ecosure

Cane toad tadpole trapping project

Draft Report

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Brisbane City Council

ecology / vegetation / wildlife / aquatic ecology / GIS

Executive summary

Brisbane City Council engaged Ecosure Pty Ltd to conduct a six-month trial of the cane toad *Rhinella marina* tadpole trapping using an attractant bait in waterbodies throughout Brisbane City. Through strong community interest, Brisbane City Council is identifying innovative approaches to cane toad management and trialling an attractant baiting program is one methodology under consideration for assisting in the control of this pest species. The aims of the project were to assess the capability of an attractant bait to lure cane toad tadpoles to a trap, and whether another means of tadpole capture is more efficient. The trapping program was completed over the 2017-18 cane toad breeding season from November 2017 to April 2018 with fifteen waterbodies targeted during the trapping program.

A total of 36 trapping cycles were completed within this timeframe. Trapping data reveals a total of 23.87 litres of cane toad tadpoles captured within baited traps.

The outcome of statistical testing confirmed the visual onsite evidence where the baited trap attracted cane toad tadpoles. The results show this type of trapping is more efficient at capturing tadpoles than physical fishing/capture methods.

Trap design, placement, vegetation and weather conditions all factored into the capture success of the trapping program. Field results supported scientific literature regarding breeding cycles and tadpole behaviour. Preferred breeding conditions occurred after a significant rainfall event (25 mm of rainfall), but smaller rainfall amounts were also found to encourage breeding. Ideal trap locations are gentle sloping muddy banks with little or low vegetation. Tadpoles preferred a sunny aspect close to the edge of a waterbody.

Successful trap design includes low set recessed funnels and clear plastic lids. Multiple traps within one waterbody are possible if traps are separated by at least 15 metres. Ideal trapping conditions occur between approximately one to three weeks after a breeding event.

Incorporating trapping is one part of an approach to cane toad control. Other factors to be considered for control of this pest species are habitat modification through regenerative planting and continued community support for adult toad capture and humane disposal.

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1 Introduction

Ecosure Pty Ltd (Ecosure) was engaged by Brisbane City Council (BCC) to complete a six-month trial of a cane toad *Rhinella marina* tadpole trapping program using an attractant bait, in waterbodies throughout Brisbane City. Initially, thirteen waterbodies were targeted as a part of the trial. Additional trapping locations were subsequently added to bring the total to fifteen waterbodies by the close of the program. The trapping program was completed over the 2017-18 cane toad breeding season from November 2017 to April 2018.

1.1 Program aims

The aims of this project were to provide evidence as to the effectiveness of an attractant bait and whether a baiting program is an efficient means of cane toad tadpole capture. To enable discussion and analysis of these aims, the following questions were asked:

1. Do traps baited with BufoTab baits result in the capture of cane toad tadpoles?
2. What is the efficacy of baited traps compared with active capture of tadpoles?

1.2 Trapping locations

Traps were deployed in thirteen waterbodies previously identified by BCC and Ecosure, including:

- City Botanic Gardens, Gardens Point, Brisbane City
- Biami Yumba Park, Fig Tree Pocket
- Edenbrooke Park, Sinnnamon Park
- McGinn Road Park, Ferny Grove
- Mount Coot-tha Botanic Gardens, Mount Coot-tha
- Karawatha Forest Park, near Pamela Crescent, Karawatha
- Thomas McLeod Park, Sinnamon Park
- John Sprent Reserve (2 waterbodies), Moggill
- JC Slaughter Falls, Mt Coot tha
- Ross Road Reserve (3 waterbodies), Upper Kedron.

A control waterbody, Inverness Park, Upper Kedron, was also established. It was chosen as it was of a similar size and land use context as the trapping sites, but in a separate sub-catchment from the target waterbodies. In addition, part way through the trapping program, two additional trapping locations were added by BCC. These two trapping locations were positioned in one waterbody at Lockrose Street, Mitchelton. During December 2017, a second baited trap, 'Mt Coot tha mobile' was deployed at the Mt Coot tha Botanic Gardens. At the close of the trapping program, 17 sets of traps across 15 waterbodies were being utilised across Brisbane. Figure 1 maps the locations of the waterbodies utilised in the trapping program.

1.3 Cane Toad Challenge

The University of Queensland, Institute for Molecular Bioscience (IMB), established the Cane Toad Challenge (CTC) to work with communities to try and manage the environmental and economic impact of cane toads in Australia. The IMB have developed a cane toad tadpole attractant bait (BufoTab) over several years. The basis of the attractant is a chemical taken from the parotoid gland of adult cane toads. The isolated chemical is turned into a water-soluble attractant which is released from a funnel trap as a plume, attracting cane toad tadpoles to the trap before removing them from the environment. The role of the CTC is to work with community groups, commercial organisations and government entities to conduct field research locally to assist with the continued development of chemical attractants ensuring successful trap and bait design.

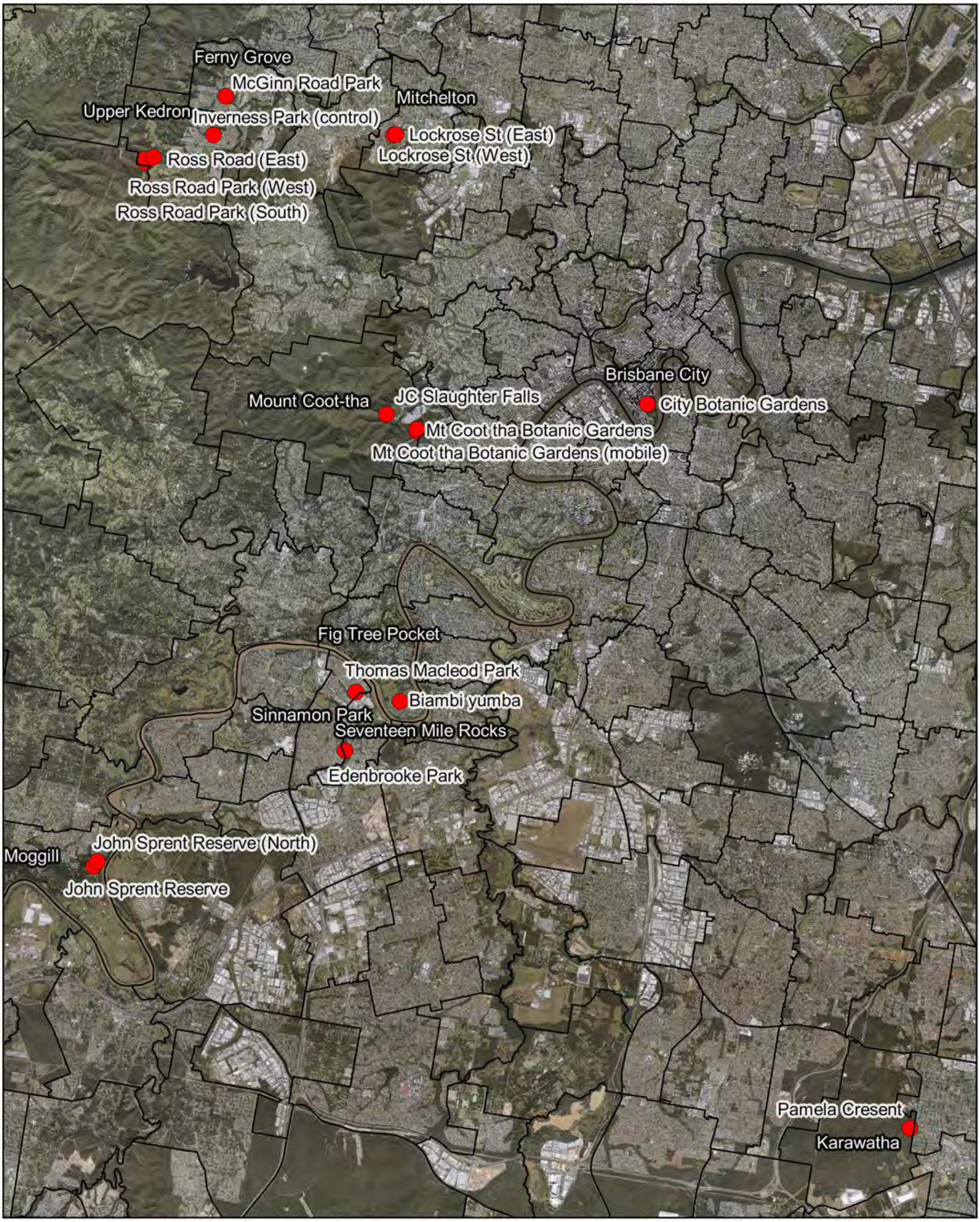

Figure 1: Trapping locations

Trapping locations

Suburb boundaries

Brisbane City Council
Cane toad tadpole trapping project

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 19/06/2018

0 2 4 6 8 kms

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

2 Literature review

2.1 Life history

The cane toad is a ground dwelling predator (Shine, 2010) which forages in a variety of habitats from open forests and woodlands, grasslands through to mangrove intertidal flats, beach dunes and suburban areas (Cogger, 2014). The cane toad is a member of the “true toads” (family Bufonidae) (Shine, 2010), which is distinct from native Australian frogs of south eastern Queensland which are members of family Hylidae (tree frogs) and family Myobatrachidae (marsh, tusked, barred and southern frogs as well as pobblebonks and froglets) (Queensland Museum, 2007).

As with all amphibians, cane toads have permeable skin and consequently avoiding dehydration is a prime driver of behaviour (Cohen & Alford, 1996), with a focus on inhabiting sites which limit desiccation (Schwarzkopf & Alford, 1996). Highly vascularised skin contacting a moist substrate allows cane toads to reabsorb water lost through dehydration (Shoemaker, et al., 1992). Preferred sites for adult toads which assist with water regulation may have any or all the following attributes: standing water, moist soil, wet vegetation, existing burrows or shaded conditions (Cohen & Alford, 1996).

