ecosure

Management Options
Palmetum Flying-fox Roost, Townsville

REPORT
March 2016

TOWNSVILLE CITY COUNCIL

ecology / vegetation / wildlife / aquatic ecology / GIS

Acknowledgements

Ecosure would like to thank Townsville City Council for assistance in project planning and background, including the provision of historical data. We also appreciated data and knowledge shared by members of North Queensland Wildlife Care Inc. and Birdlife Townsville.

Acronyms and abbreviations

ABLV	Australian bat lyssavirus
BFF	Black flying-fox (*Pteropus alecto*)
COP	Code(s) of practice
DoE	Commonwealth Department of the Environment
EHP	Department of Environment and Heritage Protection
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	Endangered, vulnerable or near threatened
LGA	Local government area
LRFF	Little-red flying-fox (*P. scapulatus*)
MNES	Matters of National Environmental Significance
NC Act	*Nature Conservation Act 1992*
SFF	Spectacled flying-fox (*P. conspillilatus*)
SoMI	Statement of Management Intent
TCC	Townsville City Council
UFFMA	Urban Flying-fox Management Area
VM Act	Queensland *Vegetation Management Act 1999*

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1 Introduction

Townsville City Council (TCC) engaged Ecosure to develop a roost management options report for the flying-fox roost at the Palmetum Botanic Gardens, Annandale. This is the priority site for management and is the focus of this report, however other known roost sites in the Townsville area are also briefly discussed. Further information on flying-foxes in the region can be found in the draft 'Townsville flying-foxes strategic review' (Townsville City Council 2014).

Site assessment (13th and 14th January 2016) focused on roost assessment, consultation with stakeholders and assessment of potential habitat across the city.

The Palmetum Botanic Gardens (the Palmetum) were officially opened in September 1988 as a Bicentennial Project. The Palmetum covers 22.85ha, housing an extensive palm collection displayed in a variety of habitats which is the main attraction of the gardens (Townsville City Council 2012).

A small group of black flying-foxes (*Pteropus alecto*, BFF) have been present at the Palmetum for approximately 20 years with large seasonal influxes of the little red flying-fox (*P. scapulatus*, LRFF). An increase in numbers coincided with disturbance to the large roost at the mouth of the Ross River associated with the construction of the Port Access Road and Cyclone Yasi.

Council has received numerous complaints from residents, visitors and businesses surrounding the Palmetum in relation to the roost, reporting primarily amenity and financial impacts, and to some extent fear of disease.

Flying-foxes are a critical element of ecological biodiversity and are protected in Queensland under the *Nature Conservation Act 1992* (NC Act). Long-range seed dispersal by flying-foxes is probably the most critical component for the ongoing persistence of plant populations (Westcott et al. 2008), and the significance of this is magnified when considered in the context of large-scale habitat loss and fragmentation. For this reason they are also critical to key economic activities such as forestry and tourism.

Flying-foxes appear to be more frequently roosting and foraging in urban areas because of habitat clearing elsewhere, human encroachment and drought, combined with the opportunities presented by year-round food availability from native and exotic species in urban areas. In urban settings the noise, smell and excrement originating from these roosts can cause significant concern for nearby residents and businesses.

In addition to Council, there are a number of stakeholders with a keen interest in the site and flying-fox roost. These stakeholders include:

- surrounding residents, including residents of The Good Shepard Nursing Home
- surrounding businesses, including the Tumbetin Tea rooms

- community groups such as the Townsville Garden & District Club, Birdlife Townsville and the North Queensland Wildlife Care Inc. Club
- visitors to the botanic gardens.

Figure 1 shows all known roosts within Townsville City Council area.

Figure 1: Flying-fox roost locations within Townsville City Council LGA

Townsville City Council

Management Options – Palmeatum Flying-fox Roost

- Flying-fox roost
- Unconfirmed flying-fox roost site
- Townsville LGA boundary
- Urban flying-fox management area

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2 Legislative and policy framework

2.1 Local government

Local government agencies are required to prepare planning schemes consistent with Queensland Planning Provisions under the *Sustainable Planning Act 2009*.

Planning schemes enable an LGA to manage growth and change in their local government area through land use and administrative definitions, zones, overlays, infrastructure planning provisions, assessment codes and other administrative matters. A planning scheme identifies the kind of development requiring approval, as well as areas constrained by their environmental value.

There are no specific requirements under the current Townville City Plan (2014), for flying-fox management or restrictions on trimming or removal of vegetation.

2.2 Queensland

2.2.1 *Nature Conservation Act 1992*

EHP administers the NC Act and is responsible for the management and conservation of flying-foxes in Queensland. Flying-foxes and their habitat are protected under the NC Act. SFF are listed as a Vulnerable species under the NC Act.

An unauthorised person may face significant financial penalty or one year imprisonment if they attempt to destroy a flying-fox roost, or drive flying-foxes away from a roost. Significant penalties may also apply for unauthorised disturbance of a flying-fox roost.

Council-managed land

In 2013 the Queensland Government revised its approach for managing flying-foxes. This included the release of two codes of practice that provide the public and local governments authority to undertake particular activities to manage flying-foxes. It is important to note that this does not obligate local government to implement those revised approaches.

The latest reform implemented in 2013 allows management of flying-fox roosts, including:

- The ‘as-of-right’ authority for local governments to manage and/or disperse flying-fox roosts in Urban Flying-fox Management Areas (UFFMA) in accordance with a code of practice (COP) without the need for a permit under the NC Act. Any other landholder wishing to undertake management of a flying-fox roost on their land must still independently apply to EHP for a Flying-fox Roost Management Permit, as must Council for activities outside the UFFMA.

- The 'as-of-right' authority for all persons (including residents) to undertake certain low impact management activities (e.g. weeding, mulching, mowing and minor tree trimming) within and outside the UFFMA in accordance with a COP.

The COP – *Ecologically sustainable management of flying-fox roosts* (EHP 2013a) sets out how local government may manage roosts within the UFFMA (defined by EHP). Specifically, the code outlines how councils may:

- destroy a flying-fox roost
- drive away, or attempt to drive away, a flying-fox from a flying-fox roost, and
- disturb a flying-fox in a flying-fox roost.

Proposed management actions undertaken by local governments that do not comply with the codes may only be conducted under the approval of a Flying-fox Roost Management Permit (FFRMP) (issued by EHP).

Without an EHP-approved Flying-fox Management Plan (FFMP), local government requires a FFRMP for roosts outside the UFFMAs. However following the development of and EHP endorsement of an FFMP, management activities for roosts outside the UFFMAs will be permitted without an FFRMP for a period of three years.

Council must notify EHP at least two business days prior to any roost management activity using the form on the EHP website.

Non-council land

The COP– *low impact activities affecting flying-fox roosts* (EHP 2013b) sets out how a private landowner may undertake low impact activities at a flying-fox roost anywhere in the State of Queensland in accordance with section 41B of the Nature Conservation (Wildlife Management) Regulation 2006. Operating outside of the COP is not authorised and may have legal consequences.

Under this code, low impact activities are mulching, mowing or weeding under or near roost trees, and/or minor trimming of roost trees, where the activities are not directed at destroying a flying-fox roost, driving away, or attempting to drive away, a flying-fox from a flying-fox roost, or disturbing a flying-fox in a flying-fox roost.

The code outlines the following restrictions for activities undertaken by private landowners.

- No roost tree may be trimmed when there are flying-foxes in that part of the tree being trimmed, or when flying-foxes are near the tree and likely to be harmed as a result of the trimming.
- Any trimming of roost trees must be limited to 10% of the total canopy occupied by the roost (not 10% of the whole tree's canopy).
- Low impact activities must immediately cease, and EHP be immediately notified, if a flying-fox appears to have been killed or injured.

- Where low impact activities are required to be undertaken during the day time, works must immediately cease and EHP be immediately notified if 30% or more of the adult flying-foxes leave the roost for five minutes or more.

Where a private landholder wishes to manage a roost in any way not specifically outlined in the low impact COP, they must apply to EHP for a FFRMP.

It is important to note that neither code provides exemptions to other legislation and provisions that are likely to be relevant to flying-fox management activities, such as the Queensland *Vegetation Management Act 1999* (VM Act), *Fisheries Act 1994*, the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and various state and local planning provisions. They also do not provide exemptions for all vegetation under the NC Act (see below).

Vegetation

All plants that are indigenous to Australia are protected in Queensland under the NC Act. Prior to any clearing of protected plants, a person must check the flora survey trigger map to determine if the clearing is within a high risk area for the occurrence of endangered, vulnerable or near threatened (EVNT) plants:

- In a high risk area, a flora survey must be undertaken and a clearing permit may be required for clearing EVNT plants and their supporting habitat.
- If a flora survey identifies that EVNT 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 EVNT plants are present.
- Clearing of least concern plants is exempt from requiring a clearing permit within a low risk area.

2.2.2 *Vegetation Management Act 1999*

The clearing of native vegetation in Queensland is regulated by the VM Act, the *Sustainable Planning Act 2009* 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
- who is 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 DNRM for each proposed vegetation clearing activity.

