



Parramatta North Flying-fox Camp Management Plan

Department of Planning, Industry and Environment

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Template 2.8.1

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Acronyms and abbreviations

Abbreviation	Description
ABLV	Australian bat lyssavirus
BFF	black flying-fox (<i>Pteropus Alecto</i>)
DoEF	Commonwealth Department of the Environment and Energy
DPI	Department of Primary Industries (NSW)
DPIE	Department of Planning, Industry and Environment (NSW)
EP&A Act	<i>Environmental Planning and Assessment Act 1979 (NSW)</i>
EPA	Environment Protection Authority (NSW)
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)</i>
GHFF	grey-headed flying-fox (<i>Pteropus poliocephalus</i>)
the Guideline	Referral guideline for management actions in grey-headed and spectacled flying-fox camps 2015 (Commonwealth)
HeV	Hendra virus
LGA	local government area
LGNSW	Local Government NSW
LRFF	little red flying-fox (<i>Pteropus scapulatus</i>)
MNES	matters of national environmental significance
NPW Act	<i>National Parks and Wildlife Act 1974 (NSW)</i>
NPWS	National Parks and Wildlife Service (NSW)

Abbreviation	Description
OEH	Office of Environment and Heritage (NSW)
PEPs	protection of the environment policies
the Plan	Camp Management Plan
POEO Act	<i>Protection of the Environment Operations Act 1997 (NSW)</i>
the Policy	Flying-fox Camp Management Policy 2015 (NSW)
SEPPs	State Environmental Planning Policies
SIS	Species impact statement
TEC	Threatened ecological community
TSC Act	<i>Threatened Species Conservation Act 1995 (NSW)</i>

1. Objectives

The objectives of this Camp Management Plan (the Plan) are to:

- protect and maintain the Parramatta North flying-fox camp in the long-term
- manage public health and safety risks
- ensure development in the area is planned and managed sympathetic to flying-fox behaviours and requirements, and avoids creating conflict with the community
- enhance the amenity of the area
- improve community understanding and appreciation of flying-foxes, including their critical ecological role
- ensure management activities are consistent with the NSW Flying-fox Camp Management Policy (OEH 2015b) and the Flying-fox Camp Management Code of Practice 2018 under the Biodiversity Conservation Regulation 2017
- facilitate licence approval, where required, for actions at the camp under the Biodiversity Conservation Act 2016
- implement an adaptive approach to camp management that recognises the constraints of the site and the conflict between animals and humans, and provides for management actions to be adjusted where necessary based on lessons from implementation, monitoring outcomes, and feedback from wildlife carers, community and site managers.
- facilitate a coordinated approach to camp management that recognises the multiple landowners and responsibilities

2. Context

2.1 Camp area and history

The camp is at the centre of the metropolitan Sydney region in Parramatta North on the banks of the Parramatta River. Locations of the metropolitan camps in relation to Parramatta North are shown in **Figure 1**.

Core camp habitat at Parramatta North comprises approximately 2 ha of riparian vegetation upstream of Buttons Bridge (footbridge) (**Figure 2**). The western part of the camp is within Parramatta Park and Wisteria Gardens, and the eastern part is within the heritage precinct of the Parramatta North Urban Transformation (PNUT) area. The camp has moved further south and west into Parramatta Park since the previous Camp Management Plan in 2008. Some Parramatta residents remember the camp being in its current location since the 1960s. Flying-foxes in Parramatta were first recorded in written accounts in 1798 (Collins, 1798).

At Rose Hill the heat on the 10th and 11th of the month, on which days at Sydney the thermometer stood in the shade at 105, was so excessive, (being much increased by the fire in the adjoining,) that immense numbers of the large fox bat were seen hanging at the boughs of the trees, and dropping into the water, which, by their stench, was rendered unwholesome. They had been observed for some days before regularly taking their flight in the morning from the northward to the southward, and returning in the evening. During the excessive heat many dropped dead while on the wing; and it was remarkable, that those which were picked up were chiefly males.

Land uses and activities near the camp have changed over the decades. In the last three years nearby uses have included reconstruction of the Parramatta Stadium, repairs to heritage buildings on the eastern side of the camp and entertainment events in Parramatta Park.

As indicated in **Figure 3**, in recent years the camp has been permanently occupied by Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF), and occasionally Black Flying-foxes (*Pteropus alecto*). This is typical of camps in the Sydney metropolitan area.

The Parramatta North camp usually has approximately 5000-10,000 flying-foxes, although seasonal influxes of around 20,000 have been recorded in May 2014, August 2015 and February 2016. The quarterly data in **Figure 3** is from the National Flying-fox Monitoring Program (NFMP) coordinated by the Department of the Environment and Energy, with results available to the public via website¹. A point-based distance sampling method is used in the NFMP, in which people moving around a camp's perimeter and at random points count every flying-fox they can see and the distance of each flying-fox or cluster of flying-foxes from where they are standing. This distance is subsequently used to estimate the probability, otherwise known as detection error, of detecting a flying-fox.

Results from NFMP quarterly monitoring are consistent with monthly monitoring undertaken by ELA ecologists since 2016 in relation to the PNUT heritage building repairs. As discussed in the PNUT GHFF Summary Report (ELA 2018), the heritage building repairs were conducted in accordance with a flying-

¹ <http://www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf>

fox protocol (similar to the protocol in Chapter 6 of this Plan) and no adverse impacts were observed on individual flying-foxes or the camp.

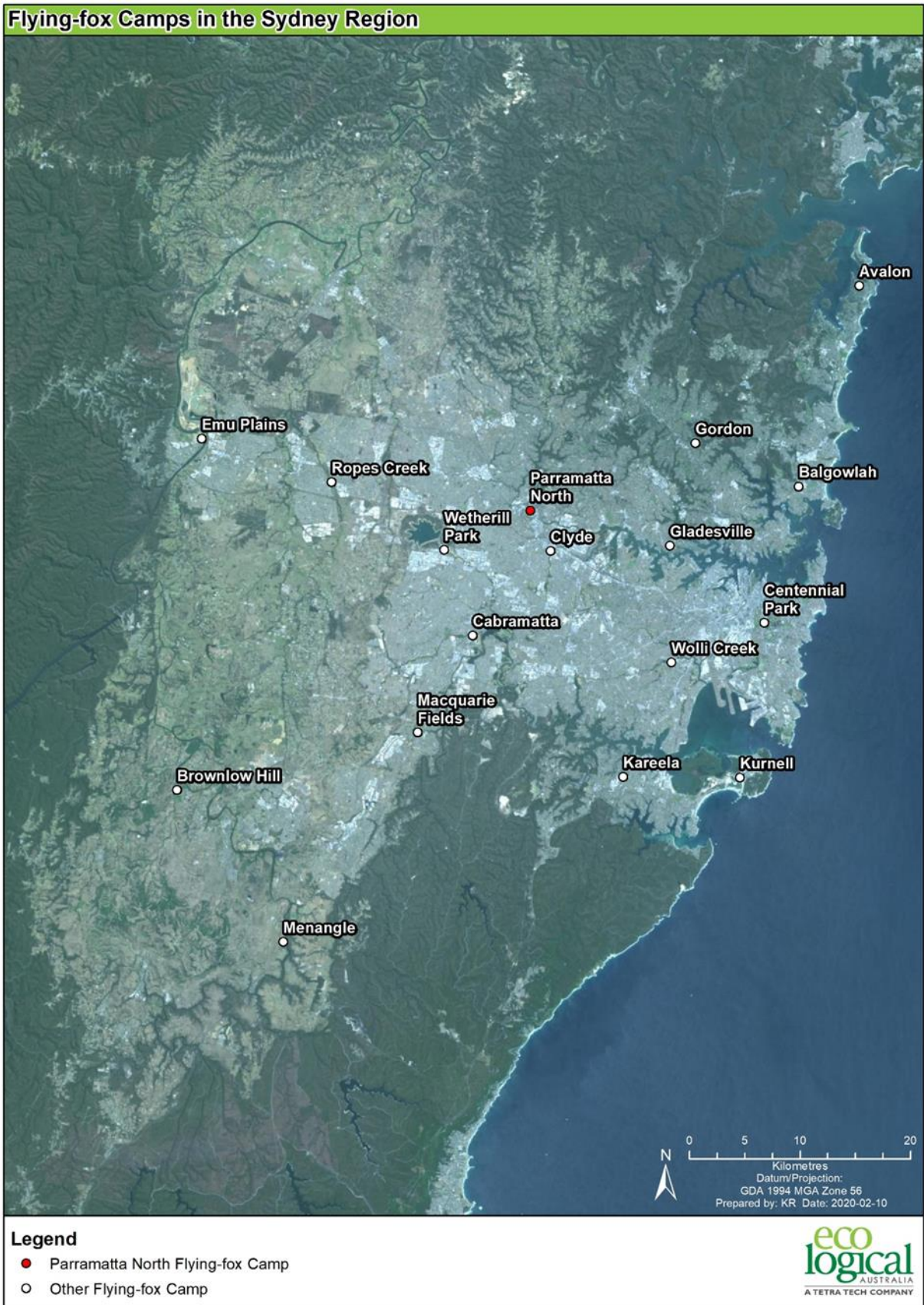


Figure 1 Flying-fox camps in the Sydney region



Figure 2 Parramatta North flying-fox camp location and 300 m radius around camp

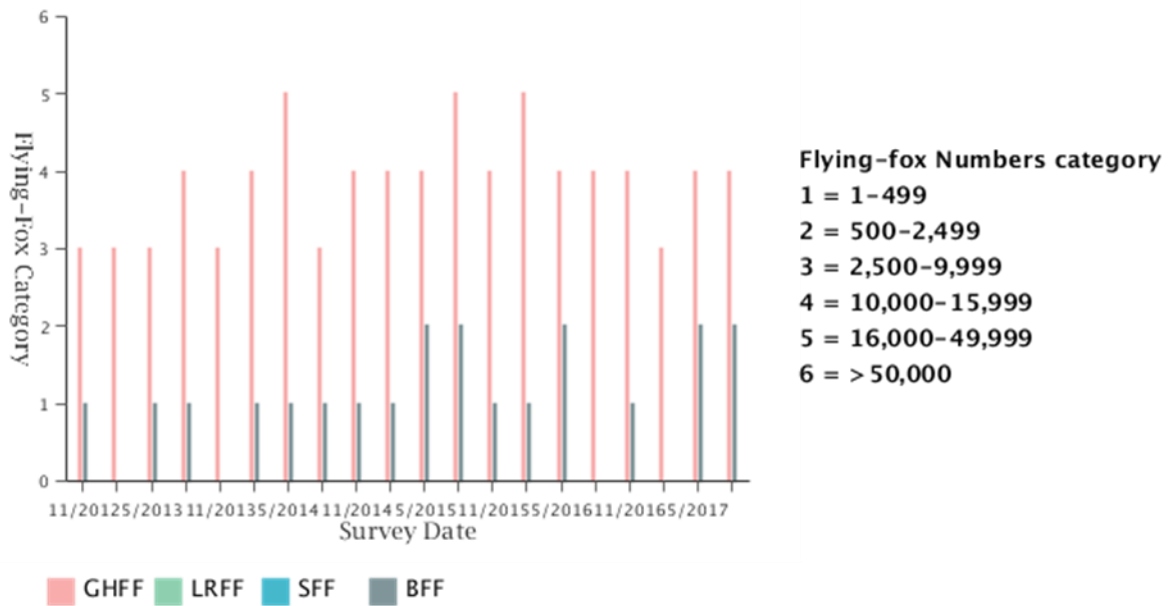


Figure 3 Quarterly records of flying-foxes at Parramatta North camp (Dept of Environment 8/2/2018)

2.2 Land tenure

The camp is on public land managed by the following government agencies:

- Parramatta Park Trust (PPT)
- Department of Health, planned to be transferred to Parramatta Council
- Properties NSW
- UrbanGrowth Development Corporation (UGDC)
- Properties NSW.