All life stages of the cane toad (i.e. eggs, tadpoles, metamorphs and adults) are toxic, although toxin types and content change markedly during toad development (Shine, 2010). Toxin levels are highest in eggs and adults and are lowest at metamorphosis (Greenlees & Shine, 2011). The parotoid (shoulder) glands of cane toads secrete a viscous white liquid - bufotoxin which contains bufogenins (among several of the contributing poisonous compounds). The active constituents of these toxins are steroid-derived (Shine, 2010) and affect the function of the heart (Vanderduys & Wilson, 2011).

Cane toad diet consists mainly of arthropods, particularly ants, termites and beetles (Shine, 2010), aquatic insects and snails (Grant, 1996), but they are also opportunistic feeders (Shine, 2010) and have been known to consume a variety of other food sources including pet food (DoEE, 2010). Cane toads can tolerate the toxins of their own species (Crossland & Shine, 2011) and juvenile toads regularly prey upon metamorphs of their own species (conspecific predation) (Child, Phillips , & Shine, 2008).

Similar to juveniles, tadpoles are also cannibalistic within an early stage in their lifecycle with a preference for cane toad eggs (Crossland & Shine, 2011). A study by Crossland & Shine (2011), highlighted that the pattern of intermittent cannibalism shown by tadpoles to predate on their own species could be to ensure the fittest of the species survives, or may reflect opportunity. To ensure the species survival and expansion, the fittest female reaches a waterbody first and any subsequent female’s eggs will be consumed by the already hatched tadpoles. This cycle ensures females breed quickly and disperse to new areas. A second reason suggested for cannibalism is strictly for nutritional benefit. Specific forces of cannibalism are unclear but could be either or both reasons (Crossland & Shine, 2011). This study also found tadpoles eat dead tadpoles, and newly emerged metamorphs offer an easy target for juvenile toads when prey abundance is low.

Adult toads are unlikely to encounter conspecific prey as they are not restricted to pond margins as they are more able to tolerate desiccation. Due to their abilities to attain high population densities and large dietary consumption, cane toads have the potential to cause declines in abundance and diversity of invertebrate taxa (Shine, 2014). This is particularly important to note especially in times of dry conditions, where cane toads concentrate around areas of preferred habitat, decimating invertebrate species and competing with other native predators for the same food resources.

2.2 Reproduction

Cane toads breed seasonally, and the breeding cycle is generally triggered by favourable weather conditions (Crossland, Alford, & Shine, 2009). Female cane toads lay their eggs in a variety of waterbody types with a preference for still or calm shallow water (Crossland, Alford, & Shine, 2009). Studies by Semeniuk, Lemckert, & Shine (2007) and Hagman & Shine (2006) found that cane toads are very selective when it comes to choosing breeding sites, with a preference for disturbed areas, open ground, low levels of vegetation and gentle sloping banks. These results correspond to research undertaken in South America which also noted that in addition to the other preferences, cane toads avoided breeding at sites with over hanging branches (Hagman & Shine, 2006). Cane toad spawning preferences differ from native frog species which lay clumped eggs in concealed locations or on submerged vegetation, leaf litter or gravel (Queensland Museum, 2007). The presence of other species, native competitors and predators (fishes and birds), had little impact on spawning site selection by female toads in a further study (Semeniuk, Lemckert, & Shine, 2007). Females produce between 8,000 – 35,000 eggs (Australian Museum, 2016) and the large range in egg numbers may coincide with body size or mass (Lampo & De Leo, 1998). In comparison, the fecundity of most Australian frogs is far lower (Shine, 2014). Cane toad eggs hatch in two to four days and tadpoles can metamorphose in two to four weeks (water temperature dependent) (Lampo & De Leo, 1998), but commonly the tadpole stage lasts between four and eight weeks (Crossland, Alford, & Shine, 2009). Once metamorphosis is complete, cane toads move toward terrestrial refugia and energy is devoted to growth (Lampo & De Leo, 1998). Sexual maturity is often reached a few months post metamorphosis (Shine, 2014), but most seem to delay reproduction until their second breeding season (Lampo & De Leo, 1998). Adult females can breed twice a year (DoEE, 2010), but it is also suggested by Lampo & De Leo (1998) that females are unlikely to reproduce a second time in one season because embryonic development is dependent on accumulated fat tissues.

2.3 Cane toad tadpoles and pheromone detection

Pheromone detection by cane toad tadpoles can elicit both positive and negative responses depending on the chemical signal. Tadpoles use certain chemical cues in detecting food resources, as an alarm response to predators, and even use pheromones to constrain development of early cane toad embryonic stages.

Cane toad tadpoles detect, approach and consume late-stage eggs based on chemical cues, with conspecific predation occurring as the jelly surrounding the eggs begins to breakdown (Crossland & Shine, 2011). Toad tadpoles have been recorded eating freshly-laid toad spawn as well as late stage eggs, which suggests chemical cues may be evident even in recently spawned eggs. A study by Crossland & Shine (2011) found that while toad tadpoles targeted cane toad eggs and dead tadpoles, they did not consume eggs and tadpoles of Australian native frogs. Australian frog tadpoles also targeted freshly laid cane toad spawn but were unable to tolerate the toxins leading to mortality of native tadpoles.

Toad larvae produce a pheromone or chemical cue in response to injury or presence of predators. Responses to the alarm pheromone is twofold with the primary response being rapid avoidance. A secondary response induces major modification to larval morphology and behaviour (Hagman & Shine, 2009). A study by Hagman & Shine (2009) found repeated exposure to alarm pheromones reduced survival rates of tadpoles by up to 50% and reduced size at metamorphosis by 20%. The same study revealed no adverse effects to 15 species of native Australia tadpoles suggesting chemical cues are species specific.

A third cane toad tadpole pheromone has been studied and shows a waterborne chemical cue is produced that suppresses development in the egg stage of the toad life cycle (Crossland & Shine, 2011). Crossland & Shine's (2011) study found 72-hour exposure to specific waterborne chemical cues produced by older cane toad tadpoles reduced survival and growth rates of younger cohorts of toad tadpoles. When tadpoles metamorphosed, control tadpoles were twice the size of individuals exposed to chemical cues (Crossland & Shine, 2011). Reduced size because of exposure to alarm pheromone response, or reduced size due to chemical cues produced by older cohorts suggests a similarity between the composition of these two chemical cues.

2.4 Impacts of tadpoles to native species (competition and predation)

Impacts to native species by cane toads varies considerably, with some anecdotal evidence proposing high mortality of native species in all stages of the cane toad lifecycle. While a majority of studies focus on the impacts of adult toads, research has also been conducted on native species interaction with cane toad tadpoles with a variety of outcomes (Crossland & Alford, 1998; Crossland, Alford, & Shine, 2009; Shine, 2014; Shine, 2010).

There have been several studies into Australian native frogs and the impact from cane toads and results generally suggest tadpole competition between cane toad and native frogs is minimal, being confined to changes in growth and development (Williamson, 1999). In most instances, high mortality of native tadpoles was attributed to consumption of cane toad eggs rather than tadpole competition. Changes in growth and development of both cane toad and native frog species have also been reported as a consequence of reproductive timing (Crossland, Alford, & Shine, 2009). This provides another variable in identifying impacts of cane toad early developmental stages. In a study by Crossland, Alford, & Shine (2009), which focused on the interaction between cane toads and one Austrailan frog species (ornate burrowing frog *Opisthodon ornatus*), results showed highly complex outcomes with changes in reproductive timing. These results were:

- survival rates of toads were decreased by earlier arriving frogs

- toads metamorphosed at larger sizes from the treatment in which toad eggs were added after frog tadpoles (reduced interspecific interactions)
- no frog metamorphs emerged from treatments where the frogs were added after toads (high mortality due to cane toad egg consumption)
- reduced survival rates of both frogs and toads increased body mass of both species at metamorphosis by lessening competitive suppression.

These findings suggest that earlier presence of cane toad tadpoles negatively impacts native tadpoles, but positively enhances native metamorphs size. This suggests cane toad presence might enhance reproductive output of native frogs from a waterbody (Crossland, Alford, & Shine, 2009).

Several studies have been undertaken focusing on impacts to native aquatic predators from cane toad tadpoles and eggs. It is important to recognise that only the ovum of the cane toad egg is toxic, and the surrounding jelly layer is non-toxic but masks the toxic centre (Crossland & Shine, 2010). Studies by Greenlees & Shine (2011) and Crossland & Alford (1998) identified cane toad eggs as having a greater potential to cause high mortality than the tadpoles. Native tadpoles, gastropods (slugs and snails) and leeches showed no avoidance response to cane toad tadpole eggs, consuming gelatinous coating and eggs which proved fatal (Crossland & Alford, 1998). A different outcome was found when studying native fish and cane toad egg consumption. It was suggested that many fish species (barramundi [*Lates calcarifer*], fly specked hardyhead [*Craterocephalus stercusmuscarum*], southern purple-spotted gudgeon [*Mogurnda adspersa*], northern trout gudgeon [*M. mogurnda*] and firetail gudgeon [*Hypseleotris galii*]) can identify toxicity through olfactory cues within the jelly coating and as a consequence there was no significant reduction in survival (Greenlees & Shine, 2011). In this instance avoidance rather than tolerance of toxins reduced mortality. Several invertebrate species were also studied to find responses to cane toad eggs and larval stages. Dytiscid beetles (predaceous water beetles), belstomatids (giant water bugs) and crustaceans are all capable of successfully consuming cane toad eggs and tadpoles (Greenlees & Shine, 2011). Outcomes of these studies showed that there was little change in toxicity through early developmental cycles, meaning susceptibility is dependent on an ability to detect and avoid toxins as well as which stage of cane toad lifecycle a predator species utilises.

3 Methods

3.1 BufoTab baits

BufoTabs are attractant baits derived from the chemicals extracted from the toxic parotoid gland in an adult cane toad. The extracted chemical is secreted on a porous round substrate approximately 12 to 15 mm in diameter. When the attractant bait is immersed in water the extracted chemicals are released resulting in a plume being spread from the point source. When the trap is submerged in water and the bait added, an attractant plume is released and exits through one of two funnels and is spread through the water column. During the trapping program, the attractant baits where placed at the centre of the trap to give equal chance of an attractant plume spreading from both funnels.

