REGIONAL FLYING-FOX MANAGEMENT STRATEGY

TOOWOOMBA REGION

CONTENTS

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PART 1: STATEMENT OF MANAGEMENT INTENT

OBJECTIVES

The key objectives of Toowoomba Regional Council's Flying-fox Management Strategy are to achieve the following:

- manage concerns of residents experiencing lifestyle impacts caused by flying-fox camps in the immediate vicinity of their residences, and in a cost-effective manner;
- conserve and coexist with flying-foxes in the Toowoomba Region;
- manage flying-foxes and their habitat consistent with legal obligations;
- identify and prevent future conflicts with flying-foxes; and
- inform and educate the community about flying-foxes and related matters, and therefore increase community understanding and appreciation.

MANAGEMENT RESPONSIBILITIES

The responsibility to manage flying-foxes lies with the owners of properties on which flying-foxes roost or forage. Council is not responsible for the management of flying-fox colonies on land that is not controlled by Council (e.g. private or State land).

Managers of flying-fox colonies on such land may utilise this document to guide their actions but will need to liaise with the Department of Environment and Heritage Protection as to whether a Flying-fox Roost Management Permit is required. While local governments are able to execute their as-of-right authority to manage flying-fox colonies on private land, and the Department of Environment and Heritage Protection prefers to refer private cases to local government, Council will not plan, coordinate, execute or fund any flying-fox management activities on private land.

Should human-flying-fox conflict arise on both private and Council land, Council may contribute to joint management activities. Such contributions and their extent are at the discretion of Council and will be assessed on a case-by-case basis.

MANAGEMENT APPROACH

In order to minimise risks and costs, Council's preferred management approach is to minimise interference with flying-foxes and their roosts.

Community education

Public information and education programmes will provide factual information about flying-foxes, their ecology and the minimal disease risks to make it easier for residents to live with flying-foxes.

Management of black and grey-headed flying-foxes and mixed-species camps

Age of camp and level of conflict

The approach to managing camps of black and/or grey-headed flying-foxes primarily depends on the age of the camp, and the level of potential conflict at the camp's current location as well as at any surrounding potential roost habitat.

Council's management approach will be designed to minimise the risk of exacerbating impacts on the community and/or transferring impacts to other and potentially more problematic locations.

The decision support tool in Attachment 1 provides assistance in assessing each situation and choosing appropriate responses.

Management of flying-fox roosts at suitable low-conflict locations, irrespective of their age, will aim at protecting the roosts and maintaining these at their current locations. This may include active enhancement of roost habitat to reduce the risk of flying-foxes relocating passively. The roost will be monitored and management actions directed towards maintaining the low-conflict status of the roost site. This includes the application of planning instruments to direct future development near the roost site – even if the roost is not permanently occupied.

More intensive management options, especially dispersal, will only be considered in exceptional circumstances and after careful consideration of associated risks, probability of success and development of a dispersal strategy analysing appropriate methodologies specific to each case.

As it is thought to be easier to manage new roosts before flying-foxes have developed a strong association with the site, early intervention dispersal may be considered for newly established roosts in high-conflict locations. This does not apply to new roosts of nomadic little red flying-foxes – see below.

Should neither regular *in situ* management options (i.e. management that aims at retaining the flying fox camp at its current location) nor dispersal be considered feasible, Council will not proceed with dispersal but may consider alternative options to ameliorate impacts or compensate residents/ businesses for the impacts of flying fox roost sites.

A staged approach

A staged approach will be adopted for all management actions. This is to ensure risks, costs and off-target effects of flying-fox management are minimised. Any management actions at the lower end of the risk/cost scale (see Part 4 of this document) are to be exhausted before more invasive actions are considered.

Where vegetation management is appropriate, weed species will be removed first and trimming or removal of native vegetation will only be considered if weed management is determined to be insufficient.

Management of little red flying-foxes

Due to the temporary nature of little red flying-foxes' presence (see Part 2 of this document for details), Council's preferred management option is to leave roosts of this species in place and allow them to disperse naturally once flowering in the region ceases.

In many cases little red flying-foxes temporarily join camps of black and grey-headed flying-foxes, which prevents active management as the latter species raise young during spring and summer.

Community education about the different species and their ecology, including the transitory nature of little red flying-fox camps, will improve acceptance of temporary camps of little red flying-foxes.

PART 2: BACKGROUND

FLYING-FOXES

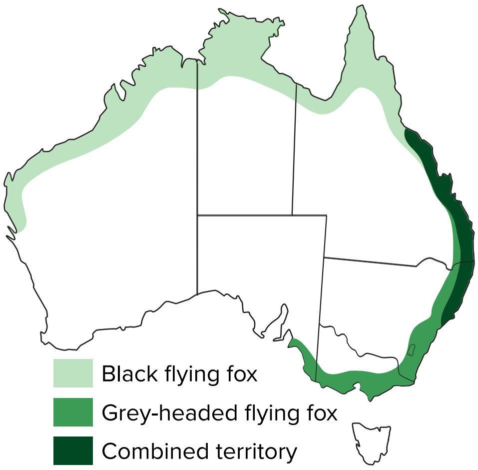
Flying-foxes (also commonly known as fruit bats) are large bats belonging to the sub-order of megabats (Megachiroptera). Unlike the much smaller insectivorous microbats (Microchiroptera), they rely on eyesight and smell (as opposed to echolocation) for orientation and to forage for nectar, pollen and fruit (Churchill 2008).

Of the four species of flying-foxes native to mainland Australia, three occur in the Toowoomba Region. These include the grey-headed flying-fox (*Pteropus poliocephalus*), the black flying-fox (*P. alecto*) and the little red flying-fox (*P. scapulatus*). All three species are protected under Queensland's *Nature Conservation Act 1992* while the grey-headed flying-fox is also listed as 'vulnerable' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

THE SPECIES

Grey-headed and black flying-foxes

Grey-headed and black flying-foxes have an adult wingspan of up to 1 m and a body weight of up to 1 kg (Hall 2002). Both species mainly occupy coastal regions, with grey-headed flying-foxes occurring exclusively in south-eastern and eastern Australia, while black flying-foxes inhabit northern Australia as well as parts of Papua New Guinea and Indonesia (Churchill 2008).



MAP: BLACK AND GREY-HEADED FLYING-FOX DISTRIBUTION IN AUSTRALIA

Both species are canopy feeders, exploiting primarily the blossom of eucalypts and fruit from a wide range of rainforest trees. Blossom and fruit of introduced species, including commercial orchards, also form part of their diet, particularly when native food is scarce (Harden et al. 2004)

A decline in numbers of grey-headed flying-foxes of more than 30% from 1989 to 1999 triggered its listing as 'vulnerable' under the EPBC Act (Hall 2002).

PHOTO LEFT: GREY-HEADED FLYING-FOXES (B. THOMSON)
PHOTO RIGHT: BLACK FLYING FOXES (B.THOMSON)

Little red flying-foxes

Little red flying-foxes weigh up to 500 g and are distributed throughout eastern, northern and north-western Australia, with their range generally extending further inland than black and grey-headed flying-foxes (Vardon and Tideman 1999). They are nearly exclusively nectarivorous, feeding primarily on the blossom of eucalypts (Hall and Richards 2000). The species is highly nomadic, does not occupy stable camps, and generally spends the winter months in northern Australia and spring-summer elsewhere in response to flowering (at which time it may be present in the Toowoomba Region). Little red flying-foxes often temporarily join existing camps of black and grey-headed flying-foxes, may turn up very suddenly and in large numbers and can stay for periods ranging from days to months. Whether and for how long they remain in an area is dependent on the availability of food resources (i.e. flowering eucalypts) at that time (Roberts at al. 2012). Unlike the other two species of flying-fox, little red flying-foxes tend to roost in dense clusters on individual branches, which can cause considerable damage to trees.

MAP: LITTLE RED FLYING-FOX DISTRIBUTION IN AUSTRALIA
PHOTO: LITTLE RED FLYING-FOXES (B.THOMSON)

REPRODUCTION

Flying-foxes start breeding at two to three years of age and females only produce a single offspring per year. This low reproductive rate limits their ability to recover from population declines and makes it impossible for flying-foxes to breed to 'plague numbers' (Australian Museum 2013).

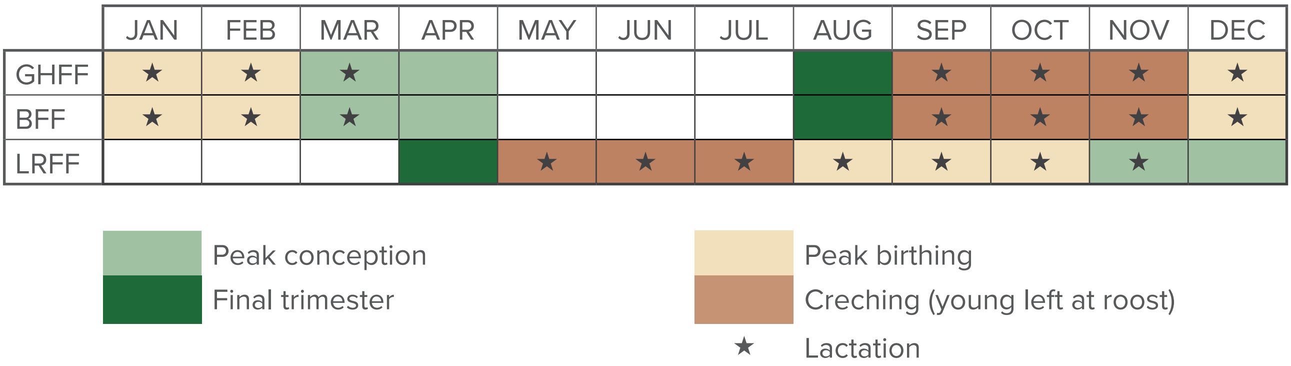
Breeding is seasonal and synchronous, though slight variations occur between locations and years (Queensland Museum 2007). However, in recent years an increasing number of females have been observed giving birth later in the season, considerably extending the time during which dependent young are present in a maternity roost (T. Wimberley, pers. comm.).

PHOTO: LITTLE RED FLYING-FOXES MATING (K.COLEMAN)

Black and grey-headed flying-foxes mate in March/April, with females usually giving birth to a single pup from September - November. Newborn flying-foxes rely on their mothers for food, care and thermoregulation, and are carried on foraging flights for the first three to five weeks of their life. After this period, they are left in crèche trees during the night. At about three to four months of age, young are capable of independent flight and start to accompany their mothers on foraging trips. They are usually weaned when they reach around five to six months of age (Australian Museum 2013).

The reproductive cycle of little red flying-foxes is similar but offset by about half a year (Birt 2005).

FIGURE 1: Indicative flying-fox breeding cycles of grey-headed (GHFF), black (BFF) and little red (LRFF) flying-foxes in Southeast Queensland. Please note, yearly variations and out-of-sync breeding can considerably extend the time frames shown.



ROOSTS

All three species are social animals that roost in communal (and often mixed) camps during the day. Factors influencing camp site selection by flying-foxes are poorly understood; however, they often roost close to permanent water sources in vegetation patches of at least 1 ha in size, and comprising tall emergent trees over a dense mid- and understorey (see also Part 3) (Roberts 2005).

Camps not only provide resting places, but are also important for social interactions, mating and rearing of young. Camps can be occupied permanently, seasonally or temporarily, and the number of occupants often varies throughout the year (McElhinny et al. 2006). In particular, the influx (and departure) of large numbers of little red flying-foxes can contribute to sudden and extreme variations in camp sizes. Fluctuations can also be influenced by seasonal availability of food in the surrounding area as well as the animals' reproductive cycle.

Although not all camps are permanently occupied, their locations are often stable over many years (some have been known to be occupied since before European settlement); however, individual flying-foxes are highly mobile and often travel from camp to camp, sometimes covering hundreds of kilometres (Markus and Hall 2004). New camps are often established as a result of the habitat destruction or harassment of flying-foxes at traditional camp sites (Roberts et al. 2012a).

Recently, 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 (Markus and Hall 2004). Urban areas also may assist navigation, and likely offer protection from predators and persecution at orchards.

Furthermore, the population seems to be fragmenting into many small roosts (likely in part due to human interference at roost sites), compared with few large roosts historically found in natural areas (Fujita and Tuttle 1991).

PHOTO: FLYING FOX ROOST

These factors are contributing to increased human-flying-fox interaction, which often leads to the misconception that flying-foxes are increasing in number.

Flying-foxes often travel considerable distances to reach appropriate foraging habitat, including up to 50 km from their roost in a single night, although feeding usually takes place within approximately 20 km of the camp (Roberts 2005).

Individuals at a roost do not behave as a unit, but rather move independently between a network of roosts within their range. This, in combination with flying-foxes' high mobility and ability to travel long distances, means that each of the three species is considered to constitute a single population across its entire respective range (Roberts et al. 2012a).

ECOLOGICAL SIGNIFICANCE

Flying-foxes play a vital role in the reproductive and evolutionary processes that maintain native forest ecosystems, including a number of commercially important hardwood species (Rose 2011). When feeding on the blossom of eucalypts and other tree species, large numbers of pollen grains are transported in the fur of flying-foxes, pollinating subsequently visited flowers. Feeding on fruit results in small seeds being retained in the digestive system and transported and spread over large areas.

PHOTO: LITTLE RED FLYING-FOX FEEDING ON BLOSSOM (K.COLEMAN)

A number of Eucalyptus species have been found to increase their production of nectar at night, while the flowers of several hardwood species are only receptive for pollination at night. This indicates a strong adaptation of these species to pollination by nocturnal animals such as flying-foxes (Marshall 1993).

While other animals also contribute to pollination and seed dispersal, the high mobility and long distances regularly moved by flying-foxes make them unique in their ability to maintain genetic diversity of forest ecosystems across their range. Flying-foxes are able to easily traverse barriers and link isolated patches of forest, and therefore with ongoing landscape fragmentation their importance as pollinators and seed dispersers will continue to increase (Eby 1995).

The draft national recovery plan for the grey-headed flying-fox identifies over 100 threatened native flora species and ecological communities across Australia that benefit from this species (DECCW 2009).

PHOTO: LITTLE RED FLYING-FOXES ROOSTING IN CASUARINA TREES

THREATS

Historical and ongoing large scale clearing and degradation of forests continue to reduce feeding and roosting habitat for flying-foxes, and as a result are identified as a high priority threat in the draft national recovery plan for the grey-headed flying-fox. Another identified threat to flying-foxes is the persecution and deliberate destruction of large numbers in response to damage to commercial fruit crops (Kirkwood 2002).

The destruction of resources across their range is thought to contribute to flying-foxes becoming increasingly reliant on non-native food species in urban areas, and also splinter large roosts into several smaller ones (Markus and Hall 2004). Furthermore, the majority of flying-fox camps, particularly in Southeast Queensland and New South Wales, are located in areas that have experienced high rates of development and urbanisation in recent decades. This results in more frequent interactions (and therefore conflict) with humans, and may contribute to the perception that numbers of flying-foxes are increasing (Roberts 2005). Negative public attitudes and conflict with humans result in the harassment and killing of individuals. Disturbance and destruction of roost sites are also identified as a threat to flying-foxes in Australia (Thiriet 2010).

HUMAN/FLYING-FOX CONFLICT

In urban areas, conflicts mainly occur when flying-foxes roost in the immediate vicinity of residential developments. People living near flying-fox camps are affected by noise, odour and droppings. The perceived risk of disease and impacts on property values are also of concern to some (Rose 2011).

Noise

Flying-foxes are social animals that use vocalisations to communicate. This includes alarm calls, communication between mothers and their young, calls to settle territorial disputes and as part of courtship (Hall and Richards 2000). Noise levels in camps are particularly high at dusk and dawn when flying-foxes prepare to leave and return from foraging. Flying-foxes may also be heard squabbling over food in backyard trees; however this is unrelated to the location of the roost site and limited to times when food is available.

During the day, flying-fox camps are noisier during the mating season and when the colony is disturbed. Noise at the roost during the night also increases during peak mating and créching seasons. Of the three species, little red flying-foxes tend to be more active and vocalise more than black and grey-headed flying-foxes (Markus and Hall 2004).

The effects of prolonged exposure to noise can range from annoyance to sleep disturbance, which have the potential to impact on the physical and mental health of nearby residence.