Despite being on public land, access has been limited on the eastern side due to the steep river banks and adjacent land uses. This has likely contributed to the longevity of the camp.

The land is zoned Infrastructure: Health Services Facilities (SP2) and Public Recreation (RE1) to the west, and zoned RE1, Mixed Use (B4) and Private Recreation (RE2) on the eastern side of the river (**Figure 4**).

The City of Parramatta has mapped the core camp area as 'Environmentally Sensitive Land' due to its outstanding biodiversity values. This has influenced recent plans for the PNUT site and needs to be considered in future planning for Parramatta Park, PNUT and surrounds.

2.2.1 Surrounding land uses

The lands surrounding the camp are currently used for a range of activities that can create conflict issues. These include:

- Parramatta Park
 - Events held at multiple locations within the park
 - Café / Little Coogee
 - Recreation Areas
 - Wisteria Gardens (including festivals)
 - Nearby loop road used by motorists and cyclists – and a future People's Loop

- Pedestrian access to the weir, causeway and bridges
- Old Kings Oval
- Parramatta Stadium
 - Major events planned
- Parramatta North Urban Transformation
 - Major redevelopment of the area is currently underway, including residential development planned close to the camp.

2.3 Stakeholders

Relevant land managers are responsible for any actions that impact on flying-foxes, and for delivery of this plan. This is particularly relevant for Parramatta Park Trust, UGDC and Council.

There are a range of stakeholders who are directly or indirectly affected by the flying-fox camp, or who are interested in its management. These include stakeholders likely to live, work or use the area within 300 m of the camp (**Figure 2**) over the next ten years. Stakeholders include those shown in **Table 1**.

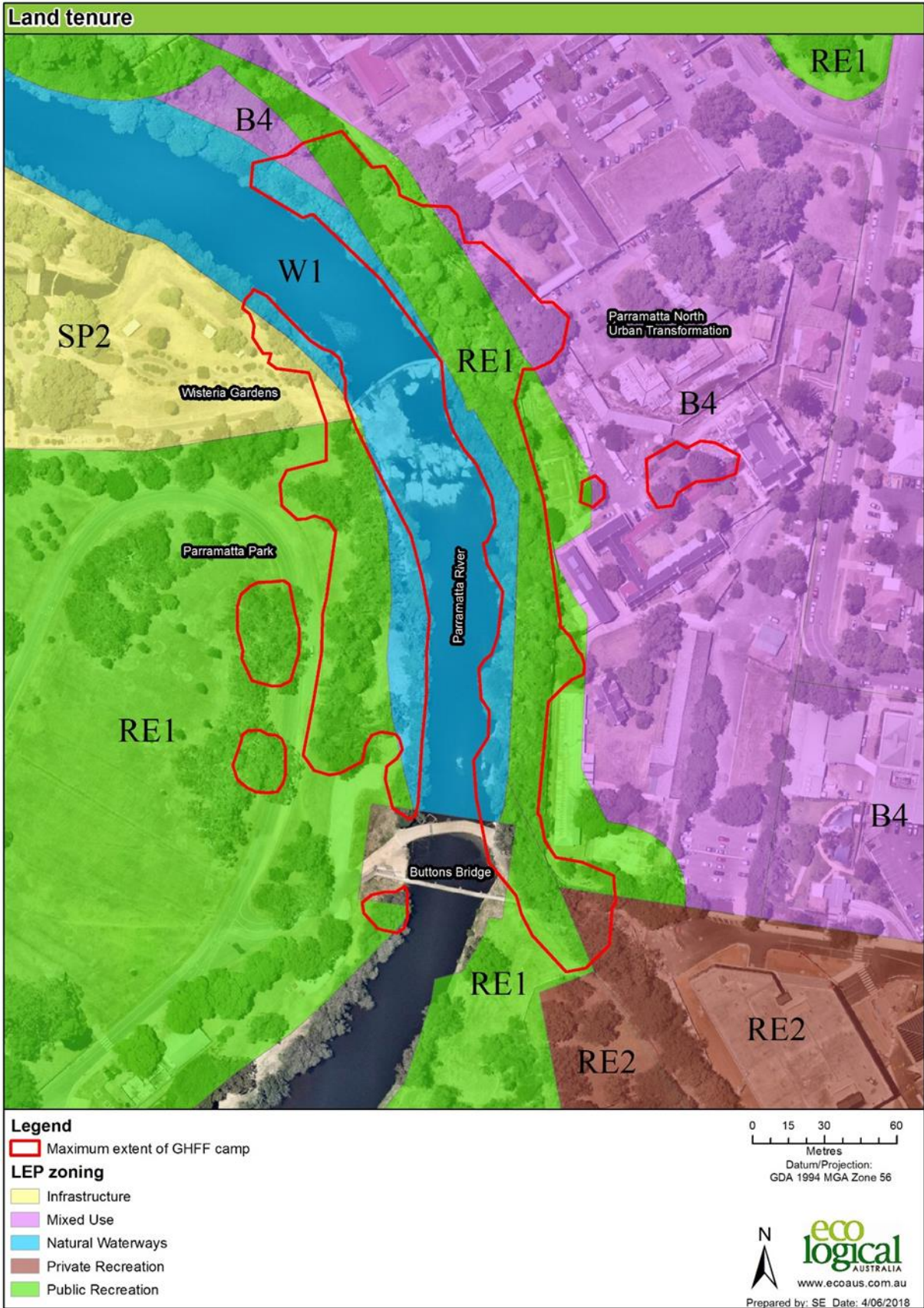


Figure 4 Land use zones (Parramatta LEP 2011)

Table 1: Stakeholders in the camp and Plan

Stakeholder	Interest/reported impacts
DPIE	DPIE is responsible for administering legislation relating to (among other matters) the conservation and management of flying-foxes.
Commonwealth Department of the Environment and Energy (DoEE)	DoEE is responsible for administering federal legislation relating to matters of national environmental significance, such as the Grey-headed Flying-fox and any other federally-listed values of the camp site.
Land owners	The camp is currently on land managed by Parramatta Park Trust, Parramatta Council, UGDC, Department of Health and Properties NSW. Long term responsibility for management of land is yet to be determined. An integrated management approach, consistent with this Plan is recommended.
Users of Parramata Park	<p>Parramatta Park is a popular destination for recreational activities such as walking, running, cycling, picnicking, nature photography, and organised events (e.g. concerts, film festival). It features landscaped and natural areas as well as cafes and car parking.</p> <p>There is a need to maintain or enhance amenity for park users by removing rubbish and controlling weeds at the camp.</p> <p>The camp needs to be managed and contained to minimise conflicts with recreation and Park business.</p>
Developers and construction workers	Parramatta North is central to the broader metropolitan region and is the subject of future planning and development. Any future development near the camp may be subject to restricted activities to avoid harm to the flying-foxes.
Future residents and organisations	The types and locations of future development in the area need to be planned and managed to avoid creating conflict over issues such as noise, odour and faecal drop.
Existing residents in the broader area	Flying-foxes forage at night up to 20 km from the camp. This can disturb residents and cause short-term conflict.
Civic leaders and influencers (including local, state and federal politicians)	A wide range of views have been expressed by local politicians and other influencers. These views range from a preference to disperse the camp through to protect the camp and use it as an eco-tourist attraction.
Wildlife carers and conservation organisations e.g. <ul style="list-style-type: none"> • Sydney Metropolitan Wildlife Services (Sydney Wildlife) • NSW Wildlife Information, Rescue and Education Service (WIRES) • Royal Society for the Protection of Animals (RSPCA) • Australasian Bat Society 	Wildlife carers and conservation organisations are actively engaged in flying-fox welfare and conservation at Parramatta North. Volunteers with these groups provide valuable advice and assistance with care of sick or injured flying-foxes, including during heat stress events.
Equine facilities and vets <ul style="list-style-type: none"> • Sydney Equestrian Centre • Sydney International Equestrian Centre • Portelli Racing • Warwick Farm Equine Centre 	Equine facility managers and local vets should be aware of Hendra virus risk and appropriate mitigation measures. Where feasible, all horse owners within 20 km of the camp should be included in such communications.

Stakeholder	Interest/reported impacts
Researchers/universities/CSIRO	Researchers have an interest in flying-fox behaviour, biology and conservation.

2.4 Community engagement

The draft Parramatta Flying-fox Camp Management Plan was prepared by consultants Eco Logical Australia (ELA), in collaboration with relevant landholders (Parramatta Park Trust, Parramatta Council and Urban Growth NSW) and the Department of Planning, Industry and Environment (DPIE).

The plan was publicly exhibited from 18 June 2019 to 19 July 2019 on the websites of the Parramatta Park Trust and Parramatta Council. Notification about the exhibition was also sent to key stakeholders, including the local branch of WIRES and a concerned resident. DPIE also promoted the draft plan at a WIRES Bat event night during the exhibition period. Four submissions were received and a number of changes were made to the final plan in response to submissions.

2.5 Reported issues related to the camp

Despite being in a highly urbanised area in the centre of Sydney, the nearest residence is approximately 150 m and the closest hospital, Cumberland Hospital, is approximately 200 m from the camp. The lack of potentially conflicting adjacent land uses has likely been a reason why there are very few records of complaints from the community about the flying-fox camp. Members of the community have expressed concern to the land managers regarding flying-foxes through comments relating to:

- disturbance of the camp by landscape and facilities management activities in Parramatta Park,
- disturbance of the camp by Park visitor activities in Parramatta Park,
- feral foxes attacking or killing flying-foxes that have fallen to the ground.
- faecal drop on the road and paths making them unsafe
- destruction of the vegetation by the animals

General matters raised and discussed by ELA regarding the camp during community education events facilitated by UGDC over the last two years relate to:

- faecal drop
- smell
- potential disease transmission
- damage to vegetation
- the landscape-scale benefits flying-foxes provide through seed dispersal and pollination
- the need to conserve flying-foxes as an important native species
- enjoyment at watching flying-foxes at the camp and/or flying out or in
- the value of the camp as a potential tourism opportunity/attraction.

