Townsville Flying-Fox Roost Management Plan

March 2026

Acronyms and abbreviations

ABLV	Australian bat lyssavirus
ACP Act	Animal Care and Protection Act 2001 (Queensland)
BFF	Black flying-fox (Pteropus alecto)
CMS	Canopy-mounted sprinklers
Council	Townsville City Council
DAF	Department of Agriculture and Fisheries (Queensland)
DAWE	Department of Agriculture, Water, and Environment (Commonwealth)
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Commonwealth)
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth)
FFRMP	Flying-fox Roost Management Permit
Fisheries Act	Fisheries Act 1994 (Queensland)
Gardens	Dan Gleeson Memorial Gardens
GHFF	Grey-headed flying-fox (P. poliocephalus)
The Guideline	Flying-fox Roost Management Guideline (Queensland)
HeV	Hendra virus
HSE	Heat stress event
LGA	Local Government Area
Low Impact COP	Code of Practice – Low impact activities affecting flying-fox roosts (Queensland)
LRFF	Little red flying-fox (P. scapulatus)
Management COP	Code of Practice – Ecologically sustainable management of flying-fox roosts (Queensland)
MNES	Matters of national environmental significance
NFFMP	National Flying-Fox Monitoring Program
NC Act	Nature Conservation Act 1992 (Queensland)
NSW	New South Wales
The Plan	Townsville Flying-fox Roost Management Plan
Planning Act	Planning Act 2016 (Queensland)
PPE	Personal protective equipment
Qld	Queensland
SEQ	South East Queensland

SFF	Spectacled flying-fox (P. conspicillatus)
SoMI	Statement of Management Intent
TNT	Threatened/Near Threatened (Critically endangered, endangered, vulnerable or near threatened)
UFFMA	Urban Flying-fox Management Area
VM Act	Vegetation Management Act 1999 (Queensland)

Contents

1. Introduction

Townsville local government area (LGA) covers 3,736 km2 halfway between the tip of Cape York and Brisbane. Townsville LGA has a population of almost 200,000 residents which is projected to increase to approximately 280,000 by 2041 (ABS 2018). Townsville has both mainland and island communities, and is made up of developed urban areas, rural, and natural areas.

This Flying-fox Roost Management Plan (the Plan) provides Townsville City Council (Council) with a framework to manage issues associated with flying-fox roosts in the LGA. There are at least 16 recorded flying-fox roosts1 in the Townsville LGA, where numbers of flying-foxes vary throughout the year. This Plan will focus on five urban roosts, including Dan Gleeson Memorial Gardens, Morstone Park, Riverside Gardens, the Palmetum Botanic Gardens, and Alice River.

This plan includes a rang of options to enable Council to support residents within the Townsville LGA that are being impacted from living near flying-foxes. The Council intends to manage flying-fox roosts on Council-owned or managed land but may also provide advice and assistance to residents and landowners affected by a flying-fox roost on privately-owned land. Where a roost spans Council-owned and private land, Council will encourage joint mitigation actions.

Four flying-fox species have been recorded within the Townsville LGA: Black flying-foxes (Pteropus alecto; BFF) are generally present in the Townsville LGA year-round, with seasonal influxes of the little-red flying-foxes (P. scapulatus; LRFF). The grey-headed (P. poliocephalus; GHFF) and spectacled flying-fox (P. conspicillatus; SFF) are rare visitors to the Townsville LGA. Flying-foxes are keystone species for their critical role in long-distance pollination and seed dispersal, which is particularly important over fragmented landscapes. All species and their habitats are protected in Queensland (Qld) under the Nature Conservation Act 1992 (NC Act), administered by the Department of Environment, Tourism, Science and Innovation (DETSI). The GHFF and SFF are also protected under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) as a threatened species due to population decline and ongoing threats (see Section 1.4, Appendix 1, and Appendix 2).

1.1. Flying-foxes in urban areas

Flying-foxes appear to be roosting and foraging in urban areas more frequently. In a recent study of 654 known national flying-fox roosts, 55% of roosts occurred in urban areas and a further 23% occurred in agricultural areas (Timmiss et al. 2021). Only 7% occurred in protected areas such as national parks (Timmiss et al. 2021). Furthermore, the number of roosts increased with increasing human population densities (up to ~4000 people per km2) (Timmiss 2017). There are many possible drivers for this urbanising trend (Tait et al. 2014):

- loss of native habitat from urban expansion and agriculture
- food availability from native and exotic species found in urban areas
- disturbance events such as drought, fires, cyclones
- human disturbance or culling at non-urban roosts or orchards
- urban effects on local climate
- refuge from predation
- movement advantages, e.g. ease of manoeuvring in flight due to the open nature of habitat or ease of navigation due to landmarks and lighting.

Living near a flying-fox roost presents unique challenges for the community. State approval is required under legislation to manage a roost (see Section 1.4). If a roost is recognised as established by DETSI, certain management actions may be undertaken in accordance with the Code of Practice – Ecologically sustainable management of flying-fox roosts (Management COP) (see Section 1.4). Management actions may not be permissible if GHFF or SFF are present and/or at certain times of the year e.g. when dependent young (pups) are present. Actions which may affect the GHFF and/or SFF must adhere to Commonwealth policy (see Section 1.4).

Effective management strategies take a tiered approach starting with lower-level actions including community education and site maintenance. Escalation to higher-level actions such as roost dispersal may be investigated, however it is important to consider the risks with all potential management actions. Higher-level actions including attempts to disperse flying-foxes are extremely costly, and often unsuccessful in the short- and long-term (Roberts et al. 2021) as flying-foxes are likely to attempt to recolonise their preferred roost site. A significant risk of higher-level management actions is that a roost may splinter, forming multiple undesirable roosts, negatively impacting more residents. Additional information on management options is provided in Section 7.

1.2. Community concerns

Living near a flying-fox roost can be challenging for communities, with impacts such as noise, odour, faecal drop, and concern about potential health risks. These direct impacts can contribute to anxiety, sleep deprivation, and generally reduced wellbeing. Secondary impacts such as these are difficult to quantify and will vary with peoples' situations and tolerances (as shown by Lentini et al. 2020). Primary concerns regarding the Townsville LGA roosts include:

- noise during the day
- noise during the night impacting sleep
- faeces in/around the flying-fox roost and neighbouring properties (associated with roosting and/or flying over)
- smell
- health concerns.

Further detail is provided in Section 6.

1.3. Plan Objectives

Objectives of this Plan are to:

- guide management of the priority urban flying-fox roosts within the Townsville LGA:
  - Dan Gleeson Memorial Gardens, Kirwan
  - Morstone Park, Annandale
  - Riverside Gardens, Douglas
  - The Palmetum Botanic Gardens, Douglas, Alice River
- inform assessment and potential actions around newly formed flying-fox roosts
- include an analysis of the success of the 'flying-fox roost residents assistance program' and provide recommendation on whether a continuation of the program is warranted
- minimise community impacts and avoid future conflict
- improve community understanding and appreciation of flying-foxes including their ecological role
- where flying-fox roosts occur on or impact private land, private landowners are advised to contact Council to explore management options and the appropriate approval processes for addressing issues
- conserve flying-foxes and their habitat
- support ways for the community to co-exist with flying-foxes
- clearly define roles and responsibilities for management actions
- ensure actions are in accordance with relevant legislation.

1.4. Legislation overview

Flying-foxes are protected native wildlife that provide a critical ecological role in long-distance seed dispersal and pollination. As such, there are various legislation and policy that governs how flying-foxes and

their habitat can be managed in Qld (Table 1). As native animals, all flying-foxes and their roost habitat are protected under State legislation. GHFF and SFF are listed species with additional protection under Commonwealth legislation. Details of relevant legislation are provided below (see further details in Appendix 1).

Table 1 Legislation relevant to flying-fox management and conservation

Level	Instrument	Relevance to the Plan
Commonwealth	Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Approval under the EPBC Act may be required for any action likely to impact a Matter of National Environmental Significance (MNES) e.g. nationally threatened species (such as the GHFF or SFF) or ecological communities, world heritage sites, wetlands of international importance. The referral guideline for management actions in GHFF and SFF roosts (DoE 2015) specifies requirements for roost1 management, and when referral is required. To be considered a nationally important GHFF roost, a roost must have had more than one influx of ≥10,000 GHFF within the last 10 years or have been occupied by more than 2500 GHFF permanently or seasonally for the last 10 years. Neither applies to the roosts within the Townsville LGA. Regarding SFF, the criteria are yet to be set, however the Townsville roosts have recorded less than 10 SFF and no birthing, pups, or breeding, as such they are unlikely to be assessed as significant for the species.
State	Nature Conservation Act 1992 (NC Act)	All flying-foxes and their roost habitat are protected under the NC Act. Under this legislation, administered by the DETSI, it is an offence to harm the animals or disturb flying-foxes from daytime roosts2 without approval. In Qld, local governments are authorised under the NC Act to manage roosts in areas subject to an urban zoning under a council planning scheme, inclusive of a 1 km buffer around such areas. This area of management is known as the Urban Flying-Fox Management Area (UFFMA).
	The Code of Practice – Ecologically sustainable management of flying-fox roosts (Management COP)	Local governments have an 'as-of-right' authority under the NC Act to manage flying-fox roosts in mapped UFFMAs in accordance with the Management COP (DES 2020a). The Flying-fox Roost Management Guideline (the Guideline) (DES 2020b) has been developed to provide local government with additional information that may

Level	Instrument	Relevance to the Plan
	The Flying-fox Roost Management Guideline (the Guideline) Low impact activities affecting flying-fox roosts (Low Impact COP)	assist decision making and management of flying-fox roosts. Council is required to apply for a flying-fox roost management permit (FFRMP) to manage roosts outside an UFFMA, or for management actions not specified in the Management COP. It must be noted that this 'as-of-right' authority does not oblige Council to manage flying-fox roosts and does not authorise management under other relevant sections of the NC Act or other legislation. Anyone other than local government is required to apply for a FFRMP for any management directed at roosting flying-foxes, or likely to disturb roosting flying-foxes other than: ▫ certain low impact activities (e.g. mowing, minor tree trimming) if undertaken in accordance with the Code of Practice – Low impact activities affecting flying-fox roosts (Low Impact COP) (DES 2020c) ▫ instances where Council is enacting their as-of-right authority.
	Animal Care and Protection Act 2001 (ACP Act)	The ACP Act applies to all living vertebrate animals, including wildlife. To comply with the ACP Act, flying-fox management actions must not cause mental or physical suffering, pain, or distress.
	Vegetation Management Act 1999 (VM Act) and Planning Act 2016 (Planning Act)	Native vegetation is protected under various legislation, including the NC Act, VM Act, and Planning Act. Permits/approval may be required for trimming or clearing protected habitat/plants.
Local	Statement of Management Intent (SoMI)	Council endorsed a SoMI (Flying-fox Management Policy) in 2022 for Flying-fox Roost Management in Townsville LGA for the purpose of articulating Council's approach to management of flying-foxes within the Townsville LGA, specifically within UFFMA. Council's Flying-fox Management Policy aims to reduce conflict between flying-foxes and the community in addition to improving coordination and planning of flying-fox roost management within UFFMA of the Townsville LGA

2. Flying-fox ecology

2.1. Ecological role

Flying-foxes, along with some birds, make a unique contribution to ecosystem health through their ability to move seeds and pollen over long distances (Southerton et al. 2004, DES 2020). This contributes directly to reproduction, regeneration, and viability of forest ecosystems (DCCEEW 2021). It is estimated that a single flying-fox can disperse up to 60,000 seeds in one night (DELWP 2015). Some plants, particularly Corymbia spp., have adaptations suggesting they rely more heavily on nocturnal visitors such as bats for pollination than daytime pollinators (Southerton et al. 2004).

Flying-foxes are highly mobile and nomadic, each species considered to have a single national population. They move across their national range between a network of roosts (Welbergen et al. 2020). Roost occupancy may be permanent, seasonal, temporary, or sporadic and numbers can fluctuate significantly on a daily/seasonal basis (Vanderduys et al. 2024). Flying-foxes may travel 300 km in a single night (Welbergen

et al. 2020) and have been recorded travelling over 500 km in two days between roosts (Roberts et al. 2012). Each night, flying-foxes readily forage up to 20 km from their roost (Meade et al. 2021), however they may travel greater distances and return to the same roost. In comparison, bees, another important pollinator, move much shorter foraging distances of generally less than 1 km (Zurbuchen et al. 2010).

Long-distance seed dispersal and pollination make flying-foxes critical to the long-term persistence of many plant communities (Westcott et al. 2008, McConkey et al. 2012), including eucalypt forests, rainforests, woodlands, and wetlands (Roberts 2006). Seeds that are dispersed away from their parent plant that germinate have a greater chance of growing into a mature plant (Ruxton & Schaefer 2012). Long-distance dispersal also allows genetic material to be spread between forest patches that would normally be geographically isolated (Parry-Jones & Augee 1992, Eby 1991, SEQ Catchments 2012). This genetic diversity allows species to adapt to environmental change and respond to disease pathogens. Transfer of genetic material between forest patches is particularly important in the context of contemporary fragmented landscapes.

Flying-foxes are considered 'keystone' species given their contribution to the health, longevity, and diversity among and between vegetation communities. These ecological services ultimately protect the long-term health and biodiversity of Australia's bushland and wetlands. In turn, native forests act as carbon sinks (Roxburgh et al. 2006), provide habitat for animals and plants, stabilise river catchments, and add value to the production of hardwood timber, honey, and fruit (NSW Wildlife Council 2010). Native forests also provide recreational and tourism opportunities worth millions of dollars each year (DES 2020).

2.2. Roost preferences

Little is known about flying-fox roost preferences; however, research indicates that in addition to the proximity to food sources, flying-foxes choose to form roosts in vegetation with at least some of the following general characteristics (SEQ Catchments 2012):

- closed canopy > 5 m high
- dense vegetation with complex structure (upper, mid and understorey layers)
- within 500 m of permanent water source
- within 50 km of the coastline or at an elevation < 65m above sea level
- level topography (< 5° incline)
- ideally greater than 1 ha to accommodate and sustain large numbers of flying-foxes and allow the roost to shift its extent so vegetation can recover (note this does not appear to be a strong flying-fox preference, but more a consideration in roost habitat creation/improvement).

Recently research into LRFF habitat preferences revealed that roosts were most often associated with the following attributes (MacDonald et al. 2021, Westcott et al. 2020):

- taller canopy; mean height of canopy trees was 19.9 m (± 8.9 m) and of subcanopy trees was 9.9 m ± 4.8 m
- greater canopy and subcanopy cover/complexity
- marginally taller shrub layer with greater cover
- shorter, less dense ground cover layer
- preference for ten tree species (accounting for 68% of roost habitats), including Eucalyptus, Melaleuca, Rhizophora, Avicennia, Corymbia, and Tamarandus species
- generally located within 200 m of watercourse (50% of roosts).

Proximity to water is a key attribute in roost location (Hall & Richards 2000, Roberts 2005, MacDonald et al. 2021) with one study suggesting that 94% of GHFF roosts in NSW were (at that time) located adjacent to or on a waterway or waterbody (Eby & Lunney 2002).

These are general findings and flying-foxes have been known to roost in a variety of habitats outside the above criteria.

2.3. Flying-fox breeding cycle

Flying-foxes reach reproductive maturity in their second year of life, with most individuals breeding from their third year. Reproductive cycles detailed below are indicative and can vary by several weeks between regions, are annually influenced by climatic variables, and births can occur at any time of the year. The breeding cycle must be considered when assessing implement management actions. Expert assessment is required to accurately determine the phase in the breeding cycle to inform the timing and suitability of management.

Black, grey-headed, and spectacled flying-foxes

Mating begins in January with peak conception occurring around March to April/May (Table 2); this mating season represents the period of peak roost occupancy (Markus 2002). Young (usually a single pup) are born six months later from September to November depending on species (Churchill 2008). The birthing season becomes progressively earlier, albeit by a few weeks, in more northerly populations (McGuckin & Blackshaw 1991), however out of season breeding is not unusual and births may occur at any time of the year (Ecosure pers. obs. 2015-2024).

Young are highly dependent on their mother for food and thermoregulation. Young are suckled and carried by the mother until approximately four weeks of age (Markus & Blackshaw 2002). After four weeks they are left at the roost during the night in a crèche until they begin foraging locally in January to March (Churchill 2008) and are usually weaned by six months of age around March to May, depending on the species. Sexual maturity is reached at two years of age with an average life expectancy of 5-7 years (Divljan et al. 2006, Fox et al. 2008).

Individuals have been recorded to live to 18 years of age in the wild (Tidemann & Nelson 2011).

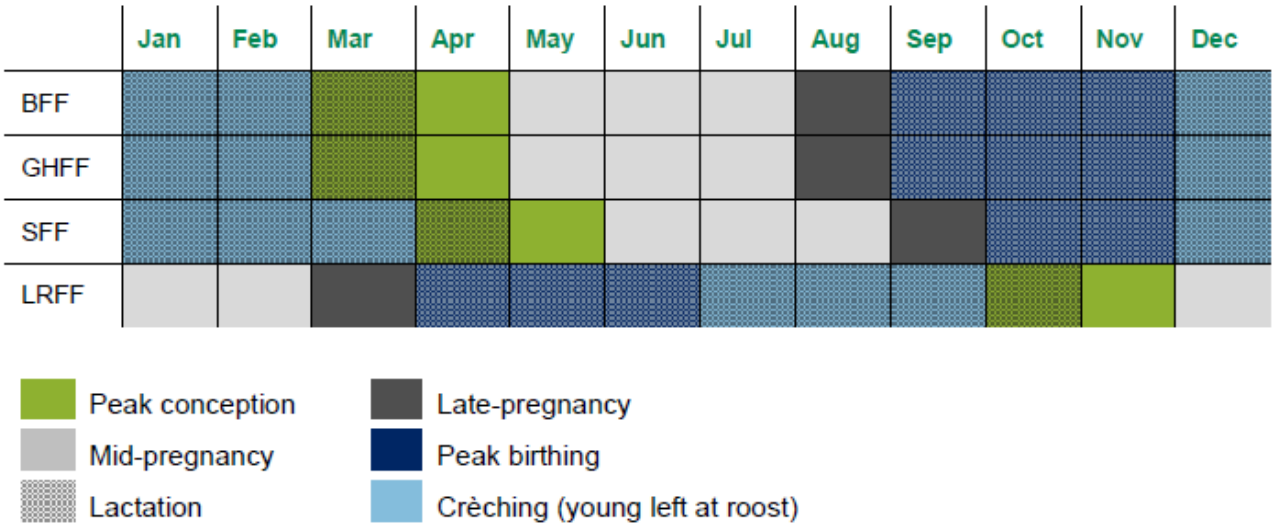
The critical reproductive period for BFF, GHFF, and SFF is generally from August/September (when females are in late stages of pregnancy) to the end of peak conception around April/May. Dependent pups are usually present from September/October to February/March.

Little red flying-fox

The LRFF breeding cycle is approximately six months out of phase with BFF and GHFF (Table 2). Conception occurs around October to November, with peak birthing in April-June (McGuckin & Blackshaw 1991, Westcott et al. 2020). Young are carried by their mother for approximately one month then left at the roost while she forages (Churchill 2008). Suckling occurs for several months while young are learning how to forage.

LRFF pups are particularly vulnerable to cold weather and can suffer hypothermia and fall from their crèche trees. If LRFF pups are present, rescuers and carers should be on stand-by during cold weather.

Table 2 Indicative flying-fox reproductive cycle



2.4. Flying-foxes in Townsville

There are at least 16 known flying-fox roosts within the Townsville LGA (Figure 1), which form part of the network of roosts across the LGA, Qld, and Australia. In Townsville, BFF are typically seen year-round, although their abundance at any roost site may fluctuate throughout the year. Historically, LRFF are far more transitory arriving in large numbers, with up to 50,000 from May/June annually in search of food (mostly nectar from native trees). GHFF and SFF have been seen infrequently in small numbers in the Townsville LGA.

Flying-fox roosts may be occupied continuously, annually, irregularly, or rarely and the number of individuals can fluctuate significantly on a daily, seasonal, or annual basis (up to 17% daily colony turnover; Roberts 2005, Welbergen et al. 2020). Being highly mobile and nomadic, flying-fox roosts should be thought of as a network of temporary accommodation across their range. The use of a roost is primarily thought to be associated with the local availability of foraging resources (pollen, nectar, fruit) (Yabsley et al. 2021). A study of satellite tracked individuals over a 60-month period and found that GHFF (n = 109), BFF (n = 80), and LRFF (n = 12) roosted at 546, 173, and 89 roosts, respectively (Welbergen et al. 2020). This data highlights the mobility of flying-foxes and their transient use of roosts.

Flying-fox occupancy in certain areas can be influenced by a multitude of factors but is generally driven by resource availability in the local area. Between 2019 and 2020, flying-foxes experienced significant challenges across the east coast of Australia due to a range of extreme weather events. A prolonged drought period caused a mass food shortage from Coffs Harbour to Gladstone, in which thousands of flying-foxes perished from starvation (Cox 2019, Huntsdale & Millington 2019). Following this, bushfires across the country resulted in the loss of large areas of native forest that provides roosting (Mo et al. 2024) and foraging habitat for flying-fox populations. In December 2023 Council reported a flying-fox mass mortality event at the Dan Gleeson Memorial Gardens roost, which was likely to be the result of a lack in available resources. Malnourished BFF pups, juveniles, and a small number of adults were either found dead or taken into wildlife care. There was also some LRFF deaths recorded at this site, which may have been due to the same cause. With these types of events severely impacting natural areas, foraging, and roosting resources in and around urban locations become even more important for flying-fox conservation.

Local and regional food resource availability influence the number of flying-foxes at a roost. This can also be influenced by significant events such as megafires in 2019-2020, where an estimated 34% of GHFF habitat across their range was lost (Baranowski et al. 2021). An assessment of the natural flying-fox foraging habitat within the Townsville LGA highlights the extensive potential habitat (Eby et al. 2019) (Figure 2). Further detail about vegetation communities, their value as flying-fox foraging habitat, and indicative flowering times can be found in spatial data and the literature available from these studies.

Figure 1: Regional context of flying-fox roosts within the Townsville LGA

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

- Priority Urban Flying Fox Roost
- Flying Fox Roost

N

0 20 40 80 120 160
Metres
GDA2020 MGA Zone 55
Scale: 1:550,754 @A4

CMO Environment Unit
Date: 13/03/2026
Author: gvt

DISCLAIMER
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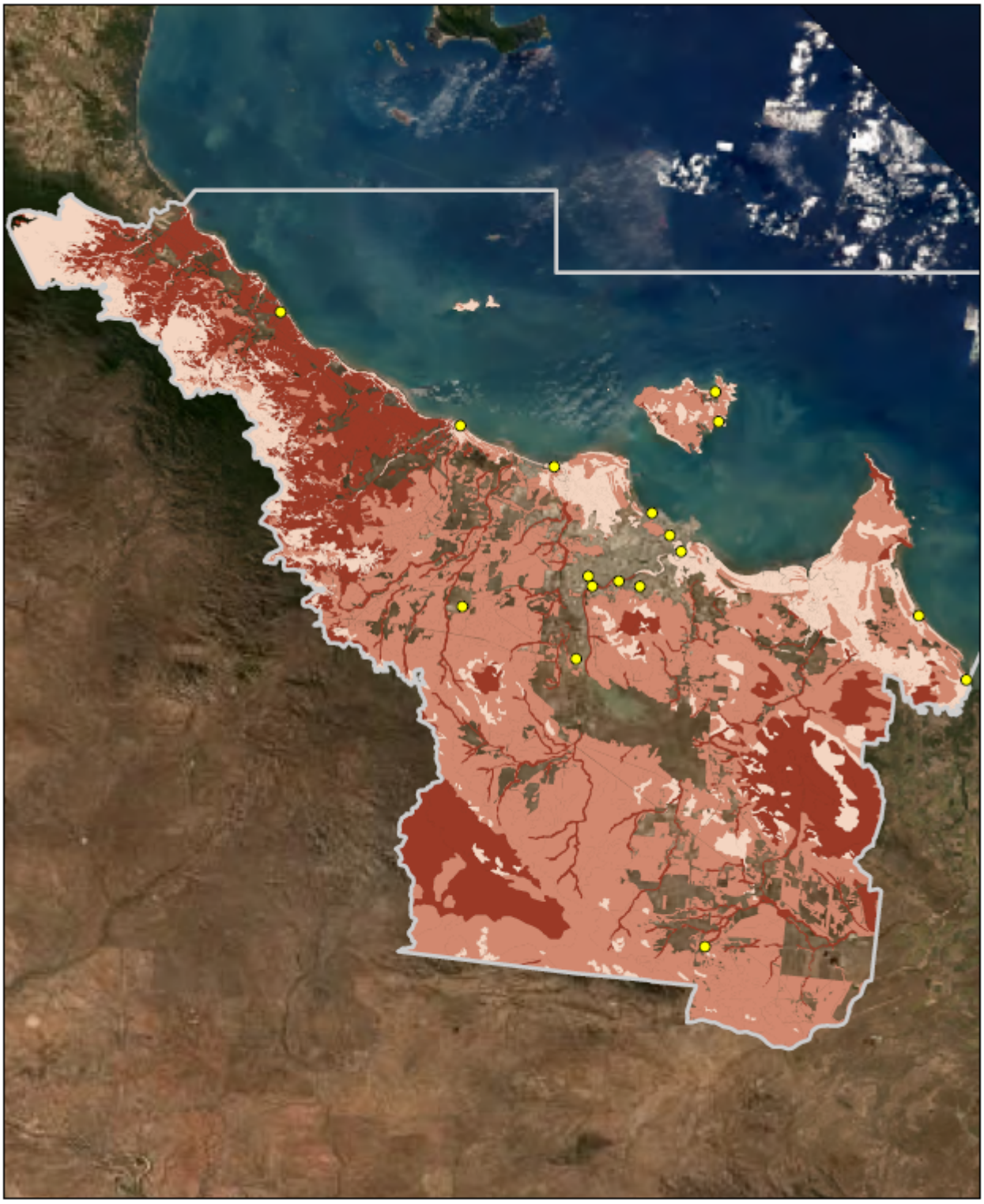

Figure 2: Distribution of the overall static nectar scores for remnant (2015) vegetation in Townsville LGA

Data courtesy of Qld Herbarium/DESI/CSIRO

Townsville City Council

Townsville LGA Flying-fox Roost Management Plan 2024

3. Potential impacts from flying-foxes

Flying-foxes in urban areas and in close proximity to dwellings can result in conflict with the community. The Plan aims to provide Council with management actions to reduce impacts on residents.

3.1. Human and animal health concerns

Flying-foxes, like all animals, may carry pathogens which can be harmful to humans. These risks are frequently associated with direct contact with flying-foxes, with indirect contact posing little risk; Council education includes the phrase “no touch, no risk”. Health concerns can be effectively managed through education, proper protocols, personal protective equipment (PPE) such as gloves, and good hygiene practices.

The key human and animal health risks associated with flying-foxes are Australian bat lyssavirus (ABLV) and Hendra virus; the latter being particularly important for flying-fox roosts located in close proximity to horse paddocks. Further information on flying-foxes and human/animal health is provided in Appendix 3.

3.2. Noise

A highly social and vocal animal, the activity heard from flying-foxes at roosts includes courting, parenting, and establishing and defending mating territories. Noise is often most disturbing to people pre-dawn. Throughout the year noise is made as the flying-foxes return to the roost pre-dawn, sometimes several hours before sunrise (Welbergen 2011). This noise is often exacerbated during pup rearing (spring/summer) as adult female flying-foxes return to the roost to feed their pups during the night. Often, the largest number of complaints occur from January to May, peaking during the mating season (mid-March to mid-May). At this time males vocalise to defend their mating territories and may stay at the roost through the night (Welbergen 2011).

3.3. Odour

Flying-foxes use pheromones to communicate with each other, which is the source of the characteristic musky smell around their roosts and some foraging trees. There are several factors that affect odour detectability and intensity, such as the number of flying-foxes, time of year, weather conditions, wind direction, and site characteristics.

Odour may be more intense at roosts during the breeding and rearing season as female flying-foxes use scent to find their pups after foraging, and males regularly mark their territories (Wagner 2008). Likewise, odour is stronger after rain as males remark branches in their territories.