PHOTO: OAKEY CREEK FLYING-FOX ROOST

Odour

To mark their territories in a roost and to attract females during the mating season, male flying-foxes rub a scent, produced by their scapular (shoulder) gland, along one to several branches. This behaviour is responsible for the characteristic odour of flying-fox camps, not as often thought, by a build-up of faecal matter underneath the camp (Thomson 2007).

The odour is particularly strong after rain (when males have to remark their branches), during hot and humid weather conditions, and at times when camp abundance is high (for example when large numbers of little red flying-foxes temporarily join a camp).

Juvenile flying-foxes also emit scent, which is thought to help mothers identify their offspring when returning from foraging.

The odour emitted from flying-fox camps is often perceived as offensive to nearby residents and can impact on their general wellbeing.

Droppings

PHOTO: FLYING-FOXES INVERT WHEN DEFECATING IN THE ROOST (K.COLEMAN)

Flying-foxes often defecate during flight. While this mostly happens at their feeding sites, they also tend to defecate immediately after leaving their camp at dusk. This affects nearby residents by soiling property such as outdoor furniture, cars, solar panels and swimming pools. If not removed quickly, droppings can damage and leave a permanent mark on objects.

This problem is exacerbated by flying-foxes feeding on the fruit of the South American cocos palm (*Syagrus romanzoffiana*), which causes their faeces to become particularly sticky (DAFF 2013). Commonly planted as ornamental garden plants, the seeds of cocos palms are spread by flying-foxes (and birds) and have become naturalised throughout Southeast Queensland. This has led to cocos palms being recognised as environmental weeds, although they are not declared pest plants in Queensland.

Perceived Health Risks

Fear of infection by flying-fox borne disease (primarily Australian bat lyssavirus and Hendra virus) is a major contributor to the opposition of many people to living, working or playing near flying-foxes and their roost sites. Like most wildlife (and pets), flying-foxes may carry diseases that can affect humans. Despite this, the risk of infection is extremely low (Francis et al. 2014).

Australian bat lyssavirus

Australian bat lyssavirus is a rabies-like virus that can cause serious illness and death in humans. Transmission of lyssavirus to humans occurs through direct contact of saliva from an infected animal with a skin penetrating bite or scratch, possibly also through exposure of mucous membranes to infective saliva (Francis et al. 2014). Therefore, people should avoid handling flying-foxes in order to minimise the risk of being scratched or bitten.

Queensland Health advise “that contact or exposure to bat faeces, urine or blood do not pose a risk of exposure to Australian bat lyssavirus, nor do living, playing or walking near bat roosting areas.” (Queensland Health fact sheet (2013): Australian Bat Lyssavirus).

Preventive vaccinations are available for people who are regularly exposed to flying-foxes, such as wildlife carers. Effective post-exposure treatment is also available should exposure to an infected animal have occurred.

Only approximately 1% of wild flying-foxes carry Australian bat lyssavirus (Francis et al. 2014).

Hendra Virus

Flying-foxes may also carry Hendra virus, which can be fatal in horses as well as humans. Hendra virus has been suggested to be transmitted to horses through feed and water contaminated with infective flying-fox urine, saliva or birth products. High level exposure to body fluids of sick horses can spread the disease to humans (Smith et al. 2014).

There is no evidence that Hendra virus can be transmitted directly from flying-foxes to humans (EHP 2016)

Effective vaccinations for horses are readily available. Placing feed and water troughs under cover, to prevent exposure to flying-fox urine and body fluids, also helps to reduce the risk of infection to horses.

PHOTO: HORSE AND THE OAKEY CREEK FLYING-FOX ROOST

Other factors

Prolonged or intensive occupation of flying-fox camps often causes defoliation and even death of trees. In particular little red flying-foxes can cause branches to snap when they are present in large numbers and roosting in dense clusters. In large vegetation patches, flying-foxes are able to move around over time, allowing damaged vegetation to recover. As suitable roosting habitat becomes more scarce and available vegetation patches smaller, recovery of damaged vegetation is less possible.

The resulting increase in penetration of light to the ground, in combination with nutrients and sometimes seeds in faeces, can lead to the proliferation of exotic weeds among flying-fox roosting habitat (Roberts 2005).

People living in close proximity to newly established flying-fox camps often also complain about a reduction in birdlife coinciding with the formation of the camp, although there is no rigorous empirical evidence for this claim.

Aircraft strike

Flying-fox camps in the proximity of an airport can increase the possibility of an aircraft strike that can pose a risk to flight safety (Parsons et al. 2009).

LEGAL CONSIDERATIONS

Federal

The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (the EPBC Act) provides protection to 'Matters of National Environmental Significance'. This includes the grey-headed flying-fox, which is listed as 'vulnerable' under the Act.

Consequently, any actions that may have a significant impact on the grey-headed flying-fox need to be referred to the Department of the Environment. The Minister will then determine whether approval is required.

The outcome of the referrals process can be that the proposed action is:

- **Not a controlled action:** The proposed action is unlikely to have a significant impact on matters of national environmental significant and can proceed without further assessment and approval.
- **Not a controlled action – particular manner:** The proposed action is not likely to have a significant impact on matters of national environmental significance if undertaken in the particular

manner outlined in the referral. If conducted in this particular manner the action can proceed without further assessment and approval.
- **A controlled action:** The proposed action is likely to have a significant impact on matters of national environmental significance and further assessment and formal approval is required.

The EPBC Act Policy Statement: **Referral guideline for management actions in grey-headed and spectacled flying-fox camps** (DoE 2015) provides assistance assessing whether an action may require approval under the EPBC Act. For activities at camps not considered *nationally important flying-fox camps*, routine camp management such as mowing or minor trimming of vegetation as well as for activities that apply *best practice mitigation standards* (as outlined in the EPBC Act Policy Statement), referral to the Department of the Environment may not be required.

Nationally important flying-fox camps are defined as those that are or have been occupied by 10,000 or more grey-headed flying-foxes more than once in the past ten years or those that have been permanently or seasonally occupied by more than 2,500 grey-headed flying-foxes every year for the last ten years. These camps are also mapped on www.environment.gov.au/node/16394.

Fees are payable to the Department of the Environment for assessments under the EPBC Act. These include a referral fee of $7,352 (as at 04/2015) and additional fees based on the progress of the assessment and complexity of the specific case.

State

Flying-foxes are protected under Queensland's *Nature Conservation Act 1992* (the NC Act) where all three species occurring in the Toowoomba Region are listed as species of 'least concern'.

However, local governments have the power to interfere with or disperse flying-fox camps within their designated *Urban Flying-Fox Management Areas (UFFMA)* – see Attachment 2. Any such action outside these urban areas, or conducted by non-council entities will require a Flying-fox Roost Management Permit.

Any action has to comply with the *Code of Practice – Ecologically sustainable management of flying-fox roosts* (EHP 2013a). Methods of interference are limited to non-lethal techniques and controls have to be in place to avoid harming or killing a flying-fox. The Flying-Fox Roost Management Guideline (EHP 2013b) provides assistance to assess management options and plan effective and safe management actions.

Councils may be required to publish a *Statement of Management Intent* (SOMI) to declare how they plan to discharge their authority to manage flying-fox roosts in their urban areas. Development of a regional flying-fox management plan can, if endorsed by the Department of Environment and Heritage Protection, expand a council's management authority beyond the designated UFFMA for a period of three years.

The *Vegetation Management Act 1999* regulates the clearing of remnant and regrowth native vegetation on state land. Clearing of such vegetation needs to be exempt or a development permit must be applied for. This needs to be considered and relevant maps indicating areas of such vegetation will need to be reviewed should vegetation management be proposed as a tool to manage flying-fox roosts.

Routine management activities at a flying-fox camp, such as mowing or minor tree trimming, is permitted provided these are compliant with the *Code of Practice – Low impact activities affecting flying-fox roosts* (EHP 2013c).

PART 3: LOCAL SITUATION

KNOWN ROOST SITES

The locations of known roost sites within the Toowoomba Region and surrounding local government areas are mapped in Figure 2 (page 14).

Kearneys Spring

This roost is located in Kearneys Spring Park on Spring Street, in-between the Kearneys Spring sporting fields and the Murray Clewett Wetlands. This park is managed by Toowoomba Regional Council.

The roost established in the University of Southern Queensland's Japanese Gardens from where it relocated to Kearneys Spring following vegetation management. Since then, the roost has been permanently occupied by black, and at most times, also grey-headed flying-foxes. Little red flying-foxes have temporarily joined the roost during summer in some years. Recorded numbers generally fluctuate between several hundred and approximately 3,000 grey-headed and black flying-foxes. Several thousand little red flying-foxes may temporarily join the camp during summer.

The distance to the nearest residential structures is just under 100 m, and few if any complaints have been recorded from residents. This is probably the result of buffering afforded by Spring Street and a section of sparsely vegetated parkland.

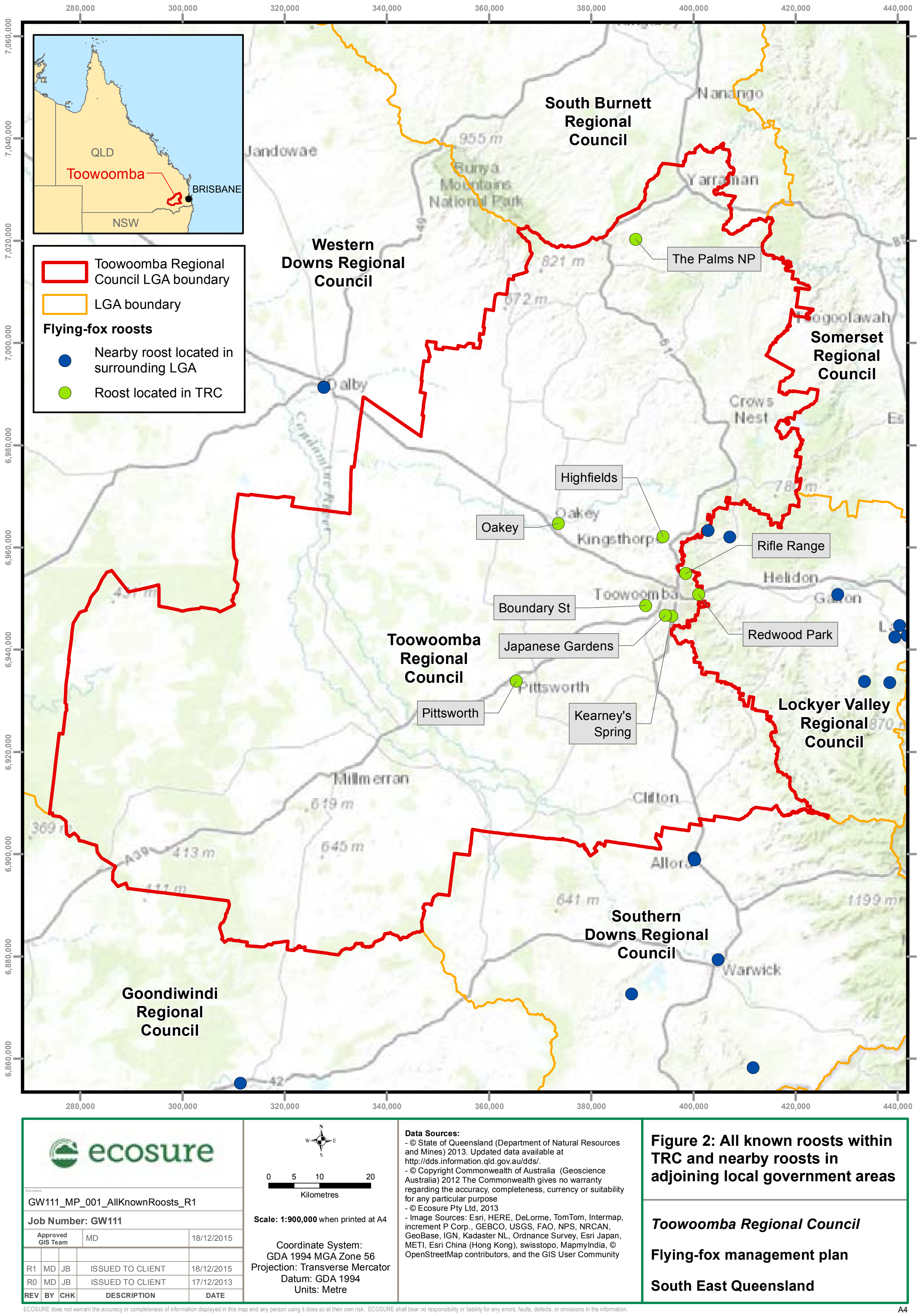
In winter 2014 selective tree removal and an active dispersal campaign moved the entire roost population – presumably to nearby Redwood Park. However, in early summer flying-foxes returned to Kearneys Spring Park.

A source of conflict at this roost is the park's use by the Toowoomba Live Steamers, a community group that operates a miniature steam train in the park. The Toowoomba Live Steamers report a drop in visitor numbers, leading to a decrease in income, since the flying-fox roost established in the park. In early 2015 Toowoomba Regional Council decided to relocate the miniature train operations to an alternative location in Lemway Avenue Park.

Kearneys Spring Park is one of only very few areas identified as suitable potential habitat of sufficient size in the Toowoomba city area – see Figure 2.

PHOTOS: KEARNEYS SPRING PARK FLYING-FOX ROOST

FIGURE 2: All known roosts within the Toowoomba Region and nearby roosts in adjoining local government areas.



Highfields

The current roost (Woolmer Road West) is located in a gully between Woolmer Road and Jackson Close/Holly Avenue. The majority of the roost is in the council-owned Woolmer Road Open Space, however, it extends onto private property in the north.

The roost established in 2013 approximately 150 m southeast of its current location (Woolmer Road East) but active dispersal and vegetation management in 2014 moved the colony. The roost comprises mainly black and grey-headed flying-foxes, with occasional temporary influxes of little red flying-foxes during summer. Recorded numbers have ranged from less than 100 just after the roost established, up to a maximum of 7,500 (which included 5,000 little red flying-foxes). While it had been occupied year-round in the first two years of its existence, the roost was empty during winter and spring of 2015.


PHOTO: HIGHFIELDS FORMER FLYING-FOX ROOST SITE

To the east the closest residential structure is approximately 70 m from the current roost site (Woolmer Road West), to the south approximately 115 m. Vegetation has been trimmed to create a buffer east of the roost.

Prior to dispersal, residents, some of whom had flying-foxes roosting less than 20 m from their houses, had reported sleep deprivation and psychological impacts, particularly associated with the noise and smell of the colony.

Oakey

This roost is located on state-owned land on the banks of Oakey Creek between Campbell and Cunningham Streets.

According to local residents, the roost has existed for more than 15 years. It comprises mainly small numbers of black and grey-headed flying-foxes (at most times several hundred), which may be temporarily joined by up to several thousand little red flying-foxes during summer.

Low numbers of flying-foxes present during most of the year have little impact on neighbouring residents and the operation of nearby Kelly's Motel. However, during peak occupancy by little red flying-foxes, the roost spills onto private properties causing disturbance and potentially loss of income at Kelly's Motel, particularly associated with noise and smell.

In 2014, vegetation was removed to create a buffer between private residences, the motel and the flying-fox roost site. An active dispersal campaign temporarily reduced numbers but did not result in the abandonment of the roost.



PHOTOS: OAKEY CREEK FLYING-FOX ROOST

Redwood Park

This roost has usually been occupied by several hundred black and/or grey-headed flying-foxes with periods of complete vacancy particularly during summer when no permanent water source is available and Redwood is usually hotter than Toowoomba. Numbers temporarily increased to several thousand in winter 2014 during active dispersal at roosts in Toowoomba and Gatton. In winter 2015 numbers ranged between 1,000 and 8,500 black and grey-headed flying-foxes.

While the roost generally occupies a core area of the park, it expands in area in response to occupancy and also moves around within Redwood Park.

Being entirely surrounded by bushland in a Council-managed bushland park, this is currently a no-conflict roost site.

An environmental volunteer group is active in Redwood Park, controlling weeds and restoring the native ecosystem adjacent to and within the flying-fox roost area.

Rifle Range

Between 2007 and 2011 several thousand black and grey-headed flying-foxes were recorded on the former Rifle Range property (currently owned by the Department of Defence) at the base of Toowoomba's eastern escarpment. In 2012 the roost site was recorded as being vacant and monitoring was discontinued. Attempts to locate the roost in 2014 were unsuccessful and it is possible that the roost was abandoned due to vigorous growth of cat's claw creeper, which is now smothering the canopy - see photo below.