Land managers have identified the need for improved amenity, including weed and rubbish control at the camp.

2.6 Management response to date

Table 2: Management responses to date for the Parramatta North camp

Reference	Actions taken	Action was taken by
Camp Management Plan (ELA 2008)	<ul style="list-style-type: none"> • Weed removal and regeneration works <ul style="list-style-type: none"> ○ weed removal within core camp undertaken by bush regenerators ○ gradual removal of woody weeds within core camp to maintain the microclimatic conditions ○ suppression of weed growth to facilitate growth of new native canopy species ○ planting of preferred roost trees within current roosting habitat and other natives to enhance the ecological community ○ preparation of a long-term regeneration / restoration plan by Parramatta Park Trust (PPT) and Sydney West Area Health Services (SWAHS) • Installation of educational signage within Parramatta Park • Fencing to limit public access at the north and south extent of the Camp on the eastern bank. 	Parramatta Park Trust
Protocol for construction contractors at PNUT (ELA 2015)	A protocol and associated camp monitoring have been implemented during the heritage building repairs	PNUT contractors on behalf of UGDC
Riparian Management Strategy (ELA and TKD 2015)	Prepared on behalf of UGDC to inform planning and future development of the riparian corridor, recognising the important ecological and heritage features of the area Development approval is the responsibility of multiple agencies including the City of Parramatta	Strategy prepared by PNUT contractors on behalf of UGDC
Discussions with various wildlife carers (pers. Comm. ELA)	Wildlife care by volunteers e.g. during heat stress events, or as needs when there is a sick or injured animal	Volunteer wildlife carers

2.7 Other ecological values of the site

Vegetation at the camp is River-flat Eucalypt Forest, which is listed as an Endangered Ecological Community (EEC) under the BC Act.

The current condition of this community within the site varies, with most patches being low to moderate condition. Patches in moderate condition contained a tree canopy, shrub layer and ground layer. Weeds are common and dominate some parts of the patch. Some patches of vegetation have been subject to regular management (such as weed removal) and fenced off to limit public access.

Patches in low condition contain little of the original vegetation, are small in area and lack diversity. Some patches in low condition have been subject to active vegetation restoration; plantings and weed management.

A list of threatened species known or likely to occur within 10 km of the site is tabulated below. No threatened flora species are known or likely to occur. Six threatened fauna species are considered to

have potential to occur on site, including the GHFF. Only one other threatened fauna species has been recorded on site, *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat) (ELA 2015).

Table 3: Threatened species and ecological communities known or predicted at the site

Species name	Common name	Status		Likelihood of occurring
Fauna				
		BC Act	EPBC Act	
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V,P		Recorded on site
<i>Mormopterus norfolkensis</i>	Eastern Freetail-bat	V,P		Potential
<i>Myotis macropus</i>	Southern Myotis	V,P		Potential
<i>Ninox strenua</i>	Powerful Owl	V,P,3		Potential
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V,P	V	Recorded on site
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bat	V,P		Potential
Threatened ecological communities				
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions		E		Recorded on site

3. Legislation and policy

3.1 State

3.1.1 Flying-fox Camp Management Policy 2015

The Flying-fox Camp Management Policy 2015 (the Policy) has been developed to empower land managers, primarily local councils, to work with their communities to manage flying-fox camps effectively. It provides the framework within which DPIE will make regulatory decisions. In particular, the Policy strongly encourages local councils and other land managers to prepare Camp Management Plans for sites where the local community is affected.

3.1.2 Crown Lands Act 1989

The principles of Crown land management include the observance of environmental protection principles and the conservation of its natural resources, including water, soil, flora, fauna and scenic quality. Any works on land that is held or reserved under the *Crown Lands Act 1989* (including vegetation management and dispersal activities) are an offence under the Act without prior authorisation obtained through the Department of Primary Industries (Lands).

3.1.3 Local Government Act 1993

The primary purpose of this Act is to provide the legal framework for an effective, efficient and environmentally responsible, open system of local government. Most relevant to flying-fox management is that it also provides encouragement for the effective participation of local communities in the affairs of local government and sets out guidance on the use and management of community land which may be applicable to land which requires management of flying-foxes.

3.1.4 Biodiversity Conservation Act 2016

The objects of the *Biodiversity Conservation Act 2016* (BC Act) include to conserve biological diversity and protect the critical habitat of threatened species, populations and ecological communities. The GHFF is listed as threatened under the BC Act (see also [Why the Grey-headed Flying-fox is listed as a threatened species](#)).

Part 2 of the BC Act provides for the application of licences if the proposed action is likely to result in:

- a. harm to an animal that is a threatened species or part of an ecological community
- b. picking a plant that is a threatened species or part of an ecological community
- c. damage to a habitat of a threatened species or ecological community
- d. damage to a declared area of outstanding biodiversity value

After submission of a Biodiversity Conservation Licence application and application fee, DPIE will process the application. The possible outcomes are that DPIE could grant a Threatened Species licence under Part 2 of the BC Act, with or without conditions, or DPIE could refuse the application.

The Flying-fox Camp Management Code of Practice 2018 is made under clause 2.9 of the Biodiversity Conservation Regulation 2017 is to authorise camp management actions in flying-fox camps in NSW to provide convenience for carrying out or giving effect to this Act.

3.1.5 Prevention of Cruelty to Animals Act 1979

It may be an offence under this Act if there is evidence of unreasonable/unnecessary torment associated with management activities. Adhering to welfare and conservation measures provided in Section 10.3 will ensure compliance with this Act.

3.1.6 Environmental Planning and Assessment Act 1979

The objects of the *Environmental Planning and Assessment Act 1979* (EP&A Act) are to encourage proper management, development and conservation of resources, for the purpose of the social and economic welfare of the community and a better environment. It also aims to share responsibility for environmental planning between different levels of government and promote public participation in environmental planning and assessment.

The EP&A Act is administered by the NSW Department of Planning and Environment.

Development control plans under the Act should consider flying-fox camps so that planning, design and construction of future developments is appropriate to avoid future conflict.

Development under Part 4 of the Act does not require licensing under the BC Act.

Where public authorities such as local councils undertake development under Part 5 of the EP&A Act (known as ‘development without consent’ or ‘activity’), assessment and licensing under the BC Act may not be required. However, a full consideration of the development’s potential impacts on threatened species will be required in all cases.

Where flying-fox camps occur on private land, land owners are not eligible to apply for development under Part 5 of the EP&A Act. Private land owners should contact Council to explore management options for camps that occur on private land.

3.2 Commonwealth

3.2.1 Environment Protection and Biodiversity Conservation Act 1999

The Commonwealth’s *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides protection for the environment, specifically matters of national environmental significance (MNES). A referral to the Commonwealth DoEE is required under the EPBC Act for any action that is likely to significantly impact on an MNES.

MNES under the EPBC Act that relate to flying-foxes include:

- world heritage sites (where those sites contain flying-fox camps or foraging habitat). This is relevant to the Parramatta North camp, as the camp is located within the Old Government House and Domain listed site, which is one of the sites that form the Australian Convict Sites World Heritage Property.
- wetlands of international importance (where those wetlands contain flying-fox camps or foraging habitat)
- nationally threatened species and ecological communities.

The grey-headed flying-fox (*Pteropus poliocephalus*; GHFF) is listed as a vulnerable species under the EPBC Act, meaning it is an MNES. It is also considered to have a single national population. DoEE has

developed the [Referral guideline for management actions in GHFF and SFF² camps](#) (DoEE 2015) (the Guideline) to guide whether referral is required for actions pertaining to the GHFF.

The Guideline defines a nationally important GHFF camp as one that has either:

- contained $\geq 10,000$ GHFF in more than one year in the last 10 years, or
- been occupied by more than 2500 GHFF permanently or seasonally every year for the last 10 years.

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

Referral will be required if a significant impact to any other MNES is considered likely as a result of management actions outlined in the Plan. Self-assessable criteria are available in the [Significant Impact Guidelines 1.1](#) (DoEE 2013) to assist in determining whether a significant impact is likely; otherwise consultation with DoEE will be required.

Mitigation standards

- The action must not occur if the camp contains females that are in the late stages of pregnancy or have dependent young that cannot fly on their own.
- The action must not occur during or immediately after climatic extremes (heat stress event³, cyclone event⁴), or during a period of significant food stress⁵.
- Disturbance must be carried out using non-lethal means, such as acoustic, visual and/or physical disturbance or use of smoke.
- Disturbance activities must be limited to a maximum of 2.5 hours in any 12 hour period, preferably at or before sunrise or at sunset.
- Trees are not felled, lopped or have large branches removed when flying-foxes are in or near to a tree and likely to be harmed.
- The action must be supervised by a person with knowledge and experience relevant to the management of flying-foxes and their habitat, who can identify dependent young and is aware of climatic extremes and food stress events. This person must make an assessment of the relevant conditions and advise the proponent whether the activity can go ahead consistent with these standards.
- The action must not involve the clearing of all vegetation supporting a nationally-important flying-fox camp. Sufficient vegetation must be retained to support the maximum number of flying-foxes ever recorded in the camp of interest.

² spectacled flying-fox (*P. conspicillatus*)

³ A 'heat stress event' is defined for the purposes of the Australian Government's Referral guideline for management actions in GHFF and SFF camps as a day on which the maximum temperature does (or is predicted to) meet or exceed 38°C.

⁴ A 'cyclone event' is defined as a cyclone that is identified by the Australian Bureau of Meteorology (www.bom.gov.au/cyclone/index.shtml).

⁵ Food stress events may be apparent if large numbers of low body weight animals are being reported by wildlife carers in the region.

These standards have been incorporated into mitigation measures detailed in Section 10.3. If actions cannot comply with these mitigation measures, referral for activities at nationally important camps is likely to be required.

4. Camp management

Management zones have been identified for the camp and immediate surrounds (refer to **Table 4** and **Figure 5**). Management responses for each of these zones conform with the 'Level 1 – routine camp management' actions in the OEH policy. Level 2 (creating buffers) and Level 3 (dispersal) actions in the OEH policy would not be consistent with the objectives of this plan and are therefore not recommended.

Table 4: Management zones and actions

Zone#	Purpose	Required management
Core habitat - existing	Sustain the flying-fox population in situ by allowing natural regeneration of trees or assisting regeneration with adaptive management, revegetation and other works as required	Public access restricted – signage and fences may be installed to manage human disturbance Mowing or other machine works under strict control protocols Staged weed control Ongoing rubbish removal Revegetation of cleared areas with tree species that will grow to >5 m, and mid-storey species to offer protection, shade and moisture during heat stress events. No disturbance actions allowed. Consult with DPIE if management actions need to be amended
Controlled habitat	overflow Provide overflow habitat when the core camp is full Provide a buffer between the core habitat and adjacent areas Provide a temporary location for camp to migrate to allow core habitat to regenerate	Maintain scattered tall trees with grass groundcover Public access allowed Mowing and other landscape maintenance machinery allowed If site becomes unsuitable as habitat, disturbance actions allowed to move flying-foxes on in accordance with DPIE licensing requirements
Unsuitable habitat	Adjacent existing and future development areas To avoid harm to flying-foxes and reduce risk of conflict May be suitable for foraging	Implement construction protocols to avoid harm to flying-foxes Consider potential impacts or conflicts associated with development or activities near the camp Education and awareness programs Property design or modification Disturbance actions allowed to move flying-foxes on in accordance with DPIE licensing requirements Implement design controls that include directions about species to use in landscaping, to avoid using flying-fox foraging species in high conflict sensitive areas.

