbers of cane toads in these locations will be almost certain to impact on the native species utilising the areas.

Whip snake autopsy

Toad autopsies

13 APPENDIX 3 – PAUL'S STORY

This article by Paul Stanley is included here as an insight into the experience of a volunteer participating in the Great Toad Muster 2006.

In September and October 2006, 126 volunteers made their way to one of the most remote and demanding parts of Australia to eradicate cane toads. The final tally was a staggering 48,320.

But what would motivate a person to do it?

Here is one volunteer's story:

THE GREAT TOAD MUSTER

by **PAUL BRADLEY**

The ancient Australian dreamtime is slowly transforming into a nightmare in the top end of our great land. Turtles, goannas, fish, snakes and crocodiles are dying at an alarming rate. The cane toad, an imported, toxic crasher of ecosystems which has no natural predator on our continent, has infiltrated the dream, is wreaking havoc and is determined to continue its work.

stopthetoad.com

THE GREAT TOAD MUSTER

'It was a shantytown camp in the middle of nowhere with some scattered tents and a camping trailer covered by a web of tarpaulins under a small tree. A windmill and cattle trough completed the postcard.'

It was introduced into Queensland in 1935 as a natural predator for the sugar cane beetle, but the experiment quickly turned into a diabolical problem.

In response to this threat, a great West Australian tradition is in its infancy: organised toad mustering. When I first saw the ad for the Great Toad Muster in my local newspaper asking for volunteers to come up to the Territory and catch cane toads, with all food and camping gear provided, the attraction to the cause and possible good time was irresistible. This was my chance to dilute a me-me-me lifestyle and give something back. It was time to act, not talk.

Armed with adventure, planet salvation and two tonnes of aviation kerosene, I caught a plane to Kununurra and bussed it into the remote pit stop of Timber Creek in the NT. It was heading towards the end of the dry season around October and in just weeks the rains would come and the toads would be camouflaged and protected by the big wet.

At the back of the lush caravan park, under the watchful eye of a huge boab tree, I presented at the field headquarters of the Stop The Toad Foundation and received a warm welcome and questioning. Toad One, a Troopy, (Toyota troop carrier), was going out that afternoon to the front line base camp at Auvergne station, 60 km west and would I like to 'get into it?' Everyone was out there.

Soon enough, Toad One took two staff and me out to the bush camp and as we drove into the unknown and swapped stories my excitement and expectations were high. This was just what I was hoping for.

As we approached the bush camp in a choke of dust and 3pm heat, I was slightly disappointed at first impressions. The conditions looked fairly hostile. It was a shantytown camp in the middle of nowhere with some scattered tents and a camping trailer covered by a web of tarpaulins under a small tree. A

'...at dusk, 19 of us squeezed into Toad One and Toad Two and laughed our way out to Dan's Lagoon in more dust.'

windmill and cattle trough completed the postcard. I mentally revised the amount of time that it would be possible to stay, the camp screamed 'challenge'. This was the deep end in the top end, and there was no quick escape.

I introduced myself individually to about 25 people, promptly forgetting everyone's names, but was relieved by an honest warm welcome from all. Everyone had questions: 'Where are you from?' 'How did you hear about the muster'?

At first there seemed to be no common thread between the collective. There were young travellers - singles and couples and groups of all ages, some from foreign countries. It was Big Brother without the cameras, the spa, and the beautiful people and I was the intruder. My tent – a mozzie dome - had no shaded cover and was like an oven in the middle of the day, but it was the best one available. I spent about five seconds in it and bolted out.

It was time to start from the beginning. The only thing to do was to watch the show and find out where my niche was, how to fit in, survive and to slowly get to know the crew.

Dinnertime was a relaxed affair and then it was time to get my 'battle gear' from the stores tent. My kit consisted of a reflective vest, a high-powered torch, and battery and bum bag, plastic bags and gloves. Personal flair completes the rest of the uniform. I was ready to fight.

Everyone fell into line for the night's briefing. We were going to Dan's Lagoon (named after a recently departed 'toader'). Each group had four to five people and a group leader. The groups were to split up for a couple of hours around the lagoon and to meet back at the aptly named 'big boab'. Then we'd see what the feeling was if we were to continue. So, at dusk, 19 of us squeezed into Toad One and Toad Two and laughed our way out to Dan's Lagoon in more dust. The instant ease, camaraderie

'There is no consolation in a depleted food chain that might slowly adapt to the toad. Put simply, cane toads do not belong here.'

and combined purpose were to eventually bring me much closer to this bunch of strangers that I ever could have hoped for.