Being entirely surrounded by bushland this is a no-conflict roost site.

The Palms NP

The Palms is a small National Park near Cooyar, which has been monitored since 2003. It supports a large permanent colony of black and grey-headed flying-foxes with records of more than 30,000 individuals. Little red flying-foxes have rarely joined the roost.

This is a low-conflict roost and is classified as a nationally important camp for the grey-headed flying-fox under the EPBC Act Policy Statement - Referral guideline for management actions in Grey-headed and Spectacled flying-fox camps (DoE 2015).

PHOTO: CAT'S CLAW CREEPER SMOTHERS THE CANOPY AT RIFLE RANGE

Boundary Street

This flying-fox camp is located along Spring Creek near the corner of Drayton-Wellcamp Road and Boundary Street South, southeast of the Drayton quarry. The camp is largely located within the creek corridor, however might extend onto private property in the south and the Council-owned Euston Road Open Space in the north. Monitoring of this camp only started in early 2014 and reported small numbers of black and little red flying-foxes and long periods of vacancy.

The closest residential structure is just over 100 m from the roost site and the home owners attest that the flying-foxes do not cause any conflict (D. Edwards pers. comm.).

Pittsworth

In late 2012 a colony of black flying-foxes established in a private backyard in Short Street, Pittsworth. Numbers fluctuated between several hundred to a maximum of 2,000, with hundreds of grey-headed and little red flying-foxes temporarily joining. In 2013, a community-led active dispersal campaign was followed by removal of roost trees, which moved the flying-foxes on from that location.

In 2014 an unknown number of flying-foxes – species unknown – started roosting in a private backyard in Aster Street in Pittsworth. It appears that lopping of trees resulted in the abandonment of this roost site.

Japanese Gardens

Between several hundred and 1,800 flying-foxes roosted in the University of Southern Queensland's Japanese Gardens between 2007 and 2009. These animals comprised primarily of black flying-foxes with grey-headed and little red flying-foxes joining the roost at times.

Removal and trimming of roost trees prompted the flying-foxes to relocate, ultimately to Kearneys Spring Park. Nevertheless, anecdotal evidence suggests that very small numbers of flying-foxes continue to occasionally roost in the Japanese Gardens.

PHOTO: KEARNEYS SPRING PARK FLYING-FOX ROOST

POTENTIAL ROOSTING HABITAT

While factors influencing roost site selection by flying-foxes are still poorly understood, vegetation structure, proximity to a water course or body, and size of the vegetation patch, topography and elevation are thought to play an important role (Roberts 2005). The latter two criteria appear to be of minor importance in the Toowoomba Region, compared to coastal areas.

Figures 3-6 show potential roost habitat in the Toowoomba Region that comprise vegetation parcels of suitable Regional Ecosystems (RE) at least 1 ha in size, located within 500 m of a water source and occur in areas of less than 25% incline.

It is important to note that several known roost sites in the Toowoomba Region occur in areas that do not satisfy these criteria, suggesting that other, so far unknown, factors are relevant for the selection of roost sites by flying-foxes.

Little red flying-foxes, which only stay at a roost temporarily, are much less selective with regard to their roost sites than black and grey-headed flying-foxes. They often join existing roosts of other species but are also commonly known to roost in isolated trees (Marcus and Hall 2004).

SUITABILITY CRITERIA

Choice of management options for a flying-fox colony will depend on the suitability of the site and therefore the level of potential conflict at that location.

In order to assess the level of potential human/flying-fox conflict, aspects such as the distance to the roost site and therefore the likelihood of conflict, the number of residences impacted, and the size of the flying-fox camp and its potential to expand need to be considered on a case-by-case basis.

Whether human/flying-fox conflict is likely to occur largely depends on the roost's surrounding land use. A flying-fox roost within less than 50 m of a residential structure, susceptible business or other incompatible land use (e.g. child care centre, equine facility) may be considered to be likely to cause human/flying-fox conflict. A separation distance of 50 – 300 m may result in conflict while it is unlikely that a roost > 300 m away will result in conflict (SEQ 2012).

Figures 3-6 identify the likelihood of conflict at potential roost habitat in the Toowoomba Region based on the distance to known building footprints.

In addition, proximity to an airport and increased risk of aircraft strike may affect the suitability of a site for roosting flying-foxes.

While general guidelines such as these can be used for an initial assessment, it is important to note that a case-by-case assessment is required to appropriately determine the potential for conflict and suitable management options at a particular location.

PHOTO: FLYING-FOXES TAKE FLIGHT (K.COLEMAN)

FIGURE 3: Potential flying-fox habitat and likelihood of conflict in Toowoomba Region.

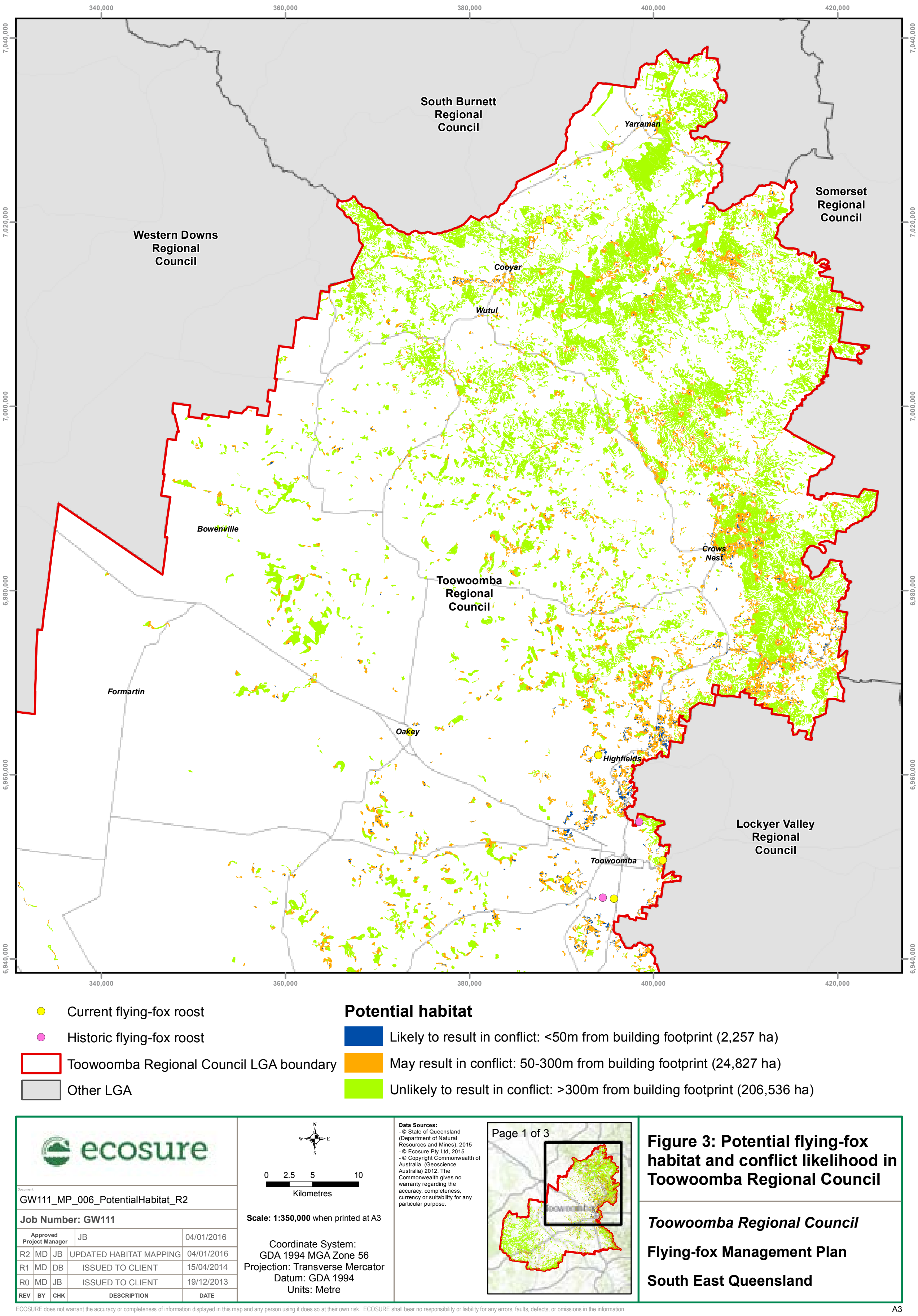
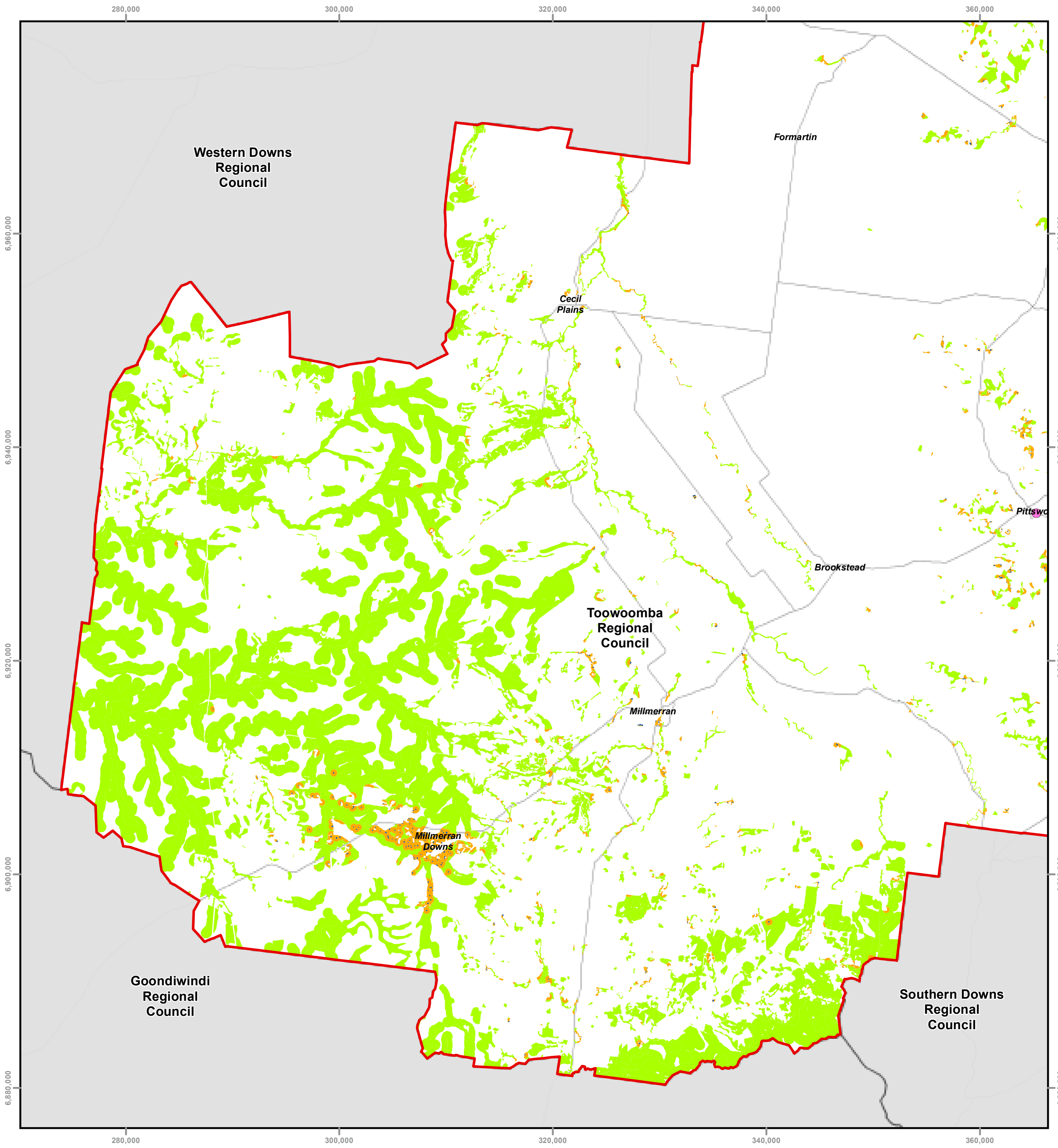


FIGURE 4: Potential flying-fox habitat and likelihood of conflict in the Toowoomba Region.



- Current flying-fox roost
- Historic flying-fox roost
- Toowoomba Regional Council LGA boundary
- Other LGA

Potential habitat

- Likely to result in conflict: <50m from building footprint (2,257 ha)
- May result in conflict: 50-300m from building footprint (24,827 ha)
- Unlikely to result in conflict: >300m from building footprint (206,536 ha)

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Document
GW111_MP_006_PotentialHabitat_R2

Job Number: GW111

REV	BY	CHK	DESCRIPTION	DATE
Approved Project Manager			JB	04/01/2016
R2	MD	JB	UPDATED HABITAT MAPPING	04/01/2016
R1	MD	DB	ISSUED TO CLIENT	15/04/2014
R0	MD	JB	ISSUED TO CLIENT	19/12/2013

N W E S

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Kilometres

Scale: 1:350,000 when printed at A3

Coordinate System:
GDA 1994 MGA Zone 56
Projection: Transverse Mercator
Datum: GDA 1994
Units: Metre

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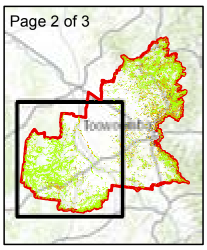


Figure 4: Potential flying-fox habitat and conflict likelihood in Toowoomba Regional Council

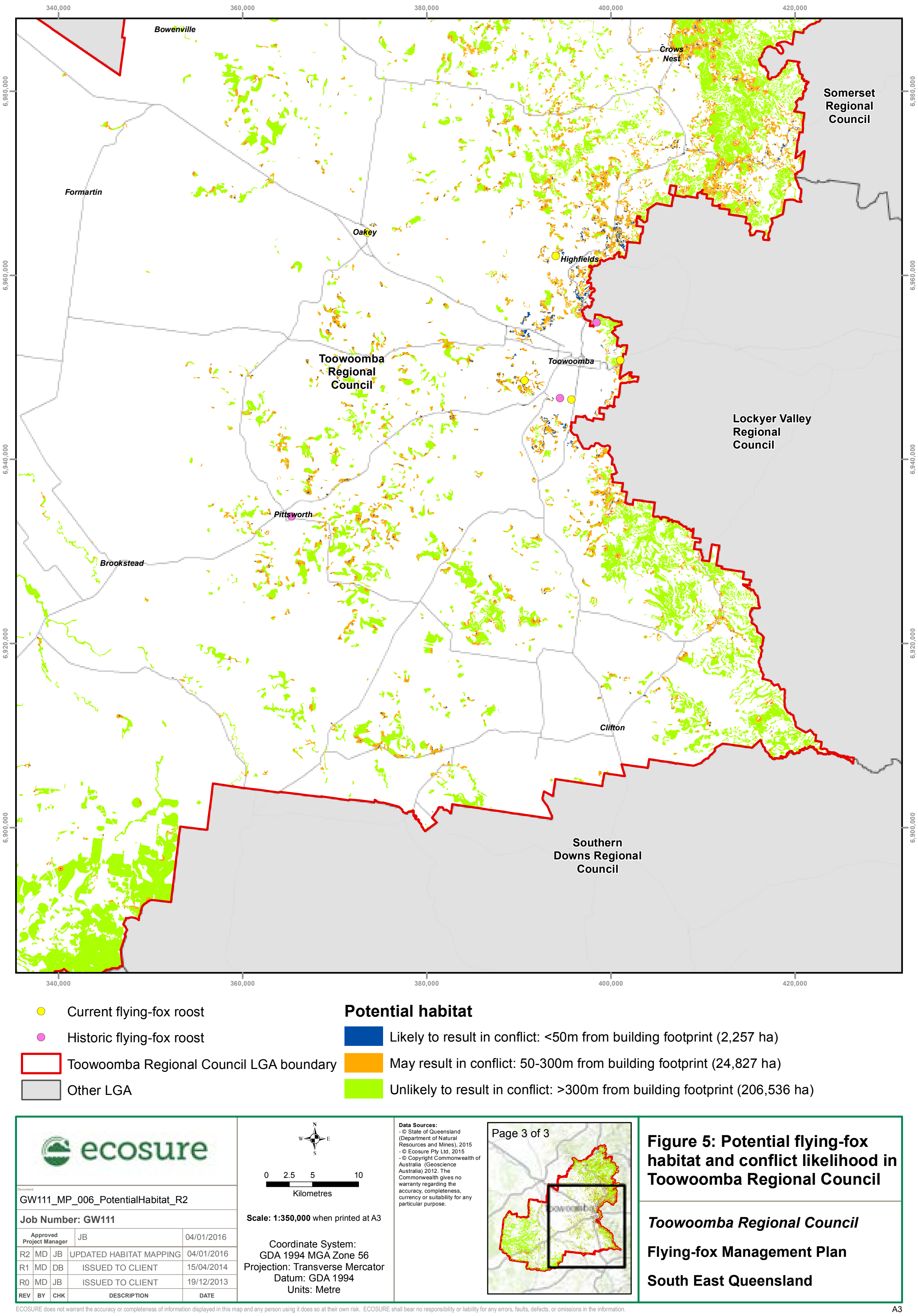
Toowoomba Regional Council

Flying-fox Management Plan

South East Queensland

A3

FIGURE 5: Potential flying-fox habitat and likelihood of conflict in the Toowoomba Region.



