NSW GOVERNMENT | Office of Environment & Heritage

Eradicating cane toads in NSW outside their current range of distribution

Best practice guidelines

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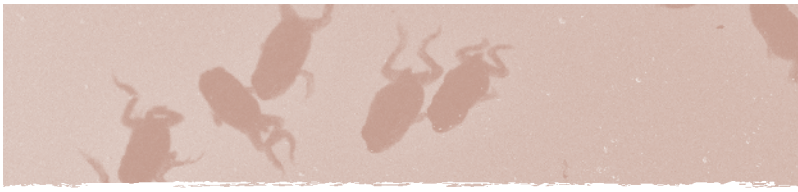


1 Introduction

These guidelines provide a comprehensive management strategy in response to new reports of cane toads. They draw on experience gained during cane toad eradication programs in Sydney and Port Macquarie. They are specifically aimed at councils and state land management agencies; if a member of the public finds a suspected cane toad, they should call their local council or local land management agency.

The guidelines summarise the best available knowledge on eradicating cane toads *Rhinella marina* (formerly *Bufo marinus*) in south-eastern NSW. They focus on areas where cane toads have not yet become established, where population numbers are still low and where the colder climate increases the chances of eradication.

Cane toads are a serious threat to biodiversity because:

- they invade the habitats of native animals and compete for food
- they consume large amounts and eat any animal they can swallow
- they can poison other animals that try to eat them – many native predators and domestic pets can't tell the difference between a cane toad and native frog, and cane toads are poisonous at all stages of their life (eggs, tadpoles, juvenile and adult toads)
- native frogs are killed when mistaken for cane toads
- there are few cane toad predators in Australia.

Cane toads were introduced into Australia in 1935 and have since colonised large areas, especially in the northern part of the continent. They have contributed to the decline of several native species, and their continued expansion is likely to cause further declines in the endemic fauna of Australia (Phillips & Shine 2004; Lever 2001; Murray & Hose 2005). Cane toads are listed as a key threatening process under both the NSW *Threatened Species Conservation Act 1995* and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (see the Australian Government's policy on cane toads at www.environment.gov.au/biodiversity/invasive/ferals/cane-toads.html).

Cane toads are found throughout much of Queensland, the wet–dry tropics of the Northern Territory, and parts of Western Australia. In south-eastern Australia, the contiguous distribution stops in the Richmond River Valley, with separate established populations at Yamba (lower Clarence Valley), Brooms Head and Mororo (including Ashby and Woombah; J Thomas, pers. comm.). During the past few decades, cane toads have been repeatedly transported to other areas in south-eastern NSW but have not survived there (White & Shine 2009). However, more recently, cane toads became established and were breeding in Port Macquarie and Sydney.

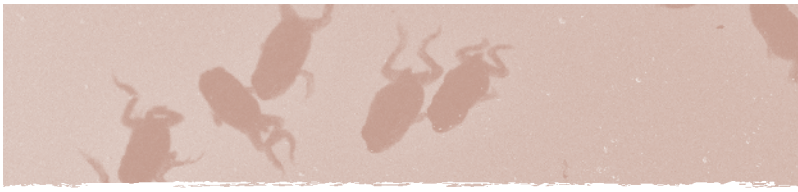
At Port Macquarie (Lake Innes), cane toads bred from 1997 to 2007. A collaborative effort by Port Macquarie–Hastings Council, Hastings Landcare, NSW National Parks and Wildlife Service, Frog and Tadpole Study Group NSW and the community reduced cane toad numbers to such low levels that they are unlikely to persist in this area (J Thomas, pers. comm.). The success of this program is attributed to a sustained community effort (approximately 900 toads were collected) and removing an artificial water source where toads were breeding.

In Sydney in January 2010, more than 50 cane toads were detected in an industrial area at Taren Point. With the help of a cane toad action group, Sutherland Shire Council developed a comprehensive eradication program. Approximately 650 toads were collected between March 2010 and October 2011 but less than 10 adult toads were found during the four months thereafter (S Harris, pers. comm.). Breeding was first confirmed in March 2011 but few or no metamorphs (young toads that have just undergone metamorphosis from tadpoles) escaped from this breeding event.

In March 2012, cane toads managed to breed again in a new, temporary pond. It took some weeks for Sutherland Shire Council to obtain access to this site. Most metamorphs from this breeding event were collected but some did escape, so the eradication program will continue as before. Given the previous success with removing adult toads, it is possible this population can also be eradicated.

We now know that cane toads can survive and breed south of their main area of distribution (e.g. south of Yamba). However, the climate in these areas is less suitable. They originate from tropical and semi-arid America, and colder temperatures, especially in winter, increase their mortality rates or slow down their metabolism (White & Shine 2009). The success of eradication programs in Port Macquarie and Sydney has also been attributed to the colder climate in these areas increasing toad mortality and slowing the rate of breeding (R Shine, pers. comm.). In northern Australia, eradication efforts have so far been unsuccessful.

Every year numerous cane toads are transported to southern Australia, mostly on trucks. Breeding populations may become established if several toads are transported to the same area within a short timeframe and the conditions are suitable for breeding (White & Shine 2009). Cane toads have a high public profile and there is widespread community concern about their negative impacts on the environment (White & Shine 2009). Land managers are thus under pressure from the community to quickly respond to sightings of cane toads in areas outside their normal range. These guidelines will help them respond quickly.



2 Cane toad biology

Cane toads are mainly terrestrial but require access to water for rehydration and breeding. During the warmer months, they are active at night. During the day and in cold or dry weather, they shelter. They can survive in temperatures ranging from 5° to 40°C.

Cane toads develop from eggs to adults in six to 18 months. The stages of their development are:

- eggs and tadpoles (in water bodies)
- metamorphs (usually restricted to areas near water bodies)
- larger juveniles and adults (which also spread out through drier landscapes).

Females produce clutches of 8,000 to 35,000 eggs up to twice a year (Barker et al. 1995; Anstis 2002; DEH 2005). In the wild, cane toads live for at least five years but in captivity individuals have lived for up to 15 years (Lever 2001).

In tropical Australia, cane toads can breed throughout the year but in southern Australia, colder winters restrict their breeding to the summer months. Their food includes almost any vertebrate or invertebrate they can swallow, though terrestrial arthropods provide the bulk of the diet. Cane toad tadpoles sometimes feed on smaller tadpoles of their own and other species (Crossland 1998; Williamson 1999).

3 Managing cane toads outside their current range of distribution

Cane toads are widespread in north-eastern NSW and eradication in these areas is not currently a possibility. However, attempts should be made to limit the spread, including eradication of populations outside the current range of distribution. This is in line with the principles of the *New South Wales Invasive Species Plan 2008–2015* (see Section 8). Further discussion of an overall framework for cane toad management in NSW is provided in the *Management Plan for Cane Toads in National Parks and Reserves* (OEH 2011).

The aim of all eradication programs should be that cane toads do not establish a breeding population. Figure 1 (opposite) provides a basic outline of the process that can lead to such an outcome, starting with the initial response to cane toad sightings. At times, individual steps may either change or need to be modified to meet local circumstances.

3.1 Identifying adult cane toads and metamorphs

Correct identification has to be the first step when managing cane toads, as native frogs are often mistaken for toads and subsequently killed. This especially happens in areas where cane toads do not usually occur. Some of these native species are threatened with extinction, so care must be taken to identify cane toads by looking for their distinct features as described in this guidelines.

The point of origin of the suspected toad should always be ascertained. In case of incorrect identification, this will enable native frogs to be returned to the point of capture and prevent the spread of chytrid fungus, which causes the disease chytridiomycosis in most amphibian species and is linked to devastating population declines and species extinctions.

Young cane toads look similar to several native frog species. Metamorphs are initially black, changing to grey after reaching 10 mm. Anyone uncertain they are dealing with a cane toad should seek advice from available experts such as at the Frog and Tadpole Study Group (www.fats.org.au) or the Australian Museum (www.australianmuseum.net.au/contact/General).

Figure 1: Flow chart with suggested order of response to cane toad reports for land management agencies. At times, steps may need to be changed or modified to fit special circumstances. Members of the public need to alert their council or local national parks office of any suspected toad sighting.

Adult cane toads features

They have all six of these:

- dry, warty skin
- bony ridge above the eyes
- webbed feet
- unwebbed hands
- large parotoid glands
- visible ear drums