My first toad catch was anything but a graceful exercise but stupidly running around after frogs in the night in such a special place quickly turned into a Zen-like experience with a sense of moment, topped up with more laughter and cries of 'toad!' It was like I forgot everything and all my focus was put into that searching circle of light from my torch, hoping to catch as many as possible. I would eventually develop a bad toad habit after three weeks. It's a highly addictive pastime, guaranteed to bring on a few laughs. It's good exercise too but it's impossible to get used to them pissing on you as you pick them up. It was natural to develop a personal toading style. I can recommend approaching them from the front, as they sit there like statues unsure of what's happening. If I approached them from the rear, they would sometimes hop away at pace but my long legs and boot would put a stop to that.

Allow me some latitude here but some toads really did appear smarter than others. Most would give in without much fight but some would hop madly in every direction with purpose. The more a toad wanted to evade me, the more I wanted to catch it and the hunting gene would kick in. We always had to keep a constant eye out for snakes and crocodiles, all potentially deadly, and there was no escaping the insects and their wicked bites.

For about two minutes I did wrestle with the karmic dilemma of killing living things but given that the species is so supremely destructive of Australian native habitats, it's very hard to love a cane toad. The toads are changing the balance of an ecosystem that has perfected over time. There is no consolation in a depleted food chain that might slowly adapt to the toad. Put simply, cane toads do not belong here.

When we arrived back at camp near midnight, we gassed the bagged toads with carbon dioxide and went to bed exhausted.

'As days passed and I tuned further into the cycle of light and dark, the day and date become more irrelevant.'

Every toad-mustering night would end like this and I would always fall asleep in my swag in seconds.

Breakfast would slowly bring everyone together again and then the first job of the day would be to count and sex the toads. The toadal tally was a very important part of the day and we would often try to guess the total of the previous night's catch for the grand prize of a Cherry Ripe. I found an opening for the job of gravedigger and strangely enjoyed the ceremony of burial up the dry creek. It wasn't a popular job but I liked it. There was a high likelihood of getting splattered with toad juice and the aroma really was something unforgettable.

There was also an indigenous group working with Stop The Toad. They were the Caring For Country Women's Rangers, a group of six to eight young locals (one of whom was a Traditional Owner) whose mission is to care for sacred women's sites, to collect ingredients and make bush products such as soaps, food and medicines. Their family members also camped with us and eventually they told me some of their dreamtime stories and gave us all a lesson in weeds and what they looked like. It was very sobering listening to traditional owner Laurie Roberts tell me about the effects of the toad on indigenous lifestyles. In the last two years in this area he has noticed a reduction in the numbers of anything that eats the toad, especially new generations of species. Hearing Laurie's suggestion that we build a zoo to protect native animals was a bit of a wake up call. Meeting and working with these people was to be a really positive experience for me.

As days passed and I tuned further into the cycle of light and dark, the day and date become more irrelevant. In the cooler hours, the camp was a hive of activity and jobs were snapped up because there really was not much else to do, except look for jobs. There is always a job somewhere in a bushcamp if you want one. The daily allocation of chores usually got everyone's attention. Our workload was different according to how we felt.

'As we were all volunteers and could leave on the next ride out, the priority and motivation was to enjoy ourselves and be positive.'

'I never learnt a single person's surname. It seemed irrelevant. If you weren't picking up toads, there was no reason to be out there.'

Sometimes the search and competition for jobs became quite comical; a camp can only tolerate so many chiefs and Indians. Occasionally jobs would be pinched without notice, so you would move on to another one. This was the perfect place to enjoy, with humour, leading and following others I didn't know. Any tensions, ill feelings or thoughts need to thaw quickly in such a camp if the operation is to be effective. There is simply no room for bad attitudes and to carry them around is the best way to alienate yourself. As we were all volunteers and could leave on the next ride out, the priority and motivation was to enjoy ourselves and be positive. The two to three staff were the solid reference points for our places in the camp. They were the benevolent dictators that the group needed.

