Flying Fox Relocation Management Plan

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Introduction

This Flying-fox Relocation Management Plan (FFRMP) has been provided to support an application by Cairns Regional Council (CRC) for undertaking management actions to encourage the relocation of an established Spectacled Flying-fox *(Pteropus conspicillatus)* (SFF) roost at the Cairns City Library, located on public land at 151 Abbott St, Cairns City, QLD 4870.

Cairns Regional Council is considering relocation of a roosting colony of SFF that currently occupies the Cairns City Library[1] and immediate surrounds (the Library roost or Library colony). The motivation for relocation has primarily arisen from first hand reports of high rates of SFF mortalities at the site and considerable urban impacts due to the location of the roost.

Council is encouraging the SFF to relocate to a new location, which has been determined to be safer for the colony because it will likely mitigate some of the negative impacts associated with the current inner city location. These include; elevated urban heat impacts to the camp, new high rise construction projects and the associated construction and traffic noise encompassing the entire roost site.

Cairns Regional Council has engaged a consultant Biodiversity Australia (Bio Aus) to relocate the SFF from the Library roost, to an alternative location that has been determined to be a more supporting location from both animal welfare and human wildlife conflict perspectives. Relocation will be undertaken via non-lethal and prescribed methods, such as specialised "for purpose" pyrotechnics, high intensity lighting, audio Hyperspike (LRAD) and other low impact audio, visual and olfactory negative reinforcers. The preference is to direct SFF to several identified interim roost locations, in close proximity the Cairns CBD or fringes of the city (NRA 2019b), this will be further refined by an alternative roost study as per methodology stated later in this document. The ultimate aim is to move the population to a suitable permanent roosting location, which contains favourable habitat characteristics[2] and where there is a low risk of conflict with humans.

The relocation should be undertaken after the breeding and pup-rearing season has ended which also corresponds with cooler climatic conditions. Council will undertake management and deterrent activities as required until the Library roost has been abandoned. Preliminary monitoring and assessments will inform the timing of the action and identify the most suitable site(s) for relocation.

Rationale behind relocation

Cairns Regional Council's decision to relocate SFF has been made in consultation and lengthy discussion with members of the Flying-fox Advisory Committee (FFAC). Cairns Regional Council is concerned about damage to the heritage listed trees at the Cairns Library, and the ongoing impacts on SFF as a result of diminishing roost tree availability and disturbance from construction activities around the Library roost (NRA 2019c). Cairns Regional Council and the FFAC, believe that the proposed relocation would; mitigate human/flying-fox conflict, enable the trees at the Library to recover, and will likely reduce the high rates of pup mortality that have been recorded at the Library roost

In conjunction with the relocation, FFAC is supportive of CRC building a new SFF rehabilitation enclosure to assist in care of orphaned and injured bats and present a potential attractant for roosting adult bats. An enclosure on the Atherton Tablelands, which houses >1,000 orphaned SFF pups, has attracted adult SFF, which are currently roosting above the enclosure. It is hoped that by constructing a

[1] The Cairns City Library is located on public land at 151 Abbott St, Cairns City, QLD 4870
[2] Alternative roost habitat will likely be located in an area that has harboured SFF in the past, or which has similar characteristics to current roosting habitat.

similar enclosure at a preferred site(s), Council will be able to encourage SFF to occupy preferred roost locations (Stephens & Kim 2018).

In addition, the Cairns community has a number of concerns about the Library colony, including the following:

- High densities of flying-foxes decrease tree health,
- The noise, and sight and smell of excreta detracts from local aesthetics,
- Faecal/urine drop sullies and/or causes damage to facilities, and property such as motor vehicles, and is a slip hazard for pedestrians,
- The danger of persons coming into contact with bats either inadvertently or deliberately and receiving scratches or bites,
- There is concern that dead flying-foxes and excreta under the roost poses a health risk,
- Maintenance works to mitigate flying-fox impacts incur a cost to ratepayers, &
- There is a concern that the abovementioned impacts will discourage the public (including tourists) from visiting and using the area, which may have negative impacts on surrounding businesses.

Although CRC acknowledges the concerns outlined above, it realises that they are not supported by the entire Cairns community nor all tourists (NRA 2019c). Council also appreciates that "*Flying-foxes are an important part of the natural environment and play a significant role in the pollination and seed dispersal of natural vegetation*" (CRC 2018).

Objectives of this management plan

- Identify the likely, target sites/areas Flying-foxes can be moved to outside of the Cairns CBD through rigorous scientifically based methods,
- Demonstrate realistic proximity and distances to new roosting areas that Flying-foxes could be expected to travel through consultation with industry professionals,
- Identify several potential interim roosting sites with suitable vegetation within the city fringes if final roost location to too far for one movement,
- Identity the non- preferred interim roosting sites (risks),
- Identify, analyse and mitigate all potential risks with the relocation process through robust analysis via applying a consequence x likelihood risk matrix,
- Detail and describe how the active management actions are to be undertaken at the current site to achieve the relocation objectives Flying-foxes,
- Detail and describe the management actions which will be utilised to continually discourage the current roost site post relocation,
- Support the premise that relocation to alternative camps or sites are unlikely to have anthropocentric impacts to bats,
- To ensure the health and welfare of Flying-foxes,
- Minimisation of the impacts on the community and on the premise that suitably located camps will reduce human –wildlife conflicts and requirements for ongoing management activities such as deterrents and species interference generally,

- Relocation approach relies on using scientific data and advice on Flying-fox population numbers and movements to determine what actions (if any) will occur and respond to those actions as well as other immediate concerns as they arise.

Current flying-fox occurrence in the Cairns region

There are at least 20 known flying-fox roost sites (or camps) across the CRC local government area (LGA), of which seven are listed as 'Nationally Important Camps' (DoEE 2018, CRC 2019; pers. com. M. Tortike, CRC, 2019; Figure 1). Many of these camps are used sporadically by flying-foxes (DoEE 2018) rather than existing as permanent camps. Three species of flying-foxes are known to occur in the CRC LGA, and all occur at the Cairns Library:

- Black Flying-fox (*Pteropus alecto*, BFF)
  - Listed as Least Concern under the *Nature Conservation Act 1992* (*NC Act*).
  - The Black Flying-fox is a sporadic visitor to the Cairns region and is occasionally recorded in low numbers at the Cairns Library and surrounds (DoEE 2018; pers. obs., D. Morrant, 2017).
  - Although potentially relevant to the proposed action, the species behaves in a similar manner to SFF when disturbed, and is not listed as a threatened[3] species under the *Environmental Protection and Biodiversity Conservation Act 1999* (*EPBC Act*) or *NC Act*.
  - Black Flying-foxes will not be considered further in this report.
- Little-red Flying-fox (*Pteropus scapulatus,* LRFF)
  - Listed as Least Concern under the *NC Act.*
  - The Little-red Flying-fox is highly mobile and nomadic, moving around the landscape in response to seasonal availability of food resources, primarily nectar and pollen (Birt *et al.* 2008, Churchill 2008).
  - Little-red Flying-fox are sporadic and transient visitors to the Cairns Library, although they can number in the thousands when they are present.
- Spectacled Flying-fox (*Pteropus conspicillatus*; SFF)
  - Listed as Endangered under the *EPBC Act* and Vulnerable under the *NC Act*.
  - The SFF is the most commonly recorded flying-fox species in the Cairns CBD.
  - Spectacled Flying-foxes display a high degree of fidelity to the Cairns Library, are usually the most numerous[4], and are the only species that consistently roost at the library.
  - The SFF is the primary species of interest for the proposed action, and is discussed in detail below.

[3] Species listed as Critically Endangered, Endangered, Vulnerable, or Near Threatened under the *Nature Conservation Act 1992*(QLD) and/or *Environment Protection and Biodiversity Conservation Act 1999* (Cth).
[4] Little-red flying-foxes are nomadic and can travel in groups of up to 1 million individuals (Birt *et al.* 2008).

Spectacled Flying-foxes

The SFF is black over most of its body, generally with a prominent yellow neck ruff and straw-coloured fur on its muzzle and around its eyes (hence the name 'spectacled'). Spectacled Flying-fox primarily eat fruit, and to a lesser extent nectar and pollen. They source their food in a broad range of habitats, including from fruit trees in suburban backyards and orchards (Richards *et al*. 2008).

Spectacled Flying-foxes occur in Indonesia, New Guinea and north Queensland, Australia (Helgen *et al*. 2008; Figure 2). The global population is not considered to be declining at a rate required to qualify for listing in a threatened category by the IUCN (Helgen *et al*. 2008). However, the Australian SFF population is considered to be threatened with extinction, and is listed as Endangered under the *EPBC Act* and Vulnerable under the *NC Act*.

Flying-foxes play a vital role in maintaining biodiversity and ecosystem health (Fujita & Tuttle 1991). Their mobility makes them highly effective dispersers of seeds and pollen across large areas, which plays an important role in forest maintenance and regeneration, and helps to maintain healthy gene pools among the plants upon which they feed (DES 2019). Some seeds can take up to 19 hours to pass through the SFF's intestinal tract, meaning that seeds may be dispersed over huge distances (Richards *et al*. 2008).

The peak mating season for the SFF is between March and May, although sexual activity tends to be continuous from January to June. Most pups are born between October and December (Richards *et al*. 2008). Mature females[5] devote most of their time to various stages of reproduction, and juveniles are nursed for 3-5 months. From 3-5 months they begin to become independent of their mothers; however, they receive some parental care for a number of months afterward (Richards *et al*. 2008). Generation length is estimated to be 7-8 years (Woinarski *et al*. 2014).

The SFF is generally associated with rainforests, with most colonial camps occurring in or within several kilometres of rainforests (Richards *et* al., TSSC 2019). They frequently move between camps, and adult SFF can disperse up to 50 km in a night to feed (Fox 2011 cited in TSSC 2019). The average GPS-tagged individual[6], tracked by Westcott *et al*. (2015), used 25 distinct roosts, either temporarily or permanently occupied by SFF.

The SFF has declined from an Australian population of 214,750 in November of 2005; the most recent, formal population estimate for the SFF in Australia was ~100,000-145,000 (Westcott *et al*. 2015). As of November 2015, the number of mature individuals was estimated to be 100,000 (TSSC 2019). It is reasonable to expect that contemporary population numbers are <100,000 individuals. Modelling suggests that the species is undergoing a continuous population decline due to a range of threats (see 'Threats' section). Modelling by Westcott *et al*. (2015) suggests that two cyclones, Larry and Yasi, appear to have been the primary driver of SFF declines leading up to their study, although there were other, as yet unidentified 'minor' drivers that contributed and which have hindered the species' recovery.

High numbers of SFF pups have been found abandoned (dead or alive) at the Library roost in recent years. For example, between September and November 2017, over 300 live SFF pups were taken into care from the Cairns Library, and 200 were found dead (Cohen 2017). Similar rates of mortality were

[5] Females do not usually produce offspring until they are three years old, although some reproduce when they are two (Richards *et al*. 2008, TSSC 2019)

[6] Westcott *et* al. (2015) GPS tracked 51 males and 12 females.

recorded in 2018-2019. It is presumed that negative impacts on SFF are exacerbated by the roost's proximity to a number of large construction projects (pers. com., M. Tortike, CRC).

To compound matters, heat stress events[7] in November 2018 and March 2019 are estimated to have caused the death of 23,000+ SFF (Kim 2018).

History of Spectacled Flying-fox occupation of the Cairns region

Spectacled Flying-foxes have formed and established (and abandoned) several roosting colonies at a number of places around Cairns including the following (Garnett *et* al. 1999, Westcott 2013):

- The Barron River in 1920 and again in the 1980s,
- Cairns Inlet prior to 1948,
- Charles Street, Cairns City in 1952,
- Alligator Creek in 1952,
- Cairns Central Swamp in 1931[8], the 1980s, 2000s etc, &
- Admiralty Island in the 1980s.

Flying-fox camps have existed at the Central Swamp for many years, and this likely represents a good location for the relocated Library colony, at least from a SFF-welfare perspective (Figure 6; WPSQ 2002[7]). Wildlife Preservation Society of Queensland (WPSQ) (2002) claimed that "the swamp is a traditional camp recorded by Francis Ratcliffe in 1931 when he visited [the] general area".

Small groups of SFF that have previously dispersed from the Cairns Library in response to management activities have tended to fly in the direction of Cairns Central Swamp, which lends support the hypothesis that such natural areas close to the city may represent a preferred alternative/refuge roost (pers. obs. D. Morrant, 2016 and 2017).

History of flying-fox management in the Cairns region

Flying-foxes' tendency to roost in human-populated areas, and their diet of fruit, can lead to conflict between flying-foxes and humans. Because of these and other factors, flying-foxes are often the subject of management actions.