3.4. Faecal drop

Flying-foxes have an extremely fast digestive process with only 12-30 minutes between eating and excreting (SEQ Catchments 2012). Given that flying-foxes regularly forage up to 20 km from their roost (Markus & Hall 2004) and establish new roosts within 600 m to 6 km when dispersed (Eby & Roberts 2013, Ecosure 2014), attempting to relocate a roost will not reduce this impact. As such, faecal drop impacts are best managed at an individual property level.

Faecal droppings can cause health concerns, reduced amenity, create a slip hazard, require time and resources to clean, and can damage paint if not promptly removed. Appropriate PPE and hygiene measures are required when cleaning any animal excrement. High-pressure hoses and specific cleaning products are available to assist cleaning. Flying-foxes can be deterred from roosting and foraging around areas of concern, such as picnic tables and play equipment, which could also be covered (e.g. with a shade canopy).

3.5. Water quality concerns

Contamination of water supplies by any animal excreta (birds, amphibians, and mammals such as flying-foxes) poses health risks to humans. This is particularly relevant for any residents who rely on rainwater tanks for drinking water. There is no known risk of contracting bat-related viruses from contact with faecal drop or urine (DPE 2023). Household water tanks can be designed to minimise potential contamination, such as using first flush diverters to divert contaminants before they enter water tanks.

Tanks should be appropriately maintained and flushed, and catchment areas regularly cleaned of potential contaminants. Trimming vegetation overhanging the catchment area for the tank (e.g. flying-fox foraging vegetation overhanging the roof of a house) will also reduce wildlife activity and associated potential contamination. Tanks in urban areas are not for domestic drinking water supply and these areas are supplied with reticulated town water.

Pool maintenance practices (e.g. filtration, chlorination, skimming, vacuuming) should remove general contamination associated with wildlife droppings. Public water supplies are regularly monitored for harmful bacteria and are filtered and disinfected before being distributed. Management plans for community supplies should consider whether any large congregation of animals, including flying-foxes, occurs near the supply or catchment area. Should this occur, increased frequency of monitoring should be considered to facilitate early detection and management of contaminants if required.

There have also been concerns about water quality in artificial or natural waterbodies near a flying-fox roost. In stagnant waterbodies there may be an increase in bacteria and nutrients associated with many animals, including flying-foxes and/or native birds. Water quality monitoring should be considered if this is of concern.

3.6. Damage to vegetation

Large numbers of roosting flying-foxes can damage vegetation. Most native vegetation is resilient and generally recovers well (e.g. casuarina and eucalypts) and flying-foxes naturally move within a roost site allowing vegetation to recover. However, damage can potentially be significant and permanent, particularly in small patches of vegetation and/or due to long-term roosting, and/or due to large numbers of LRFF. The roosting behaviour of LRFF differs to the other three species, they clump together creating dense, heavy aggregations that can snap branches. Intervention may be required (as a last resort) to protect tree health if permanent damage is likely.

3.7. Flying-foxes and aircraft

Flying-foxes are large (~1 kg) animals that transit in large numbers at relatively low altitudes. Consequently, in terminal airspace, where aircraft are operating at low altitudes, they may present a significant risk to air safety particularly prior to first light and around sunset, daily.

Between 2008 and 2017, flying-foxes and bats3 were involved in 1,303 strikes in Australia and accounted for 10% of damaging strikes (ATSB 2019). Most notably, between 2016 and 2017 flying-foxes were the most struck flying animal.

The consequence of wildlife strikes with aircraft can be very serious. Worldwide, in civil and military aviation, fatal bird strike incidents have resulted in more than 532 human fatalities and 614 aircraft losses since the beginning of aviation (Shaw et al. 2019). Wildlife strikes cost the commercial civil aviation industry an estimated US$1.2 billion per annum (Allan 2002) and involve more than just the repair of damaged engines and airframes. Even apparently minor strikes which result in no damage can reduce engine performance, cause concern among aircrew, and add to airline operating costs.

4. Protecting flying-foxes and other fauna in response to extreme weather events

4.1. Heat

Flying-foxes are especially susceptible to extreme heat. Temperatures above 38ºC, consecutive hot days, lactation, age, and other weather variables such as high humidity contribute to the likelihood of a Heat Stress Event (HSE) (Bishop 2015, Welbergen et al. 2008). Flying-foxes may die of either heat stroke or dehydration, associated with saliva spreading used for evaporative cooling. Mass mortality can occur when temperatures exceed 42˚C (Welbergen et al. 2008, Bishop et al. 2019). However, humidity is an important variable as the flying-foxes cool-down through evaporative cooling, therefore temperatures as low as 40.6ºC have caused HSEs in Qld (Bishop 2015, Collins 2014).

Over 40 HSEs have occurred in Australia since 1994 (see Lab of Animal Ecology 2024, Mo et al. 2022) including the largest on record, 45,500 deaths across 52 SEQ roosts in the summer of 2014 (Welbergen et al. 2014).

The Flying-fox Heat Event Response Guidelines SEQ (Bishop & Lyons 2018) provide information for decision makers during HSEs and should be adopted by Council if responding to HSEs. Council is proactive in planning for predicted heatwave events in Townsville to minimise impacts on flying-fox and the community. A factsheet about heat stress for flying-foxes is available for residents from Council's website as is a 'flying-fox heat stress guideline' from the Queensland government.

A range of intervention methods are used to reduce mortality in roosts, including ground-based or canopy-mounted sprinklers (CMS) or hoses to simulate a rain shower. However, Council recognises that there are risks associated with spraying water at roosts during HSEs. A review of HSE intervention methods found that the efficacy of interventions has been largely anecdotal rather than empirical (Mo and Roache 2020). Intervention also has the potential to exacerbate HSEs through disturbance of flying-foxes and/or increasing humidity with spraying water (possibly increasing the mortality rate of flying-foxes). To address this lack of empirical data, the NSW government approved a scientific trial of various methods in combination with flying-fox behaviour and temperature monitoring (started 2021 and ongoing). Where possible, Council will support research to improve HSE management and stay up-to-date with the latest recommendations.

4.2. Storms

Storm events can result in tree loss and damage to vegetation, which can lead to a reduction in roosting and, in particular, foraging resources for flying-foxes. The loss of tree crown can open the canopy, which may result in a hotter drier climate in areas with little canopy cover. Increased sunlight and drier soils often favour weed proliferation which can further degrade the habitat. Habitat restoration is critical to ensure sufficient recruitment over time to allow such canopy losses to be replaced as soon as possible.

Storms can result in injury and mortality in flying-fox roosts, particularly when flightless young are present (during summer, which coincides with storm season). Council notes that wildlife rescue at a roost must only occur when it is safe for human access.

4.3. Drought

Drought and associated lack of natural food sources for flying-foxes can lead to mass mortality and pup abandonment events. Urban roosts with varied and consistent food sources provided by urban parks, street plantings and residential areas become more important during these times. Continued protection of urban roosts will be important to limit impacts of more frequent drought under climate change.

4.4. Bushfires

The risk of a bushfire is quite low across the urban flying-fox roosts across the Townsville LGA. However, with the increasing impacts of climate change and more severe bushfire seasons in Australia, evident in the 2019-20 bushfire season, flying-foxes are vulnerable to widescale habitat loss (Baranowski et al. 2021). With large areas of roosting and foraging habitat burnt during bushfires, flying-foxes are forced to relocate and find alternative suitable roosting and foraging habitat (Baranowski et al. 2021). This can disrupt flying-foxes breeding cycle and the ability to find adequate food for survival. Significant loss of habitat in areas affected by bushfire can lead to larger influxes of flying-foxes in urban habitats as they attempt to seek adequate roosting and foraging habitat (Baranowski et al. 2021). This may lead to increasing conflict associated with urban roosts, therefore preparedness for influxes in particularly severe bushfire seasons is advisable.

5. Roost assessments

Roost assessments were undertaken by Ecosure in April 2024. Site visits were conducted with Council representatives. Detailed information on each of the five urban flying-fox roosts covered by this Plan is provided in this section. A summary is provided in Table 3.

Table 3 Townsville urban flying-fox roost overview

Roost	Roost description	Flying-fox occupancy	Sensitive receptors within 1 km	Management actions to date
Dan Gleeson Memorial Gardens	~5 ha urban park; roost occupies ~1.4 ha	Roost since 2009; ~17,500 BFF (max); ~46,000 LRFF (max); SFF (<10) & GHFF (<5) infrequently observed	8	Routine predawn deterrence; CMS; habitat management (various); LED light towers were installed 2024
Morstone Park (Annandale)	~5 ha bushland along a creek behind houses; roost occupies ~0.9 ha	Roost since 2020; ~4000 BFF (max); ~1500 LRFF (max); ~1 SFF recorded once	4	Habitat management (buffer)
Riverside Gardens	~10 ha of bushland along Ross River; roost occupied ~1 ha	Temporary roost since 2022; ~2500 BFF (max); ~20,000 LRFF (max)	5	N/A (flying-foxes have left without management)
Palmetum Botanic Garden	~17 ha of botanic garden; roost occupied ~0.2 ha	Roost since ~2006; since 2015: ~4000 BFF (max); ~8000 LRFF (max)	4	Routine predawn deterrence; LED light tower trialled
Alice River	~1.6 ha of backyard gardens; roost occupied ~0.6 ha	Temporary roost since 2022; ~4500 BFF (max); ~3000 LRFF (max)	0	Community education on predawn deterrence and habitat management; LED light tower trialled

5.1. Dan Gleeson Memorial Garden, Kirwan

5.1.1. Roost description and extent

The Dan Gleeson Memorial Gardens (Gardens) roost is located on Thuringowa Drive in Kirwan, 12 km south-west of the centre of Townsville City (Figure 1). The Gardens are set on 5 ha and are comprised of native and exotic trees and shrubs, lawns, paved pathways, and a playground (Figure 3). Thuringowa Drive (a four-lane road) runs along the eastern border of the Gardens, with the western side bordered by residential properties along Corveth Street. There are carparks to the north (for Townsville University Hospital and Health Services) and south (for local businesses) of the Gardens.

The maximum roost extent covers the entire Garden area and extends just beyond the boundary in few areas (Figure 3). The core roost extent is contained to the north-east corner of the Gardens (Figure 3), which has been Council's aim during management activities (see Section 4.1.6). Several trees have been observed to be used as pup crèche trees in the south-east corner of the Garden.

5.1.2. Land tenure

The entire roost extent is located on Lot/Plan 2SP80601, which is a Council owned and managed Reserve. It is mapped under the Townsville City Plan as having recreation and open space values.

5.1.3. Ecological values

The Gardens are mapped as non-remnant vegetation (Category X), with various native and exotic trees, palms, shrubs, and large areas of maintained lawn (Figure 3).

Threatened species recorded within 1 km of the Gardens roost include the fork-tailed swift (Apus pacificus) (WildNet 2024) (Appendix 4). This species migrates from Asia where it breeds to Australia and can be seasonally observed across large parts of Australia. It is unlikely that this species uses the Gardens. Council has recorded SFF and GHFF at this site, both species are listed under the Commonwealth EPBC Act however this roost does not meet the criteria as a nationally important roost (see Appendix 2).

5.1.4. Flying-fox roost occupancy

Flying-foxes have been roosting at this site intermittently since 2009 and the population size has varied greatly, as has the spatial distribution of the roost (Figure 4). Council's Environmental Restoration team has completed up to weekly monitoring since March 2016. Daily counts have also been undertaken at times, aligned with dispersal management activities.

The number of BFF has grown considerably during that time, with LRFF fluctuating seasonally. In 2011 flying-fox numbers in the Gardens began to increase and in 2014, a large influx of 40,000 LRFF appeared in the Gardens and left a few weeks later (Council 2017). The Gardens were mostly flying-fox free from that point until mid-2016. From that time the BFF numbers increased to between 2000 and nearly 20,000 and have been recorded each monitoring event except for early 2019. The LRFF numbers continued to fluctuate and peaked again in mid-2022 with an influx of 46,000.

The 2014 and 2022 large temporary influxes of LRFF severely impacted the rainforest area. The previously closed canopy was exposed and a majority of large trees experienced damage. This reduced the rainforest area's value and affected the amenity of the Gardens. Since June 2016, flying-foxes have returned to the rainforest rendering this previously popular area mostly unusable by Garden visitors (Figure 4). Council has designated this area for the flying-fox roost, excluding people. In 2023 Council filled-in the two ponds with the aim of decreasing the attractiveness of this area to the flying-foxes, however roosting has persisted.

A small number of SFF (i.e. less than 10) have been observed during nine surveys conducted across 2016-17, 2021, and 2023 (see Appendix 2). These reports have not been confirmed and are thought to be either outliers of nearby wet tropics populations, light coloured BFFs, or hybrids (see Townsville City Council 2017). Subsequent regular monitoring and consultation with national experts has not been able to confirm the presence of SFF at the Gardens. SFF have been confirmed within roosts south of Townsville, so it is

likely that individuals would roost in Townsville when moving through. If very small numbers have been/are periodically present, they will be far below the requirements to be considered a nationally important flying-fox roost (see Appendix 2). Similarly, small numbers of GHFF (i.e. less than 5) have been observed during nine surveys conducted across 2020 to 2024 (see Appendix 2). This species is easier to distinguish from BFF and SFF, as such there is greater confidence in these observations. GHFF have been recorded at roosts north of Townsville, although not in large numbers (i.e. will also not meet nationally important camp criteria) and infrequently.

5.1.5. Sensitive receptors

There are nine sensitive receptors located within 1 km of the Gardens roost (Figure 5), including:

- Kirwan State Primary School
- Kirwan State High School
- C & K Community Kindergarten
- Thuringowa World of Learning
- Uniting Early Learning Kirwan
- Townsville Hospital and Health Services
- Parklands Residential aged care facility
- Regis Retirement Village Kirwan.

Townsville Airport is located 6.3 km north-east of the Dan Gleeson Memorial Gardens roost.

5.1.6. Management responses to date

Council currently manages flying-fox at the Gardens as per the relevant legislation and guidelines (Section 1.4) and regularly consults with DETSI. Council staff working in the Gardens also operate in accordance with the Low impact COP (Section 1.4) for activities such as weeding, mulching, mowing or minor tree trimming.

For the last several years, management of flying-foxes by Council has contained the main population to the rear of the Gardens (Townsville City Council 2021). This has been achieved by using nudging in targeted areas of the Gardens only and leaving the flying-fox undisturbed in the containment area (i.e. orange zone on Figure 3). The nudging techniques include using smoke (i.e. burning green waste in bins), noise (e.g. slapping pool noodles), fog (i.e. a fire fighter smoke training device), and CMS. Consideration of noise and smoke impacts on neighbouring residents is a key consideration.

A CMS was installed and trialled in the flying-fox creche tree in the Pink Gardens during 2020. Council was successful with grant funding from DETSI in August 2021 and an additional 17 CMS have been installed in the canopy of trees in high profile areas within the Gardens. These can be set on a timer (changing regimes can be programmed or operated by Council's Parks team) and are used for short periods of time (20 secs) so as not to flood the area. The use of CMS has reduced the need to use other nudging techniques, which has reduced the impacts associated with noise and smoke on the neighbouring residents.

Other flying-fox deterrents used in the Gardens by Council include:

- filling in the two ponds in the north-east corner of the Gardens
- trimming of vegetation to ensure visitor and staff safety
- tree removal along the western boundary (Corveth Street) and around the playground (southern section of the park).

Council also educated the community about flying-foxes, including providing details on the different species and their breeding cycles, human safety (i.e. no touch = no risk), and intermittent influxes of larger numbers of flying-foxes, in particular LRFF. This information has been provided through letters and flyers to local residents, as well as installation of signage at the Gardens.

Council plans to install three PROVolitans LED light towers around the Pink Garden to assist existing efforts to deter roosting in this section of the Gardens. Two mobile PROVolitans light towers could be added to this site as required (assuming they aren't required elsewhere).

Figure 3: Dan Gleeson Memorial Gardens flying-fox roost

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

Maximum Roost Extent
Core Roost Extent
Properties

N

0 20 40 80 120 160
Metres

CMO Environment Unit
Date: 12/03/2026
Author: gvt

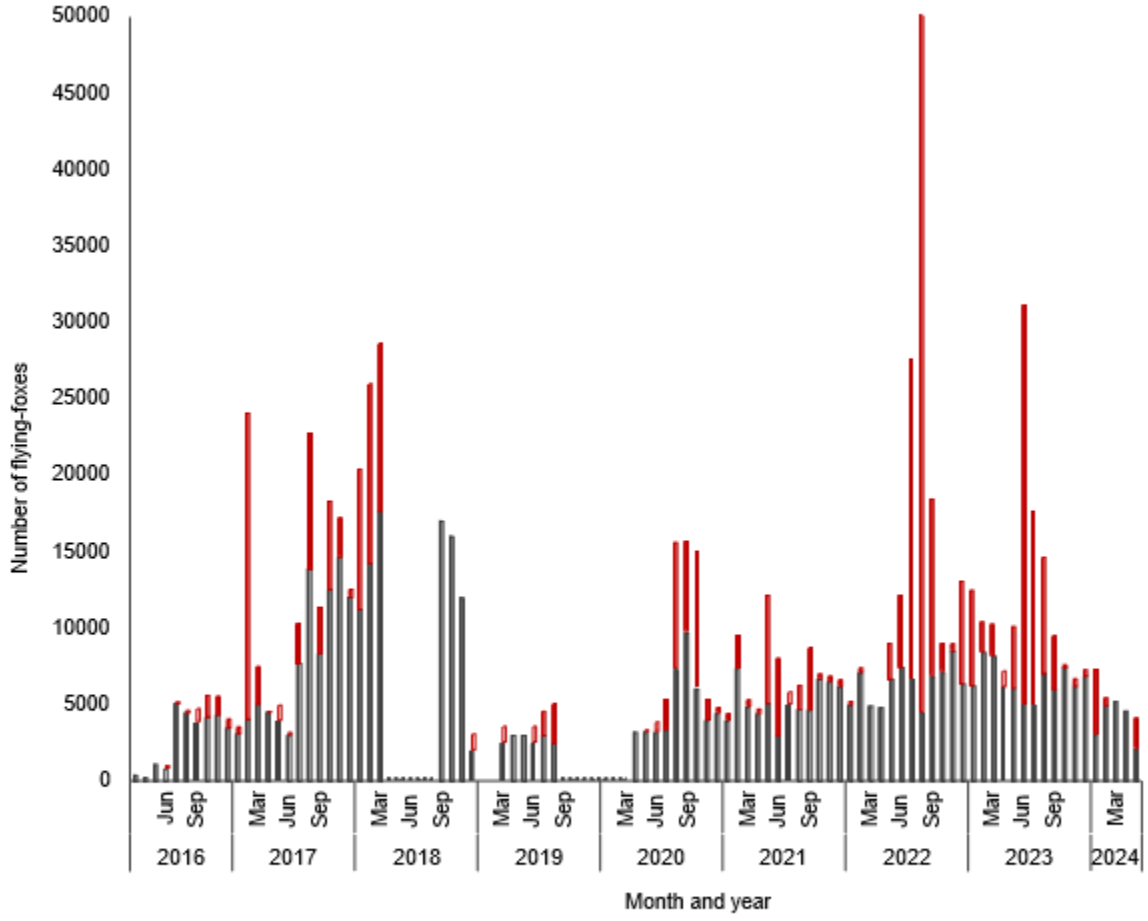

Figure 4 Dan Gleeson Memorial Gardens black (black) and little red (red) flying-fox maximum monthly population count (source Council 2024)

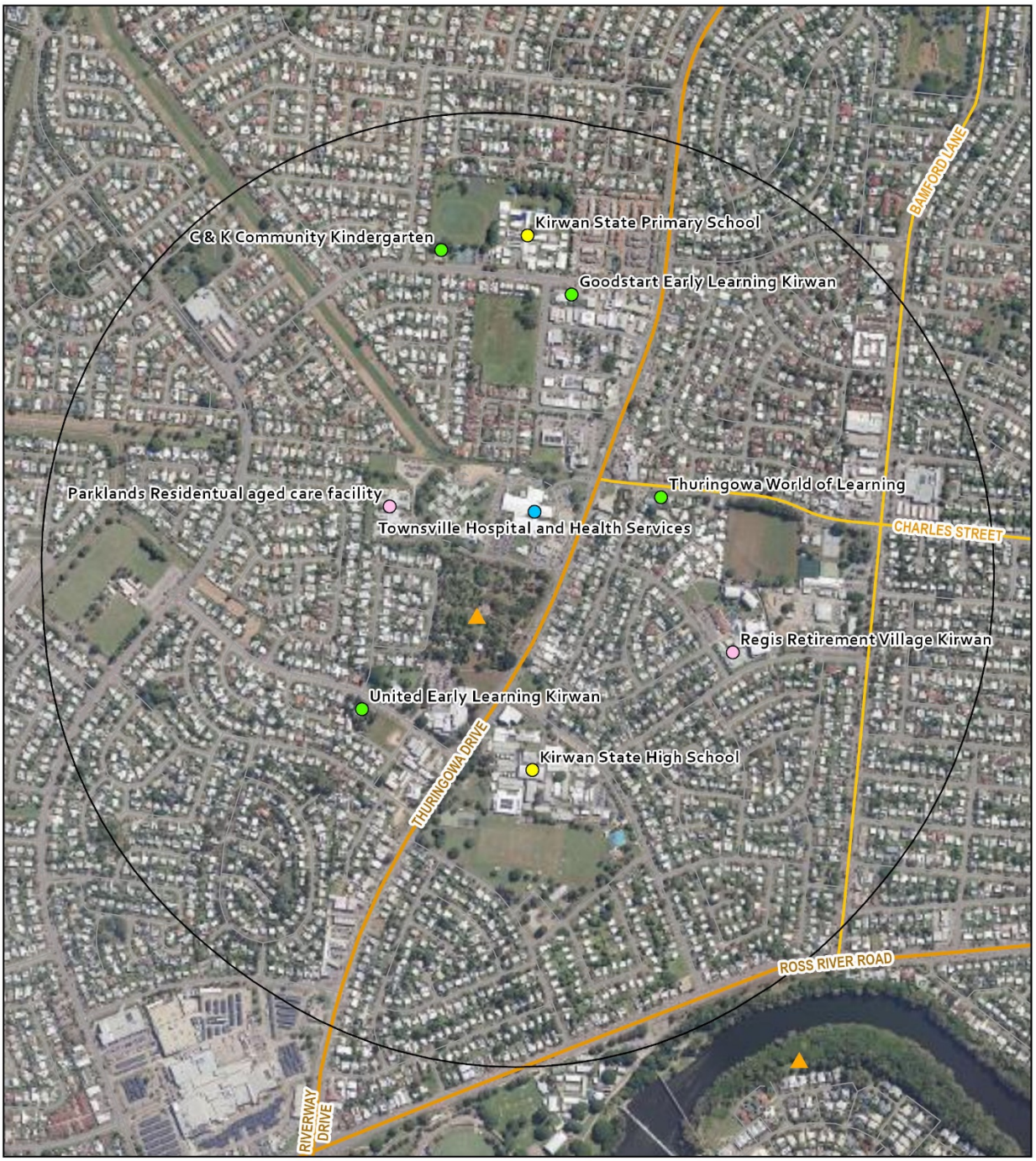

Figure 5: Sensitive receptors within 1 km of the Dan Gleeson Memorial Garden roost

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

- Aged care centre
- Childcare centre
- Hospital/Medical centre
- School
- Priority Urban Flying Fox Roost
- 1 km radius

N

0 20 40 80 120 160
Metres

CMO Environment Unit
Date: 12/03/2026
Author: gvt

5.2. Morstone Park, Annandale

5.2.1. Roost description and extent

Morstone Park (aka Macarthur Park) is approximately 7 km south-west of the centre of Townsville City in the suburb of Annadale. The flying-fox roost is located at the southern end of Morstone Park, in vegetation along a creek behind residential houses along Rosebud Place, Weddel Drive, and Davencourt Place (Figure 6). The site is mostly bushland with a creek, some cleared mown grass areas, paths and seating. The Bruce Highway (a four-lane road) runs along the southern border of Morstone Park.

The maximum flying-fox roost extent is contained within the Morstone Park boundary, except for three locations where it crosses over into the neighbouring properties (Figure 6). The core roost extent is within the central eastern part of the extent (Figure 6).

5.2.2. Land tenure

The entire roost extent is located on Lot/Plan 888RP885673, which is a Council owned and managed Reserve. It is mapped under the Townsville City Plan as having recreation and open space values.

5.2.3. Ecological values

The Morstone Park roost predominantly consists of RE is 11.3.35: Eucalyptus platyphylla and Corymbia clarksoniana woodland on alluvial plains (Least Concern). Vegetation within Morstone Park is mapped as Regulated Vegetation (Class R – GBR riverine under the VM Act 1999). Clearing of vegetation therefore requires approval under the VM Act. (Appendix 4).

Council has sought further clarification from The State Government and via the Department of Natural Resources and Mines, Manufacturing and Regional and Rural Development, have clarified that as the land is under Trust by Council for the purpose of Recreation and Open Space, Category R vegetation is exempt clearing work under the Lands Act 1994. Clearing in excess of 0.5 hectares would require a Riverine Protection Permit under the Water Act 2000.

Two plant species classified as Special Least Concern under the BC Act recorded within 1 km of Morstone Park include hydrilla (Hydrilla verticillate) and golden bladderwort (Utricularia aurea) (Appendix 4). Council has recorded SFF at this site once; this is not a significant SFF roost (see Table 1 and Appendix 2).

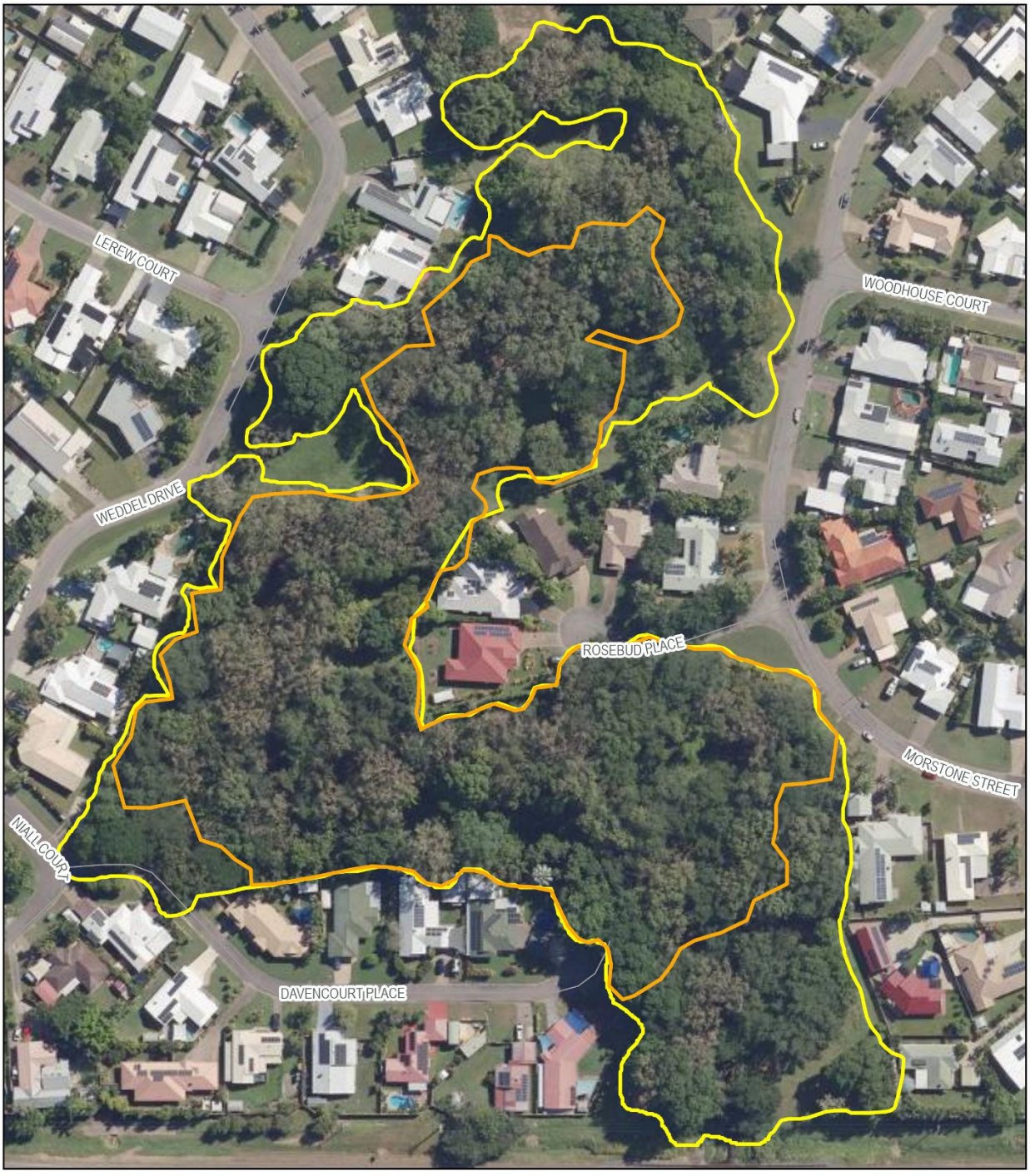

Figure 6: Morstone Park flying-fox roost

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

Maximum Roost Extent
Core Roost Extent

N

0 20 40 80 120 160
Metres
GDA2020 MGA Zone 55
Scale: 1:1,750 @A4

CMO Environment Unit
Date: 13/03/2026
Author: gvt

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5.2.4. Flying-fox roost occupancy

Council first recorded flying-foxes roosting at Morstone Park in late 2020 and has completed up to weekly monitoring since this time. The BFF population has varied between 150 and 4000 individuals with influxes of between 50 to 1500 LRFF, typically during summer (Figure 7). The maximum monthly population count for each species is presented below (Figure 7).