3.2 Waterbody characteristics assessment

At the time of trap set up, the characteristics of each waterbody were assessed and recorded. Data recorded included the type of vegetation present, slope of bank, substrate of waterbody, water quality, and water depth. This information was recorded to help understand whether the waterbody and its characteristics play a role in the capture of cane toad tadpoles.

3.3 Initial trap design

Traps were constructed in consultation with the University of Queensland (UQ) with reference to the CTC instructions. Traps comprised an 80-litre plastic box with lid and funnels attached via plastic electrical gland to small holes cut in either side of the box (see Plate 1). The electrical glands are rubber lined and allowed the funnels to be attached with a water tight seal.

The funnel attachments were watertight to allow the attractant plume to disperse effectively from the bait. An additional layer of silicone sealant was applied to the junction between the funnel and gland outer surface as a second barrier to attractant leakage. Removeable plastic blanks screwed onto the inside of the electrical glands to prevent water and animal movement in and out of the plastic box between trapping events. Large air holes were drilled into the lid to assist air flow and shade cloth was added to reduce potential heat build-up within the trap.

Plate 1: Initial trap design before deployment

3.3.1 Initial trap installation

Traps were attached to star pickets via loosely tensioned cable ties. This allowed the trap to rise and fall with fluctuations in water depth. Traps were flooded to cover the top of the funnel but leaving the remainder of the trap above the waterline. Trap positioning in the water is shown in Plate 2. Plastic lids containing the glued shade cloth were clipped into place onto the top of the trap utilising the locking mechanism assembly which forms part of the plastic tub design. Signage was installed at the front of the traps to notify the community of the trapping program. Signage utilised the star pickets anchoring the traps into place.

3.3.2 Control traps

To test the effectiveness of the attractant baits, every baited trap had a corresponding unbaited (control) trap adjacent, to test whether cane toad tadpoles were attracted to the bait or the trap itself. Traps were marked as either baited or unbaited to ensure continuity of trapping procedure. A single site (Inverness Park) had a single unbaited trap deployed that acted as a control waterbody.

Plate 2: Traps installed and submerged to cover funnels

3.3.3 Trap positioning

Reconnaissance of waterbodies was undertaken to establish suitable sites to deploy traps. Wherever possible, traps were situated close to banks in areas away from high velocity water flow and in full sun. Positioning of traps mirrored the preferences shown by cane toad adults when choosing sites to lay eggs. At several sites there were limited positions to deploy traps due to water depth and water velocity after rainfall events and consequently, less ideal, shadier positions were utilised.

3.4 Amended trap design

Modifications to the trap design were completed periodically throughout the trapping program. The initial trap design yielded minimal capture of cane toad tadpoles and consequently an amended trap design was trialled in an effort to increase capture rates. Several areas of the trap design were considered to improve capture rates. These were:

- the height of the funnels meant the traps were not able to be placed in shallow water where tadpoles were often seen
- baited and unbaited traps placed close together affecting the attractant plume
- shade cloth on the lid darkens and shades the water within the trap differing from a cane toad tadpole preference for sunny open locations
- trap positioning may not be ideal to suit cane toad tadpole preferences
- exterior funnels limit a tadpole from finding the entry to the trap.

3.4.1 Buoyancy

The first amendment to the trap design involved the addition of flotation devices to each end of a trap. On many occasions when returning to collect tadpoles, traps were often observed to be fully submerged or immersed on one end. Buoyancy was added to each end of the trap to attempt to alleviate this issue (see Plate 3).

Plate 3 Buoyancy added to traps

3.4.2 Funnels and shade netting

After trialling traps with funnels being attached to the exterior of the box, traps were redesigned to have funnels recessed into and as low as possible to the bottom of the box walls. Holes in the ends of the plastic boxes were enlarged to accommodate the open end of the funnels and funnels were plastic welded into place to maintain the structural integrity and rigidity of the trap (see Plate 4). The interior junction of the box side wall and the funnel were sealed with silicone sealant to limit leakage of the attractant plume. Shade cloth was removed from the lid of the traps to reflect environmental/weather conditions exterior to the trap, as it was thought that shaded conditions provided suitable shelter for fish other by-catch. Cane toad tadpoles prefer sunny conditions and the elimination of shade cloth would therefore enhance the chance of tadpoles being captured.

3.4.3 Trap repositioning

At the introduction of the recessed funnel design, baited and unbaited traps were also separated by several metres ensuring tadpoles were not entering the unbaited trap as it was in close proximity to the attractant plume from the baited trap.

The redesigned baited traps were also placed in shallower water and the closest edge wedged against the bank. As the trap was anchored against the bank substrate, this limited a trap from being submerged on one end and located the trap in area preferred by cane toad tadpoles. In several instances it was found that the varying water levels in some waterbodies meant that trap were often left out of water and consequentially it was ensured that a trap was positioned to ensure it was not stranded during a trapping cycle.

Plate 4 Recessed plastic welded funnels

3.4.4 Trap immersion duration

At the beginning of the trapping program, traps were immersed to the appropriate depth continuously. It was found that during continual immersion, failure of the silicone sealant was common, and this allowed attractant to pass between the gap in the box wall and the funnel. Once this failure was identified, traps were only immersed during the trapping event and were left to float on the surface, empty, between trapping cycles.

3.4.5 By-catch

By-catch captured in the trap was collected, counted and recorded. Initially all by-catch was returned to the waterbody. After consultation with BCC, native species were returned to the waterbody and exotic species (particularly exotic fish) were removed with any cane toad tadpoles and disposed of humanely off site.

3.5 Data Collection

An electronic data capture form synced to an online cloud database was utilised to record site and trapping/catch data. This allowed a user to access the form and data at any time from any location. Site data recorded included:

- proximity of vegetation to traps
- water clarity
- slope and composition of waterbody at the edge
- presence of adult toads
- photographs of the site.

Catch data was also recorded on a sub form of the site data. Each record included:

- date and time trap were set
- date and time of collection
- a measure of catch in baited or unbaited traps
- timed sampling results
- by-catch including frogs, native tadpoles, fish and other aquatic animals.

3.6 Trapping procedure

3.6.1 Trapping cycle

Initially trapping was conducted over two days with deployment of the bait on the first day and collection on the second. This allowed the attractant bait 24 hours to disperse through the water and away from the trap. Additions to the number of trapping locations resulted in difficultly in reaching all sites to collect tadpoles in one day. A change in trapping cycle was therefore required to bait half of the traps in the morning and collected in the afternoon of the first day and the remainder of the traps were processed on the second day. This redesigned trapping procedure resulted in the traps being baited for a minimum of 4 hours and an average of 6. The shorter trapping period also minimised the potential for a significant change in water level to affect the level of water within the trap.

3.6.2 Setting traps

Before the attractant bait was deployed, the trap was cleared of any funnel obstructions and water depth set to ensure funnels were covered. Traps were also visually inspected to ensure they were free of any cracks or other damage which may prevent them from functioning. Attractant bait was added, and the lid fastened. Time, date, weather conditions, attractant bait serial number and whether the trap was unbaited or baited was recorded on a mobile data collection device.

3.6.3 Tadpole collection

When checking baited traps, water was screened with a fine mesh net and the catch transferred to either to a plastic zip lock bag (for one or two individuals) or measuring cylinder for larger catches. A standard 1 litre measuring cylinder was utilised to measure each catch. The volume of cane toad tadpoles was measured by volume in millimetres. This form of measurement was utilised as a measuring cylinder is easily transportable and calibration is not required. Measuring by volume is also preferable to a physical count as the time required to determine numbers would be prohibitive. By catch was also recorded and included native frog tadpoles, a frog, fish or aquatic macroinvertebrates. By catch was released back into the waterbody. Part way through the trapping project exotic fish were also collected and recorded in addition to cane toad tadpoles. Once measured, tadpoles where transferred to plastic zip lock bags and labelled with date and location of catch. Bagged tadpoles and exotic fish were then placed in either a portable car fridge or esky with ice to cool and transport. Chilled catch was added to a freezer to euthanise and store for later disposal.

Part way through the trapping program and in consultation with BCC, the collected data was required to be converted to the number of tadpoles captured in addition to the millilitres of tadpoles captured. This was undertaken by dividing captured tadpoles into three size classes. The size ranges included newly hatched tadpoles, small tadpoles without legs and large tadpoles with developed legs. Bags of captured tadpoles were selected which had a dominant class size and a portion of the individuals were counted and measured in millilitres. A count of large tadpoles revealed 475 tadpoles per 100 ml. Small tadpoles were recorded as 3,450 tadpoles per 100 ml and newly hatched as 7,500 tadpoles per 100 ml.

3.6.4 Timed sampling

To test the efficacy of the attractant baits and trap design, an active capture timed sample was undertaken. At each trapping event, a timed sampling of tadpoles was completed. This involved using a dip net to capture tadpoles for 90 seconds along a transect. The number of tadpoles captured was recorded.

3.6.5 Weather data

Weather data was recorded automatically through the data collection application utilised for the trapping program. Data was collected at the time of trap setting and recorded the real time weather at the trap location. Parameters recorded included: temperature, recent rainfall (past 24hr), humidity, and a weather description.

3.7 Statistical analysis

Statistical analyses were completed with the data recorded through the trapping program. Several comparisons were made as follows; trapping vs dip netting and baited vs unbaited traps. The data analysis included the calculation of means with standard error, contingency tables and chi square tests. Previous studies have employed chi square test and to be able to validate and compare project data from this program with other studies, these statistics were utilised. Several assumptions have been made for the statistical analysis to be valid. It is assumed that the catchability was the same between trap designs and that the weather was consistent during each trapping cycle across all sites. It was also assumed that a waterbody acts as an independent replicate and 90 seconds of dip netting is an equivalent of physical fishing effort through dip netting to trapping effort.