2.3 Commonwealth

The Commonwealth's EPBC Act provides protection for the environment, specifically matters of national significance. A referral to the Commonwealth DoE is required under the EPBC Act for any action that is likely to significantly impact on a matter of national environmental significance (MNES).

MNES under the EPBC Act are:

- world heritage sites
- national heritage places
- wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- nationally threatened species and ecological communities
- migratory species
- Commonwealth marine areas
- nuclear actions.

The Spectacled Flying-fox (SFF) is listed as nationally vulnerable under the EPBC Act.

As per the self-assessable criteria in the Significant Impact Guidelines 1.1 (DoE 2013) an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species
- reduce the area of occupancy of an important population.
- fragment an existing important population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of an important population

- modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- introduce disease that may cause the species to decline, or
- interfere substantially with the recovery of the species.

Nationally important SFF camps have been defined as having either:

i. contained ≥ 16,000 SFF in more than one year in the last 10 years, or

ii. been occupied by SFF in at least 50% of the surveys over the last 10 years.

Provided that management at nationally important camps follows the below mitigation standards, DoE has determined that a significant impact to the population is unlikely, and referral is not likely to be required.

Mitigation standards

- The action must not occur if the camp contains females that are in the late stages of pregnancy or have dependent young that cannot fly on their own.
- The action must not occur during or immediately after climatic extremes (heat stress event[1], cyclone event[2]), or during a period of significant food stress[3].
- Disturbance must be carried out using non-lethal means, such as acoustic, visual and/or physical disturbance or use of smoke.
- Disturbance activities must be limited to a maximum of 2.5 hours in any 12 hour period, preferably at or before sunrise or at sunset.
- Trees are not felled, lopped or have large branches removed when flying-foxes are in or near to a tree and likely to be harmed.
- The action must be supervised by a person with knowledge and experience relevant to the management of flying-foxes and their habitat, who can identify dependent young and is aware of climatic extremes and food stress events. This person must make an assessment of the relevant conditions and advise the proponent whether the activity can go ahead consistent with these standards.
- The action must not involve the clearing of all vegetation supporting a nationally-important flying-fox camp. Sufficient vegetation must be retained to support the maximum number of flying-foxes ever recorded in the camp of interest.

[1] A 'heat stress event' is defined for the purposes of the Australian Government's Referral guideline for management actions in GHFF and SFF camps as a day on which the maximum temperature does (or is predicted to) meet or exceed 38°C.

[2] A cyclone event is defined as a cyclone that is identified by the Australian Bureau of Meteorology (www.bom.gov.au/cyclone/index.shtml).

[3] Food stress events may be apparent if large numbers of low body weight animals are being reported by wildlife carers in the region.

3 The Palmetum Botanic Gardens

The Palmetum is situated approximately 7.5 km south-west of the centre of Townsville City, Queensland. The Palmetum is a botanic garden with an extensive collection of palms, mainly rare and threatened species. In total 299 species and subspecies of plams in 119 genera were identified in the collection, with about 1960 individual plants (Dowe, 2005).

3.1 Site location and description

The roost is located adjacent to the Ross River and is approximately 4.5ha of rainforest comprising a number of vegetation layers, typical of rainforest. The canopy is 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*). The 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. Given the number of threatened species present and the diversity of the collection, the Palmetum is a valuable educational, tourism and scientific resource. The Palmetum incudes a system of pathways designed so that visitors can view the rare palm collection (Dowe, 2005).

Ecological values

The rainforest area at the Palmetum is a closed canopy consisting primarily of rain trees, with a rainforest understorey, providing ideal flying-fox roost habitat.

Table 1 Ecological values of the Palmetum and surrounds

Source	Value
Commonwealth	
EPBC Protected Matters Report	Protected matters search (1km) lists 16 threatened species including SFF and 16 migratory species that may occur in the area.
State	
Essential Habitat	NA
Wetland areas	NA
Regional ecosystem mapping	11.1.1, 11.1.2, , 11.1.4a, 11.1.4b, 11.1.4c, 11.1.14d,11.2.5
Regrowth	Regrowth within 50m of a watercourse in priority reef catchment area
Matters of State Significant (MSES)	Regulated vegetation – Category R
Wildlife Online database (1 km search)	Wildlife online (1km) lists 144 species, including 11 special least concern species.
Flying-fox management areas	The site is mapped within an UFFMA
Coastal Management Area	N.A
NC Act high risk vegetation	NA
Local	
Townsville City Plan	The site is mapped as having open space values.

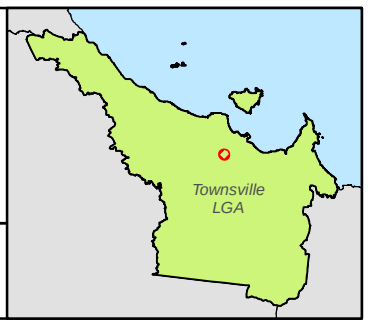
Figure 2: The Palmetum flying-fox roost

Townsville City Council

Management Options –
Palmeatum Flying-fox Roost

Cadastral boundaries

Roost boundary (Jan 2016)



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GDA 1994 MGA Zone 55
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3.2 Historical flying-fox use

A small group of BFF have been present at the Palmetum for approximately 20 years (Lovatt 2016, per comm. 14 January). The number of LRFF has increased, which is thought to be at least in part due to disturbance of the large roost at the Ross River during construction of the Port Access Road in 2008-2012. Numbers have fluctuated from between 8,000 and 40,000 (peaking in 2014). Most LRFF arrive in June/July to coincide Melaleuca flowering, and again in October/November when other Melaleuca species are in flower. Most LRFF leave with the onset of rain, usually around December/January (Thiriet 2015, per comm. 29 January). In addition to Melaleuca woodland and wetlands in the area, Corymbia woodland to the north and east of Townsville City also provide a seasonal food source (Townsville Airport Limited 2013).

The spectacled flying-fox (*P. conspicillatus*, SFF) has been recorded sporadically at this roost site and across Townsville City (Townsville City Council, 2014). The SFF is listed as vulnerable to extinction under Qld and Federal legislation, affording it additional protection (see Section 3.3).

It is unknown whether LRFF have raised young at this site (pers. comm. 2016 North Queensland Wildlife Care Inc.), however it is a maternity site for the BFF.

3.3 Reported impacts

Onsite meetings were held with Council staff, as well as with the Manager and groundskeeper of The Good Shepard Nursing Home.

Damage to the important rare palm collection, as well as noise, smell and faecal drop were the primary concerns reported.

Some palms have already been lost due to direct damage from flying-foxes roosting within the palms themselves (during LRFF influxes), and others have died or are at risk due to canopy-damage leading to palms being burnt.

Residents and staff of the nearby nursing home have concerns regarding the lack of access to the Palmetum because of areas cordoned off due to seasonal influxes of flying-foxes. Subsequent noise and smell resulting from large numbers of flying-foxes are also causes of concern. Faecal drop on buildings and in particular on solar panels have resulted in an increase in maintenance costs.

The Tumbutin Tea Rooms are mostly impacted during periods of large flying-fox influxes, particularly during evening fly-outs when events may be held outdoors, resulting in a reported reduction in reservations and associated loss of income.

Some residents and visitors to the botanic gardens are fearful of bat related diseases. As detailed in Appendix 1, actual disease risk is very low and easily preventable, and this should be communicated to ensure misconceptions are addressed.

The Townsville Bird Observers representative indicated that there has been a loss in bird diversity and bird population numbers at the rainforest since the influx of high numbers of flying-foxes. For example nesting owls and kookaburras have reportedly vacated the area. Attempts were also made to seek feedback from the Townsville & District Garden Club however contact could not be made during preparation of the report.

3.4 Previous management activities

The roost area is fenced off to avoid direct contact between visitors and flying-foxes, and protect visitors from falling limbs of damaged trees. This temporary fencing is moved as the roost extent changes. Basic signage has been erected on the temporary fencing.

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).

Council also regularly liaises with local researchers and hopes to participate in monitoring projects. This will improve local knowledge of flying-fox behaviour and movements, and can be used to inform management decisions.

In a regional context, Council created a document which strategically reviews the Townsville flying-fox issue, which provides background information and general recommendations for management (timing, methods, etc.) (Townsville City Council 2014). This report has been written to align with guiding principles outlined in this review document. Key principles of the review are that a staged management approach should adopted wherever possible, methods should be based on actual risk, and dispersal should always be a last resort.

4 Other known roosts around Townsville City

Below are other known roosts sites around Townsville City that were visited during the site assessment. It is important to consider potential impacts at these locations should the Palmetum roost be made unavailable, and also impacts at the Palmetum that may be exacerbated by management or disturbance at these other locations. Site-specific maps are provided for key roosts that were occupied at the time of the assessment.

4.1 Rowes Bay

The Rowes Bay roost is situated in mangroves adjacent to a council managed park on The Esplanade, Northward. The current population of approximately 500 Black Flying-foxes occupy a patch (0.5ha) of mangroves with potential to utilise another 1.98ha adjacent along the coast.

