STOPPING THE MARCH OF YELLOW CRAZY ANTS IN TOWNSVILLE

Scoping report

invasive species council

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About the Invasive Species Council

The Invasive Species Council was formed in 2002 to advocate for stronger laws, policies and programs to keep Australian biodiversity safe from weeds, feral animals, exotic pathogens and other invaders. It is a not-for-profit charitable organisation with over 3000 supporters, funded entirely by donations from supporters and philanthropic organisations.

Intellectual property rights

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Cover image: Yellow crazy ant by David Wilson.

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Executive Summary

This document provides a status report on invasive yellow crazy ant infestations in the Townsville area and options for their management. It arose from a roundtable meeting held in Townsville in November 2019.

Yellow crazy ant is a highly invasive ant species and one of IUCN's 100 Worst Invasive Alien Species. They have caused widespread damage in other parts of the world when they form highly cooperative supercolonies and reach high densities. They impact on ground dwelling invertebrates, birds, mammals, amphibians and reptiles and tourism, agriculture, infrastructure and human health.

Yellow crazy ants have established on Christmas Island, Arnhem Land (NT), Queensland and NSW. Outbreaks in NSW have been eradicated and a biological control agent is being trialled on Christmas Island. A comprehensive $30 million eradication program has been underway for the yellow crazy ant outbreak in the Cairns region since 2014. In 2019, the Queensland and federal governments allocated $18 million over three years to this program on a 50:50 basis.

There are five infestations in the Townsville area. Together with the Cairns and Shute Harbour outbreaks, these are the only yellow crazy ant infestations in North and Far North Queensland. The two new small Shute Harbour outbreaks originating from Townsville are currently being treated.

The five Townsville yellow crazy ant infestation sites are:

1. **Nome** – in the Nome residential areas has been subject to treatment since 2016 and is subject to post treatment monitoring prior to confirming eradication.
2. **Alligator Creek** – to the south and upstream of the Nome infestation, detected in June 2020. It is 4.5 km from the Mount Elliot section of Bowling Green Bay National Park, a high conservation value area with exceptional species endemism and is a critical climate refuge.
3. **Mount St John** – an industrial area next to Townsville civilian and military airport is small but just upstream of the expansive Town Common wetlands.
4. **Douglas** – near JCU campus and Townsville Hospital and extending to the Ross River banks and into a residential area.
5. **Black River –** about 8 km from Paluma National Park, the southern extent of the Wet Tropics World Heritage Area. It is 3km from Clemant State Forest, the only known location of the critically endangered Gulbaru gecko.

Since Biosecurity Queensland withdrew funding for yellow crazy ant eradication in 2012 and the passage of the Biosecurity Act in 2014, Townsville City Council assumed responsibility for control. Efforts have been reactive and poorly coordinated and funded.

Since 2016, treatment has focused on the Nome residential area where, with assistance from CSIRO and the Invasive Species Council, treatment has moved to the surveillance and spot treatment phase, with post treatment validation planned for 2021. Treatment of the other sites has been limited and delimitation is out of date, or in the case of the newly discovered Alligator Creek infestation, still underway.

There are significant risks from failing to control yellow crazy ants at Townsville. There are over $6.1 billion in net benefits from controlling the Cairns area yellow crazy ants over 30 years (178:1 benefit cost ratio) or $513 million if environmental benefits are excluded. Benefits of a similar magnitude would arise from eradicating the Townsville infestations.

The Townsville infestations are close to areas of high conservation significance including about 8km from the southern end of the Wet Tropics World Heritage Area and less than 5km from the Mt Elliot section of Bowling Green Bay National Park, an area of exceptional species endemism.

For four of the five sites, the risk of natural spread of the ants from existing infestations via water and the risk to conservation areas is rated as high or very high, the risk of relocation by human activity is high or very high for three sites and the risk to lifestyle values is high for one site.

There are four options available to respond to the threat of yellow crazy ants in the Townsville area.

1. **A fully funded eradication program.**
   All know infestations would be targeted. Costings have been determined based on the Wet Tropics Management Authority Yellow Crazy Ant Eradication Program.
2. **Management – containment.**
   Regular treatment would temporarily limit and reduce known threats. New infestations likely to established due to accidental spread.
3. **Management – eradication of specific/priority infestations.**
   Provides short-term relief while funds are secured, but fails to address threats from all sites.
4. **Do nothing.**
   Infestations will increase in size, new infestations likely to establish due to human-assisted movement. Growing economic, environmental and amenity impacts to broader region.

Based on current information there remains an opportunity to eradicate yellow crazy ants from the Townsville area provided there are greater resources, improved coordination and adoption of best practice treatment methods.

Achieving successful eradication of yellow crazy ants from Townsville is a wise and cost-effective investment. It will protect many threatened native species and conservation areas in North and Far North Queensland, including the Wet Tropics World Heritage Area and islands within the Great Barrier Reef Marine Park. It will also prevent impacts to agriculture, tourism and infrastructure and the social amenity of those living in the region.

Preliminary analysis has determined the cost of full eradication, including a contingency to allow for the detection of additional unknown infestations. This funding should be sourced 50:50 from the federal and Queensland governments, with additional support from Townsville City Council.

The following is recommended.

Rec 1. **Implement option 1, a fully-funded eradication program** modelled on the Wet Tropics Management Authority's Yellow Crazy Ant Eradication Program for Cairns/Kuranda.

Rec 2. **Secure $3.24 million per year as a minimum over the next ten years** for full eradication and $110,000 for establishment costs, creating 15 full time and 20-30 casual jobs.

Rec 3. **In the absence of full funding, available resources should be used for active management of known high risk infestations** to limit spread until funding is secured.

Rec 4. **Townsville City Council and the Queensland and federal governments are made aware of the seriousness of the situation and urgently requested to support full eradication**.

Contents

1 Introduction

The purpose of this document is to provide a status report on invasive yellow crazy ant infestations in the Townsville area and to set out options for managing this threat.

The document arose from a roundtable meeting held in Townsville in November 2019 where management options for controlling yellow crazy ants in Townsville were explored. Attending the meeting were representatives from the Invasive Species Council, Townsville City Council, Wet Tropics Management Authority, Biosecurity Queensland and James Cook University.

2 About yellow crazy ants

Description

Yellow crazy ants (*Anoplolepis gracilipes*) are a highly invasive, non-native species of ant inadvertently introduced into Australia. They likely originated in South East Asia and arrived in Australia as an accidental hitchhiker on imported goods.

These ants are extremely widespread on islands to the north of Australia and throughout the Pacific Ocean. Their distribution continues to expand throughout all regions of the world (Wetterer, 2005).

Yellow crazy ants are 3-4 mm long and have long slender legs. Their head and body colour is uniformly yellow and they have a slightly darker brown abdomen. When agitated or to subdue prey the ants spray formic acid.

Known Impacts

Yellow crazy ants are listed by the IUCN in its report *100 of the World's Worst Invasive Alien Species*. They are known to cause biodiversity loss and impact on tourism, agriculture, infrastructure and human health.

Although the ants are tiny, they can swarm in great numbers, killing other invertebrates and in some cases much larger animals like lizards, frogs, small mammals, turtle hatchlings and bird chicks. This occurs when they form super colonies, which can reach densities of about 1000 ants per square metre and have severe impacts on native wildlife and plants, upsetting entire ecosystems.

On Christmas Island the ants have killed millions of the famous red land crabs and large numbers of robber crabs, both of which play an important role in the island's forest floor ecology (O'Dowd et. al, 2003).

Yellow crazy ants also enable secondary pest infestations by farming pest insects such as aphids and other sap sucking insects (Haines and Haines, 1978).

The cost-benefit analysis of the Cairns-based Wet Tropics Management Authority Yellow Crazy Ant Eradication Program found that if there is no eradication program for this species the ants would spread throughout the Wet Tropics World Heritage Area and their 'impact on native species and ecosystems will be devastating'. The total impacts would be $6 billion over 30 years including about $500 million in agricultural, tourism and other non-environmental costs (Spring, Kompas and Bradhurst, 2019).