Humans and flying-foxes have been in conflict in Cairns since the early days of European settlement (Westcott 2013). From 1889 onwards there are accounts in the Cairns Morning Post, The Morning Post, and the Cairns Post, of flying-fox damage to fruit crops (Westcott 2013). Shooting, both organised and *ad hoc* was a common means of managing flying-foxes. According to Westcott (2013):

"A "severe [flying-fox] visitation".....was reported in [Cairns in] 1915. A camp at the mouth of the Barron was mentioned in February 1920 while in October 1935 thousands of flying-foxes were reported roosting in the city. In April 1944 flying-foxes are reported at the corner of Pease and Anderson Streets but in April 1948 the Cairns Post's column 'Nature Notes' reported, "In bygone years some large camps of flying foxes existed in the vicinity of Cairns- several such camps were located in the mangroves of the Cairns Inlet, Barron River and other places, but in recent times these camps appear to have been abandoned." This was but temporary, for in September of 1952 the Mayor of Cairns was reported as ruling out the use of napalm against the flying-foxes in the city centre, at Alligator [Creek] in the south and Charles [Street] in the north. He opted instead for

[7] A 'heat stress event' is defined as a day (or days) on which the maximum temperature exceeds 38°C.
[8] Francis Ratcliffe recorded a visit to a camp in the general vicinity of the Cairns Central Swamp in 1931 (WPSQ 2002).

mangrove reclamation, plans for which were completed in 1954, when the flying-fox numbers had halved and they had "…moved from their usual haunts in the mangrove swamps surrounding Cairns."

Current occurrence of spectacled flying-foxes in the Cairns CBD

The SFF colony in the Cairns Central Business District (CBD) is one of the 'Nationally Important Camps' in the region, and is occupied for most and often all of each year (DoEE 2018, CRC 2019; pers. obs., D. Morrant, 2016, 2017 and 2018). Spectacled Flying-fox numbers in the CBD are seasonally variable. In the past, SFF have roosted in dozens of different trees in the Cairns CBD, for example 14 trees in October 2012, 24 trees in March 2014 and 37 trees in March 2015 (Cohen 2015; Figure 3). However, in the years since 2015, the majority of these trees have been removed, particularly on the block on which the Cairns Aquarium and Novotel Cairns Oasis Resort are situated.

The Cairns CBD roost is now predominantly centred on five large trees within the grounds of the Cairns City Library, with spillover into adjacent street trees as SFF numbers increase during the breeding and pup-rearing season (Figures 3 and 4). Three tree species are used within the Library roost: Weeping Fig (*Ficus benjamina*; T1[9]), Rubber Fig (*Ficus elastica*; T2- T4), and Golden Penda (*Xanthostemon chrysanthus*; T5; Figure 4). Anecdotal evidence suggests that SFF have roosted in the trees in and around the Cairns Library for at least 30 years, and may have been using the general area for millennia prior to European settlement (Cohen 2017).

Previous studies have conservatively estimated the SFF population at Cairns Library at 12% of the total SFF population (NRA 2016a-b-c-d). SFF numbers at the Cairns Library tend to be highest (8,000-12,000 individuals) during the breeding and pup-rearing season, between October and early May (NRA 2016a-b; pers. com., A. McKeown, CSIRO, 2 Feb 2016; pers. obs., D. Morrant, 2016, 2017 and 2018). Numbers decrease after the breeding season (from April-May) and there can be times between late May and September when all individuals abandon the roost, although this does not occur every year (NRA 2016a-b; pers. com., A. McKeown, CSIRO, 2 Feb 2015; pers. obs., D. Morrant, 2016, 2017 and 2018).

Recent and contemporary management activities in the Cairns CBD

Council has committed significant resources and funding toward the management of flying-fox roosts within the Urban Flying-fox Management Areas (UFFMA) over a three-year duration. This includes undertaking regular physical deterrence activities in the inner city areas, and maintaining vegetation and Council properties or assets. Council concurrently engages with experts and relevant government agencies and community conservation groups to achieve sustainable and balanced approaches to significant roosts. The management of flying-foxes by nature is inherently difficult and must consider legislation compliance, conservation, public interest and expectations.

Recent flying-fox management at the Cairns Library and nearby areas in the CBD has primarily been undertaken to mitigate public concerns whilst preserving the aesthetic and conservation values of the Library (NRA 2016a, NRA 2019c). A number of SFF management actions, and related assessments, have been undertaken in the Cairns CBD in the past few years by Council, including the following:

- Spectacled Flying-fox behaviour around the Cairns Library is generally monitored by *persons knowledgeable about flying-fox behaviour*[10] during routine garden maintenance activities. To Councils knowledge, no SFF have been killed or injured during such works. It is occasionally

[9] The trees at the Cairns Library roost have been allocated alphanumeric identifiers: T1-T5.

[10] Council routinely engages expert consultants to monitor these activities, including Dr Martin Cohen, and NRA Environmental Consultants.

necessary to stop work for 1-5 minutes to allow flying-foxes to settle and/or change the location of works to 'herd' flying-foxes and thus keep them within the roost (pers. obs., D. Morrant, 2016 and 2017)

- Up to ~300 SFF occupied a Weeping Fig in the Shields Street Heart area in December 2015 (referred to as Fig Tree 1; pers. com., S. Ivory, CRC, 4 Jan 2016). The tree was inspected by a *person knowledgeable about flying-fox behaviour*, as defined in the *Code of Practice - Ecologically sustainable management of flying-fox roosts*. No females with young were seen, and most of the animals appeared to be young adult/sub-adult males (pers. obs. D. Morrant 2016). The SFF were in low numbers by late January, and were absent from the tree on 29 Jan 2016. From then, deterrent activities (with approvals) were undertaken by Council to prevent their return.
- Up to ~1,000 SFF colonised a mature Weeping Fig in the Shields Street Heart area (referred to as Fig Tree 2). Adult males and females, including numerous females with dependent young, were observed. It is believed that they began to use the tree in November 2015. Little-red Flying-foxes also occupied the tree in March-April 2016 (NRA 2016a). On 4 March 2019, when dependant young were no longer observed, Council pruned the lower branches of the tree, under the supervision of a *person knowledgeable about flying-fox behaviour* (pers. obs., D Morrant, 2016). The SFF eventually abandoned the tree[11] and ongoing deterrent activities have prevented them from returning.
- A SFF and Little-red Flying-fox colony established adjacent to the Cairns Esplanade Lagoon in March 2016. It is possible that these animals occupied this area in response to disturbance in Shields Street. An assessment was undertaken to inform a proposed dispersal before the animals could become established; however, they vacated the trees of their own accord on 4 April 2016 (pers. obs., D. Morrant, 2016).
- The Cairns City Library and footpath were cleaned in 2016 using high pressure cleaners (NRA 2016). The works resulted in minimal disturbance to SFF.
- Cairns Regional Council engaged a consultant to assess the potential impacts of maintenance and upgrade works to a multi-storey carpark adjacent to the Cairns Library in the second half of 2017. Construction was planned in consideration of the seasonal use of the Cairns Library by SFF, and under the supervision/advice of a *person knowledgeable about flying-fox behaviour* (NRA 2016 b). Subsequent construction work was undertaken without incident (pers. obs. D. Morrant, 2017).

Cairns Regional Council undertakes deliberate flying-fox deterrent activities in identified areas (in accordance with the *Code of Practice – Ecologically sustainable management of flying-fox roosts*). This activity is focused within Cairns City and CBD areas. Flying-foxes are deterred from occupying trees within a 'deterrent zone' (Figure 5) using a 'Long Range Acoustic Device' (LRAD[12]) and hand held tools and lights. The works are undertaken via a locally based, qualified operator, on a seven day a week basis and scheduled daily during the early morning, or at flying-fox 'fly in' times[13], throughout the year as required. The LRAD may also be used to lift or encourage flying foxes to move away as required and per Councils as-of-right authority or approvals.

The intention of the deterrent activity is to prevent SFF diurnal roosting occurring in high risk areas. Council does not seek to exclude flying-foxes from capitalising on opportunities for feeding and occupation during the evening. This as-of- right activity reduces the for potential human/wildlife

[11] SFF left the tree as the CBD colony dwindled at the end of the pup-rearing season.
[12] LRAD is an acoustic hailing device which can project sound over longer distances or at higher volume than normal loudspeakers. LRAD also features advanced ability to 'aim' the sound in a given direction.
[13] Flying-foxes generally return from foraging between 4 and 7 am.

conflicts in these targeted areas. To date no deterrent/dispersal actions have been required at the Library roost.

The Flying-fox Advisory Committee (FFAC)

There is ongoing debate around what constitutes appropriate management of SFF in Cairns and elsewhere in the Wet Tropics (Westcott *et al*. 2015). A broad range of stakeholders are involved in the debate, ranging from people who would like to see targeted culling of flying-foxes in the CBD, to people who are highly concerned about potential negative impacts to even individual animals (Westcott *et al*. 2015).

Cairns Regional Council established a Flying-fox Advisory Committee (FFAC) in 2015, which meets every two months. It is believed to be the first of its type in Australian Local Government. The

The FFAC was established to primarily provide advice and recommendation regarding raising community awareness and education including activities that relate to this primary mandate. However, in addition to community education and awareness the FFAC do provide opinions relating to the on-going management of SFF's in particular commentary relative to the CBD colony. The FFAC provides an interface between CRC, bat carers, wildlife experts, and the general community. There are 4 community members on the FFAC,

The committee collectively agree that the animals are safer out of this Library location and to a more suitable environment. Management actions to relocate SFF's from the CBD colony is not supported however.

Threats to spectacled flying-foxes

The following is a summary of the main threats to SFF conservation, in order of severity (TSSC 2019; also see Westcott *et al.* 2015). Most of the threats also apply to other flying-fox species.

- Climatic factors – Cyclones,
  - Cyclones directly kill many SFF, and although it is not known how many animals die, the numbers are likely to be significant,
  - Cyclones cause major canopy loss which subsequently leads to reduced fruit and flower availability (Shilton *et al.* 2008),
  - Modelling by Westcott *et* al. (2015) identifies Cyclones Larry and Yasi as the main contributors to SFF declines, and suggests that the adult population has not recovered from these events, &
  - Future cyclones may have similar negative impacts.
- Climatic factors - Climate change,
  - Changes in climate may lead to an increase in cyclones and extreme heat events (TSSC 2019),
  - Temperatures >42°C pose a major threat to the survival of SFF (Wellbergen 2008), &
  - On November 2018, and March 2019, extreme temperatures resulted in the death of at least 23,000 SFF, which is a significant portion of the entire population (Kim 2018).
- Habitat loss and fragmentation - Land clearing,
  - There has been historic and ongoing clearing of SFF habitat (TSSC 2019), &
  - Clearing has reduced the availability of foraging habitat and there may be ongoing fragmentation impacts (TSSC 2019).
- Culling and persecution - Persecution at orchards,

- Spectacled Flying-fox and other species, were historically culled by fruit growers using firearms and electrocution grids,
- In addition to direct mortality, dependent SFF young, which were left in 'creche trees' whilst their mothers foraged, starved if their mother is killed,
- Damage mitigation permits can be granted for the lethal take of flying-foxes[14] in Queensland for the purposes of crop protection; however, killing of SFF is not permitted because of their protected status under the *NC Act* and *EPBC Act*
- Illegal lethal methods (chemicals / poison, shooting, and electrocution) are sometimes used to control flying-foxes in orchards (DERM 2010b).

- Culling and persecution - Persecution at camps (especially in and near towns)
  - Persecution at flying-fox camps is not usually lethal,
  - Disturbance during early gestation can lead to young being abandoned,
  - People deliberately disturb flying-fox camps near urban areas,
  - Flying-fox distress associated with roost disturbance is affected by the nature and timing of disturbance (Edson *et al*. 2015),
  - If disturbances result in a chaotic and/or extended flight response, animals that have reduced energetic reserves (i.e. juveniles, females in the late stages of pregnancy, females with dependent young) are likely to be more severely impacted (Edson *et al*. 2015), &
  - Given the high levels of movement between camps, and seasonal fluctuations in camp use and size, long-term impacts of disturbance are likely to be minimal, except where roosts are removed or disturbance is undertaken at inappropriate times, or using methods that are likely to cause distress or injury (Edson *et* al. 2015, Woinarski *et al*. 2014).
- Diseases and abnormalities - Tick Paralysis,
  - Many SFF reportedly die of tick paralysis, particularly in the Atherton Tablelands,
  - Paralysis ticks cause significant mortality during the breeding season (DERM 2010b),
  - It is likely that SFF are exposed to ticks while feeding on the fruit of the introduced shrub, Wild Tobacco (*Solanum mauritianum*) and Guava (*Psidium guajava*) (DERM 2010b, TSSC 2019), &
  - These low shrubs/trees are an ideal height for the Australian Paralysis Tick (*Ixodes holocyclus*) to climb and wait for a host (SPRAT 2019).
- Diseases and abnormalities - Birth abnormalities (cleft palate syndrome),
  - There seems to have been an increase in cleft palate syndrome; however, the true incidence and cause are unknown (Woinarski *et* al. 2014, TSSC 2019).
- Anthropogenic obstacles,
  - Flying-foxes become entangled in anthropogenic obstacles including barbed-wire, fruit netting and powerlines, &
  - Anthropogenic obstacles are considered to be minor threats to SFF survival (DERM 2010b)
- Secondary poisoning from agricultural chemicals,
  - Although the impacts are unclear, secondary poisoning is considered a likely threat to SFF, &
  - Anecdotal evidence from banana growers suggests that SFF may die after exposure to organophosphate poisons that are used to control insects (DERM 2010b).

[14] Shooting with a shotgun is the only authorised way to cull-flying foxes (DES 2015).

- Habitat degradation and resource depletion caused by myrtle rust, fire exclusion, wildfire and/or prescribed burning
    - These factors are all suspected to pose a threat to SFF, now and in the future, although the impacts have not been quantified (TSSC 2019).