Tadpole features

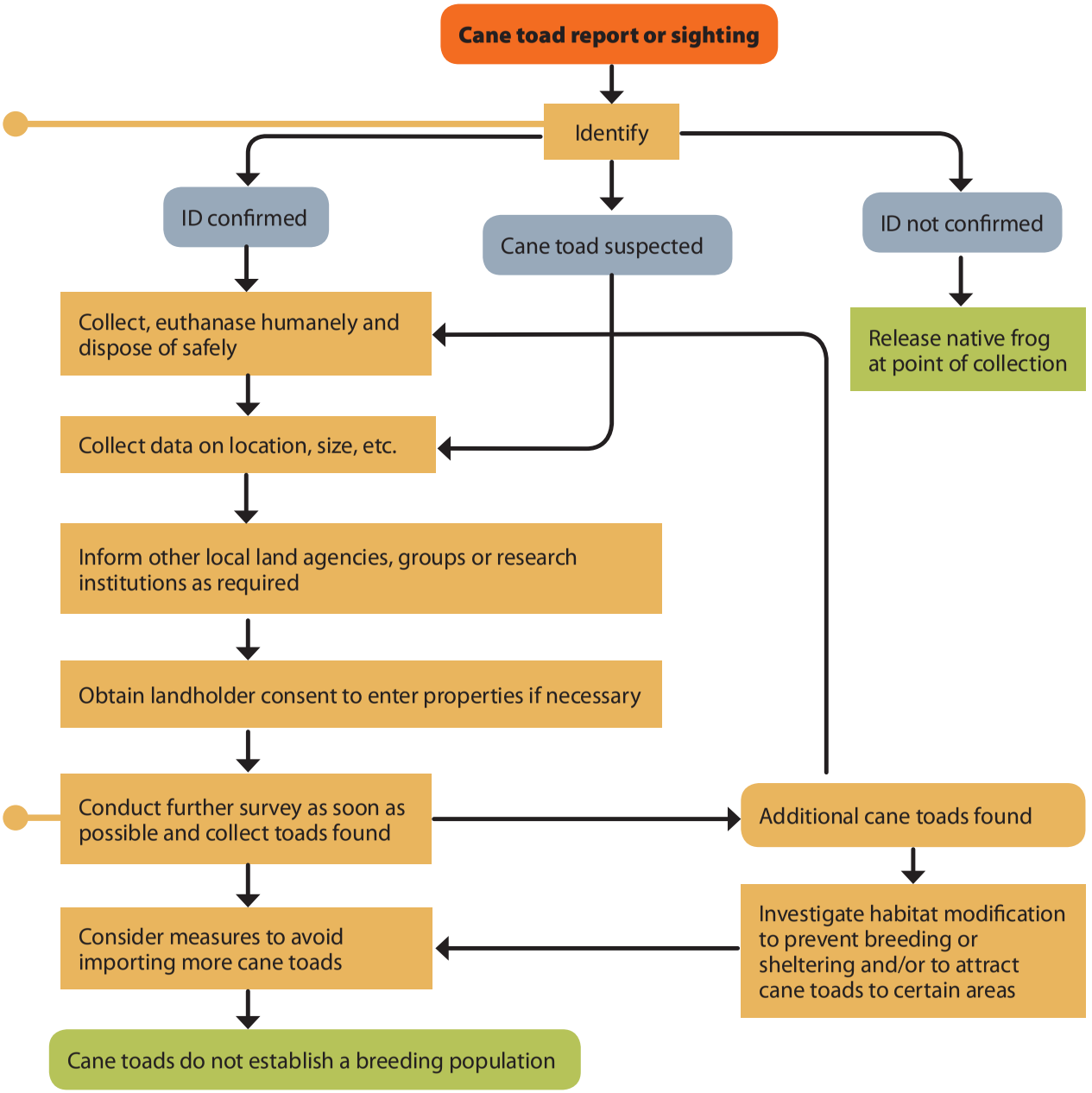
- tail is less than twice the body length
- darker than native tadpoles
- often swim in larger swarms

Spawn features

- eggs in long strings arranged in pairs

Searching for cane toads

- look for adults and juvenile toads both during the day and at night
- look for metamorphs during the day
- look for spawn and tadpoles during the day
- provide educational material to local residents and request reports of sightings
- consider setting up cane toad musters
- consider trapping, remote cameras and acoustic attractants
- consider using sniffer dogs



Adult cane toads should not be identified by their size, which can range from 10 to 23 cm. Their colour is not distinctive either, as it can range from brown to grey or yellow. The following features are not specific to cane toads but are also shared by some native frogs: warty skin, visible ear drum and webbed toes. To positively identify cane toads, all the features outlined in Figure 2 and the text box below must be present, as no native frog species would exhibit them all.

Checklist: identifying adult cane toads

Make sure the animal exhibits all the following features:

- ❑ dry, warty skin
- ❑ bony ridge above the eyes
- ❑ webbed toes on back limbs
- ❑ unwebbed 'hands' on front limbs
- ❑ large parotoid (poison) glands behind the ears
- ❑ visible ear drums.

Also note cane toads do not have suckers or enlarged toe pads on their digits. They have an upright stance, with their front hands facing inwards, and display a short, rapid hopping motion.

Male cane toads have a distinctive call during the breeding season. The call is a guttural trill, sustained for around 30 seconds (for web link see Section 7). It is best described as being like a 'telephone dial-tone' (M Greenlees, pers. comm.).

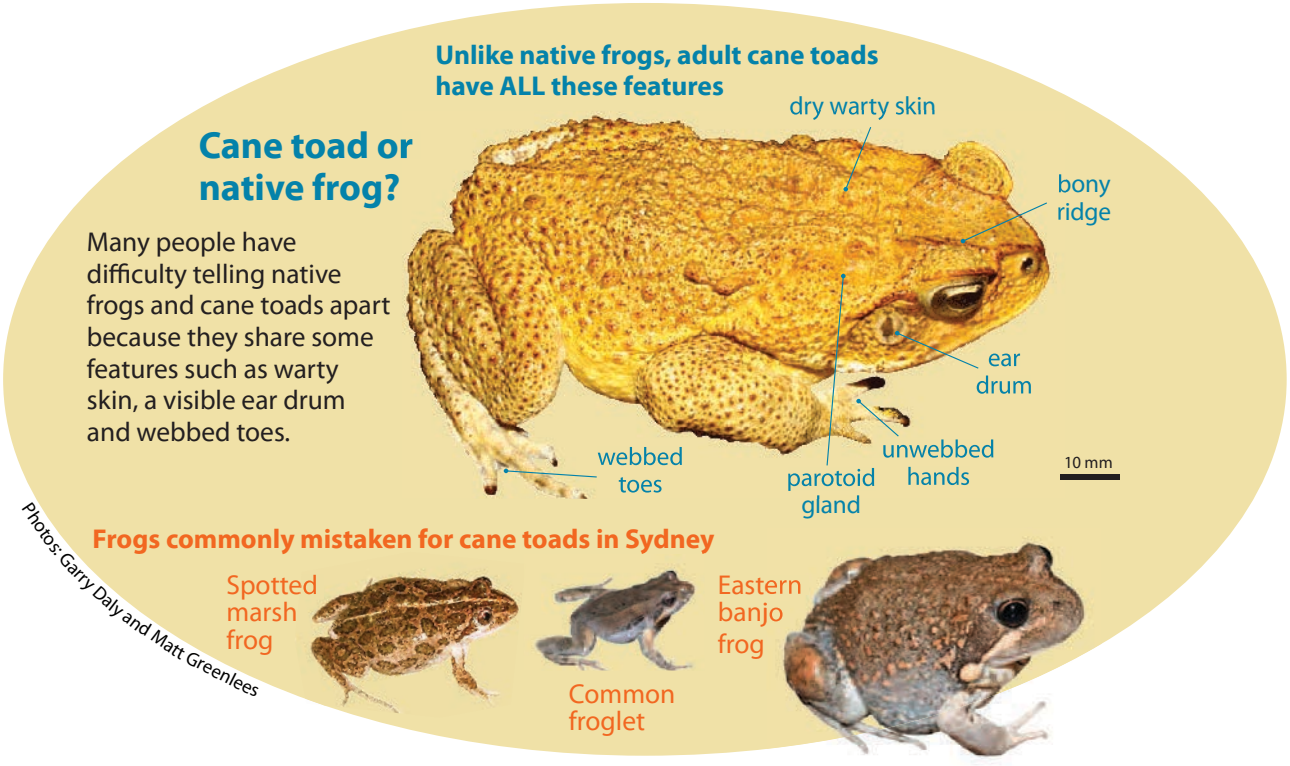


Figure 2: Cane toad identification

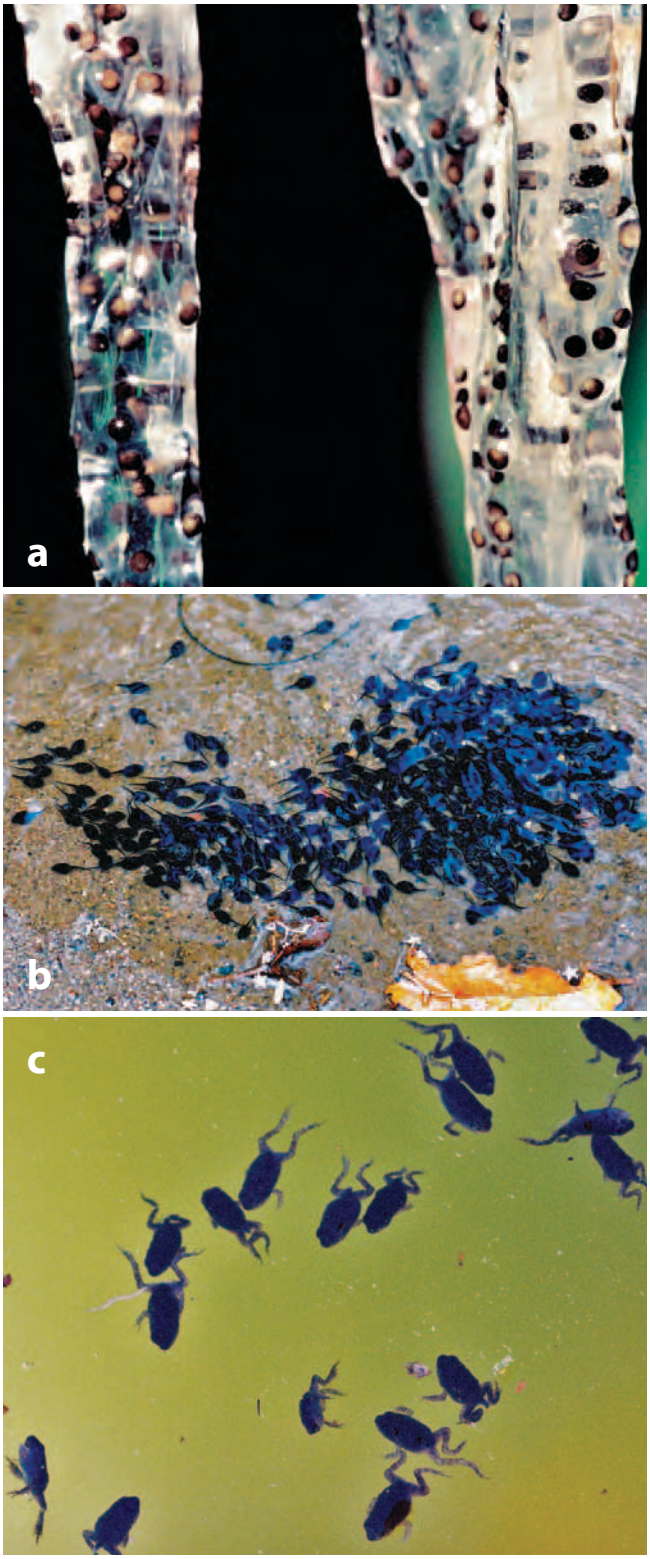
3.2 Identifying cane toad spawn and tadpoles

Cane toad spawn has the shape of long strings of black eggs arranged in pairs in continuous jelly, quite different to the spawn of all native frog species (Anstis 2002). While some native species string their eggs together, they are not usually in pairs (Figure 3a).