Trapping results from the two Lockrose Street sites have not been included as they only occurred for half of the trapping cycles. Inverness Park (control waterbody) data was not included as data collected was not comparable to other sites as a baited trap was not installed. Data for Mt Coot tha mobile trapping location were only utilised when comparing capture data to rainfall and to other sites. As there was no dip netting or unbaited trap associated with Mt Coot tha mobile, capture data from this trap were not utilised as part of comparisons between baited vs unbaited, or baited trap vs dip netting.

3.7.1 Baited vs unbaited

To complete the analysis of this comparison a contingency table and chi square test was used to test the null hypothesis that bait added to a trap does not affect a capture rate. A chi square test was used in this instance as it is ideal for the comparison of two variables to see if they are related.

3.7.2 Baited vs dip netting

To complete the analysis of the comparison between baited traps and dip netting a contingency table and chi square test was used to test the null hypothesis that a baited trap and dip netting require the same effort to capture the same amount of cane toad tadpoles.

3.7.3 Baited compared to rainfall

A calculation of means and standard error of trapping sites was plotted against rainfall data for Brisbane City (Bureau of Meteorology - Brisbane weather station, 40913). Trends from this comparison highlight whether ideal favourable conditions are the driver of reproduction.

4 Results

4.1 Site waterbody characteristics

Table 1 outlines the characteristics of each waterbody where traps were initially deployed. Where possible traps were positioned to reflect where cane toad tadpoles were observed congregating and/or preferred breeding requirements of adult cane toads. Appendix 1 shows a map of the trap position at each site and examples of site waterbody characteristics and trap positioning are shown in Appendix 2.

Table 1 Site characteristics of waterbodies used in trapping program

Site	Waterbody characteristics
Biami Yumba Park, Fig Tree Pocket	Ground cover vegetation present to edge of bank, trees largely absent, steep slope at edge. A few suitable locations for traps. Trap located in a water depth between 0.5 – 0.8 metres
City Botanic Gardens, Gardens Point, Brisbane City	Initial site: Ground cover vegetation close to edge, trees present, waterbody shaded. Edge of waterbody concrete with steep sides. One suitable location for trap. Final site: Ground cover vegetation close to edge, trees scattered, concrete edge with steep concrete slope. Many suitable trap locations. Trap located in a water depth between 0.5 – 0.7 metres
Edenbrooke, Seventeen Mile Rocks	Ground cover sparse, scattered trees, gradual/steep muddy banks and bottom of waterbody. Subject to rapid rises and falls due to use as stormwater energy dissipation site. A few suitable locations for traps. Trap located in a water depth between 0.5 – 1 metre
Inverness Park (control), Upper Kedron	Scattered ground cover vegetation, open tree canopy. Gently sloping muddy banks Trap located in a water depth between 0.2 – 0.4 metres
JC Slaughter Falls, Mt Coot tha	Ground cover adjacent to site with scattered trees near position of traps. Half of waterbody shaded. Variety of bank slopes ranging from gradual to steep. Gravel bed and site subject high-water flows during and after significant rainfall events. A few suitable trap locations. Trap located in a water depth between 0.2 – 0.4 metres
John Sprent Reserve (North), Moggill	Grass ground cover adjacent to waterbody with open tree canopy. Steep muddy banks. Several suitable sites for traps. Trap located in a water depth between 0.5 – 0.7 metres
John Sprent Reserve, Moggill	Grass surrounds waterbody. Thick water tolerant vegetation (grasses) present up to 1 metre into the waterbody. Gradual to steep sides, muddy bottom. A few suitable locations for traps Trap located in a water depth between 0.4 – 0.6 metres
Karawatha Forest Park, Pamela Crescent, Karawatha	Scattered ground cover grasses and sedges around waterbody. Gradual sloped muddy banks and open tree cover. Many locations for traps. Trap located in a water depth between 0.3 – 0.5 metres
Lockrose Street (East), Mitchelton	Shallow muddy banks with low/mown grass edges, open tree cover. Many suitable locations for traps. Trap located in a water depth between 0.2 – 0.4 metres

Site	Waterbody characteristics
Lockrose Street (West), Mitchelton	Shallow muddy banks with low/mown grass edges, open tree cover. Many suitable locations for traps. Trap located in a water depth between 0.2 – 0.4 metres
McGinn Road Park, Ferny Grove	Steep banks, half of waterbody shaded, overflow/causeway at eastern end. Large waterflow during significant rainfall. Aquatic weeds present. Very few locations for traps due to water depth and flow. Trap located in a water depth between 0.4 – 0.7 metres
Mount Coot-tha Botanic Gardens, Mount Coot-tha	Gently sloping muddy banks, sparse open grassed vegetated edges. Large daily fluctuations in water depth due to use of waterbody for irrigation. Many locations for traps. Trap located in a water depth between 0.2 – 0.8 metres
Mount Coot-tha Botanic Gardens (Mobile), Mount Coot-tha	Gently sloping muddy banks, sparse open grassed vegetated edges. Large daily fluctuations in water depth due to use of waterbody for irrigation. Trap was capable of being moved to any ideal trapping location. Trap located in a water depth between 0.2 – 0.4 metres
Ross Road Reserve (East), Upper Kedron	Gently to steeply sloping muddy banks with very sparse open canopy. Grass ground cover to edge of bank. Many trap locations. Trap located in a water depth between 0.2 – 0.7 metres
Ross Road Reserve (South), Upper Kedron	Gently to steeply sloping muddy banks with very sparse open canopy. Grass ground cover to edge of bank. Many trap locations. Trap located in a water depth between 0.2 – 0.7 metres
Ross Road Reserve (West), Upper Kedron	Gently to steeply sloping muddy banks with open canopy. Grass ground cover to edge of bank and aquatic vegetation persisting up to three metres into the waterbody from the bank. A few trap locations. Trap located in a water depth between 0.2 – 0.7 metres
Thomas McLeod Park, Sinnamon Park	Gently to steeply sloping muddy banks with open canopy. Several trap locations. Trap located in a water depth between 0.2 – 0.5 metres

4.2 Trapping cycles

Trapping cycles were initiated on the 17th November 2017 and concluded on the 13th April 2018. A total of 36 trapping cycles were completed within this timeframe. Trapping data reveals a total of 23.87 litres of cane toad tadpoles captured within baited traps, 0.5 litres within unbaited traps and 2.13 litres through dip netting. In addition to cane toad tadpoles, a myriad of other species was captured as by catch. These include exotic and native fish, fresh water (shrimp like) crustaceans, freshwater snails, water beetles, water boatmen, a leech and a single yabby *Cherax* spp.

4.2.1 Baited vs unbaited traps

An aim of this project was to identify whether traps baited with BufoTab baits resulted in the capture of more cane toad tadpoles than a trap without any bait. Figure 2 identifies a distinct difference between the baited and unbaited traps with higher baited trap capture rates in evidence onward from the tenth trapping cycle. Several large outlier results have been omitted from Figure 2 to allow a better visualisation of the trends occurring throughout the trapping program. Standard errors show high variability with averaged data and this can be attributed to large spikes in capture rates across sites.

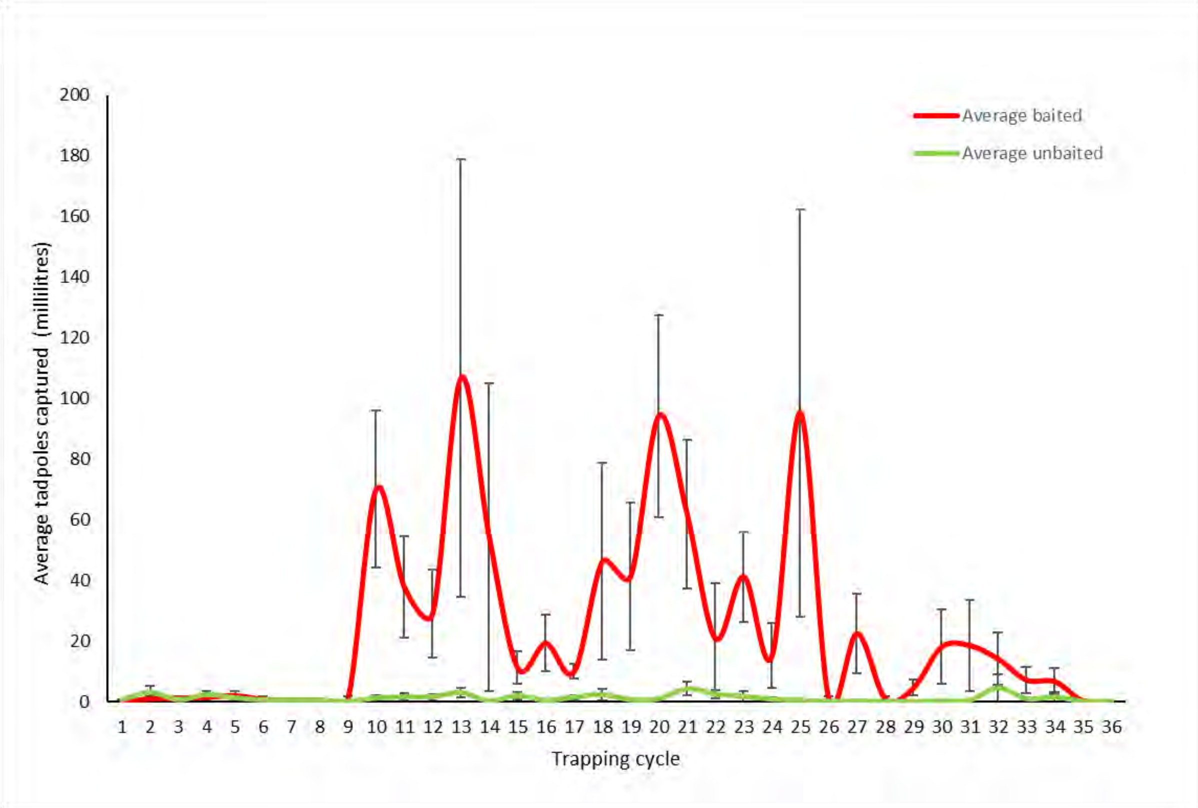

Figure 2 Comparison of baited and unbaited tadpole trapping

Contingency table and chi square test were completed, and the number of cane toad tadpoles captured in baited traps was higher than in unbaited (control) traps. 22.645 litres of tadpoles were captured in the baited traps and 0.46 litres of tadpoles captured in the unbaited traps. These results are compared to the null hypothesis that there is no significant difference between results (an equal volume of tadpoles in the baited and unbaited traps). A chi square value, χ^2= 1290, was calculated with degrees of freedom, *df* =12. Utilising a chi square table to analyse the calculated results reveals a value as being p<0.0001. These results suggest the attractant bait plays a significant role in capture success of cane toad tadpoles.