Impacts are likely to result from changes to vegetation community composition and structure, and subsequent reductions in food availability (TSSC 2019).

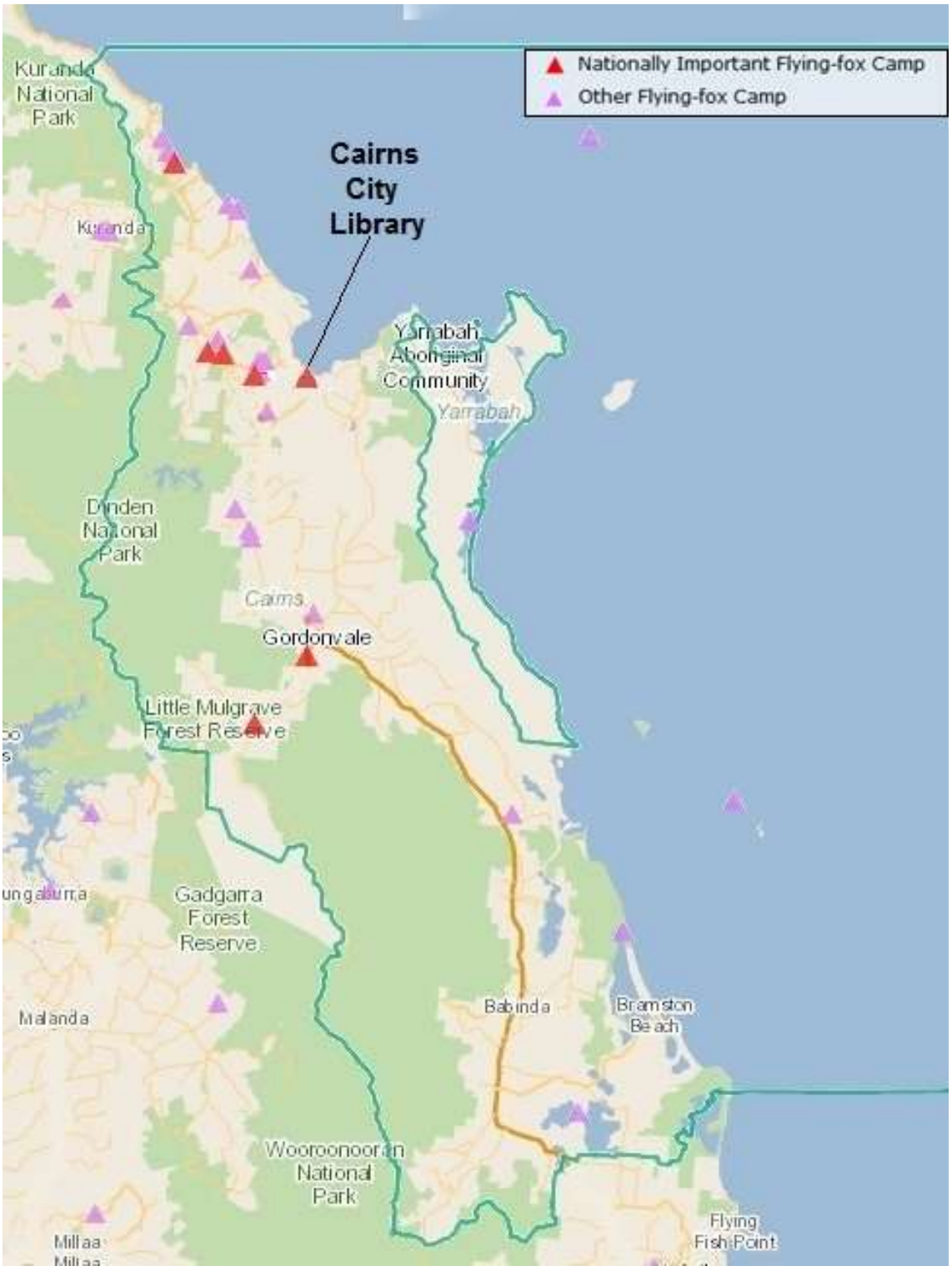


Figure 1. Location of known flying-fox roosts in the Cairns region (outlined in green; map modified from DoEE 2018)

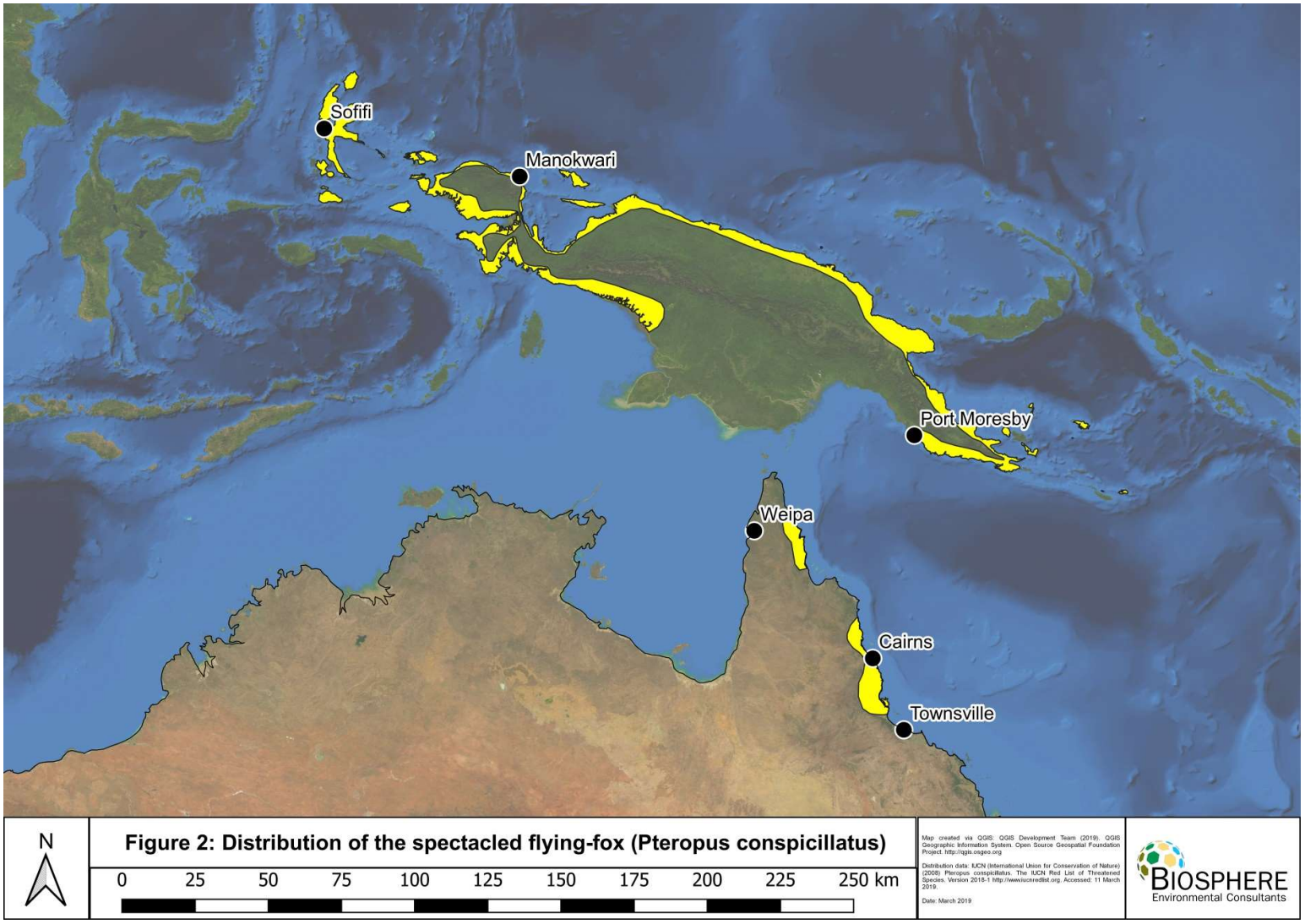


Figure 2. Distribution of the spectacled-flying fox (yellow polygons)(data source: IUCN 2008)

Figure 3. Flying-fox roost trees in the Cairns CBD in March 2015. (modified from Cohen 2015).

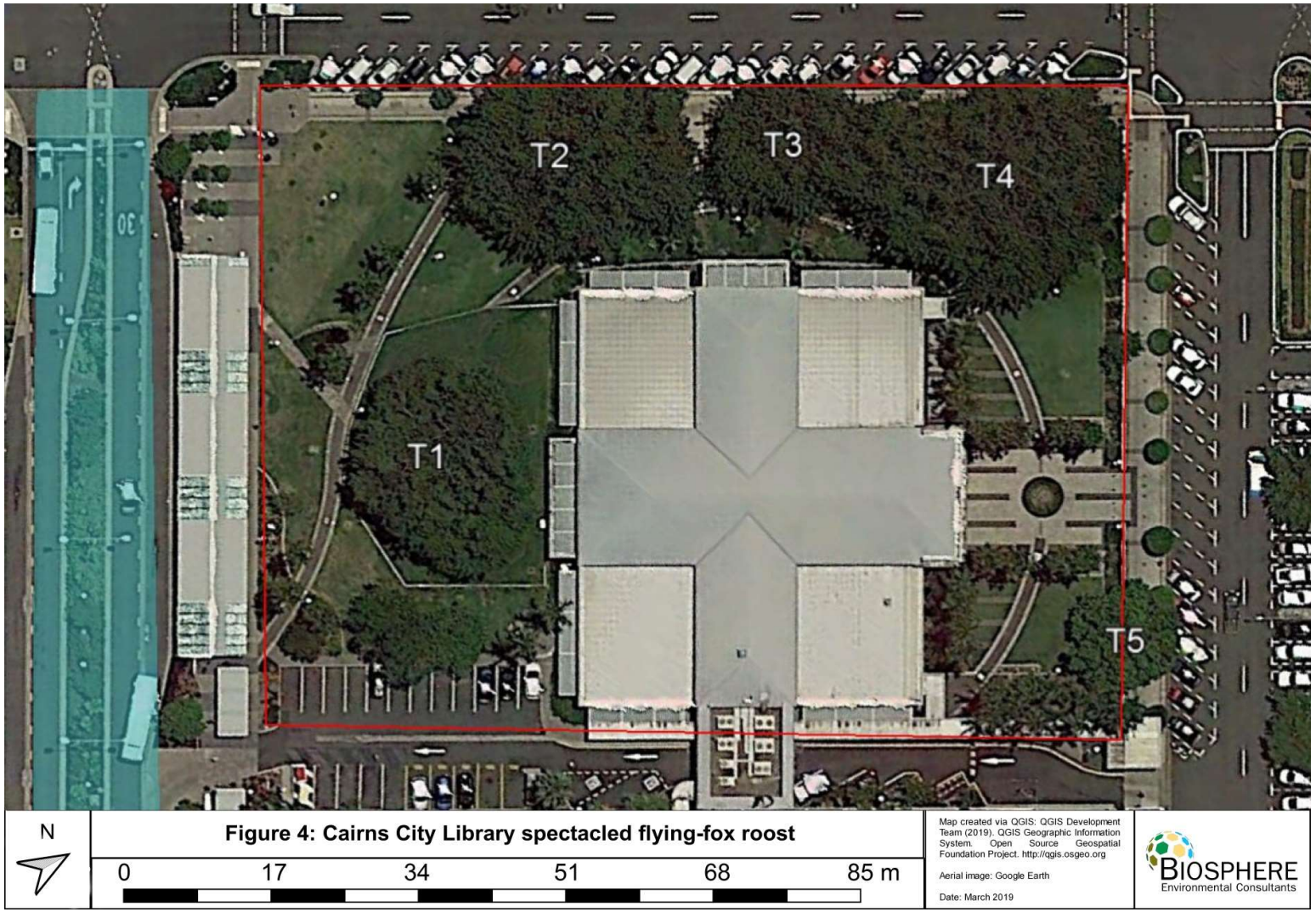


Figure 4. Cairns City Library spectacled flying-fox roost. T1-T5 denotes main roost trees. Blue shaded area denotes the deterrent zone.