Ecological values

Table 2 Ecological values of Rowes Bay roost and surrounds

Source	Value
Commonwealth	
EPBC Protected Matters Report	Protected matters search (1km) lists 24 threatened species including SFF and 37 migratory species that may occur in the area.
State	
Essential Habitat	NA
Wetland areas	NA
Regional ecosystem mapping	11.1.4
Regrowth	NA
Matters of State Significant (MSES)	Declared Fish Habitat Area
Wildlife Online database (1 km search)	Wildlife online (1km) lists 231 faunal species, including 5 vulnerable and 19 Special least concern species.
Flying-fox management areas	The site is mapped within an UFFMA
Coastal Management Area	Situated within a coastal management district
NC Act high risk vegetation	NA
Local	
Townsville City Plan	The site is mapped as having open space values.

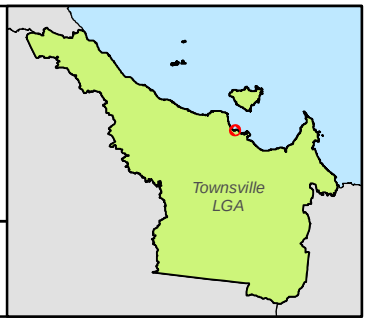
Figure 3: Rowes Bay flying-fox roost

Townsville City Council

Management Options –
Palmeatum Flying-fox Roost

Cadastral boundaries

Roost boundary (Jan 2016)



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4.2 Ross Creek

The roost of between 500 and 1000 BFF is situated on the banks of Ross Creek in a small area of remaining mangroves, approximately 0.7ha in size. The surrounding area is heavily cleared and largely urban. There is also potential development planned in cleared area adjacent, and the potential for disturbed flying-foxes to come to the Palmetum (or elsewhere) needs to be considered. Although it is unlikely this small number will greatly increase impacts at the Palmetum.

Ecological values

Table 3 Ecological values of Ross Creek roost and surrounds

Source	Value
Commonwealth	
EPBC Protected Matters Report	Protected matters search (1km) lists 15 threatened species including SFF and 12 migratory species that may occur in the area.
State	
Essential Habitat	NA
Wetland areas	NA
Regional ecosystem mapping	11.1.4
Regrowth	Regrowth within 50m of a watercourse in priority reef catchment area
Matters of State Significant (MSES)	Dugong protection area, Regulated vegetation – Category R
Wildlife Online database (1 km search)	Wildlife online (1km) lists 29 faunal species, including 4 special least concern species.
Flying-fox management areas	The site is mapped within an UFFMA
Coastal Management Area	Situated within a coastal management district
NC Act high risk vegetation	NA
Local	
Townsville City Plan	The site, known as Railway Estate is mapped as a high density residential zone.

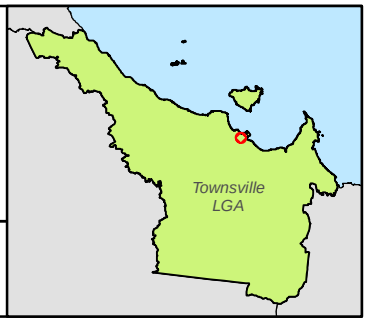
Figure 4: Ross Creek flying-fox roost

Townsville City Council

Management Options –
Palmeatum Flying-fox Roost

Cadastral boundaries

Roost boundary (Jan 2016)



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4.3 McPherson Street, Oonooba

The McPherson Street, Oonooba roost is situated in wetlands on a council controlled reserve of 65.2ha of which approximately 80% consists of mangrove ecosystems adjacent to residential area. No flying-foxes were present in January and according to a local resident the roost has remained unoccupied since 2014.

Ecological values

Table 4 Ecological values of McPherson Street roost and surrounds

Source	Value
Commonwealth	
EPBC Protected Matters Report	Protected matters search (1km) lists 14 threatened species including SFF and 17 migratory species that may occur in the area.
State	
Essential Habitat	NA
Wetland areas	NA
Regional ecosystem mapping	11.1.1, 11.1.2a,11.1.2b, 11.1.4b, 11.1.4c, 11.3.31
Regrowth	Regrowth within 50m of a watercourse in priority reef catchment area
Matters of State Significant (MSES)	Fish Habitat Area, Regulated vegetation – Category R
Wildlife Online database (1 km search)	Wildlife online (1km) lists 82 species, including 5 special least concern species.
Flying-fox management areas	The site is mapped within an UFFMA
Coastal Management Area	Situated within a coastal management district
NC Act high risk vegetation	NA
Local	
Townsville City Plan	The site is mapped as having Environmental management & conservation values

4.4 Ross River

This large area is a Council-managed reserve of 301ha and various sites within this reserve have historically been utilised by flying-foxes for a number of years. Previous colonies in this area have been disturbed by the construction of the Port Access Road and it is assumed by many locals that this was a contributing factor into the increase of flying-foxes at The Palmretum (Thieret, Boyd pers communication, January 2016). The area largely consists of mangrove communities and both LRFF and BFF were observed and counted during an evening fly-out, which can only determine the total numbers and not individual species totals, 8,584 were counted flying out and approximately 500 pups remained at the site (species could not be identified given access issues, but given seasonal timing of assessment it is assumed pups were BFF).

Ecological values

Table 5 Ecological values of Ross River roost and surrounds

Source	Value
Commonwealth	
EPBC Protected Matters Report	Protected matters search (2km) lists 27 threatened species including SFF and 63 migratory species that may occur in the area.
State	
Essential Habitat	NA
Wetland areas	NA
Regional ecosystem mapping	11.1.1, 11.1.2, , 11.1.4a, 11.1.4b, 11.1.4c, 11.1.14d,11.2.5
Regrowth	Regrowth within 50m of a watercourse in priority reef catchment area
Matters of State Significant (MSES)	Fish Habitat Area, Regulated vegetation – Category R & B, mapped dugong protection area mapped
Wildlife Online database (1 km search)	Wildlife online (2km) lists 274, including 4 vulnerable and 40 SL species
Flying-fox management areas	The site is mapped within an UFFMA
Coastal Management Area	Situated within a coastal management district
NC Act high risk vegetation	NA
Local	
Townsville City Plan	The site is mapped as having Environmental management & conservation values

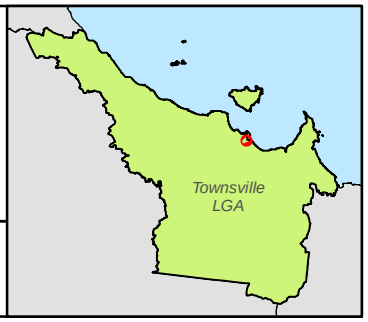
Figure 5: Ross River flying-fox roost

Townsville City Council

Management Options –
Palmeatum Flying-fox Roost

Cadastral boundaries

Roost boundary (Jan 2016)



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4.5 Dan Gleeson Memorial Gardens

Ecological values

Dan Gleeson Memorial Park is an urban council controlled reserve (5.453ha) with a wide range of native and exotic trees, shrubs and palms situated amongst lawns and pathways. The garden was impacted by a large influx of LRFF in 2014, after which vegetation management was required to ensure visitor and staff safety. The colony reportedly then returned to the Palmetum. Further vegetation modification has been required since this time to remove damaged limbs. Undesirable saplings have also been removed. While no flying-foxes were present in January 2016, it is still considered a moderately attractive site and flying-foxes may return to this location if disturbed from the Palmetum.

Table 6 Ecological values of Dan Gleeson Memorial Park roost and surrounds

Source	Value
Commonwealth	
EPBC Protected Matters Report	Protected matters search (1km) lists 16 threatened faunal species including SFF and 16 migratory species that may occur in the area.
State	
Essential Habitat	NA
Wetland areas	NA
Regional ecosystem mapping	N/A
Regrowth	N/A
Matters of State Significant (MSES)	N/A
Wildlife Online database (1 km search)	Wildlife online (1km) lists 31 species, no EVNT & SL species
Flying-fox management areas	The site is mapped within an UFFMA
Coastal Management Area	N.A
NC Act high risk vegetation	NA
Local	
Townsville City Plan	The site is mapped as having open space values.

5 Potential roost habitat in the region

An analysis was carried out to delineate potential flying-fox habitat using habitat preference criteria identified in Roberts (2006). The predictive criteria identifying areas of highest likelihood of flying-fox roost occurrence are summarised as being:

- closed canopy at least 5 m high
- complex vegetation structure – upper, mid- and understorey layers
- dense vegetation within 500 m of a river or creek
- within 50 km of the coastline or at an elevation < 65 m above sea level
- level topography, <5º incline
- at least one hectare in size (large enough to accommodate and sustain large numbers of flying-foxes)
- within nightly commuting distance (generally, <20 km) of sufficient food resources to support the population

It must be reiterated that this is identifying areas of highest likelihood only. That is, areas that are not identified (due to data limitations or flying-fox deviation from general favoured characteristics) may be used, and conversely, not all mapped habitat will be suitable. LRFF are the least selective species when choosing a roost, and are the most likely to be recorded in unpredictable locations.