PART 4: FLYING-FOX AND ROOST MANAGEMENT

MANAGEMENT OPTIONS

Several options exist to manage flying-fox camps and are listed in this section; however, not all of these are appropriate in the Toowoomba Region or in every situation. The suitability of management options needs to be assessed on a case-by-case basis through an ecological risk assessment and a cost-benefit analysis.

The decision support tool in Attachment 1 provides assistance in determining appropriate responses. For a detailed discussion of the suitability of these options please refer to Attachment 3.

Management options that aim at retaining a flying-fox camp at its current location are collectively also referred to as *in situ* management options.

Do nothing

The ‘do nothing’ approach means that the flying-fox camp remains undisturbed and that no active or pro-active management of flying-foxes, the roost site or related community concerns takes place.

Community education

Many human/flying-fox conflicts are, at least in part, a result of misinformation about flying-foxes, their ecology and the risk they represent to humans.

An effective education programme providing accurate, factual information about flying-foxes, their ecology, perceived vs. actual health risks and other relevant topics is likely to increase understanding of the animals and reduce conflict.

Education may be used in isolation to mitigate community concern, and will also form a key component of the management strategy should roost intervention be required.

EXAMPLE: FLYING-FOXES OF SE QUEENSLAND BROCHURE

Creation of buffer areas

PHOTO: PLANTING OUT BUFFER ZONES (S.FRENCH)

Vegetation around the edges of existing or historically used camp sites may be modified to create buffers between a flying-fox camp and surrounding residences/businesses, which may assist ameliorating amenity impacts. These buffer areas may be planted and maintained with low shrubs, mown grass, or mulched to maintain visual amenity but prevent its use as flying-fox roost. This can be an effective management option if a sufficiently large area is available to accommodate the buffer without significantly impacting on the flying-fox camp. Enhancement of the roost vegetation in other, low-conflict areas of the camp may compensate for loss of roost trees in the buffer.

Buffers provide a tool to ameliorate impacts on adjacent residents while avoiding the costs and risks associated with more invasive management options.

While removal of vegetation at the edge of a flying-fox camp can be effective in preventing flying-foxes from roosting close to human residences, it is important to consider the noise and visual barrier that this vegetation may provide. In some instances residents have reported increased noise impacts from the flying-fox roost after buffering was completed (K. Hofmeister, pers. comm.). Selectively removing/trimming preferred roost trees in the buffer area rather than complete removal of vegetation will assist in preventing this from occurring.

Given the potential negative impacts associated with removing vegetation, the width of buffers will be kept to a minimum, particularly at camps which only create conflict during rare times of peak occupancy. To reinstate noise barriers in the long term, a narrow screen of dense vegetation unsuitable as roost habitat can be planted. In some instances the suitability of artificial noise barriers, as found along highways, can be explored.

Alternatively, deterrents such as canopy-mounted sprinklers may be considered to discourage flying-foxes from roosting in buffer areas. See also Attachment 7 for a summary of deterrents trialled at the Royal Botanic Gardens in Sydney.

Enhancement of existing low-conflict habitat

Planting or bush restoration in and around existing low-conflict camp sites to enhance habitat and its carrying capacity, may entice flying-foxes to preferably use these camps.

Flying-fox camps are often stable throughout time even though individuals move between multiple camps. Consequently, any camp site is known to a larger number of individuals than those actually occupying the camp at any one time (Roberts et al 2012a). This increases the potential as a management tool for increasing the capacity of existing camps in low-conflict areas. Making available roosting habitat at an existing camp in close proximity to a ‘conflict roost’ could increase the likelihood of flying-foxes resettling at the former should the latter be dispersed.

The author is not aware of any successful attempts to create habitat through the use of artificial roosting structures. Therefore, planting trees and restoring favourable habitat characteristics (i.e. removing weedy vines) appear to be the only feasible options to improve existing camps. Planting is a long-term management option, taking several years to become effective.

Habitat improvement work needs to be carefully planned to ensure existing buffers, and therefore the camp’s low-conflict status, are maintained if camp abundance increases. Similarly, restoration must be carefully planned to avoid disturbing flying-foxes, and so that desired roost characteristics are retained (for example, by staging removal of a weedy midstorey).

Planning instruments

The locations of flying-fox camps usually remain the same throughout time, even though they might not always be occupied (Roberts et al 2012a). Many of today's human/flying-fox conflicts were created by developing land immediately adjacent to flying-fox camps. To avoid or reduce future conflicts at yet to be developed sites, planning instruments could be employed to appropriately separate incompatible development from current or historic flying-fox roosts. Options include the use of zoning/overlays to identify known current and historic roost sites, implementing appropriate buffer areas around roosts that have the potential to become problematic due to future residential development, implementing controls outside buffers to allow for the movement of flying-fox colonies or conditioning development applications to be 'flying-fox friendly'.

A note in the land title register for properties near existing or known historic flying-fox camp sites will avoid conflict with owners who purchased properties without any knowledge of the flying-fox camp.

Incentives/Compensation

Residents living in the immediate vicinity of flying-fox camps, and who are severely impacted, may be offered financial compensation or subsidies to building modifications to help ameliorate the impacts.

Financial compensations may be in the form of rate reductions or subsidies for double-glazing windows and air-conditioning to minimise the impact of noise and smell, or provision of outdoor shade structures to reduce the impact of faecal droppings on outdoor living areas.

It will be difficult to decide 'where to draw the line', i.e. who is affected and eligible for compensation and who is not. There might be an expectation that ongoing costs, such as electricity for air-conditioning, should also be met and, over time, residents may feel that provided compensation is not sufficient and start to lobby against flying-fox camps again. These potential issues need to be addressed before this option will be considered.

Purchase of properties

In extreme cases, where severe impacts of a flying-fox camp on a limited number of residents cannot be ameliorated appropriately, Council may offer to purchase the affected properties at market price.

This will immediately resolve conflict with the outgoing property owners and allow Council to either utilise the purchased property/properties internally or rent them out to tenants more accepting of the flying-fox roost.

PHOTO: WOODEND NATURE CENTRE IN IPSWICH CITY COUNCIL IS AN EXAMPLE OF A SUBURBAN HOME BEING TURNED INTO A COMMUNITY EDUCATION CENTRE (S.FRENCH)

This management option will only be considered in extreme cases. Should the property owner(s) reject the offer to sell, Council will not consider invasive alternative management options (such as dispersal) that will cause significant, potentially ongoing, costs to council and risk spreading conflict to multiple other locations.

Dispersal

Dispersal refers to any non-lethal activities aimed at encouraging flying-foxes to abandon problematic camps, or significantly reduce the level of occupancy at these. This can be attempted by either or a combination of the following methods:

- Habitat removal: removal of all roost vegetation to render the camp unusable by flying-foxes.
- Habitat modification: selective removal or trimming of vegetation from within the camp to render it unattractive to flying-foxes.
- Active disturbance of flying-foxes using techniques such as noise, smoke, visual deterrents or water sprinklers.

Dispersal of problematic flying-fox camps is often considered a preferred solution by many. However, the long-term stability of camp sites combined with high turnover of individuals, and the inability to predict or control where dispersed flying-foxes will relocate to, render dispersal rarely successful in resolving conflict (Hall 2002). Often, dispersal proves to be very expensive (Roberts & Eby 2013, Winter et al. 2014).

In some cases it is possible to move a high-conflict flying-fox roost a short distance to a lower-conflict location by gradually ‘nudging’ it along a continually vegetated corridor (e.g. a creek corridor) (SEQ 2012). This requires coordinated disturbance along the desired movement path of the flying-fox roost over a period of several days or weeks, and some level of maintenance disturbance or deterrents is generally required to prevent flying-foxes re-establishing at the original location (J. Bracks, pers. comm.).

By providing some control over flying-fox movements, this approach reduces the risk of the roost relocating to other high-conflict locations. Nevertheless, flying-foxes may still abandon the new roost site if it is not suitable. If vegetation at the original roost site is not modified, the likelihood of recolonisation is high.

Numerous dispersal attempts have been made in the past. The following patterns are apparent (Winter et al. 2014; Roberts & Eby 2013):

- Dispersal actions need to be ongoing, often over periods of several years
  - an extreme example of this is a flying-fox colony at Maclean, NSW, which, after more than 23 separate dispersal attempts over more than 15 years still occupies the initial camp site. Dispersal activities resulted in the creation of several additional high-conflict splinter colonies
  - the successful dispersal of flying-foxes from the Royal Botanical Gardens in Melbourne and Sydney took six and twelve months, respectively, and still requires ongoing management to prevent re-establishment
  - many camps were abandoned temporarily but flying-foxes returned at a later date.
- Costs of dispersal are often considerable and much higher than anticipated (data as of 2014)
  - ongoing dispersal since 2000 at Charters Towers, QLD, caused costs in excess of $500,000 and has been unsuccessful
  - costs of flying-fox dispersal from the Royal Botanical Gardens in Melbourne and Sydney amounted to $3 million and $1 million, respectively
  - $117,000 spent in Singleton, NSW, has not resolved conflict
  - flying-fox dispersal in Maclean cost more than $400,000 from 1999 – 2007 which included 23 dispersal attempts (Roberts et al 2011)

- It is not possible to predict or control where flying-foxes might choose to relocate. Often several new camps are established as a result of dispersal, many at equally or even more unsuitable locations.
- In most cases dispersed animals move less than 600 m and no more than 6 km, often establishing new camps in the immediate vicinity.
- Dispersal rarely resolves human-flying-fox conflict, mostly just moving it elsewhere and often exacerbating it. Often several new camps are established in similarly unsuitable locations – with the initial camp frequently remaining occupied (Hall 2002). This can lead to a larger number of people being affected.

A summary and review of past dispersal attempts is available in Attachment 4 and several dispersal case studies are described in Attachment 5.

Dispersal by habitat removal or modification

Destruction of all roosting habitat within the roost area will render a camp unusable and prevents flying-foxes from returning to the site.

Selectively trimming or removing parts of the roost vegetation can sometimes cause flying-foxes to abandon a camp, or parts of a site. Works can include trimming or removal of individual roost trees or modification of the mid- or understorey to alter the microclimate at the site. Often significant modification is required to be effective (SEQ 2012).

It is generally not possible to control where flying-foxes will choose to relocate to (Winter et al. 2014; Roberts & Eby 2013). Hence this option can provide a solution for issues at the initial camp (if dispersal is successful) but conflict is likely to be created in the surrounding area (at potentially equally or even more unsuitable locations) (Perry 2012). If dispersal includes habitat removal, unwanted outcomes cannot be reversed in the short to mid-term.

Loss of amenity and habitat for other wildlife are also negative side-effects of this option.

Habitat removal or modification cannot take place while flying-foxes are present in the camp. Works can take place at night after flying-foxes have left the camp (given no dependent young were left behind), during times of flying-foxes' seasonal absence from a camp, or immediately following dispersal by disturbance if flying-foxes are absent and have not attempted to re-colonise the camp.

Dispersal by Active Disturbance

Disturbance uses auditory, olfactory, visual and sometimes physical stimuli to make flying-foxes feel uncomfortable and cause them to leave the camp. Many different techniques have been trialled in the past with mixed results (see discussion of methods in Attachment 6).

Most flying-fox dispersals are drawn out and expensive exercises with overall limited success (Winter et al. 2014; Roberts & Eby 2013). This has to do with the high turnover of individuals at camp

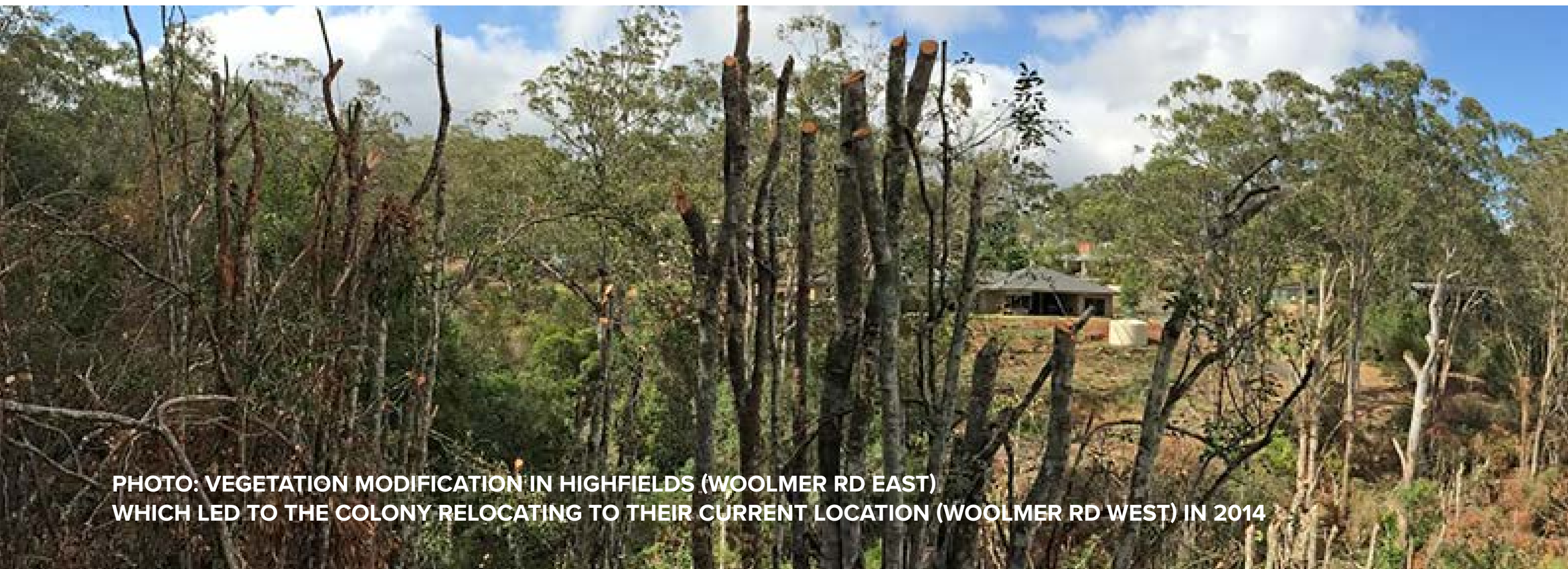


PHOTO: VEGETATION MODIFICATION IN HIGHFIELDS (WOOLMER RD EAST) WHICH LED TO THE COLONY RELOCATING TO THEIR CURRENT LOCATION (WOOLMER RD WEST) IN 2014

sites meaning that new animals constantly arrive at the disturbed camp (Roberts et al. 2012b), and that individuals often show a high level of fidelity to previously used roosts.

As it is impossible to accurately predict or control where the dispersed animals will choose to relocate, often new camps are established at equally unsuitable locations (Perry 2012). If the original camp is then recolonised (which it often is), this creates a situation in which conflict is exacerbated and more people are affected than before dispersal (Thiriet 2010).

The stress caused to the animals has previously been shown to result in abortion of foetuses and separation of dependent young from their mothers leading to death by starvation. Therefore dispersal may not take place while highly pregnant females or dependent young are present in a colony. This is to be assessed on a case by case basis but the time window available for active management generally is between May and July for grey-headed and black flying-foxes and between January and March for little red flying-foxes (Birt 2005).