Figure 5. Cairns Regional Councils' current flying-fox deterrent zone

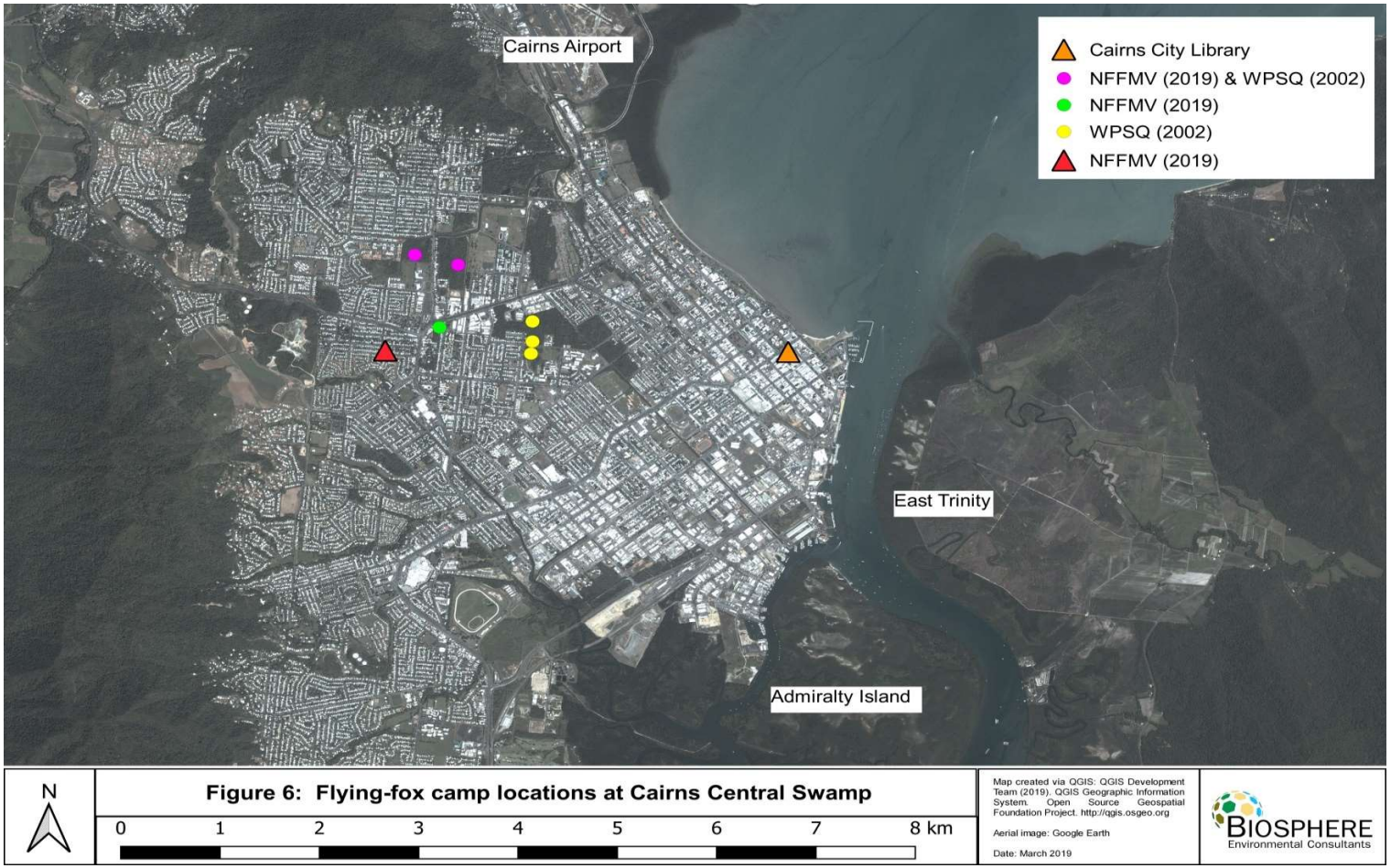


Figure 6. Flying-fox camps locations at Cairns Central Swamp (NFFMV 2019 & WPSQ 200

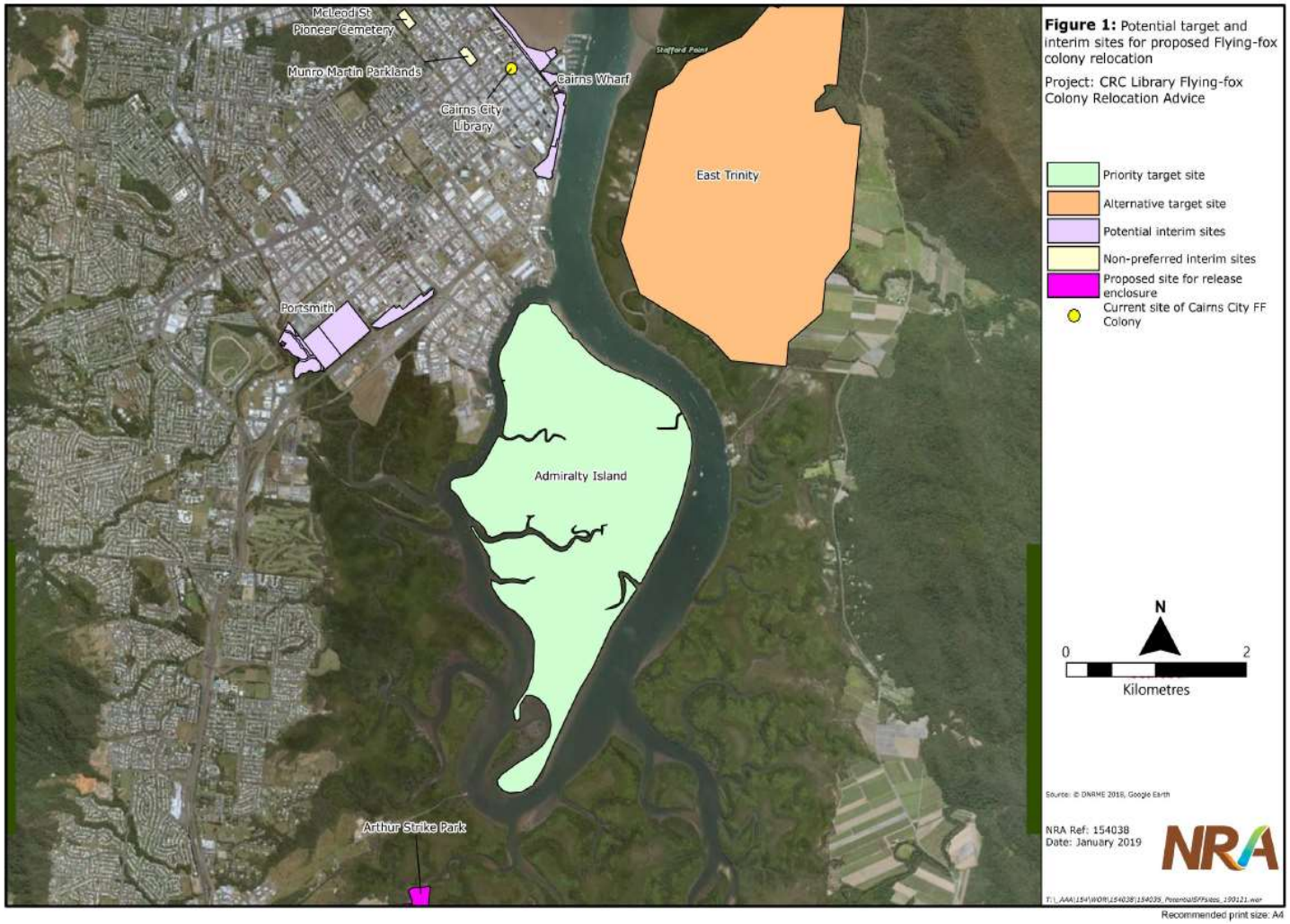
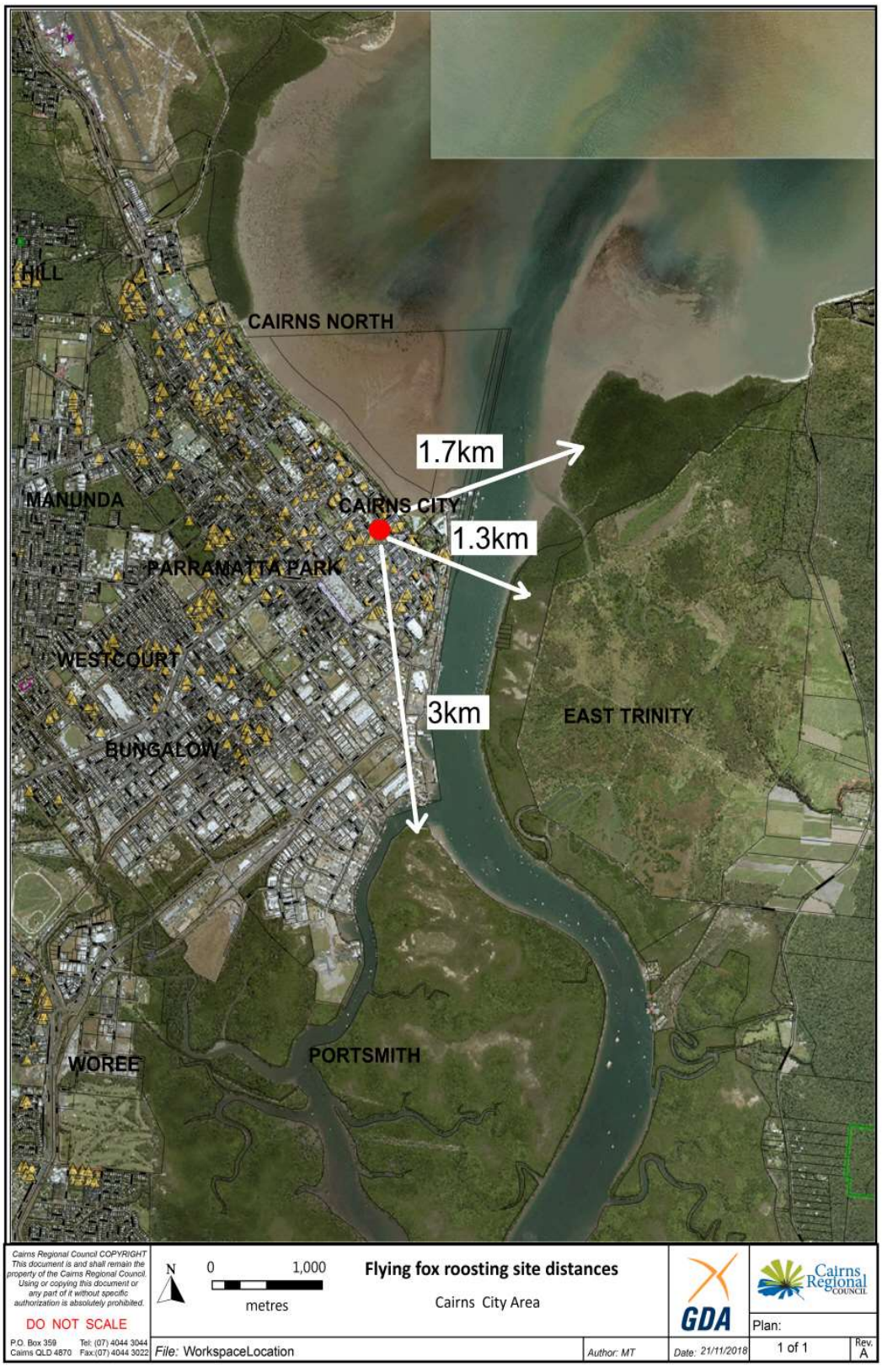


Figure 7. Example of potential target and interim sites for proposed Flying-fox colony relocation



. **Figure 8. Flying fox roosting site distances (from current city roost)**

Sources of conflict between humans and flying-foxes in Cairns

Major sources of conflict between humans and flying-foxes in the Cairns CBD are discussed below.

Noise, odour, and bodily waste deterioration

Flying-foxes tend to roost in large daytime camps. While at these camps they create significant noise, odour and bodily waste. Noise levels are generally loudest when the animals are returning from foraging and competing for roost space; however, during the day flying-foxes vocalise loudly and continuously in response to a range of triggers including human disturbance, predators and other flying-foxes encroaching upon their territory. They defecate and urinate at the roost site, and males mark their territories with glandular secretions (Wood *et al*. 2005; NRA 2016c). The smell from camps is pervasive, and can induce nausea in some people (GeoLINK 2012). Flying-fox faeces and urine also contain pathogens that can cause illnesses in humans, such as Hendra Virus, Leptospirosis and Salmonella (NSW Health 2015a, QGov 2017, QLD Health 2017b).

Vegetation damage

Long –term and persistent use of roost trees by flying-foxes can cause tree health to deteriorate (NRA 2016c, CoA 2017, NRA 2019b; pers. obs., D. Morrant). The ongoing removal of roost trees in the CBD has driven SFF to roost in increasing numbers at the Cairns Library, which has led to frequent and sustained damage to the trees (NRA 2019b). A Golden Penda Tree at the Cairns Library, which is typically occupied by 50-200 SFF during the breeding season, has several dead branches in the crown, as a result of long-term and intense flying-fox use (NRA 2019a, NRA 2019b). A large branch recently fell from the tree, prompting Council to cordon off the area surrounding the tree (pers. obs., D. Morrant). Three fig trees along Aplin Street, which house thousands of SFF during the breeding season, are also displaying signs of deterioration (NRA 2019a; pers. obs., D. Morrant).

Perceived risk to human and animal health

Flying-foxes carry a range of pathogens that pose a significant health risk to people and other animals, including Australian bat lyssavirus, Hendra virus, Menangle virus, histoplasmosis, leptospirosis and salmonella. Transmission of pathogens from flying-foxes to humans is generally unlikely; however, the pathogenicity of some of the diseases with which they can be infected warrants extreme caution when interacting with flying-foxes (NSW Health 2015a-b, NRA 2016c, QGov 2017, QLD Health 2017a-b).

Zoonoses are infectious diseases that can be transmitted between animals and humans. A range of zoonoses are associated with Australian flying foxes, including the SFF (Vogelnest and Woods 2008). The two zoonoses of greatest concern to human (and animal) health are Australian bat lyssavirus (ABLV) which is closely related to rabies, and Hendra virus (HeV), which can be transmitted from flying-foxes, to horses, and then on to humans (Heard 2003).