Tadpoles (Figure 3b) can more easily be confused with native frog species, and identification needs to be confirmed carefully by looking for all of the features outlined in the text box below. Cane toad tadpoles also often swim in larger swarms than native tadpoles, and aggregate at the margins of water bodies (Figure 3c).

Checklist: identifying cane toad tadpoles

- ❑ **dark black body colour** – most native tadpoles are brown or grey
- ❑ **small size** – body length is about 11 mm, length is 22 to 30 mm (this includes the tail when the back legs appear) – native tadpoles are usually bigger
- ❑ **a short thin tail**, 1 to 1.5 times the length of the body – in native species the tail is usually 2 to 3.5 times longer than the body
- ❑ the eyes are positioned **towards the top of the head** rather than the sides
- ❑ a **broad body** across the gill region, just behind the eyes
- ❑ **visible nostrils**
- ❑ **an underbelly** (ventral surface) that is **black around the abdomen** – in native species, the underbelly is clear, silvery white or densely speckled.



Photos: John Pumpurs

Figure 3: (a) cane toad spawn
(b) swarming tadpoles
(c) metamorphosing tadpoles (10 mm)

3.3 Finding cane toads

Land managers in areas outside the toad's main area of distribution most often receive reports of one or a few cane toads at a time. If these have been correctly identified as cane toads, or are suspected to occur in an area, it is important to start surveying as soon as possible because:

- if several cane toads have been imported together, it is easier to find them all at one location close to the point of import rather than later, when they have dispersed
- if they have laid eggs in a water body, or are about to do so, it is easier to destroy the spawn or catch adults that are mating (Figure 4) than it is to trap tadpoles, which usually hatch within two days of the eggs being laid.

The aim of the survey will be to:

- establish the size and distribution of the cane toad population
- collect all cane toads, tadpoles and spawn found for euthanasia or research
- prevent breeding
- identify where the toads may have come from to inform land managers who want to avoid future imports of cane toads into the same area (see following).

The first step is to obtain landholder permission to enter all areas near where the toad or toads were first reported. This should immediately be followed by a manual survey for adults and juvenile cane toads, as well as eggs and tadpoles (Table 1). It is important to consider the time of year and correct locations for such surveys, as outlined in Table 1 and below.

Land managers may choose to add additional survey methods, as outlined in Table 1. The appropriate level of response will depend on the number of toads identified as well as the conservation value of the area where the toads have been found (e.g. areas close to nature reserves are more vulnerable to negative impacts from toads than industrial areas).

Appendix 2 also lists two survey methods that require further trials before they can be applied on a wider scale (i.e. remote control cameras and sniffer dogs). Land managers may wish to employ these methods if they suspect a larger cane toad population in their area.

Photos: John Pumpurs

Figure 4: Mating cane toads

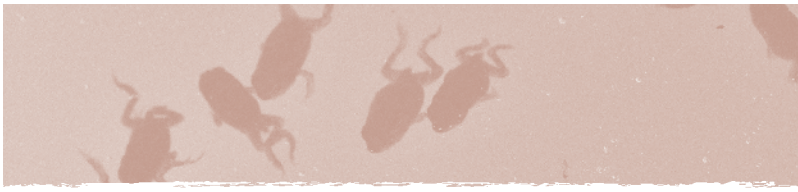


Table 1: Survey methods for cane toads

Name of method	Survey method involved	Section in text
Methods that should be applied as soon as cane toads have been reported/sighted		
Manual survey for adults and juveniles	During the warmer months, listen for calls and conduct a visual search at night with a strong torch. Collect toads as outlined in Section 3.3. Searches should focus on open areas where toads are found most often (see next page) and also around water bodies – especially if there has been no rain or ground moisture for several days. Searches should start in the area where toads were reported. Daytime searches for sheltering toads should also be included but nocturnal searches are generally more effective. During the colder months, search for sheltering toads during the day at shelter locations.	3.3.1
Manual survey for eggs and tadpoles	Focus on shallow pools with gradual rather than steep slopes, and with open and gradually sloping banks. Remove spawn and survey for tadpoles with a dip-net.	3.3.2
Methods that may be considered thereafter		
Trapping adults and juveniles	Use wire cage traps fitted with a light to attract insects and subsequently toads.	3.3.1
Eliciting and listening for calls	When listening for calling males, consider that breeding toads may be present even if calls are not heard. Calling may be elicited by playing back a cane toad call from an Mp3 player or similar portable device.	3.3.1
Chemical trapping of tadpoles	This is a breakthrough method of collecting tadpoles published in March 2012 (Crossland et al. 2012). A funnel trap baited with poison extracted from adult cane toads attracts cane toad tadpoles but repels native tadpoles.	3.3.2
Manual survey for metamorphs	If breeding is suspected, manual searches for metamorphs should initially focus on the margins of water bodies, keeping in mind their small size. Fences around ponds may be considered to keep metamorphs in the area.	3.3.2

3.3.1 Finding adult and juvenile cane toads

Manual searches

Initial searches should focus on manual collection. This can be very effective at keeping areas free of cane toads or keeping their numbers low. Such collection can be done by individuals, small groups or during coordinated cane toad musters (see Section 4.2). A strong head torch or spotlight is best for finding toads. The best times and locations for such searches are outlined below.

Trapping

Numerous trap types have been trialled around Australia. Two of the recommended traps are:

1. Stainless steel pitfall traps. Toads are attracted to the light source on the trap and when they approach they fall into a container through a false door.
2. Cage traps, including super traps. These wire traps have one or two clear finger-gates. Toads are attracted to a light installed inside the trap. Power for the lights comes from either batteries or solar panels. Electronic timers are often used to turn lights on and off at dusk and dawn. The finger-gates can only be pushed inward, thus trapping the toads once they enter. These traps are available as portable smaller models or in a much larger size ('super traps') for areas where they are only being checked every week. They need to be equipped with clean water (ideally self-filling troughs). Provide shade and shelter if they are not being checked every day.

By-catch (e.g. other fauna) cannot always be avoided and animal welfare must be taken into account if the traps are not being checked every day. A flyer outlining the guidelines for the use of the super traps has been developed for northern NSW (Appendix 3).

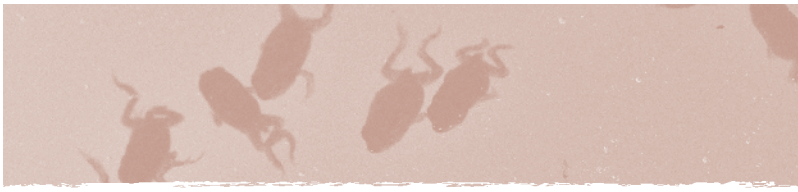
The best locations for setting traps are the same as those used for manual searches, as outlined in 'Where to search' on the next page. For security reasons, traps also need to be placed out of view of the public and should be in enclosed grounds. In some areas, traps may need to be secured by a chain to a tree or post to prevent theft.

To date, land managers have had varying success with traps. The recent eradication program in Sydney used portable cage traps with two clear finger-gates. Few cane toads were caught, and the assembly, transport (traps are bulky) and regular checks required considerable time investment. Daily checks were deemed necessary to ensure humane treatment of cane toads, remove occasional by-catch and replace batteries when necessary. Based on this experience, the cane toad working group decided the result did not justify the high investment in time, and traps were no longer used.

In some other areas, traps caught less than one per cent of toads present but did catch a high number of native animals (R Shine, pers. comm.). One reason for poor catch rates may be that during periods of increased insect activity, toads may not need to enter the traps to feed, as the light also attracts insects to the area outside the cage. This problem can be reduced by using a lower-powered light source.

A trap can be made more attractive to toads by playing cane toad mating calls from an Mp3 player inside the trap. One study showed that such playback enhanced trapping success three-fold (Schwarzkopf & Alford 2007).

In summary, traps should be seen as a temporary solution that can assist other, more efficient control methods. They allow control of toads in localised areas and empower the public to do something. This is especially the case in suburban environments, where traps may be given to individual residents, who then check them regularly and report all cane toads trapped.



Eliciting and listening for calls

Playing recorded cane toad calls (playback), can help detect cane toads in the field as it can stimulate them to call (Schwarzkopf & Alford 2007). This is especially the case in thicker bushland or if it is unknown whether cane toads are present. Use an Mp3 player with a good quality loudspeaker. Play the toad's main type of call, repeatedly, at intervals of about one minute. Calls in Mp3 format can be downloaded from the web (see Section 7). Both males and females are attracted to quiet playbacks (47 dB (A) at 1 m), whereas only males respond to loud (67dB (A) at 1 m) playback (Schwarzkopf & Alford 2007).

In northern NSW, males start calling after the first summer storms or when the water temperature reaches about 25°C. They mostly call on hot, humid summer nights and peak in January, with the season ending about March–April. In Sydney, males have been heard calling between October and January, with the breeding season ending in March.

However, surveying for cane toads using playback is not a reliable indicator of presence. They may not call, possibly due to environmental conditions such as temperature or lack of rainfall (Schwarzkopf & Alford 2007). For example, in Sydney and northern NSW, toads did not always call in areas where they were known to occur (S Harris, pers. comm.), and Mp3 players did not always elicit a response in Sydney (S Harris, pers. comm.). Toads may also breed without any calling being heard (M Greenlees, pers. comm.).