Monitoring of the colony and animal welfare before, during and shortly after any dispersal activities is required. Ongoing monitoring of the initial camp site and surrounding areas is required to be able to respond quickly to any attempts of resettlement or establishing splinter roosts.

Early intervention dispersal

Intervening with establishing or newly established flying-fox camps is thought to be much easier and more likely to succeed than the dispersal of established camps (J. Bracks, pers. comm.).

To respond promptly, strategies of action will need to be in place (including consideration of legislative implications of possible intervention techniques) and likely roost habitat will need to be monitored regularly to detect newly forming colonies at unsuitable locations.

Provision of alternative roosting habitat

This includes planting of (fast-growing) trees or erection of artificial roosting structures to attract flying-foxes to areas that have no or low potential to create conflict.

To date, factors influencing camp site selection by flying-foxes are poorly understood, and attraction of flying-foxes to a specific location has very rarely been achieved (Roberts 2005).

Culling

This includes planting of (fast-growing) trees or erection of artificial roosting structures to attract flying-foxes to areas that have no or low potential to create conflict.

To date, factors influencing camp site selection by flying-foxes are poorly understood, and attraction of flying-foxes to a specific location has very rarely been achieved (Roberts 2005).

RISK & COSTS

The biggest risk associated with flying-fox management actions is the uncertainty of outcomes. Flying-foxes are highly mobile and their behaviour and ecology is poorly understood (Roberts et al 2012b, Westcott and McKeown 2004). Therefore, their reaction to any interference is difficult to predict or control, which can lead to unexpected outcomes that potentially worsen the situation and greatly increase costs.

The risk of unexpected outcomes increases with the level of intervention, as do the costs (EHP 2013b). See Figure 6 below. Consequently, it is prudent to exhaust options at the lower end of the scale of invasiveness (such as community education, creation of buffer areas) before more drastic, risky and expensive options (such as dispersal) are considered.

Active dispersal or removal of roost vegetation often creates splinter colonies at locations nearby (Roberts & Eby 2013). As it is generally not possible to control where flying-foxes relocate to, there is a considerable risk that new roost sites are established in equally unsuitable locations (Queensland Museum 2007). As a result, conflict may be spread to additional locations requiring costly follow-up management (Hall 2002).

A further risk associated with dispersal is the potential for litigation should dispersal activities lead to a significant incident (i.e. aircraft strike). Council may also be made legally responsible for impacts by splinter colonies created as a result of active management interventions elsewhere (LGAQ 2013).

Planning of any management activities must not consider the existing conflict in isolation but needs to assess the type, likelihood and severity of conflict that may be created elsewhere as a result of management actions.

FIGURE 6: Relationship between level of intervention of flying-fox management actions and their risk/costs

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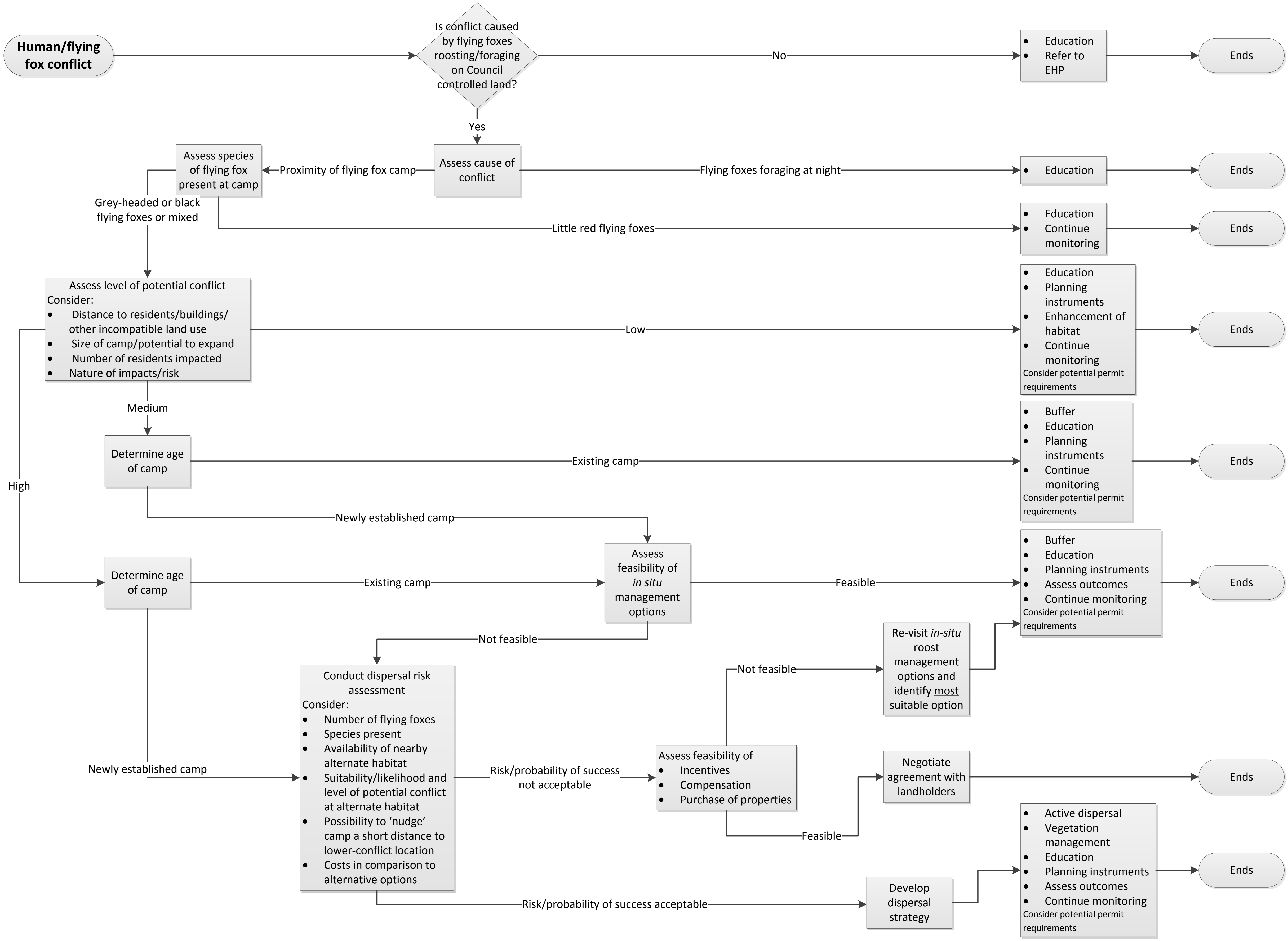
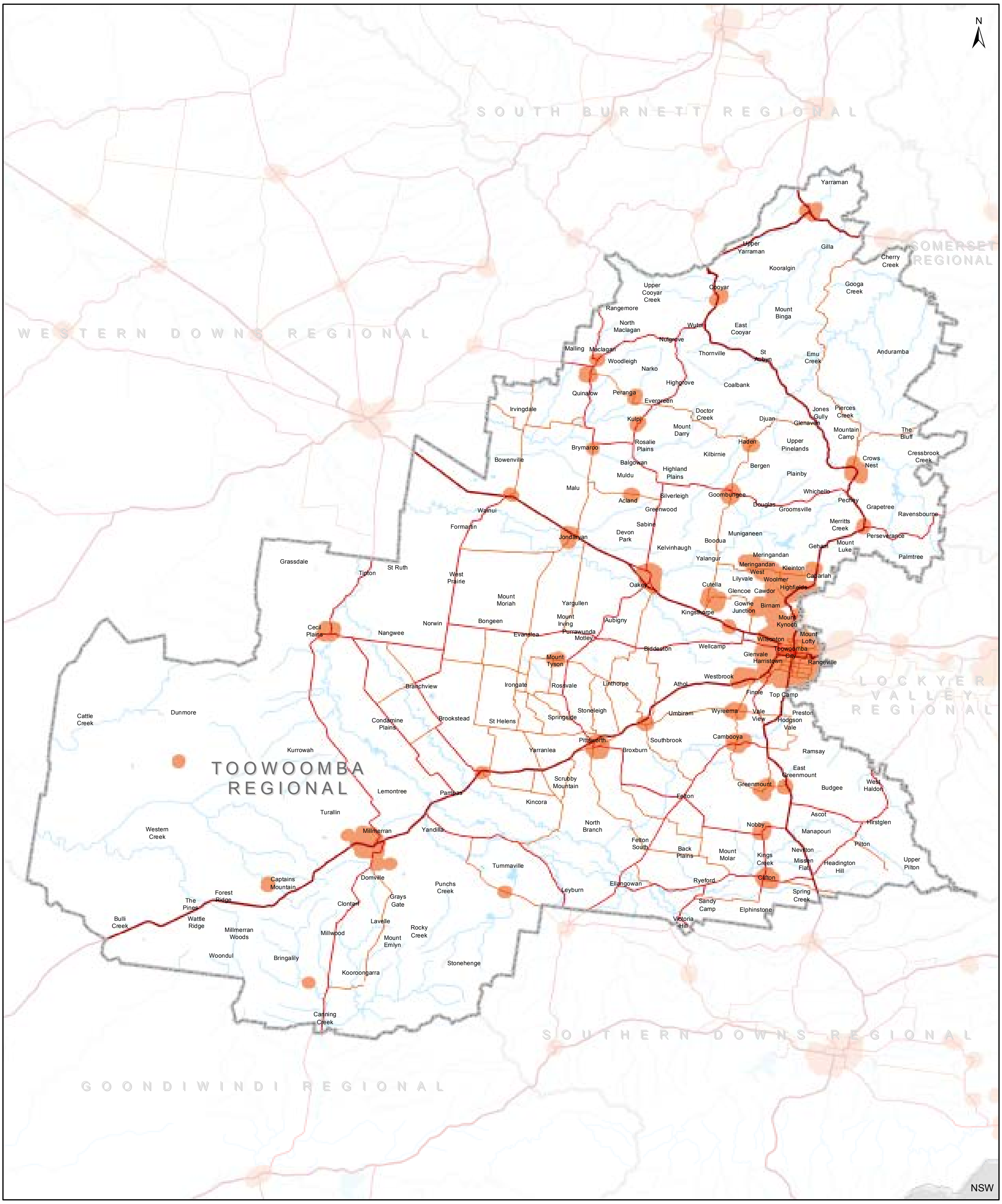
ATTACHMENTS

ATTACHMENT 1: DECISION SUPPORT TOOL FOR THE MANAGEMENT OF HUMAN/FLYING-FOX CONFLICT



ATTACHMENT 2: URBAN FLYING-FOX MANAGEMENT AREAS (UFFMA)

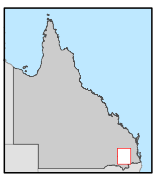


TOOWOOMBA REGIONAL

Legend

- Urban Flying-Fox Management Area
- Local Government Area
- Road

0 3.75 7.5 15 22.5 km



Urban Flying-Fox Management Area

COORDINATE SYSTEM: GCS GDA 1994
HORIZONTAL DATUM: GDA 1994

MAP PRODUCTION
29 July 2013
Nature Conservation Services
Department of Environment and Heritage Protection

Queensland Government

ATTACHMENT 3: DETAILED DISCUSSION OF MANAGEMENT OPTIONS

In order to discuss suitability of the available management options, each of them will be assessed based on the following criteria:

- Consistency with the objectives of this management plan
- Legislative considerations
- Community acceptance
- Animal welfare
- Previous experience/scientific validity
- Strengths/weaknesses
- Costs

Do Nothing

Criteria	Discussion
Consistency with objectives	Inconsistent with the objectives to address residents' concerns, prevent future conflicts and educate the community.
Legislative considerations	Taking no action does not trigger any legislative requirements.
Community acceptance	The community expects action to be taken with regards to problematic flying-fox camps.
Animal welfare	Animal welfare is not affected if no action is taken. However, illegal interference with flying-foxes and their roosts by frustrated members of the community cannot be ruled out. Monitoring and community education will reduce the risk of welfare impacts associated with community interference.
Previous experience / scientific validity	Individual camps may be abandoned without apparent reason in which case 'doing nothing' may be appropriate. However, flying-foxes' choice of roost sites is highly unpredictable and, on a regional scale, flying-foxes are likely to persist creating the potential for conflict.
Strengths	No direct costs.
Weaknesses	Unlikely to solve existing or future issues associated with flying-fox colonies in the region with the potential to • exacerbate negative attitudes towards flying-foxes • prompt illegal action against flying-foxes and their roosts • create negative community response to Council inaction
Costs	No direct costs.

Community education

Criteria	Discussion
Consistency with objectives	Consistent with the objective to inform and educate the community.
Legislative considerations	None.
Community acceptance	It is the aim of this management option to improve community acceptance and understanding of flying-foxes.

Criteria	Discussion
Animal welfare	Some improvements to animal welfare if the strategy improves tolerance of flying-foxes.
Previous experience / scientific validity	There is large scope to improve public attitudes and address misconceptions, preconceived myths and unfounded health concerns. Redland City Council runs a successful flying-fox education and information programme. This management option is particularly suitable to address conflict caused by temporary camps of nomadic little red flying-foxes.
Strengths	• Improves community appreciation and acceptance of flying-fox ecology and management issues • Opportunity to engage sections of the impacted community.
Weaknesses	• Does not address acute impacts on affected residents • Requires the community to be receptive to information • Collaboration of the media, which currently actively fuel fear and dislike of flying-foxes, would be required for maximum efficiency.
Costs	Low-moderate costs, parts of which may potentially be recovered through external grant funding.

Creation of buffer areas

Criteria	Discussion
Consistency with objectives	Consistent with the strategy's objectives to address concerns of impacted residents while conserving and coexisting with flying-fox populations.
Legislative considerations	Implications under the Queensland *Nature Conservation Act* and other legislation such as the Queensland *Vegetation Management Act* will need to be considered. If grey-headed flying-foxes are occupying the camp, the Federal *Environment Protection and Biodiversity Conservation Act* may need to be considered.
Community acceptance	If sufficiently wide buffers can be created to reduce impacts on local residents, this option is likely to find support by the community.
Animal welfare	Short-term impacts on animal welfare during creation of the buffer need to be managed by careful planning and controlling of the works. The camp area needs to be large enough to avoid significant impacts caused by the loss of roost habitat in the buffer areas - ideally combined with habitat enhancements in other areas of the camp.
Previous experience / scientific validity	At a number of sites creation of buffer areas have been successful in ameliorating impacts on surrounding residents, however in some instances, buffering has resulted in increased noise/visual impacts from the main camp due to a loss of noise-screening vegetation.
Strengths	• In situ management of flying-foxes avoids the uncertainty of where the animals might relocate to, therefore reducing the risk of creating conflict elsewhere. • Fosters the co-existence of people and flying-foxes. • Maintains majority of vegetation providing habitat to native wildlife. • Comparatively low costs.
Weaknesses	Only possible where a sufficiently large camp area is available.
Costs	Dependent on the level of vegetation modification required in the buffer area and the structure of vegetation.

Enhancement of existing low-conflict habitat

Criteria	Discussion
Consistency with objectives	Consistent with this strategy's objectives
Legislative considerations	Legislative implications under the Queensland *Nature Conservation Act* and, in the case of grey-headed flying-foxes, the Federal *Environment Protection and Biodiversity Conservation Act* may need to be considered for work within an existing flying-fox camp. If in combination with roost dispersal elsewhere, this needs to be considered separately.
Community acceptance	No objections from the community to this option are expected if the chosen camp is a true low conflict site. If in preparation for dispersal of a nearby camp, the delay caused by this long-term option might cause frustration.
Animal welfare	Long-term animal welfare benefits through the provision of suitable habitat in a low-conflict area. If in combination with roost dispersal elsewhere, this needs to be considered separately.
Previous experience / scientific validity	The dynamics of camp selection/occupation are poorly understood making it hard to predict the animals' response. However, the likelihood that flying-foxes will utilise additional roosting habitat at an already existing camp is good.
Strengths	• Sustainable long-term solution that improves flying-fox habitat in the region and reduces human/flying-fox conflict. • Will also benefit other wildlife.
Weaknesses	• Will rely on planning instruments to maintain the suitability and low-conflict status of the site in the long term. • If based on planting of additional roost trees, these will take several years to grow to a suitable size.
Costs	Dependent on the existing condition of the site. Costs may be significant if additional land needs to be purchased.