The criteria relating to nightly commuting distance to sufficient food resources was not included in the model due to there being no available data containing this information.

Key vegetation within 10km of the Palmetum was ground-truthed during site assessment, and therefore is most accurate. Ground-truthing outside this area was beyond the scope of the project.

DSITI remnant vegetation (version 9) and EHP mature regrowth data (derived from Vegetation Management Act High Value Regrowth v 2.1) were merged to create vegetation coverage across Townsville LGA. The mature regrowth data did not spatially align with the boundaries of DSITI's remnant vegetation across the entire LGA, causing some artificial gaps and overlaps (e.g. 5 – 20 m), however, updated regrowth data that spatially aligned with the DSITI remnant data was not available and therefore the decision was made to include the Mature Regrowth vegetation in the model. Where overlaps occurred, the regrowth information was removed. In addition to mapped remnant and regrowth vegetation, parks/recreation areas were included in the model. Vegetation present in parks can be composed of tree species that are not consistent with the vegetation that would naturally occur in the relevant regional ecosystem for the area, and therefore would not appear in remnant/regrowth vegetation mapping. However, this vegetation can still be used by flying-foxes. A layer showing parks was created by extracting types 'Garden' and 'Recreation area' from DNRM's 'Recreation Areas' data, and combining with DILGP's 'Land for Public Recreation' data. Within 10 km of the Palmetum, parks were ground truthed and a number were excluded from the model as containing unsuitable habitat; the remaining parks within this 10 km ground truthed area were

retained in the model for the remainder of the steps, regardless of whether they met the other critera. Outside of the 10km ground truthed area, all parks were retained in the model and were treated as 'vegetation' for the remainder of the model process, with the exception of the suitable RE type and minimum 1 ha area rules.

Buffers of 500m were added to three water feature layers across the LGA: Townsville City Council's Water polygon data (CP14_Water_Polygons), DNRM's Ordered Drainage (excluding stream order 1) and DNRM's Lakes data. These buffer layers were combined, and used to clip the above vegetation, creating a layer of vegetation within 500m of a waterway or lake/dam.

From this clipped vegetation data, vegetation communities considered suitable for flying-fox roosts were selected. Vegetation was selected by Regional Ecosystem/community, based on the description's correlation with the above two vegetation criteria and our ecologist's knowledge of those REs. Additionally, some REs would not be suitable in pristine condition, however due to the likelihood that there will be some weed composition, those REs were not all excluded from the model. Where mixed communities were present, the vegetation patch was retained in the model if one or more of the communities were identified as suitable, regardless of the percentage it comprised. As above, all parks were retained in the model at this stage.

The current or historical presence of a flying-fox roost was overlaid on the resulting vegetation to ensure communities that flying-foxes are known to exist in were included in the data; in this analysis, the camps were all found to be located on vegetation that had been selected as suitable therefore no further review of vegetation types was required.

A slope layer was created using DNRM's Digital Elevation Model (DEM). Townsville City Council provided a higher resolution DEM however it did not cover the full extent of the LGA and therefore was not suitable for this model. The slopes at known flying-fox roost locations were investigated and it was confirmed that all camps were located on slopes of $<5^0$. The slope layer was generalised, reclassified into two (areas of greater than and less than 5^0) and converted to vector format. Vegetation from the above step was then clipped to those areas where slopes were $<5^0$.

The above DEM was used to view areas where the elevation is more than 65 m. A buffer of 50 km from the coast line was created and overlaid with the 65 m elevation areas. There was one area in the South West of the LGA that was both on an elevation of more than 65m and more than 50 km from the coast and therefore this area was removed from the above vegetation.

In order to identify vegetation of sufficient size for a flying-fox camp, vegetation parcels were selected that were greater than or equal to 1 ha, either in isolation or when combined with other vegetation within 10 m. As above, any parks remaining in the data were retained regardless of meeting this criteria.

The resultant layer contains only vegetation communities preferred by flying-foxes for roosts (or parks), which are within 500 m of waterways/dams, on slopes of less than 15%, either on elevation less than 65 m or within 50 km of the coast, and that are greater than or equal to 1 ha.

Finally, the identified potential habitat was assigned a potential conflict rating according to distance from buildings. All potential habitat within 1 km of Townsville Airport and RAAF Base was also considered high conflict (note that assessment of actual strike risk was beyond the scope of this project and needs to be considered to more accurately categorise potential habitat in the aerodrome vicinity). Townsville City Council buildings footprint data was used however the data was only available for urban areas. Conflict ratings could therefore only be applied in these areas and should be used with caution when investigating conflict (e.g. areas assigned as 'low potential for conflict' may not be low conflict if in proximity of buildings that had not been mapped). The potential conflict was assigned as below:

- >300 m from buildings = low potential for conflict
- 50-300 m from buildings = moderate potential for conflict
- <50 m from buildings = high potential for conflict.

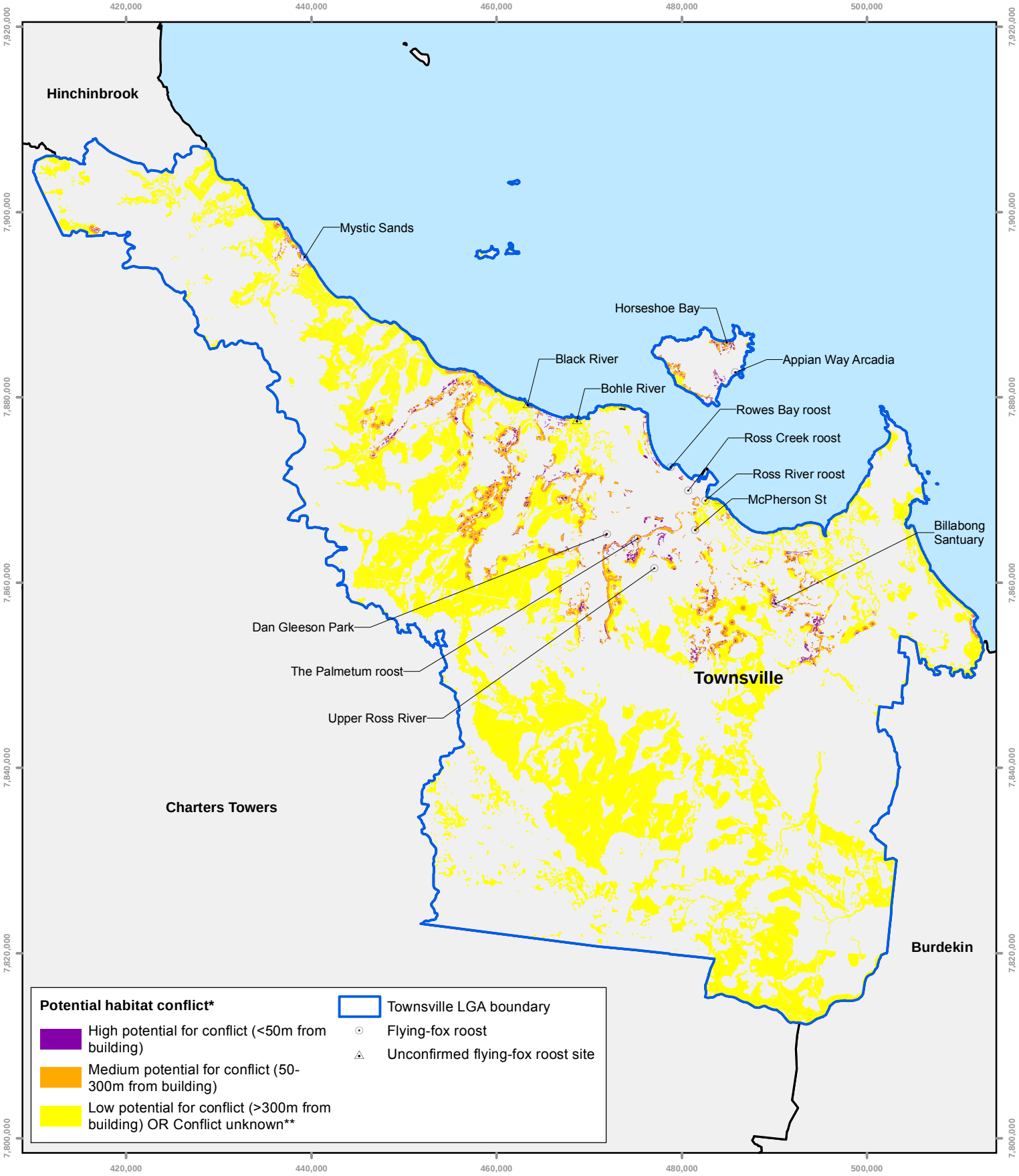

Figure 6: Flying-fox potential habitat within Townsville City Council LGA

Townsville City Council

Management Options – Palmeatum Flying-fox Roost

** see report* Management Options – Palmeatum Flying-fox Roost *(Ecosure 2016) for method*
*** conflict ratings only applied where building footprint data was available. Data was provided by Townsville City Council for urban areas.*