One SFF was recorded in September 2023, but no GHFF have been recorded to date. If very small numbers have been/are periodically present, they will be far below the requirements to be considered a nationally important SFF roost (see Appendix 2).

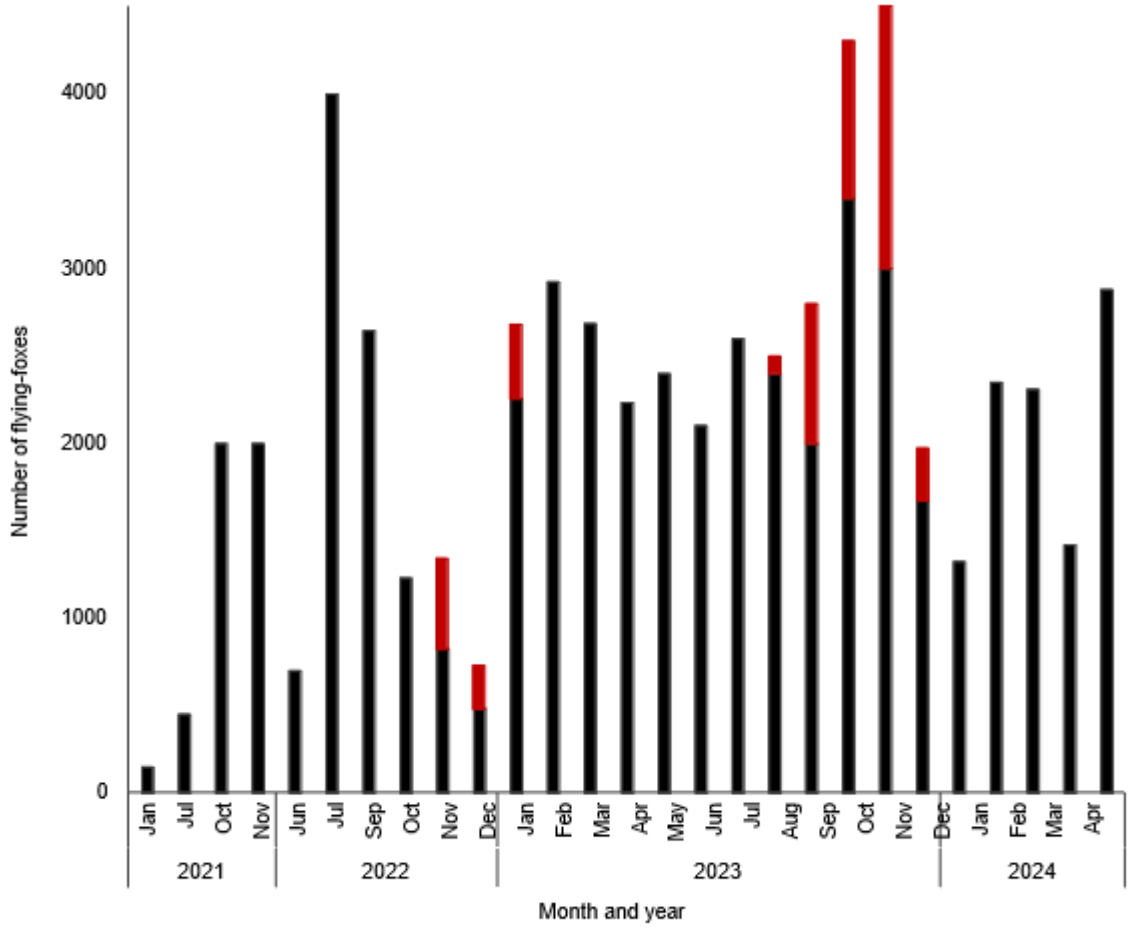

Figure 7 Morstone Park black (black) and little red (red) flying-fox maximum monthly population counts (source Council 2024)

5.2.5. Sensitive receptors

There are four sensitive receptors located within 1 km of the Morstone Park roost (Figure 8), including:

- Annandale State High School
- Annandale Christian College
- Goodstart Early Learning Annandale
- Townsville Grammar School.

Townsville Airport is located 6.8 km north, north-west of the Morstone Park roost.

5.2.6. Management responses to date

Council staff working in Morstone Park operate in accordance with the Low impact COP (Section 1.4) for activities such as weeding, mulching, mowing or minor tree trimming.

In March 2023 Council completed vegetation works at this site, focusing on the open space area behind properties on Rosebud Place, with additional works undertaken behind Rosebud Place, Corveth Street Macarthur Drive in August 2025. These works aimed to expand an existing buffer between dwellings and BFF roost trees. A series of large trees were trimmed and some exotic trees were removed to reduce the proximity of flying-foxes to private properties. All works complied with the Management COP. Council provided information about this to residents via flyers (e.g. about Council management at this site).

Figure 8: Sensitive receptors within 1 km of the Morstone Park roost

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

- Childcare centre
- School
- Priority Urban Flying Fox Roost
- 1 km radius

N

0 20 40 80 120 160
Metres

CMO Environment Unit
Date: 13/03/2026
Author: gvt

5.3. Riverside Gardens, Douglas

5.3.1. Roost description and extent

Riverside Gardens is 10.5 km south-west of the centre of Townsville City in the suburb of Douglas. The flying-fox roost is located along the Ross River, in vegetation behind residential houses on Teak Place (Figure 9). The site is mostly riverside bushland with some cleared grassed areas and paths. The Federation Footbridge is adjacent to the south-western border of Riverside Gardens. The Riverside Gardens roost is contained within Council-owned land.

5.3.2. Land tenure

The entire roost extent is located on Lot/Plan 1SP189840, which is as a Council-owned and managed reserve. It is mapped under the Townsville City Plan as having recreation and open space values.

5.3.3. Ecological values

The Riverside Gardens roost predominately consists of RE 11.3.25b: E. tereticornis or

E. camaldulensis woodland fringing drainage lines. Most of the roost is mapped as regulated vegetation (Category B – remnant vegetation) (Appendix 4) and essential habitat for the estuarine crocodile (Crocodylus porosus). Clearing of vegetation therefore requires approval under the VM Act.

The pink waterlily (Nelumbo nucifera) classified as Special Least Concern under the BC Act has been recorded within 1 km of Riverside Gardens (Appendix 4).

Figure 9: Riverside Gardens flying-fox roost

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

- Maximum Roost Extent
- Core Roost Extent
- Properties

N

0 20 40 80 120 160
Metres
GDA2020 MGA Zone 55
Scale: 1:3,500 @A4

CMO Environment Unit
Date: 12/03/2026
Author: gvt

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5.3.4. Flying-fox roost occupancy

The Riverside Gardens roost formed during October 2022 with the arrival of approximately 20,000 LRFF (Figure 10). The roost was abandoned in November 2022. In November 2023, both BFF and LRFF were observed during the first roost assessment (9 November 2023). A maximum of approximately 2500 BFF and 1300 LRFF were recorded. The BFF abandoned the roost first followed by the LRFF a week later during December 2023. The maximum monthly population count per species is presented below.

Council notes a temporary roost established in at Riverside Gardens during November 2018. Up to 5000 BFF were consistently recorded during the first two weeks of roosting at this site. The number of BFF reduced to 1000 during the third week and 300 during the fourth week of November. Then the roost was abandoned. Similarly, less than 2 km from the Riverside Gardens roost, BFF were recorded roosting along the Ross River near Bergin Road, Cranbrook. Between October 2016 and August 2017 up to 200 BFF, one LRFF, and up to two SFF were observed on four occasions. The flying-foxes vacated the site for approximately six weeks during March and April 2017. The site was permanently abandoned during August 2017.

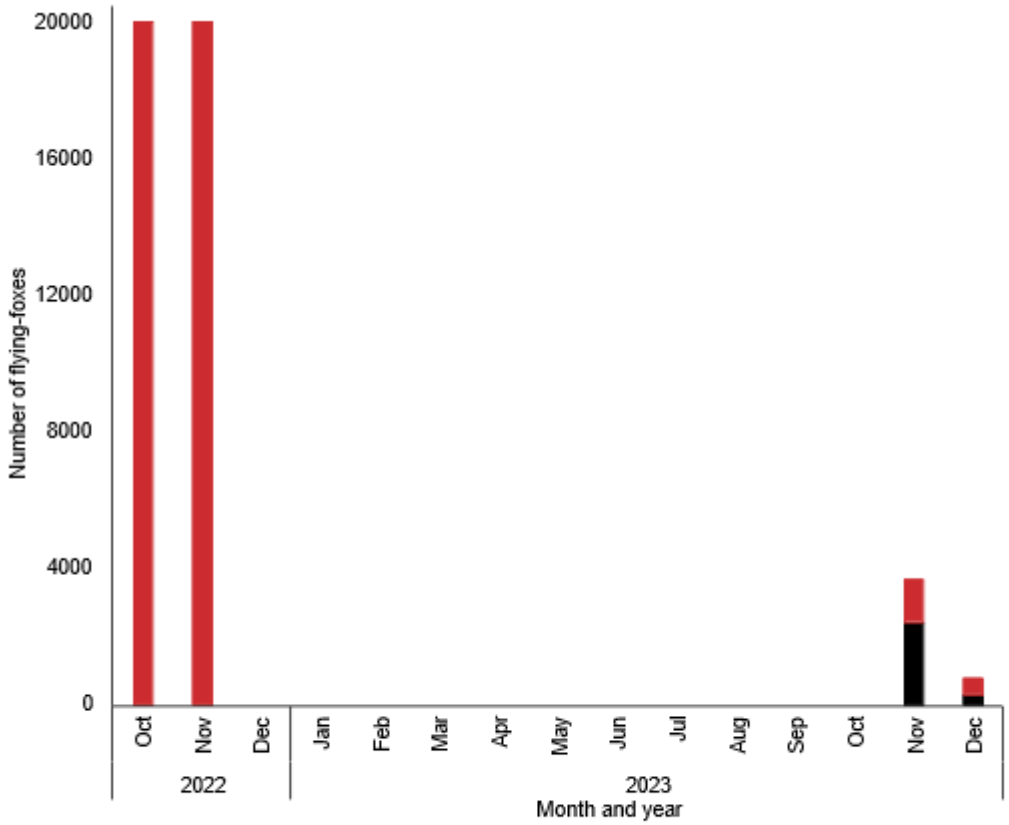

Figure 10 Riverside Gardens black (black) and little red (red) flying-fox maximum monthly population counts (source Council 2024)

5.3.5. Sensitive receptors

There are six sensitive receptors located within 1 km of the Riverside Gardens roost (Figure 11), including:

- Kirwan State High School
- Uniting Early Learning Riverview
- C&K Stepping Stones Community Kindergarten
- C&K Weir Community Kindergarten
- Weir State School.

Townsville Airport is located approximately 7.5 km north-east of the Riverside Gardens roost.

5.3.6. Management responses to date

No management has been undertaken or been required to date as the flying-foxes have temporarily roosted at this site. Council staff working in the Riverside Gardens operate in accordance with the Low impact COP (Section 1.4) for activities such as weeding, mulching, mowing or minor tree trimming.

Council will continue to monitor this site as it is anticipated that flying-foxes will roost at Riverside Gardens, or nearby, in the future.

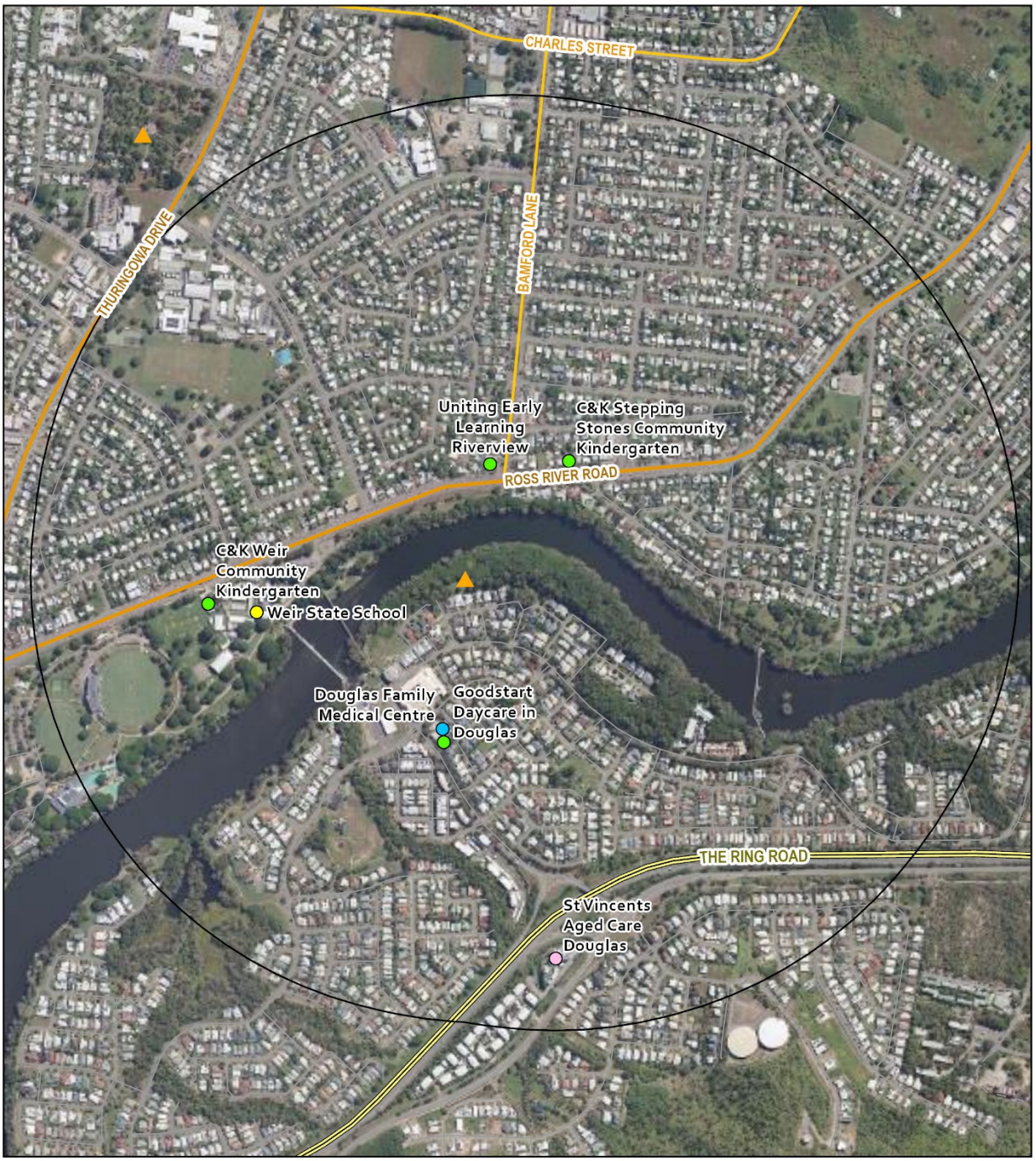

Figure 11: Sensitive receptors within 1 km of the Riverside Gardens roost

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

- Aged care centre
- Childcare centre
- Hospital/Medical centre
- School
- Priority Urban Flying Fox Roost
- 1 km radius

N

0 20 40 80 120 160
Metres

CMO Environment Unit
Date: 12/03/2026
Author: gvt

5.4. Palmetum Botanic Gardens, Douglas

5.4.1. Roost description and extent

Palmetum Botanic Gardens is 7.5 km south-west of the centre of Townsville City in the suburb of Douglas (Figure 12). The Gardens are set on 17 ha and contains an extensive palm collection, which is the site's main attraction. University Road (a four-lane road) runs along the western border of the Gardens, with The Good Shepard Home adjoining the north-western corner of the Gardens. The eastern side of the Gardens is bordered by residential properties along Marbou Drive and Ross River runs along the northern border. The Ross River Bikeway runs between the Gardens and the River.

The flying-fox roost is located in the central forested part of the Palmetum Botanic Gardens that is approximately 4.5 ha comprising a number of vegetation layers, typical of rainforest, and a system of pathways (Figure 12).

5.4.2. Land tenure

The entire roost extent is located on Lot/Plan 2RP889279, which is a Council-owned and managed reserve. It is mapped under the Townsville City Plan as having recreation and open space values.

5.4.3. Ecological values

Palmetum Botanic Gardens have been planted with a large number of rare and threatened palm species, making them one of the largest and most diverse collections in the world. The rainforest area where the flying-fox roost is located is a closed canopy approximately 15-20 m in height and is dominated by rain trees (Samanea saman) with the occasional tamarind (Tamarindus indica) and mango tree (Mangifera indica) (Ecosure 2016).

The Palmetum Botanic Gardens roost consists predominately of RE 11.3.25b: E. tereticornis

or E. camaldulensis woodland fringing drainage lines, with a small area of 11.3.35:

E. platyphylla and C. clarksoniana woodland on alluvial plains. Most of the roost is mapped as regulated vegetation (Category B – remnant vegetation) and essential habitat for the eastern curlew (Numenius madagascariensis) and Western Alaskan bar-tailed godwit (Limosa lapponica baueri) (Appendix 4). Clearing of vegetation therefore requires approval under the VM Act.

Figure 12: Palmetum Botanic Gardens flying-fox roost

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

- Maximum Roost Extent
- Core Roost Extent
- Properties

N

0 20 40 80 120 160

Metres
GDA2020 MGA Zone 55
Scale: 1:2,734 @A4

CMO Environment Unit
Date: 12/03/2026
Author: gvt

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5.4.4. Flying-fox roost occupancy

Flying-foxes have inhabited the Palmetum Botanic Gardens anecdotally for about 20 years (Townsville City Council 2016). The population size and spatial distribution within the site has varied greatly during this time. An influx of 40,000 flying-fox was recorded in 2014. In the past, large numbers of roosting flying-fox decimated trees and services, which resulted in the gardens being closed for some time due to safety concerns for workers and visitors.

An active monitoring program has been undertaken on a weekly basis since August 2015, during which time the roost site has undergone a decline in numbers (Figure 13). Over the last nine years flying-fox numbers have decreased drastically and remained low due to Council's active management (see Section 5.4.6). This roost is a maternity site for BFF, however it is unknown whether it is a maternity site for LRFF. The maximum monthly population count for each species is presented below.

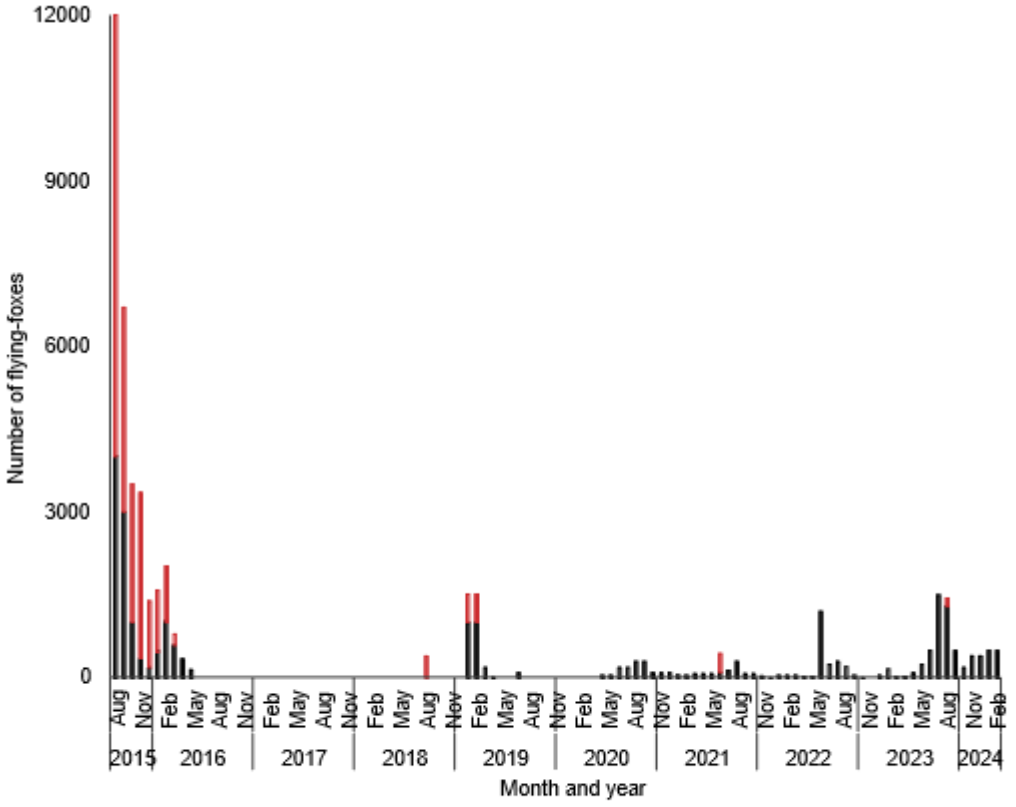

Figure 13 Palmetum Botanic Gardens black (black) and little red (red) flying-fox maximum monthly population counts (source Council 2024)

5.4.5. Sensitive receptors

There are four sensitive receptors located within 1 km of the Palmetum Botanic Gardens roost (Figure 14), including:

- My Little Feet Childcare
- Riverside Adventist School
- The Good Shephard Townsville (aged care)
- Townsville University Hospital.

Townsville Airport is located approximately 6 km north of the Palmetum Botanic Gardens roost.

5.4.6. Management responses to date

Council currently manages flying-fox at the Palmetum Botanic Gardens as per the relevant legislation and guidelines (Section 1.4) and regularly consults with DETSI. Council staff working in the Gardens also operate in accordance with the Low impact COP (Section 1.4) for activities such as weeding, mulching, mowing or minor tree trimming.

Council has implemented a concerted management program at the Palmetum Botanic Gardens since 2015 (Figure 13)(Townsville City Council 2021). This has been achieved by using nudging techniques including smoke (i.e. burning green waste in bins), noise (e.g. slapping pool noodles), and fog (i.e. a fire fighter smoke training device). In the early years of the management the roost area was fenced-off to avoid direct contact between visitors and flying-foxes and protect visitors from falling limbs of damaged trees. This temporary fencing was moved as the roost extent changed; currently there is no fencing.

Flying-fox management, particularly actions that aim to reduce the number of animals roosting, requires long-term consistent management. Following the intensive management implemented during 2015, which significantly reduced the number of roosting flying-foxes, Council has been implementing a maintenance program. At present this includes predawn deterrence including noise (e.g. slapping pool noodles), light (PROVolitans), and fog (i.e. a fire fighter smoke training device).

Council will be undertaking a palm mapping project to spatially record (and label) the exact location of each specimen. This will include data on damage/loss over a 10 year period (primarily associated with the roost).

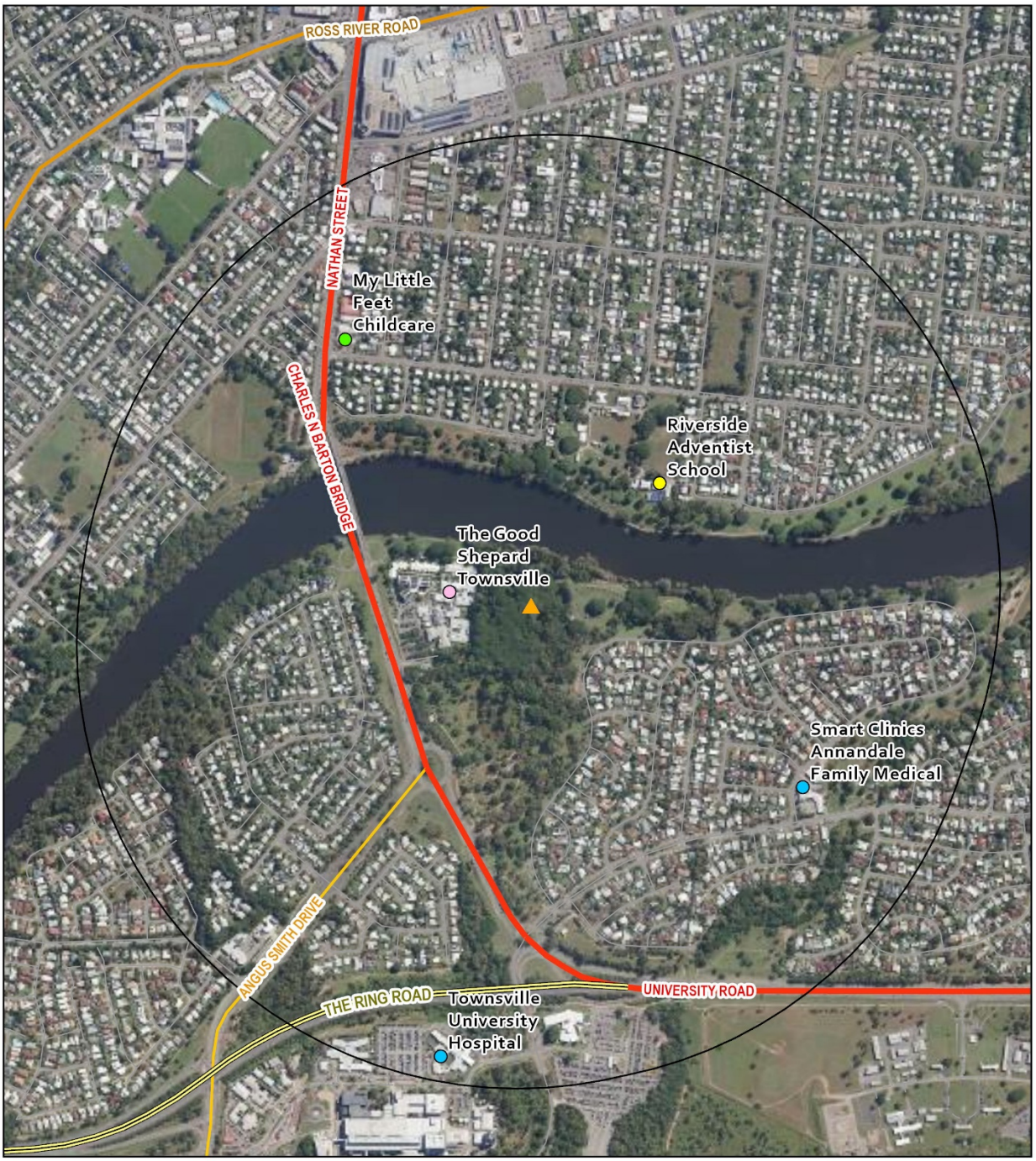

Figure 14: Sensitive receptors within 1 km of the Palmetum Botanic Garden roost

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

- Aged care centre
- Childcare centre
- Hospital/Medical centre
- School
- Priority Urban Flying Fox Roost
- 1 km radius

N

0 20 40 80 120 160
Metres

CMO Environment Unit
Date: 12/03/2026
Author: gvt

5.5. Alice River

5.5.1. Roost description and extent

The Alice River roost is 24 km south-west of the centre of Townsville City in the outer suburb of Alice River. Pinnacles National Park is 7.6 km south-east of the roost and Mount Cataract Forest Reserve is 9 km north-west.

