



FLYING-FOX CAMP MANAGEMENT PLAN

MUSWELLBROOK

Camp Management Plan

May 2024 | Muswellbrook Shire Council



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This revision was prepared by Muswellbrook Shire Council using the original plan prepared by the Hunter Joint Organisation of Councils



Contact Details:

Sustainability Unit – Muswellbrook Shire Council
PO Box 122
MUSWELLBROOK NSW 2333
Phone: 02 6549 3700

Email: sustainability@muswellbrook.nsw.gov.au

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Acknowledgements

Involved in this review:

Tracy Ward – Muswellbrook Shire Council

Oxana Midlin – Muswellbrook Shire Council

Theresa Folpp – Muswellbrook Shire Council

Alexandra Hathaway – Muswellbrook Shire Council

Involved in the preparation of the original document:

Alan Keown – GIS Consultant

Peggy Eby – Ecologist

Narawan Williams – Ecologist

Eva Twarkowski – Hunter Councils Environment Division

Ellen Saxon – Hunter Councils Environment Division

Bradley Nolan – Hunter Councils Environment Division

We acknowledge the broader input received from Local Council Officers undertaking similar Flying-fox Camp Management Plans in the Hunter Region, as their efforts may have influenced the creation of this Camp Management Plan (CMP).

We acknowledge input by the NSW Office of Environment and Heritage, and consultants Ecosure, in developing the template on which this Camp Management Plan was based. Peggy Eby also provided advice included in this template.

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Acronyms and Abbreviations

ABLV	Australian bat lyssavirus
BFF	black Flying-fox (<i>Pteropus alecto</i>)
DoE	Commonwealth Department of the Environment
DPI	Department of Primary Industries (NSW)
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i> (NSW)
EPA	Environment Protection Authority (NSW)
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Commonwealth)
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</i> (NSW)
NPWS	National Parks and Wildlife Service (NSW)
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</i> (NSW)
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</i> (NSW)

Executive Summary

In 2005, flying-foxes established a camp at the confluence of Muscle Creek and the Hunter River. Historically the camp has been occupied by the threatened grey-headed Flying-fox (GHFF) with the population varying seasonally over time. In recent years, Little Red Flying-foxes (LRF) have also been occupying the site, intermittently. The land occupied by the main camp area is owned by Muswellbrook Shire Council, Department of Infrastructure – Lands, and Australian Rail Track Corporation (ARTC).

The Muswellbrook Flying-fox Camp is located close to residential and business areas. The Camp's proximity to motels, a caravan park and public facilities including walkways, recreational areas, sporting fields, clubs are the main areas of concern for the community and conflict increases when the number of flying-foxes increase.

In December of 2022, a small camp of Grey Headed Flying-foxes was noted in the Denman Van Village. The Department of Planning and Environment was notified. This population will be monitored by Council, along with Muswellbrook camps.

Grey-headed Flying-foxes are listed as threatened species under both NSW and Commonwealth legislation, and disturbance to flying-foxes and their habitat is limited by legislation. This species is highly mobile and camp populations vary widely over time due to food resource availability.

The Muswellbrook Flying-fox Camp Management Plan provides a tool to ensure appropriate management of the camp.

Experience in other locations has shown that attempts to move camps are generally unsuccessful, expensive, and moves the problems to neighbouring areas. Management actions proposed in the Plan aim to reduce the impact of Flying-foxes roosting close to residential dwellings and to reduce the risk of disease transmission to the local equine industry.

This review predominantly addresses actions required to assist residents with mitigation of impacts of flying-foxes living nearby.

Given the mobility of Flying-foxes and the expected variability of the population of the camp over time, the focus of implementation actions is on:

- Providing residents with car covers and/or pool covers and/or clothesline covers, where they are directly affected by roosting Flying-foxes.
- Providing residents with access to a high-powered water gurney where they are directly impacted by roosting flying-foxes.
- Education and awareness programs.

The original plan was prepared to identify actions to reduce the impact of flying-foxes on residents, particularly adjacent to the land occupied by the camp, while maintaining suitable habitat to support the population of the grey-headed Flying-fox, a listed threatened species. The plan also provided general guidance throughout the Muswellbrook local government area for Flying-fox camps.

If approved by Environment NSW (in combination with other relevant license applications and legislative requirements), the revised plan will enable management of the Flying-fox habitat to reduce human/bat conflict. Included actions pose little to no direct impact to Flying-foxes, and Council will need to apply for biodiversity conservation license to undertake any work in or around the camp.