Zone#	Purpose	Required management
		Support the use of foraging species in parklands and open space where foraging can be supported.

Figure 5 shows management zones

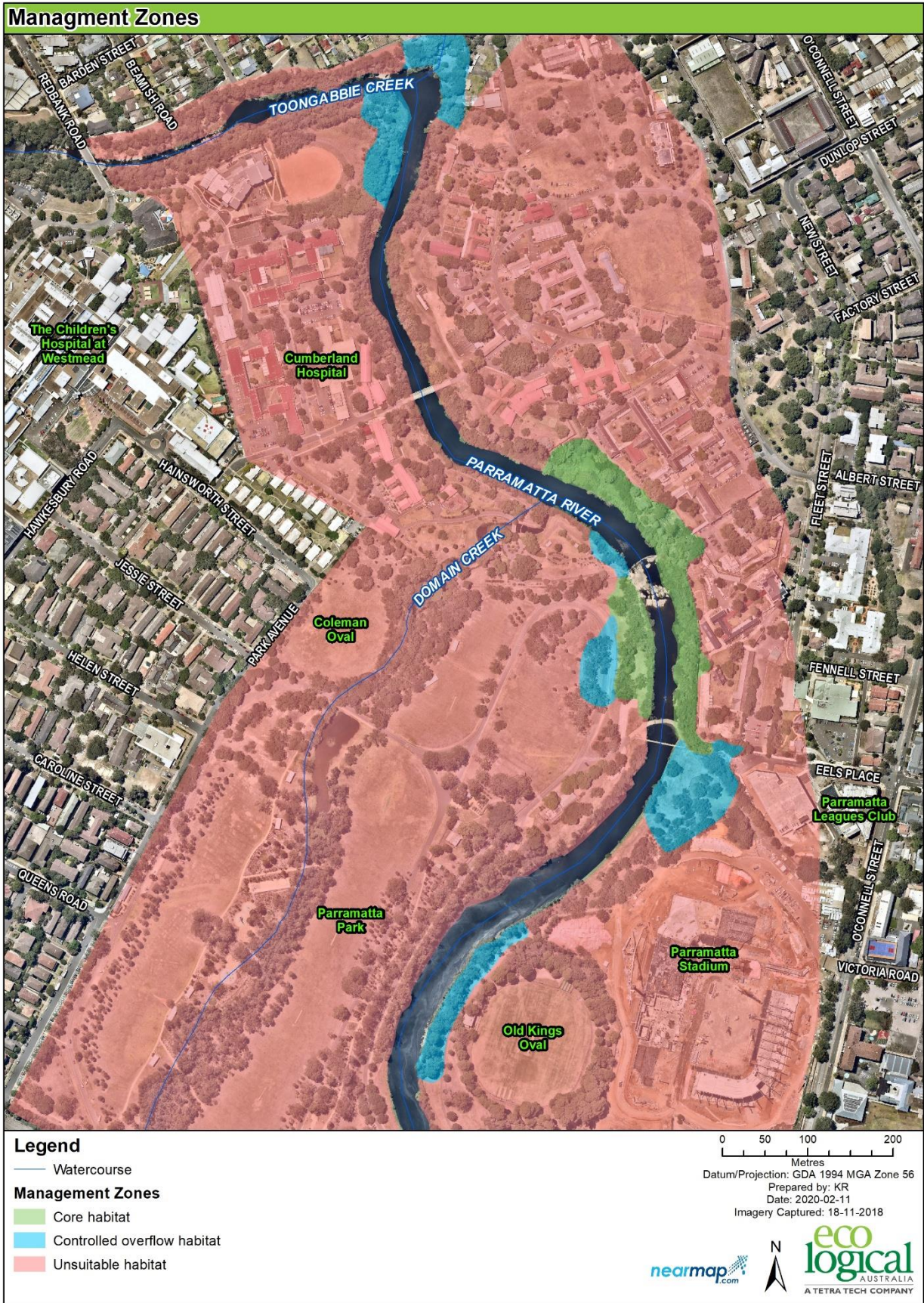


Figure 5 Management zones for Parramatta North flying-fox camp

4.1 Land-use planning

The camp is recognised as a constraint to nearby development and activities in Parramatta North to protect the flying-foxes and prevent conflict with future users of adjacent development areas (e.g. PNUT). The planning and development process is informed by:

- formal planning instruments such as the Environmentally Sensitive Lands layer in the Parramatta LEP
- this camp management plan
- other plans and strategies, including the PNUT Riparian Corridor Strategy (ELA 2016).

The 2016 PNUT Riparian Strategy provides the framework for managing the important ecological and heritage values of the eastern bank of the camp. Relevant planning principles that were identified include:

- *There needs to be an ongoing commitment to transformation and management of the corridor due to its degraded condition and urbanised setting (e.g. potential for weeds, litter, vandalism).*
- *The significant ecological and cultural heritage values of the riparian corridor will be retained, conserved and enhanced.*
- *Where management objectives for ecological and cultural heritage values conflict or are inconsistent then further consideration of alternative options will need to be undertaken until an appropriate balance is achieved.*
- *Specialists (e.g. ecologist, Aboriginal and historical (non-Aboriginal) archaeologists and cultural landscape specialists) will need to provide further technical advice on issues if they arise during detailed planning and on-ground works in the riparian corridor.*
- *Vegetation will be restored or managed so that the river banks are not exposed to potential erosion. This may require temporary erosion control measures (e.g. jute mat) when weeds are removed and prior to plants becoming established either by revegetation or regeneration.*
- *Bush regeneration, where applicable, will be conducted in a staged or mosaic pattern, by hand where possible, to minimise the risk of erosion/sedimentation, loss of habitat, and risk of disturbing significant cultural heritage elements, such as views, building settings, cultural plantings and Aboriginal and/or historical (non-Aboriginal) archaeology.*
- *Public access to the GHFF camp will be restricted by physical barriers and signage, subject to consistency with the cultural heritage values of the site.*
- *The camp and surrounding development will be managed so that the camp is sustained in situ.*
- *The heritage wall on the edge of the camp will be retained and restored (taking into account suitable times and methods to avoid impacts to the GHFF). The wall will provide a partial barrier between the camp and adjacent uses.*
- *Protocols need to be established to manage heat stress as this can result in mass injury and death of flying-foxes.*

Additional matters to consider during detailed planning and design of building activation or modification in areas outside core habitat include:

- no permanent paths will be built within the camp on the eastern bank
- no new buildings will be built within 50 m of the camp

- The adaptive re-use of significant buildings will take into consideration the need to avoid conflict between the GHFF and people. Likely considerations will include odour, noise and faecal drop associated with the camp. For example:
 - Position eating areas (e.g. cafe tables) under covered areas to avoid contamination by flying-foxes.
 - Install double-glazed windows, insulation and use air-conditioners when needed to reduce noise disturbance and smell associated with a nearby camp.
 - Avoid building designs that generate excessive noise and light.

Adjacent development will be subject to planning approval. It is recommended that applications for approval of development or activities incorporate the camp protocol in Section 6 that explains how to minimise disturbance, stop work triggers and monitoring requirements. These protocols should apply to all on-ground work within 100 m of core camp habitat.

4.2 Access and signage

The existing wooden barriers and occurrence of long grass are likely to create enough of a buffer between the camp and Park visitors that formal fencing is not required.

Access to the rock platform (e.g. for photographers) will be formalised in a location and manner that avoids removal of habitat trees and minimises likely disturbance of the camp. Carefully formalising the access, including signage, is considered a better approach than allowing unregulated access through the camp.

Signs about flying-foxes have been erected near Buttons Bridge and the ridgeline in Parramatta Park to promote public awareness about the Parramatta North camp. These signs will be reviewed and, if necessary, updated and replaced by the Trust. Any new bridge crossings will be designed to minimise any impacts to the Camp.

4.3 Vegetation management

4.3.1 Mowing and other machinery use

Mowing and using brush-cutters within core habitat (existing and to be enhanced / established) will be managed under strict protocols to promote vegetation regrowth and prevent disturbance to the camp. Regrowth should be monitored and managed by bush regeneration practices (see below) to promote native species rather than weeds. Chainsaws may only be used when the cause is to reduce a health and safety risk situation (eg, unstable tree). Chippers are not allowed in the core habitat.

Mowing, brush cutting or use of other powered machinery (chainsaws, chippers) will be permitted in overflow habitat areas to maintain grass with scattered trees under strict protocols.

All other adjacent landscape works must operate mindful of impacts to the camp and refer to stop work triggers for operation.

4.3.2 Regeneration and revegetation

A staged program of bush regeneration and revegetation is recommended to consolidate and provide replacement habitat in core areas. Replanting and weed control in core habitat should be performed by trained and qualified bush regenerators, preferably vaccinated for Lyssavirus.

Core habitat has been mapped as having moderate or low native species resilience. Regeneration will need to be monitored and managed to ensure that regrowth is consistent with species associated with the River Flat Eucalypt Forest (RFEF) vegetation community rather than weeds. Removal of weeds and replacement by native species should be gradual (over years) to ensure the microclimatic conditions are maintained.

Areas that are not regenerating with preferred species should be revegetated with tree species that will grow > 5 m tall (**Table 5**), and planted at a density of 1/25 m². Additional shrub and groundcover species consistent with the ecological community may supplement the canopy planting.

Cocos Palms in or near the camp should be removed as GHFF can choke on their fruit.

Table 5: Recommended RFEF tree species for revegetation

Scientific name	Common name
<i>Acacia decurrens</i>	Green Wattle
<i>Angophora floribunda</i>	Rough-barked Apple
<i>Eucalyptus amplifolia</i>	Cabbage Gum
<i>Eucalyptus moluccana</i>	Grey Box
<i>Eucalyptus tereticornis</i>	Forest Red Gum
<i>Melaleuca decora</i>	White Feather Honeymyrtle

4.4 Maintenance activities

Routine camp management actions include:

- rubbish removal
- tree limbs or whole trees in the overflow habitat zone that pose a genuine health and safety risk, as determined by a qualified arborist, should be removed when no flying-foxes are roosting in these trees
- faecal matter should be removed from adjacent pedestrian / cycle tracks and facilities, as required.

Routine maintenance tasks should be conducted at least annually.