The flying-fox roost is bordered by Ring Road to the south and Brosnan Court to the west. The roost occurs across several private properties, extending across a small Council easement located between 118 and 122 Ring Road (Figure 15). The Council easement contains sparse eucalypt trees and mown grass. The dense vegetation within neighbouring backyards is likely the main attraction for roosting at this site. Given that this roost occurs within backyards there is considerably more disturbance to residents compared to other roost sites within the Townsville LGA.

5.5.2. Land tenure

The Alice River roost stretches across both Council-managed and private land. The core roosting area is located on private owned land (Lot/Plans 341RP804054, 342RP804054, 43RP804054, and 348RP804054) and stretches across Council-managed land (Lot/Plans 502SP112194 and 503132676). During large influxes, flying-foxes have occupied a larger extent across additional private properties along Brosnan Court and Ring Road (Figure 15). All properties are classified as residential zone.

5.5.3. Ecological values

The Alice River roost is mapped on non-remnant vegetation (Category X). There are no regional ecosystems mapped for this site or threatened species records within 1 km of the roost (Appendix 4).

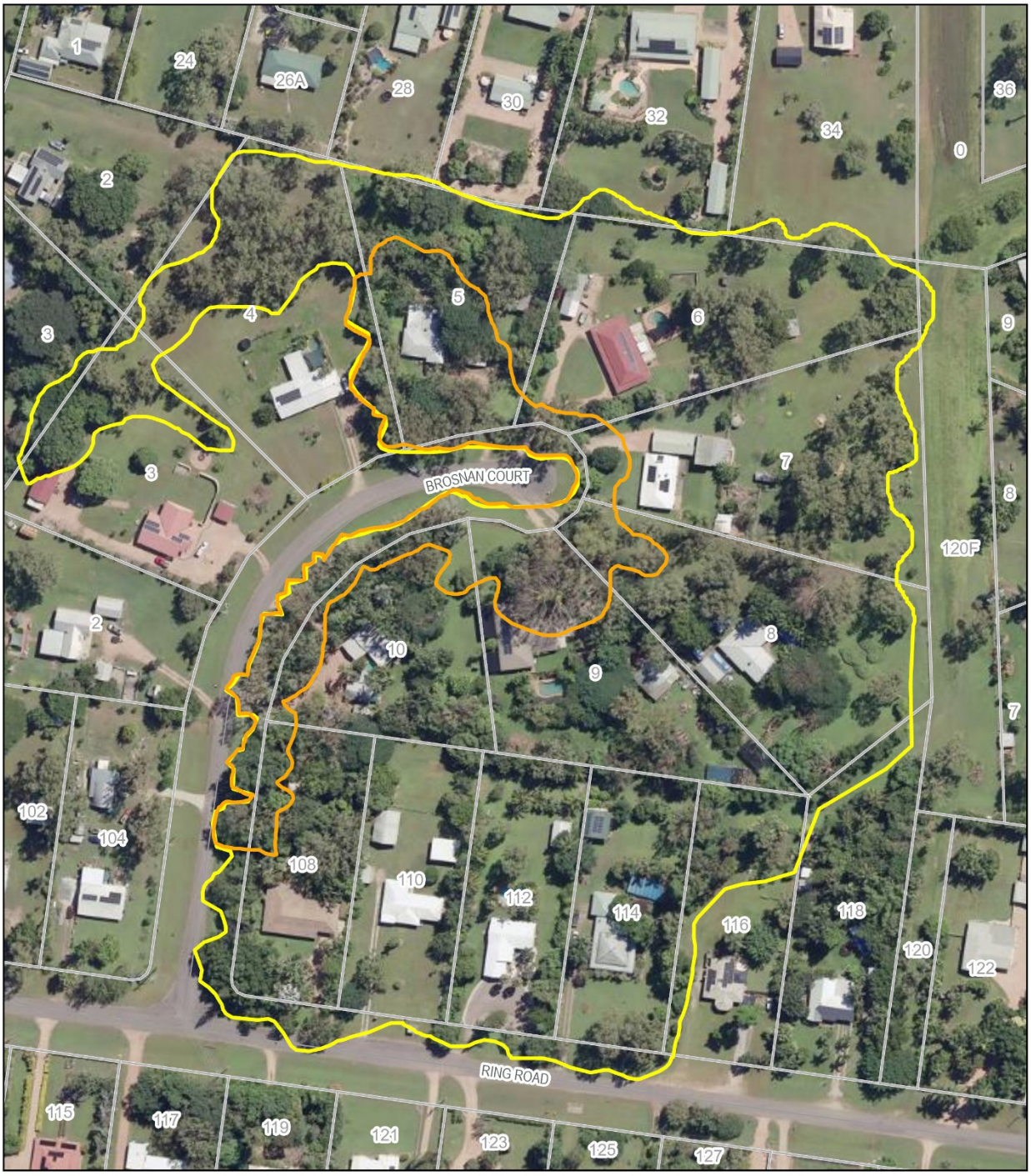

Figure 15 Alice River flying-fox roost

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

Maximum Roost Extent
Core Roost Extent
Properties

N

0 20 40 80 120 160
Metres
GDA2020 MGA Zone 55
Scale: 1:2,000 @A4

CMO Environment Unit
Date: 12/03/2026
Author: gvt

DISCLAIMER
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5.5.4. Flying-fox roost occupancy

In the past flying-foxes have inhabited the Alice River roost sporadically in large numbers but for relatively small periods of time. Therefore, it was only monitored quarterly or when Council's Environmental Restoration team is alerted to the roost being used again.

During late 2023 flying-fox roosting became more consistent, monthly maximum population estimates are presented (Figure 16). In response, from November 2023 Council increased the frequency of monitoring to up to weekly counts. During this time BFF have been present for all except two monitoring events (on 17 November 2023 and 24 May 2024), with numbers have fluctuating between 700 (on 12 November) and approximately 4,500 (on 22 April 2024). LRFF have also been present with approximately 3,000 in November. No SFF or GHFF have been recorded at this site.

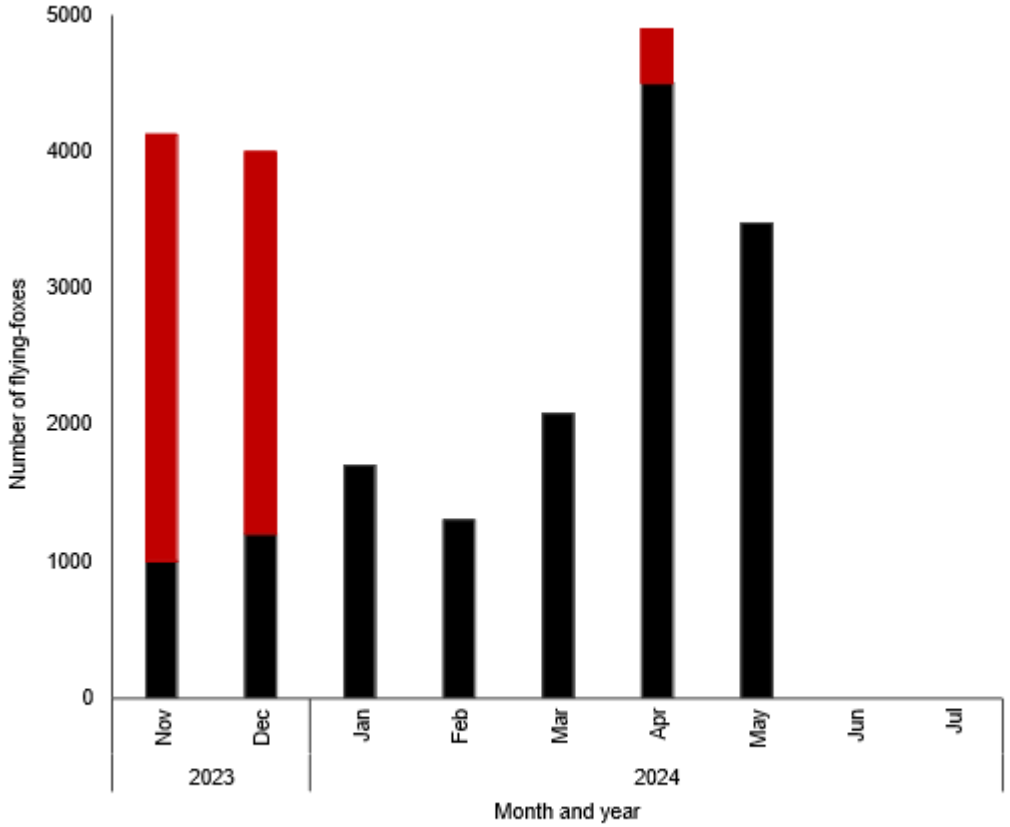

Figure 16 Alice River black (black) and little red (red) flying-fox maximum monthly population counts (source Council and Ecosure 2024)

5.5.5. Sensitive receptors

There are no sensitive receptors located within 1 km of the Alice River roost (Figure 17). Townsville Airport is located approximately 19.5 km north-east of the Alice River roost.

5.5.6. Management responses to date

In late 2023 Council provided an information session, this included guidance on flying-fox deterrence methods for the community. The deterrence methods included information on using sound and light to deter flying-foxes roosting and guidance on vegetation management. At this time Council installed a portable PROVolitans LED light tower as part of a trial to deter flying-foxes roosting within bamboo along the eastern boundary of 118 Ring Road, where the vegetation abutted the Council-managed easement.

Council has monitored the flying-fox population and behaviour at this site to inform future management planning and actions.

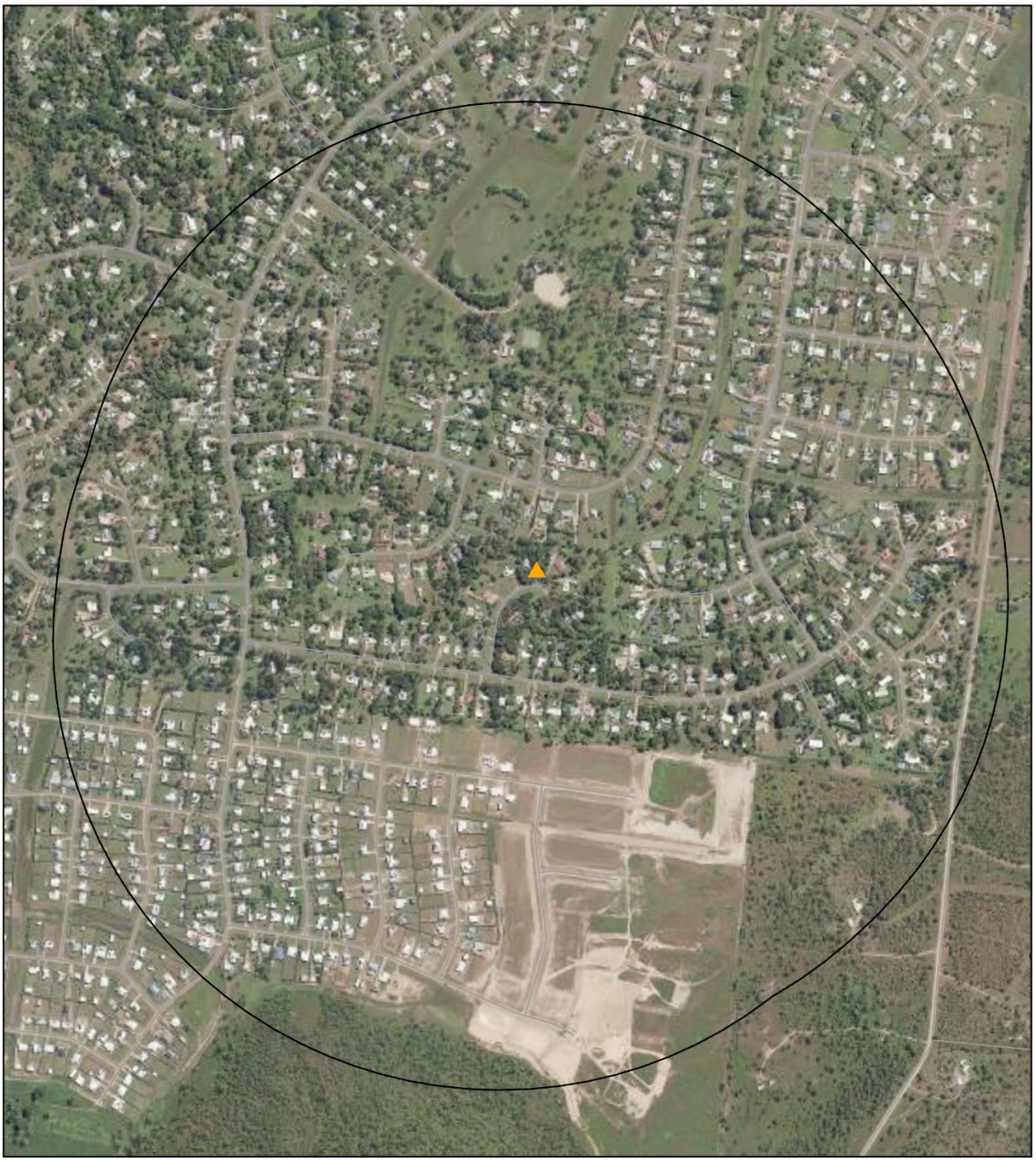

Figure 17: Sensitive receptors within 1 km of the Alice River roost.

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

Priority Urban Flying Fox Roost

1 km radius

N

0 20 40 80 120 160
Metres

CMO Environment Unit
Date: 12/03/2026
Author: gvt

6. Community Engagement

Early and effective community engagement and education has benefits for both communities and land managers. These include increasing community understanding and awareness of flying-foxes, their critical ecological role, and factors that need to be considered in developing a management approach. Engaging with the community is equally important to ensure land managers understand impacts associated with a roost to effectively manage community concerns.

Council sought to consult with all stakeholders with an interest in the flying-fox roosts during the development of the Plan. This included Ecosure site assessments, meetings with Council, and community information sessions for residents of Dan Gleeson Memorial Gardens, Morstone Park, and Alice River in April 2024. The community information sessions provided an opportunity to directly seek feedback from residents and the wider community. Each session was attended by six to 15 people, the small groups allowed for all present to share their experiences, for questions to be answered, and for general flying-fox management and ecological information to be shared/discussed. In addition, the community was invited to complete an online survey; the survey results are outlined below. Previous community engagement for flying-fox roosts is briefly outlined in Section 4.

6.1. Online survey results

An online survey was available on Council's website to directly inform Council of the community's knowledge and attitudes towards flying-foxes and management options. The survey was open between 12 April to 7 June. Council shared the survey through various channels to encourage participation. This included corflute signage at flying-fox roosts, direct letterbox distribution, and related media releases. Council received respondent submissions via the Have Your Say Townsville online platform or in person at one of the community information sessions. A total of 233 people visited the survey web page, of which 57 people completed the survey.

The online survey collected participants demographic information and asked attitudinal and knowledge questions about flying-foxes and management. Some questions were mandatory while others were optional, as such the sample size of 57 completed surveys is lower for some questions.

Demographics

Of the respondents (n = 57), most were in the 31-50 years (39%) and 51-70 years (32%), with some 18-30 years (17%) and 71+ years (12%). Most were female (82%) and most are residents of Townsville (89%). Four respondents owned a business in Townsville and two respondents were visitors to Townsville. Of the respondents (n = 54), more than half live less than 1 km from a flying-fox roost (70%). Based on this data it must be acknowledged that the results are indicative of people living near a roost and may not be representative of the wider community across the LGA.

Below we provide most of the questions and a summary of answers.

If you live near a roost and you are being impacted by flying-foxes, please report at what time.

The main times of the day that respondents (n = 54), who could select multiple time periods, were impacted by flying-foxes at their properties included early evening after sunset (62%), sunset (50%), through the night (37%), and pre-dawn (31%). The times respondents reported being impacted align closely with the times they reported being home: early evening after sunset (90%), pre-dawn (87%), through the night (87%), and sunset (81%).

Please provide a response (true, false, unsure) for each of the following.

When presented with mandatory true or false statements (n = 57 respondents), 84% answered that flying-foxes are protected under legislation. With respect to Townsville LGA we asked are flying-foxes increasing and 56% answered 'true'; the data available suggests that this is correct for the LGA with seasonal and annual variation (see Section 5). However, no meaningful national population data is available for BFF or LRFF; these are the two species that most commonly occur within the Townsville LGA. Furthermore, the National Flying-Fox Monitoring Program (NFFMP) reports that the GHFF population is stable, possibly

increasing slightly (Vanderduys et al. 2024); this species is a rare visitor to the Townsville LGA. Lastly, the SFF is a rare visitor to the Townsville LGA, the population of this species is declining. When asked if 'flying-fox populations are not decreasing nationally' 33% answered true; two of the four species are listed as threatened due to population decline and loss of habitat (the GHFF and SFF). Lastly, 42% answered that flying-foxes carry disease that is easily transmitted to humans and animals, while 40% answered that this is false, and 18% were unsure. As noted in this Plan, it is extremely rare for flying-foxes to transmit ABLV to humans or Hendra virus to horses (see Appendix 3).

Please indicate how strongly you agree or disagree with the following statements.

Most of the respondents (n = 57) strongly agreed that flying-foxes are a nuisance in their community (51%). Similarly, most respondents strongly agreed that flying-foxes in their community should be managed (60%), and that living near flying-foxes is horrible (54%). 47% of respondents strongly disagreed that they enjoyed when flying-foxes visited their neighbourhood and 33% strongly disagreed that flying-foxes should be able to share the urban environment with humans. One additional comment noted that it is important to create habitat for flying-foxes to replace the habitat lost to urban sprawl as they are essential to our ecosystem.

Which of the following topics relating to flying-foxes are of concern to you?

Respondents (n = 57) could select more than one answer, as such each category is out of a possible 100%. The topics of most concern were: faecal droppings (70%), smell (63%), concern about disease (49%), noise (47%), and damage to vegetation (45%). Foraging close to my house (36%), flying-fox habitat protection (35%), and misinformation about flying-foxes (31%) were of lessor concern. When asked similar questions in relation to 'around your home' respondents (n = 57) said the impacts of faecal droppings (66%), smell (61%), noise (49%), disease (43%), and feeding close to my home (38%) were their biggest concerns. An additional comment noted that the flying-fox noise and faecal droppings are impacting their homes and ability to sleep.

How would you rate your experience or interactions with flying-foxes?

Respondents (n = 57) reported negative experience or interaction (63%), positive (33%), and neutral (4%). When answering follow-up questions, where respondents (n = 57) could select more than one answer, they reported that flying-foxes are great pollinators and seed dispersers (52%), that flying-foxes are an important part of our ecosystem (45%), and that they appreciate being able to live with native wildlife (43%). Some respondents provided additional information, saying that they are concerned that flying-foxes are harmed by dispersal and that management actions should consider impacts on this long-lived species. Some respondents said the only had negative experiences and a few specifically mentioned smell, faecal droppings, and noise from the flying-foxes impacting their health and wellbeing. Some noted that fruiting trees in urban areas are attracting the flying-fox.

Which of the following educational options appeal to you?

Respondents (n = 57) weakly supported all eight options (note that more than one option could be selected, so each category is out of a possible 100%). Educational signage (40%) was the most appealing. The following three all received 31%: fact sheets with up-to-date information regarding flying-foxes or the roost, website with links to up-to-date information, and school engagement programs. Talks by Traditional Owners/wildlife researchers and promote flying-foxes as a natural asset to future residents were both 29%. Respondents selected 'none of the above' and added comments including questioning where the funding for these programs would be coming from. One comment suggested that a good education program with factual information is important and introducing activities at festivals would reach large sectors of the population.

Please answer the following questions on a scale of 1 to 10, where 1 is not at all important, and 10 is extremely important.

Respondents (n = 54) were asked a series of questions on a scale of 1 (not important) to 10 (very important). How important is it to you that management actions are cost-effective? 26% selected 1 (not important) and 24% selected 5 (neutral). How important is it to you that Council protects vegetation and other environmental values in parkland and bush areas? 48% selected 10 (very important), while only 4% selected 1 (not important). Respondents (n = 53) were asked how important is it to you that Council assists managing impacts associated with flying-foxes? 44% selected 10 (very important), while only 6% selected 1 (not important).

Respondents (n = 54) were asked how important is it to you that Council protects flying-foxes? 33% selected 10 (very important), while 20% selected 1 (not important). How important is it to you that Council does not disturb flying-foxes? 50% selected 1 (not important), 24% selected 10 (very important). How important is it to you that community members do not disturb flying-foxes roosting during the day without a permit? 37% selected 1 (not important), while 31% selected 10 (very important).

Would receiving a subsidy help to reduce flying-fox impacts on your property? (E.g. to contribute to car covers, double glazing, etc.)

Respondents (n = 53) answered no (40%), yes (38%), and don't know (23%). When asked to select considerations for subsidy programs (note multiple options could be selected so each category is out of a possible 100%) periodic cleaning was the most popular (53%). This was followed by netting (34%), car cover (32%), and outdoor cleaning (32%). Clothesline cover (30%), pool cover (26%), double glazing windows (26%), and loan of pressure cleaner from Council (19%) were the next most popular. Comments for other subsidies that could assist included existing tree trimming or removal, supply of LED bright lights, repair damaged paint on car and/or house, pool sanitiser, and subsidies of electricity bills. Three respondents commented 'none of the above' and 'no subsidies wanted'. Respondents (n = 48) selected up to $3000 per house (39%) followed by up to $1000 per house (31%), up to $6000 per house (15%), and more than $6000 per house (15%). One additional comment noted that certain addresses should not have to apply each time for a subsidy but rather be automatically granted based on their location and known impacts from a flying-fox roost.

Which of the following management options do you support?

Respondents (n = 49) could answer all questions, so each category is scored out of a possible 100%. The management option most selected (57%) was use of plants that flying-foxes don't like to create buffers between flying-foxes and property/dwellings. This was followed by use of deterrents (e.g. CMS) to create buffers between flying-foxes and property/dwellings (47%), protecting and enhancing flying-fox roost habitat in low conflict areas (47%), and targeted noise aiming to gradually push roosting flying-foxes a short distance (e.g. 1 km) away from dwellings into a larger area of bush (45%). Community education, land use planning including zoning for flying-fox roosts, and dispersal aiming to remove roosting flying-foxes were the next most popular (45% each). Additional comments noted that dispersal is not adequate and doesn't work, birds of prey can be effective, tree trimming should include reducing canopy by 10%, and removal of exotic plant species. Some comments noted that community education is not helping residents and that installed CMS have been ineffective. Respondents (n = 24) selected that they would like information about garden plants to avoid attracting flying-foxes to your backyard (40%), while 48% said this was not applicable.

Which of the following actions do you feel are appropriate to protect flying-foxes in parkland and bush areas?

Respondents (n = 44) could select all options, so each category is scored out of a possible 100%. Habitat restoration and tree planting to protect where flying-foxes roost during the day (41%) and monitoring flying-fox behaviour and welfare (41%) were selected at the same frequency. As were habitat restoration and tree planting to provide more native foraging habitat (39%) and all of the above (39%).

Lastly, an open comment section allowed respondents to provide further information. Several comments reiterated the direct impacts of flying-foxes on the residents: noise, smell, reduced amenity, and health impacts. Several respondents called on Council to proactively manage flying-foxes. There was also reference to the law and Council favouring flying-foxes and not humans. Two commented that the local flying-fox populations need to be reduced and/or dispersed. One comment noted that the decision to use smoking machines to keep bats away from houses is concerning.

7. Management option analysis (landscape)

Site-specific assessment of flying-fox impact management options commonly used across Australia, and their suitability for the Townsville LGA urban flying-fox roosts (Table 4).

Table 4 Management options for the Townsville LGA urban flying-fox roosts. Further information on management options is provided in Appendix 5, and appraisal in Section 8

Management option	Relevant impacts	Cost $-$$$	Advantages	Disadvantages	Suitability
Routine management actions					
Community engagement and awareness	Fear of disease Noise Smell Faecal drop Water contamination	$	Low cost, increasing awareness will help the community understand the ecology of flying-foxes, providing options for landholders to reduce impacts. This is an effective short and long-term solution. Education can be undertaken on an ongoing basis and in response to community concerns/needs.	Education and advice alone may not mitigate all issues, and on its own may not be acceptable to the community.	Community education, advice, and awareness programs are key components of any plan to manage flying-foxes and their roosts. Install educational signs at Dan Gleeson Memorial Gardens and the Palmetum. Signs could include a QR code to Council's website to provide additional information. Council should continue to provide up to date information to the community. This may include notifying the community that part of a park is closed for a day or a period for visitor safety and/or flying-fox welfare (e.g. Dan Gleeson Memorial Gardens). For example, paths are closed to allow cleaning or vegetation management (including planting). Similarly, areas may be closed if large numbers of flying-foxes are present to reduce disturbing the roosting animals. This action also aims to reduce noise impacts to the neighbours, flying-foxes alarm call when disturbed and will often take flight; this can shift roosting flying-foxes to undesirable locations such as the trees along the eastern boundary. Council should also consider community engagement sessions to convey Councils management intentions and provide advice to affected residents, especially during times with large influxes, and support land managers of sensitive sites as required. Appraisal: Adopt

Management option	Relevant impacts	Cost $-$$$	Advantages	Disadvantages	Suitability
Roost monitoring	Noise Smell Faecal drop	$	Relatively inexpensive. Allows for an understanding of population dynamics over time which is important to inform community engagement actions. Allows for data to be used to determine the efficacy of management actions.	Not a direct management action that will minimise impacts.	Council undertakes monthly monitoring of urban roosts; weekly monitoring is possible during high conflict periods. A minimum of quarterly monitoring, feeding this information to DETSI and the NFFMP. Monthly monitoring allows for the collection of key information. Including: roost extent, flying-fox numbers, seasonal trends, flying-fox demographics (species present, age), and can assist in informing when management actions can be implemented and allows for data to be collected over time to assess management efficacy. Appraisal: Adopt. Drone monitoring (thermal) could be considered as a complimentary method of obtaining count and roost extent data. Appraisal: Investigate.
Property modification / service subsidies	Noise Smell Faecal drop Health/wellbeing	$$$	Property modification is one of the most effective ways to reduce amenity impacts of a roost. Property modification can promote conservation of flying-foxes, provide long-term outcomes, can be undertaken quickly, will not impact on the site, and may add value to the property. Property modification, such as glazing windows or installing noise attenuating insulation, will greatly assist with noise impacts inside residences and businesses. Installing shade sails, car ports, or covering other affected areas will reduce the impacts of faecal drop.	May be cost-prohibitive for private landholders, however subsidies would assist.	Council has determined that the community is interested in a subsidy program. The next step is to secure funding as part of future budgets and plan a staged delivery. Funding is recommended to be allocated using a tiered approach based on distance to the roost. For example, the first tier may include houses within 50 m, the second tier may include houses within 100 m, etc. Eligibility criteria will need to be applied and amount available per house per tier will be funding-dependent. Appraisal: Investigate.

Management option	Relevant impacts	Cost $-$$$	Advantages	Disadvantages	Suitability
Routine roost maintenance	Health/well-being	$$$	This action is not aimed at managing flying-foxes, it allows the landholder to undertake routine maintenance at or near the flying-fox roost (in line with the Low impact COP). Note, weed removal has the potential to reduce habitat at a roost and reduce numbers of roosting flying-foxes.	Will not, in general, mitigate amenity impacts for nearby landholders.	Two roosts are located within the highly manicured Gardens, as such this management action is being implemented. A different level of management is appropriate for Morstone Park and Alice River, mainly mowing grassed areas and general tree safety and vegetation maintenance. Protocols should be developed for carrying out operations that have the potential to disturb flying-foxes, which can increase impacts such as noise and smell, and create a flying-fox welfare issue. Vegetation maintenance should aim to identify opportunities to enhance or create future roosting habitat where the roost can extend into or shift to in the future. Any weed removal should be staged and mindful of disturbance or exacerbating the potential for HSEs. Appraisal: Adopt.
Alternative habitat creation	Noise Smell Faecal drop Health/wellbeing	$$$	If successful in attracting flying-foxes away from high conflict areas, dedicated habitat in low conflict areas will mitigate most impacts and help flying-fox conservation. Rehabilitation of degraded habitat that is likely to be suitable for flying-fox use could be a more practical and a faster approach than habitat creation. Improving potential alternative roost habitat should be part of a medium-to long-term plan	Generally costly, long-term (~5-10 years for roost tree growth) approach so cannot be undertaken quickly, previous attempts to attract flying-foxes to a new site have not been known to succeed.	Appropriate for Dan Gleeson Memorial Gardens within the designated roost area to sustain roosting in the area, reducing future expansion into adjacent areas due to habitat loss (see Figure 18). This is a low priority action for Morstone Park, however recruitment of future roost trees is important for all roosts (Figure 19). Creating future roost habitat adjacent to the Palmetum Botanic Gardens should be a priority (see Figure 20). Regarding Alice River, creating suitable habitat on the Council easement is likely to be preferable to flying-foxes roosting within residents' backyards. However, this management action would only slightly reduce the impact on residents and would only be effective if significant vegetation was removed from residents' properties (see Figure 21). Appraisal: Investigate.