1 Overview

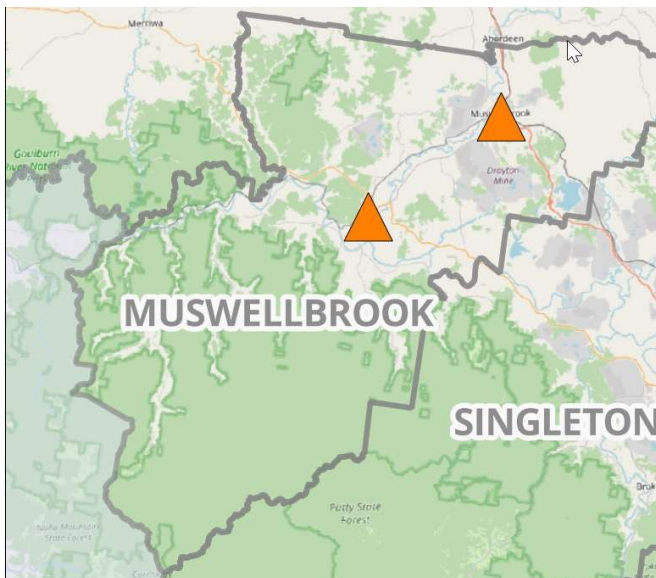
1.1 Background

The original Camp Management Plan was developed as part of a Hunter wide project that developed Flying-fox Camp Management Plans for Central Coast Council, Mid Coast Council, Muswellbrook Shire Council, Singleton Council, Port Stephens Council and Upper Hunter Shire Council in 2017. This is its first scheduled review.

Participating in the original project has enabled strong alignment with the actions of other Councils and the creation of active working relationships with these Councils, so that if any management action undertaken affects the roosting behaviours or Flying-foxes in one jurisdiction, a network of land management / ecology specialists can notify neighbouring Councils of any possible increased Flying-fox movements.

The plan has been prepared to identify actions that are available to reduce the impact of flying-foxes on residents, particularly adjacent to the land occupied by the camp, while maintaining suitable habitat on the site to support the population of the grey-headed Flying-fox, a listed threatened species. The plan also provides general guidance throughout the Muswellbrook local government area for Flying-fox camps.

The purpose of this plan is to identify the various Flying-fox management activities to be undertaken at the Camp. If approved by Environment NSW (in combination with other relevant license applications and legislative requirements), this plan will enable appropriate management of the Flying-fox habitat to reduce human/bat conflict. Included actions pose little to no direct impact to Flying-foxes, and Council will need to apply for a threatened species license to undertake any work in or around the camp. The original plan operated for a period of 5 years. This is its first review. The reviewed plan will operate for 5 years and will be due for further review in 2028 unless camp numbers increase significantly before this plan expires, in which case it will trigger another review.



Map 1: Flying-fox Camps in Muswellbrook LGA

1.2 Objectives

Muswellbrook Shire Council has developed this Flying-fox Camp Management Plan to provide Council, and the community a clear framework for the management of the Muswellbrook Flying-fox Camp.

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

- minimise impacts to the community, while conserving Flying-foxes and their habitat
- enable land managers and other stakeholders to use a range of suitable management responses to sustainably manage Flying-foxes

The following Plan provides details on the Camps, Flying-fox species, community inputs, management opportunities and an agreed Management Plan designed to achieve the above stated objectives.

The objectives of the plan are consistent with the Office of Environment and Heritage Flying-fox Camp Management Policy (OEH 2015).

1.3 Roles and Responsibilities

There are several organisations with a role in the management of issues related to the Muswellbrook Flying-fox Camps.

1.3.1 Muswellbrook Shire Council

The Flying-fox camps at times occur on Muswellbrook Shire Council managed land, and as the representative organisation of the local community Council plays an active role in developing management actions for these sites.

1.3.2 NSW Department of Industry - Lands

The NSW Department of Industry - Lands is a landowner of portions of Crown Land on which the Muswellbrook Flying-fox Camps are located; subsequently decisions about how to manage the Flying-fox Camp should be made in conjunction with this agency.

1.3.3 NSW Department of Planning and Environment

The Department of Planning and Environment is responsible for administering the Threatened Species Licence and for ensuring the impact of any action affecting threatened species is properly assessed. Any application by DPI-Lands to disrupt the Flying-foxes roosting site (the camp) is assessed by OEH Regional Operations Group Hunter Central Coast (ROG-HCC), Planning and Ecosystems and Threatened Species teams.