Impacts include:

- Displacement and local extinction of native ants, both through aggression and competition for resources.
- Displacement and local extinction of invertebrates through predation and trophic impacts.
- Displacement and local extinction of vertebrates through trophic impacts, predation and irritation.

3 History in Australia

Yellow crazy ants were first detected in Australia on Christmas Island sometime prior to 1934 and other infestations have occurred in North East Arnhem Land (Northern Territory), Cairns and Kuranda in far north Queensland, the Brisbane city area and Townsville (Hoffmann, 2017). Infestations have been found recently at other locations in Queensland and NSW.

Queensland

These ants were first detected in Cairns, Queensland, in 2001 and then in Townsville four years later in 2005. Since then they have been found at multiple sites across the Brisbane area, Caboolture and Hervey Bay (Csurhes and Hanakamer, 2016). The infestations have been subject to sporadic, state government-led eradication efforts but in 2012 the Queensland Government declared yellow crazy ants ineradicable and withdrew eradication funding.

In 2014 the Australian Government funded the Wet Tropics Management Authority to eradicate the invasive ant species in the Cairns and Kuranda areas and stop them from threatening the Wet Tropics World Heritage Area. In 2019 this program was expanded with $18 million in joint federal and Queensland government funding through to 2022.

In 2018 yellow crazy ants were detected at Shute Harbour in the Whitsunday region and in 2020 they were discovered a short distance away. Both Whitsunday infestations are subject to a local government-run eradication program.

Yellow crazy ants are a category 3 restricted biosecurity matter under the *Queensland Biosecurity Act 2014*. This means they must not be distributed or disposed of into the environment. Under the general biosecurity obligation, the Act requires everyone takes all reasonable and practical steps to minimise the risks associated with tramp ants under their control (Queensland Government, 2014).

Northern Territory

Numerous infestations of yellow crazy ants have occurred throughout the Arnhem land region of the Northern Territory, where they were first detected in 1975. Eradication efforts began in 2004, with more than 20 sites eradicated. In 2008 eradication was considered financially unviable and efforts were shifted to containment (Hoffmann, 2009). Limited containment efforts are continuing.

Christmas Island

Yellow crazy ants were thought to have been introduced to Christmas Island sometime between 1915 and 1934. The impacts of these ants on the island are extensive and have been well documented (TSSC, 2010, O'Dowd et. al, 2003). They have killed tens of millions of the island's iconic and ecologically important red crabs and robber crabs. Prior to a multi-million-dollar baiting program, they had invaded over a quarter of Christmas Island's rainforest, reaching densities of more than 2000 foraging ants per square metre and transforming ecosystems. In many places where the ants flourish on Christmas Island not much else does. It is very likely they are responsible in part for two of Australian's most recent vertebrate extinctions – the Christmas Island pipistrelle (2009) and Christmas Island forest skink (2014).

On Christmas Island eradication of yellow crazy ants is not currently considered viable and activities are aimed at suppression and reduction in their numbers to maintain ecosystem health (PANCI, 2002). More recently trials began of a biological control agent - a parasitoid micro-wasp - to suppress scale insects that provide a major food source for yellow crazy ants. It is hoped this control agent will lead to lower ant densities (Parks Australia, 2020).

New South Wales

Yellow crazy ants have been detected three times in NSW. The first was at Goodwood Island in 2004 (Dominiak *et al.*, 2011), with eradication declared in 2008 (Dominiak *et al.*, 2011). The second and third detections were at Lismore and Terania Creek (near Lismore) in 2018. In March 2020, the NSW Government declared the ants eradicated (*The Land* newspaper, 2020)

4 Management in Townsville

The following section details the current status of yellow crazy ant infestations and control efforts in Townsville.

Townsville infestations

Yellow crazy ants were first detected in the Townsville region in 2005 (Csurhes and Hanakamer, 2016) and are known to occur in five areas – Nome, Alligator Creek, Mount St John, Black River and Douglas (See **Figure 1**). The only infestation to have an eradication plan is Nome (Hoffmann, 2017). The four other areas have only received minor or in some cases no suppression activities at all. Stakeholder liaison has been sporadic. There is a risk that during the February 2019 flooding event yellow crazy ants may have been washed downstream from current infestations at all sites.

As at the time of the publication of this report, the spatial extent of current infestations is unknown, except for the original Nome infestation. There has not been a complete delimitation survey conducted at any site since 2018 except for post treatment detector dog surveillance at Nome in 2019 and 2020. Most delimitation surveys have only been undertaken using rapid assessment techniques, which have a high level of uncertainty. Surveys undertaken in June and September 2020 by the Wet Tropics Management Authority during detector dog training at Nome discovered yellow crazy ants in a new area at Alligator Creek to the south of Nome, 2.4 km from their previously known extent. The total, current infested area of yellow crazy ants, including a 100 m treatment buffer, is approximately 870ha.

It is highly probable there are other, undetected populations of yellow crazy ants in the Townsville region.

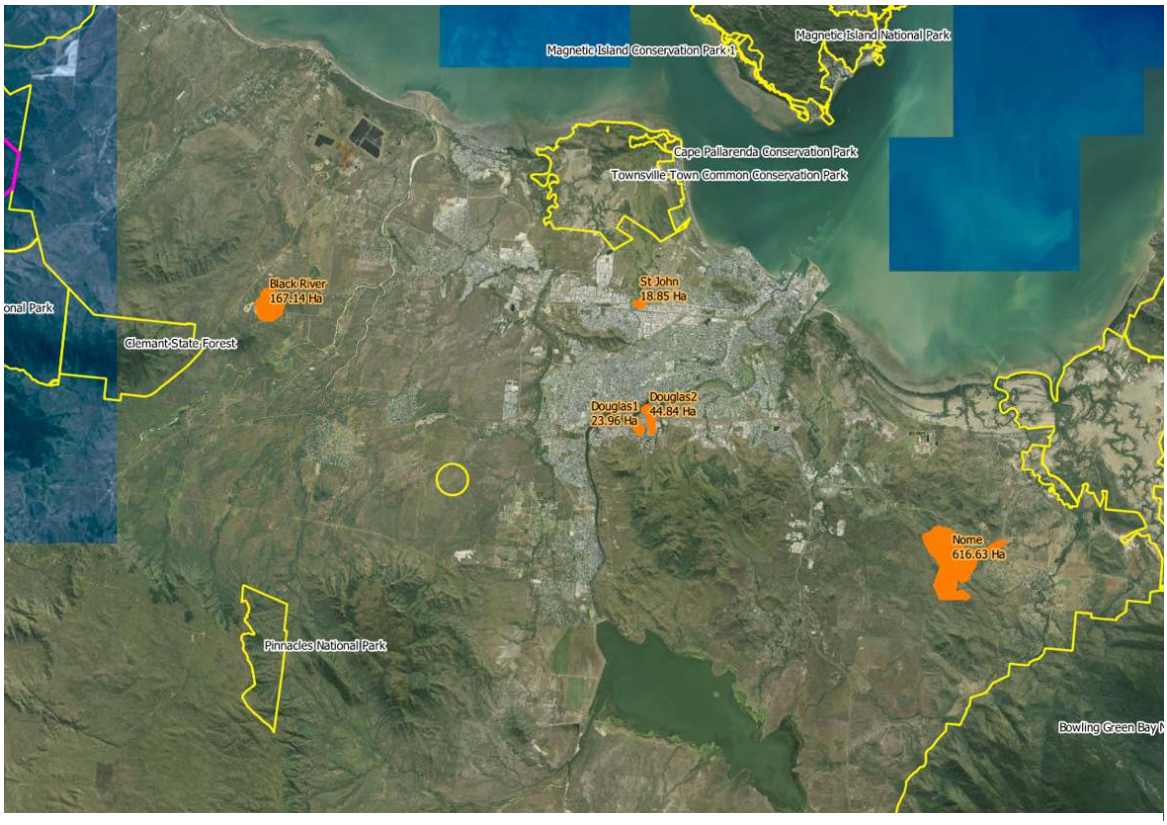

***Figure 1**. Location of known Townsville yellow crazy ant infestations. The infestations total 870+ hectares including a 100m treatment buffer. The Nome area includes the area in Nome under surveillance and spot treatment and the new Alligator Creek infestation currently being delimited.*