When to search

During the warmer months (September–March) cane toads are mostly active after dark, so searches need to take place during this time. Peaks of activity occur between 9 pm and 1 am and between 5 am and 7 am. Night-time surveys need to be on suitably warm and wet nights. In Sydney, toads seemed to be less active during windy nights.

Night-time surveys during the warmer months may be accompanied by occasional daytime searches for sheltering cane toads. During colder months, surveys need to focus on shelter sites only (see 'Where to search' below). Surveys should continue during the colder months, as toads can still be detected in their shelter sites. In Sydney, a total of 180 toads were collected during the 2010 winter (S Harris, pers. comm.).

Where toads are being detected, surveys should take place at weekly or shorter intervals. Nearby areas that are not yet known to be inhabited by toads should be surveyed in approximately monthly intervals.

Where to search

Initial searches for adult and juvenile cane toads should focus on the location where toads were reported. These animals are likely to have arrived as hitchhikers on goods transported from further north and it is important to collect all the individuals that arrived in the same load before they disperse. Dispersal rates can differ between individual toads and are dependent on whether toads can move without becoming dehydrated. In northern Australia, toads cover distances ranging between 0 and 1.3 km per night (Schwarzkopf & Alford 2005). They frequently move more than 200 m a night, with one toad covering over 21 km in a month (Phillips et al. 2007). In Sydney, a study of 12 toads showed they travelled, on average, only 17 m per night, with one toad travelling 785 m over 12 nights (M Greenlees, pers. comm.).

During warmer months, when the toads are more active, it is important to carry out surveys beyond the site where the toads were first discovered. All searches should focus on the following features in a landscape, where cane toads are most often found:

- **Open, disturbed or human-modified habitats close to water**, such as riverbanks, cleared areas, woodland, parks, paddocks, golf courses and dams. Also around houses and buildings where sprinklers, leaking taps and air-conditioners can provide additional moisture.
- **Open corridors**, such as roads, footpaths, bicycle paths, wallaby tracks as well as other animal or human-made tracks. Cane toads are found more often along such corridors than in many types of surrounding

vegetation (Seabrook & Dettmann 1996). Preliminary radio-tracking studies in the Grafton area showed they never moved more than two to three metres into the denser ground cover next to such corridors (M Greenlees, pers. comm.). They are often found as road kill.

- **Open areas that are lit at night, such as by security lights or floodlights** – lights attract the invertebrates cane toads feed on.
- **Water bodies** – cane toads need to hydrate their bodies every few days, especially in drier landscapes (Alford et al. 1995). Surveys should include all available freshwater bodies in the study area, including temporary water bodies. Where available, aerial thermal images may be considered for detecting water bodies. These need to be quite recent and of a fine enough resolution to detect smaller puddles; they may need to be taken by professionals. Alternatively, all water bodies present in an area should be mapped, preferably using GIS software. Cane toads tolerate muddy water (R Shine, pers. comm.). Saltwater is less suitable, but it is not a complete barrier to their dispersal. Cane toads are able to tolerate salinity of up to five per cent (15 per cent seawater) and sometimes forage in brackish channels. However, they are unlikely to spend longer periods in mangroves or similar areas that are frequently inundated by saltwater (M Greenlees, pers. comm.).
- **Shelter sites** – during the day and in colder months, searches need to focus on potential shelter sites. While cane toad's shelters seem to differ between seasons, they will most often use crevices between rocks, hollows under large, live trees and leaf litter or dense vegetation on the ground (Seebacher & Alford 2002). Artificial shelters include drainpipes or habitat in watered gardens. In Sydney, toads mostly shelter in drainpipes or other areas immediately adjacent to fresh water; they are often only partially covered by the substrate under which they shelter, with up to 80 per cent of an individual exposed (M Greenlees, pers. comm.).

When choosing search locations, it helps to know that toads may not be able to reach certain areas. Larger water bodies can serve as a barrier for toad dispersal, as they are not good long-distance swimmers. They can, however, travel on rafts, especially if there is a current (M Greenlees, pers. comm.). Similarly, toads are unlikely to cross dense understorey and they do not climb walls higher than 50 cm.

Checklist: finding adult and juvenile cane toads

- ❑ obtain landholder permission
- ❑ start survey as soon as possible
- ❑ consider time of year and day when deciding where and when to search
- ❑ choose suitably warm and wet nights for summer surveys where possible
- ❑ obtain equipment: gloves, head torches or spotlight, suitable containers
- ❑ consider obtaining traps and Mp3 players if toad numbers are likely to be high
- ❑ choose suitable methods for euthanasia and disposal (Section 3.5)
- ❑ consider OH&S when surveying and handling toads (Section 3.4).

3.3.2 Detecting breeding – finding eggs and tadpoles

Where to search

Cane toads prefer to lay eggs in shallow pools with open (not vegetated) gradually sloping, muddy banks. They tend to avoid flowing water and pools with steep surrounds. When they do breed in flowing watercourses, they prefer shallow, still areas with high water-transparency. These observations were made in Australia's wet–dry tropics and northern NSW (Hagman & Shine 2006; Semeniuk et al. 2007). Favourable water temperatures for breeding are 25° to 30°C.

Breeding ponds can carry water either permanently or temporarily. In Sydney, cane toads have laid eggs in a newly erected stormwater detention pond that was leaking but carried water during a period of heavy rain. Such temporary water bodies should therefore be included in any searches for spawn or tadpoles.

Manual search for tadpoles

Tadpoles hatch within 24 to 72 hours after eggs have been laid, so egg masses can only be collected during this time. The strings of spawn are often tangled around rocks or water plants. They should be removed manually with the aid of a dip-net. Gloves need to be worn as the egg masses are toxic.

Tadpoles are detectable for much longer, as the tadpole stage may last from three to 20 weeks, depending on food supply and water temperature. Cane toad tadpoles are most active during the day and tend to form dense groups containing hundreds of animals in shallow, still waters. When they approach metamorphosis, they aggregate in shallow margins.

So far, tadpoles have mainly been collected with a dip-net but a more efficient chemical method of trapping tadpoles has recently been developed (see *Chemical trapping of tadpoles* on the next page) which may replace dip-netting in the future, except where the water is too shallow to install any traps. When using a dip-net,

Photo: Matt Greenlees

Figure 5: Sediment pond where cane toads bred in Sydney

Photo: Matt Greenlees

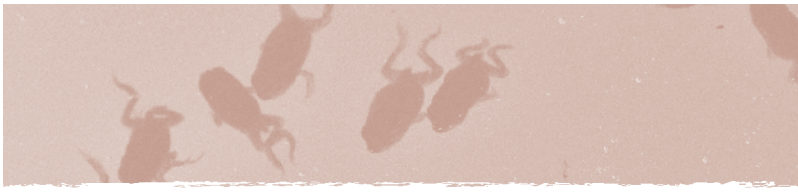
Figure 6: Chemical trapping of tadpoles

take samples from different depths (bottom, mid-water and surface) and at different distances from the pond edge, employing a thorough swooping movement. Take care not to collect tadpoles of other frog species, particularly in turbid water where tadpoles are not clearly visible. Here, it is important to examine the contents of the dip-net following sampling.

Chemical trapping of tadpoles

A highly promising breakthrough method of collecting tadpoles was recently discovered by researchers at the University of Sydney (Crossland et al. 2012). Funnel-traps placed in natural water bodies were baited with toxins collected from adult cane toads (Figure 6). Almost all tadpoles then swam into these traps. Cane toad tadpoles usually eliminate intraspecific competitors by consuming newly laid eggs, and they find these by searching for the toxins present in the eggs. Most native (non-target) tadpoles were repelled by the toad's toxins. This method not only has potential for targeted toad-tadpole removal, it can also provide an early-warning system to detect toad breeding in natural water bodies.

The technology involved is quite simple and is well suited for use by land managers or community groups. It is also likely that traps equipped with chemical bait may remain effective for several weeks or even months, so a single trap deployment at the beginning of the breeding season may be sufficient to remove all tadpoles present (for ethical reasons, tadpoles will still need to be removed from the traps daily). However, because of the dangers of human exposure to toad toxins, toxin collection should be undertaken by officers trained in safe procedures.



Future research will explore ways to embed the toxin in a matrix that prolongs the time that it can be used as bait (because it is released more slowly into the water) and is less likely to harm children or domestic pets. Meanwhile, all land managers wishing to apply this method should refer to the publication by Crossland et al. (2012). Land managers may contact the Shine Lab at the University of Sydney at http://sydney.edu.au/science/biology/shine/ for the latest update on this technology and to form potential research collaborations for trialling this method in the field.

Draining ponds

In Yuragir National Park cane toad tadpoles were successfully removed from some ponds by draining the water (J Thomas, pers. comm.). This method can only be applied in ponds where no native tadpoles are present and is easiest to use with smaller ponds.

Where native tadpoles are present, pumping the water through filters and back into the pond may be an option if there is only a small amount of water. After filtering all the water, any native fauna and flora retrieved should be returned to the water body immediately. Draining a pond may also require a scientific licence (*National Parks and Wildlife Act 1974*) as it can potentially harm native fauna and flora.

Chemical treatment of a water body

Chemical treatment of a water body to kill cane toad tadpoles is unacceptable as it is likely to cause both short- and long-term harm to the ecology of the water body, unless the water is guaranteed to contain no native plants or animals.

Manual survey for metamorphs

If breeding is suspected, searches for metamorphs should initially focus on the margins of water bodies, as they tend to stay in these areas to avoid desiccation. During dry conditions, they are likely to stay close to water bodies for longer periods. However, they can disperse rapidly during wet periods or where sufficient local water is available for them to avoid dehydration (Child et al. 2008). Metamorphs also tend to disperse when there are many other cane toads present as this reduces the risk of cannibalism (Child et al. 2008). Surveys should mainly take place during the day, as this is when metamorphs are mostly active (M Greenlees, pers. comm.).