1.3.4 Wildlife Care Groups

Injured or distressed Flying-foxes are rescued and cared for by licenced wildlife rehabilitators. Care can be arranged by calling WIRES on 1300 094 737. WIRES will coordinate local rescue groups to assist.

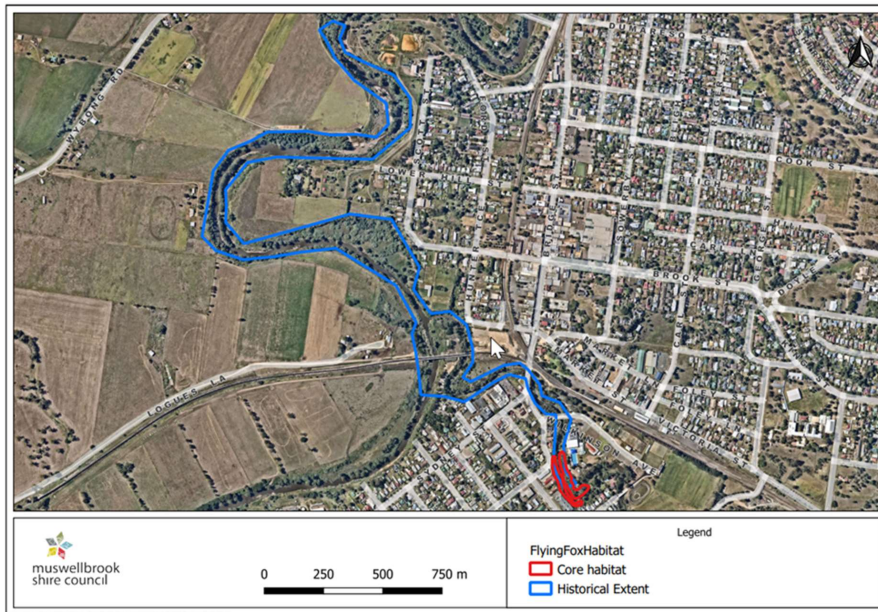
2 Context

2.1 Local Context

2.1.1 Muswellbrook Flying-fox Camp and Surrounds

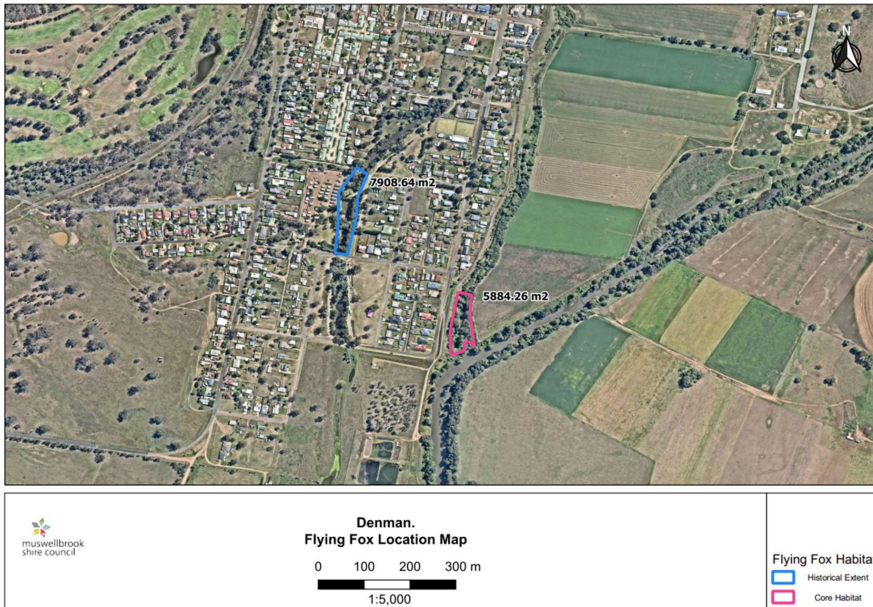
Grey-Headed Flying-foxes predominantly roost adjacent to the Muswellbrook Aquatic Centre, local motels adjacent to Muscle Creek, ARTC land alongside the Hunter River and the Riverside Caravan Park.

In August 2015, the population of grey-headed flying-foxes peaked at approximately 32,000 animals, they were observed roosting from Scott Street in the north to the Hunter River immediately west of the Caravan Park. Flying-foxes were also roosting on Muscle Creek between residential properties from Wilkinson Street to Wilder Street (Refer to Map 2). Flying-foxes were observed roosting on both sides of the creek, with the majority roosting along the eastern side of Muscle Creek.