4.2.2 Trapping vs dip-netting

A second aim of this project was to compare the efficacy of baited traps compared with active capture of tadpoles. Figure 3 shows a comparison of the two capture methods with baited traps more successful at capturing cane toad tadpoles with the same physical effort.

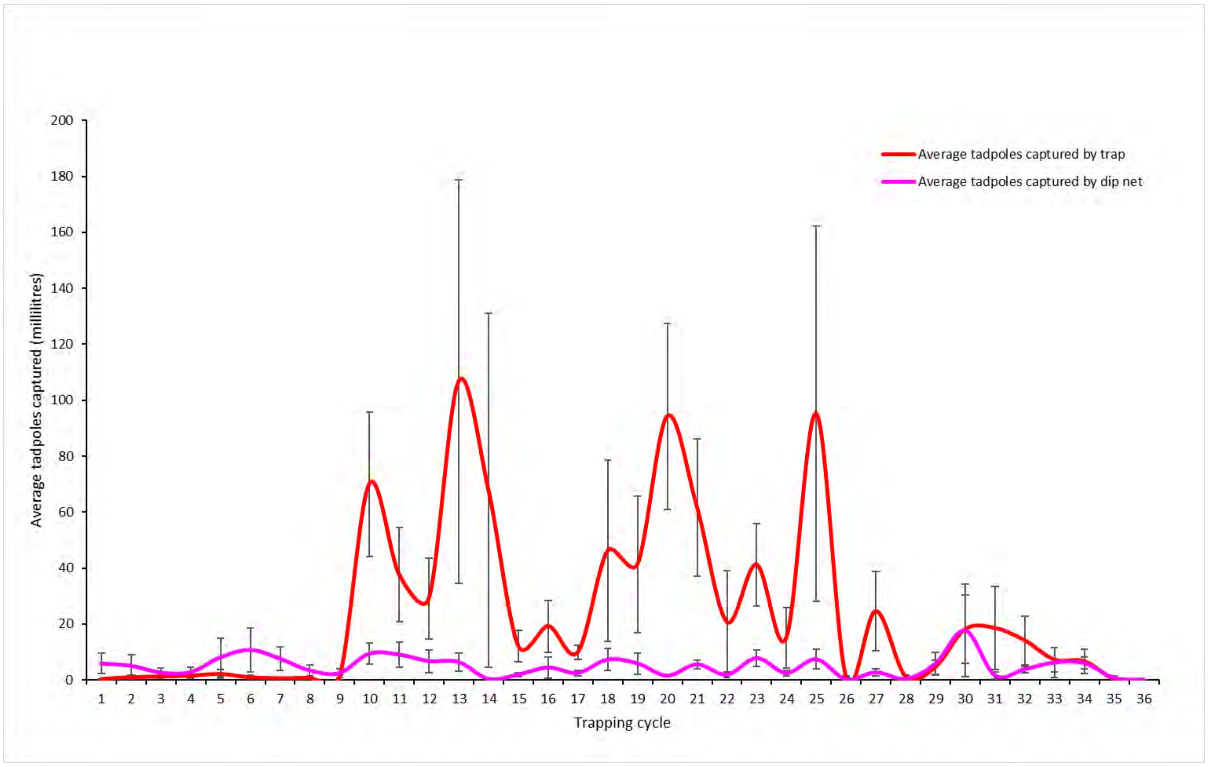

Figure 3 Comparison of baited traps with dip netting

Higher baited trap capture rates are evident onward from the tenth trapping cycle which coincides with the modification of funnel design and trap placement. Standard errors show high variability with averaged data and this can be attributed to large spikes in capture rates across sites most likely related to variability in cane toad breeding events. Several large outlier results have been omitted from Figure 3 to allow a better visualisation of the trends occurring throughout the trapping program.

Contingency table and chi square test were completed, and the number of cane toad tadpoles captured in baited traps was higher than with dip-netting. 22.645 litres of tadpoles were captured via baited traps and 2.029 litres were captured through dip netting. Compared to the null hypothesis of equal results between baited and dip netting, a chi square value of χ^2= 2721 was calculated with degrees of freedom, *df* =12. As with baited verses unbaited, the value is p<0.0001. These results suggest the attractant baited trap is more efficient in capturing cane toad tadpoles.

4.2.3 Trapping cycle and rainfall

To identify significant trends attributed to weather, Brisbane rainfall data was plotted against the average captured cane toad tadpoles per trapping cycle. Figure 4 shows the results of this comparison. Larger (significant) rainfall events (greater than 25 mm) occurred on 19th and 30th November, 26th December 2017, 23rd and 24th February 2018. Smaller rainfall events were scattered through the trapping period. Large spikes in trap capture occurred mid-January and early – mid March. Results showed an approximate two to three-week lag between significant rainfall and large capture rates.

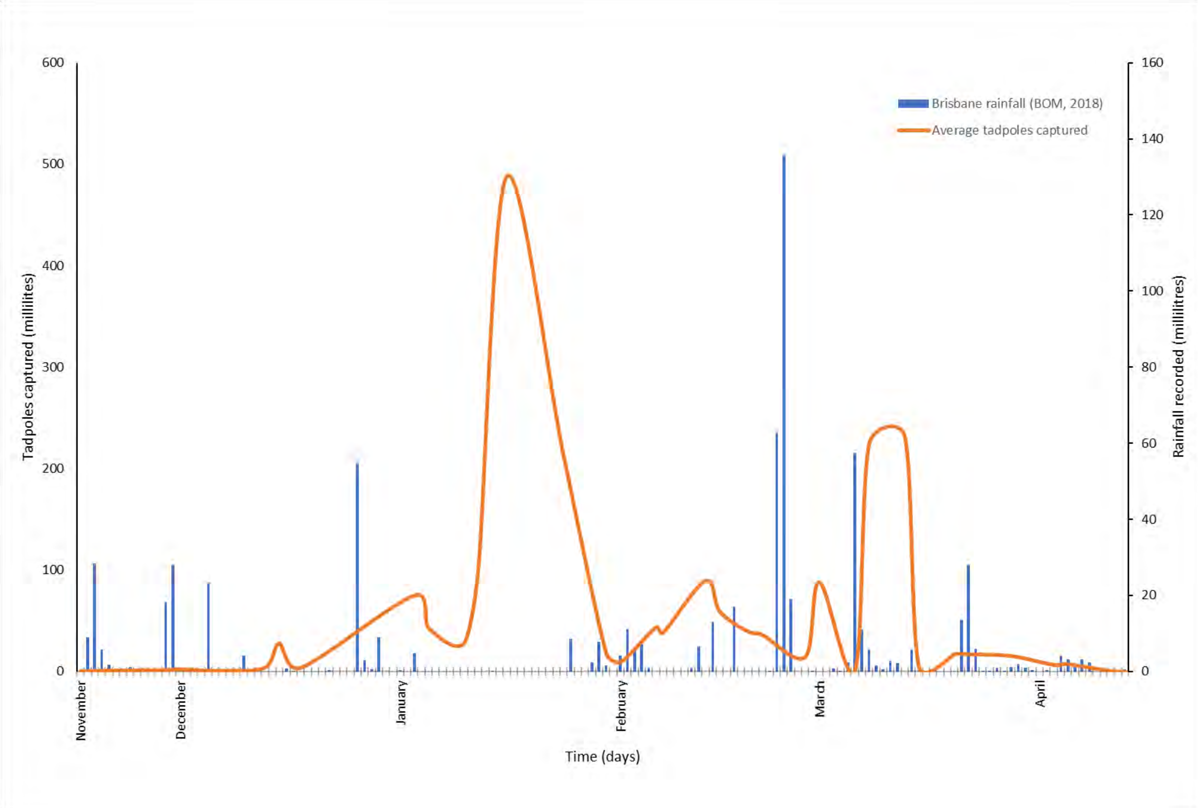

Figure 4 Tadpole capture plotted against rainfall data

4.2.4 Capture by site

Large variations in tadpole capture existed between sites with several sites producing very large capture events. Figure 5 shows a comparison of capture results at each site for the duration of the trapping cycles.