Table 1. *Sites with yellow crazy ants in the Townsville area.*

Infestation	Nome	**Alligator Creek**	Mount St John	Douglas	Black River
Current treatment status (4 stages)	Phase 3: Surveillance and spot treatment	Phase 1: Detection and delimitation	Phase 1: Detection and delimitation	Phase 1: Detection and delimitation	Phase 1: Detection and delimitation
Initial Detection	2005	2020	June 2008	April 2009	Prior to 2018
Last surveyed	2020, no detections	2020	April 2018	November 2019	March 2018
Treatments **[update]**	2017 Hydrogel and Synergy treatments. 2018 Antoff and Synergy treatments.	None	Partial treatment pre 2019 floods. Synergy and hydrogel.	2017 hydrogel spread mitigation treatment. 2019 Antoff Infrastructure/machinery spread reduction.	Termidor sprayed on materials leaving quarry. Quarry site treated regularly.
Infestation size at last survey (ha)	210	tbd 350+	30	50	230
Land use	Residential, caravan park, wildlife sanctuary and housing subdivision	Cattle property, close to residential areas.	Industrial, railway, airport, Town Common wetland	JCU campus, hospital, residential, main road, power substation, Ross River foreshores	Quarry and large landholding
Landholder engagement?	Regular newsletters sent and roadside signs erected.	Yes.	Out of date. Need confirmation if local businesses are treating goods sent offsite. WTMA are assisting.	Engagement with JCU, Ergon, hospital, TMR. Minimal interaction with residents.	Good.
Comments	No ants detected for over a year. Undergoing surveillance.	About 1km upstream from Nome infestation, connected by creek. Full delimitation to be completed.	Very complex site: Access is seasonally and physically limited (long grass, crocodiles).	Need to fully survey up and downstream. Very likely yellow crazy ants present in residential area.	Quarry treatment efficacy needs confirmation. Has expanded several hundred metres or more since last delimitation.

Townsville City Council

Townsville City Council has led the response to yellow crazy ants since the Queensland Government withdrew funding in 2012. In 2016/17, Biosecurity Queensland provided the city council with a $200,000 grant to help raise awareness and delimitation of yellow crazy ants.

Townsville City Council have contributed staff time of up to $120,000 per year for yellow crazy ant control over the last four years (TCC pers comm, 2020). Two dedicated biosecurity staff are responsible for all invasive pests, both plants and animals, in the local government area. The amount of time devoted to yellow crazy ants varies significantly, depending on the severity and urgency of other known problems. In 2019 council biosecurity staff devoted approximately 5% of their time to treatment (two officers) and 20% of time to surveys (one field officer) for yellow crazy ants (Wet Tropics Management Authority, 2020b). Additional council funds in prior years has supported the purchase of ant bait and the use of a helicopter to assist baiting of non-residential areas in Nome, however no additional council funds are presently available.

Works planned for 2020 include delimitation of the Alligator Creek infestation using rapid assessment techniques and eradication planning and stakeholder consultation for Douglas. Douglas treatments are expected to begin in October 2020. Spot treatments in Nome are also planned, with further resources needed to reduce the risk of reintroduction from the Alligator Creek infestation via the connecting creek near Elliot Springs.

Council staff hold the authority to enter private properties for the purpose of survey and control activities through a yellow crazy ant prevention, control and surveillance program declared in 2018 under the Queensland Biosecurity Act. The council uses bait authorised through an APVMA research permit under the supervision of Dr Ben Hoffmann from the CSIRO. The council has submitted a minor use permit application for Antoff in September 2020, and will be submitting a minor use permit application for the hydrogel.

Responses to yellow crazy ants have been reactive and poorly coordinated. Current resources to manage yellow crazy ants in Townsville are inadequate, and while the ants are listed as one of three critical priority pest animal species in the recently adopted Townsville City Council Biosecurity Plan 2020-24 (Townsvillle City Council, 2020), the resources available are insufficient to adequately address the issue. Whilst management actions have taken place since the biosecurity plan was first drafted in 2017, the scale of the resources needed to manage the yellow crazy ant threat is significant and unlikely to be met by Townsville City Council alone. This situation will worsen as the ants spread and new infestations are detected.

Invasive Species Council

The Invasive Species Council is a non-government organisation and provides two part time staff contributing a total of between one- and two-day's effort per week to help with yellow crazy ant eradication efforts in Townsville. Invasive Species Council staff have been focused on the Nome infestation and have prepared this scoping document.

The Invasive Species Council has supported the Townsville City Council's yellow crazy ant control efforts since the start of 2018 through community engagement, monitoring and treatment. This work included establishing the Townsville Yellow Crazy Ant Community Taskforce, modelled on a successful community taskforce led by Kuranda Envirocare that has been successful in eradicating yellow crazy ants from Kuranda. Teams of trained volunteers assisted with baiting and surveillance, under the supervision of the Invasive Species Council community coordinator and Townsville City Council staff. The support also included the purchase of ant bait and sticky traps, street signage, community mailouts, attendance at community events and schools, GIS support, the use of a

detector dog and the facilitation of knowledge transfer from the Wet Tropics Management Authority. While this effort concentrated on Nome, community engagement and surveillance were carried out at the other four sites. In 2020, Invasive Species Council staff first detected ants near Bush Oasis Caravan Park at Nome that ultimately led to the discovery of the Alligator Creek infestation.

***Figure 2**. Invasive Species Council community taskforce coordinator at the Townsville Ecofiesta 2018 (left) and community taskforce volunteers prior to baiting Billabong Sanctuary at Nome (right). Photos:ISC.*

The work of the Invasive Species Council in Townsville was funded by a $50,000 Queensland Government Community Sustainability Action grant and a $60,000 private grant as well as in-kind support. The Queensland Government grant funded a community-led eradication project in Nome. This funding ends in October 2020.

Other support

Queensland Government

The Queensland Government administers the *Biosecurity Act 2014*. Actions and enforcement for the majority of pest species are delegated to local government. Biosecurity Queensland would only become involved if a biosecurity event occurred such as an aggravated offense such as deliberately moving yellow crazy ants with the intent to cause damage or in relation to a prohibited matter, such as red fire ants or electric ants. As mentioned above, Biosecurity Queensland provided one-off funding support for education and surveillance in 2016-17. A local Biosecurity Queensland officer has scheduled up to 5 days for 2020 to assist in survey and/or on-ground control.

CSIRO

The CSIRO was engaged in 2017 to provide technical advice to Townsville City Council for an eradication program for the Nome infestation. It prepared the Nome yellow crazy ant eradication plan, arranged APVMA approval to use ant baits under a research permit and oversaw bait application and surveillance in the Nome area (Hoffmann, 2017). This formal involvement ended in 2019, however CSIRO continues to provide in-kind support and advice.

Wet Tropics Management Authority

The Wet Tropics Management Authority has provided valuable in-kind support through knowledge transfer of treatment methods, training, data management and GIS support. Invasive Species Council and Townsville City staff have visited the authority's treatment sites in the Cairns and Kuranda area several times and attended meetings of the Wet Tropics Yellow Crazy Ant Reference Group. During 2020, the authority's yellow crazy ant detector dog visited Townsville several times to assist with surveillance as part of its risk management strategy.

5 Best practice control methods

The Wet Tropics Management Authority's yellow crazy ant eradication program, which has been running since 2014, has developed extensive knowledge and methodology on the eradication of yellow crazy ants (Wet Tropics Management Authority, 2020a). The following information draws on this knowledge.