Metamorphs are difficult to locate because of their small size (1 to 1.5 cm long). In Sydney, Sutherland Shire Council erected a 60 cm high silt fence around the pond, which stopped the metamorphs dispersing. This allowed them to develop into larger animals that could be detected more easily. This method may also be suitable in other areas where fencing is both affordable and logistically possible. An additional advantage is that cane toads within the fenced areas are likely to cannibalise each other.

3.4 Handling and collecting cane toads

For OH&S reasons, always wear protective gloves and eyewear when handling cane toads: they extrude poison from glands positioned behind the head (Figure 7). When handled, toads can sometimes squirt a fine spray of this poison over a short distance. This may reach the eyes or may be rubbed in after handling toads. While this poison is not fatal for humans, it may burn the eyes and hands, and irritate the skin. First aid includes flushing the area exposed to the toad poison with a lot of water and seeking medical attention if symptoms persist (australianmuseum.net.au/Cane-Toad/).

Also, the animal picked up might be a native frog. Native frogs are susceptible to chytrid fungus, so using disposable gloves which are changed after handling each frog or tadpole reduces the risk of pathogen transfer. A link to detailed information on the hygiene protocol for controlling disease in frogs is in Section 7.

Cane toads should be collected and held in containers that are closed, adequately ventilated, constructed of non-toxic materials and insulated to protect the animals against temperature variations. Provide a small amount of water. Toads must be euthanased as soon as possible after collection (see Section 3.5).

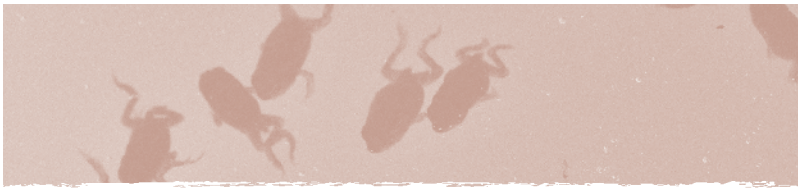
When collecting a toad, always gather data that may be important for land managers and researchers, such as location, time of year and day, number of toads found, toad behaviour and any other notable observations.

Members of the public should not euthanase toads. To arrange for confirmation of identification and pick-up of live toads to be euthanased or to be used for research purposes, they need to contact the local council, National Parks and Wildlife Service office or state museum.

Anyone handling cane toads must adhere to the *Prevention of Cruelty to Animals Act 1979*. Managing cane toads on NPWS estate must abide by the NPWS Cane Toad Management Plan (OEH 2013).

Photo Arthur White

Figure 7: Cane toad extruding poison from its poison glands



3.5 Euthanasia and disposal of cane toads

Euthanasia of cane toads should only be carried out by land managers, pest-control officers and researchers. Lethal control methods for cane toads need to be as humane as possible. Table 2 shows various methods of toad euthanasia that are currently regarded as acceptable, controversial or unacceptable by different authorities. The Commonwealth Government provided funding to the NSW Department of Primary Industries to develop a standard operating procedure (SOP) for the field euthanasia and disposal of cane toads (available online at www.environment.gov.au/biodiversity/invasive/publications/humane-control.html#canetoads).

When choosing a method of euthanasia from Table 2, the SOP is only a guide and does not replace or override the legislation that applies in the relevant state or territory. The SOP guidelines are subject to the applicable legal requirements operating in the relevant jurisdiction (including OH&S and animal welfare legislation). The guidelines also state that as new information becomes available, the appropriateness of euthanasia methods for cane toads will be reviewed.

When disposing of dead cane toads, consider that even freshly killed cane toads can poison other animals. One option is to place them in a covered compost or garbage bin.

It would be advantageous to provide the recently euthanased toads to an expert herpetologist such as from the Shine Lab at the University of Sydney (http://sydney.edu.au/science/biology/shine/) or the Frog and Tadpole Study Group NSW (www.fats.org.au) for dissection.

3.6 Habitat modifications

Habitat modifications can serve two purposes: to deter toads from areas where they are not wanted, and to attract toads to certain areas where they can be more easily collected. Also, fencing can be used to stop the dispersal of cane toad metamorphs from certain areas, as outlined in Section 3.3.2, and to prevent adults from accessing potential spawning sites.

3.6.1 Avoiding toads through habitat modification

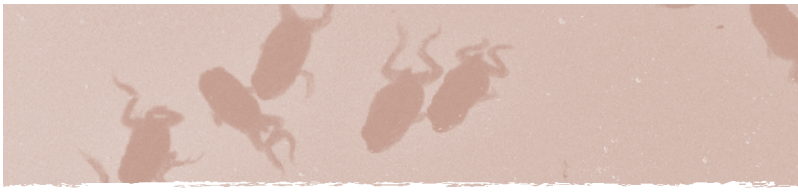
Suburban areas can be made less appealing to toads by removing their favourite shelter sites. One study of 48 toads found that more than half the toads (58 per cent) in urban environments selected human-made shelters, and that filling small holes in concrete and putting mesh on openings of pipes and culverts will inhibit them from using this habitat (Schwarzkopf & Alford 2006). It is also helpful to remove standing water and rubbish or other debris where toads can shelter during the day.

Cane toads are selective in their choice of breeding site. Studies throughout their current range show they prefer shallow pools with open (non-vegetated), gradually sloping muddy banks (summary in Semeniuk et al. 2007); for example, dams. Such sites can be made less suitable by creating a 50 cm high wire fence around them. While toads will not be able to get through this barrier, they will exploit even the smallest opening to get to the water body (Semeniuk et al. 2007).

The dispersal of toads in suburban areas is facilitated by artificial night-time lighting and sprinklers that are turned on at night. Lights attract insects that toads feed on, and sprinklers help them avoid dehydration. Where possible, night-time lights and sprinklers should be turned off, or at least only turned on during the coldest hours of the night (around 1 am to 5 am), when toads tend to be less active (R Shine, pers. comm.).

Table 2: Methods of cane toad euthanasia currently regarded as acceptable or unacceptable by different authorities. The standard operating procedure (SOP) is published by the NSW Department of Primary Industries.

Name of method	Method involved	Notes
Acceptable methods		
Stunning followed by decapitation	Holding toad by the back legs against a solid surface, stunning with a large-headed hammer, decapitating it promptly with a sharp knife or cleaver. Full face masks or visors need to be worn, as toad toxin may spray into face.	This is recommended in the SOP but the authors agree it requires experience and is time intensive if large numbers of toads need to be killed (1–2 minutes per toad). This is not accepted by many cane toad managers as it is perceived as cruel, requires considerable experience to aim hammer at the correct point and carries OH&S risks (spraying toxin, injuries with hammer and knife).
Gassing with carbon dioxide for more than four hours	Up to 20 toads in one bag are gassed with carbon dioxide that has a concentration of greater than 90 per cent. Exposure time is four hours or longer. A warming coil and/or plastic tube is used to pre-warm the carbon dioxide.	Recommended in the SOP. This is not accepted by many cane toad managers as carbon dioxide cylinders are heavy, require a special storage place and pose OH&S risk (inhalation of carbon dioxide if used in locations without sufficient ventilation).
Hopstop®	Spraying toads with an aerosol spray specifically designed for euthanasing cane toads (Pestat Pty Ltd, www.pestat.com.au).	This is conditionally acceptable in the SOP but was off the market for some time due to a structural fault in some cans. Safer spray cans have since been developed.

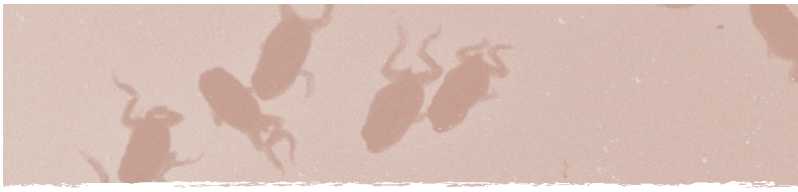


Name of method	Method involved	Notes
Unacceptable methods		
Cooling followed by freezing	Putting toads in a secure plastic/ cardboard container with air holes (plastic bags are not recommended), placing them in a refrigerator and cooling them to 4° C overnight. The chilled container is then placed in a deep freezer for at least 48 hours.	This is not considered acceptable in the SOP. Toads need to be deeply anaesthetised or unconscious before they are put in the freezer as they may otherwise suffer pain or distress due to the formation of ice crystals on the skin and in tissues. The SOP states it is unknown whether placing toads in the fridge renders them unconscious enough. Other land managers and scientists believe it does (R Shine, pers. comm.). The RSPCA approved this method for the cane toad control program in Sydney before release of the SOP.
Rapid freezing	Placing toads in a freezer	This is not considered acceptable in the SOP. It is considered inhumane since it may cause pain or distress due to the formation of ice crystals on the skin and in tissues.
Benzocaine gel	Applying a topical gel (7.5 per cent benzocaine) on toads	This is not considered acceptable in the SOP: trials showed mixed results of its efficacy.
Clove oil solution	Applying clove oil on toads, which is anesthetising and euthanasing	This is not considered acceptable in the SOP: it did not kill cane toads in trials.
Dettol®	Applying Dettol® (a household cleaner) on toads	This is not considered acceptable in the SOP: cane toads showed obvious signs of suffering in trials.
AQUI-S®	Applying AQUI-S® (a fish anaesthetic) on toads	This is not considered acceptable in the SOP: cane toads showed obvious signs of suffering in trials.

3.6.2 Attracting toads through habitat modification

Habitat modification can also be used to attract toads, which makes collecting them easier. As already discussed, night-time lights will attract toads and it may also be possible to attract toads to human-made daytime shelters, such as logs, tarps, that can be easily turned over during surveys. This method is currently being trialled in Sydney and may be useful in areas with few natural shelter sites.

Similarly, the toad's preference for shallow pools with open banks could be used to attract them to water bodies where they can be collected. If other waterholes were made less suitable, the concentration of toads in the preferred waterholes may also increase cannibalism between toads, thus increasing mortality even further (Semeniuk et al. 2007).