ecosure

Job number: PR1169
Revision: 1
Author: MED
Date: 09/03/2016

0 2.5 5 10
Kilometers

GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994
Units: Meter

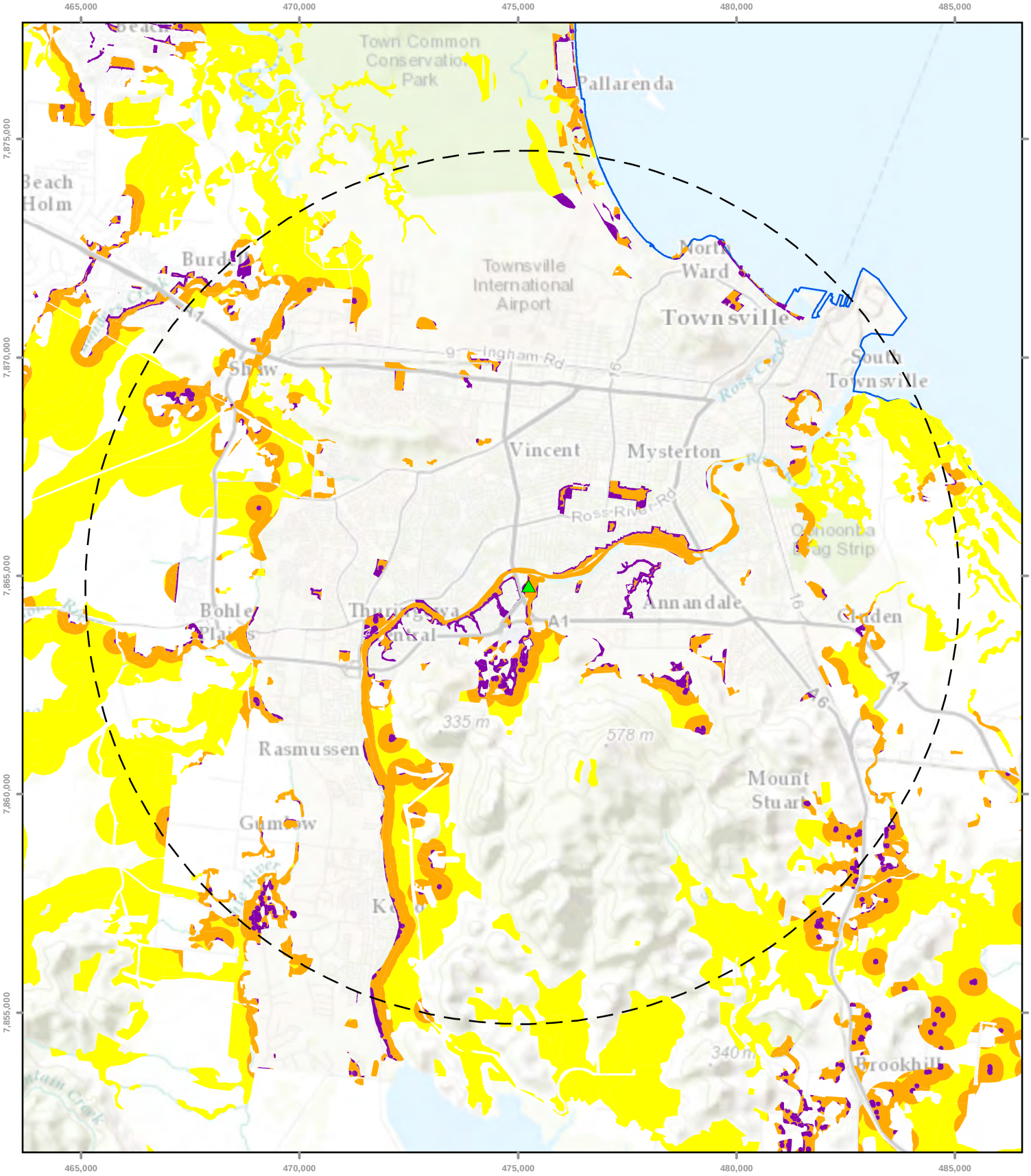

Figure 7: Potential habitat modelling 10km from the Palmetum

Townsville City Council

Management Options – Palmeatum Flying-fox Roost

The Palmetum roost

Townsville LGA boundary

10 km from roost

Potential habitat conflict*

High potential for conflict (<50m from building)

Medium potential for conflict (50-300m from building)

Low potential for conflict (>300m from building) OR Conflict unknown**

** Conflict ratings only applied where building footprint data was available. Data was provided by Townsville City Council for urban areas.*

ecosure

Job number: PR1169
Revision: 1
Author: MED
Date: 09/03/2016

0 1 2 4
Kilometres

GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994
Units: Meter

PR1169_MP_Fig7_Palmetum10km_R1
A4

6 Management options

Management options can be broadly categorised as either mitigation (in-situ management) or dispersal. Mitigation aims to reduce amenity impacts to residents while flying-foxes remain at the roost, whereas dispersal aims to non-lethally disperse the population from the site with the aim of them relocating to a more suitable location(s).

As discussed above, key issues associated with the Palmetum are as follows:

- Damage and loss of rare and threatened palms
- Noise and smell impacts, particularly for the Good Shepherd Nursing Home
- Faecal drop and increased cleaning/maintenance costs
- Reduced access to the Palmetum for visitors and Nursing Home residents
- Risk of injury associated with falling branches
- Fear (and misconeptions) about disease risk
- Reported loss of income to the Tumbutin Tea Rooms

The following is a full suite of options that will assist mitigating these impacts.

Recommendations are detailed in Section 8.

6.1 Mitigation

6.1.1 Education

Engaging and educating people is key to ensuring the community understands the ecological importance of flying-foxes, the actual (low) health risks, and options available to reduce impacts associated with roosting and foraging flying-foxes. Collecting and providing information should always be the first response to community concerns, and should be a key component of any approach.

There are a number of things that landholders can do to reduce these impacts, as detailed in Section 6.1.2.

6.1.2 Property modification

Neighbouring land managers should consider the following measures to minimise impacts from roosting and foraging flying-foxes:

- 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 m). Vegetation that produces fragrant flowers can assist masking roost odour where this is of concern. This option may also be considered by Council at the edge of the reserve boundary.

- 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 areas where faecal contamination is an issue
- Move or cover eating areas (i.e. BBQs and tables) within close proximity to the roost
- Install double-glazed windows, insulation and use air-conditioners when needed to reduce noise disturbance and smell associated with a nearby roost
- Turn off lighting at night (e.g. floodlights) which flying-foxes are thought to use as navigational beacon, which may reduce fly-over impacts
- Avoid disturbing flying-foxes during the day which will increase roost noise and smell.

Opportunities for funding assistance through environment and other local/state grants may be available that reduce the need to actively manage a roost.

6.1.3 Subsidies/incentives

Fully funding or providing subsidies to property owners for property modifications may be considered. 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.

Alternatively services could be subsidised, such as clothes washing, cleaning, car washing or power bills, or access to resources provided (e.g. free hire of high-pressure water cleaners).

Incentives such as reduction in rates or facilities charges (e.g. water) may also assist.

The level and type of subsidy would need to be agreed between TCC and the landholder. Critical thresholds for when such subsidies/incentives may apply would also need to be determined, such as distance to a roost and flying-fox numbers at a roost.

6.1.4 Buffers

Buffers can be created through vegetation removal, installation of permanent/semi-permanent deterrents, ‘nudging’ flying-foxes from conflict areas using low intensity disturbance, or by using a combination of these methods.

Buffers through habitat modification

Removing vegetation in high conflict areas can alter the habitat so it is no longer suitable for roosting animals. The amount of vegetation removal needed varies between sites and particular roosts; it may be as little as removing a weedy understorey to alter the microclimate, selectively trimming roost trees, or in some instances can require the removal of more than 90% of the canopy.

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 this site given the high value of the vegetation. Thorough site assessment will inform whether vegetation

management is suitable (i.e. can impacts to other wildlife and/or the community be avoided).

Loss of under and midstorey vegetation may increase flying-fox mortality during heat stress events (which are common in summer). Aside from obvious welfare and conservation impacts associated with increased mortality, flying-fox mortality will also impact surrounding residents (i.e. smell) which should be considered when planning habitat modification.

Buffers with deterrents

Permanent/semi-permanent deterrents may be installed to deter flying-foxes from a designated buffer area. Many deterrents have been trialled in the past with limited success, however several options are worthy of further investigation:

- Canopy-mounted water sprinklers – this method has been highly effective in deterring flying-foxes from certain roost trees during dispersal (Ecosure personal experience).
- Netting – netting trees could be used to exclude flying-foxes from certain areas. It is important that wildlife friendly netting is used to avoid any fauna becoming entangled.
- Wires – thin wires (unsuitable for roosting) could be installed over the top of the canopy to limit access by roosting flying-foxes. The design and type of wire would need to be carefully considered to avoid injuring flying-foxes or other wildlife.
- Python excrement – bagged snake excrement hung in trees has previously had localised effects. Logistical issues associated with sourcing and regularly applying large amounts of snake excrement would need to be overcome. The smell of large amounts may also impact nearby residents. There is also the potential for flying-foxes to habituate to this deterrent.
- Visual deterrents – visual deterrents, such as plastic bags, fluoro vests and balloons (Ecosure personal experience) in roost trees have been shown to have localised effects (i.e. with flying-foxes avoiding roosting within 1-10 m). The type and placement of visual deterrents would need to be varied regularly to avoid habituation.
- 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. **Note**: flying-foxes hearing is in the same spectrum as humans, and therefore sonic/high frequency deterrents will not be effective.