Map 2: Muswellbrook Flying-fox Camp location and extent

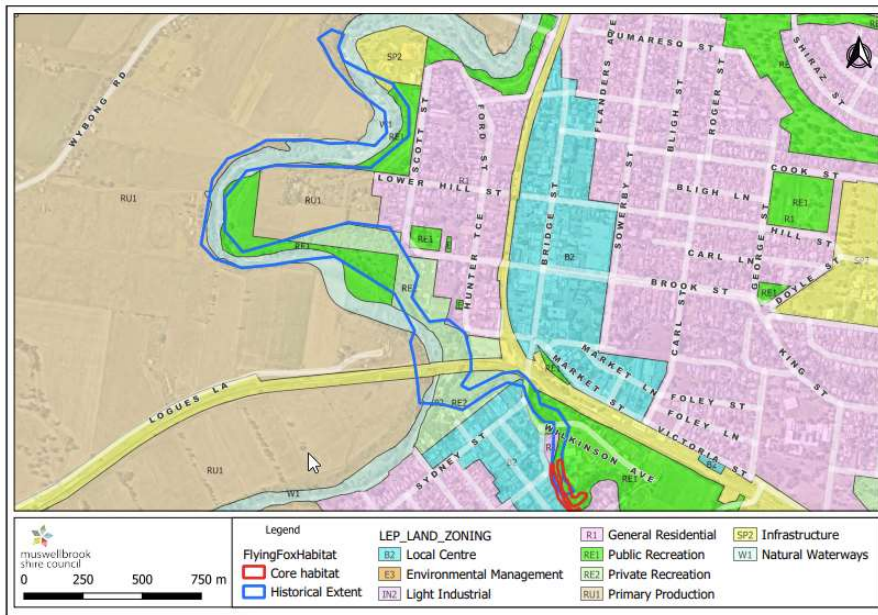
In December 2022, a small camp of approximately 50 Grey Headed Flying-foxes were observed roosting in Casuarina trees adjacent to the Denman Van Village. By February 2023, this number had swelled to over 1000. (pers. obs. T. Ward) This camp was predominantly on private land but later the camp shifted to Sandy Creek which is a mix of Council and Crown land.



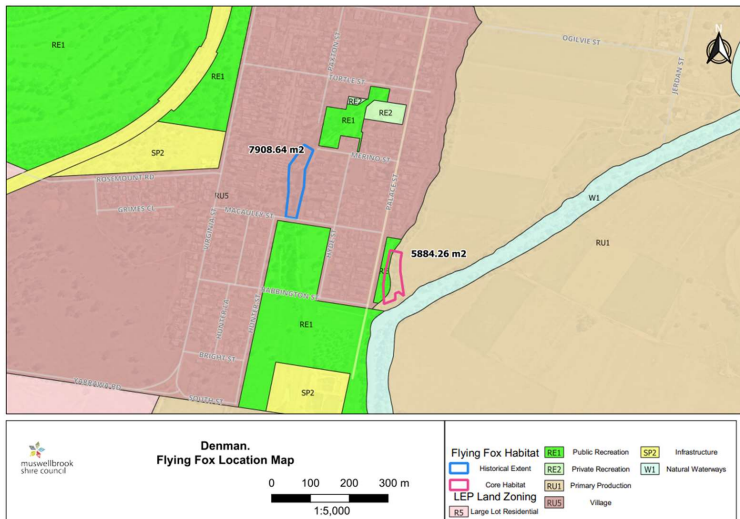
Map 3: Denman Grey Headed Flying-fox Camp location and extent.

2.1.2 Land Tenure, Land Use and Zoning

In addition to residential dwellings, several public facilities, services, and businesses are located close to the Camp; these are a school, caravan park, disability services building, hotels and motels, petrol stations, the Muswellbrook aquatic centre and other sporting facilities.



Map 3: Zoning of Land surrounding the Muswellbrook Flying-fox Camp



Map 4: Zoning of Land surrounding the Denman Flying-fox Camp

This Camp is close to primary production areas, residential properties, and a natural waterway.

2.1.3 Flying-fox Population & Statistics

Scientific Committee Recommendation for Listing as a Nationally Vulnerable Species

Advice to the Federal Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) on Amendments to the list of Threatened Species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) recommended that Grey Headed Flying-foxes be listed as vulnerable. They are listed as vulnerable in the *NSW Biodiversity Conservation Act, 2016*.

The Committee noted population size data obtained by fly-out count surveys contain a degree of error that is difficult to quantify (related to the survey methodology; and the comparability of the survey results for the purpose of calculating trends in population size or species abundance). Fly-out counts are acknowledged by the scientific community to be the best method currently available of obtaining reliable and reproducible estimates of abundance (if not actual population counts) for Flying-foxes. The available data for 1989 and 1998-2001 has been obtained using the same survey techniques that are widely acknowledged to be appropriate for estimating the abundance of this species.