4 Community involvement

4.1 Requesting feedback from local residents

Targeted awareness campaigns can help obtain cane toad reports from local residents. They need to focus on correct identification and encourage reporting to local authorities. Such campaigns may include door-knock visits to residents, school education programs, media releases, workshops, and mail-outs to residents and industry in areas where cane toads are suspected.

Section 4.3 lists several existing educational products that can be used for demonstrating the typical features of a cane toad. A taxidermy specimen of a cane toad would also be useful.

In Sydney, residents reported several cane toads to Sutherland Shire Council after receiving a leaflet in the mail. Tenants sometimes missed the leaflets because property owners did not pass on the mail, so personal visits can be more effective in obtaining feedback from residents.

The media usually pays great attention to reports of cane toads in new areas. Media reports often talk about 'killer toads' or use similar phrases that can easily evoke panic or fear in people. This can lead to a high rate of misidentification, with even blue-tongue lizards being reported as cane toads in some areas. In Sydney, the Frog and Tadpole Study Group found that 90 per cent of so-called cane toad reports were of native frogs (A White, pers. comm.). Hence it is important to stress the need for correct identification, and for reporting cane toads to authorities rather than killing them instantly.

4.2 Cane toad musters

The community usually shows a high level of interest in cane toad management, and cane toad musters are a good way to involve the community in monitoring and collecting activities. This method involves a group of people collecting toads after dark.

Organisers usually provide equipment (head torches, bags or containers to collect toads, gloves) and provide an OH&S introduction at the beginning of each muster. Musters should preferably take place at locations where cane toads are known to occur and where OH&S risks are low (see below). They typically take place during the warmer months to increase the chances of finding toads. This also makes it more likely that participants will return for another muster. The size of the muster groups should depend on the number of supervisors present, as participants often require assistance with identifying and collecting the toads.

The following lists the main OH&S risks organisers should consider during cane toad musters:

- traffic hazards, especially as collections often take place near roads
- poor visibility at night-time, which could lead to tripping on uneven surfaces, colliding with branches, etc.
- hazards near water bodies, such as slipping, drowning, sharp objects in water, etc.
- snake and spider bites
- harmful effects of toad poison if handled incorrectly.

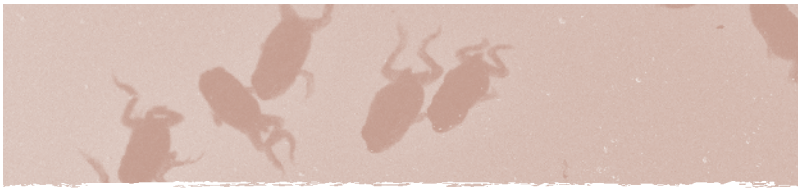
4.3 Educational material

Studies of community perception show that people are much less aware of cane toad habits and characteristics in areas where toads have recently arrived or do not occur (Bureau of Rural Sciences 2009). Educational material, such as flyers and posters, can fill these knowledge gaps. Numerous educational products are available, which can either be used as they are or modified to include local details.

Sutherland Shire Council created a flyer and distributed it to all households in the area (Appendix 4); an electronic copy may be obtained from the council. This flyer could easily be adjusted to new locations by changing contact and location details.

Other posters and flyers are more suitable for land managers in northern NSW as they show the local native frogs. The 'Frog or toad?' poster shows frog species that can be confused with cane toads and the 'Stop the toad' poster identifies how to stop the further spread of cane toads (both are in Appendix 5). PDF files for both posters are available from www.environment.nsw.gov.au/pestsweeds/HelpStopTheSpreadOfCaneToads.htm.

A 'Trap that toad' teachers' resource was developed in 2008 by OEH in northern NSW for delivery to local primary schools. The kit consisted of a bumbag containing an Mp4 player with cane toad and native frog calls, various laminated cards on cane toads, a cane toad puzzle, a tanned and stuffed toad and a teacher resource book with a CD. Similar kits based on this successful model could be developed for other areas.



5 Avoiding the importation of further cane toads

Cane toads continue to be transported to Sydney and other areas, such as Wollongong and Dubbo (325 toads were recorded between 2002 and 2008; White & Shine 2009). Ongoing vigilance is therefore required to detect any toads imported into these areas and to avoid importing additional individuals.

Cane toads are often found in highly disturbed habitats such as depots of landscaping or building supply companies. They like to shelter in landscaping material or building supplies during the day – the time when most trucks would be loaded (White & Shine 2009). This combination makes it more likely that they are accidentally loaded onto delivery trucks.

Detecting toads within piles of woodchip and mulch is difficult but they can be seen when they begin to disperse from the unloading location. They are often found within 24 hours of unloading and within 100 m of the unloading site (White & Shine 2009). If possible, searches for cane toads should thus take place within 24 hours of unloading, focusing predominantly on a circumference of 100 m.

The chances of collecting toads can be increased if woodchip or mulch is unloaded in bare concrete areas without additional hiding places for toads, and/or if there is a wall around the area. Cane toads are poor climbers and unable to leap large distances, so they are easily excluded by low barriers (White & Shine 2009). Installation barriers as low as 50 cm can stop toads dispersing from the unloading point. Similarly, they can stop toads entering areas where goods are loaded.

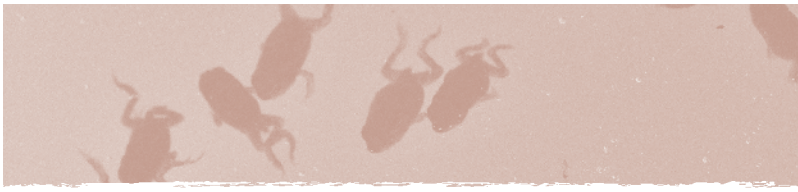
Cane toads occasionally arrive in shipping containers or hollow concrete blocks and it is not unusual for several toads to arrive in one shipment (White & Shine 2009). Similarly, vigilance is required when unloading other types of load originating from areas further north, such as pot plants or similar material that provide hiding places for toads.

It is important to inform businesses about the dangers of importing cane toads and be encouraged to look at their supply chain to determine the risk. The risk is particularly high if the trucks or containers are coming from the north coast of NSW or south-eastern Queensland; these are the geographic origins of most toads imported into areas further south (White & Shine 2009). If so, it is important to check trucks and containers for cane toads, prior to and after transportation.

6 View to the future

Several authors have predicted the future range of cane toads in Australia, based on models that incorporate their tolerance to climate, the speed at which they currently disperse and several other factors. While one such model predicted that they will occur in several regions of southern Australia (Urban et al. 2007), another model predicted that cane toads cannot survive in southern Australia and that breeding in Sydney was marginal but not impossible (Kearney et al. 2008). The latter study implies that in Sydney, cane toads are expected to do well some years and then crash, and that they are much easier to control because the colder climate slows their breeding rate (M Kearney, pers. comm.).

Given the latter scenario, there is hope that the combination of a colder climate and efficient management of new cane toad populations will be sufficient to halt the spread of cane toads into new areas.



7 Further information

Australian Government policy on cane toads:
www.environment.gov.au/biodiversity/invasive/ferals/cane-toads.html

Australian Museum cane toad information:
http://australianmuseum.net.au/Cane-Toad

Cane toad call:
www.environment.nsw.gov.au/resources/pestsweeds/canetoad.mp3

Cane toads volunteer trapping and hand catching manual:
www.canetoads.com.au/volmanual.htm

Commonwealth key threatening process listing:
www.environment.gov.au/biodiversity/invasive/ferals/cane-toads.html

Commonwealth standard operating procedures for cane toads:
www.environment.gov.au/biodiversity/invasive/publications/humane-control.html#canetoads

Hygiene protocol for the control of disease in frogs:
www.environment.nsw.gov.au/resources/nature/hyprfrog.pdf

Identifying cane toad eggs, tadpoles and adults:
www.frogsaustralia.net.au/documents/doc_12_bufo_native_eggs_and_tadpoles_of_wa.pdf

NSW invasive species plan 2008–2015:
www.dpi.nsw.gov.au/agriculture/pests-weeds/nsw-invasive-species-plan

Office of Environment and Heritage NSW cane toad web page:
www.environment.nsw.gov.au/pestsweeds/CaneToads.htm

Shine Lab at the University of Sydney, summary of research papers:
http://sydney.edu.au/science/biology/shine/canetoad_research/scientific-publications-the-biology-of-canetoads.shtml

Survey guidelines for amphibians:
www.environment.nsw.gov.au/resources/threatenedspecies/09213amphibians.pdf

Traps – one commonly used type of trap can be purchased from FrogWatch in the NT:
http://cart.frogwatch.org.au/index.cfm?attributes.fuseaction=shop&goto=trap

8 References

Alford RA, Cohen MP, Crossland MR, Hearnden MN and Schwarzkopf L 1995, 'Population biology of *Bufo marinus* in northern Australia', pp. 173–81 in *Wetland Research in the Wet-Dry Tropics of Australia*, edited by CM Finlayson, Supervising Scientist Report 101, Canberra.

Anstis M 2002, *Tadpoles of south-eastern Australia*, Reed New Holland, Sydney.

Barker J, Grigg GC, Tyler MJ 1995, *A field guide to Australian frogs*, Surrey Beatty, Chipping Norton, NSW.

Bureau of Rural Sciences 2009, *Cane toads in communities – executive report*, Department of Sustainability, Environment, Water, Population and Communities, Canberra, viewed 26 November 2013, www.environment.gov.au/system/files/pages/01400eac-dadb-4953-8c9f-28766a785966/files/cane-toad-brs-report.pdf

Child T, Phillips BL and Shine R 2008, 'Abiotic and biotic influences on the dispersal behaviour of metamorph cane toads (*Bufo marinus*) in tropical Australia', *Journal of Experimental Zoology*, vol. 309A, pp. 215–24.