6.1.5 Noise attenuation fencing

Noise attenuation fencing could be installed in areas where the camp is particularly close to residents. 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.

6.1.6 Nudging

Noise and other low intensity disturbance restricted to certain areas of the roost can be used to 'nudge' flying-foxes away from high conflict areas. This technique aims to make high conflict areas (i.e. buffers) less attractive for roosting flying-foxes, while allowing them to remain in other areas of the roost.

Nudging should not generally be conducted early in the morning as this may lead to inadvertent dispersal of flying-foxes from the site. It should rather be conducted during the daytime to encourage flying-foxes to move a small distance (i.e. 10 m) rather than leaving the roost. Daytime disturbance such as this is not permitted under the COP, and would require approval from EHP. Disturbance during the day should also be limited in frequency (i.e. up to four times per day, with regular rest days of no disturbance) to avoid welfare impacts. As with dispersal, it is also critical to avoid periods when dependent young are present (as identified by a suitably experienced person).

6.1.7 Provision of artificial roosting habitat

This management option involves constructing artificial structures to augment roosting habitat in current camp 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.

6.1.8 Revegetation and land management to create alternative habitat

Revegetating and managing land to create alternative flying-fox roosting habitat through improving and extending existing low-conflict camps or developing new roosting habitat in areas away from human settlement should be considered as part of a long-term strategy.

Selecting new sites and attempting to attract flying-foxes to them have had limited success in the past, and ideally habitat at known camp sites would be dedicated as flying-fox reserves. However, if a staged and long-term approach is used to make unsuitable current camps 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 camp preferences may improve the potential to create new flying-fox habitat.

When improving a site for a designated flying-fox camp, preferred habitat characteristics outlined in Section 5 should be considered.

Foraging trees planted amongst and surrounding roost trees (excluding in/near horse paddocks) may assist to attract flying-foxes to a desired site. It 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 camp

location. Supply of an artificial water source (fresh water recommended which will provide flying-foxes with favoured habitat conditions and a source of drinking water) should be considered if naturally unavailable, however may be cost-prohibitive.

Potential habitat mapping using camp 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.

6.1.9 Using planning instruments to avoid future land use conflict

To avoid future land use conflict, planning instruments may be able to be used to ensure adequate distances (ideally 300 m but at least 50 m recommended) are maintained between the roost and future residential developments.

The inclusion of a flying-fox overlay and supporting code in the Townsville Plan may help alleviate future land use conflict. Future development could then be designed where possible to provide a buffer around existing roosts.

6.2 Dispersal

Dispersal aims to encourage a roost to move to another location, through either disturbance or habitat modification.

There are a range of potential risks associated with dispersal from the Palmetum. These include:

- splintering the roost and/or move it to other location(s) that may be equally or more problematic (as identified in Sections 4 and 5)
- impacting on residents and visitors associated with ongoing dispersal attempts
- excessive initial and/or ongoing resource and financial investment
- negative public perception
- impacts on animal welfare and conservation
- increased aircraft strike risk by changing flying-fox movement patterns
- unsuccessful management requiring multiple attempts, which may exacerbate all of the above.

Successful dispersals generally require either:

- substantial vegetation removal or modification (which is not appropriate at this location)
- sustained disturbance at the site and intensive monitoring, and potential additional dispersals from splinter roosts that may form at unsuitable locations.

Flying-foxes generally move within 6 km of a roost site in response to dispersal, and often within 600 m (see Appendix 2). Further, they will often continue to return to the original

preferred site meaning that management is ongoing (or habitat modification is required to deter them from returning).

Despite these risks, where serious impacts cannot be managed any other way, dispersal may be required. Dispersal can broadly be categorised as 'passive' or 'active' as detailed below.

6.2.1 Passive dispersal with vegetation removal

Removing vegetation can be used to passively disperse a roost, by gradually making the habitat less attractive so that flying-foxes abandon the site. This usually involves removing an extensive amount of vegetation, and is not an option at the Palmetum as it will destroy the rainforest and palm collection.

6.2.2 Active dispersal without vegetation removal

A range of tools are utilised to actively disperse flying-foxes, including noise (stock whips, whistles, recorded noise), visual deterrents (lights) and olfactory (smoke).

Dispersal personnel position themselves under the roost prior to flying-foxes returning to the roost from nightly foraging, which varies seasonally but may be as early as 0300. In accordance with the EPBC guideline (see Section 3.4), dispersal should continue for no more than 2.5 hours each morning. It is anticipated that at least four-six personnel would be required at the Palmetum with additional stand-by staff that may need to disperse flying- foxes from other inappropriate splinter locations.

Initial dispersal generally spans several weeks, with maintenance dispersal required as flying-foxes attempt to re-establish the roost (which often continue for many years). Some level of maintenance dispersal is usually required for at least several years, and often indefinitely without habitat modification or deterrents.

In addition to risks detailed above, dispersal activities at this location are likely to:

- disrupt residents (including potential health impacts associated with smoke, which is a key dispersal tool)
- stress noise-phobic pets
- increase flying-fox vocalising during the day
- result in trampling damage to the understory of the rainforest.

As detailed above, additional risk management and welfare impact mitigation strategies are required for active dispersal, and if this is the desired strategy a detailed site-specific dispersal plan will be required.

Where this last-resort option is required, Ecosure advocates a gentle approach aimed at irritating (rather than stressing) flying-foxes so fewer return to the roost each day. An aggressive approach to dispersal (i.e. using excessively loud noise, not allowing flying-foxes to settle in any area of the known roost) forces flying-foxes to find an alternative roost on the morning of dispersal, which is much more likely to stress the animals, and cause them to

splinter to other undesirable locations.

6.2.2.1 Dispersal costs & likelihood of success

Management costs are highly variable and are virtually impossible to predict for management options where the outcomes are unpredictable (dispersal). Risks vary as well with management approach, with the highest level of risk associated with dispersal. Dispersal often requires upward of a $150,000, with the most costly dispersal known to be in exess of $3M and ongoing (i.e. Melbourne Botanic Gardens).

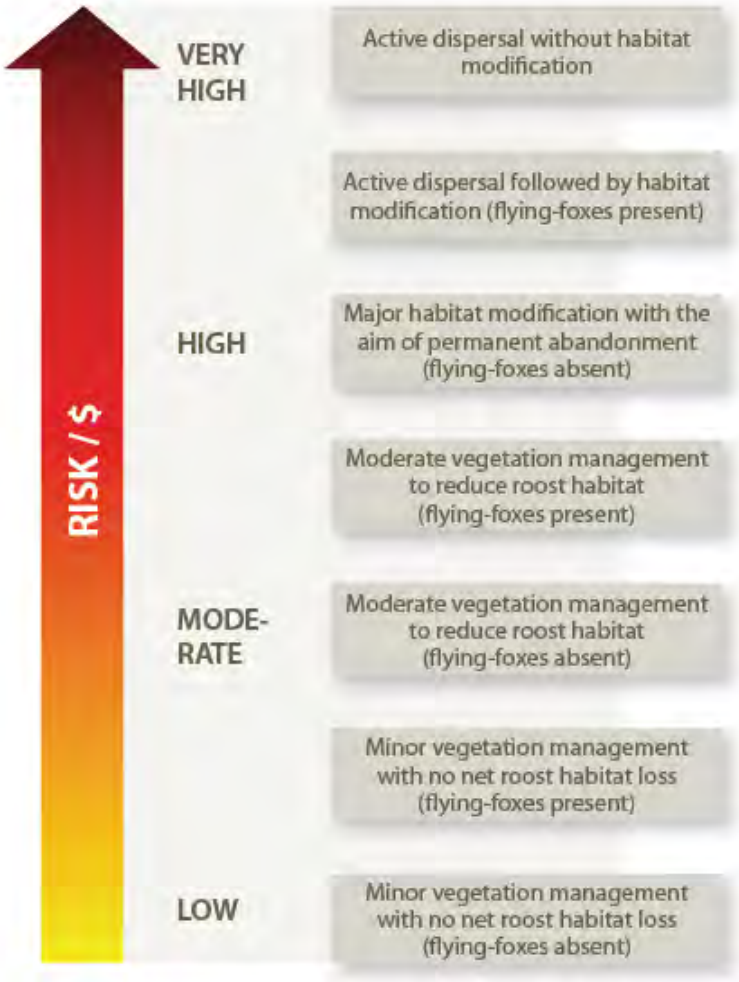

Figure 8 Roost management options - indicative cost and risk (Ecosure 2013)

7 Risk assessment

The following shows a basic risk assessment of the risk associated with the Palmetum with no mitigation measures, and residual risk after mitigation measures are implemented.