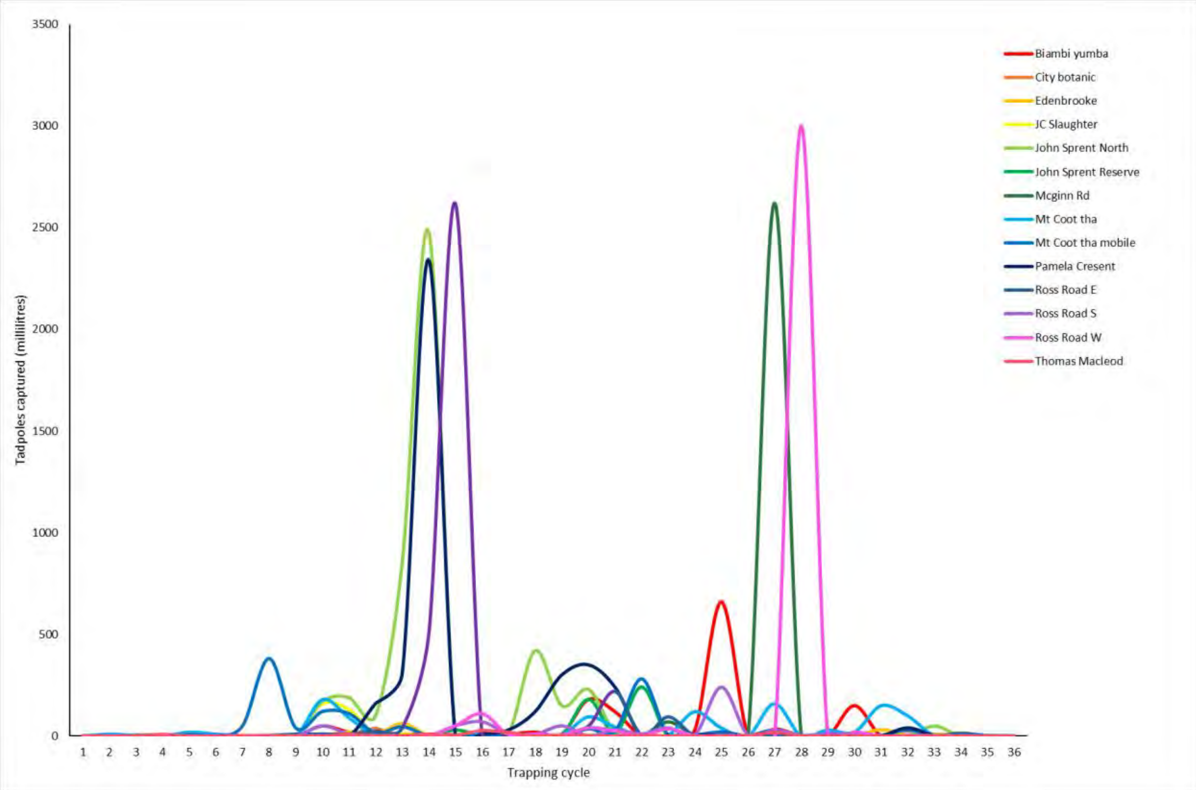

Figure 5 Tadpole capture per trapping cycle for all sites

4.2.5 By catch

A myriad of other species was captured within baited and unbaited traps during the trapping program. Twenty-nine native tadpoles were caught, of which, thirteen were captured in baited traps and sixteen captured in unbaited traps. Native fish species were recorded in both baited and unbaited traps and include firetail gudgeon (*Hypseleotris galii*) and Agassiz's glassfish (*Ambassis agassizii*). The exotic mosquito fish (*Gambusia spp.*) were regularly captured and in far greater numbers than native species and tended to be attracted to traps with baits (collector observation). A second exotic fish species occasionally captured were juvenile tilapia (*Oreochromis mossambicus* or *Tilapia mariae*). Through the trapping cycle, 1,482 fish were captured in unbaited traps and 5,473 fish in baited traps. Baited and unbaited traps also captured a range of invertebrates. Captures ranged from shrimp like crustaceans, water snails to aquatic insects. Water snails were commonly found within traps whilst traps were immersed between trapping cycles. Once traps were floated on the surface between trapping cycles, records of water snail capture did not occur.

5 Discussion

Results of analysis confirmed that trapping using attractant baits is more effective than an unbaited trap and more efficient than dip netting. Statistical analysis through chi square test revealed that the observed distribution suggests that attractant bait is the factor which enables the baited trap to capture more cane toad tadpoles than the unbaited trap or a baited trap compared with dip netting. Statistical analysis reflects visual observations.

Once trap design was modified, baited traps collected large volumes of cane toad tadpoles when compared with unbaited traps. Similarly, the baited trap once modified, was far more efficient at catching tadpoles compared with dip netting. Whilst trap set up was more monetarily and time expensive, once set up, time and effort required was reduced. Dip netting has a low financial cost (a net) but the time required to capture the equivalent volume of tadpoles was far greater.

Once set up, trapping has less impacts due to disturbance whilst dip netting continues to create disturbance with every visit. Continued tracking back and forth disturbs sediments impacting water quality and has the potential to affect aquatic flora and fauna through habitat modification.

Once established, the baited trapping program became a successful method to capture cane toad tadpoles. Therefore, it is important to discuss the problems and solutions which enabled the baited design to be successful. A diversity of circumstances including: trap position, vegetation, trap design, rainfall and waterbody characteristics all impacted capture rates and are discussed in detail below.

5.1 Trap design

Trap design is important when considering the effectiveness of trap capture. Within the first month, several traps were found flooded or sunken on one end, allowing the attractant plume to leak out of the top rather than through the funnels. The traps were set in the top 15 - 20 cm of water but if water depth was greater than this, there was the potential for traps to tilt as they were loosely fastened at the top to allow a rise and fall with changes in water depth. It was observed that water fowl were using the traps as a vantage point, and by them standing on one end, submerging the trap. This tilting was alleviated by adding flotation to the ends of each trap.

Initial design of the traps built using the instructions from UQ, positioned the funnels exterior to the trap (Plate 1). Despite favourable breeding conditions (significant rainfall was recorded on the 19th November 2017) minimal catches were recorded through December 2017. A test trap, Mt Coot tha mobile, was built with the funnels recessed into the side of the trap and the shade cloth removed. This design more accurately reflects the original trap design as per the CTC specifications and the design used by Crossland, *et al* (2012). This trap was deployed in the same waterbody as the original Mt Coot tha Botanic Gardens traps but more than 40 metres apart. Mt Coot-tha mobile was first deployed on the 13th December 2017 and captured 50 ml of tadpoles, which was at the time, the highest recorded capture for any baited trap in the program. The trap was deployed again on the 15th December and captured 380 ml. Overall this trap was deployed on 29 occasions and only failed to capture tadpoles on 3 occasions. This mobile trap was moved around the waterbody and on several occasions was within 15 metres of the other Mt Coot tha traps providing anecdotal evidence that multiple traps can co-occur in one waterbody. The successful capture of tadpoles with the Mt Coot tha mobile trap prompted the change of all baited traps to reflect a recessed funnel design. The recessed funnel trap design replaced the exterior funnel design in the week beginning 3rd January 2018.

The changed trap design also coincided with the separation of the baited and unbaited traps which were placed together side by side. Originally the traps were placed adjacent as it was thought the attractant signal was well defined within the water column and a tadpole would be able to follow the attractant plume to the funnel of the baited trap. On several occasions within the first month of the trapping program, the baited trap recorded minimal catch and the adjacent unbaited trap a larger catch. It is suggested that the baited trap attracted tadpoles to the vicinity of both traps, but they did not differentiate between the traps as the attractant plume is more spread out rather than a defined trail. For these reasons the baited and unbaited traps were separated by several metres to more effectively assess the efficiency of the attractant bait.

Changes to the funnels, spacing between the baited and unbaited traps lead to a change in capture rates, with the new design achieving consistent capture through the trapping cycles. Modification of trap design and separation of baited and unbaited traps made trapping more efficient that dip netting.

5.2 Trap position

Positioning of the trap influenced the capture success. While tadpoles were observed in deeper water, most of the times they were identified closer to an edge in shallower water. Traps located in deeper water (e.g. Biami Yumba Park) rarely had a consistent capture event. Sites where traps were positioned in shallower water (e.g. Pamela Crescent, Ross Road East) had consistent capture occurrences. Sites with minimal canopy shading also showed better capture rates and this reflects the results of other studies into cane toad breeding (Hagman & Shine, 2000; Semeniuk, Lemckert, & Shine, 2007), which suggest a preference for low vegetation and shallow water. In several instances, where cane toad eggs (strings) were identified, submerged structure (branches or sticks) are utilised by the female cane toad to anchor egg strings. Where eggs were found it was usually on gently sloping muddy banks rather than on rocky/gravel substrates which matches preferred breeding habitats from other studies (Crossland, Alford, & Shine, 2009).

Where tadpoles were sited at the beginning of a trapping cycle, it was usually in a sunny position within shallow water. They were commonly found on either rock, gravel or on muddy substrates showing their preference is for sunny, shallow water. It was also noted on two occasions on extremely hot days (+32°C) that cane toad tadpoles retreated to deeper water. Traps were placed hard up to the bank in approximately 10-15 centimetres of water adjacent a large concentration of tadpoles and at collection, the tadpoles were not as close to the bank and in deeper water suggesting tadpoles may be influenced by extremes in temperature. The result of that trapping event was that capture rates were lower than anticipated. This highlights the need for traps to be situated dependent on the prevailing weather conditions on the day.

Multiple traps in a single waterbody was undertaken at two sites. This occurred at Mt Coot tha Botanic Gardens and Lockrose Street, Mitchelton. At Mt Coot tha, the baited traps were separated by a minimum of 15 metres and captures were recorded in both baited traps. At Lockrose Street the traps were separated by approximately 30 metres with both baited traps recording captures within the same cycle. Throughout the program, baited traps were never closer than 15 metres, but additional research could be conducted to identify an effective minimum distance separating traps, thereby allowing additional traps in an individual waterbody should it be required.

5.3 Trapping cycle

On several occasions, where there were large capture events, a portion of the tadpoles captured where found deceased when returning to collect captured tadpoles. The first of these events coincided with high temperatures (10th January 2018). As a result of this event, and the number of traps being serviced increasing due to additional sites, a change was made from 24-hour trapping cycles to minimum 4-hour trapping cycle. This means trapping cycles were completed over one day rather than over two, to mitigate the impact of high temperatures. The same results occurred several more times despite reduced times in the trap, suggesting temperature may have not be the initial reason for mortality within traps. A possible reason may be reduced oxygen concentration within the trap due to very high tadpole numbers utilising the oxygen resource. The traps only have two small apertures for water to circulate, and because of high tadpole numbers, oxygen may have been depleted to the point where mass mortality occurred. Further research could assist in identifying whether another unrelated circumstance is influencing tadpole survival within the trap during high capture cycles.