Both ABLV and HeV cause serious illness in humans and there is no known treatment for disease associated with either virus (NSW Health 2015a, NSW Health 2015b, QLD Health 2017a, QLD Health 2017b). Whilst transmission from flying-foxes to humans is rare (DES 2016), the consequences of contraction are severe. Three cases of ABLV have been recorded in humans since the disease was first identified in 1996; all of these cases were fatal (NSW Health 2015b, QLD Health 2017a). Hundreds of people have been exposed to horses that were infected with HeV but have not been infected; however, seven (7) people have contracted the virus following intense exposure to infected horses, and four (4) of those have died (NSW Health 2015a, QLD Health 2017b).

The roosting habits (i.e. large aggregations), high mobility, interspecies interactions, and propensity to bite facilitates transmission of these viruses between flying-foxes, and to a lesser extent humans (Heard 2003). Avoiding horse exposure to flying-fox urine, for example by not placing food or water troughs under roosts or trees in which flying-foxes feed, can help reduce the risk of HeV transmission to horses and subsequently to humans (Heard 2003). Australia Bat Lyssa Virus transmission is via bites or scratches from an infected animal. The best protection against ABLV is to avoid handling bats. Only people experienced in handling bats, and who have been vaccinated against ABLV[15], should touch flying-foxes, and careful hygiene practices should be employed (NSW Health 2015b, QLD Health 2017a).

Edson *et al*. (2019) investigated the impact of roost modification and dispersal on HeV infection dynamics in flying-foxes. They found no statistical association between roost disturbance and HeV urinary excretion prevalence, which suggest that roost disturbance alone does not necessarily lead to increased stress and subsequent HeV excretion in dispersing flying-foxes. Rather, the timing and nature of disturbances to flying-fox roosts affected the level of distress that flying-foxes experienced, which was associated with increases in HeV excretion. Their findings highlight the need for a 'best practice' approach to dispersal or roost modification activities.

General human wellbeing and amenity

Flying-fox roosts may have a range of impacts on individuals and businesses (CoA 2017). A range of ailments have been attributed to living near flying-fox camps, including sore throats, nausea, asthma, bronchitis, laryngitis, sinusitis, allergies, headaches/migraine, tinnitus, and skin irritation (GeoLINK 2012, CoA). People living near roosts may suffer from disturbed sleep, caused by the loud noises from the camps, which is particularly problematic when flying-foxes return to their roosts after foraging (CoA 2017). Some residents may even suffer from mental illness as a result of feeling 'trapped' in their homes because of the noise and smell from flying-fox camps (CoA 2017).

Economic impacts

Flying-foxes can cause significant damage to commercial fruit crops which costs producers millions of dollars annually (NRA 2016c). The Australian fruit industry considers flying-foxes to be its main vertebrate crop pest (Aziz *et al*. 2006). Flying-fox damage to commercial fruit crops is an ongoing problem which causes economic and emotional distress to growers (CoA 2017).

Businesses that are located near roosts may suffer decreased revenue as a result of noise, smell and excrement. The tourism industry is often the most severely affected (CoA 2017).

Stakeholders

Flying-fox management requires engagement and cooperation with a broad range of stakeholders, who are responsible for a range of duties such as administering legislation on roost management, or who may be impacted by flying-foxes.

Stakeholders[16] that are relevant to the proposed relocation include but are not limited to:

- The Department of Environment and Science (DES) – Queensland Government
    - All flying-foxes and their roosts are protected under the *NC Act*, *Nature Conservation (Wildlife Management) Regulation 2006* (*NC* Regulation; QLD) and related Codes of Practice.

[15] ABLV is closely related to rabies. Vaccination against rabies also provides protection against ABLV.
[16] See DERM (2010a) for a more comprehensive list of potential stakeholders.

- DES is responsible for administering the abovementioned legislation.

- Biosecurity Queensland – Queensland Government
  - Biosecurity Queensland (BQ) leads the Queensland "Government's efforts to prevent, respond to and recover from pests and diseases threatening agricultural prosperity, the environment, social amenity and human health" (DAF 2019).
  - BQ therefore is responsible for managing diseases in flying-foxes such as HeV and ABLV and undertaking surveillance for emerging infectious diseases such as rabies which, if they reach Australia, could infect a range of animals including flying-foxes.

- Queensland Health – Queensland Government
  - Queensland Health is responsible for investigating cases of notifiable diseases and providing medical advice.
  - Flying-foxes carry and transmit a number of pathogens that pose a major threat to human health.
  - Pathology requests or pathological diagnosis of ABLV or HeV require 'immediate notification' to Queensland Health (*Public Health Regulation 2018* [QLD]).

- Cairns Regional Council – Local Government
  - Council provides a broad range of services to its constituents including oversight of building, planning, and business services, water supply and drainage, waste and recycling, roads and public works, community services, facilities, sport and leisure, and environmental management.
  - Council has 'as-of-right' authority under the *NC Act* to manage (including disperse/relocate) flying-foxes in the Cairns Urban Flying-fox Management Area.
  - Activities under the 'as-of-right' authority must be undertaken in accordance with the *Code of Practice – Ecologically sustainable management of flying-fox roosts.*
  - Low impact activities near a roost may be undertaken under the *Code of Practice – Low impact activities affecting flying-fox roosts*.

- Indigenous groups, special interest groups and general community
  - Cairns residents, including Aboriginal people and organisations, may be affected by flying-foxes in many ways, or have an interest in their conservation, ecology and management.
  - Community concerns about the negative impacts of the existing Library roost are outlined in the 'Introduction' section of this report.
  - While SFF are maligned by some sectors of the community, others see them as valuable for a range of reasons including their ecological role, value as a tourism drawcard, or simply for their intrinsic value.
  - Groups that do not live in the community but have an interest in flying-foxes and their management include the Australasian Bat Society, Ecological Society of Australia, Australian Mammal Society, Australian Wildlife Management Society, and fauna care and rescue groups such as RSPCA Queensland.

Legislative framework

All species of flying-foxes are protected under the *NC Act*, and Spectacled- and Grey-headed Flying-foxes have additional protection under the *EPBC Act*. Flying-fox management that is undertaken without appropriate planning and approvals from State and/or Commonwealth Governments can incur hefty fines and even prison sentences. In addition to wildlife-related legislation, there are a number of other pieces of legislation relevant to the proposed relocation.

Commonwealth - *Environment Protection and Biodiversity Conservation Act 1999*

Spectacled Flying-foxes are listed as Endangered under the *EPBC Act*. Under the *EPBC Act* an action will require approval from the Australian Government Environment Minister if it has, will have, or is likely to have, a significant impact[17] on a matter of national environmental significance. A 'self-assessment' process can be undertaken to decide whether or not referral may be required (DoE 2013).

Queensland - *Nature Conservation Act 1992*

All flying-fox species that occur in Queensland are protected under the *NC Act*, and any interference or management of a flying-fox roost is regulated under the subordinate *NC Regulation*. Under the *NC Act/Regulation* flying-foxes may be managed in the following ways:

- All persons may undertake low impact activities such as "mulching, mowing or weeding under or near roost trees, and/or minor trimming of roost trees, where the activities are not directed at destroying a flying-fox roost, driving away, or attempting to drive away, a flying-fox from a flying-fox roost, or disturbing a flying-fox in a flying-fox roost" (under the *Code of Practice - Low impact activities affecting flying-fox roosts*)
- Local Governments within an UFFMA have an as-of-right authority to manage flying-foxes under the *Code of Practice - Ecologically sustainable management of flying-fox roosts.*
- Persons or local governments operating under an approved 'flying-fox roost management permit' can also undertake such actions.

Queensland - *Animal Care and Protection Act 2001*

The *Animal Care and Protection Act 2001* (*ACP Act*) "promotes the responsible care and use of animals". Under the *ACP Act* people in charge of animals have a duty of care to meet those animals' needs in an appropriate manner.

Queensland - *Vegetation Management Act 1999*

Clearing of remnant vegetation during flying-fox management may be subject to the *Vegetation Management Act 1999* (*VM Act*).

Queensland Heritage Act 1992

The object of the *Queensland Heritage Act 1992* is to provide for the conservation of Queensland's cultural heritage. The Cairns City Library is listed on the QLD Heritage Register (QHR601576). This listing places restrictions on damage to vegetation on the site, as the mature trees form part of the significant context of the property.

Local Government Legislation

Local Government Legislation (also known as Local Laws) may be relevant to the proposed relocation. For example, there may be requirements or restrictions relating to the use of noise, smoke, and general nuisance associated with flying-fox disturbance.

[17] "A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity" (DoE 2013).

Relocation sites and a Flying fox release enclosure

In discussion with the FFAC and in anticipation of the camp relocation, Council has instigated construction of a purpose- designed Flying-fox enclosure on a parcel of Council land.

The area is approximately eight kilometres south of the Cairns city at 'Arthur Strike Park' Edmonton. This site preference is away from further urban threats and impacts (RE type) to assist bat careers rearing and rehabilitating orphaned bats in the future.

Cairns Regional Council is funding the SFF facility at an estimated cost of $75,000. The structure is a 10 x 4 metre steel and wire cage. The purpose-built enclosure will assist wildlife carers raise young and orphaned bats in a controlled area, for release into the wild. Forest habitat regeneration and support of carers through ongoing training have also been approved.

Based on recent anecdotal evidence of adult SFF being attracted to roosts, it is hoped that over time the new enclosure facility at Edmonton will also lure or attract other Flying foxes into the area and potentially allow the formation of a safe and sustainable permanent new roosting site relatively close to the existing Library roost.

Example 1. The notion of luring bats to roost has occurred locally with a Wildlife Carer near Kuranda building cage enclosures for orphaned SFF. The enclosure demonstrated has attracting new bats to roost directly in the vicinity.

Example 2. In Melbourne, Victoria a new habitat was created to suit the species of Grey- headed Flying-fox (GHFF) and a colony was deterred from an existing roost and herded to the new area, with GHFF the colony moving about 7km (CAFNEC 2018).

Methodology of relocation

Cairns Regional Council have engaged Biodiversity Australia to develop and undertake the relocation works associated with this project. The decision to use Biodiversity Australia was based on the following;

- Extensive demonstrated experience in the field of flying-fox relocations,
- Extensive experience demonstrated by personnel undertaking the works,
- High success rate in successfully undertaking flying-fox relocation works,
- Large number and specialisation of tools utilised,
- Holistic and scientific based approach to flying-fox relocations, &
- Thorough understanding of and ability to mitigate risks associated with flying-fox relocation works.

The methodologies presented in the following sections have been developed to provide a holistic management approach which takes into account the all potential risks involved in such a project and mitigates them to acceptable levels. The approach is staged into the following scopes of work;

- **Alternative Roost Study –** to identify potential alternative roosting locations for the Cairns CBD population through rigorous scientific process.
- **Risk Analysis and Management –** once the alternative roosting sites have been identified, a thorough risk assessment will be undertaken and potential mitigation measures will be utilised. A key example of a potential risk is an increase in the potential for wildlife strike risk at the Cairns International Airport

- **Community Extension and Education –** this is aimed at notifying the community of the upcoming works to mitigate complains and limiting their interference etc,
- **Undertaking On-ground relocation works,**
- **Implement passive deterrents at current CBD roost locations**
- **Establish a rapid response reporting platform** for CRC staff and the public to quickly report new camp establishments and allow for rapid deployment of relocation staff, &
- **Establishment of a rapid response relocation service** which utilises the methods presented within the FFRMPas soon as non-desirable roosts occur.

Alternative roost study

Multi-criteria land-use suitability analysis

Prior to field verification, a series of models will be created using Geographic Information Systems (GIS) to assess the suitability of land surrounding the Cairns Library roost to support a flying-fox reserve. All models will be created using a multi-criteria evaluation framework, in which multiple attributes weighted according to their attractiveness to flying-foxes (e.g; areas close to a water course, wetland, or high value vegetation were weighted more highly).

All sites within a 5 km radius of the Cairns Library roost were assessed in this analysis. This distance was chosen on the assumption that the likelihood of flying fox camp relocation success decreases with distance (e.g; the greater the distance from the original roost to new roost site, the more difficult and expensive successive camp relocations will be).

Weighted overlay analysis

A weighted overlay analysis involves the combination of multiple sub-models into one larger model so that multiple criteria can be evaluated at once. Sub-models may be weighted according to their importance relative to overall project objectives. For example, the presence of a watercourse may be weighted more highly than presence of high value vegetation in determining flying-fox habitat suitability. All attributes will be mapped as rasters, with areas of decreasing desirability receiving lower scores on a continuous scale. Alternative flying-fox roost suitability criteria are presented within table 1. below.

In addition to the desirable attributes above, a number of undesirable attributes will also be incorporated into the analysis with weighting ranging from complete exclusion of the area through to a progressive radial scaling out from the negative receiver over distance. Examples of such sites may include;

- Airports,
- Schools,
- Horse stables,
- Public areas, etc.

The two models are then combined to show which areas best demonstrate suitability for the flying-foxes whilst avoiding sensitive receivers. An example of such a figure is shown within Figure X

Upon completion of the multi-criteria land use suitability analysis, a field verification will be undertaken by Biodiversity Australia Senior Staff to verify the conditions and suitability of the sites, additional sites may also be included at this stage as some information entered into the multi-criteria analysis may be incomplete.