Planning instruments

Criteria	Discussion
Consistency with objectives	Consistent with the strategy's objective to identify and prevent future conflicts.
Legislative considerations	No active flying-fox management, therefore no legislative implications.
Community acceptance	Support of this management option from the wider community is expected. However individuals and/or developers who are directly affected by planning restrictions might oppose this move.
Animal welfare	Will provide long-term animal welfare benefits by reducing human/flying-fox interaction and disturbance.
Previous experience / scientific validity	Formal and informal processes to implement buffers and ‘flying-fox friendly’ developments have successfully reduced likelihood and level of potential conflict in a number of cases in other LGAs.
Strengths	• Proactive management avoiding future conflict • Vegetation in buffer zones can provide habitat for other wildlife • Potentially also reduces other human/wildlife conflict.

Criteria	Discussion
Weaknesses	• Does not address current human/flying-fox conflicts • Impossible to predict flying-fox camp dynamics and which camps will remain occupied in the long term or where new camps may establish. • Planning schemes may need regular updating when new information becomes available
Costs	Potentially significant if the purchase of land or compensation to property owners is required.

Incentives/compensation

Criteria	Discussion
Consistency with objectives	Consistent with the objectives to address concerns of affected residents and to conserve and coexist with flying-foxes.
Legislative considerations	No active management of flying-foxes, therefore no legislative implications.
Community acceptance	Affected residents may appreciate the assistance but might not feel that this is enough to ameliorate or compensate for lifestyle impacts. Other members of the community may not agree with the provision of financial incentives to individuals.
Animal welfare	No active management of flying-foxes, therefore no animal welfare implications.
Previous experience / scientific validity	Over time residents may get used to compensation and lobby against flying-foxes again. Compensation and building modification may also be regarded as not sufficient.
Strengths	• Building modifications will provide immediate relief. • Flying-foxes may remain *in situ* and unharmed and risk of spreading conflict to other locations is minimised.
Weaknesses	• May not satisfy affected residents in the long term • 'Outdoor lifestyle' of residents will remain restricted • May create precedent for financial compensation for other impacts (e.g. by other urban wildlife).
Costs	Dependent on the number of residents affected and the level of support provided. Considerable initial costs may be followed by claims for assistance with ongoing costs.

Purchase of properties

Criteria	Discussion
Consistency with objectives	Consistent with the objectives to address concerns of affected residents and to conserve and coexist with flying-foxes.
Legislative considerations	No active management of flying-foxes, therefore no legislative implications.
Community acceptance	Some residents may take up such an offer and sell their properties while others might not be willing to. Other members of the community may not agree with the Council's expending considerable sums to purchase private properties.
Animal welfare	No active management of flying-foxes, therefore no animal welfare implications.

Criteria	Discussion
Previous experience / scientific validity	Only appropriate in extreme cases. Will immediately resolve serious conflict – but only if the residents take up the offer.
Strengths	• Gives previous residents the ability to relocate immediately and therefore resolves conflict for them. • Flying-foxes may remain *in situ* and unharmed and risk of spreading conflict to other locations is minimised. • Provides Council with control over the use/occupants of the purchased property and therefore over the level of conflict. • Purchased properties become a Council asset.
Weaknesses	• Some residents may not be willing to sell • Purchased properties will need to be managed by Council.
Costs	Dependent on the properties to be purchased and their number. Potentially significant costs, however properties will become and remain Council assets.

Dispersal

Criteria	Discussion
Consistency with objectives	Addresses (not always successfully) concerns of residents around the camp but might create conflict at other locations. Applied in isolation, inconsistent with the objective to conserve and coexist with flying-foxes. Identifies and prevents future conflict if carried out at a newly established high-conflict roost site, although, may create conflict at other locations.
Legislative considerations	In the case of grey-headed flying-foxes, the Federal *Environment Protection and Biodiversity Conservation Act* may need to be considered. A Flying-fox Roost Management Permit will be required if outside of 'Urban Flying-fox Management Area' or if management is to be conducted by an entity other than Council. Removal of certain vegetation may trigger legislation such as the Queensland *Vegetation Management Act*. Potential for litigation if dispersal leads to a significant incident (i.e. aircraft strike) or spreads conflict to other areas.
Community acceptance	Drastic vegetation modification as a means of dispersal may cause mixed reactions from the community. Impacted residents may welcome the action while the wider community might be concerned about loss of amenity and habitat for wildlife. Creation of problematic camps elsewhere is likely to cause negative reactions.
Animal welfare	Can cause high levels of stress and fatigue. If undertaken at inappropriate stage in breeding cycles may lead to abortion of unborn young or separation from their mothers and subsequently starvation of dependent young. Likely to cause stress and increase predation risk if animals are forced to fly during the day and occupy sub-standard camp sites.
Previous experience / scientific validity	Most dispersal attempts have been unsuccessful or created new/additional problem camps in similarly unsuitable locations, often exacerbating the problem. Ongoing action is likely to be necessary causing considerable costs. In most cases severe habitat modification is required to prevent flying-foxes from returning. Removal of all suitable roost vegetation in the Toowoomba Region is unrealistic.
Strengths	Relief to impacted residents if successful.

Criteria	Discussion
Weaknesses	• Likely to be ongoing, causing considerable and unpredictable costs. • Impossible to predict or control where flying-foxes will resettle, therefore likely to move conflict elsewhere and possibly exacerbate. • Stress from regular dispersal and overcrowding roost sites has the potential to increase disease prevalence; similarly potential for dropped young/ injured flying-foxes increases the likelihood of negative community/flying-fox interactions. • Loss of amenity and habitat for other wildlife.
Costs	Active disturbance requires good coordination by qualified staff and is likely to be ongoing. Costs are very significant and often range in the hundreds of thousands. Costs of vegetation management are dependent on the size of the area, level of modification and type of vegetation. Removal of mature trees is expensive.

Provision of new alternative roosting habitat

Criteria	Discussion
Consistency with objectives	Consistent with this strategy's objectives.
Legislative considerations	No legislative implications as flying-foxes are not actively managed. If in combination with roost dispersal elsewhere, this needs to be considered separately.
Community acceptance	No objections from the community are to be expected if in true low-conflict locations.
Animal welfare	Should flying-foxes take up the new habitat, this provides long-term benefits. If in combination with roost dispersal elsewhere, this needs to be considered separately.
Previous experience / scientific validity	Roost site selection by flying-foxes is currently very poorly understood. Consequently it is very hard to select/create sites that will attract flying-foxes. Despite considerable works, requiring significant funds, attempts to attract flying-foxes from the Royal Bot. Gardens in Melbourne to a predetermined site have been unsuccessful.
Strengths	Long-term solution if successful.
Weaknesses	Low likelihood of success.
Costs	Dependent on the existing condition of the site. Costs may be significant, particularly if suitable land needs to be purchased.

Culling

Criteria	Discussion
Consistency with objectives	Inconsistent with the objectives to conserve and co-exist with flying-foxes, violates legal obligations and does not prevent future conflicts.
Legislative considerations	Lethal management of flying-fox camps violates the Queensland *Nature Conservation Act* and Federal *Environment Protection and Biodiversity Conservation Act*, and is most likely in breach of the Queensland *Animal Care and Protection Act*.
Community acceptance	Large proportions of the community will oppose lethal management of flying-foxes.

Criteria	Discussion
Animal welfare	This action is likely to result in large numbers of flying-foxes being killed and injured in an inhumane way causing significant suffering.
Previous experience / scientific validity	Culling has previously been an unsuccessful technique to manage flying-fox colonies. Maclean and Bellingen Island are examples of colonies that are still occupied despite historical culling programs.
Strengths	Immediate short-term reduction in camp occupation rates.
Weaknesses	• Inconsistent with state and federal legislation • Animal welfare concerns • Ineffective as long-term management strategy • Negative publicity, community backlash • Condemnation from states (and possibly countries) practising (or advocating) the protection of native wildlife
Costs	Unknown

Research

Criteria	Discussion
Consistency with objectives	Consistent with the objectives of this strategy.
Legislative considerations	Legislative implications are dependent on each individual research project and the proposed methodology.
Community acceptance	Unlikely to attract major opposition. However, large amounts of resources invested in research might attract resistance.
Animal welfare	Animal welfare implications are dependent on each individual research project. Long-term animal welfare benefits through improved knowledge of the species.
Previous experience / scientific validity	Improved knowledge about local camp dynamics may assist with local flying-fox management. Participation in other, large-scale research collaborations will provide more general information about flying-fox ecology and behaviour, assisting management in the long term.
Strengths	Potential to improve flying-fox management in the long term, reducing conflicts, animal welfare impacts and costs.
Weaknesses	• To address some management questions, knowledge expansion at a national level will be necessary, which is beyond the scope of Council alone • Outcomes of research projects and therefore value of investment is usually hard to predict.
Costs	Dependent on the particular research project and contributions of collaborating organisations. External grant opportunities may be available to support research.

ATTACHMENT 4: SUMMARY OF PAST DISPERSAL ACTIONS

Review of past flying-fox dispersal actions between 1990-2013.

Prepared by Billie Roberts and Peggy Eby June 2013

To understand the utility of dispersals as a management tool to resolve conflict between humans and flying-foxes, the outcomes of 17 recent camp dispersal attempts were systematically reviewed. The review identified a set of common outcomes of camp dispersals that should guide their use in Australia. A further observation was that the outcomes of dispersals are often not known for several years.

1. In all cases, **dispersed animals did not abandon the local area**[1].
2. In 16 of the 17 cases, **dispersals did not reduce the number of flying-foxes** in a local area.
3. **Dispersed animals did not move far** (in approx. 63% of cases the animals only moved <600m 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 extensive vegetation removal).
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).

There were a few exceptions to these patterns, but they only occurred when there were abundant financial and human resources (e.g. RBG Melbourne and RBG Sydney) and/or specific landscape characteristics (e.g., isolation from neighbours (Batchelor, NT) or habitat link to 'acceptable' location (RBG Melbourne)).

Further reading:

Roberts B.J., Catterall C.C., Eby P., and Kanowski J.K. (2012a) Long-distance and frequent movements of the flying-fox *Pteropus poliocephalus*: implications for management. *PloS ONE,* **7**(8): e42532. doi:10.1371/journal.pone.0042532.

Roberts B.J., Eby P., Catterall C.C., Kanowski J.K. and Bennett G. (2012b) The outcomes and costs of relocating flying-fox camps: insights from the case of Maclean, Australia, pp. 277-287 in *The Biology and Conservation of Australasian Bats*, edited by B. Law, P. Eby, D. Lunney and L. Lumsden. Royal Zoological Society of NSW, Mosman, NSW, Australia.

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

Table 1 Summary of known documented attempts to disperse Australian flying-fox camps using non-lethal methods, during 1990 to 2013.

Location	Species	FF population estimate at time of dispersal	Method	Did the animals leave the local area?	Did the local population reduce in size?	How far did they move?	Were new camps formed (number of new camps if known)?	Number of separate actions	Cost (if known)	Was conflict resolved at the original site?	Was conflict resolved for the community?	Source+
Barcaldine, Qld	R	>50,000	VN	no	no	≈2 km	yes (1)	trees in township felled		yes	no	1,2
Batchelor, NT	B	200	BNS	no	no	<400 m	yes (1)	2		yes	yes	3,4
Boyne Island, Qld	BR	25,000	LNS	no	no	<500 m	yes (2)	3		yes	no	5,6,7
Bundall, Qld	GB	<400	V	no	no	uk, but 4 camps were within 5 km	yes (3)	1		yes	uk	8,9,10
Charters Towers, Qld	RB	variable	HLNPOW	no	no	200 m	no (returned to original site)	repeated since 2000	>$500,000	no	no	11,12
Dallis Park, NSW	BG	28,000	V	no	yes	300 m	yes (1)	2		yes	no	13
Duaringa, Qld	R	>30,000	VNFO	no	no	400 m	yes	1	$150,000	yes	uk	14
Gayndah, Qld	RB	200,000	VN	no	no	600 m	yes	3 actions, repeated		yes	no	9
Maclean, NSW	BGR	20,000	NS	no	no	350 m	yes (7)	>23	>$400,000 and ongoing	no	no	13
Mataranka, NT	BR	>200,000	BHLNOSW	no	no	<300 m	uk	>9		no	no	13
North Eton, Qld	B	4800	VNFB	uk	no	<1.5 km initially	yes (≈4 majority temporary)	2	$45,000	yes	yes (conflict at one site)	10,15,16, 17

Location	Species	FF population estimate at time of dispersal	Method	Did the animals leave the local area?	Did the local population reduce in size?	How far did they move?	Were new camps formed (number of new camps if known)?	Number of separate actions	Cost (if known)	Was conflict resolved at the original site?	Was conflict resolved for the community?	Source+
Royal Botanic Gardens, Melbourne, Vic	G	30,000	NS	no	no	6.5 km	yes (2)	6 mths	$3 million	yes	yes, ongoing management required	13
Royal Botanic Gardens, Sydney, NSW	G	3,000	LNPOW	no	no	4 km	no	ongoing daily actions for 12 mths	>$1 million and ongoing	yes	yes	13,18,19
Singleton, NSW	GR	500	LNUW	no	no	<900 m	no (returned to original site	>3	$117,000 and ongoing	no	no	13,20
Townsville, Qld	BR	35,000	BNS	no	no	400 m	no (returned to original site)	5		no	no	13
Warwick, Qld	GRB (dispersal targeted R)	200,000	NLBP	no	no	≈1 km	no (site known to be previously occupied by GB)	5 days	$28,000	yes	uk (complaints persisted until migration)	8,21,22
Young, NSW	L	<5000	VN	no	no	<600 m	yes (1)	uk		yes	no	23

* G = grey-headed flying-fox; B = black flying-fox; R = little red flying-fox
# B = “birdfrite”; F = fog; H = helicopter; L = lights; N = noise; P = physical deterrent; O = odour; S = smoke; U = ultrasonic sound; V = extensive vegetation removal; W = water.
+ 1 Storm Stanford (Wildlife carer, pers comm. 2013); 2 Louise Saunders (Bats Qld, pers comm. 2013); 3 Phillips *et al.* (2007) Displacement of Black flying-foxes *Pteropus alecto* at Batchelor, Northern Territory *Australian Zoologist* 34: 119-124; 4 John McCarthy (Northern Territory Government, pers comm. 2010); 5 Roberts (2006) *Management of Urban Flying-fox Camps: Issues of Relevance to Camps in the Lower Clarence, NSW.* Valley Watch Inc., Maclean; 6 Information from Gladstone Regional Council in 2010 and 2013; 7 Joe Adair (formerly DEHP, pers. comm. 2010); 8 Trish Wimberly (Australia Bat Clinic pers. comm. 2013); 9 Information obtained from Department of Environment and Heritage Protection (DEHP) in 2013; 10 Billie Roberts unpublished data; 11 Scott Sullivan (DEHP, pers. comm. 2010); 12 Information from Charters Towers Regional Council in 2010 and 2013; 13 Roberts *et al.* (2012b) and additional references within; 14 Perry Deeds (Central Highlands Regional Council, pers. comm 2013); 15 Jarmaine (2010) *Species Management Plan,* Mackay Regional Council; 16 Heidi Jarmaine (Mackay Regional Council, pers. comm. 2013); 17 Daryl Barnes (Walkerston resident, per comm. 2013) 18 Peggy Eby (Ecologist, pers comm. 2013) 19 John Martin (RBG, pers comm. 2013); 20 Singleton Council Meeting Minutes; 21 Information from the Southern Downs Regional Council in 2013; 22 Tim Low (pers. comm. 2013); 23 Young Shire Council.

ATTACHMENT 5: DISPERSAL CASE STUDIES

Maclean Rainforest Reserve, NSW (Roberts 2006)

The flying-fox camp at Maclean has been occupied since at least the 1890s. Since then many unsuccessful attempts were made to clear the camp by shooting, fires and explosives. During the 1990s the camp increased in size, while at the same time, the adjoining high school built new classrooms within 10 m of the flying-fox camp.

Subsequently, complaints about noise, odour, droppings and perceived health risks increased along with calls for the removal of the flying-foxes.

In 1999 dispersal of the camp numbering between 10,000 and 20,000 mainly grey-headed flying-foxes was attempted using noise at dusk and dawn. Since then flying-foxes continually attempt to return to Maclean Rainforest Reserve. Several new camps were established, some of these in equally unsuitable locations.