The Department of Agriculture, Water and the Environment produced the National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus* (2021) and within this plan acknowledge many threats to the survival of the Grey-headed Flying-fox including climate change, degradation of roosting and foraging habitats, extreme heat events causing heat stress and heat related mortality.

It is estimated in the EPBC Act that the national Grey Headed Flying-fox population is 680,000 \pm 164,500. (CSIRO, 2015)

The surveys of 1998 -2005 have been compared with surveys conducted as part of the National Flying-fox Monitoring Program conducted since 2012. This program is conducted nationwide on a quarterly basis with representatives performing a count of their local camp and reporting these numbers to the CSIRO. It is suggested that the population remains comparatively stable, rather than being in decline as previously reported. However, the threats identified to Grey-Headed Flying-foxes such as habitat decline due to development, remain and some new threats have arisen, specifically extreme heat events. (CSIRO, 2015)

It was suggested that the projected habitat clearance in northern NSW is the primary ongoing threat to Grey-headed Flying-foxes. One expert stated that annually reliable winter resources are limited in distribution to a narrow coastal strip in northern NSW and Queensland. These coastal areas are targeted for intensive residential development to cater for a projected 25% increase in the human population over the next decade. It was this argument that convinced the Editorial Panel of the Bat Action Plan to identify Grey-headed Flying-foxes as vulnerable, although the Editorial Panel was not unanimous in its decision.

Flying-fox Population at the Muswellbrook Flying-fox Camp

According to the CSIRO census, August is the peak month for Flying-fox activity in Muswellbrook, but this was due to an anomaly in 2015. (See table.) Anecdotal evidence from residents and subsequent year's data suggests that flying-foxes have been observed at the site much longer than the census data suggests. This is thought to be resource driven. (Lunn et al., 2021) The population appears to fluctuate in response to flowering occurring in the Muswellbrook Shire. It is quite possible that these flowering patterns are changing in response to weather pattern changes. (Rosenwig, 2008)

Table 1 – Flying-fox numbers in the Muswellbrook Shire as per CSIRO National Flying-fox Census

	Aug 15	Nov- 15	Feb- 16	May- 16	Aug- 16	Nov- 16	Feb- 17	May- 17	Aug- 17	Nov- 17	Feb- 18	May- 18	Aug- 18	Nov- 18	Feb- 19	May- 19	Aug- 19	Sept -19	Nov - 20	Feb - 21	Mar- 2021	Aug- 21	May 22	June 22	Aug 2022	Dec 22	Feb 23
Hunter Camps	112,624	127,982	269,317	139,196	37,691	20,552	38,744	114,511	37,691	138,593	309,962	19,934	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Muswellbrook Camp GHFF	32000	1000	800	0	0	0	1000	800	NA	10000	800	500	6500	70	NA	10000*	600	5500	1377	5500	5500	6000	10000	vacant	10000	NA	1289
Muswellbrook Camp LRFF	0	0	0	0	0	0	0	0		0	0	0	0	0		0	0	0	465	1000	1000	0	0	0	0	NA	0
Muswellbrook Camp BFF	0	0	0	0	0	0	0	0		0	0	0	0	4		5*	5	0	0	0	0	0	0	0	0	NA	0
Denman Camp GHFF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	872
% of Hunter Region FF in Muswellbrook	28.4%	0.8%	0.3%	0%	0%	0%	2.6%	0.7%	NA	7.2%	0.3%	2.5%	0%														

Flying-fox counts did not occur between October 2019 and October 2020 due to Covid 19 restrictions.