Management option	Relevant impacts	Cost $-$$$	Advantages	Disadvantages	Suitability
Odour reducing / masking plants	Noise Smell Health/wellbeing	$	Planting dense screens and fragrant plants to assist with odour and noise and trim tall trees to less than 5 m high and/or use wildlife friendly netting to prevent occupation by flying-foxes.	May take time for plants to provide the desired effect, and unlikely to mitigate odour during large influxes.	Residents could be encouraged to modify properties by planting dense screens and fragrant plants. This information can be provided in an education program and Council could provide free plants. Appraisal: Adopt.
Indoor neutralising pots	Smell	$	Indoor odour neutralising pots (Hostogel™) contain a gel-based formula to chemically mask odour have been shown to have a localised positive effect in reducing odour. Inexpensive. has been trialled for neutralising indoor odour.	If residents rely on keeping windows open for airflow in warmer months, this may not be a suitable option for minimising odour.	Indoor odour neutralising pots could be trialled for residents impacted by odour. This could be considered as part of a subsidy program and incorporated into future budgets (outlined above). Appraisal: Investigate.
Provision of artificial roosting habitat	Noise Smell Faecal drop Health/wellbeing	$$$$$	Artificial roosting habitat could be considered to supplement vegetation damaged by large numbers of flying-foxes.	No guarantee that flying-foxes would use artificial habitat, but collaborating with a researcher on varying design options would increase the likelihood of success.	Investigate the potential for implementing innovative solutions for roost structures; would require a trial phase. Methods to enhance roosting opportunities while simultaneously working on establishing additional roost trees could be explored. Appraisal: Investigate.

Management option	Relevant impacts	Cost $-$$$	Advantages	Disadvantages	Suitability
Protocols to manage incidents	Health/wellbeing Fear of disease	$	Low cost will reduce actual risk of negative human/pet-flying-fox interactions, promotes conservation of flying-foxes, can be undertaken quickly.	Will not mitigate amenity impacts but will reduce fear of disease.	Community education regarding disease risk to humans and pets. Council to maintain/develop (where required) standard internal procedures for operations, response to HSEs, and other potential incidents. Appraisal: Adopt.
Support flying-fox carers	Health/wellbeing Flying-fox welfare	$	Low cost, fosters relationship between Council and wildlife carers, can decrease risk of negative human/pet/flying-fox interactions with early intervention of carer support during HSEs, food shortages, etc.	Will not mitigate amenity impacts.	Council to maintain good working relationship and support flying-fox carers, especially during times of increased likelihood of HSEs, food shortages, and during pupping and crèching periods. Appraisal: Adopt.
Research	Noise Smell Faecal drop Health/wellbeing	$-$$$	Support research that improves understanding and more effectively mitigates impacts. Develop understanding of local flowering.	Generally, cannot be undertaken quickly, management trials may require cost input.	Council should stay up-to-date with contemporary research and review the Plan as required. Analysis of scats to assess foraging species. Monitoring the timing, distribution, and extent of flowering across the LGA. Drone surveys provide increased accuracy over ground count methods. GPS tracking movements in your area would inform community engagement and an assessment of foraging habitat. Appraisal: Investigate.
Appropriate land use planning	Noise Smell Faecal drop Health/wellbeing	$	Suitable planning for future development will reduce potential for future conflict.	Will not mitigate current impacts.	Extensive natural areas across the LGA. Appraisal: Investigate.

Management option	Relevant impacts	Cost $-$$$	Advantages	Disadvantages	Suitability
Property acquisition	All for specific property owners Nil for broader community	$$$$$$$	Mitigation for directly impacted residents (within the approved criteria threshold).	Cost prohibitive.	Not feasible. Appraisal: Disregard.
Do nothing	Nil	Nil	No resource expenditure.	Will not mitigate impacts and would not be considered acceptable by impacted members of the community.	Not appropriate. Appraisal: Disregard.
Low Impact COP					
Buffers through vegetation modification	Noise Smell Health/wellbeing	$$	Any vegetation modification should be done using a staged approach, with the aim of changing native vegetation as little as possible and only if flying-foxes' use of this vegetation is directly affecting residents.	Modifying vegetation can increase visibility into the roost and noise issues for neighbouring residents which may create further conflict. Vegetation removed too quickly could cause inadvertent movement to less desirable locations within/adjoining a roost or dispersal of a roost.	A vegetative buffer could include the removal or trimming of trees and the retention of native shrubs and grasses. Vegetation management should start with the removal of weed species. Buffer creation can also include screening shrubs, particularly species with fragrant flowers or foliage. This is suggested for Dan Gleeson Memorial Gardens along the perimeter of the designated roost area (Figure 18). Appraisal: Adopt.

Management option	Relevant impacts	Cost $-$$$	Advantages	Disadvantages	Suitability
Buffers through visual deterrents, canopy-mounted sprinklers	Noise Smell Health/wellbeing Damage to vegetation	$$$$	Successful creation of a buffer will reduce impacts, promotes flying-fox conservation, can be undertaken quickly, options without vegetation removal may be preferred by the community.	May impact the site, buffers will not generally eliminate impacts, maintenance costs may be significant, often logistically difficult, limited trials so likely effectiveness unknown.	The use of canopy mounted sprinklers (CMS) could be considered as favourable compared with a vegetative buffer in some locations. Equally, both methods are often complementary: a buffer of shrubs and CMS in the trees along the buffer edge to deter flying-foxes roosting close to houses (see Figure 19). The use of PROVolitans (Figure 18) or LED lighting systems can create a buffer or asset protection (e.g. deter roosting within an individual high value tree). A cost-benefit analysis should compare the cost and effectiveness of various methods (e.g. vegetative, CMS, light buffer creation) before deciding on an approach as this is likely to differ between specific context. For more detail see Appendix 5. Appraisal: Investigate.
Noise attenuation fencing	Noise Smell Health/wellbeing	$$$$	Noise attenuation fencing is intended to alleviate amenity issues for residents. Advice from an acoustic consultant may provide site-specific alternatives.	Noise attenuation fencing is costly and can be considered unsightly for property fencing. This management action may be negated if flying-foxes move to roost in vegetation closer to sensitive receptors.	Unlikely to achieve a meaningful and lasting outcome in relation to the Townsville LGA urban roosts. Appraisal: Disregard.

Management option	Relevant impacts	Cost $-$$$	Advantages	Disadvantages	Suitability
Management COP					
Nudging	All	$$$$$	Can encourage flying-foxes to shift away from high conflict areas next to residential areas.	May lead to inadvertent dispersal and splintering of the roost if not done at the correct time, frequency, or intensity.	Nudging is currently used predawn to restrict flying-fox numbers and their roost extent at Dan Gleeson Memorial Gardens and the Palmetum Botanic Gardens. This option isn't appropriate for Morstone Park as the flying-foxes are likely to move within proximity of other residents. This method is currently being used by Alice River residents. Monitoring is required to ensure that nudging isn't implemented if pups are in a crèche tree. Council monitoring should aim to inform staff, contractors, and the community (i.e. Alice River) of this behaviour and where it is occurring. Alternatively, nudging could be paused during months when pup crèche trees are identified. Appraisal: Adopt.
Active dispersal	All (generally appropriate for amenity impacts only)	$$$$$	If successful can mitigate all impacts at that site. It is important to note that the outcomes of dispersal are generally temporary, and repeat dispersal is likely to be required as flying-foxes attempt to re-establish the roost. This may be seasonally, annually, or more regularly.	Dispersal is rarely successful without significant vegetation removal or ongoing effort and excessive expenditure (e.g. several years and $1M for Sydney Botanic Gardens). Flying-foxes will almost always continue to roost in the area (generally within 600 m), and often splinter into several locations nearby (including	The option to disperse flying-foxes from a camp or roost site will be individually risk assessed. Appraisal: Adopt

Management option	Relevant impacts	Cost $-$$$	Advantages	Disadvantages	Suitability
				many remaining at the original site). See Appendix 6 for further information of dispersal attempts.	

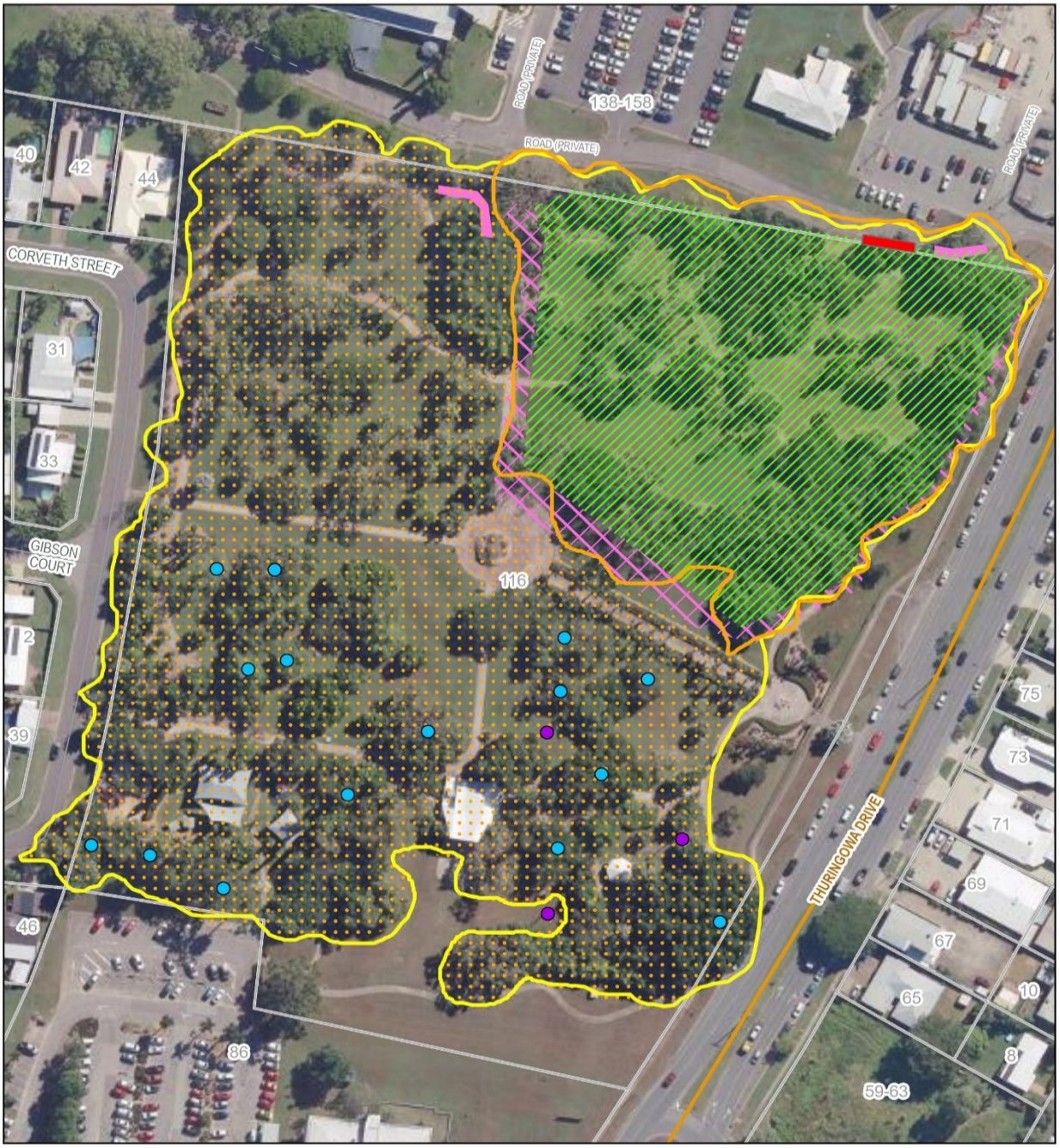

Figure 18: Dan Gleeson Memorial Gardens optional management actions

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

- Maximum Roost Extent
- Core Roost Extent
- 5m visual buffer
- Canopy over footpath
- Nudging area
- Successional habitat creation
- Tree trimming over foot path
- Canopy Sprinkler
- Provitalin Light Tower
- Properties

N

0 20 40 80 120 160
Metres

CMO Environment Unit
Date: 12/03/2026
Author: gvt

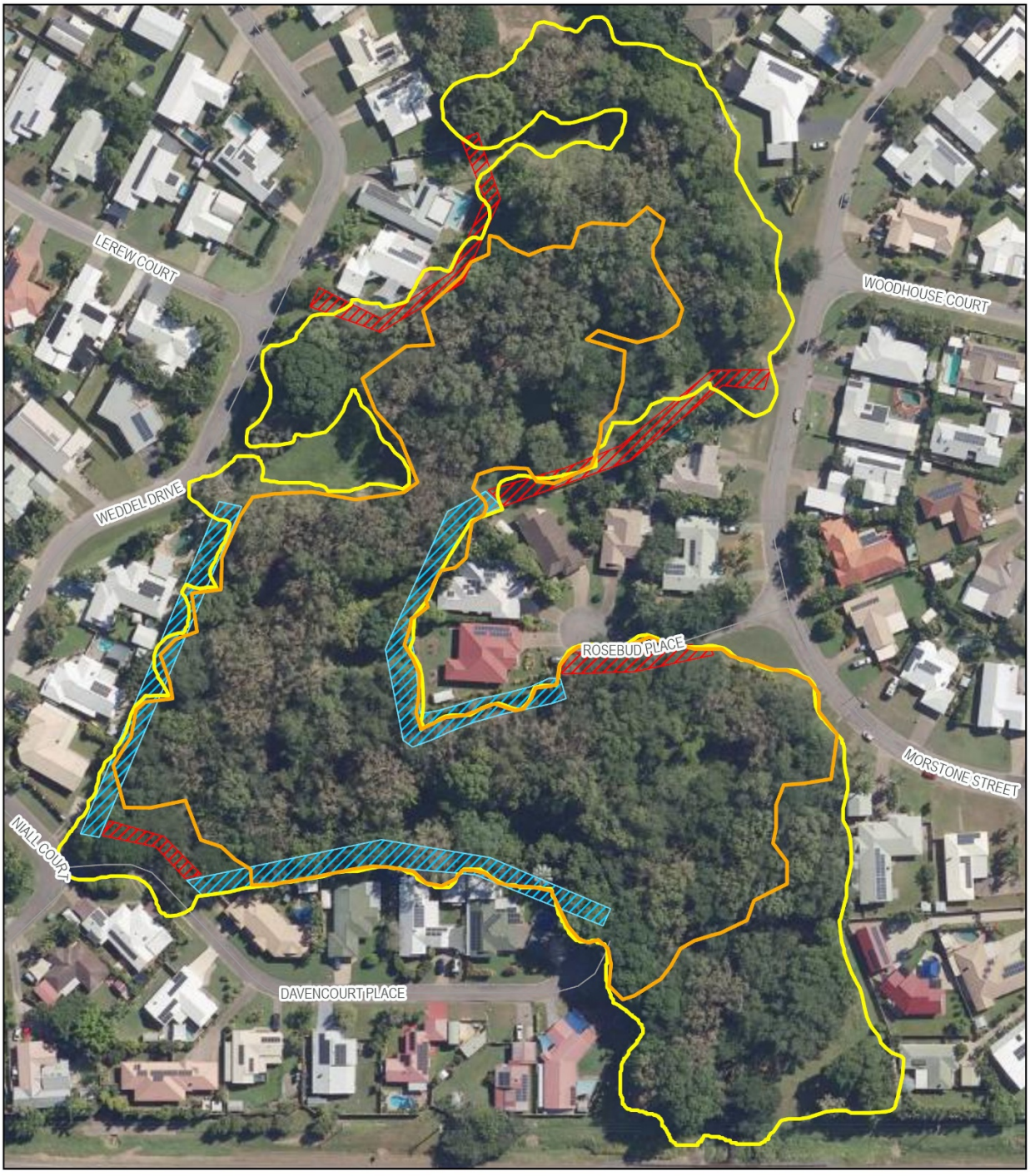

Figure 19: Morstone Park optional management actions

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

- Maximum Roost Extent
- Core Roost Extent
- Priority tree trimming and CMS area
- Secondary tree trimming area

N

0 20 40 80 120 160

Metres
GDA2020 MGA Zone 55
Scale: 1:1,750 @A4

CMO Environment Unit
Date: 13/03/2026
Author: gvt

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Figure 20: Palmetum Botanic Gardens optional management actions

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

Maximum Roost Extent
Core Roost Extent
Nudging area
Roost habitat restoration/ planting in lower conflict area
Properties

N

0 20 40 80 120 160
Metres
GDA2020 MGA Zone 55
Scale: 1:2,734 @A4

CMO Environment Unit
Date: 12/03/2026
Author: gvt

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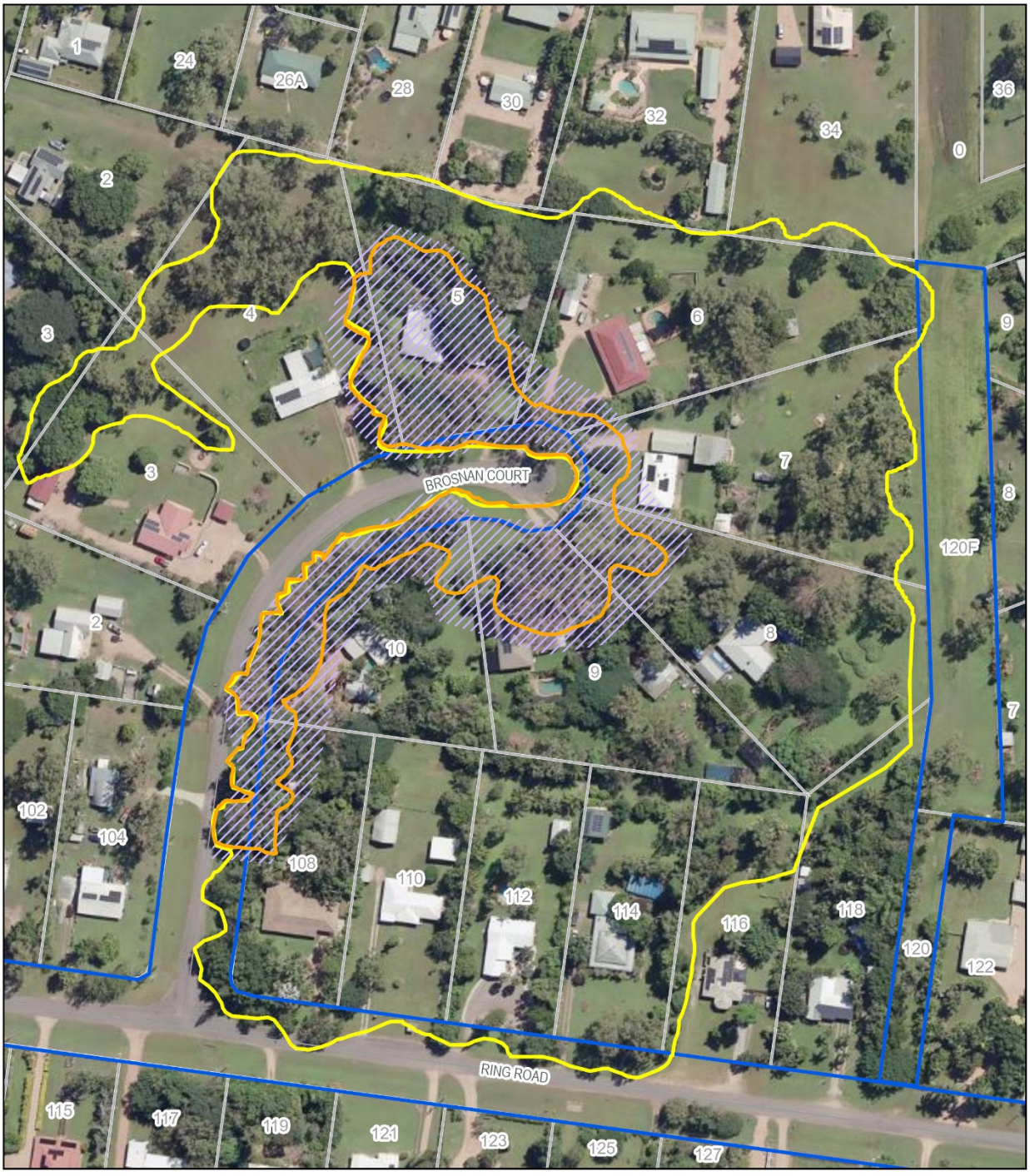

Figure 21: Alice River optional management actions

Townsville City Council
Townsville LGA Flying-fox Roost Management Plan 2024

- Maximum Roost Extent
- Core Roost Extent
- Council managed land
- Management area
- Properties

N

0 20 40 80 120 160

Metres
GDA2020 MGA Zone 55
Scale: 1:2,000 @A4

CMO Environment Unit
Date: 12/03/2026
Author: gvt

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7.1. Management framework for emerging roosts

This flow chart outlines a general procedure to assess and manage emerging flying-fox roosts4. Once assessed, the management of emerging roosts will align with the options detailed in Appendix 5.

8. Planned Management actions

Management actions aiming to reduce impacts on residents and habitat associated with flying-fox roosts in the Townsville LGA are outlined (Table 5). The actions align with legislation (Section 1.4), roost assessments (Section 5), and consultation with Council. Implementation of management actions must be considerate of approvals potentially required, site values, and in accordance with measures to avoid impacts (see Appendix 5). Evaluation measures are provided for each action which will be used to evaluate progress and success. Details of how the Plan and the actions below will be implemented are described.

Table 5 Planned management activities

Strategy	Action	Details	Applicable locations	Approvals required	Timeframe/Progress	Evaluation measure
Routine management actions						
Community engagement and awareness	Ensure clear and up-to-date information available regarding legislation and human and animal health.	Ensure the community is aware of legislation around flying-foxes, and that management affecting flying-foxes is illegal without relevant approvals. Education should be delivered in the form of events, online material and/or hardcopy brochures, and should include up-to-date health information, impact mitigation options available at a property level (e.g. odour-neutralising gel pots), and legislative responsibilities. One-on-one engagement may be required for primary-affected residents.	All roosts	No	Short-term and ongoing	Community informed and engaged.
	Keep community informed of flying-fox numbers, routine management, and up-coming management including trialling new methods	Engagement platforms including Facebook, websites, media release, and digital/hard copy mail (e.g. brochures, fact sheets) will be utilised to maintain awareness and keep the community updated and informed. Support land managers of sensitive sites as required.	All roosts	No	Short-term and ongoing	Up-to-date information readily available for the community.

Strategy	Action	Details	Applicable locations	Approvals required	Timeframe/Progress	Evaluation measure
Impact mitigation	Roost monitoring	Ensure regular (e.g. monthly; at least quarterly) monitoring of all active flying-fox roosts within the Townsville LGA; recording roost spatial extent is valuable. Share survey data with DETSI and the NFFMP. Drone monitoring can provide more accurate results on roost numbers and extent, this method should be considered however ground counts are required to assess species level population estimates.	All roosts	Monitoring approved by DETSI Animal ethics may be required for some monitoring	Ongoing	Regular monitoring undertaken at urban roosts and quarterly monitoring at all roosts.
	Community Assistance Program	Community Assistance Program's offer distance-scaled subsidies for residents affected by flying-fox roosts. Subsidies may cover property modification and/or services to manage impacts associated with flying-foxes (see Appendix 5 for further information). Note, Council has implemented subsidies programs with varying success; the community noted that the reimbursement process of the 2024 program was a barrier to participation.	All current and future roosts	Public notification requirements	Short- and long-term	Investigated feasibility, community support, and best practice implementation
	Alternative habitat creation	Protect, improve, and restore low conflict roost habitat to avoid future conflict (see Figure 18 and Figure 20).	All roosts	No approvals required where improvement includes increasing the density of the mid- and upper-canopy and, where possible, expanding the area of available habitat.	Long-term	Investigated opportunities to restore or create low-conflict roost habitat.

Strategy	Action	Details	Applicable locations	Approvals required	Timeframe/Progress	Evaluation measure
	Shelter over pedestrian access paths	Reduce human-wildlife conflict, specifically faeces from roosting flying-foxes landing on pedestrians by building a canopy over specific high-traffic pedestrian areas and/or trimming vegetation (Figure 18 and Figure 19	Dan Gleeson Memorial Gardens, Morstone Park	No where action is in compliance with the Low Impact COP	Short-term	Canopy installed and/or vegetation trimmed
	Odour reducing / masking plants	Boundaries between flying-fox roosts and residents can be densely planted, selecting species that produce fragrant flowers to create an odour barrier/buffer to reduce odour impacts (see Figure 18).	All roosts	No	Long-term	Reduced odour impacts for residents living adjacent to flying-fox roosts.
	Indoor odour neutralising pots	Trial indoor odour neutralising pots to determine effectiveness in reducing odour impacts. Consider incorporating into subsidy program if budgets allow.	All roosts	No	Short term and ongoing if effective	Reduced odour impacts for residents living adjacent to flying-fox roosts.
Avoiding future conflict, conservation	Protocols to manage incidents	Collaborate with wildlife rescue and care organisations to monitor potential future HSEs during predicted hot weather. Develop a Heat Stress Response Plan that outlines information on the factors that contribute to HSEs, how to monitor flying-fox stress, the importance of having a roost-specific response plan, personnel roles in attending to HSEs, active spraying of flying-foxes, recovery, and response to mortalities, as well as the importance of collecting data on HSEs.	All roosts	No	Short-term and ongoing	Heat Stress Response Plan developed and communicated. Ongoing communication with wildlife

Strategy	Action	Details	Applicable locations	Approvals required	Timeframe/Progress	Evaluation measure
						rescue and care organisations.
	Support flying-fox carers	Support the ongoing rescue, care, and conservation efforts of local wildlife carers, particularly during flying-fox influxes in the LGA and HSEs.	All roosts	No	Ongoing	Strong relationship between flying-fox carers and Council.
	Support research	Support research, particularly projects which will assist in understanding local flying-fox movements, diet, population, and ways to mitigate impacts on the community. A priority area of research is to better understand foraging resources in the area to allow proactive management and preparation for future influxes.	All roosts	No	Long-term and ongoing	Council up-to-date on contemporary research and relevant outcomes used to inform roost management.
	Appropriate land use planning	Work with Council's Town Planners to investigate implementing measures to avoid future conflict between roosts and the community when assessing development applications, including new urban areas. Identify potential buffer areas to zone as natural areas/flying-fox management areas, as appropriate, to mitigate impacts to residents. Consider habitat protection measures (zoning, Biodiversity Agreements) for existing flying-fox roosts.	All roosts and future roost sites	No	Long-term	Flying-fox roost management areas incorporated into planning instruments.
Low Impact COP						
Impact mitigation	Routine roost maintenance	Continue routine roost maintenance as usual. Develop protocols to mitigate operations that may disturb flying-foxes during sensitive periods e.g. night works. Disturbance can increase impacts such as noise and smell and can create flying-fox welfare issues (e.g. dropped pups). Weed management should be staged and mindful of inadvertent dispersal or exacerbating HSEs.	All roosts	No permit required for weed management or habitat improvement, and if	Ongoing	Successional vegetation creation and maintenance where appropriate.