The actions did not resolve conflict at the original camp site and created further issues in other parts of the area. The costs incurred so far are estimated at $500,000 and are ongoing.

Royal Botanic Gardens Melbourne, VIC (Richards 2002)

Grey-headed flying-foxes established a permanent camp at the Royal Botanic Gardens in Melbourne in 1986. The numbers at the camp reached 28,000 in 2003 causing considerable damage to the botanically and historically significant vegetation.

Consequently, the decision was made to relocate the colony to a predetermined site approximately 8 km from the Botanic Gardens. To attract the animals to this site, large enclosures were installed that housed life individuals, leaf litter and flying-fox droppings from the Botanic Gardens were spread to create a familiar smell and flying-fox calls were replayed at the site.

Dispersal from the Botanic Gardens used a large crew making noise from mobile ‘sound buggies’ daily for several weeks. The action fragmented the colony with smaller groups roosting in parks and gardens throughout inner city Melbourne. To prevent these camp sites becoming established, flying-foxes were dispersed immediately. At times, dispersal activities were being conducted at up to 15 sites simultaneously.

Monitoring and dispersal of returning individuals from the Botanic Gardens was required for many months.

The flying-foxes did not settle at the predetermined site and eventually relocated to Yarra Bend Park approximately 5 km from the original camp. Limited conflict with residents at the new site is ongoing.

The costs of the relocation are estimated to have reached $3 million (including considerable investment in preparing the predetermined camp site and enhancements at Yarra Bend Park) and are ongoing.

Coffs Creek, Coffs Harbour, NSW (Coffs Harbour City Council 2007)

Grey-headed flying-foxes have seasonally been using the camp site at Coffs Creek, approximately 1.1 km west of inner-city Coffs Harbour for at least 50 years. In the late 1990s, the camp became permanent. Numbers grew and residential development in the immediate vicinity resulted in growing conflict. A number of illegal dispersal attempts by local residents fragmented the camp and worsened the situation.

Coffs Harbour City Council responded by developing a flying-fox camp strategy and vegetation management plan in consultation with the community. The strategy involves vegetation management and bush regeneration to alter the shape and location of the flying-fox camp. This includes buffers around residential properties and revegetation to improve flying-fox habitat in areas away from houses.

Burdekin Park, Singleton, NSW (Nelson JE 2008)

Grey-headed flying-foxes have been utilising Burdekin Park in the centre of Singleton as a seasonal camp since 2000. Small numbers of little red flying-foxes occasionally joined the camp and total numbers usually fluctuated between 500 and 5,000 with a peak of approximately 14,000 in 2008-09.

The park is a popular location for social and community events and numerous unsuccessful attempts have been made since 2003 to disperse the colony using spotlights, reflective material hung in trees, noise and water sprinklers. A commercial Birdguard deterrent system proved equally ineffective.

Hosing the animals with high water pressure from a cherry picker disturbed the flying-foxes temporarily but they returned soon after. All dispersal attempts pushed flying-foxes into neighbouring backyards but didn’t result in the abandonment of Burdekin Park as a roost site.

In 2007 licenses to cull the flying-foxes were sought but never granted.

At the time of writing the flying-foxes still occupy the park. Costs of the failed dispersal attempts are estimated at $117,000.

Gold Coast Equine Precinct, Bundall, QLD (Ecosure 2013)

In 2010 a camp of between 200 and 4,500 black and grey-headed flying-foxes established within the Gold Coast Equine Precinct. At that time, a vaccination against Hendra virus had not been available and a risk assessment found a very high risk of Hendra virus infection, warranting dispersal.

Gold Coast City Council and their contractor applied a method of passive dispersal by progressive removal of roost vegetation at night while the camp was vacant. Flying-foxes abandoned the camp after approximately 70% of canopy trees and 90% of understorey vegetation had been removed. To reduce the likelihood of roost re-establishment, the canopy was further reduced by up to 90% in parts of the camp site.

Flying-foxes from that roost are thought to have been assimilated into one of several nearby roosts.

This approach came at a cost to Council of approximately $250,000.

Kearneys Spring, Oakey, Highfields, Toowoomba Region, QLD

In 2013 Toowoomba Regional Council decided to disperse three flying-fox roosts in Kearneys Spring, Oakey and Highfields. In Kearneys Spring, conflict resulted from a miniature steam train operation underneath the flying-fox roost site and a reported drop in visitor numbers to the attraction. In Oakey, the small permanent colony of black and grey-headed flying-foxes is occasionally joined by considerable numbers of little red flying-foxes. During such times they spill over into properties adjoining the roost site and reportedly caused a reduction in business to ‘Kelly’s Motel’. In Highfields, the newly established camp cause distress to a number of residents living close to the roost site.

Council applied a combination of active dispersal and vegetation management in winter 2014. The colony in Kearneys Spring relocated immediately to the existing summer-roost in nearby Redwood Park but returned during spring and with the beginning of the breeding season. In Oakey, dispersal activities had little impact on the black and grey-headed flying-foxes present at that time, while vegetation management moved the camp in Highfields by a short distance to a lower-conflict location.

In 2015 Council decided to discontinue dispersal at all three sites and manage any impacts while maintaining the camps in-situ. This included the relocation of the miniature steam train facilities from Kearneys Spring Park.

The flying-fox dispersal programme, excluding the relocation of the miniature train facilities, came at a cost to Council of over $450,000.

ATTACHMENT 6: METHODS OF DISTURBANCE

A number of techniques were trialled on grey-headed flying-foxes at the Royal Botanic Gardens Sydney (ARCUE 2009 - see Attachment 7). For a discussion of these techniques see also GeoLink (2012). Unless stated otherwise, the following information is obtained from these two sources.

Noise

Noise is the most commonly used technique to disperse flying-fox colonies. As flying-foxes become quickly accustomed to any disturbance, it is important that a variety of different noises are produced in random sequence and from different locations. The mobility of noise generators (on foot and/or from the back of a vehicle/buggy etc.) is considered to have been critical to the success of the dispersal of grey-headed flying-foxes from the Royal Botanic Gardens in Melbourne (R. van der Ree, pers. comm.).

This means that static or automated noise generation is unlikely to be effective, increasing the labour intensity of the activity.

The range of noises often used include those of small plant such as whipper snippers and chainsaws; starters' pistols, gas guns and BirdFrite as well as banging of metal objects such as drums or bin lids. These are usually combined with a series of computer-generated sounds. The Botanic Gardens Trust Sydney recorded a CD with a selection of noises for the purpose of flying-fox disturbance. Ultra-sonic deterrent systems (e.g. Shu Roo) or recorded flying-fox distress calls have been found to be ineffective.

Monitoring of flying-foxes' reactions to and adjustment of the stimuli used is recommended to avoid animals becoming accustomed and desensitised.

Visual disturbance

This includes high intensity spot or strobe lighting, hanging of reflective objects (such as CDs), plastic bags or similar in trees. Waving of flags on poles or inflatable 'Eventmen', balloons and fake predators have been used, too.

These methods usually had only limited and localised effects. Furthermore, flying-foxes became quickly accustomed to the visual stimuli.

Olfactory stimuli

These often had only localised and short-lived effects in deterring flying-foxes. Scents trialled include toilet deodoriser blocks or bags with python excrement hung in trees, commercially available deterrent (D-Ter), chilli or fermented shrimp paste applied to branches.

The necessity to regularly reapply large quantities of these scents to branches across the entire camp site makes this option expensive and logistically challenging.

Physical disturbance

Heavy fishing line in the canopy of roost trees was trialled as a trip hazard/nuisance at the Royal Botanic Gardens in Melbourne but flying-foxes became quickly accustomed to it and started to hang off it. Netting of entire camp sites will be prohibitively expensive and considerably affect the aesthetic value of the area.

Canopy sprinklers

A canopy mounted sprinkler system, automatically operated on random cycles was tested and found promising at the Royal Botanic Gardens in Sydney. With this technique it is important to recognise that flying-foxes are not deterred by getting wet but by the physical force of being hit by a direct jet of water (R. van der Ree, pers. comm.).

Consequently, sprinklers need to be mounted as to directly cover all areas of the canopy. This means a sprinkler system might be an option to protect individual trees but is not feasible for an entire camp.

At the time of writing, Sunshine Coast Council was trialling a sprinkler system within the buffer area around an urban flying-fox roost. Preliminary results showed the sprinklers to be effective in deterring flying-foxes from roosting within the buffer area (R. Draper pers. comm.).

Smoke

Smoke is often used in conjunction with other techniques. Smoke from smoke machines can be effective with little red flying-foxes but was shown to have little effect on other species (J. Bracks, pers. comm.). Smoke from burnt vegetation is highly effective at deterring animals. The main difficulty with this technique is that it is greatly affected by prevailing wind conditions, which can make it difficult to direct smoke into the roost trees and can therefore reduce its effectiveness (J. Bracks, pers. comm.).

ATTACHMENT 7: SUMMARY OF DISPERSAL METHODS AND DETERRENTS TRIALLED AT THE ROYAL BOTANIC GARDENS SYDNEY AND ELSEWHERE

From: ARCUE (2009): Public Environment Report: Proposed relocation of a camp of Grey-headed Flying-foxes (*Pteropus poliocephalus*) from the Royal Botanic Gardens Sydney; pp. 53-63).

Deterrents already trialled at the RBGS and elsewhere

Technique	*When and how*	*Result and reason for not continuing*
Plastic bags - Empty - with paradichlorobenzene (toilet deodoriser blocks) - with small pieces of raw bullock liver - small quantities of carbide, allowed to get wet through	1992	Little effect; slightly more effective in windy weather. GHFF generally do not roost within 1-2 m of the bags. However, the cost of hiring a mechanical tower that can reach high canopies was high ($2,000 for 3 days). GHFF did not roost within 3-4 m of toilet deodorise blocks. However, this caused some GHFF to move to neighbouring trees, and resulted in more damage. No evidence of success for bullock liver and carbide as noise disturbance was found to be successful at this time. Furthermore, plastic bags are unsightly, and will require frequent re-installation as they quickly degrade
Shu Roo (ultrasonic deterrent)	16 September 1992, 3.00 am -6.00 am	No marked effect.
Two ultrasound frequency signals (21-25 kHz, 118 dB SPL at 1 m) were trialled as a deterrent for GHFF at the Royal Botanic Gardens, Melbourne (van der Ree et al., 2002a). Flying-fox numbers remained consistent throughout the trial period, and there was no change in their behaviour during playback. The overall auditory range of the GHFF is 2-54 kHz, being most sensitive between 9-20 kHz (Calford et al., 1985 in van der Ree et al., 2002a). The ultrasonic deterrent appeared to be of insufficient strength to affect flying-foxes.		
Single **strobe light** of high intensity	16 September 1992, 3.00am-6.00am	Only very slight reaction when the flying-foxes are about to land, if the strobe flashed. This did not stop them settling, and no adverse reaction was noted once they had roosted.
Synthesized sound imitating the sound of the street sweeper	16 September 1992, 3.00am-6.00am	Unlike the motoroised street sweeper, this deterrent had no marked effect on the GHFF. However, observers noted that the flying-foxes respond less and less to street sweeper passing under their roost trees as they grew accustomed to the sound.
Flying-fox distress calls from standard tape player	1992	No response from roosting flying-foxes.

Branch-wrapping with piping (plumbing or agricultural) to make the branches unattractive for roosting.	18-25 March 1999	A trial was conducted using agricultural piping within one tree for over a week; this was done on a small area of the tree (10%). Disturbance was carried out on that tree, so the resulting decline in number was confounded. However, two flying-foxes were seen roosting on the pipe, suggesting that tubing, at least with pipes of the diameter used, is ineffectual. Moreover, targeting individual branches would take an enormous amount of time, and would only disperse GHFF to other trees.
D-ter animal and bird repellent	18 May 1999, sprayed test trees with D-ter between 1430 and 1530 hrs. Three observations following treatment were carried out at 0800, 1000 and 1200 hrs on 19 May; 0800 on 20 May, and 0730 on 21 May.	In test tree 1, flying-fox numbers dropped from 120 to 70 over 3 days (to 20 May). Noise in the area disturbed the animals and confounded results. Test tree 2 – numbers dropped from 50 to 40. Test tree 3 – numbers dropped from 50 to 30. Success is limited, short-term, and confined to individual trees. High cost was associated with the of travel tower to access branches for application of D-ter

Repellent trails involving 1) **chilli paste** made from ground chilli powder, hot chilli sauce and honey/glucose solution; 2) **fermented shrimp paste**, purchased at an Asian supermarket. Fermented shrimp paste is widely used in South east Asia as a flying-fox repellent on commercial fruit trees. Fermented shrimp paste is organic, non-toxic and washes away with rain. The repellent trial was conducted by consultants Greg Richards and Leslie Hall. This was conceived as a 'micro-management tool' for short- or long-term conservation of significant trees.	*Trial 1*: On Wednesday 13 December 2000, a number of trees in beds 28, 32 and 41 were selected for testing as the trees did not contain non-flying juvenile flying-foxes. Several trees in other areas were selected as controls. Numbers of GHFF occupying select branches were made on 14 Dec. 2000, and repellents made freshly on the same day. Large areas of trees were sprayed with chilli paste or smeared with fermented shrimp paste, from 2000-2200 hrs, when the GHFF were absent. Trees were inspected on 15 Dec. There were identical numbers in two trees, and more flying-foxes in another.	The preliminary trial proved unsuccessful. The effectiveness of these substances to repel GHFF probably requires ingestion and subsequent association of the smell and unpleasant taste sensation.
	Trial 2: A fermented shrimp paste concoction was prepared on 28 March 2001, and applied to six flying-foxes with a squirt gun from ground level.	The animals (juveniles and females) flew away immediately and had not returned 1-2 hours later. Some flying-foxes received a light mist spray were seen intensely grooming and wing-flicking. Males defending mating perches were out of reach.
	Trial 3: Initial trial where prawn paste was smeared on territorial perches during the night on 5-6 perches to reduce affinity associated with scent marking.	Target males returned to the same perches the follow morning.
	Trial 4: Hand delivery of a solution made from prawn paste, honey and water.	Effective for removing individuals from perches, especially those that were reluctant to move when the sonic system was in operation. This led to the trial of a delivery system with sprinklers. High and frequent cost associated with application of these treatments across large numbers of branches/trees.

<table>
<tr><td colspan="3">Trial involving Envirospray Ultrawax, used widely in the U.S.A. to repel a range of herbivores, was conducted at Melbourne’s Royal Botanic Gardens to test its capacity to deter GHFF from roosting (van der Ree and Nelson 2002). Flying-foxes returned to perches sprayed with Envirospray Ultrawax after a similar length of time to the perches treated with water, and there were no behavioural indications of discomfort. Although numbers were significantly lower in the four (4) three-day periods following treatment, the effect is likely attributed to the presence of a cherry picker tower in the trees, as numbers were lower in both the treatment and control branches.

Most Capsaicin-based deterrents such as Envirospray Ultrawax are utilised to prevent browsing, and may need to be ingested to have an effect. This product appears to be similar to fermented shrimp paste and D-ter in terms of delivery, cause of deterrence, and effect; therefore, this product was not trialled at the RBGS.</td></tr>
<tr><td>Python excrement trial

Pythons are one of the major predators of flying-foxes, and the smell of a python may be known to GHFF</td><td>Commenced on 27 March 2001.

Two bags of python excrement were wrapped in nylon flyscreen mesh and tied to branches used by dominant males in the Flindersia schottiana in Bed 41a. Two controls consisting of soil and leaves wrapped in identical flyscreen mesh were tied to trees used by dominant males in another bed.

The test trees were checked until the 9th trial day (April 5).</td><td>There was no effect at the control trees, with all GHFF in their usual locations, although one male was displaced by a bag.

A noticeable effect was observed at the test tree, where GHFF roosted within ~ 2 m of either of the 2 bags that contained python excrement.

On the 9th day, the repellent still appeared somewhat effective, although distance of flying-foxes from the bags appeared to be less (~ 1.5 m).