There are a number of control measures used globally to control yellow crazy ants. These include:

Surveillance and monitoring

a. A significant proportion of eradication/management efforts involves ongoing surveillance of known yellow crazy ant infestations. Without ongoing surveillance, it is not possible to determine treatment efficacy or declare eradication.
b. Delimitation surveys need to provide a clear negative boundary to ensure infestations are fully delimited. Experience of the Wet Tropics Management Authority's yellow crazy ant eradication program has demonstrated this needs to be at least 200 metres from the edge of the infestation as well as surveying all waterways upstream and downstream from the infestation as far as practically possible.
   Applying this protocol may have detected the Alligator Creek infestation during delimitation of the Nome infestation. The newly discovered Alligator Creek infestation is about 1 km upstream of the creek that connects the Nome infestation.
c. Trace-back and trace-forward analysis is useful to try and determine the source of the infestation and identify other possible infestations that may have originated from the infestation. Trace-back and trace-forward involves looking at likely risks and transmission pathways and using genetic studies of known populations to determine their relatedness.
d. After treatment of an area heavily infested with yellow crazy, small numbers of spatially discrete clusters may remain, especially if the treatment regime is not meticulously followed. Surveys need to become increasingly sensitive to detect the ants at low numbers and patchily distributed. There is no current technique that has 100% probability of detecting yellow crazy ants at a given time, this means surveys need to be repeated over several years to provide a high level of confidence in eradication.
e. Implementing regular surveillance of high risk 'sentinel sites' such as transfer stations and landfill sites. These types of sites act as catchment areas for a range of materials and are continually at risk of infestation. The detection of pest species at sentinel sites provides a warning of potentially unknown sites within the catchment.
f. Land holders in treated sites and the general community should be encourage to look for and report suspected yellow crazy ants. The treatment coordinator must have the capacity to quicky follow up all credible reports.

Physical controls

a. Restrict movement of high-risk materials both from and within known infestation areas.
b. Use the *Biosecurity Act 2014* to enforce movement controls.
c. Promote mulching on site to limit the movement of plant materials and garden waste.
d. Use zoned agriculture systems to ensure quarantine measures such as vehicle washdowns after harvesting in infestation zones before entering 'clean' areas are enacted.
e. Ensure residents and industry are informed, prepared and undertake implementation of biosecurity measures to limit the risk of yellow crazy ants moving throughout a region.

Chemical controls

Yellow crazy ant eradication can be achieved by the repeated application of baiting products, both as a blanket and spot treatment. Baits may be distributed by hand or using helicopters, drones, retrofitted quad bikes and backpack-blower devices with a reach of up to 10 metres. Only hand and helicopter distribution are used at Townsville. Treatment using baits must be repeated at regular intervals, typically three times a year. Timing will depend on weather and ant behaviour and requires monitoring of bait effectiveness to determine the optimal application regime.

All treatments must be used according to APVMA permit conditions. Distribution using helicopters must not occur near dwellings due to aviation controls and APVMA conditions.

The following baits are typically used in Australia for yellow crazy ant treatment:

Antoff – active ingredient fipronil 0.01g/kg in a fishmeal matrix. Antoff is a proven effective and readily available product, with permits being generally easier to obtain.

Vanquish Pro – active ingredient 0.06g/kg fipronil delivered as a paste in a protein and carbohydrate matrix. This is very effective for spot treatment.

Synergy Pro – active ingredient 3.65g/kg hydramethylnon 2.5g/kg pyriproxyfen in an oil-soaked bait.

Synergy Pro acts in two ways. Hydramethylnon limits energy production, causing lethargy and the slow death of affected ants. Pyriproxyfen is an insect growth regulator that prevents queen ants from laying viable eggs.

Hydrogels – water-based gels are mixed with Termidor (active ingredient fipronil 100g/l) and sugar solution (often 30% sugar solution). Hydrogels are still an experimental tool and at present only research permits are available.

Biological controls

The trial of a non-native parasitic micro-wasp that attacks the scale insects that provide a food source to yellow crazy ants is being trialled on Christmas Island (Joyner, 2019). This micro-wasp is unlikely to have potential in other areas of Australia since the lac scale which is the target of the micro-wasp is not found in Far North Queensland and the micro-wasp's prey preference is that particular scale insect.

Engagement and education

Community engagement and education is critical to eradication success. The community will be a major source of ad-hoc detections, identifying new outbreaks or detecting ants in treated areas in between extensive surveys. Compliance with movement restriction will require a combination of awareness raising and voluntary support, backed up by legal compliance as a last resort. Illegal dumping of garden waste is a major source of new outbreaks, and the risk of this will be lower with a strong engagement and education program.

A formalised mechanism for community input will build confidence in the program and create goodwill and support for the program amongst key stakeholders and community leaders. The reference group that included representatives from over twenty organisations established for the Cairns region eradication program played a pivotal role in leveraging strong in-kind support and cooperation and helped demonstrate to state and federal governments the need for program funding.

The four management phases – from detection to eradication

The sequence of steps required to achieve successful eradication involves four management phases (Wet Tropics Management Authority, 2020a):

1. detection and delimitation,
2. broadscale aerial and on-ground treatment,
3. transition to surveillance and remnant spot treatment and
4. continued surveillance and post-treatment validation.

Delimitation is the process of finding the outer boundaries of an infestation. The stages and detailed steps are explained in Figure 3 below.

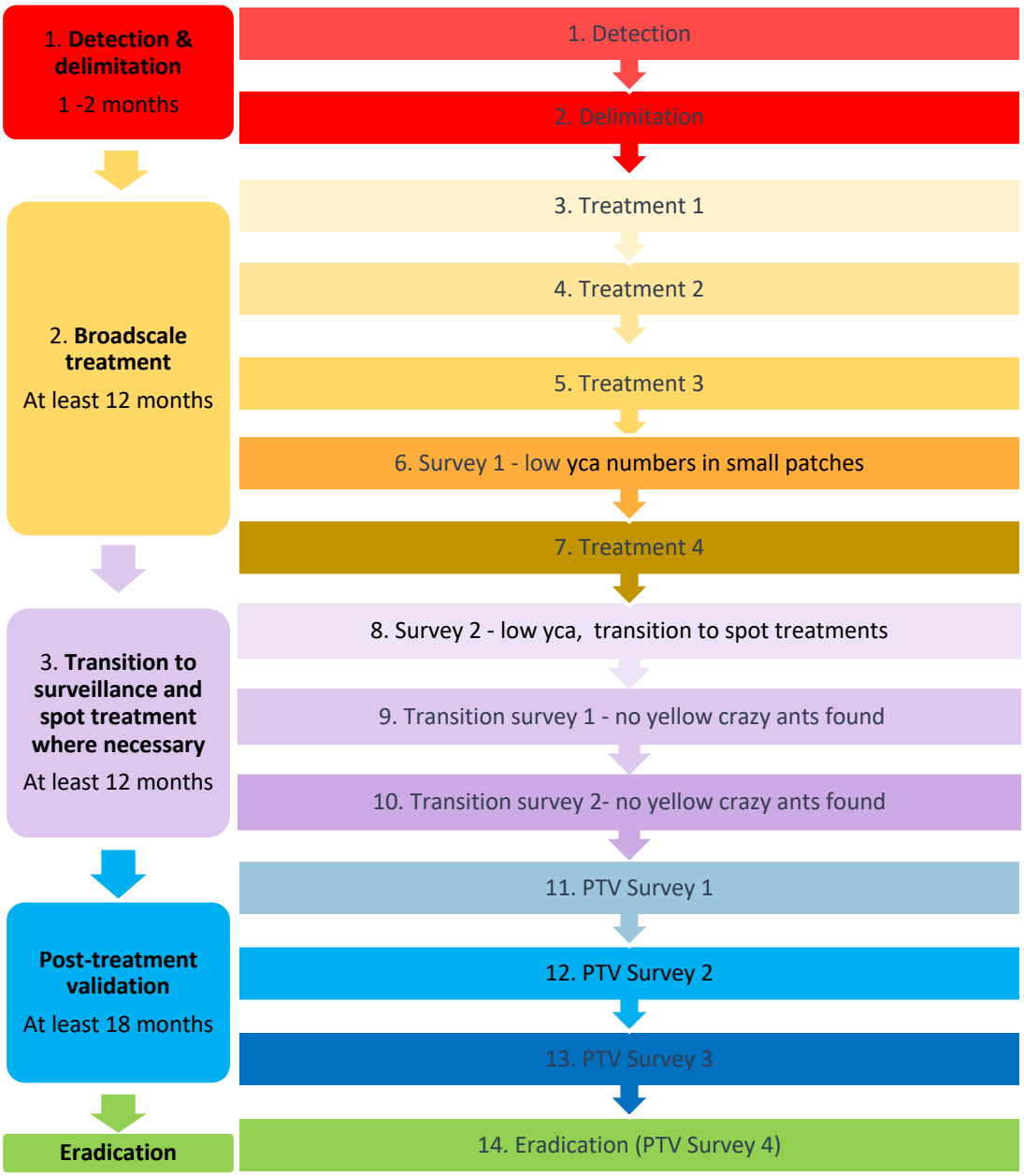

***Figure 3**: The four phases and fourteen stages from detection to eradication (Wet Tropics Management Authority, 2020a).*