Crossland MR, Haramura, T, Salim, AA, Capon, RJ and Shine, R 2012, 'Exploiting intraspecific competitive mechanisms to control invasive cane toads (*Rhinella marina*)', *Proceedings of the Royal Society B*, London, published online: doi:10.1098/rspb.2012.0821.

DEH 2005, 'The biological effects, including lethal toxic ingestion, caused by cane toads (Bufo marinus)', final determination as a key threatening process under the Commonwealth *Environment Protection Biodiversity Conservation Act 1999*, Department of Environment and Heritage, Canberra.

Hagman M and Shine R 2006, 'Spawning site selection by feral cane toads (*Bufo marinus*) at an invasion front in tropical Australia', *Austral Ecology*, vol. 31, pp. 551–8.

Kearney M, Phillips BL, Tracy CR, Christian KA, Betts G and Porter WP 2008, 'Modelling species distributions without using species distributions: the cane toad in Australia under current and future climates', *Ecography*, vol. 31, pp. 423–34.

Lever C 2001, *The cane toad: the history and ecology of a successful colonist*, Westbury Academic and Scientific Publishing, Yorkshire, United Kingdom.

Murray BR and Hose GC 2005, 'Life-history and ecological correlates of decline and extinction in the endemic Australian frog fauna', *Austral Ecology*, vol. 30, pp. 564–71.

OEH 2013, *Management plan for cane toads in national parks and reserves 2012*, Office of Environment and Heritage, Sydney.

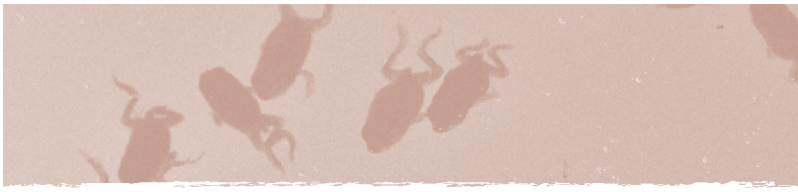
Phillips BL and Shine R 2004, 'Adapting to an invasive species: toxic cane toads induce morphological change in Australian snakes', *Proceedings of the Natural Academy of Science USA*, vol. 101, pp. 17150–5.

Phillips BL, Brown GP, Greenlees M, Webb JK and Shine R 2007, 'Rapid expansion of the cane toad (*Bufo marinus*) invasion front in tropical Australia', *Austral Ecology*, vol. 32, pp. 169–76.

Schwarzkopf L and Alford RA 2007, Acoustic attractants enhance trapping success for cane toads, *Wildlife Research*, vol. 34, pp. 366–70.

Schwarzkopf L and Alford RA 2005, 'Movement and dispersal in established and invading toad populations', paper presented at the East Kimberley Cane Toad Forum, Kununurra, Western Australia, 15–15 March 2005, viewed 26 November 2013, www.canetoads.com.au/forumprocedespp4.htm

Seabrook WA 1993, *Habitat use of the cane toads Bufo marinus: implications for assessment of impact and control strategies*, PhD Thesis, University of Sydney, Sydney.



Seabrook WA and Dettmann EB 1996, 'Roads as activity corridors for cane toads in Australia', *Journal of Wildlife Management*, vol. 60, pp. 363–8.

Seebacher F and Alford RA 2002, 'Shelter microhabitats determine body temperature and dehydration rates of a terrestrial amphibian (*Bufo marinus*)', *Journal of Herpetology*, vol. 36, pp. 69–75.

Semeniuk M, Lemckert F and Shine R 2007, 'Breeding-site selection by cane toads (*Bufo marinus*) and native frogs in northern New South Wales, Australia', *Wildlife Research*, vol. 34, pp. 59–66.

Urban MC, Phillips BL, Skelly DK and Shine R 2007, 'The cane toad's (*Chaunus [Bufo] marinus*) increasing ability to invade Australia is revealed by a dynamically updated range model', *Proceedings of the Royal Society B*, vol. 274, pp. 1413–19.

White AW and Shine R. 2009, 'The extra-limital spread of an invasive species via "stowaway" dispersal: toad to nowhere?', *Animal Conservation*, vol. 12, pp. 38–45.

Williamson I 1999, 'Competition between the larvae of the introduced cane toad *Bufo marinus* (Anura: Bufonidae) and native anurans from the Darling Downs area of southern Queensland', *Australian Journal of Ecology*, vol. 24, pp. 636–43.

Personal communications

Personal communications cited in the text were obtained from:

- **M Greenlees**, Post-doctoral fellow, Shine Lab, University of Sydney
- **S Harris**, Pest Species Officer, Sutherland Shire Council
- **R Shine**, Professor of Evolutionary Biology, University of Sydney
- **J Thomas**, Pest Management Officer, NPWS North Coast Region, Grafton

Appendix 1: Cane toad poster Used in Sydney, April 2012.

They're on the move

Cane toads are often accidentally transported to Sydney from infested areas.

A serious threat

Cane toads are prolific breeders and noxious pests that consume large numbers of native wildlife.

Native animals and domestic pets get poisoned when trying to feed on them. They can't tell the difference between a cane toad and native frog.

stop the Cane Toads

Your help is needed to stop the spread of cane toads in Sydney

1 Check for toads

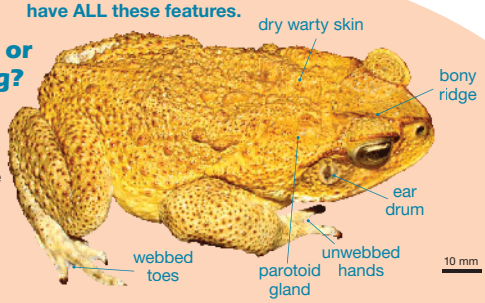
If travelling from infested areas, check your vehicle. Favourite hideouts include in and around pot plants, mulch, pallets, tyre wells, timber and other stored materials.

In your yard, check after dark, especially near night time lighting.

2 Cane toad or native frog?

Many people have difficulty telling native frogs and cane toads apart because they share some features such as warty skin, a visible ear drum and webbed toes.

Unlike native frogs, adult cane toads have ALL these features.



Frogs commonly mistaken for cane toads in Sydney.

3 I've found one... now what?

Collect the cane toad in a plastic bag or container with air holes and water.

Contact your local council or National Parks & Wildlife Service to arrange for identification and pick-up.

Remember to wear protective gloves and eyewear when handling cane toads.

Do not dispose of the toad yourself, as many people mistake cane toads for native frogs (including some threatened with extinction).

Cane toads have been breeding in the Taren Point area since 2010. If you are in the Sutherland Shire, contact SSC on 9710 0333 or the National Parks & Wildlife Service on 9668 2000.

4 Keep cane toads out

Remove standing water and rubbish from around your yard. Cane toads are often found in puddles.

Cane toads are not good at climbing or hopping. Keep toads out of storage and loading areas by using a solid, smooth barrier at least 50 cm high and secured into the ground.

Avoid keeping lights on at night as they attract moths and other insects for cane toads to feed on.

This program has been assisted by the New South Wales Government through its Environmental Trust.
Photos: Garry Daly and Matt Greenlees.
2012

For further information go to:

www.environment.nsw.gov.au
www.invasiveanimals.com
australianmuseum.net.au/Cane-Toad
www.canetoadsinoz.com

Appendix 2: Survey methods for cane toads that require further trialling

1. Remote cameras

Remote cameras could be a useful tool to establish whether cane toads are present. This method has yet to be trialled sufficiently on cane toads but has been widely successful in a range of surveys for similar-sized animals.

Most cameras on the market trigger a photo based on the temperature difference between the moving object and the background (ambient) temperature. Whether cane toads will consistently trigger the cameras has yet to be trialled. However, it is possible given that reptiles – and even wind-blown vegetation – are known to cause triggering.

Three types of cameras are available: infrared, white-flash, and a camera that combines the two light sources. White-flash cameras take colour photos day and night, whereas infrared cameras use an infrared flash that only takes comparatively low-resolution black-and-white photos at night (when toads are most active). The latter could make positive identification problematic, especially in areas where similar-looking frogs are found. However Infrared cameras have other advantages: they usually use less energy, so batteries last longer. They can also be considerably cheaper, especially the models with a slower response time. Such models may be sufficient given that cane toads move relatively slowly.

Install cameras close to the ground in open areas and/or near light sources – where adult cane toads are most often found. They might need to be secured against theft. Establish a monitoring plan that incorporates regular data downloads. This plan should also allow sufficient time for data analysis, which can be considerable, especially where other fauna or events may trigger many photographs.

2. Cane toad detection dogs

Trials in northern NSW and Western Australia have shown that cane toad detection dogs ('sniffer dogs') can be effective at detecting cane toads in small isolated populations and at vehicle checkpoints and industrial sites. The limitations are the significant cost of the initial and ongoing training along with maintaining the dog.

Two detection dogs were trained for the eradication program in Sydney. They clearly showed the ability to detect cane toads during training but found few toads when deployed on industrial land. There were two most likely reasons for this failure. First, only a few adult toads were left by the time the dogs were trained well enough to be deployed in the field. This was because the manual collection of toads in this area prior to deploying the dogs was so successful. The dogs, therefore, had little reward and training in the field could not be fully completed. Second, the dogs did not always distinguish between the scent of a toad present in an area and the scent of a toad that had already moved away, so handlers often searched for toads that were no longer present.

Photo: Stephen Austin

Max the sniffer dog

The dogs' trainer believes that it is possible to more successfully train a cane toad detection dog by incorporating the lessons learnt so far. Worldwide, dogs are being used to detect a variety of fauna and also explosives. Training them for cane toad detection is a novel approach that is promising but requires further refinement. Pursuing this approach is justified if cane toads continue to appear in new locations, providing the funds for training and maintaining dogs can be obtained.

Appendix 3: Flyer outlining the use of super traps

Developed in the North Coast region.

NSW National Parks and Wildlife Service

Cane Toad control

Using the Super Trap

The Super Trap is a self sufficient Cane Toad catching unit that can be used along with other methods to control the spread of Cane Toads. The super trap can be used in a semi permanent situation and requires only a minimal amount of monitoring.