4.5 Education and awareness programs

The camp's accessible location provides an opportunity for a flying-fox education and awareness program to provide accurate information to the community about flying-foxes. Such a program would include managing risk and alleviating concern about health and safety issues associated with flying-foxes, options available to reduce impacts from foraging flying-foxes, an up-to-date program of works being undertaken at the camp, and information about flying-fox numbers and flying-fox behaviour at the camp.

The likelihood of improving community understanding of flying-fox issues is high. Extensive education for decision-makers, the media and the broader community is required to overcome negative attitudes towards flying-foxes.

Currently very few complaints have been made to Council by local residents regarding the Parramatta North flying-fox camp. However, the response to community education events facilitated by UGDC indicates that the community is receptive to information about the camp and flying-foxes in general. Informative signage could be installed (pending heritage protocols) around the perimeter of the core camp boundary to provide educational material to the public (see **Figure 5**).

WIRES North West host Bat Nights at Parramatta Park for members of the community when funding and community interest provides opportunity.

There is potential to incorporate the camp in future ecotourism ventures associated with Parramatta Park and PNUT.

4.6 Heat stress management

The Parramatta North flying-fox camp is susceptible to heat stress and is likely to become increasingly so with the increased temperatures and extreme weather events under predicted climate change (Welbergen et al, 2008). The Flying-fox Heat Stress forecaster <http://www.animalecologylab.org/ff-heat-stress-forecaster.html> (Welbergen 2017a) should be monitored prior to a predicted heat wave where local temperatures are likely to exceed 38°C.

Parramatta Park may close / reduce public access to camp when a public health risk, food shortage or roost collapse has been determined. Access should be restricted for a suitable period to allow flying-foxes to recover, to arrange removal of bodies and to reduce the risk of members of the public coming into contact with dead/injured flying-foxes. Relevant stakeholders (e.g. Council, Parramatta Park Trust, OEH and wildlife carers) should determine when to allow access to the camp. Trained and vaccinated staff and volunteers will be exempt from public access exclusions to attend to affected flying-foxes if required.

WIRES Sydney North West branch have a Heat Stress Plan to respond to future heat-stress events which may affect the Parramatta North GHFF colony. During known heat-stress events WIRES volunteers actively monitor the camp to determine if / when intervention is required. Intervention occurs in conjunction with Sydney Wildlife and generally involves triage, rehydration and removal of the animal into care. Current management practices do not involve preventative measures, but the possibility of installation of a spray system and using the Parramatta River as a water source for spraying, prior to intervention becoming necessary, has been suggested (Sarah Cohen, WIRES, pers. comm 2018).

4.7 Analysis of actions

An analysis of the recommended actions is tabulated below. All actions are Level 1 and compared to Level 2 or 3 actions (such as camp dispersal) are low cost.

Table 6: Analysis of management actions (all Level 1)

Management	Cost	Advantages	Disadvantages
Land use planning	\$	Likely to avoid or reduce future conflict (and associated cost and problems) Camp sustainability	
Access and signage	\$	Improve amenity and awareness	Land-use restrictions impact the landholder
Vegetation management	\$\$	Reduced area to mow Camp sustainability Improved amenity	Reduce visual amenity, impact on heritage values
Maintenance activities – rubbish and faecal matter	\$\$	Improve public perception of the site Manage public safety risks	Weed removal and replacement roost trees planting should be done carefully over years to avoid adverse microclimate changes, otherwise activities may constitute a Level 3 action Ongoing vegetation management costs Ongoing maintenance costs
Education	\$	Improve environmental awareness and enjoyment, and reduce general need for intervention	Ongoing costs Education and advice itself will not adequately address the objectives of this plan
Heat stress management	\$	Animal welfare and conservation	Reliance on volunteers

5. Assessment of impacts

Management actions recommended in Chapter 4 are intended to minimise disturbance to the flying-foxes. However, some disturbance is possible during:

- vegetation management within the core habitat area
- construction or other noisy activities within 100 m of the core habitat.
- events at Parramatta Park or Parramatta Stadium
- if GHFF roost in unsuitable habitat

The protocol in Chapter 6 aims to mitigate potential impacts.

This plan does not replace the need for ecological impact assessment of any proposed development or major activity near the camp. However, it provides guidance on how adverse impacts can be minimised.

No significant removal of flying-fox habitat or active dispersal of the camp is recommended in the plan and as such there are not expected to be any impacts upon other camps in the region (**Figure 1**).

GHFF roosting in unsuitable habitat may be dispersed with the aim to encouraging them to roost in the core camp or controlled overflow habitat.

GHFF roosting in controlled overflow habitat may be dispersed with the aim to encouraging them to roost in the core camp once the need for the controlled overflow habitat is deemed unnecessary.

Impacts to other threatened species and ecological communities are likely to be as follows:

- No change to habitat for threatened microbat species such as *Miniopterus schreibersii oceanensis* (Eastern Bentwing-bat)
- Long-term improvement in the condition and extent of RFEF.

5.1 Licensing and approvals

It is understood that relevant land managers will manage the camp and surrounds in line with the Flying-fox Camp Management Code of Practice 2018. Land managers will submit a Biodiversity Conservation Licence to DPIE to undertake actions in accordance with this CMP that fall outside the code. The following actions will need to be undertaken under licence:

- disturbance of GHFF in unsuitable habitat
- disturbance of GHFF in controlled overflow habitat
- Installing park maintenance infrastructure to manage Park users
- Installing interpretation infrastructure
- Tree clearing and management for creating buffers.

Due to the location of the camp within Parramatta Park, it is expected that a multi-year license aligned to the actions under this Management Plan would be appropriate.

6. Protocol to mitigate potential impacts

The following protocol needs to be implemented for any activities within or near the camp that could disturb the flying-foxes. It is recommended that this protocol be incorporated in safe work method statements and induction materials for staff and contractors working in or near the camp.

The purpose of the protocol is to reduce the risk of harm to people and animals.

This protocol includes disturbance to GHFF that roost in unsuitable habitat or controlled overflow habitat.

This protocol is to be used as the basis for management protocols for events. Event protocols for GHFF are mandatory within event management plans.

6.1 Communication and responsibilities

All staff and contractors working within 100 m of the core habitat are to undertake environmental inductions regarding disease risks associated with flying-foxes and the stop work triggers (**Table 7**).

A designated ecologist⁶ should be available to contact at any time if there are concerns for the welfare of GHFF at the camp. If needed, the ecologist will inspect the camp and provide advice.

Any stop work decision would be made by the relevant land manager.

The public and land users need to know who to contact (e.g. WIRES or Sydney Wildlife) if dead or injured flying foxes are found. A range of communication and messaging methods will be employed to facilitate this.

It is the responsibility of the land manager and contractors to conduct a risk assessment and determine workplace health and safety requirements; however minimum requirements are provided below.

6.2 Working in core habitat and immediate surrounds

6.2.1 General

- All personnel working in the camp will wear protective clothing including long sleeves and pants. Additional items such as eye protection and a hat are also recommended. People working under the camp should wash their clothes daily. Appropriate hygiene practices will be adopted such as washing hands with soap and water before eating/smoking.
- A wash station will be available along with an anti-viral antiseptic (e.g. Betadine) should someone be bitten or scratched. If a person is bitten or scratched by a FF they should:
 - wash the wound with soap and water for at least five minutes (do not scrub)
 - contact their doctor immediately to arrange for post-exposure vaccinations.
 - If bat saliva contacts the eyes, nose, mouth or an open wound, flush thoroughly with water and seek immediate medical advice.

⁶ All references to ecologist in this section assumes an ecologist with skills and experience as set out in Appendix A

- Details of the nearest hospital or doctor who can provide post-exposure prophylaxis will be kept on site.
- Only trained and vaccinated personnel should handle injured or dead flying-foxes.

6.2.2 Weed control, revegetation and landscape maintenance

- Vegetation management in the core camp habitat will be carried out by suitably qualified and experienced bush regenerators, with at least one supervisor knowledgeable about flying-fox habitat requirements and experienced in working under a camp.
- Vegetation modification, including weed removal, will not alter the conditions of the site such that it becomes unsuitable flying-fox habitat for Level 1.
- Weed removal should follow a mosaic pattern, maintaining refuges in the mid- and lower storeys at all times.
- Weed control in the core habitat area will be undertaken using methods to minimise time in the core habitat for most effective outcomes. This may include the use of machinery under the protocols and triggers below.
- Species selected for revegetation will be consistent with the RFEF habitat on site.
- Landscape maintenance outside the core habitat must be aware of the triggers and protocols and initiate risk reduction from 50m radius.

The following table identifies potential stop work triggers and signs, and how to mitigate impacts to flying-foxes in the camp.

Table 7: Triggers and actions to mitigate impacts

Welfare trigger	Signs	Actions
Signs of stress	<ul style="list-style-type: none"> • more than 30% of the camp takes flight and individuals are in flight for more than 20 minutes • saliva spreading • located on or within 2 m of the ground • aborting young 	Cease disturbance for the day and contact an ecologist to monitor stress levels if the activity needs to be done the following day/s
Breeding season	<ul style="list-style-type: none"> • females in final trimester (generally August – September) • dependent/crèching young present (generally September – January) 	<p>Noise-generating activities (e.g. building demolition, tree removal, woodchipping) within 100 m of the camp to be avoided where possible</p> <p>If not possible to avoid, then consult an ecologist for guidance</p> <p>Noise generating activities outside of 100m such as construction works or Park or Stadium events to consider GHFF as a sensitive receiver in sound management plans and include in monitoring</p>
Gale force wind	<ul style="list-style-type: none"> • inability to forage • located on or within 2 m of the ground 	Minimise disturbance within 100 m of the camp and monitor animal welfare
Heat stress	<ul style="list-style-type: none"> • panting • saliva spreading • located on or within 2 m of the ground 	Monitor weather conditions and prepare teams to respond to heat stress - refer to Section 4.6 for details

Welfare trigger	Signs	Actions
Food shortage	<ul style="list-style-type: none"> loss of condition evident 	Minimise disturbance within 100 m of the camp and monitor animal welfare
Injury/death	<ul style="list-style-type: none"> a flying-fox appears to have been injured/killed due to non-natural causes 	<p>Contact an ecologist or wildlife carer if needed</p> <p>Investigate possible cause and cease action that was a factor, if relevant</p>

The following protocols must be followed where machinery is used in the core camp, overflow area or adjacent to the site:

- Ensure all plant and equipment is maintained to Australian Standards to minimise noise generation.
- Position plant and equipment as far from the camp as possible.
- Shield noise at its source, where possible.
- Modify equipment to produce less noise or use alternative construction techniques to minimise noise.
- Avoid construction or noise activities during hours when the GHFF are most settled in the camp.
- Avoid shining lights toward the GHFF camp or foraging habitat.
- Reschedule work to night-time when the flying-foxes are foraging, although avoid when young are creching (usually December-January).
- Start loud equipment (e.g. chainsaws) away from the camp and allow it to run for a short time to allow flying-foxes to habituate or relocate to other suitable roosts.
- Schedule noise activities at dawn before the camp settles or dusk as the camp leaves.
- Machinery work in the core camp (or overflow if occupied) is limited to no more than 2.5 hours in a 12 hour period.