6 Risks

A 2019 cost benefit analysis of the Wet Tropics Management Authority's yellow crazy ant eradication program in the Cairns region found that benefits of eradication outweighed the costs by 178:1 (Spring, Kompas and Bradhurst, 2019). This equates to a net benefit of $6.1 billion over thirty years. Even excluding environmental benefits, there will be significant costs to agriculture, tourism and households valued at $513 million over 30 years if the ants are uncontrolled (net present value based on a 7% discount rate) (Spring, Kompas and Bradhurst, 2019). Costs of a similar magnitude are likely if yellow crazy ants in the Townsville area are uncontrolled, but may vary depending on differences between Cairns and Townsville region businesses, residential areas and environments.

There are significant conservation values at risk from the spread of yellow crazy ants in Queensland. The conservation values of areas close to current infestations or that are particularly vulnerable to human-assisted spread of yellow crazy ants are listed below. Native frogs, reptiles, small mammals and bird chicks including cassowaries may be particularly vulnerable to attack by yellow crazy ants.

Australia's Dry Tropics are home to habitat particularly suitable for yellow crazy ants. If not controlled these invasive ants will eventually colonise large parts of our Dry Tropics and spread from there. Modelling undertaken as part of a cost benefit analysis for the Wet Tropics Management Authority indicated that without control, yellow crazy ants are likely to colonise large areas of North and Far North Queensland, particularly when human-assisted movement is factored in (Spring and Kompas, 2019).

Additional impacts on human amenity, businesses and tourism are considered in the risk matrix at the end of this section.

Exporting infestations

The spread of yellow crazy ants from the Townsville infestations is most probably occurring. Genetic analysis has confirmed that a newly-discovered outbreak at Shute Harbour in the Whitsundays is genetically similar and may have originated from the Townsville infestations (WTMA pers comm, 2020). The Shute Harbour outbreak either came from a common third site that remains undetected (which is feasible since a logistic company lies with the infestation area of both known sites) or more probably came from the Townsville infestation.

The spread of yellow crazy ants outwards from Townsville is a direct threat to the Wet Tropics World Heritage Area, the Great Barrier Reef World Heritage Area islands - including nearby Magnetic Island - and other areas of conservation and tourism significance.

Following the detection of yellow crazy ants at Shute Harbour the Queensland Parks and Wildlife Service has instigated invasive ant surveys on islands under their jurisdiction in the Whitsunday areas. While they have not detected yellow crazy ants, they have detected other invasive ant species (Ryan Hackett-Brooks, pers. com, 7 May 2020).

Wet Tropics World Heritage Area

The Wet Tropics Management Authority considers the risk in the short to medium term of yellow crazy ants from the Townsville infestations spreading further afield through human-assisted movement to be high. It recommends control and containment efforts be intensified, as should other efforts, such as far greater education of people, organisations and industries whose activities are considered a high risk when it comes to enabling the spread of yellow crazy ant infestations (Wet Tropics Management Authority, 2020b). Support expected from the Wet Tropics Management Authority would be limited to in-kind training and capacity building that does not detract from their

own ability to treat and survey the Cairns region infestation (Wet Tropics Management Authority pers comm, 2020).

Failing to take action on yellow crazy ants in the Townsville region is a direct threat to the significant investment ($30+ million since 2014) made by both state and federal governments to protect the Wet Tropics World Heritage Area from yellow crazy ants in the Cairns region (Wet Tropics Management Authority, 2020b).

The Black River infestation is about 8 km from the southern end of the Wet Tropics World Heritage Area at Paluma.

Magnetic Island

Magnetic Island has high conservation significance, including a national park that occupies 55% of the island. The island is home to 34 reptile species and 9 frog species, ground-dwelling species that may be particularly vulnerable to yellow crazy ants. Twenty-two species terrestrial plant and animal species on the island are listed as endangered, rare or vulnerable under the *Queensland Nature Conservation Act 1992* and a number of species are listed as endangered or vulnerable under the federal EPBC Act (Harvey, 2008).

Townsville Town Common

Townsville Town Common is managed by the Queensland Parks and Wildlife Service as a conservation park and includes a large wetland area several kilometres downstream from the Mount St John infestation. Up to 11 frog species and 280 bird species have been recorded in the area, including magpie geese and brolgas (Dept of Environment and Science, 2020).

Paluma National Park and Clemant State Forest

Paluma National Park includes the southernmost portion of the Wet Tropics World Heritage Area, which is about 8 km from the Black River infestation. An extension to the park includes the Clemant State Forest (also spelt Clement), the only known location of the critically endangered Gulbaru gecko (*Phyllurus gulbaru*). It is just 3km from the boundary of the Clemant State Forest to the Black River infestation.

Table 2: *Species of conservation significance in Paluma National Park and Clemant State Forest.*

Scientific Name	Common Name	NCA	EPBC
Pteropus conspicillatus	spectacled flying-fox	E	E
Bettongia tropica	northern bettong	E	E
Petaurus gracilis	mahogany glider	E	E
Dasyurus maculatus gracilis	spotted-tailed quoll (northern subspecies)	E	E
Calidris ferruginea	curlew sandpiper	E	CE
Calidris tenuirostris	great knot	E	CE
Numenius madagascariensis	eastern curlew	E	CE
Charadrius mongolus	lesser sand plover	E	E
Casuarius casuarius johnsonii (southern population)	southern cassowary (southern population)	E	E
*Phyllurus gulbaru**	Gulbaru gecko	E	CE
Lepidochelys olivacea	olive ridley turtle	E	E
Litoria nannotis	waterfall frog	E	E

*Locally endemic with very restricted range

Bowling Green Bay National Park

The Alligator Creek yellow crazy ant infestation is currently 4.5 km from the boundary of the Mt Elliot section of Bowling Green Bay National and upstream of creeks that flow into the national park.

Mount Elliot is an outlier to the Wet Tropics bioregion and forms a biogeographic island. While not within the Wet Tropics World Heritage Area, it has high conservation value due to its high levels of local endemism and as a climate refugium with many species found only on Mount Elliot including the Saxicoline sunskink and the Mount Elliot crayfish (Department of Environment and Science, 2019). It hosts 18 frog species, including the Mount Elliot nursery frog that is critically endangered. It is also an invertebrate biodiversity hotspot. Frogs and invertebrates are particularly vulnerable to yellow crazy ants.

The climate at Mount Elliot is suitable for colonisation by yellow crazy ants.

Bowling Green Bay National Park has eight endangered species, four of which are critically endangered. Most of these species are migratory birds and are unlikely to be affected by yellow crazy ants unless numbers are extreme. The lowland section of Bowling Green Bay is a listed Ramsar wetland of international importance due to its rich and varied birdlife.

Once yellow crazy ants establish in mangrove communities the difficulty in applying treatment increases. Challenges include the presence of crocodiles and restrictions on applying ground bait in tidal areas.