Table 2: Flying-fox land-use suitability criteria

Objective	Criteria	Less desirable		More Desirable		Weighting
Areas that are already preferred by flying foxes are far more likely to be chosen as roost locations, meaning that the provision of a reserve near an existing camp is far more likely to successfully recruit seasonal influxes of flying fox.	Camp preference: Proximity to existing flying fox camp preferences measured on a 100 m scale (Source: CSIRO Flying Fox Camp Records, and other historic records such as newspaper articles)	Area is not within close proximity of an existing camp, decreasing the likelihood that flying fox will find and utilize the reserve for its intended purpose.	-	-	Area is within a close distance of existing camp, maximizing the chances that flying foxes will successfully relocate to the intended area.	40%
Flying foxes are known to prefer roosting in close proximity to a water body or riparian area (Mildenstein *et al.*, 2005).	Watercourse Presence: Proximity to watercourses measures on a 100m scale (Source: QLD Watercourse)	Area is not within close proximity of a watercourse – reduces likelihood that habitat will be suitable long-term for flying foxes	-	-	Area within close proximity of a watercourse, increasing likelihood that flying foxes will have all available habitat requirements.	15%
Flying fox roost tree selection is non-random with respect to tree species (Hahn *et al.*, 2014). Flying foxes are more likely to roost in trees with larger diameters and canopy trees. Colony size also tends to be larger in densely forested regions with lower annual precipitation and flood affected areas (Hahn *et al.*, 2014).	Vegetation: Complexity of vegetation structure and type of vegetation present. Forest must be closed canopy forest (greater than 5 meters in height) of a total area no less than 1 hectare in size (Source: QLD Regional Ecosystem Mapping)	No fodder species present or fodder species present with a discontinuous canopy	1-2 fodder species	Surrounding RE has 3-4 fodder species	Surrounding RE has <4 fodder species	30%

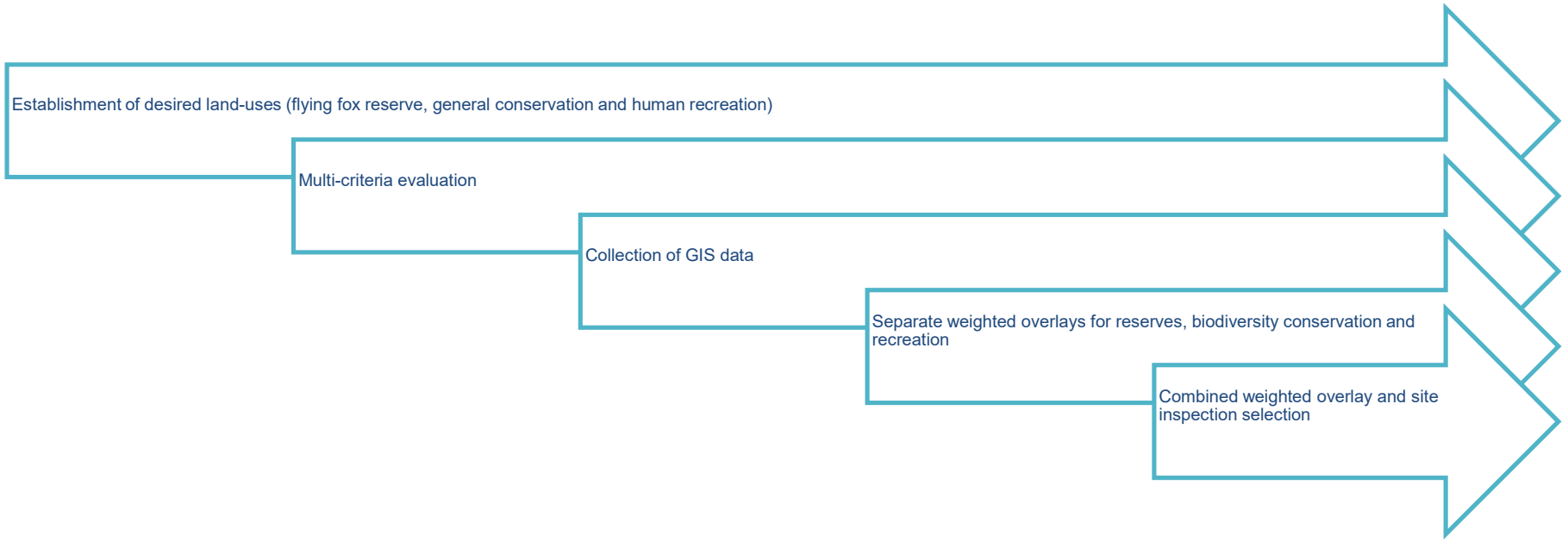


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Figure 9: Steps followed in the land-use suitability analysis

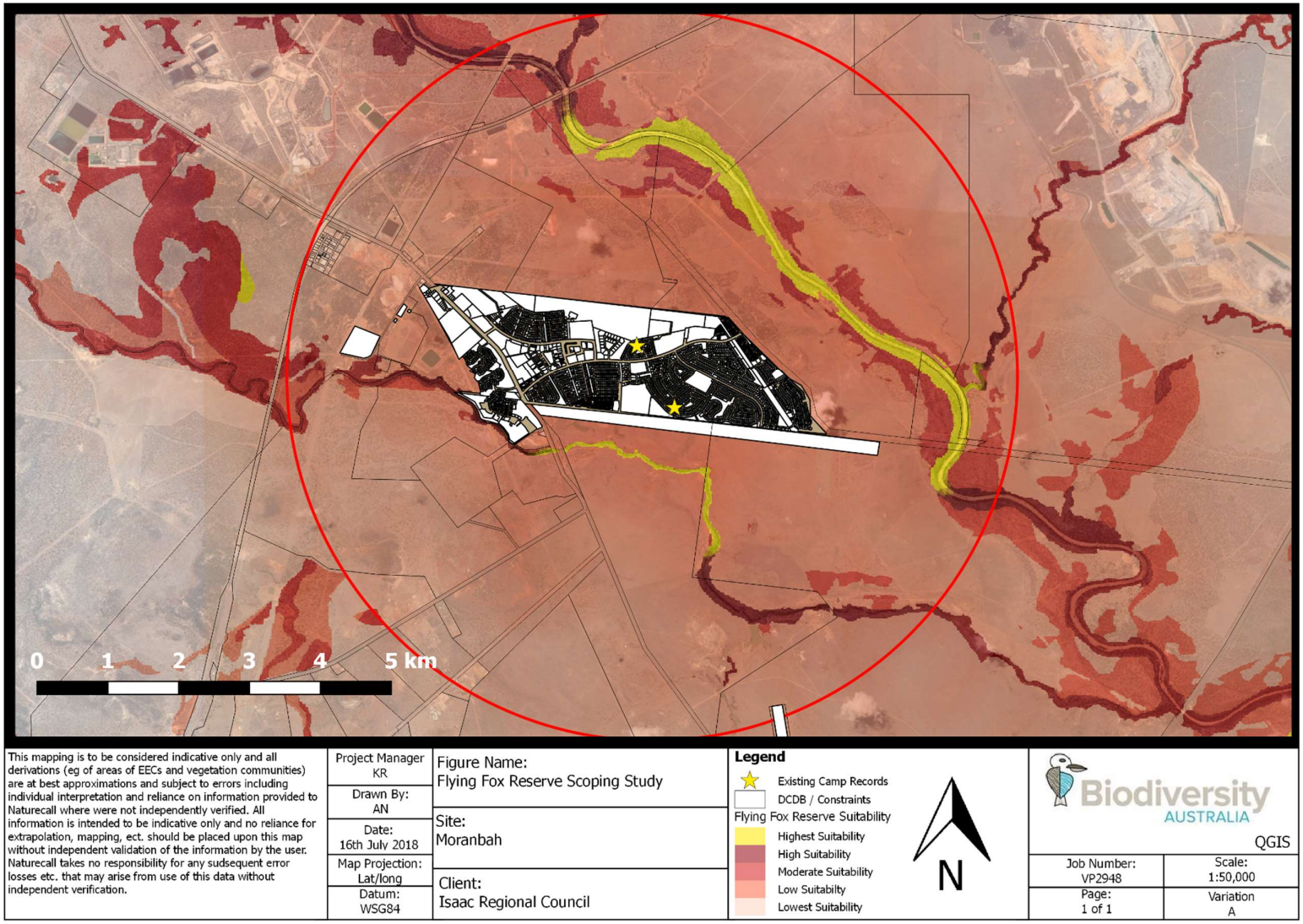

Figure 10: Flying-fox land suitability modelling example.

Field Verification Surveys

Field verification surveys will be undertaken once the multi-criteria analysis is completed and a list of potential alternative roosts has been recorded. This may include up to ten alternative roost sites.

Data collected during these surveys is compared with the criteria used in the land-use suitability analysis, and involves collation of vegetation data, verification of presence of important land features (such as waterbodies) and anecdotal knowledge of historical use by flying foxes (where possible).

This field verification also allows for the inclusion of potential alternative roosts by Biodiversity Australia's senior staff which may not have been identified through the formal land use suitability analysis for one reason or another. Any sites selected via this method would need thorough justification and risk assessment.

A summarized description of data collection structure is shown in Table 2.

Feature	Data collected
Vegetation	
Dominant species	Record of dominant canopy species present at each site.
Canopy Cover (%)	Random meander through site - average canopy cover recorded at 10 random locations approximately 45 meter spacing between each sample.
Diameter at breast height (DBH) (m)	Measurements for 10 canopy trees undertaken randomly at approximately 30 meter spacing between each sample.
Average tree height (m)	Average tree height of the site determined by approximating the height of three random trees using a clinometer.
Structure	Age classes and summary of canopy and sub-canopy structure recorded for each site following consensus with project ecologists.
Biodiversity value	
Use by flying foxes	Anecdotal evidence of site use by flying fox was noted, as was any additional evidence of flying fox use (i.e. observation of roosts etc)
Other species present	Record of all other fauna species observed during the survey
Significant land features	
Proximity to watercourse	Identification of watercourses within the site, both anthropogenic and natural.
Wetland presence	Verification of permanent/ephemeral wetlands within the site.
Conservation values	
Threatened Regional Ecosystems	Identified by RE mapping on desktop, confirmed following vegetation identification on site.

Table 2: Description of data collection structure

Once this analysis is completed, Biodiversity Australia staff will identify three priority relocation sites in a range of areas and at varying locational bearings to the current camp. This is done to ensure that relocation works are not fighting against the natural movement and behaviour of the Cairns SFF. For example, the main priority alternative roosting location may be identified within vegetation on the eastern side of the Trinity Inlet, however the SFF may choose to naturally travel in a western direction. Instead of relocation efforts fighting against these natural urges, Biodiversity Australia staff will switch to priority location number two which is in a westerly direction i.e. the Cairns Central Swamp.

Consultation with Stakeholders

Once the alternative roosting study has been completed and proposed locations have been determined, the suitability of the sites will be discussed within the FFAC to gauge the best approach and anticpate any unidentified or unforeseen risks. Council will include the wider community, residents, businesses and bat carers, ensuring balanced and inclusive consultation process.

Risk Identification and Mitigation

Biodiversity Australia will undertake a comprehensive risk identification and management analysis for the final alternative roosting sites.

This will be undertaken by holding an intensive think tank with senior Flying-fox management staff within Biodiversity Australia and other key stakeholder within the FFAC.

Key objectives of the think tank will be to:

- Review previous projects and identify risks which were dealt with on those projects,
- Run scenario's and consequences,
- Identify a list of key stakeholder to liaise with directly,
- Use the Consequence x likelihood analysis to formulate actual risk,
- Analyse proposed mitigations and assess their ability to effectively mitigate the risk.

The following risk matrix will be utilised against all risks identified. The matrix allows for assessment of initial risk based on consequence x likelihood matrix as well as subsequent assessment of that risk once mitigation measures are applied. The objective of the analysis is to lower all risks to an acceptable level of low risk.

The risk assessment model is as follows;

1. **ASSESSING THE RISK** - Consequence x Likelihood = Risk

Consequence Table	**1 - Insignificant**	No harm / near miss.
	2 - Minor	Incident requiring attention but easily fixed.
	3 - Moderate	Incident requiring attention and may cause moderate disruptions.
	4 - Major	Incident requiring immediate attention and intervention that may cause significant disruptions, illness, financial implication etc.
	5 - Catastrophic	Incident which may result in Fatality.

Likelihood Table		
	A - Certain to Occur	Expected to occur in most circumstances.
	L - Very Likely	Will probably occur in most circumstances.
	P - Possible	Might occur occasionally.
	U - Unlikely	Could happen at some time.
	R - Rare	May happen only in exceptional circumstances.

RATING THE RISK - Using the Risk Matrix in the next column, rate the risk considering the consequence and likelihood of the hazard occurring.

Risk Matrix		**Consequence**				
		1 Insignificant	**2 Minor**	**3 Moderate**	**4 Major**	**5 Catastrophic**
Likelihood	**A - Certain to Occur**	High	High	Extreme	Extreme	Extreme
	L - Very Likely	Medium	High	High	Extreme	Extreme
	P - Possible	Low	Medium	High	Extreme	Extreme
	U- Unlikely	Low	Low	Medium	High	Extreme
	R - Rare	Low	Low	Medium	High	High

2. **MANAGE THE RISK** - Identify hazard controls using the hierarchy of controls.