Strategy	Action	Details	Applicable locations	Approvals required	Timeframe/Progress	Evaluation measure
				tree trimming is in compliance with the Low Impact COP		
	Consult with residents about supporting buffer maintenance through vegetation management (trimming/removal)	Liaise with residents to assess attitude and support for property owners and Council to implement buffer vegetation work on targeted properties, whilst minimising removal of roosting habitat. Council can support by providing the necessary licences (where required), liaise with DETSI, assist with developing the work plan, assist with oversight, and, where appropriate, help with the implementation of the work.	All roosts	No permit required for weed management or habitat improvement, and if tree trimming is in compliance with the Low Impact COP	Ongoing	Actions implemented to reduce conflict roosting around dwellings. Residents wishing to maintain buffers supported by Council.
	Consult with residents about potential buffers between dwellings/ properties	Buffers of less desirable roosting habitat, such as on private property, up to 20 m from dwellings can be established through a collaborative approach. This includes a combination of weed removal, selective trimming/removal, CMS, and/or lighting strategies. Management actions will be undertaken by property owners with support from Council. Council can support by providing the necessary licences (where required), liaise with DETSI, assist with developing the work plan, assist with oversight, and, where appropriate, help with the implementation of the work.	All roosts	Authorised under the Low Impact COP – permit required for protected vegetation (see	Short-term/on-going	Buffers implemented if appropriate and funds available.

Strategy	Action	Details	Applicable locations	Approvals required	Timeframe/Progress	Evaluation measure
				section 5)		
Management COP						
Impact mitigation	Provision of artificial roosting habitat	Artificial roosting habitat could be considered to supplement vegetation damaged by flying-fox roosting behaviour (defoliates branches). The provision of artificial roosting habitat has many potential benefits; experimentation would be required as this would be a novel, innovative solution.	Dan Gleeson Memorial Gardens	Authorised under the Management COP	Short term and ongoing if effective	Investigate feasibility and application
	Nudging	Coordinated application of deterrents (e.g. noise, light, CMS, smoke, human presence) to deter flying-foxes from roosting in trees/areas deemed unacceptable. Nudging the flying-foxes to identified non-disturbance areas aim to habituate the flying-foxes to use specific areas and reduce human-wildlife conflict associated with roosting in undesirable locations.	All roosts (CMS only with grant funding)	Authorised under the Management COP	Short- and long-term conflict mitigation	
Management COP/Flying-fox roost Permit (Management outside of COP)						
Impact mitigation	Dispersal	Coordinated application of deterrents (e.g., noise, light, CMS, smoke, human presence) to deter flying-foxes from roosting in an area deemed unacceptable.	All roosts following results of a site-specific Risk Assessment	Authorised under the Management COP or if outside of the COP (e, g., not UFFMA) Authorised under a flying-fox roost management permit	Short and long-term conflict mitigation	Dispersal actions planned, implemented and outcomes assessed. Regional monitoring undertaken to assess for splintering or increase of other known roost sites.

9. Plan evaluation and review

9.1. Plan administration

This Plan will be reviewed annually including ongoing evaluation of the strategies (Table 5). The Plan shall remain in place until a revised version is adopted by the Council; a 5-year review is recommended. The following may also trigger a review of the Plan:

- completion of a significant action (Low impact COP or above)
- changes to relevant legislation
- any negative incident associated with roosting or foraging flying-foxes.

9.2. Monitoring

Council will monitor and keep internal records to allow the effectiveness of each management action to be evaluated and inform future planning. Monitoring of the roosts will be undertaken on a quarterly basis to determine the extent of the roost as well as estimate the number and composition of flying-foxes; more frequent monitoring, e.g. monthly, is encouraged and is more informative for Council, management, and the community. Council is encouraged to share monitoring data with DETSI and the NFFMP.

9.3. Reporting

Council is responsible for implementation of the Plan. Council will complete the DETSI evaluation form for actions under its as-of-right authority (excluding activities listed under the Low Impact COP), returned within six weeks of the date of actions being completed, and will comply with any reporting obligations under other permits or approvals obtained to implement the Plan.

Information to collect and report includes:

- results of pre- and post-work population monitoring
- any information on new roosts that have formed in the LGA
- further management actions planned to include a schedule of works
- an assessment of how the community responded to the works, including details on the number and nature of customer enquiries before and after the works
- detail on any compensatory planting
- outcomes from evaluation and review.

9.4. Avoid impacts to flying-foxes

Any on ground works will be undertaken in accordance with standard measures to avoid impacts (Appendix 5). This will ensure the welfare of flying-foxes during proposed minor works, and the safety of personnel working in the roost. As such, impacts on flying-foxes are expected to be minimal.

References

ABS 2018, Regional Population Growth, Australia, https://www.townsville.qld.gov.au/about-townsville/living-in-townsville#:~:text=Our%20local%20government%20area%20covers,the%20Northern%20Beaches%20growth%20corridor.

Atlas of Living Australia 2022, *Spectacled flying-fox (*Pteropus conspicillatus*), viewed 23rd May 2024, https://bie.ala.org.au/search?q=Pteropus+conspicillatus.*

Australian Museum2020, *Little Red Flying-fox*, Australian Museum, <australianmuseum.net.au/little-red-flying-fox>.

Birt, P 2000, 'Summary information on the status of the Grey-headed (*Pteropus poliocephalus*) and Black (*P. alecto*) Flying-Fox in New South Wales', pp.78–86 in *Proceedings of Workshop to Assess the Status of the Grey-headed Flying-fox in New South Wales*, University of Sydney, Sydney NSW.

Bishop, T 2015, The management, treatment and physiology of heat stroke in flying-foxes, presentation.

Bishop, T, Pearson, T, Lyons, R and Brennan, M 2019, *Flying-fox Heat Event Response Guidelines*.

Bradford, M, Venz, M, Bell, KL, Hogan, L, Smith, GC, Eby, P, Eyre, TJ, McKeown, A, Vanderduys, E, MacDonald, S and Westcott, D 2022, 'The diet of a specialist nectarivore in Australia: The little red flying-fox (*Pteropus scapulatus*, Pteropodidae)', *Austral Ecology* 47, 619-628.

Churchill, S 2008, *Australian Bats*, Allen and Unwin, Crows Nest, NSW.

Council 2017, Dan Gleeson Flying-Fox Management Plan. Townsville City Council.

Cox, L 2019, 'Flying foxes found dead and emaciated across eastern Australia as dry weather bites' The Guardian, <https://www.theguardian.com/environment/2019/oct/17/flying-foxes-found-dead-and-emaciated-across-eastern-australia-as-dry-weather-bites>.

Currey, K, Kendal, D, van der Ree, R and Lentini, P 2018, 'Land Manager Perspectives on Conflict Mitigation Strategies for Urban Flying-Fox Roosts', *Diversity* 10, 39.

DAF 2020, *Australian bat lyssavirus: Information for veterinarians*, Department of Agriculture and Fisheries, Qld Government.

DAWE 2021, *National Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus*, Department of Agriculture, Water, and Environment, Commonwealth of Australia, Canberra.

DCCEEW 2021, *National Recovery Plan for the Grey-headed Flying-fox Pteropus poliocephalus*, Department of Climate Change, Energy, the Environment and Water, Australian Government, <https://www.dcceew.gov.au/environment/biodiversity/threatened/publications/recovery/grey-headed-flying-fox>.

www.environment.gov.au/system/files/resources/99449a95-4a42-4a68-8735-303408b8470f/files/pteropus-conspicillatus-recovery-plan.pd

DES 2018, *Conservation advice (incorporating listing advice) for the Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South East Queensland ecological community*, Department of Environment and Science, <https://www.environment.gov.au/biodiversity/threatened/communities/pubs/141-conservation-advice.pdf>.

DES 2020a, *Code of Practice Ecologically sustainable management of flying-fox roosts*, Department of Environment and Science, <https://documents.parliament.qld.gov.au/tp/2021/5721T242.pdf#:~:text=Purpose%20and%20operation%20of%20this,appropriate%20welfare%20standards%20are%20upheld>.

DES 2020b, *Flying-fox Roost Management Guideline*, D Department of Environment and Science ES, <https://www.qld.gov.au/ data/assets/pdf_file/0009/221022/Guideline-Roost-Management.pdf>.

DES 2020c, *Code of Practice Low impact activities affecting flying-fox roosts*, Department of Environment and Science, <https://www.qld.gov.au/ data/assets/pdf_file/0014/221027/cp-wl-ff-low-impact-roosts.pdf>.

DES 2020d, *Importance of flying-foxes*, Department of Environment and Science, Qld Government, <https://www.qld.gov.au/environment/plants-animals/animals/living-with/bats/flying-foxes/about-flying-foxes/importance-of-flying-foxes>.

DES 2021a, *State of the Environment Report 2020*, Department of Environment and Science ES, Qld Government.

DES 2021b, Interim policy for determining when a flying-fox congregation is regarded as a flying-fox roost under section 88C of the NC Act, Department of Environment and Science, <https://www.qld.gov.au/data/assets/pdf_file/0011/221024/op-wl-ff-roost-definition.pdf>.

Divljan, A, Parry-Jones, K and Wardle, GM 2006, 'Age Determination in the Grey-Headed Flying Fox', *Journal of Wildlife Management*, vol 70, no. 2, pp. 607-611.

DoE 2015, *Referral guideline for management actions in grey-headed and spectacled flying-fox roosts - EPBC Act Policy Statement*, Department of Environment, Australian Government.

DPE 2023, *Flying-foxes*, Department of Planning and Environment, <https://www.environment.nsw.gov.au/topics/animals-and-plants/native-animals/native-animal-facts/flying-foxes>.

Driessen M, Brereton R and Pauza M 2011, 'Status and conservation of bats in Tasmania', pp.324–336 in Law B, Eby P, Lunney D and Lumsden L (eds), *The Biology and Conservation of Australasian Bats*, Royal Zoological Society of New South Wales, Mosman, NSW.

Eby, P and Lunney, D 2002, Managing the Grey-headed Flying-fox Pteropus poliocephalus as a threatened species: a context for the debate, Royal Zoological Society of New South Wales, NSW.

Eby, P 1991, 'Seasonal movements of Grey-headed Flying-foxes, *Pteropus poliocephalus* (Chiroptera: Pteropodidae) from two maternity roosts in northern New South Wales', *Wildlife Research*, vol. 18, pp. 547–59.

Eby, P 2000, 'The results of four synchronous assessments of relative distribution and abundance of Grey-headed Flying-fox Pteropus poliocephalus', Proceedings from workshop to assess the status of the Grey-headed Flying-fox in New South Wales, pp. 66-77.

Eby, P and Law, B 2008, 'Ranking the feeding habits of Grey-headed flying-foxes for conservation management: a report for The Department of Environment and Climate Change (NSW) and The Department of Environment, Water, Heritage and the Arts', <https://www.environment.nsw.gov.au/resources/threatenedspecies/GHFFmainreport.pdf>.

Ecosure 2016, *Townsville management options report*, Report to Townsville City Council, Brisbane

Ecosure 2011, 'Hendra Virus Risk Assessment for the Gold Coast Equine Precinct: Residual Risk Report', unpublished report to City of Gold Coast.

Ecosure 2014, 'Outcomes of a new flying-fox management framework: Review of management actions 2013-2014', unpublished data collected in collaboration with Griffith University (Industry Affiliates Program).

Eyre, TJ, Hogan, LD, Venz, MF, Smith, GC, Bradford, M, Hoskins A, Butler, DW, Westcott, D 2020, *Little Red Flying-fox Dynamic Resource Mapping Final Report*, Qld Herbarium and CSIRO, Brisbane and Townsville.

Fox S, Spencer H and O'Brien GM 2008, 'Analysis of twinning in flying-foxes (Megachiroptera) reveals superfoetation and multiple-paternity', *Acta Chiropterologica*, vol. 10, no. 2, pp. 271-278.

Fox, S 2011, 'The Spectacled Flying-fox – a review of past and present knowledge' in Law, B (ed), The Biology and Conservation of Australasian Bats, Royal Zoological Society of NSW,

pp. 136-145.

GeoLINK 2012, *Lorn Flying-fox management strategy*, report prepared for Maitland City Council.

Hall L and Richards G 2000, *Flying foxes: Fruit and Blossom Bats of Australia*, UNSW Press, Sydney.

Huntsdale, J and Millington, B 2019, 'Mass baby bat deaths threatening the future of forests as effects of drought and bushfires mount',ABC Illawarra,

<https://www.abc.net.au/news/2019-12-14/mass-baby-bat-deaths-from-drought-and-bushfire/11793826>.

Lentini, PE, Kendal, D, Currey, K and Williams KJH, 2020, *A large scale survey of residents living close to flying-fox roosts to guide conflict management: preliminary report*, University of Melbourne and University of Tasmania.

MacDonald, S, Bradford, M, McKeown, A, Vanderduys, E, Hoskins, A, Westcott, D 2020,

Roost site habitat preferences of the little red flying-fox (*Pteropus scapulatus*) in Queensland.

Australian Journal of Zoology 68, 234-253. https://doi.org/10.1071/ZO20079

Markus, N and Blackshaw, JK 2002, 'Behaviour of the Black Flying-fox *Pteropus alecto*: 1. An ethogram of behaviour, and preliminary characterisation of mother-infant interactions', *Acta Chiropterologica*, vol. 4, no. 2, pp. 137-152.

Markus, N and Hall, L 2004, 'Foraging behaviour of the black flying-fox (*Pteropus alecto*) in the urban landscape of Brisbane, Qld, *Wildlife Research*, vol. 31, no. 3, pp. 345-355.

Markus, N 2002, 'Behaviour of the Black Flying-fox *Pteropus alecto*: 2. Territoriality and

courtship', *Acta Chiropterologica*, vol. 4, no. 2, pp.153–166.

McConkey, KR, Prasad, S, Corlett, RT, Roostos-Arceiz, A, Brodie, JF, Rogers H and Santamaria, L 2012, 'Seed dispersal in changing landscapes', *Biological Conservation*, doi:10.1016/j.biocon.2011.09.018.

McGuckin, MA and Blackshaw, AW 1991, 'Seasonal changes in testicular size, plasma testosterone concentration and body weight in captive flying-foxes (*Pteropus poliocephalus* and *P. scapulatus*)', *Journal of Reproduction and Fertility*, vol. 92, pp. 339-346.

Meade, J, Martin, JM and Welbergen, JA 2021, Fast food in the city? Nomadic flying-foxes commute less and hang around for longer in urban areas, *Behavioral Ecology*, vol. 32, pp. 1151–1162. https://doi.org/10.1093/beheco/arab078

Merritt, T, Taylor, K, Cox-Witton, K, Field, H, Wingett, K, Medez, D, Power, M, Durrheim, D 2018, 'Australian bat lyssavirus', *Australian Journal of General Practice*, vol. 47, no. 3.

Milne, DJ and Pavey, CR 2011, 'The status and conservation of bats in the Northern Territory', in Law, B, Eby, P, Lunney, D and Lumsden, L (eds), *The Biology and Conservation of Australasian Bats*, Royal Zoological Society of NSW, Mosman, NSW, pp. 208–225.

Mo, M and Roache, M 2019, Subsidies for products and services to assist communities living with flying-foxes: Insights from flying-fox subsidy programs in New South Wales, Department of Planning Industry and Environment, NSW Government.

Mo, M, Roache, M and Demers, M 2020, Reducing human-wildlife conflict through subsidizing mitigation equipment and services: helping communities living with the grey-headed flying-fox, Department of Planning Industry and Environment, NSW Government.

Mo, M, Roache, M, Davies, J, Hopper, J, Pitty, H, Foster, N, Guy, S, Parry-Jones, K, Francis, G, Koosmen, A, Colefax, L, Costello, C, Stokes, J, Curran, S, Smith, M, Daly, G, Simmons, C, M, Hansen, R, Prophet, D, Judge, S, Major, F, Hogarth, T, McGarry, C.A, Pope, L, Brend, S, Coxon, D, Baker, K., Kaye, K, Collins, L, Wallis, M, Brown, R, Roberts, L, Taylor, S, Pearson, T, Bishop, T, Dunne, P, Coutts-McClelland, K, Oliver, L, Dawe, C and Welbergen, JA 2021, 'Estimating flying-fox mortality associated with abandonments of pups and extreme heat events during the austral summer of 2019–20', *Pacific Conservation Bio.*, vol. 28, pp.124–139.

NSW Wildlife Council 2010, *Flying-foxes*, <https://www.nwc.org.au/wp-content/uploads/2016/12/Flying_Fox_Article_June2010.pdf>.

OEH 2020, *Grey-headed Flying-fox – profile*, Office of Environment and Heritage, NSW Government

<https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10697#:~:text=The%20Grey%2Dheaded%20Flying%2Dfox,be%20up%20to%201%20m>.

Olkkola, A, 2019, PROVolitans Flying-fox Webinar, <https://provolitans.com/>.

Parry-Jones, KA and Augee, ML 1992, 'Movements of the Grey-headed Flying Foxes (*Pteropus poliocephalus*) to and from a colony site on the central coast of New South Wales', *Wildlife Research,* vol. 19, pp. 331–40.

Parsons, J 2005, 'Spatial and temporal patterns of resource use by Spectacled Flying-foxes (*Pteropus conspicillatus*)' in *School of Tropical Biology*, James Cook University, Townsville,

pp. 100.

Pearson, T and Cheng 2018, 'It's not just noise', Presentation at the 2018 National Flying-fox Forum, Cairns, Australia.

Qld Arboricultural Association Inc no date, The Cost Lopping – Information for Tree Keepers,

<https://qaa.net.au/wp-content/uploads/2015/07/the-cost-of-lopping-dl.pdf>.

Qld Government 2023, *Hendra virus*, Qld Government,

<https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/biosecurity/animals/diseases/guide/hendra-virus>.

Qld Health 2022, *Bats and Human Health*, Qld Health, <http://conditions.health.qld.gov.au/HealthCondition/condition/14/33/14/bats-and-human-health>.

Ratcliffe, F 1932, 'Notes on the fruit bats (*Pteropus* spp.) of Australia', *Journal of Animal Ecology*, vol.1, pp.32–57.

Reynolds, B 2021, 'Kooloonbung Creek Flying-Fox Roost Management Plan – Delivery of Actions', Presentation at the 6th Annual National Flying-fox Forum, Brisbane, 14 September 2021.

Richards, G 1990, The Spectacled flying-fox, *Pteropus conspicillatus,* (Chiroptera: Pteropodidae) in North Queensland. 1. Roost sites and distribution patterns. *Australian Mammalogy*, 13, pp. 17–24.

Richards, G, ed 2000. Proceedings of a Workshop to Assess the Status of the Grey-headed Flying-fox in New South Wales. Unpublished report to the NSW Threatened Scientific Committee.

Roberts, B and Eby, P 2013, 'Review of past flying-fox dispersal actions between 1990–2013', publisher unknown, <www.environment.nsw.gov.au/resources/animals/flying-fox-2014-subs/flyingfoxsub-jenny-beatson-part2.pdf>.

Roberts, B 2005, 'Habitat characteristics of flying-fox roosts in South East Qld, BSc. (Hons.) Thesis, Griffith University, Brisbane.

Roberts, B 2006, 'Management of Urban Flying-fox Roosts: Issues of Relevance to Roosts in the Lower Clarence', NSW, Valley Watch Inc., Maclean.

Roberts, BJ, Catterall, CP, Eby, P and Kanowski, J 2012, 'Long-Distance and Frequent Movements of the Flying-Fox *Pteropus poliocephalus*: Implications for Management', *PLoS ONE* 7(8): e42532.

Roberts, BJ, Mo, M, Roache, M and Eby P, 2021, Review of dispersal attempts at flying-fox roosts in Australia, *Australian Journal of Zoology,* vol. 68, pp. 254-272.

Roxburgh SH, Wood SW, Mackey BG, Woldendorp G and Gibbons P 2006, 'Assessing the carbon sequestration potential of managed forests: a case study from temperate Australia', *Journal of Applied Ecology,* vol. 43, no. 6, pp. 1149-1159.

Ruxton, G & Schaefer, H 2012, 'The conservation physiology of seed dispersal', *Philosophical Transactions of the Royal Society B: Biological Sciences*, vol. 367, no. 1596, pp. 1708 – 1718.

SEQ Catchments 2012, *Management and Restoration of flying-fox Roosts: Guidelines and Recommendation*s, South East Queensland Catchments Ltd funded by the Australian Government's Caring for Our Country, <www.environment.nsw.gov.au/resources/animals/ flying-fox-2014-subs/flyingfoxsub-jenny-beatson-part3.pdf>.

Shinwari, MW, Annand, EJ, Driver, L, Warrilow, D, Harrower, B, Allcock, RJN, Pukallus, D, Harper J, Bingham, J, Kung, N and Diallo, IS 2014, 'Australian bat lyssavirus infection in two horses', *Veterinary Microbiology*, vol. 173, pp. 224–231.

Southerton, SG, Birt, P, Porter, J, and Ford, HA 2004, 'Review of gene movement by bats and birds and its potential significance for eucalypt plantation forestry', *Australian Forestry*, vol. 67, no. 1, pp. 45-54.

Tait J, Perotto-Baldivieso HL, McKeown A and Westcott DA 2014, 'Are flying-foxes coming to town? Urbanisation of the spectacled flying-fox (*Pteropus conspicillatus*) in Australia', *PLoS ONE*, vol. 9: e109810.

Tidemann, CR and Nelson, JE 2011, 'Life expectancy, causes of death and movements of the grey-headed flying-fox (*Pteropus polioephalus*) inferred from banding', *Acta Chiropterologica*, vol. 13, no. 2, pp. 419-429.

Timmiss, E 2017, 'Spatial factors influencing the establishment and occupancy of roosts of the four mainland Australian flying-fox species (Pteropus spp.)', Honours thesis, University of New South Wales.

Timmiss, L, Martin, J, Murray, N, Welbergen, J, Westcott, D, McKeown, A, Kingsford, R 2020, 'Threatened but not conserved: flying-fox roosting and foraging habitat in Australia', *CSIRO Publishing*, vol. 68, pp. 226-233.

Townsville City Council 2016, *Roost management plan - Palmetum*, Townsville City Council.

Townsville City Council 2017, *Roost Management Plan - Dan Gleeson Gardens*. Townsville City Council.

Townsville City Council 2021, Dan Gleeson Memorial Gardens Flying Fox Roost Relocation Background information. Townsville City Council.

Van der Ree, R and North, JM 2009, Public Environment Report: *Proposed relocation of a roost Grey-headed Flying-foxes (Pteropus poliocephalus) from the Royal Botanic Gardens Sydney*, report prepared for the Royal Botanic Gardens and Domain Trust and submitted to the Commonwealth Department of the Environment.

Vanderduys, EP, Caley, P, McKeown, A, Martin, JM, Pavey, C and Westcott, D 2024, Population trends in the vulnerable Grey-headed flying-fox, *Pteropus poliocephalus*; results from a long-term, range-wide study, *PLOS ONE* 19(3): e0298530. https://doi.org/10.1371/journal.pone.0298530

Vardon, MJ and Tidemann, CR 1999, 'Flying-foxes (*Pteropus alecto* and *P. scapulatus*) in the Darwin region, north Australia: patterns in roost size and structure', *Australian Journal of Zoology*, vol. 47, pp. 411–423.

Wagner, J 2008, 'Glandular Secretions of Male Pteropus (Flying Foxes): Preliminary Chemical Comparisons Among Species', *Independent Study Project (ISP) Collection*, vol 559.

Webb, N and Tidemann, C 1995, 'Hybridisation between black (Pteropus alecto) and grey-headed (P. poliocephalus) flying-foxes (Megachiroptera: Pteropodidae)', *Australian Mammalogy*, vol. 18, pp. 19–26.

Webb, N and Tidemann, C 1996, 'Mobility of Australian flying-foxes, Pteropus spp. (Megachiroptera): evidence from genetic variation', *Proceedings of the Royal Society B*, vol. 263, iss. 1369, pp. 497-502.

Welbergen, JA, Meade, J, Field HE, Edson, D, McMichael, L, Shoo, LP, Praszczalek, J, Smith, C and Martin, JM 2020, 'Extreme mobility of the world's largest flying mammals creates key challenges for management and conservation', *BMC Biology*, vol. 18.

Westcott, DA, Dennis, AJ, Bradford, MG, McKeown, A and Harrington, GN 2008, 'Seed dispersal processes in Australia's Wet Tropics rainforests', in Stork, N and Turton, S, *Living in a dynamic tropical forest landscape*, Blackwells Publishing, Malden, pp. 210–223.

Westcott, DA, McKeown, A, Murphy HT and Fletcher, CS 2011, ,*A monitoring method for the grey-headed flying-fox*, Pteropus poliocephalus, CSIRO, < https://www.dcceew.gov.au/sites/default/files/env/pages/391f5fed-e287-4dd3-85ac-640037926ef5/files/310112-monitoring-methodology.pdf>.

Westcott, DA, McKeown, A, Bradford, M, Vanderduys, E, Hoskins, A, Macdonald, SL, Eyre, T, Bracks, J, Bell, K, Hogan, LD, Smith, GS, McVicar, TR, Venz, MF, Pegg, G, Thomas, K, Shaw, P, Brumby, M, Abbott, B, Batchelor, K, Butler, DW, Collingwood, T and Li, LT, 2020, 'The Little Red Flying-fox: Ecology and Management of Australia's most abundant and enigmatic flying-fox', Report for the Queensland Department of Environment and Science.

WHA 2019, *Australian bat lyssavirus Fact Sheet*, WHA,

<https://wildlifehealthaustralia.com.au/Portals/0/Documents/FactSheets/mammals/Australian_Bat_Lyssavirus.pdf>.

WHA 2021, *Hendra virus and Australian wildlife Fact Sheet*, WHA, <https://wildlifehealthaustralia.com.au/Portals/0/Documents/FactSheets/Mammals/Hendra_virus_and_Australian_Wildlife.pdf>.

Wildnet 2024, *WildNet database*, WildNet, <https://www.qld.gov.au/environment/plants-animals/species-information/wildnet>.

Wright, T 2013, *A dog tests antibody positive for lyssavirus*, NSW Animal Health Surveillance. Orange, NSW. July-September 2013, pp 3-4.

Zurbuchen, A, Landert, L, Klaiber, J, Muller, A, Hein, S and Dorn, S 2010, 'Maximum foraging ranges in solitary bees: only few individuals have the capability to cover long-foraging distances', *Biological Conservation*, vol. 142, no. 3, pp. 669–676.

Appendix 1 Legislation

Commonwealth

Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth's EPBC Act provides protection for the environment, specifically MNES. A referral to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) is required under the EPBC Act for any action that is likely to significantly impact on an MNES. The GHFF is listed as a vulnerable species under the EPBC Act, meaning it is an MNES.

State

Nature Conservation Act 1992

As native species, all flying-foxes and their roosting habitat are protected in Qld under the NC Act. State approval is required to:

a) destroy a flying-fox roost

b) drive away, or attempt to drive away, a flying-fox from a flying-fox roost ('drive away' is defined to mean "cause the flying-fox to move away from the roost; or if the flying-fox has moved away from the roost, deter the flying-fox from returning to the roost") and/or

c) disturb a flying-fox in a flying-fox roost.

Note that the definition under Qld law means that once a flying-fox roost is established, it remains as such even when it is unoccupied. The Interim policy for determining when a flying-fox congregation is regarded as a flying-fox roost under section 88C of the NC Act (DES 2021b) has recently been released and is currently in consultation. It is our understanding that this Plan aligns with this roost policy, however amendments can be made to this Plan in consultation with DES if required.

A 'flying-fox roost' is defined under the NC Act as 'a tree or other place where flying-foxes congregate from time to time for breeding or rearing their young'.

Council 'as-of-right' management

Under the NC Act, local governments have an 'as-of-right' authority under the NC Act to manage flying-fox roosts in mapped UFFMAs, without the requirement for a permit, in accordance with the Management COP (DES 2020a).

Councils must however still notify DETSI of the planned management. Notification is by means of a completed 'flying-fox management notification form' from the DETSI website submitted at least two business days prior to commencing any management actions, unless an authorised person from DETSI provides written advice that these actions can commence earlier. Local governments may also choose to, with the relevant landholder's permission, exercise their 'as-of-right' authority on private land. Notification is valid for all notified management actions within a four-week timeframe.

The Guideline (DES 2020b) has also been developed to provide local government with additional information that may assist decision making and management of flying-fox roosts. Councils are required to apply for a FFRMP to manage flying-fox roosts outside an UFFMA, or for management actions not specified in the Management COP. It must be noted that this 'as-of-right' authority does not oblige a council to manage flying-fox roosts and does not authorise management under other relevant sections of the NC Act or other legislation (such as the VM Act).