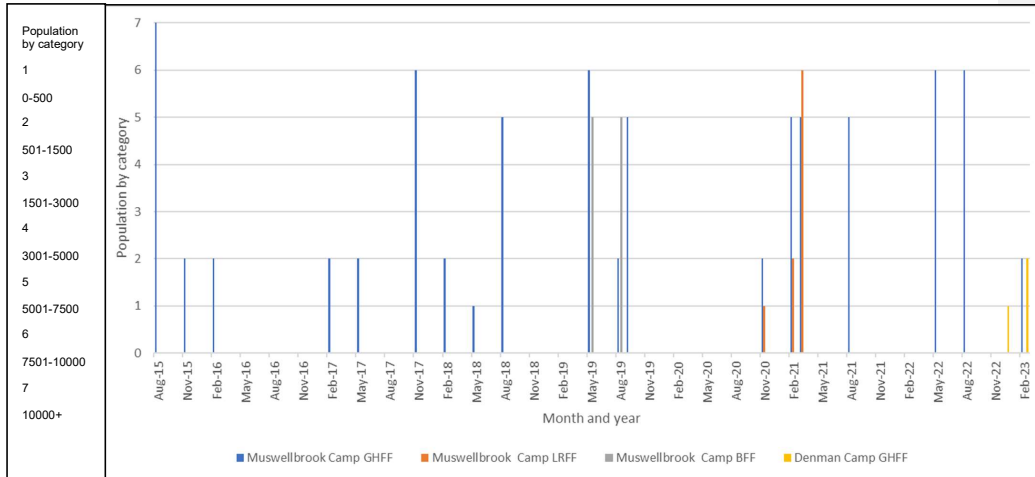
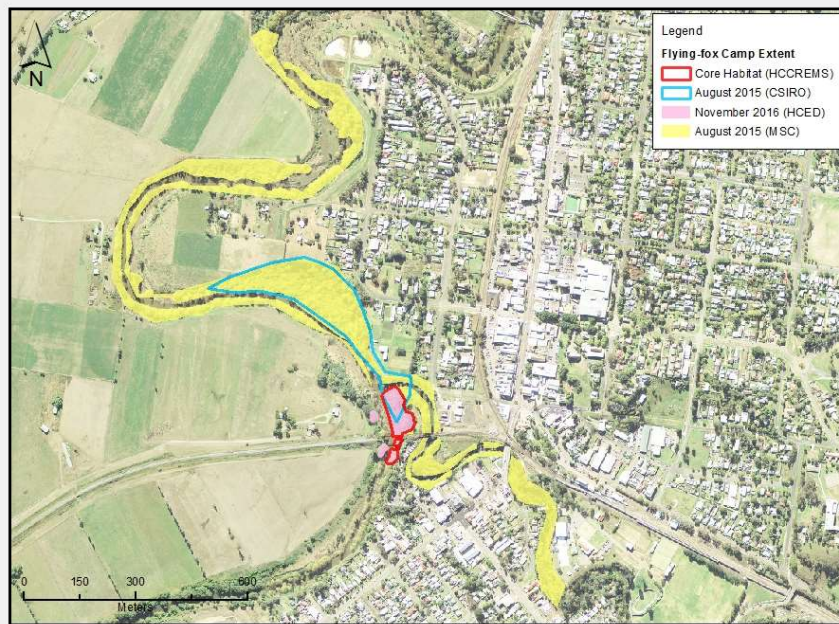


Figure 1: Graph of Flying-fox census results for Muswellbrook LGA Flying-fox Camps

Commented [TW1]: Need to put pop categories on top of graph!

The location and extent of the camp has changed over time, see 6 for details on historical camp extent during census surveys.



Map 6: Historical camp extent boundaries as noted during CSIRO Flying-fox census activities

2.1.4 Community Interests and Issues Related to the Camp

Flying-foxes have almost become an accepted part of the Muswellbrook community. Many in the community still object to their presence but since Council began offering car covers, washing line covers and gurney hire to residents affected by flying-foxes, complaints have decreased. There is a sense that Council is doing something. The two affected motels have also received subsidies from Council, as a result of a grant from the Office of Environment and Heritage, to perform property modifications and replace outdoor furniture which had been damaged by flying-fox faeces. Residents were made aware of this assistance via media releases to local papers, local radio news outlets, posts on Facebook and on Council's website and a letterbox drops within a 300 metre radius from the camp. See references for an example of a letter to residents.

Council has only received a total of ten complaints concerning flying-foxes in the past six years. Most of these complaints were in relation to flying-fox droppings on private property. All complainants were contacted by Council officers and offered items such as car covers and washing line covers to protect items from droppings. In addition to complaints made through official channels, there are also complaints made on social media community noticeboards. Anecdotally it is noted that the frequency of these complaints appears to be decreasing when compared to past data.

2.1.5 Management Response to Date

To date Council has monitored flying-fox numbers and health of the population and supplied affected residents with items such as car and washing line covers. Council has also purchased some gurneys which they loan to residents whose premises are affected by bat droppings. Council has also assisted local motels affected by the flying-fox camp's proximity via state government grant funding, replacing damaged outdoor furniture, and supporting modifications to motel properties including funding window replacements and the construction of permanent covered areas for laundering of bed linen etc.