Most Effective	**Elimination**	Complete removal of hazard or practice from the workplace.
	Substitution	Use a safer less hazardous process, material or substance.
⇩	**Isolate**	Enclosures, barriers, guards, covers and remote control systems.
	Engineering	Trolleys, guards, barriers, ventilation, distance, speed and timing.
	Administrative	Develop policies, work methods, procedures, training, and signage.
Least Effective	**PPE**	Protective footwear, glasses, clothing, helmet, mask and gloves.

Low	Continue or commence activity – Review controls if risks change / otherwise as periodically scheduled.
Medium	Only continue or commence activity if risks are as low as reasonably practicable. Continue to monitor effectiveness of controls and/or elevations in risk status during task.
High	STOP - do not continue or commence work. Authorisation required contact Biodiversity Australia supervisor immediately, verify controls and ensure risks are as low as reasonably practicable.
Extreme	STOP - do not continue or commence work. Notify Biodiversity Australia supervisor immediately.

NOTE – If job steps have a final risk rating of HIGH or EXTREME, do not start work and contact Biodiversity Australia Immediately.

The results of this risk analysis will be formalised within a Job Risk Analysis Report and held with CRC.

Public Consultation

Flying-fox relocation works are often loud and are undertaken in the very early hours of the morning. Managing public expectation and providing notice of proposed works is a key process is managing the expectations and attitudes of local business owners and the public. As part of this process Biodiversity Australia and CRC will:

- Provide notification of works via letter box drop to all residence and businesses within 3km of the current camp at least three weeks prior to works commencing,
- Provide a media release within two of the local newspapers at least 3 week prior to works commencing,
- Provide information about the proposed works within council's website
- Establish a contact line for questions and concerns,
- Use clearly visible vehicles during the works,
- All personnel will be Biodiversity Australia or CRC branded,
- Signage will be erected around the general location of works,
- A contact information flyer will be available at the site for concerned citizens, &
- All enquiries will be filed and responded to in a timely manner.

Undertaking on-ground relocation works

The process of undertaking relocation of flying-fox camps is a scope of work that Biodiversity Australia have been specialising in for over 16 years. The tools and methods which the team incorporate have been trialled and refined over that time. Nonetheless, the success of the relocation works is heavily dependent upon the competence, experience and skill of the ecologists and wildlife technicians and their understanding of the flying-fox behaviour. Accordingly, Biodiversity Australia propose the following team of highly experienced technicians to undertake the proposed works.

Flying-fox relocation team

Relocation manager and technical lead

Steve Noy is the founder and Managing Director of Biodiversity Australia. With more than 25 years' experience in wildlife management and fauna research, Steve has a wealth of operational and practical knowledge and expertise in environmental management and is a regular author of and contributor to scientific papers.

Steve has worked expensively with flying fox colonies over the past 16 years and has lead a large number of successful relocations on roosts ranging from 2,000 to 300,000 animals. Steve has been successful in achieving the client's desired outcomes on 100% of his relocation engagements.

Steve is passionate about inspiring positive change and dedicated to high industry standards across Australia which is evident in his 'pro bono' public works such as leading the stakeholder group responsible for developing the current draft code of practise for the QLD fauna spotter catcher industry. He is active within the sector, providing thought-leadership, operational advice and on-the-ground management.

Project Director and Lead Ecologist

Karl Robertson is a Senior Ecologist and sits as Operations Manager of Biodiversity Australia. Karl has eight years' experience in terrestrial and aquatic ecology throughout NSW and QLD. He pursues a holistic knowledge of Australian Ecology, in doing so, he has developed advanced survey and assessment skills. He is able to survey and identify the full complement of Australian native and exotic fauna and flora. Karl has a broad understanding of both State (QLD & NSW) and Federal Legislation, having prepared an extensive amount of Ecological Assessments, Monitoring Reports, Seven Part Tests, EPBC Act MNES assessments, federal referral documents, SEPP 44, 14 and 26 assessment as well as the preparations of Review of Environmental Factors, Vegetation Management Plans and Control Plans for Exotic Flora. Karl is also an accomplished spatial analyst with experience in the use of ArcGIS and MapInfo as well as a vast range of data collection software (GBM Mobile, GIS Pro, Weed Map Pro) and hardware (Trimble, iPad, GPS, Toughbook).

Over the past five years Karl has undertaken numerous flying fox roost studies, impact assessments and has lead numerous successful relocation works. He has extensive experience in the preparation of species management plans, EPBC MNES assessments, and referral guidelines for the management of Grey-headed and Spectacled Flying-fox camps. He oversees all of the flying fox management projects that Biodiversity Australia undertake nationally.

Lead Field Technician

Andrew Williams has been with Biodiversity Australia since March 2016 and is the currently Projects Coordinator for the Human / Wildlife Interaction and Aviation division. During this time, he been a key member of he Human / Wildlife Interaction and Aviation team two units which work with flying-foxes on a daily occurrence. Andrews's extensive experience within the aviation industry gives him an almost unique understanding of the risks that flying-fox can potentially pose. Andrew has experience in a range of environmental fields including wildlife conservation & biology, environmental management, vertebrate pest management, parks and wildlife management and venomous snake handling. Andrew has extensive experience in the capture & restraint of native wildlife, wildlife health assessments, species identification, habitat analysis, husbandry and care of native animals, and client liaison. Andrew is also responsible for training other wildlife harassment specialists.

Andrew has worked alongside both Karl and Steve in all of Biodiversity Australia's flying fox related projects since starting at the company. He is responsible for responding to emergency wildlife call outs, as well as assisting in on-ground population management for a number of urban-adapted species.

Specialist Tools

To compliment Biodiversity Australia's extensive experience in this field a wide range of specialist tools will be available to the team which will allow them to operate in a myriad of different situations. This selection of tools will allow the team to achieve the desired outcomes with minimal stress to the SFF as it allows periods of stress to be reduced daily to around 30mins and the overall length of relocations to be reduced significantly. All of the tools utilised are non-lethal and are aligned with the *Code of Practice -Ecologically sustainable management of flying-fox roosts*.

Gas Gun – Thunderbird 100: The ThunderBird 100 is a wildlife dispersal tool used across Australia in industries ranging from Defence, airports, councils, oil rigs, wineries, landfills, agriculture, aquaculture and golf courses. The ThunderBird emits a loud audible 'bang' (decibel rating of 125db to 145db). The mobility of this product allows wildlife managers to disperse wildlife hazards, such as flying-foxes with a degree of directional control not found with ordinary dispersal tools. Designed with the highest levels of safety, the ThunderBird 100 maximises the safety, reliability and effectiveness. This tool also does not require any specific licences which makes it usable for all technicians.

Hyperspike (LRAD): The HS-10 is a portable audio deterrent device with the ability to penetrate high background noise environments to ensure that unmistakable commands and piercing alert tones are heard. Exceeding traditional megaphones and common hailing devices, it has a peak acoustic output of 144dB for a communication range of 750+m. The focused audio beam can be used to transmit selected wildlife distress calls, predator calls or alert tones.

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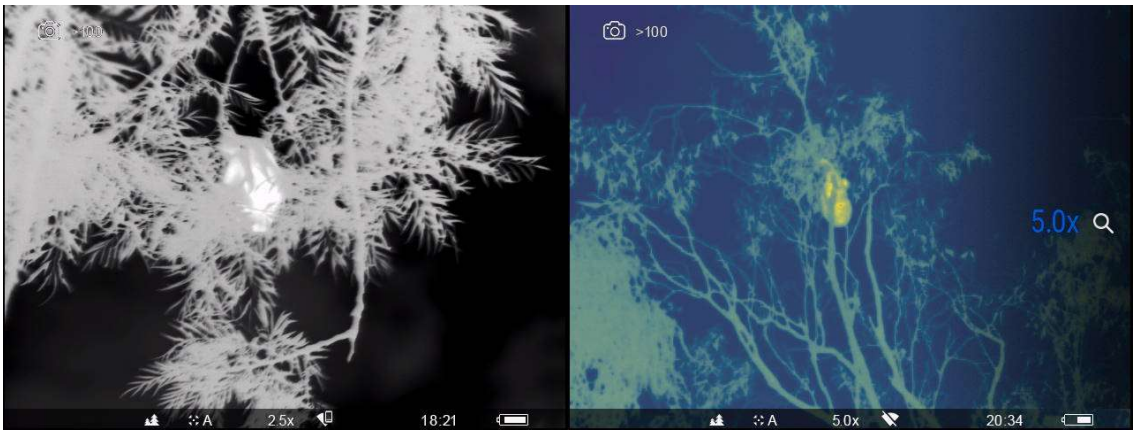
Thermal Imagery: professional grade thermal imagery will be available to the Biodiversity Australia field staff. this technology has proven to be very valuable in the identification of créching animals at the roost site, which can be done from a distance without disturbance.



Specialist Pyrotechnics: Biodiversity Australia will provide the nominated and appropriately licenced team members with access to a broad selection of industry-leading wildlife management pyrotechnics. These pyrotechnics can be used from a 12g firearm (with an N-One Pyro adaptor) or from specialised pistol. The range of pyrotechnic wildlife management tools is one of the key differences between this method and historical methods. the range of pyrotechnics include loads which have strong audible deterrents, strong visual deterrents, erratic flight paths as well as ones which leave trailing smoke which presents a visual, audible and olfactory deterrent. By using this tool Biodiversity Australia's highly trained technicians are able to manipulate the flying fox colony in the air allowing for unprecedented levels of control over the camp.

Stock Whip: The use of stock whips, while simple, is highly effective in moving flying-foxes. Stock whips create a loud crack, which acts as an audible deterrent. In addition, the fast movements of the whip and wildlife manager's arm result in a negative physical/visual cue. This method requires some practice, but is very effective and useful in a range of situations at short notice.

Air Horn: Air horns, which produce a loud, high-pitched blast, are also an effective flying-fox deterrent. When in use, the air horn is activated for approximately one to two seconds, up to four times or until effective dispersal has been achieved.

Pool Noodle: Whilst a very simple tool, the pool noodle has proven to be a key deterrent on many previous dispersal works. The hollow noodle is cut in halves. Two halves are then brought together in a clapping motion, echoing sound in the direction of the flying-fox. This is a basic, yet very effective tool for dispersal programs.

Quad Bike: The quad bike is used to allow greater accessibility throughout the site as a dispersal technique. The quad bike is used to provide a contract to the "on-foot" approach that commonly accompanies other methods.

Hand-held UHF Radios: Biodiversity Australia staff will all be equipped with hand held UHF radio to allow for positive communication over large areas, this allows field technicians to report in flying-fox behaviour to the project manager as well as take directly quickly and promptly.

Relocation Works

The following section describes the typical methods which would be undertaken within the relocation project, whilst these methods may alter according to flying-fox behaviour etc. the basic principal will remain the same. It should be noted that all activities undertaken in accordance with Biodiversity Australia's internal Code of Practice for flying-fox management which meets and exceeds the provisions of the Department of Environment and Science Flying-fox Camp Management - Code of Practice. A copy of this is provided within Appendix A.

Pre-works

- Throughout understanding of objectives and risks has been achieved through the alternative roosting study and risk analysis,
- All appropriate stakeholders have been notified of the proposed works and appropriate mitigations have been enforced i.e. NOTAM at the Cairns Airport,
- All appropriate safe work method statements have been developed,
- One day prior to the relocation works, Biodiversity Australia staff and relevant CRC will undertake a project familiarisation session at the site to run through the main objectives and contingency plans, &
- Al equipment will have the final checks undertaken so that they are confirmed to be fit for purpose.

Day 1

- All relevant staff meet at the library roost site one hour prior to first light,
- The project manager and project director undertake a pre-start meetings to have a final run through safety and reinforce individual roles etc,
- Scouting staff are located at highly sensitive receptors to communicate if flying-foxes are landing in these areas, which will allow for immediate response and mitigation,
- Passive equipment such as high intensity lighting and audio equipment will be set up in strategic locations to provide a passive deterrent to the original roost site,
- The project manager and allocated key senior team members will be equipped with pyrotechnics whilst all other technicians will be equipped with pool noodle deterrents,
- The project manager will place technicians in key locations and senior staff will be roaming,
- All staff will remain silent until instructed by the project manager,
- Once flying-foxes begin to fly in from the nights foraging, they will be allowed to gather for approximately 10-15min. This allows staff to then lift the entire population in one movement and manipulate them into a single rotational mass which can be influenced by the use of pyrotechnic smoke screens. Initial lifts will be undertaken by shotgun simulators and loud pyrotechnics,

- If the flying-foxes are to move in a westerly direction, visual and olfactory pyrotechnic deterrents will be raised on the eastern side of the rotational mass creating a negative association with that direction, hence pushing the rotational mass west,
- This process is followed until the flying-foxes are in an acceptable temporary location or the project manager and/or project director deem that stress levels are getting too high,
- Typical relocation works take between 20 to 40 minutes which is well below the 2hrs standard,
- Technicians continue to monitor the flying-fox population at the new roost as well as roaming throughout the town to identify any potential splinter camps,
- The project manager conducts a post works de-brief to go through successes and failures of the day and set actions in preparation for the next day's works,
- A small number of technicians will continue to monitor the population in their new location throughout the day to look for signs of excessive stress etc.
- A dusk that afternoon field technicians will undertake flying out surveys and monitor roosting sites for créching etc.
- All welfare based stop work triggers are described within the Biodiversity Australia Code of Practice.