The Super Trap

When set up with adequate water and all parts functioning correctly, the Super Trap can house captured toads humanely for an extended period of time.

An example of a Super trap

Components

- 25 gauge x 25mm x 25mm holes galvanised wire mesh.
- 20watt solar panel*
- 12volt battery
- Black UV lights
- Solar panel charge controller MP3128*
- Trough with float valve
- Drum for water
- One way perspex finger gates**

* available from Jaycar Electronics
* *available from www.frogwatch.org.au

Construction

1. Make a wire cage 1200mm x 1000mm x 500mm.
2. Measure the trap in half.
3. Cut holes in proposed section, large enough to be able to remove toads.
4. Cut an access hole in the proposed rear section, large enough to be able to remove toads.
5. Make a divider and fix it to the roof of the trap ensuring it sits 50-100mm from the trap floor.
6. Attach a light to this divider.
7. Place a water trough and drum in the rear of the cage.
8. Secure solar panel.
9. Insulate rear enclosed section with insulation.
10. Cover top of trap.
11. Super trap is now ready for use.

How does the trap work?

During the day the lights are off, at nightfall the solar panel controller turns the lights on. These will remain on until the solar panel detects light, the lights are then switched off, and the charging of the battery is continued.

When the lights are on they attract insects, the insects in turn attract the toads. The toads push on the one way finger gates to enter the trap to feed on the insects and become captured. During their stay in the trap they feed at their own will at night and seek shelter and water from the trough during the day.

Door showing finger gates manufactured by Frogwatch, Northern Territory

UV black lights available from electronics outlets

Northern Rivers CMA CATCHMENT MANAGEMENT AUTHORITY

Environment & Climate Change

Where should the trap be placed?

Choosing the right location is critical to the success of the trap. The trap should be located near a water body or in an area where toads have been seen on consecutive nights. It is extremely important that the trap is not located near a competing light source.

Setting up the Super Trap up

Initial setup of the trap should be done using the following steps:

1. Place Trap on the ground and secure if required by a chain and lock to a tree/post or something sturdy to prevent theft.
2. Water drum inside the trap should be filled with clean water, check that float valve is functioning correctly and that there are no leaks.
3. Some small logs and rocks should be placed inside the holding room (enclosed) part of the trap for captured animals to shelter during the day.
4. It is recommended that an observation be made at night to check that the trap is functioning.

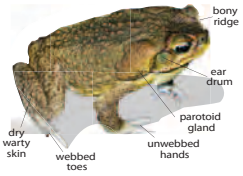
Trough and float valve supply water to captured toads

Monitoring

The Super Trap should be checked once a week for cane toads throughout the season from October to March. Trap should be functional throughout this period.

If native frogs are caught be careful to handle them with gloves on and release them in the local area. If repeated non-target animals are caught a different trap location should be chosen.

Cane toad



Toad captured, now what?

Once captured toads should be removed for humane euthanasia.

Toad carcasses can be disposed of by burial in a garden; ensuring that the depth is sufficient so native and domestic animals don't dig up the carcasses. Alternatively they can be placed in a lidded compost or garbage bin.

Cane toad caught in a super trap at Mebbin NP during a trial.

Material suppliers

- Mesh, see your local rural merchandiser
- All electronics available from outlets such as Jaycar electronics
- The one way, frog friendly perspex finger gates are available from Frogwatch NT, www.frogwatch.org.au

For further information contact

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NPWS Northern Rivers Region
PO Box 856, Alstonville, NSW 2477
Phone: 66270200.
Email: northernrivers.region@environment.nsw.gov.au

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web: www.environment.nsw.gov.au
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DECC 2007(PWD NB)

Appendix 4: Flyer developed by Sutherland Shire Council (Sydney)

Used in Sydney, March 2012.

Sutherland Shire COUNCIL

PEST SPECIES MANAGEMENT

Cane toad fact sheet

frog or toad?

Unlike native frogs, adult cane toads have all of these features

Pictures are not to scale

Sutherland Shire Council (SSC) and the NSW National Parks & Wildlife Service (NPWS) have become aware of the presence of a breeding population of cane toads in the Taren Point/Caringbah area.

Report any suspected sightings to: Sutherland Shire Council 9710 0333 or NPWS 9668 2000.

Why are they a problem?

Cane toads (*Rhinella marina*) are a serious threat because:

- They invade the habitats of native animals and compete for food. They have a huge appetite and eat anything that fits in their mouths.
- They can poison other animals who try to eat them.
- Native frogs are killed when mistaken for cane toads.
- There are few cane toad predators in Australia.

For more information go to:
www.environment.nsw.gov.au or
www.amonline.net.au

Sutherland Shire Cane Toad Control Program

The control program has included:

- A survey to establish the size and distribution of the cane toad population.
- A study of the breeding viability of the population.
- Production of educational material, workshops and media briefings.
- Assistance to residents/occupiers in the identification and removal of cane toads.
- Completion of regular surveys and collections in the affected areas.
- Trapping, habitat modification and control operations in appropriate circumstances.
- Completion of regular cane toad musters with volunteers and the use of a cane toad detector dog.
- Wetland modification/fencing and control of any cane toad tadpoles.
- The use of radio tracking and infra red cameras to monitor the movement of cane toad and identify any possible new breeding habitats.
- Support of research studies to investigate possible future management opportunities, such as biological and chemical controls.

Recent observations and data strongly suggest that the cane toad population has been greatly decreased and their potential impact has been reduced, however ongoing vigilance is required.

Cane toads are listed as a "Key Threatening Process" under the *Threatened Species Conservation Act 1995*.

Council's control program aims to significantly reduce the population and potential impact of this pest species on the Sutherland Shire environment.

If you find a cane toad…

Many native frogs are often mistaken as cane toads. Some species are listed as threatened with extinction, so please take care.

Definitely do NOT kill frogs or toads.

If you think you have found a cane toad please follow these three easy steps:

1. Make sure it is a cane toad. Look for the features shown on the previous page.
2. Wear protective gloves and eyewear when handling toads. Put the cane toad in a container with water supplied.
3. Contact Sutherland Shire Council 9710 0333 or the National Parks & Wildlife Service on 9668 2000 to arrange for identification and pick up of live cane toads.

Information supplied by the National Parks & Wildlife Service.
Photographs: Garry Daly
Produced with the assistance of Sydney Metropolitain Catchment Management Authority
This program has been assisted by the New South Wales Government through its Environmental Trust.

NSW GOVERNMENT | NSW Environmental TRUST

INFORMATION FROM YOUR COUNCIL

Tel 02 9710 0333 **Fax** 02 9710 0265

Email ssc@ssc.nsw.gov.au
www.sutherland.nsw.gov.au

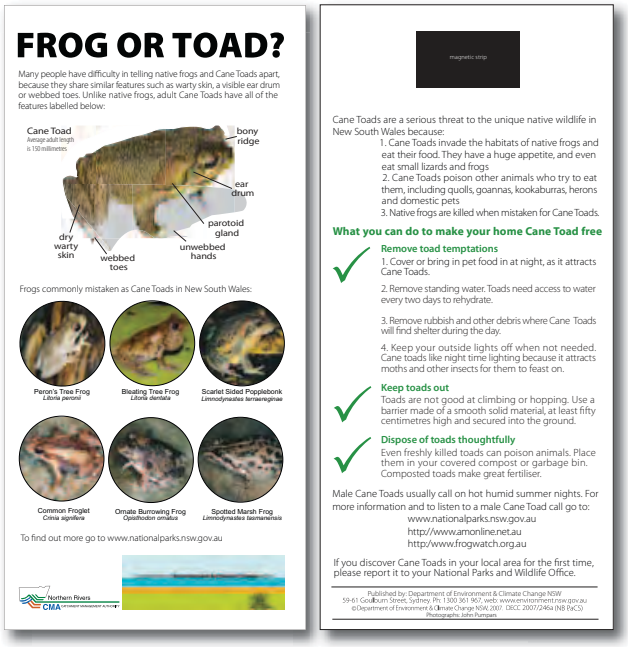
Sutherland Shire COUNCIL

Appendix 5: 'Frog or toad?' and 'Stop the toad' posters from northern NSW

Developed in the North Coast region.

Other support material available...

DL Leaflet front and back



DL magnetised card front and back

DL magnetised card front and back

Appendix 6: 'Trap that toad' teacher's resource

Developed in the North Coast region (supplies are no longer available but this is a useful kit to emulate).

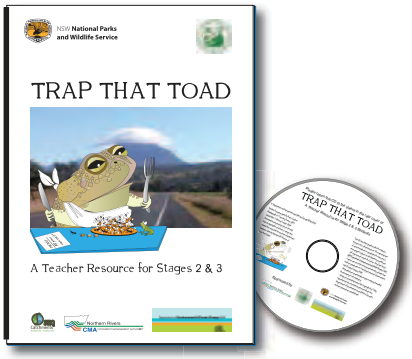
TRAP THAT TOAD

Kit contents pack up checklist

☐ 1 x tanned and stuffed Cane Toad
(ie no bufotoxin)

☐ Teacher Resource Book containing
CD in sleeve on inside back cover

CD contains:
- native frog calls
- Cane Toad call
- native frog images
- Cane Toad images
- Cane Toad lifecycle (PowerPoint)



☐ Cane Toad and native frog calls
6 x A4 laminated cards
(images on CD and MP4 player)

☐ Cane Toad lifecycle
8 x A4 laminated cards
(same as Powerpoint presentation)

☐ Cane Toad puzzle
16 x laminated cards

☐ MP4 player housed in bumbag

Bumbag contains:
- MP4 player
- MP4 instructions for use
- cabling for recharging player
- USB cable for computer connection

MP4 player contains:
- native frog calls
- Cane Toad call
- native frog images
- Cane Toad images
- The Cane Toad Song

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www.environment.nsw.gov.au