6.3 Disturbance of GHFF in unsuitable habitat

It is recognised that the impacts of GHFF roosting in areas that are unsuitable for habitat could pose major health and safety issues. Whilst the general public activities and maintenance around the site is expected to naturally hold the site in its current location, it may be necessary to deliberately disturb the animals if they begin roosting in trees in unsuitable habitat. This may also be the case where controlled overflow habitat becomes degraded.

The purpose of these protocols are to ensure GHFF do not settle into new sites that are unsuitable or do not overtly degrade overflow habitat rendering unsuitable. The protocols allow swift action to manage the spatial location of the animals. Disturbance actions must follow the following:

- OEH must be informed prior to commencement of disturbance
- Disturbance is to occur at dawn when GHFF are looking to settle
- Disturbance methods should not impact on animals in the core camp
- Low level, multiple attempt (over days) is preferred with short, sharp noises (metallic).

7. Plan administration and review

7.1 Performance criteria

This Plan will be successful if the following measures are satisfied, as determined by annual reporting to DPIE as per licensing requirements:

- no harm to the flying-foxes other than through natural processes
- low levels of conflict with current or future users, as measured by complaints
- camp sustained in situ (as determined by monitoring – see Section 7.2)
- no roosting in unsuitable habitat
- improved amenity (less rubbish and weeds).

7.2 Monitoring and reporting

Quarterly monitoring of the area, size and composition of the Parramatta North camp is currently being undertaken by staff of the Royal Botanic Gardens (RBG). This is being undertaken in accordance with the NFFMP methodology and reporting standards (February, May, August and November each year). This should continue (by the RBG or relevant land manager) regardless of whether the NFFMP continues.

Additional, more frequent monitoring may be required as a condition of consent for proposed activities or development in the area.

7.3 Plan review triggers

If monitoring indicates that these performance criteria are not being satisfied, this will trigger a review of the Plan.

Other factors that would trigger a review include changes to relevant policy/legislation

- new management techniques becoming available
- outcomes of research that may influence the Plan
- incidents associated with the camp.

Results of each review will be included in reports to DPIE (as per reporting timing outlined in Section 7.2).

If the Plan is to remain current, a full review including stakeholder consultation and expert input will be undertaken in the final year of the Plan's life prior to being re-submitted to DPIE.

7.4 Funding

Relevant land managers will use recurrent funding for ongoing management actions, such as bush regeneration contracts. Grant funding will be sought by relevant land managers, with DPIE assistance if required, for other opportunities.

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Appendix A Flying-fox ecologist

The following are the minimum required skills and experience which must be demonstrated by the flying-fox ecologist.

Essential

- Knowledge of flying-fox habitat requirements
- Knowledge and experience in flying-fox camp management
- Knowledge of flying-fox behaviour, including ability to identify signs of flying-fox stress
- Ability to differentiate between breeding and non-breeding females
- Ability to identify females in final trimester
- Ability to estimate age of juveniles
- Experienced in flying-fox population monitoring including static and fly-out counts, demographics and visual health assessments
- ABLV-vaccinated.

Desirable

- Trained in flying-fox rescue
- Local knowledge and experience.

Appendix B Flying-fox ecology and behaviour

B1 Ecological role

Flying-foxes, along with some birds, make a unique contribution to ecosystem health through their ability to move seeds and pollen over long distances (Southerton et al. 2004). This contributes directly to the reproduction, regeneration and viability of forest ecosystems (DoEE 2016a).

It is estimated that a single flying-fox can disperse up to 60,000 seeds in one night (ELW&P 2015). Some plants, particularly *Corymbia* spp., have adaptations suggesting they rely more heavily on nocturnal visitors such as bats for pollination than daytime pollinators (Southerton et al. 2004).

Grey-headed flying-foxes may travel 100 km in a single night with a foraging radius of up to 50 km from their camp (McConkey et al. 2012), and have been recorded travelling over 500 km in two days between camps (Roberts et al. 2012). In comparison bees, another important pollinator, move much shorter foraging distances of generally less than one kilometre (Zurbuchen et al. 2010).

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

Flying-foxes are considered 'keystone' species given their contribution to the health, longevity and diversity among and between vegetation communities. These ecological services ultimately protect the long-term health and biodiversity of Australia's bushland and wetlands. In turn, native forests act as carbon sinks, provide habitat for other fauna and flora, stabilise river systems and catchments, add value to production of hardwood timber, honey and fruit (e.g. bananas and mangoes; Fujita 1991), and provide recreational and tourism opportunities worth millions of dollars each year (EHP 2012; ELW&P 2015).

B2 Flying-foxes in urban areas

Flying-foxes appear to be roosting and foraging in urban areas more frequently. There are many possible drivers for this, as summarised by Tait et al. (2014):

- loss of native habitat and urban expansion
- opportunities presented by year-round food availability from native and exotic species found in expanding urban areas
- disturbance events such as drought, fires, cyclones
- human disturbance or culling at non-urban roosts or orchards
- urban effects on local climate
- refuge from predation

- movement advantages, e.g. ease of manoeuvring in flight due to the open nature of the habitat or ease of navigation due to landmarks and lighting.

B3 Under threat

Flying-foxes roosting and foraging in urban areas more frequently can give the impression that their populations are increasing; however, the grey-headed flying-fox is in decline across its range and in 2001 was listed as vulnerable by the NSW Government under the Biodiversity Conservation Act 2016.

At the time of listing, the species was considered eligible for listing as vulnerable as counts of flying-foxes over the previous decade suggested that the national population may have declined by up to 30%. It was also estimated that the population would continue to decrease by at least 20% in the next three generations given the continuation of the current rate of habitat loss and culling.

The main threat to grey-headed flying-foxes in NSW is clearing or modification of native vegetation. This threatening process removes appropriate roosting and breeding sites and limits the availability of natural food resources, particularly winter–spring feeding habitat in north-eastern NSW. The urbanisation of the coastal plains of south-eastern Queensland and northern NSW has seen the removal of annually-reliable winter feeding sites, and this threatening process continues.

There is a wide range of ongoing threats to the survival of the GHFF, including:

- habitat loss and degradation
- conflict with humans (including culling at orchards)
- infrastructure-related mortality (e.g. entanglement in barbed wire fencing and fruit netting, power line electrocution, etc.)
- predation by native and introduced animals
- exposure to extreme natural events such as cyclones, drought and heat waves.

Flying-foxes have limited capacity to respond to these threats and recover from large population losses due to their slow sexual maturation, small litter size, long gestation and extended maternal dependence (McIlwee & Martin 2002).

B4 Camp characteristics

All flying-foxes are nocturnal, roosting during the day in communal camps. These camps may range in number from a few to hundreds of thousands, with individual animals frequently moving between camps within their range. Typically, the abundance of resources within a 20–50 km radius of a camp site will be a key determinant of the size of a camp (SEQ Catchments 2012). Therefore, flying-fox camps are generally temporary and seasonal, tightly tied to the flowering of their preferred food trees. However, understanding the availability of feeding resources is difficult because flowering and fruiting are not reliable every year, and can vary between localities (SEQ Catchments 2012). These are important aspects of camp preference and movement between camps, and have implications for long-term management strategies.

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

- closed canopy >5 metres high
- dense vegetation with complex structure (upper, mid- and understorey layers)
- within 500 metres of permanent water source
- within 50 kilometres of the coastline or at an elevation <65 metres above sea level
- level topography (<5° incline)
- greater than one hectare to accommodate and sustain large numbers of flying-foxes.

Optimal vegetation available for flying-foxes must allow movement between preferred areas of the camp. Specifically, it is recommended that the size of a patch be approximately three times the area occupied by flying-foxes at any one time (SEQ Catchments 2012).

B5 Species profiles

Black flying-fox (*Pteropus alecto*)



Figure 6 Black flying-fox indicative species distribution, adapted from OEH 2015a

The black flying-fox (BFF) (**Figure 6**) has traditionally occurred throughout coastal areas from Shark Bay in Western Australia, across Northern Australia, down through Queensland and into NSW (Churchill 2008; OEH 2015a). Since it was first described there has been a substantial southerly shift by the BFF (Webb & Tidemann 1995). This shift has consequently led to an increase in indirect competition with the threatened GHFF, which appears to be favouring the BFF (DoEE 2016a).

They forage on the fruit and blossoms of native and introduced plants (Churchill 2008; OEH 2015a), including orchard species at times.

BFF are largely nomadic animals with movement and local distribution influenced by climatic variability and the flowering and fruiting patterns of their preferred food plants. Feeding commonly occurs within 20 kilometres of the camp site (Markus & Hall 2004).

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

Grey-headed flying-fox (*Pteropus poliocephalus*)

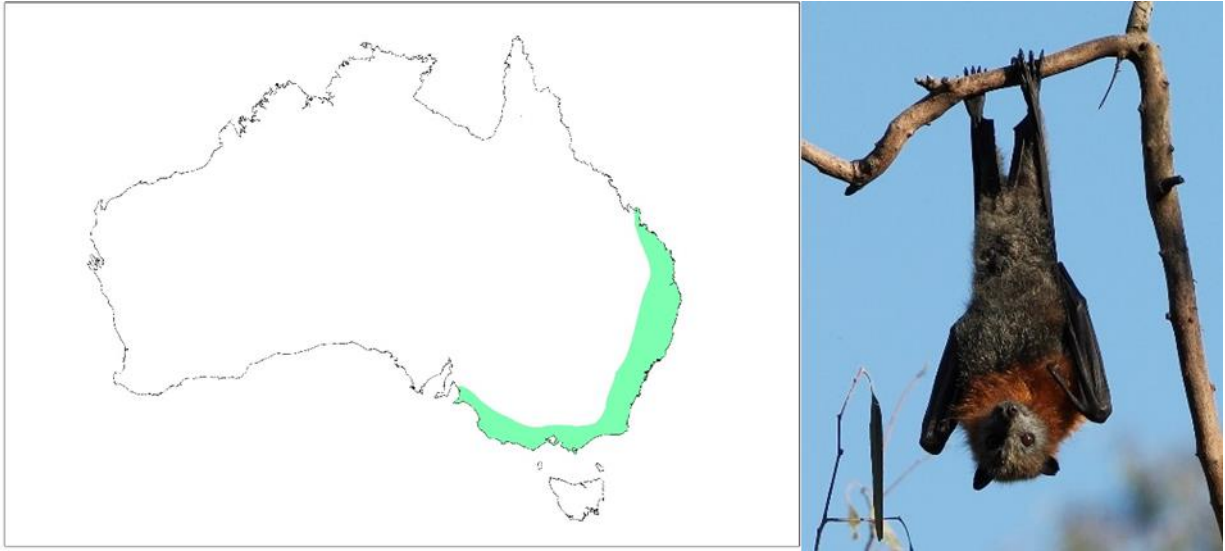


Figure 7 Grey-headed flying-fox indicative species distribution, adapted from OEH 2015a

The grey-headed flying-fox (GHFF) (**Figure 7**) is found throughout eastern Australia, generally within 200 kilometres of the coast, from Finch Hatton in Queensland to Melbourne, Victoria (OEH 2015d). This species now ranges into South Australia and has been observed in Tasmania (DoEE 2016a). It requires foraging resources and camp sites within rainforests, open forests, closed and open woodlands (including melaleuca swamps and banksia woodlands). This species is also found throughout urban and agricultural areas where food trees exist and will raid orchards at times, especially when other food is scarce (OEH 2015a).