Table 3: *Species of conservation significance in Bowling Green Bay National Park.*

Species	Common Name	NCA	EPBC	
Poephila cincta cincta	black-throated finch (white-rumped subspecies)	E	E	
Calidris canutus	red knot‡	E	E	
Calidris ferruginea	curlew sandpiper‡	E	CE	
Calidris tenuirostris	great knot‡	E	CE	Breeds overseas.
Numenius madagascariensis	eastern curlew‡	E	CE	Breeds overseas.
Rostratula australis	Australian painted snipe	E	E	
Charadrius mongolus	lesser sand plover	E	E	
Philipis ellioti				Endemic. Only from top of Mt Elliot above 1,000m.
Nurus rex				Endemic. Flightless beetle; Largest (50mm) rainforest ground beetle in Australia. Only above 1,000m on Mt Elliot summit.
Lissapterus ogivus				Endemic. Flightless stag beetle, known only from above 1,000m on Mt Elliot summit.
Apterotheca ghislaini				Endemic. Restricted to Mt Elliott at or above 1,000m
Aptenocanthon wollumbin				Endemic. Only from summit rainforest of Mt Elliot 1,000–1,200m.

Species	Common Name	NCA	EPBC	
Fastosarion helenkingae	Mount Elliot semi-slug			Endemic. Above 900m in elevation.
Lampropholis mirabilis	Saxicoline sunskink			Mt Elliot outlier, limited distribution.
Cophixalus mcdonaldi	Mount Elliot nursery frog	V	CE	Narrow endemic, Mt Elliot outlier.
Euastacus bindal	Mount Elliot crayfish	V	CE	Endemic. Mt Elliot outlier.
Glaphyromorphus clandestinus	Mount Elliot mulch-skink			Endemic. Known only from a single location, 425m above sea level on Mount Elliot.

Source: (Department of Environment and Science, 2019) and others.

If yellow crazy ants are not controlled, they would spread through population expansion and human assisted movement. Figure 4 below shows the predicted spread of yellow crazy ants from the infestations in the Cairns region known in 2018 over a 30 years period if there was no eradication program. Similar local spread patterns would be expected of yellow crazy ants in Townsville.

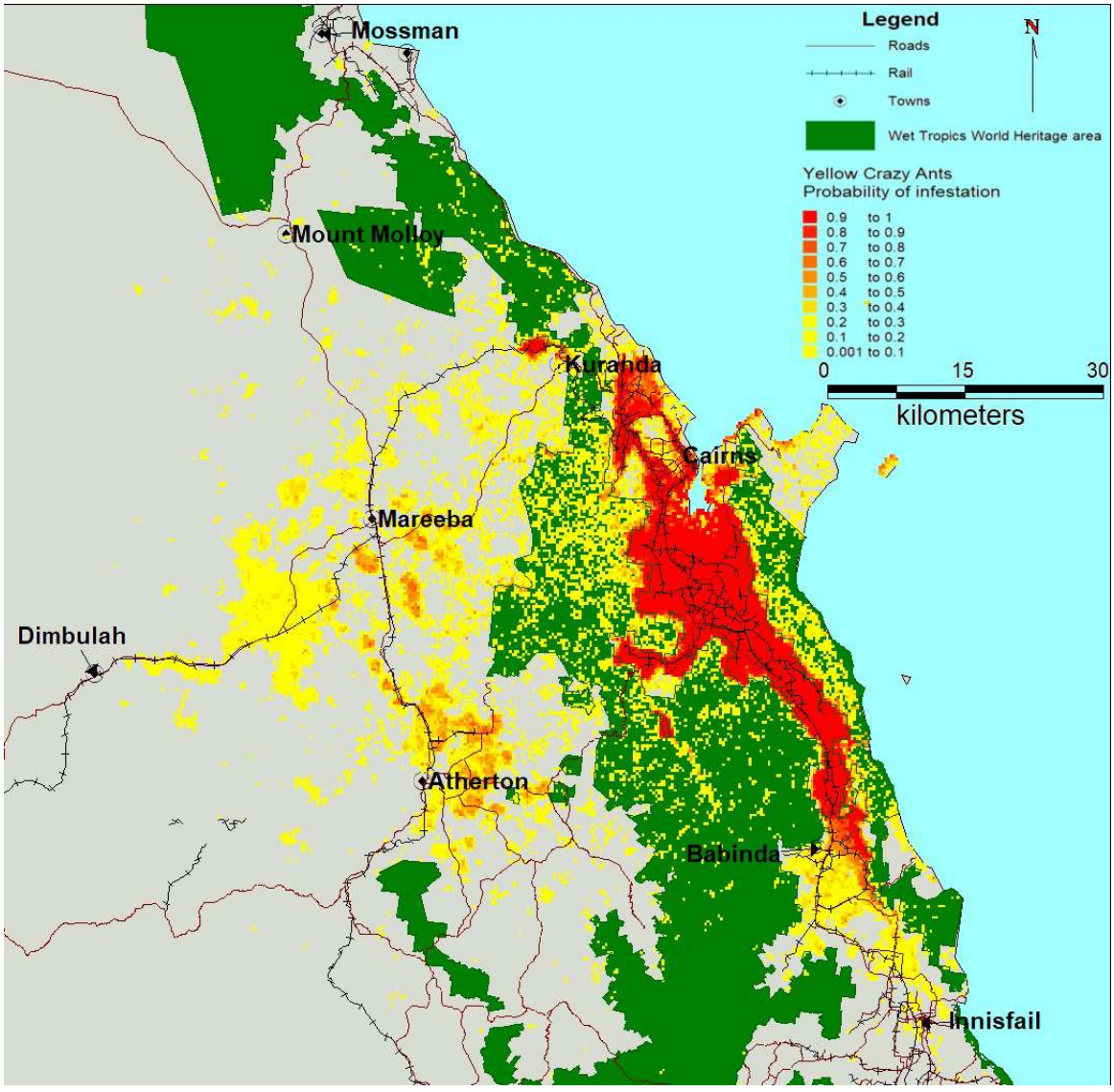

Figure 4. *Modelling of predicted yellow crazy ant spread over 30 years in the Cairns region if yellow crazy ants were allowed to spread uncontrolled (Spring, Kompas and Bradhurst, 2019)*

Table 4 estimates the risks of the five yellow crazy ant infestation sites. It was compiled based on discussion at the November 2019 roundtable and a review of the risks identified in this section.

***Table 4**. Summary of risks posed by Townsville* yellow crazy ant *infestations.*

RISK / SITE	Nome	Alligator Creek	Mt St John	Douglas	Black River
Risk of Natural Spread via water	High	Very High	High	Very High	Moderate
Risk to conservation values	Very High	Very High	High	Moderate	Very High
Risk of relocation by human activity	Moderate	Moderate	Very High	High	High
Risk to lifestyle values	Moderate	Low	Low	High	Low

7 Options

There are four distinct options currently available to manage the risk of yellow crazy ants in the Townsville area, each with varying benefits and costs. Over the last four years, a variant of option 3 has been implemented, with occasional aspects of option 2. If enough time has passed without option 1 or 2 being implemented and the ants spread further, option 1 becomes no longer practically feasible.

Option 1. Fully funded eradication program

a. Target **all known infestations** with the aim of eradication and conduct extensive surveys to determine if and where other infestations exist.
b. Estimated minimum cost **based on current infestation and a 50% contingency**: about $3.24 million per year for a 10-year program plus $110,000 for establishment costs. See Appendix 1 for detailed costings.
c. It is a limited life one-off program.
d. It is **highly likely** other infestations will be found. All invasive ant eradication programs in Australia have found additional areas of infestation once wide-scale surveys begin. For this reason, a 50% contingency has been included to allow for the discovery and treatment of new areas totalling approximately half the infestation size.
e. The Wet Tropics Management Authority is currently dealing with an infestation area approximately 2000ha in size in the Cairns area.
    i. The Cairns eradication program has a current operating budget of $6M per year and covers approximately 2000 hectares. The program expects to completely eradicate yellow crazy ants from the region by 2026.
    ii. The Wet Tropics Management Authority team currently employs 26 staff and a seasonal workforce of up to another 50 people. Given currently known infestations, Townsville could reasonably expect to carry out its work with around half the resources.
f. Provision should be made for a review of program progress and milestones, successes and failures and lessons learned every three years.