Anyone other than local government is required to apply to DETSI for a FFRMP for any management directed at roosting flying-foxes, or likely to disturb roosting flying-foxes. Certain low impact activities (e.g. mowing, minor tree trimming) do not require approval if undertaken in accordance with the Low Impact Code (DES 2020c).

Flying-fox roost management permits

Councils wishing to manage flying-fox roosts located outside an UFFMA or to conduct flying-fox management activities that are not Code-compliant, must apply to DETSI for a FFRMP. Under the Nature Conservation (Animals) Regulation 2020 (the Animals Regulation), a FFRMP may only be approved for

management of a flying-fox roost where its resident flying-foxes are causing or may cause damage to property; or represent a threat or potential threat to human health or wellbeing. The Management COP may generally also apply where such a requirement is stated on the FFRMP. Such a permit is valid for a period of one year, or up to three with a DETSI-approved flying-fox management plan (e.g. this Plan).

Anyone other than local government is required to apply for a FFRMP for any management directed at roosting flying-foxes, or likely to disturb roosting flying-foxes other than:

- certain low impact activities (e.g. mowing, minor tree trimming) if undertaken in accordance with the Code of Practice – Low impact activities affecting flying-fox roosts (Low Impact COP) (DES 2020c)
- instances where Council is enacting their as-of-right authority.

Low impact roost management

All landholders – private or public – can undertake low impact activities such as mulching, mowing and weeding near flying-fox roosts, as well as allowing trimming of up to 10% of the total canopy of the roost without a FFRMP if it is done in accordance with the Low Impact Code (DES 2020c). These activities are authorised provided they are not being undertaken with the intention of destroying the roost, or disturbing or driving away the flying-foxes.

Flying-fox management statements and planning

Council has a SoMI to articulate the approach for management of flying-fox roosts in the Townsville region. Local councils may also opt to develop a flying-fox management plan for the whole of their LGA (i.e. this Plan). If this is approved by DETSI, the local council can be granted three years' approval to manage flying-foxes outside their UFFMAs under an FFRMP.

The Guideline (DES 2020b) was developed to provide local councils and other entities wishing to manage flying-fox roosts with additional information that may assist their decision-making, including developing SOMIs and flying-fox roost management plans.

Vegetation under the NC Act 1992

All plants native to Australia are protected under the NC Act. Prior to any clearing of protected plants, a person must refer to the flora survey trigger map to determine if the clearing is within a high-risk area.

- in a high-risk area, a flora survey must be undertaken and a clearing permit may be required for clearing threatened or near threatened plants and their supporting habitat.
- if a flora survey identifies that threatened or near threatened plants are not present or can be avoided by 100 m, the clearing activity may be exempt from a permit. An exempt clearing notification form is required.
- in an area other than a high-risk area, a clearing permit is only required where a person is, or becomes, aware that v plants are present.
- clearing of least concern plants will be exempt from requiring a clearing permit within a low-risk area.

Vegetation under the Fisheries Act 1994

The clearing of native vegetation in Qld is regulated by the VM Act, the Planning Act and associated policies and codes.

The type of clearing activity allowed, and how it is regulated, depends on:

- the type of vegetation (as indicated on the regulated vegetation management map and supporting maps)
- the tenure of the land (e.g. freehold or Indigenous land)
- the location, extent and purpose of the proposed clearing
- the applicant proposing to do the clearing (e.g. state government body, landholder).

Depending on these factors, clearing activities will either:

- be exempt from any approval or notification process

- require notification and adherence to a self-assessable code
- require notification and adherence to an area management plan
- require a development approval.

VM Act exemptions allow native vegetation to be cleared for a range of routine property management activities without the need for a development approval or notification. A number of VM Act exemptions may apply to clearing vegetation that is flying-fox roosting or foraging habitat. However, specific advice should be obtained from Department of Natural Resources and Mines Qld for each proposed vegetation clearing activity.

No explicit VM Act exemptions for clearing flying-fox roosting or foraging vegetation were in place as of June 2024.

Animal Care and Protection Act 2001

The ACP Act provides for animal welfare. The ACP Act is administered by Biosecurity Qld within the Department of Agriculture and Fisheries. The ACP Act applies to all living vertebrate animals, including wildlife. To comply with the ACP Act flying-fox management actions must not cause mental or physical suffering, pain or distress.

Civil Aviation Act 1998

The Civil Aviation Act establishes Australia's Civil Aviation Safety Authority functions in relation to civil aviation, with particular emphasis on safety. Civil Aviation Safety Regulations 1998 Part 139 contains specific requirements for wildlife hazard management.

Appendix 2 Species profile

Black flying-fox (Pteropus alecto)

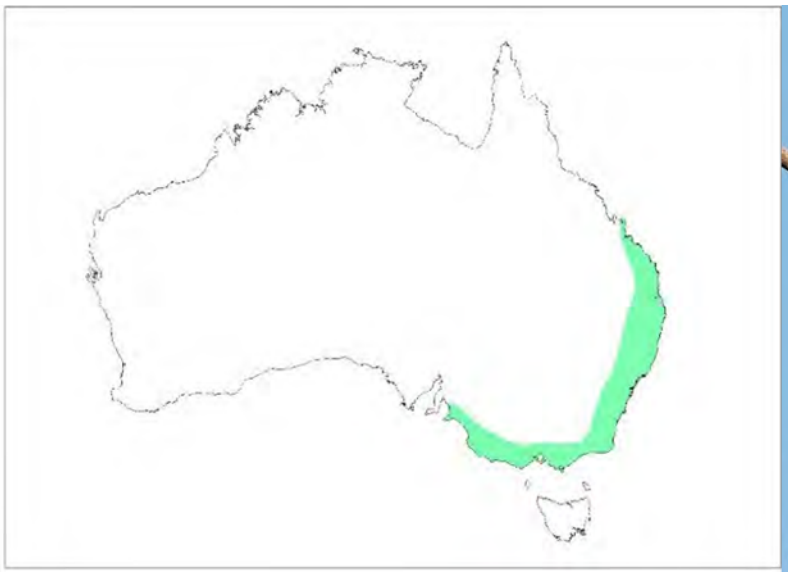
Black flying-fox indicative species distribution (Department of Planning and Environment [DPE] 2023)

The BFF has traditionally occurred throughout coastal areas from Shark Bay in Western Australia, across Northern Australia, down through Qld and into NSW (Churchill 2008). Since it was first described there has been a substantial southerly shift by the BFF (Webb & Tidemann 1995). This shift has consequently led to an increase in indirect competition with the threatened GHFF, which appears to be favouring the BFF (DAWE 2021).

They forage on the fruit and blossoms of native and introduced plants (Churchill 2008), including orchard species at times. BFF are largely nomadic animals with movement and local distribution influenced by climatic variability and the flowering and fruiting patterns of their preferred food plants. Feeding commonly occurs within 20 km of the roost site (Markus and Hall 2004).

BFF usually roost beside a creek or river in a wide range of warm and moist habitats, including lowland rainforest gullies, coastal stringybark forests and mangroves. Roost sizes can change significantly in response to the availability of food and the arrival of animals from other areas.

Grey-headed flying-fox (Pteropus poliocephalus)



Grey-headed flying-fox indicative species distribution (DPE 2023)

The GHFF is found throughout eastern Australia, generally within 200 km of the coast, from Finch Hatton in Qld to the north to Melbourne, Victoria (Office of Environment and Heritage [OEH] 2020). This species now ranges into South Australia and individual flying-foxes have been reported on the Bass Islands and mainland Tasmania (Driessen et al. 2011). It requires foraging resources and roost sites within rainforests, open forests, closed and open woodlands (including melaleuca swamps and banksia woodlands). This species is also found throughout urban and agricultural areas where food trees exist and will feed in orchards at times, especially when other food is scarce (OEH 2020).

All the GHFF in Australia are regarded as one population that moves around freely within its entire national range (Webb and Tidemann 1996, DAWE 2021). GHFF may travel up to 300 km in a single night (Welbergen et al. 2020) with a foraging radius of up to 50 km from their roost (McConkey et al. 2012). They have been recorded travelling over 500 km over 48 hours when moving from one roost to another (Roberts et al. 2012).

The GHFF population has a generally annual southerly movement in spring and summer, with their return to the coastal forests of north-east NSW and South East Qld in winter (Ratcliffe 1932, Eby 1991, Parry-Jones & Augee 1992, Roberts et al. 2012). This results in large fluctuations in the number of GHFF in New South Wales, ranging from as few as 20% of the total population in winter up to around 75% of the total population in summer (Eby 2000). They are widespread throughout their range during summer, but in spring and winter are uncommon in the south. In autumn they occupy primarily coastal lowland roosts and are uncommon inland and on the south coast of New South Wales (OEH 2020).

There is evidence the GHFF population declined by up to 30% between 1989 and 2000 (Birt 2000, Richards 2000). There is a wide range of ongoing threats to the survival of the GHFF, including habitat loss and degradation, culling in orchards, conflict with humans, infrastructure-related mortality (e.g. entanglement in barbed wire fencing and fruit netting, and power line electrocution) and competition and hybridisation with the BFF (DCCEEW 2021). For these reasons it is listed as vulnerable to extinction under NSW and federal legislation.

GHFF have been observed north of Townsville, and within Townsville (Figure 22), however these observations are infrequent.

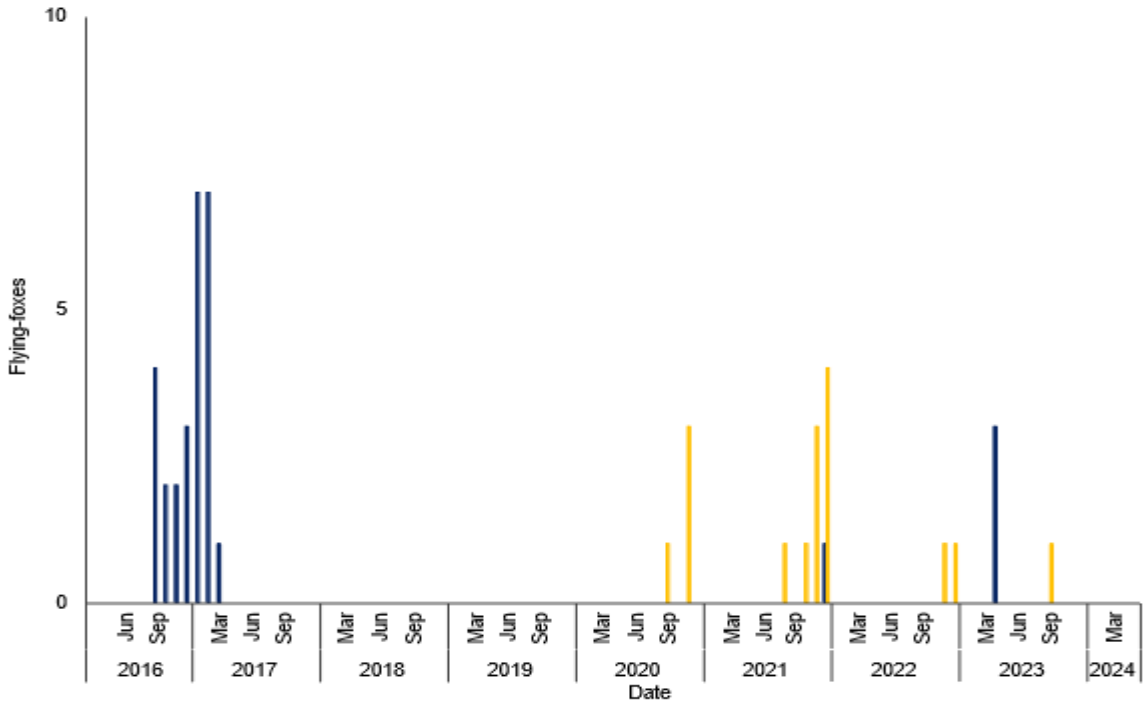
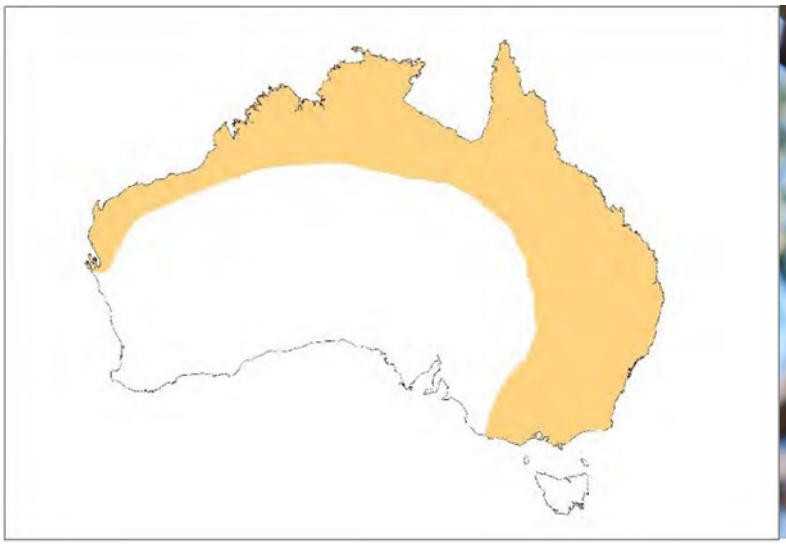
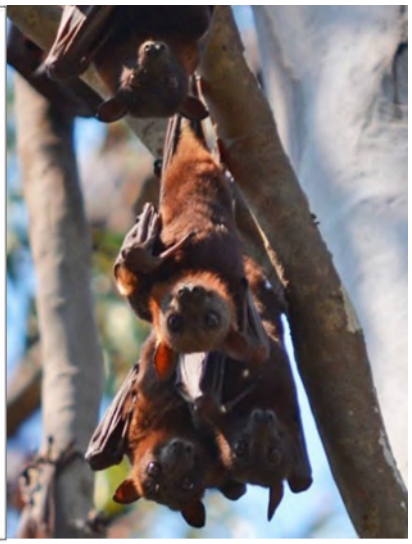


Figure 22 Grey-headed and spectacled flying-foxes observed at Dan Gleeson Memorial Gardens (source Council 2024)

Little red flying-fox (Pteropus scapulatus)





Little red flying-fox indicative species distribution (DPE 2023)

The LRFF is widely distributed throughout northern and eastern Australia, with populations occurring across northern Australia and down the east coast into Victoria.

The LRFF forages almost exclusively on nectar and pollen, although will eat fruit at times and occasionally raids orchards (Australian Museum 2020). LRFF often move sub-continental distances in search of sporadic food supplies. The LRFF has the most nomadic distribution, strongly influenced by availability of food resources (predominantly the flowering of eucalypt species) (Churchill 2008), which means the duration of their stay in any one place is generally very short.

Habitat preferences of this species are quite diverse and range from semi-arid areas to tropical and temperate areas, and can include sclerophyll woodland, melaleuca swamplands, bamboo, mangroves and occasionally orchards (Australian Museum 2020). LRFF are frequently associated with other Pteropus species. In some colonies, LRFF individuals can number many hundreds of thousands and they are unique among Pteropus species in their habit of clustering in dense bunches on a single branch. As a result, the weight of roosting individuals can break large branches and cause significant structural damage to roost trees, in addition to elevating soil nutrient levels through faecal material (SEQ Catchments 2012).

Throughout its range, populations within an area or occupying a roost can fluctuate widely. There is a general migration pattern in LRFF, whereby large congregations of over one million individuals can be found in northern roost sites (e.g. Northern Territory, North Qld) during key breeding periods (Vardon & Tidemann 1999). LRFF travel south to visit the coastal areas of South East Qld and NSW during the summer months. Outside these periods LRFF undertake regular movements from north to south during winter–spring (July–October) (Milne & Pavey 2011).

Spectacled flying-fox (Pteropus conspicillatus)

Spectacled flying-fox indicative species distribution (Atlas of Living Australia 2024)

Within Australia, the SFF is known only to occur in North East Qld; with the largest population based in the Wet Tropics World Heritage Area between Townsville and Cooktown and small outlier populations north in the Iron and McIllwraith Ranges on Cape York and to the south at Finch Hatton, near Mackay (Tait et al. 2014). SFF are also found in Papua New Guinea, however there is significant isolation between populations, with little gene flow between them (Fox 2011).

SFF feed on a wide variety of fruits and blossom primarily from the canopies of a wide range of vegetation communities from closed forest, gallery forest, eucalypt open forest and woodland through to coastal Melaleuca swamps, mangroves, vegetation in urban settings, and commercial fruit crops (DoE 2015). Studies have indicated that SFF particularly target fruit crops when fruiting and flowering of native vegetation is poor and availability of supplementary foods such as leaves and insects is limited (DERM 2010). Generally the roosting preferences of SFF show a high correlation between close proximity (<7 km) to rainforest in locations with a mean annual rainfall of at least 1400 mm (Richards 1990), however some roost sites – such as in city parks – seem to contradict this leading to the possibility that there may be other important factors influencing roost choice (Fox 2011; Parsons 2005).

Recent studies have identified a trend in the urbanisation of SFF roosts, with the majority of the population appearing to increasingly occupy urban rather than non-urban roosts; though it was observed that there was some seasonality to this pattern, with urban-associated roosts recording higher roost populations in May and June (Tait et al. 2014).

SFF have been observed south of Townsville, and within Townsville (Figure 22), however these observations are infrequent.

Appendix 3 Human and animal health

All animals can carry pathogens that may pose human health risks. In Australian bats, the most well-defined of these include ABLV and Hendra virus HeV. Specific information on these viruses is provided below.

Excluding those people whose occupations require contact with bats, such as wildlife carers and vets, human exposure to ABLV and HeV, their transmission, and frequency of infection is extremely rare. These diseases are also easily prevented through vaccination, PPE, safe flying-fox handling (by trained and vaccinated personnel only) and appropriate horse husbandry. Therefore, despite the fact that human infection with these agents can be fatal, the probability of infection is extremely low, and the overall public health risk is also judged to be low (Qld Health 2022).

Below is current information at the time of writing. Please refer regularly to Qld Health for up-to-date information on bats and health.

Australian bat lyssavirus

ABLV is a rabies-like virus that may be found in all flying-fox species on mainland Australia. It has also been identified in yellow-bellied sheathtail bats (Saccolaimus flaviventris), an insectivorous microbat, and seroconversion (development of virus-specific antibodies) has been found in seven microbat genera (WHA 2019). It is assumed that all bats may be capable of hosting ABLV (WHA 2019). The probability of human infection with ABLV is very low with less than 1% of the flying-fox population being affected (WHA 2019) and transmission requiring direct contact with an infected animal that is secreting the virus. In Australia, three people have died from ABLV infection since the virus was identified in 1996 (WHA 2019).

Transmission of the virus from bats to humans is through a bite or scratch but may have potential to be transferred if bat saliva directly contacts the eyes, nose, mouth or broken skin (WHA 2019, Merritt et al. 2018). ABLV is unlikely to survive in the environment for more than a few hours, especially in dry environments that are exposed to sunlight (Department of Agriculture and Fisheries; DAF 2020). Transmission of closely related viruses suggests that contact or exposure to bat faeces, urine or blood does not pose a risk of exposure to ABLV, nor does living, playing or walking near bat roosting areas (DAF 2020).

The incubation period in humans is assumed to be similar to rabies, generally around three to eight weeks (Merritt et al. 2018). However, in few cases, the incubation period has ranged from a few days to several years (Merritt et al. 2018). The disease in humans presents essentially the same clinical picture as classical rabies. Once clinical signs have developed, the infection is invariably fatal. However, infection can easily be prevented by avoiding direct contact with bats (i.e. handling). Pre-exposure vaccination provides reliable protection from the disease for people who are likely to have direct contact with bats, and it is generally a mandatory workplace health and safety requirement that all persons working with bats receive pre-vaccination and have their level of protection regularly assessed. Like classical rabies, ABLV infection in humans also appears to be effectively treated using post-exposure vaccination and so any person who suspects they have been exposed should seek immediate medical treatment. Post-exposure vaccination is usually ineffective once clinical manifestations of the disease have commenced.

Domestic animals are also at risk if exposed to ABLV. In 2013, ABLV infections were identified in two horses (Shinwari et al. 2014). A dog that caught and consumed a flying-fox also tested positive for ABLV antibodies in 2013 (Wright 2013). According to the Qld Government's ABLV factsheet for veterinarians, clinical symptoms are most likely to appear in animals within 1 – 6 months following exposure (DAF 2020). Given the incubation period variability, animals that are bitten or scratch by a flying-fox should monitor for clinical symptoms for months to years following potential exposure (DAF 2020). Consultation with a veterinarian should be sought if exposure is suspected.

If a person or pet is bitten or scratched by a bat they should:

- wash the wound with soap and water for at least five minutes (do not scrub)
- contact their doctor immediately to arrange for post-exposure vaccinations.

If bat saliva contacts the eyes, nose, mouth or an open wound, flush thoroughly with water and seek immediate medical advice.

Please refer to WHA's Australian bat lyssavirus fact sheet for further information.

Hendra virus

Flying-foxes are the natural host for HeV, which can be transmitted from flying-foxes to horses. Infected horses sometimes amplify the virus and can then transmit it to other horses, humans and on two occasions, dogs (WHA 2021). There is no evidence that the virus can be passed directly from flying-foxes to humans or to dogs (WHA 2021). Clinical studies have shown cats, pigs, ferrets and guinea pigs (as well as hamsters and African green monkeys – not applicable to Australia) can carry the infection, though there is no evidence of direct HeV transmission from flying-foxes to any species other than horses (WHA 2021). As of 2021, over 106 HeV infections in horses (confirmed or possible cases) have been reported (WHA 2021). These infections occurred across over 60 disease outbreak events, three of which also involved human infections. Although the virus is periodically present in flying-fox populations across Australia, the likelihood of horses becoming infected is low and consequently human infection is extremely rare.

The transmission of HeV from flying-foxes to horses is thought to be complex and involve several host and environmental factors (WHA 2021). The most likely route of transmission is through exposure of horse mucous membranes to infected flying-fox urine, body fluids, or excretion (WHA 2021). This may occur directly (direct contact of infected fluids with mucous membranes) or indirectly (e.g. ingestion of contaminated forage or water). The incubation period of HeV in horses is estimated to be 5 – 16 days (WHA 2021). The mortality rate of HeV in horses is approximately 80% (Qld Government 2023).

While considered very rare, humans may contract the disease after close contact with respiratory secretions (e.g. mucous) and/or blood of an infected horse (WHA 2021, Qld Government 2023). Similarly, the dogs may become infected following close contact with infectious bodily fluids of infected horses (Qld Government 2023). HeV infection in humans presents as a serious and often fatal respiratory and/or neurological disease and there is currently no effective post-exposure treatment or vaccine available for people. The mortality rate of HeV in humans is approximately 70% (Qld Government 2023).

Previous studies have shown that HeV spillover events have been associated with foraging flying-foxes rather than roost locations. Therefore, risk is considered similar at any location within the range of flying-fox species and all horse owners should be vigilant. Vaccination of horses can protect horses and subsequently humans from infection (Qld Government 2023), as can appropriate horse husbandry (e.g. covering food and water troughs, fencing flying-fox foraging trees in paddocks, etc.).

Although all human cases of HeV to date have been contracted from infected horses and direct transmission from bats to humans has not yet been reported, particular care should be taken by select occupational groups that could be uniquely exposed. For example, persons who may be exposed to high levels of HeV via aerosol of heavily contaminated substrate should consider additional PPE (e.g. respiratory filters), and potentially dampening down dry dusty substrate.

Please refer to WHA's Hendra virus and Australian wildlife fact sheet for further information.

General health considerations

All animals, including flying-foxes, can carry bacteria and other microorganisms in their guts, some of which are potentially pathogenic to other species. Bat urine and faeces should be treated like any other animal excrement. As with any accumulation of animal faeces (bird, bat, domestic animals), fungi or bacteria may be present and care should be taken when cleaning faeces. This includes wetting dried faeces before cleaning or mowing, wearing appropriate PPE and maintaining appropriate hygiene. If disturbing dried bird or bat droppings, particulate respirators should be worn to prevent inhalation of dust and aerosols. See 'Work with bird and bat droppings' for detail.

Contamination of water supplies by any animal excreta (birds, amphibians and mammals such as flying-foxes) poses a health risk to humans. Household tanks should be designed to minimise potential contamination, such as using first-flush diverters to divert contaminants before they enter water tanks. Trimming vegetation overhanging the catchment area (e.g. the roof of a house) will also reduce wildlife activity and associated potential contamination. Tanks should also be appropriately maintained and flushed, and catchment areas regularly cleaned to remove potential contaminants. Public water supplies are regularly monitored for harmful microorganisms and are filtered and disinfected before being distributed. Management plans for community supplies should consider whether any large congregation of

animals, including flying-foxes, occurs near the supply or catchment area. Where they do occur, increased frequency of monitoring should be considered to ensure early detection and management of contaminants.

Appendix 4 Environmental reports

Please see Townsville Flying-fox Roost Management Plan Attachment 1 - Environmental reports.

Appendix 5 Management options

Below is an overview of management options commonly used across Qld and Australia which were considered in the development of the Plan.

Low impact options

Education and awareness programs

This management option involves undertaking a comprehensive and targeted flying-fox education and awareness program to provide accurate information to the local community about flying-foxes.

Such a program would include information about managing risk and alleviating concern about health and safety issues associated with flying-foxes, options available to reduce impacts from roosting and foraging flying-foxes, an up-to-date program of works being undertaken at the roost, and information about flying-fox numbers and flying-fox behaviour at the roost.

Residents should also be made aware that faecal drop and noise at night is mainly associated with plants that provide food, independent of roost location. Staged removal of foraging species such as fruit trees and palms from residential yards, or management of fruit (e.g. bagging, pruning) will greatly assist in mitigating this issue.

Collecting and providing information should always be the first response to community concerns in an attempt to alleviate issues without the need to actively manage flying-foxes or their habitat. Where it is determined that management is required, education should similarly be a key component of any approach.

The likelihood of improving community understanding of flying-fox issues is high. However, the extent to which that understanding will help alleviate conflict issues is probably less so. Extensive education for decision-makers, the media and the broader community may be required to overcome negative attitudes towards flying-foxes.

It should be stressed that a long-term solution to the issue resides with better understanding flying-fox ecology and applying that understanding to careful urban planning and development.

An education program may include components shown below.

Possible components of an awareness-raising program

Property modification

The managers of land on which a flying-fox roost is located would promote or encourage the adoption of certain actions on properties adjacent to or near the roost to minimise impacts from roosting and foraging flying-foxes. For example:

- Create visual/sound/smell barriers with fencing or hedges. To avoid attracting flying-foxes, species selected for hedging should not produce edible fruit or nectar-exuding flowers, should grow in dense formation between two and five metres (Roberts 2006) (or be maintained at less than 5 metres). Vegetation that produces fragrant flowers can assist in masking roost odour where this is of concern.
- Manage foraging trees (i.e. plants that produce fruit/nectar-exuding flowers) within properties through pruning/covering with bags or wildlife friendly netting, early removal of fruit, or tree replacement.
- Cover vehicles, pools/spas, and clothes lines (e.g. with carports or tarp covers) where faecal contamination is an issue, or remove washing from the line before dawn/dusk (e.g. use clothes dryers)
- Move or cover eating areas (e.g. BBQs and tables) within close proximity to a roost or foraging tree to avoid contamination by flying-foxes.

- Install double-glazed windows, door seals, insulation, and sound-proof curtains, and use air-conditioners when needed to reduce noise disturbance and smell associated with a nearby roost.
- Use white noise machines and fragrance dispensers or deodorisers within the home to reduce noise and odour impacts.
- Include suitable buffers and other provisions (e.g. covered car parks) in planning of new developments.
- Install rainwater first-flush diverters on rainwater tanks to remove potentially harmful bacteria and microbes from flying-fox faecal drop
- Turn off lighting at night which may assist flying-fox navigation and increase fly-over impacts.
- Consider removable covers for swimming pools and ensure working filter and regular chlorine treatment.
- Appropriately manage rainwater tanks, including installing first-flush systems.
- Avoid disturbing flying-foxes during the day as this will increase roost noise.