All the GHFF in Australia are regarded as one population that moves around freely within its entire national range (Webb & Tidemann 1996; DoEE 2015). GHFF may travel up to 100 kilometres in a single night with a foraging radius of up to 50 kilometres from their camp (McConkey et al. 2012). They have been recorded travelling over 500 kilometres over 48 hours when moving from one camp to another (Roberts et al. 2012). GHFF generally show a high level of fidelity to camp sites, returning year after year to the same site, and have been recorded returning to the same branch of a particular tree (SEQ Catchments 2012). This may be one of the reasons flying-foxes continue to return to small urban bushland blocks that may be remnants of historically-used larger tracts of vegetation.

The GHFF population has a generally annual southerly movement in spring and summer, with their return to the coastal forests of north-east NSW and south-east Queensland in winter (Ratcliffe 1932; Eby 1991; Parry-Jones & Augee 1992; Roberts et al. 2012). This results in large fluctuations in the number of GHFF in NSW, ranging from as few as 20% of the total population in winter up to around 75% of the total population in summer (Eby 2000). They are widespread throughout their range during summer, but in spring and winter are uncommon in the south. In autumn they occupy primarily coastal lowland camps and are uncommon inland and on the south coast of NSW (DECCW 2009).

There is evidence the GHFF population declined by up to 30% between 1989 and 2000 (Birt 2000; Richards 2000 cited in OEH 2011a). There is a wide range of ongoing threats to the survival of the GHFF, including habitat loss and degradation, deliberate destruction associated with the commercial horticulture industry, conflict with humans, infrastructure-related mortality (e.g. entanglement in barbed wire fencing and fruit netting, power line electrocution, etc.) and competition and hybridisation with the BFF (DECCW 2009). For these reasons it is listed as vulnerable to extinction under NSW and federal legislation (see Section 4).

B6 Reproduction

Black and grey-headed flying-foxes

Males initiate contact with females in January with peak conception occurring around March to April/May; this mating season represents the period of peak camp occupancy (Markus 2002). Young (usually a single pup) are born six months later from September to November (Churchill 2008). The birth season becomes progressively earlier, albeit by a few weeks, in more northerly populations (McGuckin & Blackshaw 1991), however out of season breeding is common with births occurring later in the year.

Young are highly dependent on their mother for food and thermoregulation. Young are suckled and carried by the mother until approximately four weeks of age (Markus & Blackshaw 2002). At this time they are left at the camp during the night in a crèche until they begin foraging with their mother in January and February (Churchill 2008) and are usually weaned by six months of age around March. Sexual maturity is reached at two years of age with a life expectancy up to 20 years in the wild (Pierson & Rainey 1992).

As such, the critical reproductive period for GHFF and BFF is generally from August (when females are in final trimester) to the end of peak conception around April. Dependent pups are usually present from September to March (see **Figure 8**).

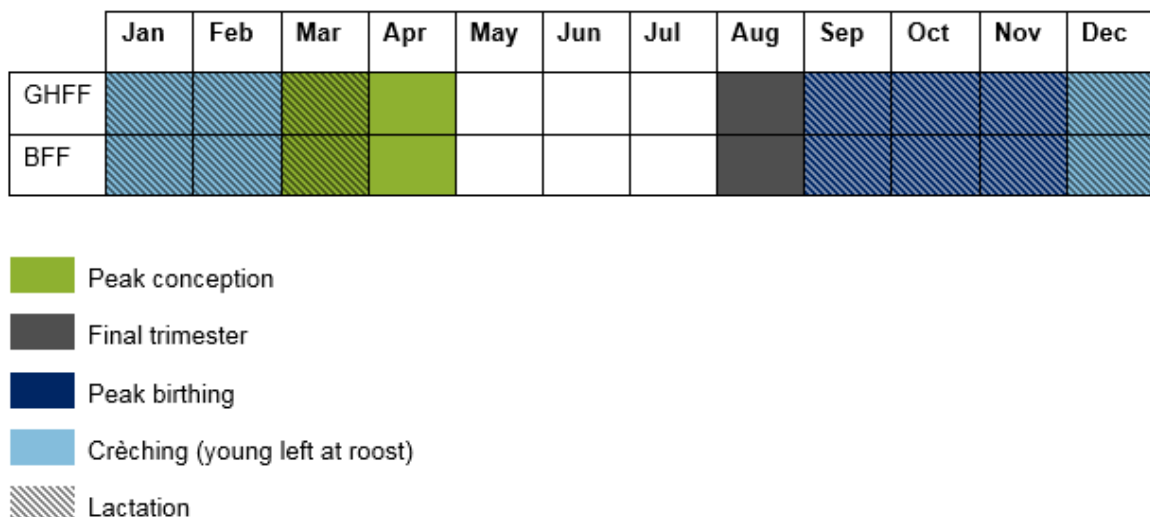


Figure 8 Indicative flying-fox reproductive cycle. The breeding season of all species is variable between years and location, and expert assessment is required to accurately determine phases in the breeding cycle and inform appropriate management timing.

Appendix C Human and animal health

Flying-foxes, like all animals, carry pathogens that may pose human health risks. Many of these are viruses which cause only asymptomatic infections in flying-foxes themselves but may cause significant disease in other animals that are exposed. In Australia the most well-defined of these include Australian bat lyssavirus (ABLV), Hendra virus (HeV) and Menangle virus. Specific information on these viruses is provided in Appendix 5.

Outside of an occupational cohort, including wildlife carers and vets, human exposure to these viruses is extremely rare and similarly transmission rates and incidence of human infection are very low. In addition, HeV infection in humans apparently requires transfer from an infected intermediate equine host and direct transmission from bats to humans has not been reported. Thus despite the fact that human infection with these agents can be fatal, the probability of infection is extremely low and the overall public health risk is judged to be low (Qld Health 2016).

A recent study at several camps before, during and after disturbance (Edson et al. 2015) showed no statistical association between HeV prevalence and flying-fox disturbance. However the consequences of chronic or ongoing disturbance and harassment and its effect on HeV infection were not within the scope of the study and are therefore unknown.

The effects of stress are linked to increased susceptibility and expression of disease in both humans (AIHW 2012) and animals (Henry & Stephens-Larson 1985; Aich et. al. 2009), including reduced immunity to disease.

Therefore it can be assumed that management actions which may cause stress (e.g. dispersal), particularly over a prolonged period or at times where other stressors are increased (e.g. food shortages, habitat fragmentation, etc.), are likely to increase the susceptibility and prevalence of disease within the flying-fox population, and consequently the risk of transfer to humans.

Furthermore, management actions or natural environmental changes may increase disease risk by:

- forcing flying-foxes into closer proximity to one another, increasing the probability of disease transfer between individuals and within the population
- resulting in abortions and/or dropped young if inappropriate methods are used during critical periods of the breeding cycle. This will increase the likelihood of direct interaction between flying-foxes and the public, and potential for disease exposure
- adoption of inhumane methods with potential to cause injury which would increase the likelihood of the community coming into contact with injured/dying flying-foxes.
- The potential to increase disease risk should be carefully considered as part of a full risk assessment when determining the appropriate level of management and the associated mitigation measures required.

C1 Australian bat lyssavirus

ABLV is a rabies-like virus that may be found in all flying-fox species on mainland Australia. It has also been found in an insectivorous microbat and it is assumed it may be carried by any bat species. The probability of human infection with ABLV is very low with less than 1% of the flying-fox population being

affected (DPI 2013) and transmission requiring direct contact with an infected animal that is secreting the virus. In Australia three people have died from ABLV infection since the virus was identified in 1996 (NSW Health 2013).

Domestic animals are also at risk if exposed to ABLV. In 2013, ABLV infections were identified in two horses (Shinwari et al. 2014). There have been no confirmed cases of ABLV in dogs in Australia; however, transmission is possible (McCall et al. 2005) and consultation with a veterinarian should be sought if exposure is suspected.

Transmission of the virus from bats to humans is through a bite or scratch, but may have potential to be transferred if bat saliva directly contacts the eyes, nose, mouth or broken skin. ABLV is unlikely to survive in the environment for more than a few hours, especially in dry environments that are exposed to sunlight (NSW Health 2013).

Transmission of closely related viruses suggests that contact or exposure to bat faeces, urine or blood does not pose a risk of exposure to ABLV, nor does living, playing or walking near bat roosting areas (NSW Health 2013).

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

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

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

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

C2 Hendra virus

Flying-foxes are the natural host for Hendra virus (HeV), which can be transmitted from flying-foxes to horses. Infected horses sometimes amplify the virus and can then transmit it to other horses, humans and on two occasions, dogs (DPI 2014). There is no evidence that the virus can be passed directly from flying-foxes to humans or to dogs (AVA 2015). Clinical studies have shown cats, pigs, ferrets and guinea pigs can carry the infection (DPI 2015a).

Although the virus is periodically present in flying-fox populations across Australia, the likelihood of horses becoming infected is low and consequently human infection is extremely rare. Horses are thought to contract the disease after ingesting forage or water contaminated primarily with flying-fox urine (CDC 2014).

Humans may contract the disease after close contact with an infected horse. HeV infection in humans presents as a serious and often fatal respiratory and/or neurological disease and there is currently no effective post-exposure treatment or vaccine available for people. The mortality rate in horses is greater than 70% (DPI 2014). Since 1994, 81 horses have died and four of the seven people infected with HeV have lost their lives (DPI 2014).

Previous studies have shown that HeV spillover events have been associated with foraging flying-foxes rather than camp locations. Therefore risk is considered similar at any location within the range of flying-fox species and all horse owners should be vigilant. Vaccination of horses can protect horses and subsequently humans from infection (DPI 2014), as can appropriate horse husbandry (e.g. covering food and water troughs, fencing flying-fox foraging trees in paddocks, etc.).

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

C3 Menangle virus

Menangle virus (also known as bat paramyxovirus no. 2) was first isolated from stillborn piglets from a NSW piggery in 1997. Little is known about the epidemiology of this virus, except that it has been recorded in flying-foxes, pigs and humans (AVA 2015). The virus caused reproductive failure in pigs and severe febrile (flu-like) illness in two piggery workers employed at the same Menangle piggery where the virus was recorded (AVA 2015). The virus is thought to have been transmitted to the pigs from flying-foxes via an oral–faecal matter route (AVA 2015). Flying-foxes had been recorded flying over the pig yards prior to the occurrence of disease symptoms. The two infected piggery workers made a full recovery and this has been the only case of Menangle virus recorded in Australia.