This deterrent was considered to be logistically undesirable due to its short range effect necessitating the use of many bags for an individual tree, and difficulty in sourcing supplies.</td></tr>
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Sonic deterrent trials with the **Phoenix Wailer** (PW), developed by Greg Richards for the deterrence of flying-foxes in orchards. The PW (master unit and 4 speakers) can produce a variety of electronic sounds, as well as 'natural' sounds such as shotgun blasts and distress cries. During the January 2001 visit, sound levels were measured from 18 locations. The highest level recorded was 76 dB in the test area. The ambient level was ~ 65 dB, and a passing truck and tractor were measured at 78-80 dB. The ambient city noise level at Mrs Macquaries Road was 70-78 dB. Thus, the nose of the PW was at the upper end of the city ambient range. However, as the sound is high in the tree canopy, it did not appear to be disturbing patrons of the RBGS. It was envisioned that the PW could be used as a macro-management tool, and flying-foxes may be moved from one area to another as tree damage becomes visible. Two consultants (Greg Richards and Leslie Hall) inspected RBG for areas of significance within the Palm Grove which required protection from the flying-foxes (13-16 Dec. 2000; Richards and Hall 2000, 2001).	*Trial 1*: PW was installed in a test area in the Palm Grove, and trial commenced on Jan 31 2001, between 0400-0600 hrs. The site was attended from 0330 to sure correct function and to observe effects. Observations suggested that operation of PW from first light onwards would be more appropriate as it allows the colony to return. Time period of operation was changed to 0630-0800 hrs for 1 Feb. 2001.	There was immediate effect with large numbers of GHFF dispersing to other trees. Number of GHFF in the four test trees decreased from ~ 450-300 (33%) in the first two hours of operation. With the change in operation time period, greater effect was noted with numbers reduced from ~ 520-170 (67%). GHFF that remained were adult females with non-flying young, and those that occupied 'sound shadow' areas behind dense foliage. Further studies were planned for March/April when the breeding season has finished.
	Trial 2: PW was programmed to operate between 0500-0700 hrs, when the GHFF were arriving back at the site after feeding. Trial conducted between March 27 2001 and April 5 2001; both electronic and 'natural' sounds were used.	This proved effective, as numbers in one tree dropped from ~150 to ~60 on the first morning and ~50 on the second morning. The GHFF that remained were large dominant males guarding mating territories. Numbers dropped to ~ 10 after nine days (~90% reduction). GHFF in sound shadows appeared to be less affected. Away from the trial site, reduction was not as great (~ 40% cf. 90%). The average reduction in the trial area was 61%, compared with natural decline of 36.3% in the adjacent area. Shotgun blasts were ineffective and inappropriate at canopy level. The distress screams from the PW were indistinguishable from similar sounds made during mating. It was concluded that it would be more effective to program the PW to produce electronic sounds.
	Trial 3: A longer trial was conducted from 14 Jan to late Feb and 12 April through May 2002. A timer was installed and operation occurred for 5 minutes each daylight hour (excluding 1200-1400).	PW produced mixed success. A drop of 16% in flying-fox numbers (1670-1400) was seen in 11 trees between 14 and 24 Jan 2002. After the initial dispersal, a number of GHFF drifted back to their original roost positions. There was some decline in numbers, though this may be the result of normal departure of immigrant animals. A BGT staff observed a PW trial at 0615-0655 hrs on 21 Feb. 2002. The electronic sounds had little effect on roosting flying-foxes. In contrast, a large street sweeper disturbed hundreds of animals.

In December 2001, a pilot study on the capacity of the Phoenix Wailer to deter GHFF was conducted by the Australian Research Centre for Urban Ecology in Melbourne's Royal Botanic Gardens (van der Ree et al. 2002b). Whilst a slight decrease was found in GHFF numbers in close proximity to the speaker (0-10 m), the difference was not significant to pre-trial numbers. Furthermore, during playback on the first morning (0500-0700 hrs), not only did the GHFF exhibit no signs of stress, they approached the speakers via the cable from which the speakers were suspended, 'to investigate the speakers at close range. A small number of GHFF even suspended themselves from the speakers to investigate the source of the sound'. The efficacy of the Phoenix Wailer as a broadscale deterrent for GHFF appears to be limited both in space and time. It may be useful in the deterrence of immigrant GHFF from individual trees, but is unlikely to provide protection from resident animals.		
Canopy sprinkler system Standard garden water sprinkler system, with a hole to squirt water while rotating 360 degrees. The rotations alternated from a slow turn taking approximately 20-25 seconds followed by a quicker turn of about 7-10 seconds. The water sprinkler was installed on the tree at the level where the animals roost (Richards and Hall 2002).	*Trial 1*: A home garden sprinkler was erected in a test tree and left for several weeks to allow habituation. Various solutions prepared for testing (i.e. water, water+honey, water+honey+prawn paste) were prepared and placed in four 20 L drums, accessed by a pump powered by a portable generator.	Water from the first drum succeeded in dispersing all 150 GHFF within seconds due to the noise of the sprinkler head. GHFF in adjacent trees also flew away. Since noise was the deterring factor, other solutions were not needed. However, a proportion of the population returned after ~ 1 hour, and the process was repeated for several hours until no GHFF returned, with immediate effect each time.
	Trial 2: Sprinklers were fitted to a group of trees by RBGS staff and operated by hand from a tap. Counts were conducted between 15 Oct. and 1 Nov. 2001.	There was immediate dispersal of GHFF in most trees, although some returned when disturbance ceased. Without automation with electronic timer or infrared movement sensor, this method would be very labour intensive.
	Trial 3: 15 consecutives weeks from 10/06/2002 to 23/09/2002	Reduction of the animals in the trees by about 92-100%.
	Trial 4: May 2008	Appeared to be effective at deterring the GHFF from the target tree while the sprinklers were operating. However, they soon returned to the target tree once the sprinklers were turned off. This kind of movement in and out of trees is likely to cause more damage rather than prevent it.

Singleton Council used hoses from an Elevated Work Platform (EWP) on 24-25 April 2003 in an attempt to disperse GHFF from the Anzac Memorial in Burdekin Park. Hosing caused GHFF to take flight and land in other trees; however, as soon as the EWP returned to the ground, GHFF returned to the original trees. In another attempt to disperse the GHFF from Burdekin Park, water sprays were used from 4-18 August 2003, and found to be effective in dispersing the GHFF from the park. However, disturbance had to cease as GHFF were roosting in trees near residences and the hospital (Singleton Council 2008).		
Lighting Tower with high powered spotlight	May 2008, pre-dawn as the GHFF return to roost. A high-powered lighting tower was raised up to the canopy level of a popular GHFF roost tree and shone into the branches in the early hours of morning where some GHFF had already begun roosting and others were still arriving. Lights were also rotated to create moving light.	Despite strong light at the canopy level, only a couple of metres from roost branches, either shone directly into the tree or rotated to create movement, the GHFF were undeterred and continued to land close to the light.
Singleton Council used lighting in an attempt to deter the GHFF from returning to Burdekin Park in Spring; this was unsuccessful. Beacons and reflective objects hung in trees were also deployed, without success (Singleton Council 2008).		
'Eventman' An air-powered inflatable windsock in the shape of a 'man'; nicknamed 'Eventman'. A similar device had some localised effect in the Royal Botanic Gardens, Melbourne.	Install in July 2008; removed in May 2009. It was moved from one hotspot (of more serious damage) to another to prevent habituation and to protect more than one area at a time (due to potential lag effect). Installed again in September 2009, to provide temporary relief to one tree.	Localised effect; GHFF were dispersed to surrounding trees. Over time, GHFF became habituated to the presence of Eventman, and returned to roost in close proximity to the deterrent. Number of GHFF appears to have been reduced.
Fluoro vests	Aug 18 2009 - 2 and 3 three high visibility flouro vests were hung in two roost trees.	Localised effect; GHFF do not roost within 1-2 m of the vests.

Management methods yet to be trialled

Technique	*Analysis of likelihood of success*
Birdgard	Used for 23 days by Singleton Council to disperse GHFF in Burdekin Park; approximate cost was $5,000, and there was no effect (Roberts 2006).
Gas gun or **Birdfrite** (12 gauge cartridges fired from shotguns)	Gas gun (single, double and triple shot, from $650-$760); provides for irregular but intensive disturbance more likely to affect surrounding residents than GHFF. Birdfrite ($300 for 100 rounds) is being considered for use as part of the relocation. The level of noise it creates (~ 140 dB) may have significant impact on surrounding residents. GHFF are likely to become habituated to both birdfrite and gas guns if they are used in the same location/manner over long periods of time.
Heavy fishing line	This was used in the RBGM; GHFF soon became accustomed to the line and began to hang off it (Richard Barley, Divisional Director, Melbourne Gardens, Bat Club Meeting 14 December 1998).
Smoke	Smoke was trialled for two weeks at the RBGM, using a theatrical smoke machine. The machine was ineffective in any wind conditions, and a bigger smoke unit was recommended, to make the smoke rise up through the canopy in order to produce greater visual impact. GHFF were quite agitated by the smoke, however the smoke dissipated quite quickly. Smoke from burnt vegetation (blackberry and weeds) on one of the islands at RBGM dispersed the GHFF, and they did not return for two days (Bat Club Meeting 5 February 1999). However, the presence of people on the usually people-free islands would also have contributed to the relocation by the bats. The bats returned shortly after the trial was completed. BGT has applied for the use of smoke to facilitate the dispersal of GHFF during the primary relocation phase, as GHFF may become habituated to noise disturbance. Smoke from plant debris collected in the Gardens will only be used should noise disturbance not achieve the desired effect of dispersal after two weeks. DECCW has expressed that smoke may be used only when absolutely necessary. Thus, approval is pending on-ground observations during the relocation.

Artificial Roost	GHFF do not exhibit clear preference for particular branch diameter or angle for roosting, although a minimum of 2 cm diameter is recommended for roosting perches (Roberts 2005). GHFF are curious and adaptive animals, and have been observed to hang from fishing wire, speaker cables, mesh, cargo netting and natural fibre or jute ropes. However, no long-term usage has been observed. Artificial roosting is still in the early stages of development and trialling, as there are many aspects to consider. Material for roosting is important - nylon ropes and galvanised wires are not recommended due to slipperiness in the former and potential for causing injuries in the latter (Murphy 2008). Furthermore, male GHFF mark their territorial area by rubbing their neck on the perch; artificial roost material must allow this important function to be performed, and for the scent to persist after rain (Tim Pearson, pers. comm.). Other aspects that require consideration are: provision of adequate space for behaviour such as fanning, taking off and landing; provision of shade, as a dense understorey with emergent structure is considered essential for thermoregulation; appearance of the artificial roost, as GHFF are visual animals and visual cues may play a large part in camp selection; and exposure of roosting material to captive GHFF to reduce human and/or chemical smells. Erecting artificial roosts within the established roosting ground is considered essential in attracting GHFF. GHFF are gregarious animals, and artificial structure in close proximity to existing roosts allow for the maintenance of normal social structure. New, artificial structures are more likely to attract juveniles and migrant animals without pre-established territory, as opposed to residents that defend a territory all year round, or migrants that return to the same branch year after year. GHFF are not likely to use artificial structures unless existing trees are over-crowded. Therefore, even if GHFF were to use artificial structures, mitigation of damage to existing roost trees would be minimal; increasing the density of GHFF in the area may also incur greater damage to that already sustained by the understorey plants from guano. In order to allow the most damaged trees to recover, physical barriers would be required to prevent the GHFF from roosting. There are several difficulties, outlined in the section below (see Netting). The presence of netting and jumbles or ropes or mesh would detract from the character of the Gardens and the enjoyment of its patrons, and offer minimal assistance in the protection of individual trees. Therefore, artificial roosts, though a scientifically interesting idea, has not been pursued as it is still in the infancy of development and testing, and its usage is unlikely to provide protection of any individual tree.

Netting	Netting has been considered but is not viable. In orchards where netting is installed trees are a uniform height (usually no more than 5m) and planted in straight rows. In the RBGS netting would need to accommodate the tallest affected trees which are 30 m tall and would have to cover the entire Palm Grove as the trees and palms form a single canopy. The structure would also need to be large enough to enable the trees to move in the wind. Netting would be very expensive and unlikely to be considered appropriate for the aesthetics and heritage values of the Gardens. The cost of netting entire beds, including footpaths where the paths are shaded by the canopy, is estimated to be upwards of half a million dollars, excluding regular maintenance fees. Netting of individual trees was also considered to be cost-prohibitive. For example, netting of the Tree Waratah for one year costs approximately $122,000, not including GST, and half-yearly maintenance fees. In order to prevent entanglement of wildlife, netting needs to be full-exclusion, with all sides taut, and the mesh size must not be greater than 40-44 mm. This will prevent wildlife from entering and exiting the enclosure, and impede movement between the netted area and the rest of the Garden. Netting would also require daily inspection. Should the structure need to be moved, the entire structure would have to be dissembled. Similar suggestions have been made by the 'Bat Club' in the past. For example, Dr Peggy Eby suggested that, as GHFF do not roost throughout all of the trees, a series of aluminium frames (modular system) could be used to enclose specific areas. John Gough suggested using a series of light mobile framed structures on the branches; they could be aluminium and round so as not to rub the branches (Bat Club Meeting 5 February 1999); other suggestions include trialling different meshes/shade cloths over branches (Bat Club Meeting 22 July 1999); cheaper options of tying a net or cover over a roost tree, on to other taller surrounding trees, or a covered light frame similarly tied to adjacent trees. Use of the frame would lessen wind movement (Bat Club Meeting 21 September 1999). However, no research has been conducted; BGT is not aware of evidence of success in deterring wildlife with the aforementioned suggestions. Unless the netting were to cover the entire Palm Grove as well as adjoining garden beds where the flying-foxes are roosting, it is likely that the flying-foxes would simply concentrate in the un-netted areas of the Gardens. In any case the end result would also be relocation. The BGT wants to save the heritage trees and safely relocate the flying-foxes to an appropriate habitat. Unlike mobile disturbance, netting would not be able to direct the flying-foxes to any particular locations once they had left the Gardens.

Revegetation	During the relocation of GHFF from the RBGM, over $600,000 was spent at the preferred site in Ivanhoe to set up cages for housing 80 GHFF, (with ropes alongside and 200 GHFF models, as well as buckets of food; dropping and litter from RBGM and playback at night), and installation of a sprinkler system. Over 100 GHFF visited this site but roosted only 5 times and the maximum number was 8. This example illustrates that at present, we do not have enough knowledge on roost selection by GHFF, and cannot attract them to any particular site (Nelson 2008a). At Coffs Creek, NSW, land managers revegetated parts of the camp that were away from residential areas, and removed branches and shrubs that were too close to houses. The enlarged buffer zone was compensated by revegetation, which allowed GHFF to move to other parts of the camp, away from incompatible land uses (Coffs Creek Flying-fox Camp Strategy 2007). The GHFF camp at RBGS occupies a diverse assemblage of specimens in the central part of the Gardens. GHFF have spread out of the Palm Grove to lawn trees with no mid- or understorey. Planting near the camp is unlikely to alleviate damage due to (i) the large area needed to support the population in summer; and (ii) many damaged trees would die in the time it takes for plantings to be of value to GHFF. The RBGS is an integral part of the site of the first permanent European settlement in Australia, and is one of the oldest, richest and most extensive landscapes of European-influenced agricultural and horticultural activities, and later on, a focus for botanic discovery and research. It is now a composite of specialist garden areas presented as a predominant parkland landscape character. The RBGS contains the largest and most diverse continuously curated plant collection in Australia, with elements dating from all the major periods of the development of the site, from the colonial period and its association with plant discovery to plant scientific research and conservation at the present time. The Palm Grove and fern gully is of exception significance as a reception area for plants collected on trips of botanical exploration in the early 1860s, and for the striking contrast it presents to neighbouring areas of the Garden. It is the BGT's responsibility to maintain the aesthetics of the living collection and to provide the public. The composition of the living collections in each precinct is strongly related to collecting biases dating back to the earliest days of the Botanic Gardens' history. Whilst individual specimens or trees may not be able to be preserved, the themes presented should continue to be preserved as a defining feature, linking the present to the past. The RBGS Conservation Management Plan (Conybeare Morrison 2005) is a point of reference when considering thematic designs and garden developments; it advises the maintenance of the tradition of a diverse mixture of tree species and density of planting with the constraints of effective horticultural management. For the Palm Grove, this entails the maintenance of the dominance of Arecaceae, Araucariaceae, and broadleaf evergreen Australian rainforest emergent species. Creating a habitat for GHFF would compromise the thematic plan that has been in place since the earliest days of the RBGS. Plantings will take at least 15-20 years to be of roosting value to GHFF, and the area currently occupied by the GHFF would be completely altered and degraded.

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