The cost would be borne by the person or organisation who modifies the property; however, opportunities for funding assistance (e.g. environment grants) may be available for management activities that reduce the need to actively manage a roost.

Odour neutralising trial

Odour neutralising systems (which modify odour-causing chemicals at the molecular level rather than just masking them) are commonly used in contexts such as waste management, food processing, and water treatment. They have the potential to be a powerful tool for managing odour impacts associated with flying-foxes. Two trials have been undertaken that utilised two different odour-neutralising systems. The indoor system uses a Hostogel™ pot containing a gel-based formula for neutralising indoor odour. These are inexpensive, only require replacement every few months, and may be sufficient to mitigate odour impacts in houses affected by flying-fox roosts. Initial results suggest there may be a positive localised effect in reducing flying-fox odour within homes. This option may be useful for affected residents (particularly those directly adjacent to the roost), as residents could choose whether or not they wish to have a gel-pot in their living space and can simply put the lid back on the pot when the odour is not impacting on them.

The outdoor system consists of a Vapourgard™ unit that dispenses an odour-neutralising vapour through diffuser pipes that are installed on boundary fences. A world-first trial was undertaken in April – June 2021 with the participation of residents living near a flying-fox roost at Porter Park, Sunshine Coast. The system followed a predetermined schedule (alternating on / off cycles) for nine weeks and residents were asked to rate the flying-fox odour every day throughout the trial.

Objective results were difficult to obtain due to the significant negative experience of residents as a consequence of the large influxes of flying-fox numbers during the trial, however initial results indicated both the indoor and outdoor systems were beneficial. If future trials confirm this technique is effective, the odour-neutralising system could be installed along the boundary of residential properties bordering the flying-fox roost.

Subsidy programs

Subsidy programs provide councils with an opportunity to support impacted residents living near flying-fox roosts. There are a number of factors to consider when establishing a subsidy program, including who to offer subsidies to (i.e. who is eligible, generally based on proximity to roost), what subsidies to offer (e.g. service-based or property-based), how subsidies should be offered (e.g. reimbursements for purchases or upfront funding), and how the program will be evaluated to determine effectiveness for reducing flying-fox impacts to residents. A recent report published by the NSW Department of Planning, Industry & Environment (Mo & Roache 2019) summarised the implementation and efficacy of subsidy programs across six councils in NSW: Eurobodalla, Ku-ring-gai, Cessnock, Tamworth, and Sutherland councils. This report provides insight into the aforementioned factors for council's consideration, if a subsidy program is to be adopted.

Government initiatives that provide financial assistance commonly assess residents' eligibility based on a number of variables, including property distance from a roost, and deliver subsidies as partial or full reimbursements for purchases. It is important to consider that the popularity of certain subsidies likely varies across different communities, so affected residents should be consulted in the process of establishing an effective subsidy program. The NSW subsidy study (Mo & Roache 2019) found managers who design programs that best meet community needs have an increased probability of alleviating human-wildlife conflicts. Critical thresholds of flying-fox numbers at a roost and distance to a roost may also be used to determine when subsidies would apply.

While subsidies have the potential to alleviate flying-fox impacts within a community, they can be negatively received if residents believe there are broader issues associated with flying-foxes that are not being addressed (Mo & Roache 2019; Mo et al. 2020). As such, it is important (as with any community-based program) to assess the needs of residents and have open, ongoing communication throughout the program to ensure the subsidies are effectively reducing impacts, and if not, how the program can be adapted to address these needs.

A brief description and examples of property and service-based subsidies is provided below.

Property modification/item subsidies

Fully funding or providing subsidies to property owners for property modifications may be considered to manage the impacts of the flying-foxes. Providing subsidies to install infrastructure may improve the value of the property, which may also offset concerns regarding perceived or actual property value or rental return losses. Focusing funds towards manipulating the existing built environment also reduces the need for modification and removal of vegetation. Property modifications/items listed under 'Property modifications' above may be included in a subsidy program. Of these, vehicle and clothesline covers and high-pressure water cleaners were the most common subsidies taken by residents (Mo & Roache 2019).

When offered, double-glazing windows was popular amongst residents and was able to achieve a 65% reduction in flying-fox noise (Mo & Roache 2019). Furthermore, in a study by Pearson & Cheng (2018), it was found using infrastructure such as double-glazing windows significantly reduced the external noise level measured inside a house adjacent to a roost. This finding was supported by post-subsidy surveys undertaken by Port Macquarie Hastings Council that showed that double-glazed windows were rated as being more effective in mitigating impacts than any other subsidised option (e.g., high pressure cleaners, clothesline covers, shade cloths etc.) (Reynolds 2021).

Sunshine Coast Council undertook Round 1 of a private property grant trial in July 2021. The trial was used to facilitate property improvement or impact reduction infrastructure on eligible private properties. Feedback from this round confirmed that residents that have lived nearby a roost long-term are more likely to participate in the trial and experience more positive outcomes. It is acknowledged that residents that have only experienced short-term impacts may not be ready yet for this intervention. Council is currently implementing Round 2 of the grant trial where a one-off grant would be provided to eligible residents, which would be supported by ongoing roost management, education, research and monitoring.

Service subsidies

This management option involves providing property owners with a subsidy to help manage impacts on the property and lifestyle of residents. The types of services that could be subsidised include clothes washing, cleaning outside areas and property, solar panel cleaning, car washing, removing exotic trees, or contributing to water/electricity bills. The NSW subsidy study showed that while many property modification subsidies proved popular amongst residents (e.g. high-pressure cleaners, air conditioners), many raised concerns over the increase in water/electricity bills. Increases in bills can be difficult to quantify and justify and has not yet been effectively offered by a council in a subsidy program.

Routine roost maintenance and operational activities

All persons are authorised to undertake low impact activities at roosts in accordance with the Low Impact COP impact activities affecting flying-fox roosts. Low impact activities include weeding, mulching, mowing or minor tree trimming (not in a tree where flying-foxes are roosting).

Protocols should be developed for carrying out operations that may disturb flying-foxes, which can result in excess roost noise. Such protocols could include limiting the use of disturbing activities to certain days or

certain times of day in the areas adjacent to the roost and advising adjacent residents of activity days. Such activities could include lawn-mowing, using chainsaws, whipper-snippers, using generators and testing alarms or sirens.

Revegetation and land management to create alternative habitat

This management option involves revegetating and managing land to create alternative flying-fox roosting habitat through improving and extending existing low-conflict roosts or developing new roosting habitat in areas away from human settlement.

Selecting new sites and attempting to attract flying-foxes to them has had limited success in the past, and ideally habitat at known roost sites would be dedicated as a flying-fox reserve. However, if a staged and long-term approach is used to make unsuitable current roosts less attractive, whilst concurrently improving appropriate sites, it is a viable option (particularly for the transient and less selective LRFF). Supporting further research into flying-fox roost preferences may improve the potential to create new flying-fox habitat.

Foraging trees planted amongst, and surrounding roost trees (excluding in/near horse paddocks), may help to attract flying-foxes to a desired site. They will also assist with reducing foraging impacts in residential areas. Consideration should be given to tree species that will provide year-round food, increasing the attractiveness of the designated site. Depending on the site, the potential negative impacts to a natural area will need to be considered if introducing non-indigenous plant species.

The presence of a water source is likely to increase the attractiveness of an alternative roost location. Supply of an artificial water source should be considered if unavailable naturally, however this may be cost-prohibitive.

Potential habitat mapping using roost preferences and suitable land tenure can assist in initial alternative site selection. A feasibility study would then be required prior to site designation to assess likelihood of success and determine the warranted level of resource allocated to habitat improvement.

Provision of artificial roosting habitat

This management option involves constructing artificial structures to augment roosting habitat in current roost sites or to provide new roosting habitat. Trials using suspended ropes have been of limited success as flying-foxes only used the structures that were very close to the available natural roosting habitat. It is thought that the structure of the vegetation below and around the ropes is important.

Protocols to manage incidents

This management option involves implementing protocols for managing incidents or situations specific to particular roosts. Such protocols may include monitoring at sites within the vicinity of aged care or child care facilities, management of compatible uses such as dog walking or sites susceptible to heat stress incidents (when the roost is subjected to extremely high temperatures leading to flying-foxes changing their behaviour and/or dying).

Participation in research

This management option involves participating in research to improve knowledge of flying-fox ecology to address the large gaps in our knowledge about flying-fox habits and behaviours and why they choose certain sites for roosting. Further research and knowledge sharing at local, regional and national levels will enhance our understanding and management of flying-fox roosts.

Appropriate land use planning

Land use planning instruments may be able to be used to ensure adequate distances are maintained between future residential developments and existing or historical flying-fox roosts. While this management option will not assist in the resolution of existing land use conflict, it may prevent issues for future residents.

Property acquisition

Property acquisition may be considered if negative impacts cannot be sufficiently mitigated using other measures. This option will clearly be extremely expensive, however is likely to be more effective than dispersal and in the long-term may be less costly.

Do nothing

The management option to 'do nothing' involves not undertaking any management actions in relation to the flying-fox roost and leaving the situation and site in its current state.

Buffers

Buffers can be created through vegetation removal, revegetation of non-flying-fox attractant vegetation and/or the installation of permanent/semi-permanent deterrents.

Creating buffers may involve planting low-growing, spiky, non-flowering plants between residents or other conflict areas and the flying-fox roost. Such plantings can create a physical and/or visual buffer between the roost and residences or make areas of the roost inaccessible to humans.

Previous studies have recommended that vegetation buffers consisting of habitat not used by flying-foxes, should be 300 m or as wide as the site allows to mitigate amenity impacts for a community (SEQ Catchments 2012). Buffers need to take into consideration the variability of use of a roost site by flying-foxes within and across years, including large, seasonal influxes of flying-foxes. The usefulness of a buffer declines if the flying-fox roost is within 50 m of human habitation.

Buffers through vegetation removal

Vegetation removal aims to alter the area of the buffer habitat sufficiently so that it is no longer suitable as a roost. The amount required to be removed varies between sites and roosts, ranging from some weed removal to removal of most of the canopy vegetation.

Any vegetation removal should be done using a staged approach, with the aim of removing as little native vegetation as possible. This is of particular importance at sites with other values (e.g. ecological or amenity), and in some instances the removal of any native vegetation will not be appropriate. Thorough site assessment will inform whether vegetation management is suitable (e.g. can impacts to other wildlife and/or the community be avoided?).

Removing vegetation can also increase visibility into the roost and noise issues for neighbouring residents which may create further conflict.

Suitable experts should be consulted to assist selective vegetation trimming/removal to minimise vegetation loss and associated impacts.

The importance of under- and mid-storey vegetation in the buffer area for flying-foxes during heat stress events also requires consideration.

Buffers without vegetation removal

Permanent or semi-permanent deterrents can be used to make buffer areas unattractive to flying-foxes for roosting, without the need for vegetation removal. This is often an attractive option where vegetation has high ecological or amenity value.

While many deterrents have been trialled in the past with limited success, there are some options worthy of further investigation:

- Physical visual deterrents – Visual deterrents such as fluoro vests (GeoLINK 2012) and balloons (Ecosure, pers. comm.) in roost trees have shown to have localised effects, with flying-foxes deterred from roosting within 1–10 metres of the deterrents. The balloon method (and similar methods) has the potential to create rubbish. In the absence of effective maintenance, this option could potentially lead to an increase in rubbish in the natural environment.
- Visual deterrents – Lights tend to have limited effectiveness in deterring roosting. For example, a high-intensity strobe light was trialled in the Sydney Botanic Gardens to deter roosting; flying-foxes demonstrated only a slight reaction, and lights did not deter flying-foxes from roosting (van der Ree & North 2009). However, a study identified a light that flying-foxes perceive as abnormal (Olkkola 2019). A trial using the PROVolitans system illuminating the canopy of a roost tree, reported an 80% decrease in the number of flying-foxes roosting in the tree. PROVolitans lights may offer a non-harmful method of flying-fox deterrence for future trials. Ultimately, the type and placement of visual deterrents would need to be varied regularly to avoid habituation.

- Council has trialled mobile PROVolitans light towers at Dan Gleeson Memorial Gardens, the Palmetum Botanic Gardens, and Alice River.
- Council is installing three fixed PROVolitans light towers within Dan Gleeson Memorial Gardens in 2024 (Figure 6).
- Council's lighting expert notes:

  The PROVolitans System is a lighting method for training flying-foxes to roost away from unfavourable sites and uses a process of behavioural reinforcement. Therefore, the system does not rely on startling or frightening the bats to achieve outcomes, rather it relies on certain wavelengths being highly visible to the flying-foxes, and being polarised, affects their perception without causing harm to their eyes. This change in visual perception relies on the unique nature of the bats eyes, and especially the effect of certain wavelengths and instead of dazzling with light intensity, or mimicking eye shine of predators, the PROVolitans System instead impedes their movements and for example ability to establish a normal hierarchy in the roosting tree. The net effect is to make the trees in the "lit area" less attractive to individual flying-foxes, and the whole colony. Due to the light intensity only being uncomfortable, but not in any way harmful, the system is deemed safe for the flying-foxes, other wildlife, and for humans, and is not damaging to eyesight.

  The system is constrained by the nature of light and is effective only in the area lit by the lights, and only during dark and twilight hours. However, the lighting systems wavelength performance can be enhanced by using PROVolitans in areas of rainforest or dense/closed canopy. The dense/closed canopy reduces the bats flight radius and enhances the power of the lights through reflection off the canopy. Council's intention is to use the system in conjunction with other methods such as arboreal sprinklers to increase their efficacy in areas with open canopies or areas where the bats wait in nearby trees and then relocate to the treated area at daylight. According to the animal behavioural ideologies, bats will eventually learn to avoid the areas all together, because the lighting will also signal to the bats, that later during the day this assigned area is not a favourable site for day-time roosting.

  The methods for deploying the system are still being developed and tested with the intent of having an Operational Manual for the Lighting System, which outlines the best deployment methods and synergies for applying into different types of flying-fox habitats.

- Noise emitters on timers – Noise needs to be random, varied and unexpected to avoid flying-foxes habituating. As such these emitters would need to be portable, on varying timers and a diverse array of noises would be required. It is likely to require some level of additional disturbance to maintain its effectiveness, and ways to avoid disturbing flying-foxes from desirable areas would need to be identified. This is also likely to be disruptive to nearby residents.
- Smell deterrents – For example, bagged python excrement hung in trees has previously had a short-term localised effect (GeoLINK 2012). The smell of certain deterrents may also impact nearby residents, and there is potential for flying-foxes to habituate.
- CMS – This method has been effective in deterring flying-foxes during dispersals (Ecosure personal experience), and current use in Qld are showing promise for keeping flying-foxes out of designated buffer zones. This option can be logistically difficult (installation and water sourcing) and may be cost-prohibitive. Design and use of sprinklers need to be considerate of animal welfare and features of the site. For example, misting may increase humidity and exacerbate heat stress events, and overuse may impact other environmental values of the site. Further information regarding CMS is detailed below.
- Screening plants – A 'screen' can be created by planting a row of trees along the edge of a roost, with the aim of reducing visual impacts associated with flying-foxes. This technique can be particularly useful in cases where residents can suffer extreme reactions triggered by the mere sight of flying-foxes.

Canopy-mounted sprinklers

CMS can be used to deter flying-foxes from a buffer either:

- without any roost tree trimming/removal or
- accompanied by selective roost tree trimming/removal.

Canopy mounted sprinklers installed by Sunshine Coast Council (source: National Flying-fox Forum 2016, Ecosure).

To date CMS have been successful at numerous locations, including Dan Gleeson Memorial Gardens, at discouraging flying-foxes from roosting in the buffer zone and enabling residents to have more control over flying-foxes near their properties.

CMS can be installed and effectively operated without the need for any vegetation removal, as long as the vegetation is not so thick as to restrict the extent of water spray. If vegetation thinning is required to allow sprinklers to operate effectively in some areas, approval will be required under the VM Act as exemptions do not exist for this purpose (see Appendix 1). CMS can reach a radius of 15 m but due to vegetation cover this reach may be less.

Water pressure must be firm so it is sufficient to deter flying-foxes, however, must not risk injuring flying-foxes (or other fauna) or knocking an animal from the tree. Water misting should be minimised as this is unlikely to deter flying-foxes and could exacerbate heat stress event effects. Flying-fox heat stroke generally occurs when the temperature reaches 42°C, however, can occur at lower temperatures in more humid conditions (Bishop 2015). Given that humidity is likely to increase with water in the environment, sprinklers may need to be turned off in higher temperatures (e.g. >30°C) to avoid exacerbating heat stress (N.B. a NSW government- funded trial through Western Sydney University is currently underway to assess if sprinklers increase humidity and potential heat stress impacts; results should be considered for sprinkler usage during HSE).

Sprinklers should release a jet of air prior to water, as an additional deterrent and to cue animals to move prior to water being released. The intention of the sprinklers is to make the buffer unattractive, and effectively 'train' individuals to stay out of the buffer area.

If installed, sprinklers should be programmed to operate on a random schedule and in a staggered manner (i.e. not all sprinklers operating at the same time, to avoid excessive disturbance). Each activation should be for approximately 30-45 seconds per sprinkler. Each sprinkler should be activated up to five times

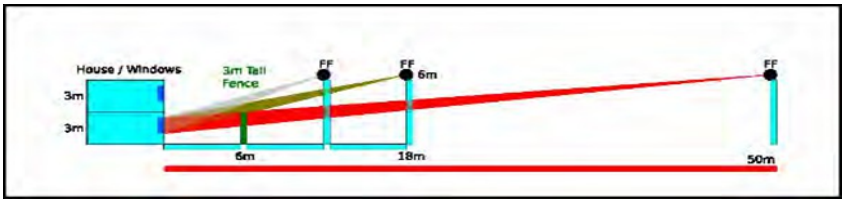
between 0630 and 1600 avoiding critical fly-in or fly-out periods. To avoid flying-foxes habituating to the stimuli, sprinklers should only be operated by residents when flying-foxes are within range. Sprinkler settings would also need to account for seasonal changes (e.g. not in the heat of the day during summer when they may be an attractant, and/or could increase humidity and exacerbate heat events). Individual sprinklers may also need to be temporarily turned off depending on location of creching young, or if it appears likely that animals will be displaced to undesirable locations.

Infrastructure should ideally be designed to accommodate additional sprinklers should they be required in the future. Sprinklers should be designed and attached in a way that allows for future maintenance, replacement, and sprinkler head adjustments, with consideration given to vandalism if located in a publicly accessible area.

Noise attenuation fencing

Example of noise attenuation fencing (source: http://www.slimwall.com.au/gallery)

This may also assist with odour reduction, and Perspex fencing could be investigated to assist fence amenity. Although expensive to install, this option could negate the need for habitat modification, maintaining the ecological values of the site, and may be more cost-effective than ongoing management. Temporary fencing is also available which is more cost-effective.



Indicative scaled distances to achieve shielding for bats approximately 6 m elevated, to a typical window height (Air Noise Environment 2019). Image is indicative only with further investigation required.

Figure 23 Temporary noise fencing - Sound Block Acoustic Barrier (source:https://fortressfencing.com.au/sound-block-acoustic-barrier-noise-barrier).

Disturbance or dispersal

Nudging

Noise and other low intensity active disturbance restricted to certain areas of the roost can be used to encourage flying-foxes away from high conflict areas. This technique aims to actively 'nudge' flying-foxes from one area to another, while allowing them to remain at the roost site.

Unless the area of the roost is very large, nudging should not be done early in the morning as this may lead to inadvertent dispersal of flying-foxes from the entire roost site. Disturbance during the day should be limited in frequency and duration (e.g. up to four times per day for up to 10 minutes each) to avoid welfare impacts. As with dispersal, it is also critical to avoid periods when dependent young are present (as identified by a flying-fox expert).

Dispersal

Dispersal aims to encourage a roost to move to another location. Dispersing flying-foxes may be achieved in two ways:

- actively disturbing the roost pre-dawn as flying-foxes attempt to return from nightly foraging
- passively, by removal of all roosting habitat.

There is a plethora of research that demonstrates flying-fox dispersals are not effective long-term, and often have unpredictable outcomes. A review of dispersal attempts between 1990 and 2013 found that flying-foxes only moved within 600 m of the original site in 63% of cases (Roberts & Eby 2013). Similarly, another review of 69 dispersal attempts undertaken between 1992 and 2020 found that in 88% of dispersals, new roosts established within 1 km and resulted in new conflict sites (Roberts et al. 2021). In addition, a review of 25 dispersal attempts in Qld between November 2013 and November 2014 found that when flying-foxes were dispersed, they did not move further than 6 km away from the original roost site (Ecosure 2014). Ultimately, these results indicate that, when dispersed, flying-foxes generally relocate within 600 m – 1 km of the original roost site, and do not travel further than 6 km away.

Driving flying-foxes away from an established roost is challenging and resource intensive. There are also a range of risks associated with roost dispersal. These include:

- shifting or splintering the roost into other locations that are equally or more problematic
- impacts on animal welfare and flying-fox conservation
- impacts on the flying-fox population including disease status and associated public health risk
- impacts to the community associated with ongoing dispersal attempts
- increased aircraft strike risk associated with changed flying-fox movement patterns
- high initial and/or ongoing resource requirement and financial investment
- negative public perception from some community members and conservationists opposed to dispersal.

Despite these risks, there are some situations where roost dispersal may be considered 'Passive' or 'Active' is described further below. See Appendix 5 for further information regarding dispersal attempts across Australia.

Passive dispersal

Removing vegetation in a staged manner can be used to passively disperse a roost, by gradually making the habitat unattractive so that flying-foxes will disperse of their own accord over time with little stress (rather than being more forcefully moved with noise, smoke, etc.). This is less stressful to flying-foxes, and greatly reduces the risk of splinter colonies forming in other locations (as flying-foxes are more likely to move to other known sites within their roost network when not being forced to move immediately, as in active dispersal).

Generally, a significant proportion of vegetation needs to be removed in order to achieve dispersal of flying-foxes from a roost or to prevent roost re-establishment. For example, flying-foxes abandoned a roost in Bundall, Qld once 70% of the canopy/mid-storey and 90% of the understorey had been removed (Ecosure 2011). Ongoing maintenance of the site is required to prevent vegetation structure returning to levels

favourable for colonisation by flying-foxes. Importantly, at nationally important roosts, sufficient vegetation must be retained to accommodate the maximum number of flying-foxes recorded at the site.

This option may be preferable in situations where the vegetation is of relatively low ecological and amenity value, and alternative known permanent roosts are located nearby with capacity to absorb the additional flying-foxes. While the likelihood of splinter colonies forming is lower than with active dispersal, if they do form following vegetation modification there will no longer be an option to encourage flying-foxes back to the original site. This must be carefully considered before modifying habitat.

There is also potential to make a roost site unattractive by removing access to water sources. However, at the time of writing this method had not been trialled so the likelihood of this causing a roost to be abandoned is unknown. It would also likely only be effective where there are no alternative water sources in the vicinity of the roost.

Active dispersal through disturbance

Dispersal is more effective when a wide range of tools are used on a randomised schedule with animals less likely to habituate (Ecosure, pers. obs. 1997–2015). Each dispersal team member should have at least one visual and one aural tool that can be used at different locations on different days (and preferably swapped regularly for alternate tools). Exact location of these and positioning of personnel will need to be determined on a daily basis in response to flying-fox movement and behaviour, as well as prevailing weather conditions (e.g. wind direction for smoke drums).

Active dispersal will be disruptive for nearby residents given the timing and nature of activities, and this needs to be considered during planning and community consultation.

This method does not explicitly use habitat modification as a means to disperse the roost, however if dispersal is successful, some level of habitat modification should be considered. This will reduce the likelihood of flying-foxes attempting to re-establish the roost and the need for follow-up dispersal as a result. Ecological and aesthetic values will need to be considered for the site, with options for modifying habitat the same as those detailed for buffers above.

Early dispersal before a roost is established at a new location

This management option involves monitoring local vegetation for signs of flying-foxes roosting in the daylight hours and then undertaking active or passive dispersal options to discourage the animals from establishing a new roost. Even though there may only be a few animals initially using the site, this option is still treated as a dispersal activity, however it may be simpler to achieve dispersal at these new sites than it would in an established roost. It may also avoid considerable issues and management effort required should the roost be allowed to establish in an inappropriate location.

It is important that flying-foxes feeding overnight in vegetation are not mistaken for animals establishing a roost.

Maintenance dispersal

Maintenance dispersal refers to active disturbance following a successful dispersal to prevent the roost from re-establishing. It differs from initial dispersal by aiming to discourage occasional over-flying individuals from returning, rather than attempting to actively disperse animals that have been recently roosting at the site. As such, maintenance dispersal may have fewer timing restrictions than initial dispersal, provided that appropriate mitigation measures are in place.

Unlawful activities

Culling

Culling is addressed here as it is often raised by community members as a preferred management method; however, culling is illegal under local, State, and Commonwealth legislation and is not permitted as a method to manage flying-fox roosts.

Appendix 6 Dispersal summary results

Multiple studies have clearly demonstrated the long-term ineffectiveness of flying-fox roosts dispersals. Dispersal via disturbance has been shown to reduce concerns and improve amenity in the short-term, however, roosts are usually recolonised, and the conflict remains (Roberts & Eby 2013, Currey et al. 2018).

Roberts and Eby (2013) summarised 17 known flying-fox dispersals between 1990 and 2013, and made the following conclusions:

- In all cases, dispersed animals did not abandon the local area5.
- In 16 of the 17 cases, dispersals did not reduce the number of flying-foxes in the local area.
- Dispersed animals did not move far (in approx. 63% of cases the animals only moved

  < 600 metres from the original site, contingent on the distribution of available vegetation). In 85% of cases, new roosts were established nearby.
- In all cases, it was not possible to predict where replacement roosts would form.
- Conflict was often not resolved. In 71% of cases, conflict was still being reported either at the original site or within the local area years after the initial dispersal actions.
- Repeat dispersal actions were generally required (all cases except where extensive vegetation removal occurred).
- The financial costs of all dispersal attempts were high, ranging from tens of thousands of dollars for vegetation removal to hundreds of thousands for active dispersals (e.g. using noise, smoke, etc.).

Ecosure, in collaboration with a Griffith University Industry Affiliates Program student, researched outcomes of management in Qld between November 2013 and November 2014 (the first year since the current Qld state flying-fox management framework was adopted on 29 November 2013).

An overview of findings6 is summarised below.

- There were attempts to disperse 25 separate roosts in Qld (compared with nine roosts between 1990 and June 2013 analysed in Roberts and Eby [2013]). Compared with the historical average (less than 0.4 roosts/year) the number of roosts dispersed in the year since the framework was introduced has increased by 6250%.
- Dispersal methods included fog7, birdfrite, lights, noise, physical deterrents, smoke, extensive vegetation modification, water (including cannons), paintball guns and helicopters.
- The most common dispersal methods were extensive vegetation modification alone and extensive vegetation modification combined with other methods.
- In nine of the 24 roosts dispersed, dispersal actions did not reduce the number of flying-foxes in the LGA.

5 Local area is defined as the area within a 20 km radius of the original site, i.e. typical feeding area of a flying-fox.

6 This was based on responses to questionnaires sent to councils; some did not respond and some omitted responses to some questions.

7 Fog refers to artificial smoke or vapours generated by smoke/fog machines. Many chemical substances used to generate smoke/fog in these machines are considered toxic.

- In all cases, it was not possible to predict where new roosts would form.
- When flying-foxes were dispersed, they did not move further than 6 km away.
- As at November 2014 repeat actions had already been required in 18 cases.
- Conflict for the council and community was resolved in 60% of cases, but with many councils stating they feel this resolution is only temporary.
- The financial costs of all dispersal attempts were considerable, regardless of methods used, ranging from $7500 to more than $400,000 (with costs ongoing).

Newly published research investigating the effectiveness of dispersal attempts (Roberts et al 2021) has shown similar findings which are summarised below:

- In 95% of cases, dispersal did not reduce the number of flying-foxes from the local area.
- Of the 48 roost dispersals attempted, only 23% were deemed a success at reducing conflict with communities, and this generally only occurred after extensive destruction of roost habitat.
- No project with a budget less than A$250,000 was deemed successful.
- Repeat actions were required in 58% of cases, some for months and years following the initial activities.

In 88% of cases, replacement roosts were established within 1km of the original roost, transferring conflict to neighbouring communities.