Council undertook a community consultation and education program and has distributed education brochures to residents in the affected zone. These education brochures are available on Council's website and at Council's administration centre. Council continues to meet with affected residents if the population increases. In the case of new camps forming, Council performs a letter box drop of residents within a 300-metre radius of the camp, leaving an information brochure and letter informing residents of the assistance that is available to them.

Council has undertaken large scale revegetation works along Muscle Creek including weed removal, bank subsidised and plantation of habitat trees.

Council also commenced a "weed tree removal program" with funding from Local Government NSW. This allowed the removal of Cocos Palms and Privet from private properties in 2021, 2022, 2023 and 2024, with residents being subsidised for the cost of removal of these trees from resident's properties. This had a twofold benefit: residents saw less flying-fox activity at their properties, and it is believed that removal of these trees also reduced the amount of seed dispersal for these species. This program will be continued as long as budget allows.

Plans are being considered for flying-fox habitat restoration projects in Muswellbrook and Denman which will include planting of food trees, roosting trees away from residential areas. Council is yet to successfully attract grant funding due to a lack of available suitable Council owned land for such a project. Several discussions have been held with different private landholders about possible locations for planting over the past three years, without success, however it is still the intention of Council to undertake these projects.

2.2 Ecological Values of Flying-foxes, the Camp and Surrounding Areas

2.2.1 Flying-fox Species Profiles

There are three species of Flying-foxes utilising the Muswellbrook Flying-fox Camps. The Black Flying-fox, whilst recorded occasionally in camps, has only been recorded in very low numbers and on very few occasions. Flying-foxes recorded in high numbers in Muswellbrook camps are the Grey Headed Flying-fox (*Pteropus poliocephalus*) and the Little Red Flying-fox (*Pteropus scapulatus*) - although Little Red Flying-foxes tend to have briefer stays than Grey Headed flying-foxes. (Pers.obs. Ward, T.)

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

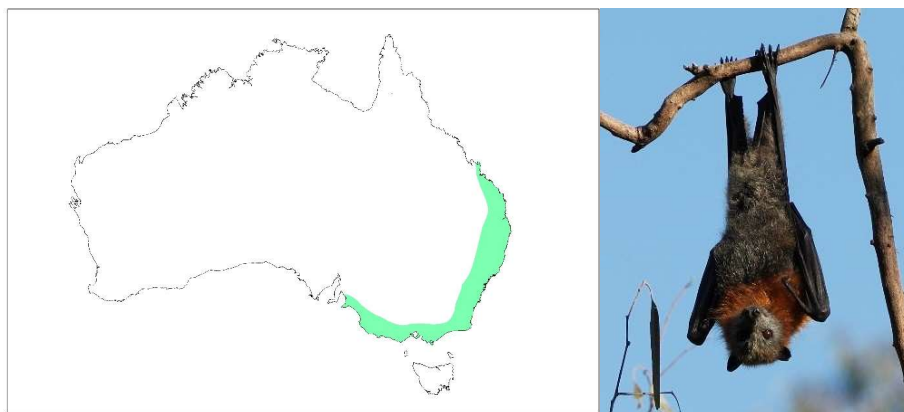


Figure 2: Grey-headed Flying-fox indicative species distribution, adapted from OEH 2015a

The Grey-Headed Flying-fox (Figure 2) is found throughout eastern Australia, generally within 200 kilometers 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 (DoE 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). Tidemann, C. R., & Nelson, J. E. (2004). Long-distance movements of the grey-headed flying-fox (*Pteropus poliocephalus*). *Journal of Zoology*, 263(2), 141-146.

All the Grey-Headed Flying-fox in Australia are regarded as one population that moves around freely within its entire national range (Webb & Tidemann 1996; DoE 2015). GHFF may travel up to 100 kilometers in a single night with a foraging radius of up to 50 kilometers from their camp (McConkey et al. 2012). They have been recorded travelling over 500 kilometers over 48 hours when moving from one camp to another (Roberts et al. 2012). Grey-Headed Flying-fox generally demonstrate 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 Grey-Headed Flying-fox 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 Grey-Headed Flying-fox 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 Grey-Headed Flying-fox 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 Grey-Headed Flying-fox, 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.). For these reasons it is listed as vulnerable to extinction under NSW and federal legislation.

Little Red Flying-fox (*Pteropus scapulatus*)



Figure 3: Little red Flying-fox indicative species distribution, adapted from OEH 2015a

The Little Red Flying-fox (Figure 3) is widely distributed throughout northern and eastern Australia, with populations occurring across northern Australia and down the east coast into Victoria.