Option 2. Management – containment

a. Regular treatments to depress numbers to a low level.
b. **Reduces the risk of spread** but does not eliminate it. In some cases, it may increase the risk of human-assisted movement as people become complacent.
c. Demands ongoing surveillance and compliance activities. Intensive surveillance is generally more resource intensive than treatment.
d. Demands ongoing engagement from impacted stakeholders.
e. Cost is ongoing.
f. It is **highly likely** that other infestations of yellow crazy ants exist in the Townsville area. Any management program focused on containment should also include capacity for an extended surveillance program and seek to identify the source of each infestation.
g. If extended surveillance does not occur and undetected populations exist, any resources allocated to management will be ineffective.

Option 3. Management – eradication of specific/priority infestations

a. Eradicate specific infestations.
b. Can serve to prove program efficacy while seeking further funds for other infestations.
c. **Does not address risks** from other infestations.

d. Does not locate any further infestations. It is **highly likely** that other infestations of yellow crazy ants exist in the Townsville area.
e. Prioritisation is difficult as each site has different risks.
f. Cost is ongoing and **increasing** over time.
g. Without ongoing surveillance, additional infestations likely to be **undetected**.
h. Limited capacity for compliance and stakeholder engagement.
i. Likelihood of relocation/expansion of other infestations is **very high.**

Option 4. Do nothing

a. All infestations **will** continue to increase in size.
b. Human-assisted spread **will** occur.
c. There **will be impacts** on industry, lifestyle, environmental and economic values.
d. While not an immediate threat, eventually the Wet Tropics World Heritage Area may be affected and the current investment in yellow crazy ant eradication at Cairns compromised (in the absence of effective control measures, the risk to the World Heritage is 'likely to become a serious issue in the longer term' (WTMA, 2020b)).
e. Other local government areas **will** be impacted and investment in yellow crazy ant management/eradication will be compromised. eg Shute Harbour, Whitsundays.
f. The longer it is left, the **greater the costs** of management.

8 Recommendations

Rec 1. **Implement option 1 above, a fully-funded eradication program** modelled on Wet Tropics Management Authority's Yellow Crazy Ant Eradication Program for Cairns/Kuranda.

Rec 2. **Secure $3.24 million per year as a minimum over the next ten years** for full eradication and $110,000 for establishment costs, creating 15 full time and 20-30 casual jobs. See Appendix 1 or detailed costings.

Rec 3. **In the absence of full funding, available resources should be used for active management of known high risk infestations** to limit spread until funding is secured.

Rec 4. **Townsville City Council and the Queensland and federal governments are made aware of the seriousness of the situation and urgently requested to support full eradication.**

Actions

1. **Determine a lead agency**. Options include:
    a. Townsville City Council.
    b. NQ Dry Tropics NRM.
    c. Wet Tropics Management Authority.
    d. Invasive Species Council.
2. **Source funding for a coordinator**. Funding should be the immediate priority for any proposed eradication or management program. That person's role should be to:
    a. Identify potential funding sources
    b. Determine the level of funding required for multiple scenarios ie. management or eradication.
    c. Facilitate discussions with potential funding sources.
    d. Coordinate funding proposals.
3. **Establish a network of supportive stakeholders**
    a. Create a reference group modelled on the Wet Tropics Management Authority's Yellow Crazy Ant Eradication Program Reference Group.
    b. Involve stakeholders including Townsville City Council, Invasive Species Council, Biosecurity Queensland, tourism bodies, industry representatives (eg. quarry, businesses at Mount St John), Australian Defence Force, Indigenous representative groups, Dry Tropics NRM, residential representatives, the Queensland Parks and Wildlife Service.
    c. Raise awareness of yellow crazy ants and the long-term threats, not only to the Townsville area, but also the likelihood of spreading infestations from Townsville.
4. **Develop an adaptive eradication plan** modelled on the Wet Tropics Management Authority guide *Detection to Eradication* (WTMA, 2020a). Until funding is secured, the short-term priority would be centred on undertaking urgent treatment and risk mitigation in high risk locations. This plan should encompass:
    a. Engagement and collaboration
        i. Educating residents in and around current infestation zones to know what to look for and who to contact.
        ii. Education on safe disposal of green waste.
        iii. Establishment of a community committee to facilitate communication and build support for yellow crazy ant control with community, industry and other stakeholders. This would be modelled on the successful Wet Tropics Management Authority yellow crazy ant eradication program reference group.

iv. Education and training for relevant groups such as:
    - Townsville City Council staff such as road crews, waste station staff.
    - Port, airport and rail staff.
    - Waste station staff.
    - Logistics companies.
    - Pest managers.
    - Gardening and maintenance crews.
    - Road works surveying, engineers and construction crews.
    - Utility maintenance staff (power, telecommunications).
    - Building development on-ground staff.
    - Ecological surveyors.
    - Agriculturalists and contractors.
    - Beekeepers association.
    - Recreational and biological organisations such as Birdlife Australia.
    - others.

v. Collaborate with neighbouring LGAs to develop a biosecurity plan, facilitated through the North Queensland Regional Organisation of Councils with support from Dry Tropics NRM.

vi. Approach the North Queensland Regional Organisation of Councils, Australian Defence Force and other key stakeholders for support in conducting a full delimitation of current infestations using the Wet Tropics Management Authority/FNQROC NAMAC taskforce as a model.

b. Delimitation
    i. Delimitation of known infestations
    ii. Extend surveillance to detect previously unknown populations
    iii. Establish mechanisms for the public to report suspicious ants.

c. Treatment
    i. Chemical Controls
        a. Using proven baiting products repeatedly, both as a blanket and spot treatment. Distribution by:
            i. Hand.
            ii. Helicopters.
            iii. Backpack blower devices with a reach of up to 10 metres.
        b. Procure APVMA permits and ensure training and compliance. May include non-target species monitoring.

d. Monitoring and post treatment surveillance
    i. Ongoing surveillance and post treatment validation surveys.
    ii. Visual detection with GPS marking.
    iii. Lure flags and cards.
    iv. Sticky lure traps (new design for the Dry Tropics climate).
    v. Detector dogs.
    vi. Use of buffer zones on baiting maps and ensuing baiting programs to ensure reasonable coverage, including lag time between delimiting and baiting.

e. Compliance
    i. Best practice measures implemented to reduce the likelihood of yellow crazy ants entering/reinfesting high value and environmentally sensitive areas such as:

- Physical controls
    a. Restricting movement of green waste, soil and plants from and within known infestation areas.
    b. Apply a mulch on site policy.
- Legislative controls
    a. Enforce controls using the *Biosecurity Act 2014*.
    b. Link implementation of the Townsville Biosecurity Plan with the eradication plan mentioned in this section.

f. Collaboration
g. Program review
    i. A program review should be undertaken to measure progress and milestones, successes and failures and lessons learned.

9 Conclusion

The failure to control yellow crazy ants in the Townsville area poses a major threat to a large number of native species and conservation areas in North and Far North Queensland, including the Wet Tropics World Heritage Area and islands within the Great Barrier Reef Marine Park. The ants would also impact on agriculture, tourism and infrastructure and affect social amenity of those living in the region.

Control efforts to date have been poorly resourced and coordinated. Despite these difficulties Townsville City Council-led efforts have resulted in some good progress, including the likely eradication of yellow crazy ants from the Nome residential area, to be confirmed once post-treatment surveillance has been completed next year. This success has been undermined by the lack of full delimitation and treatment at three other sites, as well as the discovery of a large outlier infestation of yellow crazy ants to the south of the original Nome infestation in June 2020.

Based on current information there remains an opportunity to eradicate yellow crazy ants from the Townsville area provided there are greater resources, improved coordination and adoption of best practice treatment methods.

Preliminary costings based on the Wet Tropics Management Authority eradication program have found that full eradication is likely to cost at least $3.24 million each year for the next ten years and $110,000 for program establishment. This includes a contingency to allow for the detection of additional unknown infestations. This funding should be sourced 50:50 from the federal and Queensland governments, with additional support from Townsville City Council.

The eradication program would generate at least 15 full time jobs and 20-30 casual jobs over ten years.

Critical to success will be support from community and industry partners and the willingness of everybody in the vicinity of infested sites to adhere to control measures to prevent the accidental spread of yellow crazy ants into new areas.