Day 2

- As per Day 1 – to the next acceptable temporary roost location

Day 3

- As per Day 1 – to the next acceptable temporary roost location

Day 4

- As per Day 1 – to the next acceptable temporary roost location
- It is theorised that by approximately the fourth day the flying-foxes will have been relocated to their final location, this will be dependent upon flying-fox behaviour etc.
- If additional days are required they will be coordinated in accordance with Day 1.
- Full relocation days such as those described for Day 1 will only be undertaken for six consecutive days as a maximum, at which time the relocation works will be suspended for one full day.

Continual dissociation

- Once the colony has been relocated to the desired location continual negative association works will continue at the original roost site for a period of approximately one week. these works are characterised by very low intensity pool noodle and lighting at the original roost site,
- Once the original roosting location has been abandoned, other passive deterrent works such as tree pruning etc are recommended to further enforce the negative association.

Rapid reporting and response program

Whilst the methodology presented above has had very good proven success historically, it has been noted that in future seasons/years when flying-fox numbers fluctuate they can sometimes gravitate towards the original roosting site at the Cairns Library. In order to account for this possibility, a rapid response reporting hotline will be established for the community, carers or even CRC staff to report the re-establishment of the camp very rapidly. This will in turn allow for a very rapid response (within 48hrs) from Biodiversity Australia personnel to undertake early intervention relocation works whilst the camp is still very small and not yet re-established. By undertaking these rapid response works flying-foxes are much more willing to move and it requires a far smaller team for fewer days. This ultimately results in; a more guaranteed result, less stress on the flying-foxes and a far smaller financial investment.

The ability for the community to become educated in the process and take part – through the rapid response platform also allows for the community to take ownership of the issue. This has been proven to promote better community attitudes towards the works as demonstrated with previous projects by Biodiversity Australia in Moranbah and Miriam vale QLD.

References

Aziz, S.A., Olival, K.J., Bumrungsri, S., Richards, G.C. & Racey, P.A. (2016) The conflict between pteropodid bats and fruit growers; species, legislation and migration, in *Bats in the Anthropocene: Conservation of Bats in a Changing World*. Springer International Publishing, New York.

Birt, P., McCoy, M. & Palmer, C. (2008) Little red flying-fox *Pteropus scapulatus*, in *The Mammals of Australia* (eds. S. Van Dyck and R. Strahan). Reed New Holland, Sydney.

Churchill, S. (2008) *Australian bats*. Allen & Unwin, Crows Nest.\

CAFNEC (2018) *Ecotone* - Volume 38 Number 3. Cairns and Far North Environment Centre, Cairns

URL:https://cafnec.org.au/wp-content/uploads/2018/08/201711-Ecotone-web.pdf . Accessed 10th February 2019.

CoA (2017) *Living with fruit bats - Inquiry into flying-fox management in the eastern states*. House of Representatives Standing Committee on the Environment and Energy. Commonwealth of Australia, Canberra.

Cohen, M. (2015) *Flying Fox Survey in the Cairns* CBD (March, 2015). Report to Cairns Regional Council. Wild about Australia, Cairns.

Cohen, M. (2017) Spectacled Flying-foxes in Cairns CBD – a wildlife emergency. *Ecotone (Magazine of the Cairns and Far North Environment Centre)* **37**:18.

CRC (2018) *Management of flying foxes general policy*. Cairns Regional Council, Cairns. URL: https://www.cairns.qld.gov.au/__data/assets/pdf_file/0008/91268/Flying-Fox-Colony-Management-General-Policy.pdf. Accessed: 11 March 2019.

CRC (2019) *Flying-foxes – Spectacled flying-foxes. Cairns Regional Council*, Cairns. URL: https://www.cairns.qld.gov.au/community-environment/native-animals/flying-foxes. Accessed: 11 March 2019.

DAF (2019) *About us – Biosecurity Queensland*. Department of Agriculture and Fisheries, Brisbane. URL: https://www.daf.qld.gov.au/our-organisation/about-us. Accessed: 11 March 2019.

DERM (2010a) *National recovery plan for the spectacled flying fox Pteropus conspicillatus*. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

DERM (2010b) *Wet Tropics Natural Resource Management Region Back on Track Actions for Biodiversity*. Department of Environment and Resource Management, Brisbane.

DoE (2013) Matters of National Environmental Significance: Significant Impact Guidelines 1.1. Department of the Environment, Canberra.

DoEE (2018) *National Flying-fox monitoring viewer*. Department of the Environment and Energy, Canberra. URL: http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf. Accessed: 10 March 2019.

Edson, D., Field, H., McMichael, L., Jordan, D., Kung, N., Mayer, D. & Smith, C. (2015) Flying-fox roost disturbance and Hendra virus spillover risk. *PloS One* **10**:e0125881.

DES (2015) Code *of Practice: Ecologically sustainable lethal take of flying-foxes for crop protection*. Department of Environment and Science, Brisbane. URL: https://environment.des.qld.gov.au/wildlife/livingwith/flyingfoxes/pdf/cp-wl-dmp-lethal-flying-fox.pdf. Accessed: 11 March 2019.

DES (2016) *Viruses hosted by flying-foxes. Department of Environment and Science*, Brisbane. URL: https://environment.des.qld.gov.au/wildlife/livingwith/flyingfoxes/viruses.html. Accessed: 10 March 2019.

DES (2019) *Importance of flying-foxes. Department of Environment and Science*, Brisbane. URL: https://environment.des.qld.gov.au/wildlife/livingwith/flyingfoxes/importance.html. Accessed: 11 March 2019.

Fox, S. (2011). The Spectacled Flying Fox – a review of past and present knowledge, in *The biology and conservation of Australasian bats* (eds. B. Law, P. Eby, D. Lunney & L. Lumsden). Royal Zoological Society of New South Wales, Mosman.

Fujita, M.S. & Tuttle, M.D. (1991) Flying foxes (Chiroptera: Pteropidae): Threatened animals of key ecological and economic importance. *Conservation Biology* **5**:455-463.

Garnett, S., Whybird, O. & Spencer, H. (1999) The conservation status of the spectacled flying-fox (*Pteropus conspicillatus*) in Australia. *Australian Zoologist* **31**:38-54.

GeoLINK (2012) *Lorn flying-fox management strategy*. Report to Maitland Council/ GeoLINK, Lennox Head.

Heard, D. (2003) Chiroptera (bats), in *Zoo and wild animal medicine* (eds. M.E. Fowler & R.E. Miller). Elsevier, Missouri.

Helgen, K., Salas, L. & Bonaccorso, F. (2008) *Pteropus conspicillatus*. The IUCN Red List of Threatened Species 2008. URL: http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T18721A8510243.en. Accessed: 10 March 2019.

IUCN (International Union for Conservation of Nature) (2008) *Pteropus conspicillatus*. The IUCN Red List of Threatened Species. Version 2018-1 http://www.iucnredlist.org. Accessed: 11 March 2019.

Kim, S. (2019) *Extreme heat wipes out almost one third of Australia's spectacled flying fox population*. ABC Far North, Cairns. URL: https://www.abc.net.au/news/2018-12-19/heat-wipes-out-one-third-of-flying-fox-species/10632940. Accessed: 10 March 2019.

Mildenstein, Stier, Nuevo-Diego, & Mills. (2005). Habitat selection of endangered and endemic large flying-foxes in Subic Bay, Philippines. Biological Conservation, 126(1), 93-102.

NRA (2016a) *EPBC Act self-assessment report: In situ management of Spectacled Flying –foxes within Stage 2 of the Shields Street Heart Project*. Report to Cairns Regional Council. NRA Environmental *Consultants, Cairns (Author: Morrant, D.S).*

NRA (2016b) EPBC Act self-assessment report: Potential impacts on spectacled flying-foxes (Pteropus conspicillatus) resulting from upgrades to a multi-storey carpark adjacent to Cairns City Library. Report to Cairns Regional Council. NRA Environmental Consultants, Cairns (Author: Morrant, D.S).

NRA (2016c) *Central Highlands Regional Council Flying-fox Management Plan*. Report to Central Highlands Regional Council. NRA Environmental Consultants, Cairns (Author: Morrant, D.S).

NRA (2016d) *EPBC Act Self-assessment Report – Potential impacts on spectacled flying-foxes* (*Pteropus conspicillatus*) *resulting from cleaning and maintenance at the Cairns City Library.* Report to Cairns Regional Council. NRA Environmental Consultants, Cairns (Author: Morrant, D.S).

NRA (2019a) *Cairns City Library Tree Removal EPBC Act self-assessment*. Report to Cairns Regional Council. NRA Environmental Consultants, Cairns (Author: Popple, L.).

NRA (2019b) *Cairns Regional Council library flying-fox colony relocation advice*. Report to Cairns Regional Council. NRA Environmental Consultants, Cairns (Author: Popple, L.).

NRA (2019c) *Cairns Regional Council Library flying-fox colony relocation advice* (*2*). Report to Cairns Regional Council. NRA Environmental Consultants, Cairns (Author: Popple, L.).

NSW Health (2015a) *Communicable diseases factsheet: Hendra virus*. NSW Health, Sydney. URL: https://www.health.nsw.gov.au/Infectious/factsheets/Factsheets/hendra.pdf. Accessed: 10 March 2019.

NSW Health (2015b) *Communicable diseases factsheet: Rabies and Australian bat lyssavirus infection*. NSW Health, Sydney. URL: https://www.health.nsw.gov.au/Infectious/factsheets/Factsheets/rabies.pdf. Accessed: 10 March 2019.

Olsson, A. & Woods, R. (2008) Bats, in *Medicine of Australian Mammals* (eds. L. Vogelnest and R. Woods). CSIRO Publishing, Collingwood.

QGov (2017) *Bats and human health*. Queensland Government, Brisbane. URL: http://conditions.health.qld.gov.au/HealthCondition/condition/14/217/14/Bats-human-health. Accessed: 11 March 2019.

QLD Health (2017a) *Australian bat lyssavirus*. Queensland Health, Brisbane. URL: http://conditions.health.qld.gov.au/HealthCondition/media/pdf/14/217/10/australian-bat-lyssavirus-v9. Accessed: 10 March 2019.

QLD Health (2017b) *Hendra virus infection*. Queensland Health, Brisbane. URL: http://conditions.health.qld.gov.au/HealthCondition/media/pdf/14/217/363/hendra-virus-infection-v14. Accessed: 10 March 2019.

Richards, G.C., Spencer, H.J. & Fox, S. (2008) Spectacled flying-fox *Pteropus conspicillatus*, in *The Mammals of Australia* (eds. S. Van Dyck and R. Strahan). Reed New Holland, Sydney.

Shilton L.A., Latch P.J., McKeown A., Pert P. & Westcott D.A. (2008) Landscape-scale redistribution of a highly mobile threatened species, *Pteropus conspicillatus* (Chiroptera, Pteropodidae), in response to Tropical Cyclone Larry. *Austral Ecology* **33**:549-561.

SPRAT (2019) *Species Profile and Threats Database*: *Pteropus conspicillatus* - Spectacled flying-fox. URL: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=185. Accessed: 11 March 2019.

Stephens, A. & Kim, S. (2018) Using *baby bats as bait: Cairns council tries new tactic to lure flying fox colony out of CBD.* ABC Far North, Cairns. URL: file:///G:/Biosphere/Projects/001_CRC/001002_SFF%20dispersal%20and%20relocation%20plan/Data/Flying-fox%20literature/Media/Using%20baby%20bats%20as%20bait%20%20Cairns%20council%20tries%20new%20tactic%20to%20lure%20flying%20fox%20colony%20out%20of%20CBD%20-

%20ABC%20News%20(Australian%20Broadcasting%20Corporation).htm. Accessed: 11 March 2019.

Tait, J., Perotto-Baldivieso, H.L., McKeown, A. & Westcott, D.A. (2014) Are flying-foxes coming to town? Urbanisation of the spectacled flying-fox (*Pteropus conspicillatus*) in Australia. *PLoS One* **9**: e109810.

TSSC (2019) *Conservation advice Pteropus conspicillatus*. Threatened Species Scientific Committee - Department of the Environment and Energy, Canberra.

Westcott, D. (2013) *Flying-foxes and settlements in FNQ: evidence from the early Cairns newspapers*. Online, Cairns and Far North Environment Centre. URL: https://cafnec.org.au/2013/09/17/flying-foxes-and-settlements-in-fnq-evidence-from-the-early-cairns-newspapers/. Accessed: 11 March 2019.

Westcott, D.A., Heersink, D.K., McKeown, A. & Caley, P. (2015) *Status and trends of Australia's EPBC-listed flying-foxes.* Report to the Department of the Environment (Cth). CSIRO, Australia.

Woinarski, J.C.Z., Burbidge, A.A., & Harrison, P.L. (2014). *The Action Plan for Australian Mammals 2012*. CSIRO Publishing, Collingwood.

Wood W.F., Walsh A., Seyjagat J., Weldon P.J. (2005) Volatile compounds in shoulder gland secretions of male flying foxes, genus *Pteropus* (Pteropodidae, Chiroptera). *Zeitschrift für Naturforschung C* **60**:779-84.

WPSQ (2002 [NB: date uncertain) *Report and map Cairns Central Swamp flying fox sites*. Wildlife Preservation Society of Queensland archive documents from the James Cook University Library. James Cook University, Townsville.