C4 General health considerations

Flying-foxes, like all animals, carry bacteria and other microorganisms in their guts, some of which are potentially pathogenic to other species. Direct contact with faecal material should be avoided and general hygiene measures taken to reduce the low risk of gastrointestinal and other disease.

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

Public water supplies are regularly monitored for harmful microorganisms, and are filtered and disinfected before being distributed. Management plans for community supplies should consider whether any large congregation of animals, including flying-foxes, occurs near the supply or catchment area. Where they do occur, increased frequency of monitoring should be considered to ensure early detection and management of contaminants.

Appendix D Flying-fox rescue protocol

D1 Reference documents:

OEH 2012, NSW Code of Practice for Injured, Sick and Orphaned Flying-foxes, Office of Environment and Heritage, Sydney.

OEH 2011, NSW Code of Practice for Injured, Sick and Orphaned Protected Fauna, Office of Environment and Heritage, Sydney.

D2 Purpose

These work instructions are intended for Australian bat lyssavirus (ABLV)-vaccinated fauna spotter catchers (FSCs) or wildlife rescue personnel on site during dispersal activities to monitor, capture or provide first aid treatment for sick or injured flying-foxes that may require human intervention for their survival. Flying-fox rescue must only be attempted by personnel trained and experienced in flying-fox rescue and handling.

This work instruction provides rescuers with information regarding capture and first aid until a flying-fox is in the specialist care of a veterinarian or person qualified in wildlife rehabilitation.

D3 Requirements

FSC and wildlife rescue personnel involved in flying-fox rescue must:

- be trained and experienced in rescue and handling
- be vaccinated against ABLV (titre levels checked at least once every two years)
- be aware of the hazards and risks of coming into contact with all bats
- utilise appropriate PPE and equipment for capture, transport and treatment of flying-foxes
- undertake a risk assessment before carrying out a rescue – do not endanger yourself or others during a rescue
- have the contact details for a local veterinarian or bat carer who will accept the sick or injured flying-fox.

D4 Human first aid

All bats in Australia should be viewed as potentially infected with ABLV. If bitten or scratched by a bat, immediately wash the wound with soap and water (do not scrub) and continue for at least five minutes, followed by application of an antiseptic with anti-viral action (e.g. Betadine), and immediate medical attention (post-exposure vaccinations may be required). Similarly medical attention should be immediately sought if exposed to an animal's saliva or excreta through the eyes, nose or mouth.

D5 Equipment

lidded plastic carry basket or 'pet-pack' with bedding (juveniles) / transport container with hanging perch, tall enough for bat to hang without hitting its head (in accordance with Section 5.1 of the NSW Code of Practice for Injured, Sick and Orphaned Flying-foxes (OEH 2012))

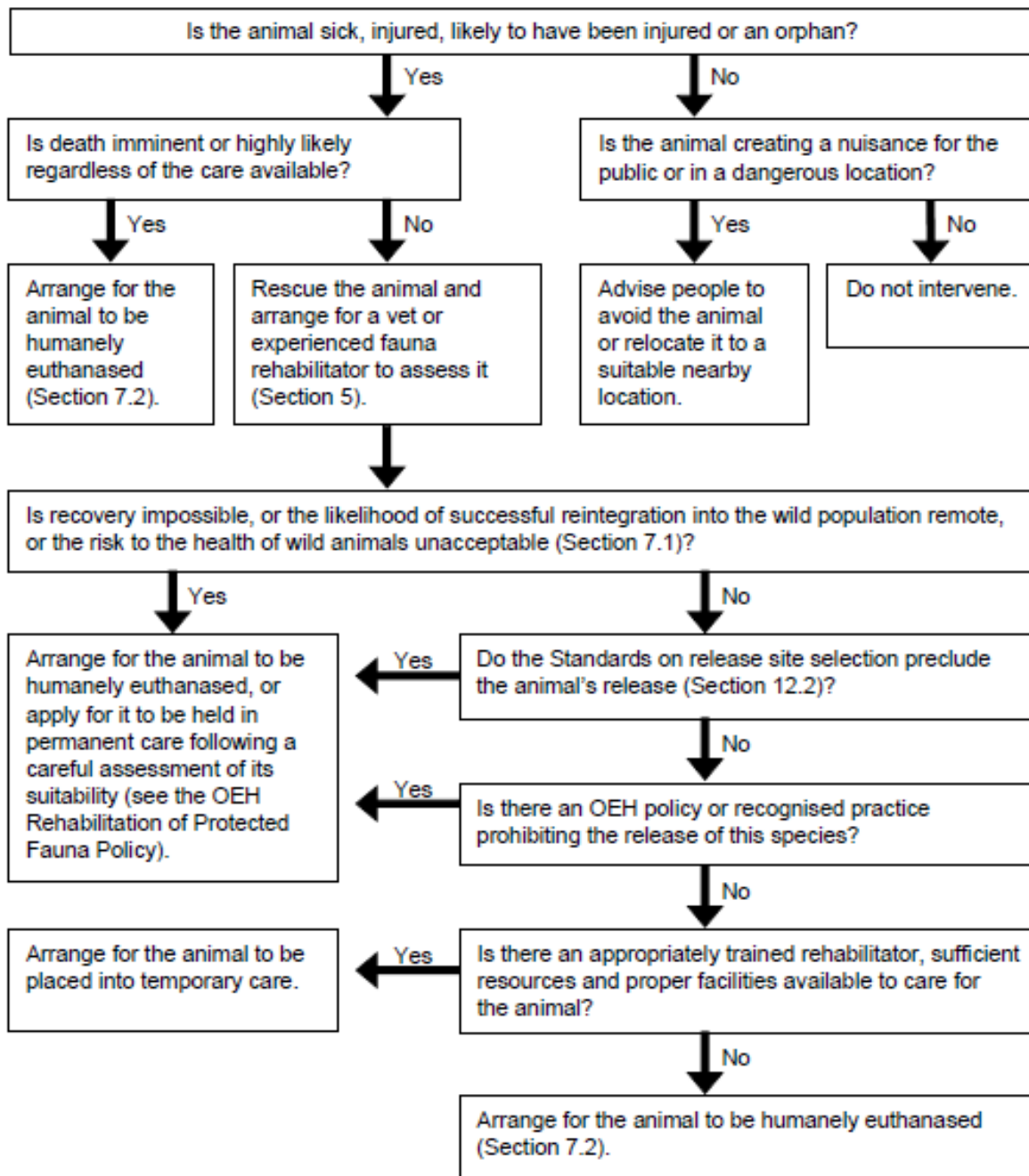
- warm water bottle / cold brick

- wraps /towels
- teats for small bottle
- extension pole or broom
- bat first aid kit – juice drink/glucose powder, syringes, cloths for wounds, Betadine/saline, dummy for baby bats. FFs only to be offered liquids under advice from a licensed wildlife carer.

D6 Work instructions

Case assessment

Observe, assess and then determine if/what intervention is required using the decision tree in the NSW Code of Practice for Injured, Sick and Orphaned Protected Fauna (OEH 2011), included below.



Personnel should approach stressed flying-foxes cautiously. If flying-foxes panic or fly this will waste energy; retreat and continue to monitor behaviour.

1. Dehydration: Eyes dull or depressed in skull, change to skin elasticity, skin stays pinched, animal cold, wing membranes dry, mouth dry.
2. Heat stress: wing fanning, shade seeking, clustering/clumping, salivating, panting, roosting at the base of trees, on the ground, falling from tree.
3. Obvious injury: bleeding, broken bones.

Rescue instructions

As per Section 4 of the NSW Code of Practice for Injured, Sick and Orphaned Flying-foxes (OEH 2012):

- i The objective is to rescue a flying-fox while minimising further stress and injury to the animal.
- ii Before a rescue attempt, rescuers must assess the risks to the flying-fox from environmental hazards and from capture.
- iii Rescuers must employ the correct rescue equipment for the condition and location of the flying-fox, and be trained in its use.

Example scenarios

1. Bat low in tree:
 - quickly place towel around bat before it can move away
 - grab hold of feet, toes may curl over rescuers fingers
 - place in carry basket / transport container.
2. Bat high in tree:
 - place pole wrapped in towel in front of bat
 - coax bat onto towel
 - once on towel, quickly move away from branches and lower to ground
 - once on ground, cover with towel and place into carry basket / transport container.
3. A bat caught on barbed wire fence:
 - two people only – one to restrain with towel, while the other untangles
 - put towels on the wire strands under or around to avoid further entanglement
 - if the membrane has dried onto wire, syringe or spray water onto wing
 - use pliers or wire cutter if necessary.

Animal first aid

Physical assessment: Keep animal wrapped and head covered, only expose one part at a time. Examine head. Unwrap one wing and extend. Wrap and extend other wing. Check legs. Examine front and back of body.

Dehydration: Provide subcutaneous fluids or, if method unavailable, offer water/juice (low acid juice only, e.g. apple/mango) orally with syringe (under supervision/advice from licensed wildlife carer ONLY).

Heat stress: Reduce temperature in heat exhausted bats by spraying wings with tepid water.

Hypothermia: May be seen in pups separated from mother – keep head covered and warm core body temperature slowly by placing near (not on) warm water bottle covered by towel.

Bleeding: Clean wounds with room temperature saline or diluted Betadine.

Transport to veterinarian / wildlife carer

See Section 5 of the NSW Code of Practice for Injured, Sick and Orphaned Flying-foxes (OEH 2012) summarised below.

Objective

To transport a flying-fox so as to minimise further stress and injury to the animal.

Standards

- a. The transport container must be tall enough for the flying-fox to hang by its feet without hitting its head on the floor.
- b. The container must be designed, set up and secured to prevent injuries to the flying-fox. The sides of the container must prevent the flying-fox from poking its head or wings out.
- c. The container must be designed to prevent the flying-fox from escaping.
- d. The flying-fox must be allowed to hang by its feet from the top of the container or if it is unable to hang, wrapped in material (e.g. sheet or flannel) and placed in a sling so its feet are higher than its head.
- e. The container must be kept at a temperature which is appropriate for the age and condition of the flying-fox. A range of 25–27°C is appropriate for an adult. A temperature of 28°C is appropriate for an orphan. A cool or warm water bottle may be required.
- f. The container must be ventilated so air can circulate around the flying-fox.
- g. The container must minimise light, noise and vibrations and prevent contact with young children and pets.
- h. During transport, a container holding a flying-fox must have a clearly visible warning label that says 'Warning – live bat'.
- i. A flying-fox must not be transported in the back of an uncovered utility vehicle or a car boot that is separate from the main cabin.

Guidelines

- Flying-fox transport should be the sole purpose of the trip and undertaken in the shortest possible time.
- The fauna rehabilitation group's contact details should be written on the transport container in case of an emergency.