If funding for a full eradication program cannot be immediately secured, steps should be taken to reduce the risk of spread to areas of high conservation value. Treatment of sites where there is a high risk of accidental movement and sites in or near residential areas should be a priority.

Achieving successful eradication of yellow crazy ants Is a wise investment. It will protect the existing $30 million government investment in eradicating yellow crazy ants threatening the Wet Tropics rainforests in the Cairns area and remove a serious threat facing all of northern Queensland.

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Appendix 1. Estimate of eradication costs

Requirements and costs for an eradication program

The following analysis for the costs of eradicating yellow crazy ants from the Townsville region has been prepared based on the costs of the Wet Tropics Management Authority (WTMA) yellow crazy ant eradication program and are a guide only. Establishment costs may be necessary regardless of whether a full eradication program or a containment program is planned.

A contingency of an additional 50% increase in treatment costs should be included to allow for yet-to-be-detected infestations that will be uncovered with community awareness and surveillance.

As has been discovered during other invasive ant eradication programs, program flexibility and an adaptive approach is needed to respond to new detections, research and learnings.

Costs listed below should be considered the **absolute minimum** required for an effective program given the current levels of infestation. Consideration needs to be given to increasing capacity using casual/agency staff during optimal survey conditions to extend surveillance from the known infestations. Costs are indicative only and based on the current WTMA yellow crazy ant eradication program costs and pre-existing supply contracts. Cost may vary significantly according to the agency responsible for delivery of a program, their associated overheads or efficiencies of scale and the resources available.

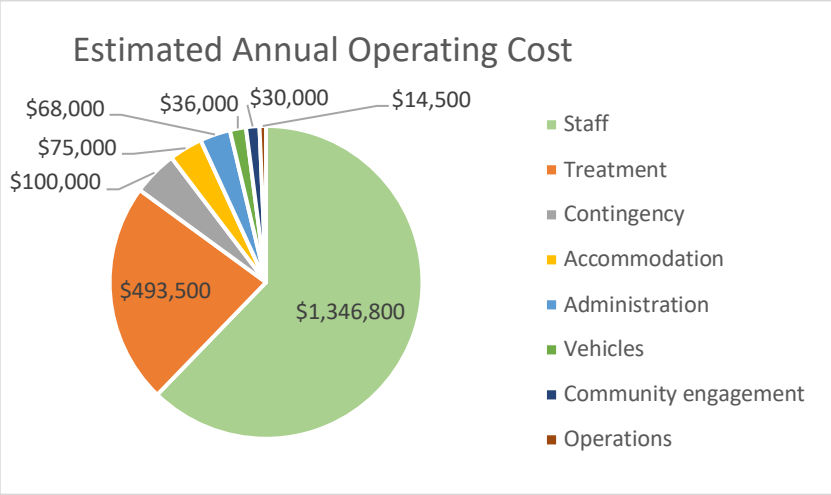
Establishment includes the cost of setting up an office and operations base.

Table 5. *Estimated establishment cost.*

Item	Yearly cost ($)
Accommodation	30,000
IT	38,000
Operations	21,750
Training	20,000
Grand Total	**109,750**

***Table 6**. Estimated Annual Operating cost.*

Item	Yearly cost ($)
Staff	1,346,800
Treatment	493,500
Contingency	100,000
Accommodation	75,000
Administration	68,000
Vehicles	36,000
Community engagement	30,000
Operations	14,500
Grand Total	**2,163,800**



Adding a 50% contingency would result in annual operating costs of about $3.24 million.

Accommodation

Field teams require an operational base to enable for storage of bait and equipment, preparation, equipment maintenance etc.

A medium industrial shed with office facilities would be suitable. This may be available through the parent organisation

Staff

A minimum of 15 full time staff (10 field staff and 5 office staff) and about 20-30 seasonal casual staff would be needed. Additional field staff would be needed if new infestations are located.

Based on current known extents of the Townsville infestations and the assumption of aiming for eradication, a field team of 10 would be considered the minimum required to be able to cover surveillance and treatment activities (J. Van Der Reijden Pers. com, 2020). In the event of new detections or infestation growth, more field staff would need to be sourced. The Wet Tropics Management Authority's program utilises seasonal casual staff during periods of high worker demand.

Similarly, office-based support would require a program manager, administration officer, engagement/compliance officer, GIS operator and an operations manager as a minimum.

Salaries

Salaries are indicative only and based on Queensland government positions. Salaries may alter with length of service increments and have included 30% overhead costs to take into account superannuation, payroll tax and other on-costs.

Training

The Wet Tropics Management Authority is prepared to offer training to any potential Townsville staff demonstrating proven methodologies and providing mentorship to administrative and technical staff as in-kind support.

All field staff should have training in CPR and first aid.

IT

Record keeping and Mapping

Data management is fundamental in any form of eradication or management program. Field operations collect a significant amount of data, including stakeholder contacts, treatment records and surveillance records. It is essential to have a robust database/Geographic Information System (GIS) in place not only for record keeping, but daily operational planning.

Townsville City Council are currently using Queensland globe to map survey efforts. This is suitable only for very small-scale operations. It lacks a range of important GIS tools that are necessary for planning and reporting. WTMA is assisting Townsville City Council with mapping and data management of survey and treatment information. One council biosecurity officer presently uses ArcGIS and needs training in its use.

WTMA strongly recommends the use of ArcGIS/ArcGIS PRO, which is an industry standard GIS system. ESRI ArcGIS Pro combined with field apps for mobile devices has the potential to deliver an integrated database/GIS for all aspects of Program Management and delivery. WTMA is currently investigating moving to this platform. The licensing costs would depend on the coordinating agency and any arrangements with ESRI.

The open source QGIS software may be a more cost effective alternative but has limitations.

Mobile computing is not essential, but a very useful tool, especially when dealing with residential properties. A mobile data collection tool such as Konect/Fulcrum or ESRI Field apps could be used. This would require phones/tablets for each field officer and associated data costs. Konect costs $850 per year for desktop manager + $760 per mobile device. The costs of ESRI Field Apps would depend on parent organisations ESRI Licensing.

An iphone and free software like iGIS and Guru maps are simpler alternatives, but battery life can be an issue.

Computers

The following IT hardware would be needed:

- 5 standard workstations/laptops
- 2 high spec dedicated GIS machines
- Printers/plotters
- Costs would depend on parent organisation's IT policies.

Field equipment

One set of uniforms is a set of three shirts and pants, boots and hydration backpack. Total cost of one set of three uniforms is $610 per person. This should be considered an annual cost.

The breakdown is as follows:

- 1 x shirt $53.20 = 159.60 p.a for three
- 1 x pants $32.90 (mens) / $50 (ladies) = $124.35 p.a. for three (averaged cost)
- 1 x boots $150 p.a.
- 1 x backpack $107.99 p.a.
- 1 x hydration bladder $26.99 p.a.
- First aid kit 1 per field officer $50

GPS

Recommended Unit: Garmin Rino750

The use of mobile computing Platforms such as ESRI field Apps, Konect or Fulcrum could potentially replace handheld GPS units, however mobile devices have lower battery life and generally poorer GPS capabilities and accuracy. The Garmin Rino750 has been proven in the field and includes a UHF radio which is invaluable when undertaking surveys in bushland.

Personal Locator beacon

1 per field team

Miscellaneous tools/equipment

- Survey equipment eg, flags, lure bottles, lure preparation equipment
- Tools – Hammers, screwdrivers etc.
- Equipment maintenance

Vehicles

4WD utilities with canopy x 3

- Lease Approx. **$12 000** p.a. per vehicle

Treatment

Bait

Pricing is based on the use of Antoff and WTMA prices. Cost of bait would need to be negotiated with Animals Control Technologies Australia.

Aerial services

WTMA currently work with Heliservices Queensland. Costs would need to be negotiated. Potential helicopter operators include:

- Heliservices Queensland Pty Ltd
  M 0407 428 790. P (07) 4061 1118. E heliservices3@bigpond.com
  Mundoo Aerodrome, Innisfail, Queensland, 4860
- Roncato Helicopter Services
- Jayrow helicopters
- McDermott Aviation
- Dwyer Aviation Services.

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