7.1 Risk associated with the roost in its current location

Table 7 Risks associated with the roost unmanaged, and residual risk with controls implemented. Refer to Appendix 3 for the risk matrix used to calculate risk scores.

Sensitive site	Risk	Risk score	Residual risk score with controls as per Section 6 and 9
Residential properties	Disease transfer	14*	3
	General hygiene issues	4	3
	Financial loss (including time cleaning)	8	5
	Noise/smell/well-being impacts	8	5
Business – Tumbetin Tea Room	Disease transfer	13*	6*
	General hygiene issues	12	4
	Financial loss (including time cleaning)	16	8
	Financial loss from reduced patronage	8	6
The Good Shepherd Nursing Home	Disease transfer	14*	10*
	Amenity/well-being for patients	7	2
	Financial loss (including time cleaning)	16	8
	Loss of access to recreational asset of Palmetum	12	3
The Palmetum Botanic Garden	Loss of rare & threatened palm species	21	14
	Loss of recreational amenity	12	4

***N.B.** This risk level assumes direct contact with a flying-fox resulting in a bite or scratch. There is no known disease risk from living near a roost.

7.2 Risk of management

The Palmetum site may at times experience impacts as a result of exacerbating impacts at other sites, including the future development at sites as depicted in the urban waterfront masterplan plan (Port of Townsville, 2010).

Table 8 Risks associated with key roost management options, and residual risk with controls implemented. Refer to Appendix 3 for the risk matrix used to calculate risk scores.

Management option	Risk	Risk score (refer to Appendix 1)	Residual risk score with controls as per Section 6 and 9
Education	Nil	N/A	N/A
General mitigation measures	Cost which may not mitigate impacts.	17	9
In-situ management	Moderate cost which may be insufficient to mitigate community impacts.	17	8
	Impact to animal welfare.	17	3
	Inadvertent dispersal	8	3
Dispersal	Impact to animal welfare and flying-fox conservation.	21	18
	Splintering the roost into other locations that are equally or more problematic.	21	21
	Shifting the issue to another area.	21	21
	Increasing disease status and associated public health risk.	22	18
	Impacts to nearby residents associated with ongoing dispersal attempts.	16	16
	Excessive initial and/or ongoing resource and financial investment.	23	23
	Negative public perception and backlash.	17	17
	Impact on habitat value (with significant vegetation management).	23	23

Classification

20-25 = EXTREME
16-19 = HIGH
7-15 = MODERATE
1-6 = LOW

8 Recommendations for key issues

The following section outlines management recommendations for each key issues associated with the Palmetum roost. As can be seen in Section 7, it is considered that impacts can be best managed with fewest risks through in-situ management.

As previously discussed, the COPs do not provide exemptions under all sections of the NC Act or other relevant legislation. As such, TCC will need to consider all ecological and cultural values of any site prior to implementing management activities that may impact on these values.

A detailed plan for any roost management activity is also required to ensure OH&S and animal welfare is properly considered. Importantly for the Palmetum and other sites with several species present, planning will need to carefully consider how impacts to heavily pregnant females/dependent young will be avoided (i.e. while BFF/GHFF breeding is generally in sync, LRFF and SFF are out of sync with BFF/GHFF by a number of months, and therefore depending on roost species composition, dependent young may be present almost all year round).

8.1 Risk to palm collection

The palm collection requires shade provided by the canopy and associated microclimate to survive. As such, protecting the collection is dependent on limiting roosting within palms, and ensuring the canopy is retained and/or provision of alternative shade.

It is recommended that the roost area is split into management zones (e.g. four as shown in Figure 9). Through deterrents, effort should be made to either:

- Restrict flying-foxes from accessing certain areas of the gardens periodically to allow the canopy to recover.
- Permanently restrict flying-foxes from one or two areas of the rainforest habitat, and transplant rare and threatened palms to these areas.

Deterring flying-foxes from these areas can be done using the same methods as discussed in Section 6.1.4. Given the Palmetum already has a network of mid-canopy sprinklers within the rainforest area, it is recommended these be modified as the primary deterrent. Sprinklers would need to be moved up to the top of the canopy, and pressure adjusted so that it is a steady stream of water. The aim of sprinklers is to create a stream strong enough that flying-foxes are deterred from roosting in the area to avoid being hit by the stream, but not strong enough that it would be painful/harm flying-foxes (or other animals) or inhibit their ability to fly. Sprinklers should be used on a random schedule to avoid flying-foxes from habituating to their timing, and not used during fly-in when flying-foxes may be dispersed.

It must be noted that at some times of the year they may be less effective, and could attract flying-foxes on very hot days (appropriate timing of sprinkler use and water pressure should reduce the potential for this).

Further assessment is required to determine the feasibility (e.g. potential to modify current sprinklers, water use in continuing drought conditions, etc.) and cost/benefit of using sprinklers.

A network of wires above the canopy is also considered likely to be effective. However unless a system can be created where wires are easily moved around the canopy, this would only be suitable to permanently deter roosting in key areas. Expert input is required during the planning stage to limit the potential for wildlife entanglement.

As well as installing deterrents in key areas, efforts to provide alternative shade for palms that may be affected by temporary canopy loss in other areas should also be considered. This may include, as already being considered by Council, may include shade cloth and dense planting.

While the provision of artificial roosting habitat has had limited success in the past, it should also be considered in the rainforest area of the gardens to remove pressure from palms and canopy trees during large influxes.

As a long-term measure, planting alternative habitat may also be considered in areas where there are few important palms (or from areas where they could be transplanted elsewhere). The rainforest habitat is by far the most attractive roost habitat on site, and it is unlikely that a more favourable habitat could be created. As such, flying-foxes would need to be discouraged from the rainforest using deterrents and/or nudging.

The palm mapping program initiated in 2005 should include a damage scoring system to evaluate the effectiveness of each mitigation measure.

All other pressures to the canopy trees should be reduced as much as possible. For example, Australian white ibis (*Threskiornis molucca*) should be deterred from the site through nest removal (under a Damage Mitigation Permit issued by EHP), and dispersing them from their roost (using noise/spotlights/lasers etc.). Note that ibis roost dispersal should be done just after last light, and should be avoided if chicks are in nests or flying-fox pups are being crèched.

8.2 Amenity impacts and fear of disease

Community fears and misconceptions about risk can reduced with the provision of educational materials. Education programs may also encourage appreciation of flying-foxes and their key ecological role. A roost education program for the Palmetum roost may include the following:

- Permanent signage. The Palmetum is an ideal location to utilise signage to communicate educational messages to visitors and nearby residents. Several signs could be installed around the rainforest area, at the entrance of the nursing home, and near the entrance of the Palmetum/Tea Rooms. As discussed in the Strategic Review (Townsville City Council 2014), signage should be reviewed to include more detailed and positive information.
- Pamphlets or brochures. This information should be made available to the Nursing Home and Tea Rooms.

- The Good Shephard Nursing Home should be regularly updated regarding ongoing management, which will allow for relevant information to be passed on to residents and their visitors.
- Guided interpretative walks which include the importance and positive aspects of flying-foxes, including the onsite management may be an opportunity to engage with visitors.
- Educational and presentations to management and residents at nearby nursing home. A visit to residents of the nursing home with a live flying-fox may improve resident and family perception of flying-foxes.
- Consider educational presentations and information guides for all Council employees including Councillors, explaining there are no known risks of lyssavirus/Hendra virus from contacting flying-fox excrement, and continue general hygiene practices (including ongoing provision of hand sanitising gel).

While flying-foxes reportedly do not regularly roost in vegetation immediately adjacent to the Nursing Home, a 15 m buffer should be maintained at all times. If flying-foxes do begin to roost in this vegetation, buffers can be created through selective canopy tree trimming, deterrents, or 'nudging'.

The Nursing Home should also be encouraged to implement measures in Section 7.3.

8.3 Loss of income

The Tea Rooms should consider promoting the roost as a tourist attraction. This may include flying-fox themed events (such as Halloween themed events) to generate additional business.

Habitat immediately adjacent to the Tea Rooms is considered of relatively low suitability, and it is unlikely flying-foxes will regularly roost here. However, if required, deterrents or selective vegetation management should be undertaken to provide a buffer to the Tea Rooms outdoor dining area.

Council may also consider subsidies if loss of income is ongoing and significant.

8.4 Restricted visitor/staff access

A significant amount of tree structural damage occurs when large influxes of flying-foxes, especially LRFF are present in the rainforest. There is also concern about flying-foxes overhanging paths and associated faecal drop, and the potential for visitors to come in direct contact with flying-foxes that are roosting low or have fallen (e.g. pups). Options to manage this issue include (and limit potential for faecal drop and visitor fear) include:

- Selective vegetation modification by pruning trees along walkways and/or covering walkways. Clear perspex could be considered to retain visual amenity of the rainforest.
- Consider additional walkways and provision of shade in areas that are not heavily used by flying-foxes.