There were always people coming and going from the camp, it was in a constant state of change. There were, on average, 20 to 30 people per night and there were plenty of characters and 'do-ers'. I never learnt a single person's surname. It seemed irrelevant. If you weren't picking up toads, there was no reason to be out there. The camp was a 'dry' one. No alcohol. This makes life far less complicated.

During the hottest hours of the 46-degree days when chores felt less important, there was not much to do in the camp except read, look at yourself, talk to others, and play chess or cards. The conditions were extreme and there was no escape. Hot wind blew through the defenceless camp intermittently and coated everything in a layer of dust. At times the wind would be cyclonic 300 metres away, yet it would be perfectly still in camp. Siestas only made me more tired so it was better to stay awake in the day. Most of the hard work was done at night.

Occasionally there was a chance to do some daytime reconnaissance of the freshwater billabongs where we were busting. Seeing all the wildlife and the horizons in the day really gave the place more perspective but the best perspective of all came later with a free 50-minute helicopter ride with two other

'We would all be asking ourselves:
"How can we ever stop them? Why bother?"'

volunteers. A local aviation company donated some airtime to help the Foundation search for freshwater bodies that weren't on the map. The ride was a reward for the three of us volunteers who had spent a bit of time for the cause.

The Territory is such a vast space, much of it inaccessible. There were often mixed emotions after a nightly bust. When we first went to a 'hotspot' there would be toads as far as the light could reach. The frenzy of the first bust on a new site would always be exciting, because there would be toads everywhere. Elation would turn to quiet despair on the way back to camp. We would all be asking ourselves: 'How can we ever stop them? Why bother?'

Only after returning to the same spot four or five nights did it become apparent that we were having a positive effect. Areas that once had plagues of toads were cleaned out. Balance was temporarily restored. It is possible to dramatically reduce toad populations and influence their advance. There's no doubt that they will return to areas that have been busted but the exercise is about managing the toads' advance. It's too late to keep them out of the Territory now. Toads are already well established and Territorians and their governments will have to learn to live with their past inaction. The Kimberley still has the slightest of chance to remain toad free, but only if we can stay active and vigilant.

'Not on my watch, not while I'm around,' said Malcolm, a 72 year-old retired surgeon from North Cottesloe. I adopted his mantra. It summed everything up about what I could be.

Later in the Great Muster, when we'd pushed the frontline further east, the bushcamp eventually moved back to the relative luxury of the Timber Creek caravan park. The move was a big operation in the heat but everyone put in their bit and got the job done. It was a bit sad to leave the bushcamp. After two weeks in the bush I was starting to have a really positive connection with the land and the changing light and season, but heat and fatigue were creeping up on those of us who had been there for

'Only after returning to the same spot four or five nights did it become apparent that we were having a positive effect.'

'After three weeks up north, I'd had one of the best experiences of my life.'

'The Stop The Toad Foundation is a positive force and its committed members are an inspiration.'

The author, Paul Bradley

Photo: Pam Steele

a while. Swimming pools and beer were calling. I was to spend my last week there at the caravan park, continuing to go out each night to new waterholes but it wasn't the same as the camp. The camaraderie and purpose were still there and growing but the luxuries and 'cool' reduced the way we'd had to rely on each other. There was even the occasional night off if we wanted.

I was promoted to team leader. I felt great pride that I had been asked to lead those who had just joined up and show them the ways. More responsibility meant more gear to carry such as a radio, a GPS, and Glad Wrap for snake bites. Safety and teamwork were our priorities and team leaders worked together well.

After three weeks up north, I'd had one of the best experiences of my life. We all worked hard for our own reward. I'd met some great people, won a Cherry Ripe, seen amazing places that I would never normally have access to, had a helicopter ride, did lots of four-wheel-driving, rode quad bikes and had a positive effect on the land, all for less than a thousand bucks.

Ignorance really is bliss in the comfort of our lounge rooms and it's easy to say that locals, pastoralists, the government and someone else should do something, but eventually we all need to take some responsibility on our own level for our impact on the environment. This exercise has taught me how to do that.

The Stop The Toad Foundation is a positive force and its committed members are an inspiration. Forget politics and dollars, the bottom line is that toads are being picked up off the ground and doing nothing is going to cost us all a lot more.