5.4 Ideal trapping conditions

Time lag between rainfall and large capture rates also reflected the outcomes of literature review. Cane toad spawning can occur two-four days after the onset of favourable conditions, with the transition to metamorphosis in two to four weeks (Lampo & De Leo, 1998). This mirrors what occurred within the trapping program where significant rainfall was recorded on the 26th December and large trapping events were recorded mid to late January. A second large rainfall event recorded on the 23rd – 24th February showed a spike in catch numbers in mid-March (as shown in Figure 4). It was also noted on several occasions that a catch rate was lower than expected at the time of setting the trap. The trap was situated approximately one metre from a concentration of tadpoles but at collection, the vast majority were not captured and remained unaffected by proximity to the baited trap. It was noted that these were all large tadpoles with fully developed legs and close to metamorphosing. Further work would be needed to assess whether the bait/attractant is still effective up until metamorphosis or whether it works best on smaller to medium sized tadpoles. It can be concluded that the ideal capture time for cane toad tadpoles can occur any time after one to two weeks, post a significant rainfall event, but generally before the tadpoles have fully developed appendages.

Figure 5 shows a comparison of tadpole capture at each site over the trapping cycle. Large catches at one site generally occurred with another large catch at another site within a similar time frame. Figure 5 also shows that cane toads were still breeding in-between peak/ideal conditions, but there were no spikes in tadpole capture rather than consistent regular catch. This seems to support the literature that weather or the development of favourable conditions due to weather is a primary factor in cane toad reproduction and oviposition (egg laying).

5.5 By-catch

Except for fish, by-catch was not influenced by the presence of bait within a trap. Visual observations and recorded occurrences showed native tadpoles and aquatic macroinvertebrates were usually present in similar numbers in either baited or unbaited traps. Count data only recorded the number of fish captured, and not counts of individual fish species. Visual observations identified that gambusia were far more prevalent in baited traps. Further research is required to assess if attractant bait is resulting in an increase in gambusia capture. Outcomes of additional research may lead to the possibility of trapping this pest fish species whilst trapping cane toad tadpoles.

5.6 Cane toad control

For many, cane toad control has often been associated with community led physical removal of individuals from an area, and while satisfying from a community standpoint, it is time consuming, rarely coordinated and sporadic. Utilising toad physiology to target cane toads provides a new avenue of actions and when used together they have the potential to reduce the impact of this exotic pest species.

Chemical cues whether an attractant or suppressant form one link in managing cane toad populations. Specific pheromones have been shown to reduce toad viability in the long term after brief exposure at the embryonic stage. Similarly, chemical cues from cane toad eggs act as an attractant to the larval stage. Both these chemical cues could be independently utilised to target larval stages enabling capture and removal from a system. The species specificity of these chemical cues means that native frog species are not readily attracted or impacted by cane toad pheromones. This suggests they can be widely deployed with minimal impact to native frogs.

A second means to affect cane toad population is modification of the aquatic habitat. Cane toad preference for gently sloping, vegetation free muddy banks and still water provides an opportunity through vegetation management to reduce suitable sites for toad spawning. Restoring riparian zones through dense edge planting as well as planting to provide future shaded bank edges, denies cane toads a readily identifiable spawning resource. This also had a positive effect for native frog species which prefer vegetated banks, shading and tolerance for flowing water. Ecological restoration of vegetation provides a win for native frog species through cane toad habitat reduction.

A variation to habitat manipulation may involve leaving suitable cane toad breeding sites to restrict cane toads to an easily accessible area. This allows vegetation management to manipulate the occurrences of cane toads rather than the cane toad to manipulate land management. Spatial concentrations of breeding may also increase intraspecific competition and predation with the potential for toad populations to be self-regulating (Semeniuk, Lemckert, & Shine, 2007). Providing cane toads with easily accessible desirable habitat allows other methods of control (chemical cues, physical removal) to be utilised to more efficiently and selectively target cane toads through their lifecycle.

6 Recommendations

Several recommendations have been made to structure an effective cane toad trapping program for future cane toad breeding seasons. These include:

- Trapping cycles should commence approximately 1 - 2 weeks after a significant rainfall event (>25 mm) and trapping should continue for several cycles in a week for at least two weeks.
- Traps should be set and collected in the same day to avoid loss/ damage through weather.
- Traps should be set and retrieved the same day to avoid loss through vandalism (several lids and a trap were smashed with rocks - found within the trap).
- A daily trap cycle limits traps being sunk (e.g. due to weather) therefore avoids the broad-scale dispersal of attractant through water.
- Ideal trap locations have gentle sloping muddy banks with low vegetation and a sunny aspect.
- Trap design should incorporate recessed funnels and no shade cloth. The absence of shade cloth mimics sunny conditions meaning tadpoles are less likely to avoid traps.
- Setting recessed funnels as low as possible to the bottom of a trap. This way, there is less water required to cover the funnels and a trap can be placed in shallower water where cane toad tadpoles congregate. For health and safety reasons, less water also means no heavy lifting of a trap full of water up a steep or muddy bank.
- If waterbodies are large enough, several traps in one waterbody is acceptable if they are well spaced. Estimated spacings are currently more than 15 metres.

Several recommendations are also made to impact cane toads through habitat modification. These include:

- Modification of bank structure of waterbodies to include dense edge planting as a barrier to adult cane toads. Limiting access reduces breeding opportunities.
- Planting of canopy species to shade banks. This changes the preferred breeding site characteristics by including overhanging vegetation.
- Modification of habitat will benefit native frog species with improved habitat. A strong local frog community will also provide additional competition to cane toads.

7 Conclusion

Cane toads have been present within Queensland since their introduction in 1935. Significant changes have occurred to native fauna including behavioural and population impacts. Much of the on-ground work carried out in cane toad control has been confined to the capture of adults. This process is often localised and undertaken at the community level without higher levels of coordination. Results of this trapping program highlighted that bait attractant traps can collect large volumes of cane toad tadpoles providing traps are in preferred breeding locations. Trapping of cane toad tadpoles with attractant baits offers the opportunity to target this pest species before it enters the wider terrestrial community. With tadpoles confined to waterbodies it allows a program to be targeted and coordinated.

Impacts by cane toads throughout their lifecycle on native species is multifaceted. Impacts are overlaid on prevailing interactions, consequentially solutions for control are equally complex. Understanding and utilising the lifecycle and physiology of the cane toad is a means of control which is efficient and effective.

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Appendix 1 Site location maps

Figure 2: McGinn Road Park trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 25/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Data Sources: © State of Queensland (Department of Natural Resources and Mines and Energy), 2018; © Ecosure 2018

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Figure 3: Mt Coot tha Botanic Gardens trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 25/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Figure 4: JC Slaughter Falls trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 25/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Data Sources: © State of Queensland (Department of Natural Resources and Mines and Energy), 2018; © Ecosure 2018

Figure 5: Biambi Yumba trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 28/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Data Sources: © State of Queensland (Department of Natural Resources and Mines and Energy), 2018; © Ecosure 2018

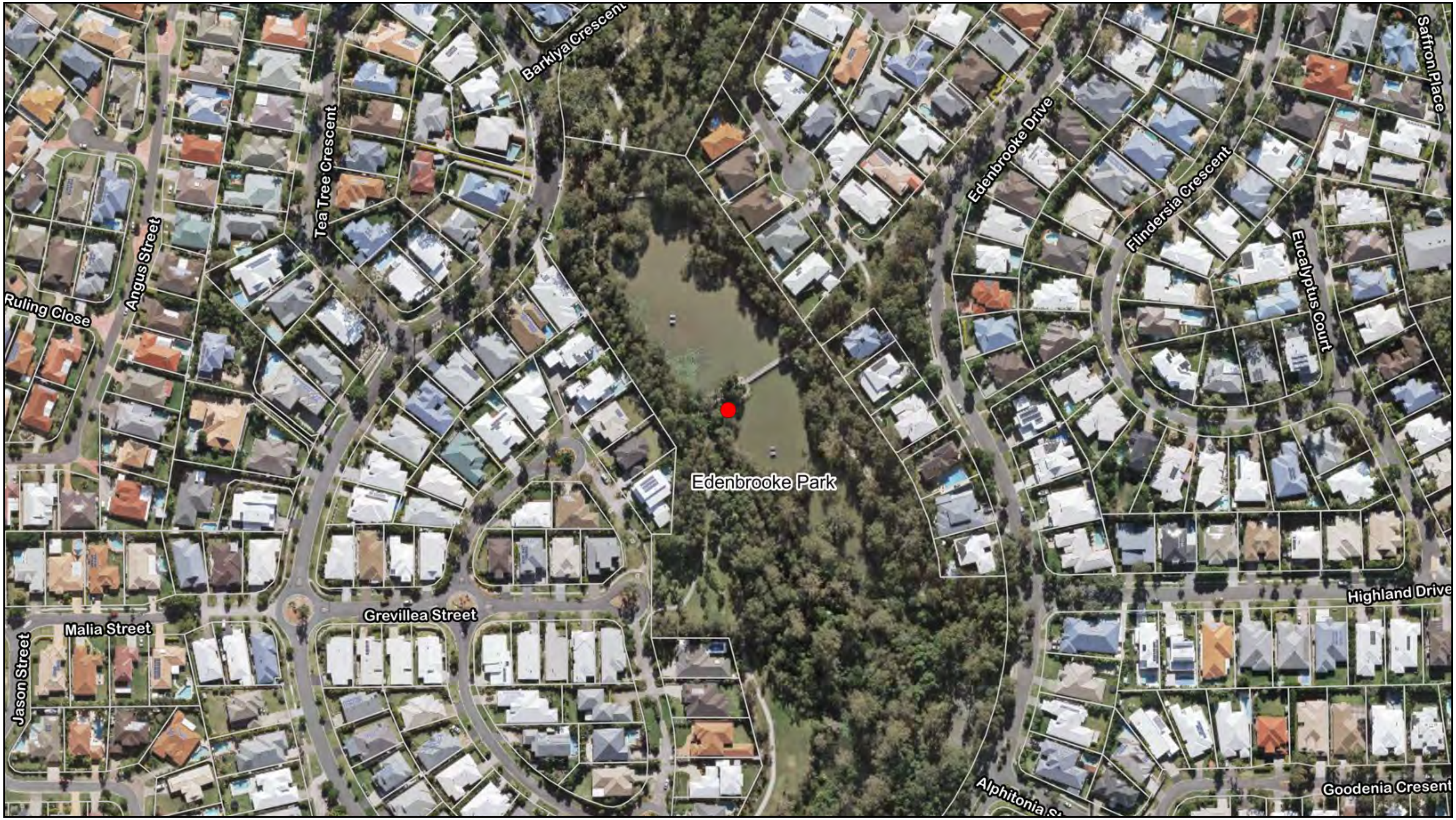

Figure 6: Edenbrooke Park trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 25/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Figure 7: Thomas Macleod Park trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations

Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 25/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Figure 8: Inverness Park (control) trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 25/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Data Sources: © State of Queensland (Department of Natural Resources and Mines and Energy), 2018; © Ecosure 2018

Figure 9: Ross Road Park trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 28/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Data Sources: © State of Queensland (Department of Natural Resources and Mines and Energy), 2018; © Ecosure 2018

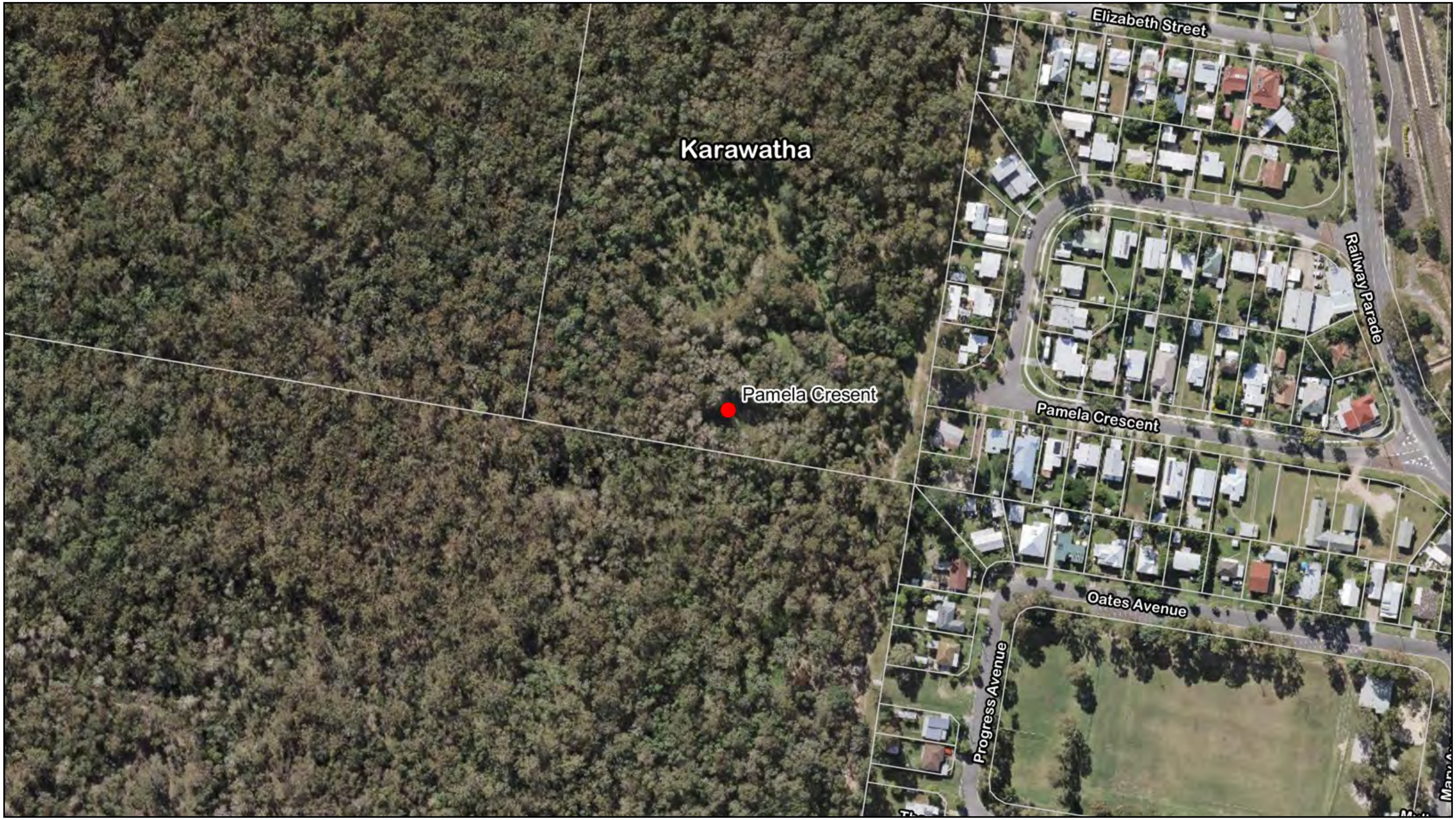

Figure 10: Pamela Cresent trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 25/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

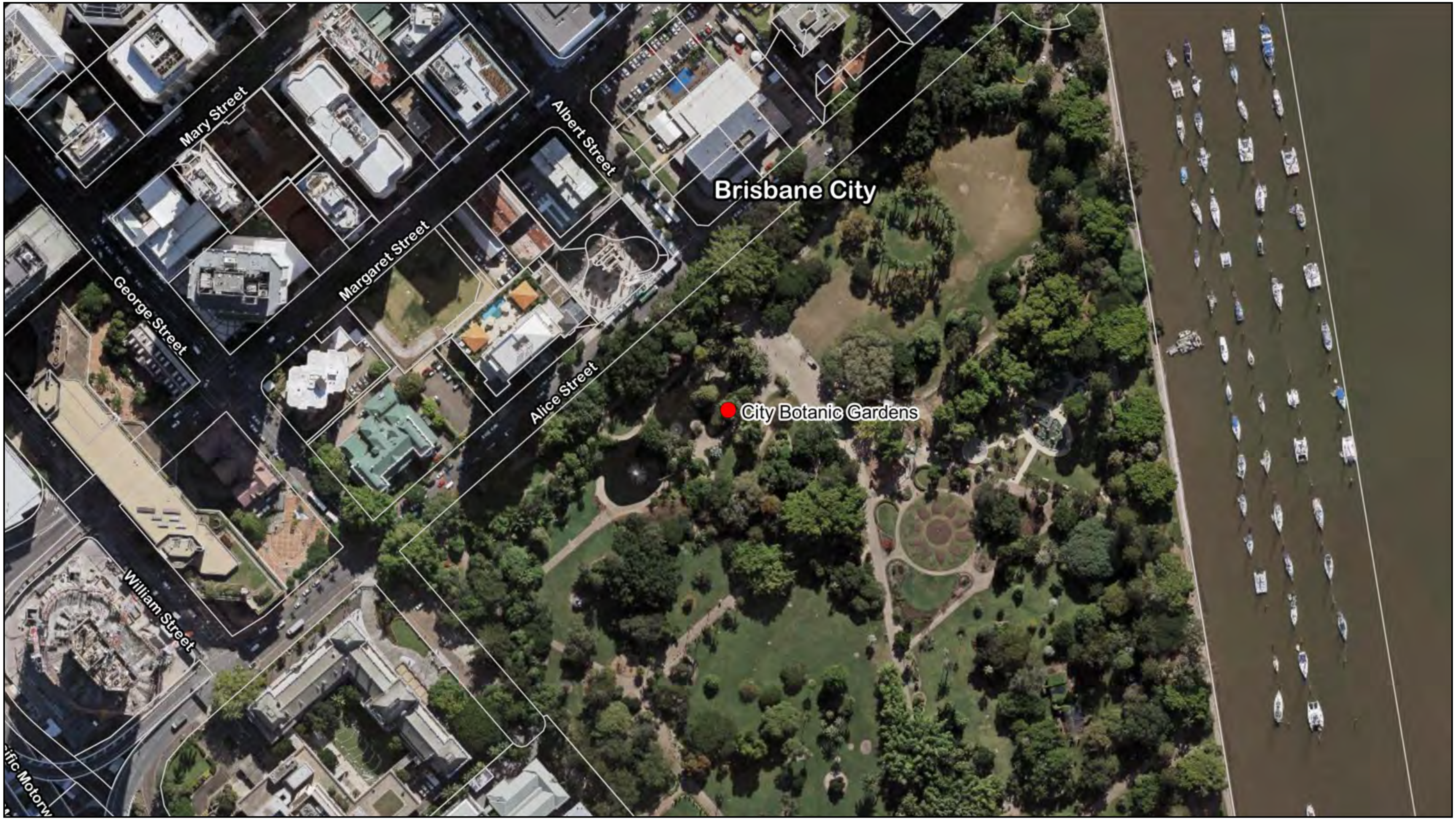

Figure 11: City Botanic Gardens trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 25/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Data Sources: © State of Queensland (Department of Natural Resources and Mines and Energy), 2018; © Ecosure 2018

Figure 12: John Sprent Reserve trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 25/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Figure 13: Lockrose St trapping locations

Brisbane City Council

Cane toad tadpole trapping

Trapping locations
Property boundaries

ecosure

Job number: PR2935
Revision: 0
Author: JE
Date: 25/06/2018

0 25 50 75 100 m

GCS WGS 1984
Datum: WGS 1984
Units: Degrees

Appendix 2 Waterbody characteristics

Plate 1 Ross Road Park (East): trapping conditions - minimal canopy cover

Plate 2 Karawatha: trapping conditions – gentle sloping muddy bank

Plate 3 McGinn Road: trapping conditions - deep waterbody and shaded conditions

Plate 4 Biamba Yumba: trapping conditions – deep water with dense vegetation extending into waterbody from steep bank

Revision History

Revision No.	Revision date	Details	Prepared by	Reviewed by	Approved by
00	19/06/2018	Cane toad tadpole trapping project	Jamie Ernst, Graduate Ecologist	Dave Fleming, Manager - SEQ	Julie Whelan, Senior Environmental Scientist

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Copy #	Date	Type	Issued to	Name
1	28/06/2018	Electronic	Brisbane City Council	Stuart White
2	28/06/2018	Electronic	Ecosure	Administration

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