- Include signage along the path informing visitors not to touch flying-foxes, and include contact details should a flying-fox be found on or near the ground so that visitors do not attempt to assist it themselves.
- Any tree which appears to have structural damage should be spatially marked and staff alerted to avoid the area. Hard hats should continue to be used when staff are working in areas that have been damaged. Trees should be trimmed as required to ensure staff safety.

8.5 Reduced biodiversity

Nest boxes could be installed in areas surrounding the camp to provide alternative nesting habitat for birds that may have been deterred from using the site.

While the reported loss of bird diversity from the Palmetum is unfortunate for visitors, it must be considered in the broad context of the ecological services that flying-foxes provide, which far offset site-specific losses in biodiversity.

A visual summary of on-site recommendations is shown in Figure 9.

Figure 9: Summary of recommended on-site management

Townsville City Council

Management Options – Palmeatum Flying-fox Roost

- Cadastral boundaries
- Roost boundary (Jan 2016)
- Reactive management if required

Initial management

- Roost area and mangement options within
- 10m buffer
- Avoid planting additional flying-fox roost habitat
- Suitable location/habitat for potential planting and improvement

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Author: MED
Date: 12/02/2016

0 10 20 40
Meters

GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994
Units: Meter

PR1169_MP_Fig9_Palmetum_Mgt
A4

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Appendix 1 Human and animal health

Australian Bat Lyssavirus

Australian Bat Lyssavirus (ABLV) is a rabies-like virus found in the four common species of flying-fox. Advice from Queensland Health is that the risk of becoming infected with ABLV is very low (Queensland Health 2015).

Transmission of the virus from bats to humans is thought to be by a bite or scratch, but may have potential to be transferred if bat saliva directly contacts the eyes, nose or mouth. ABLV is unlikely to survive in the environment for more than a few hours, especially in dry environments that are exposed to sunlight (Queensland Health 2015).

Transmission of closely related viruses suggests that contact or exposure to bat faeces, urine or blood do not pose a risk of exposure to ABLV, nor do living, playing or walking near bat roosting areas (Queensland Health 2015).

The disease in humans can easily be prevented by avoiding direct contact with bats. Pre and post-exposure vaccinations are also available that will prevent the disease.

If a person 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 your doctor immediately to arrange for post-exposure vaccinations.

If bat saliva gets into a mucous membrane or open wound, flush thoroughly with water and seek immediate medical advice.

Hendra Virus

Flying-foxes are the natural host for Hendra Virus (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. There is no evidence that the virus can be passed directly from flying-foxes to humans (or dogs) (Queensland Health 2015). 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. Horses are thought to contract the disease after ingesting forage or water contaminated with flying-fox urine, saliva or birthing fluids. Humans contract the disease after close contact with an infected horse. HeV infection in humans is a serious and often fatal disease and there is currently no effective post-exposure treatment or vaccine available for people. The mortality rate of unvaccinated infected horses is approximately 75% (Department of Agriculture and Fisheries ({DAFF} 2013a). Vaccination of horses can protect horses and subsequently humans from infection (DAFF 2013a).

Water supply contamination

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.

Pool contamination

The World Health Organisation guidelines for safe recreational water environments (i.e. recreational swimming pools) considers contamination of pool water from animal faeces a low risk to the public (WHO 2006). The only pathogenic bacteria potentially linked directly to animal faeces found in swimming pools is *Leptospira spp*. (cause of Leptospirosis). Flying-fox are known to carry this bacteria and shed it in their urine (Cox et al, 2005). According to the guidelines outbreak of Leptospirosis from swimming pools is extremely rare and can be prevented by maintaining adequate disinfectant concentrations (e.g. chlorine). Escherichia coli contamination of pools could potentially lead to infections in people but known outbreaks of disease caused by E. coli in swimming pools (as opposed to still natural pools) have been linked to people shedding the bacteria in the pool rather than through contamination from animal faeces (WHO 2006). Further, chemical treatment and filtration of pool water should prevent infections. There is no evidence to suggest that there is any risk from ABLV or HeV from flying-foxes defecating or urinating in pools. ABLV is transmitted through infected saliva or bodily fluids (not urine or faeces) and it does not survive outside of an infected animal for more than a few hours (NSW Health, nd). Hendra virus also has a short life outside of the host and infection is only known through infected horses (Queensland Government, 2014).

WHO (2006) Guidelines for safe recreational water environments Volume 2: swimming pools and similar environments. World Health Organisation. URL: http://www.who.int/water_sanitation_health/bathing/srwe2full.pdf.

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Appendix 2 Dispersal results summary

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

1. In all cases, dispersed animals did not abandon the local area[4].
2. In 16 of the 17 cases, dispersals did not reduce the number of flying-foxes in the local area.
3. Dispersed animals did not move far (in approx. 63% of cases the animals only moved <600 m from the original site, contingent on the distribution of available vegetation). In 85% of cases, new camps were established nearby.
4. In all cases, it was not possible to predict where replacement camps would form.
5. 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.
6. Repeat dispersal actions were generally required (all cases except where extensive vegetation removal occurred).
7. 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 Queensland between November 2013 and November 2014 (the first year since the current Queensland state flying-fox management framework was adopted on 29th November 2013). An overview of findings[5] is summarised below.

1. There were attempts to disperse 25 separate roosts in Queensland (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 Code was introduced has increased by 6,250%.
2. Dispersal methods included fog[6], birdfrite, lights, noise, physical deterrents, smoke, extensive vegetation modification, water (including cannons), paintball guns and helicopters.
3. The most common dispersal methods were extensive vegetation modification alone and extensive vegetation modification combined with other methods.
4. In nine of the 24 roosts dispersed, dispersal actions did not reduce the number of flying-foxes in the LGA.
5. In all cases it was not possible to predict where new roosts would form.

[4] Local area is defined as the area within a 20 km radius of the original site = typical feeding area of a flying-fox.

[5] This was based on responses to questionnaires sent to councils: some did not respond and some omitted responses to some questions

[6] Fog refers to artificial smoke or vapours generated by smoke/fog machines. Many chemical substances used to generate smoke/fog in these machines is considered toxic.

6. When flying-foxes were dispersed, they did not move further than 6 km away.
7. As at November 2014 repeat actions had already been required in 18 cases.
8. Conflict for the council and community was resolved in 60% of cases, but with many councils stating that they feel this resolution is only temporary.
9. The financial costs of all dispersal attempts, regardless of methods used were considerable ranging from $7,500 to more than $400,000 (with costs ongoing).

Appendix 3 Ecosure flying-fox risk matrix

	Potential Consequences					Probability				
Risk Score	**People – Health and Safety**	**Financial**	**Amenity**	**Environment**	**Reputation**	**A – almost certain to happen**	**B – likely to happen at some point**	**C – may happen, but not common**	**D – unlikely to happen**	**E – extremely unlikely to happen**
1 Catastrophic impact	Multiple fatalities/ permanent serious injury to more than 1 person	Could cause catastrophic loss or damage (>$200K)/resident (>$100K)	Disastrous impact; major long term impacts.	Disastrous impact; major long term impacts, long term remediation required, prosecution likely, impact to flying-foxes at a species level.	Lasting damage to reputation; national and international media criticism	25	24	22	19	15
2 Severe negative impact	Single fatality Severe permanent disability	Could cause major loss or damage for business ($100K - $200K)/resident ($10K-$100K)	Serious impact, medium term effects.	Serious impact; medium term impacts, significant remediation likely, prosecution possible, flying-fox fatalities likely/significant welfare impacts likely.	Significant damage to reputation; criticism in national media	23	21	18	14	10
3 Major negative impact	Major injury to one person (> 5 days LTI) Severe health impacts on more than one person	Could cause moderate loss or damage for business ($10K-$100K)/resident ($1K – 10K)	Moderate reversible impact.	Moderate reversible impact, moderate remediation required, prosecution unlikely, flying-fox fatalities may occur/significant welfare impacts may occur.	Significant public criticism; possibility of state media involvement	20	17	13	9	6

	Potential Consequences					Probability				
Risk Score	**People – Health and Safety**	**Financial**	**Amenity**	**Environment**	**Reputation**	**A – almost certain to happen**	**B – likely to happen at some point**	**C – may happen, but not common**	**D – unlikely to happen**	**E – extremely unlikely to happen**
4 Negative impact	Significant injury (< 5 days LTI) Health impacts on more than one person	Could cause minor loss or damage for business ($1K-$10K)/resident (<$1K)	Minor reversible impact.	Minor reversible impact, minor remediation required, prosecution unlikely, single flying-fox fatality may occur/welfare impacts may occur.	Slight negative impact on more than one individual in local community	16	12	8	5	3
5 Minor negative impact	Minor injury Health impacts on one person	Possible minimal loss or damage for business (<$1K)	Negligible, reversible impact.	Negligible reversible impact, no remediation required, prosecution unlikely. Minor flying-fox welfare impacts may occur.	Slight negative impact on an individual in local community	11	7	4	2	1

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