The Little Red Flying-fox forages almost exclusively on nectar and pollen, although will eat fruit at times and occasionally raids orchards (Australian Museum 2010). Little Red Flying-fox often relocate sub-continental distances in search of sporadic food supplies. The Little Red Flying-fox has the most nomadic distribution, strongly influenced by availability of food resources (predominantly the flowering of eucalypt species) (Churchill 2008), which means the duration of their stay in any one place is generally very short.

Habitat preferences of this species are quite diverse and range from semi-arid areas to tropical and temperate areas, and can include sclerophyll woodland, melaleuca swamplands, bamboo, mangroves and occasionally orchards (IUCN 2015). Little Red Flying-fox are frequently associated with other *Pteropus* species. In some colonies, Little Red Flying-foxes individuals can number many hundreds of thousands and they are unique among *Pteropus* species in their habit of clustering in dense bunches on a single branch. As a result, the weight of roosting individuals can break large branches and cause significant structural damage to roost trees, in addition to elevating soil nutrient levels through faecal material (SEQ Catchments 2012).

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

2.2.2 Muswellbrook Flying-fox Camp Descriptions

Flying-foxes predominantly roosted in trees near the caravan park at the confluence of the Hunter River and Muscle Creek until early 2021. The land is owned by ARTC and the Crown.

A smaller roost site occurred concurrently with the Muscle Creek Camp adjacent to the Muswellbrook Aquatic Centre and local motels on a mix of Council owned and Crown Land.

The smaller roost site has now become the main roost site with the camp on ARTC land vacating at the commencement of ARTC bridge duplication works. The numbers can be as high as between 6000 - 10000 at times.

Muscle Creek is adjacent to residential areas, parkland, a Caravan Park, Bowling Club and a Public Swimming pool. The vegetation along Muscle Creek has been modified.

Council has undertaken riparian rehabilitation in the area including removal of weeds and garden escapees that had dominated the riparian zone - there were extensive areas where the weed infestations covered 90 - 100% of the riparian zone with remaining pockets of native canopy species, of River Oak (*Casuarina cunninghamiana*), Rough-barked Apple (*Angophora floribunda*) and White Cedar (*Melia azedarach*).

This area has also had bank stabilization works with funding from various state and federal entities.

In the main Flying-fox Camp area (see photograph 1) the ground cover, shrub layer and vines are dense and weed infested. Vines are dense throughout the casuarina tree canopy. There are areas that have been cleared and mulched with several plantings of locally sourced Eucalypts and Acacias. When the Flying-fox population increases, they roost in trees along the water course to the north, south and east of the core Camp area. There do not appear to be any known roosting sites outside of the vegetated riparian zone, however properties adjacent to the River may experience Flying-foxes nearby when numbers peak.

The tree canopy in the core area is dominated by Casuarina and Eucalypt species. The Casuarina are typically about 20m high with Eucalypts averaging 25m high, all trees provide significant roosting space and protection from heat.

The camp is a known breeding Camp for Grey-headed Flying-foxes.



Photograph 1 – Main roost area over Muscle Creek. The Remington Motel is in the background.



Photograph 2: Main Flying-fox Camp area -this area is bordered by the Muswellbrook Aquatic Centre and the Platypus Walking Trail.



Photograph 3: Denman Flying-fox Camp, this camp extends on to the land owned by Denman Van Village.

2.2.3 Ecological role of Flying-foxes

Flying-foxes, along with some birds, make an important contribution to ecosystem health through their ability to move seeds and pollen over long distances (Welbergen et.al. 2020). This seed dispersal mechanism directly impacts on the reproduction, regeneration and viability of forest and bush ecosystems. (Lunn et. al. 2021). 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), recent studies have found a reduced foraging radius of 20 km (Boardman, et. al. 2021) however this could be due to seasonal flowering. There are records of Grey-headed Flying-foxes 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 (Todd et al. 2022, Westcott et al. 2008; McConkey et al. 2012), including eucalypt forests, rainforests, woodlands and wetlands (Timmiss et.al, 2020). Seeds that can 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 & Augée 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. (Lindenmayer et. al.,2013)

Flying-foxes are considered 'keystone' species given their contribution to the health, longevity and diversity among and between vegetation communities. (Mo.et al., 2021) 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 (Timmiss et. al, 2020) and provide recreational and tourism opportunities worth millions of dollars each year (EHP 2012; ELW&P 2015).

2.2.4 Flying-fox Habitat

Vegetation Communities

Vegetation assessments undertaken in 2017 at the at Wilder Street, Wilkinson Street, Mill Street and Brook Street roosting sites identified the dominant tree, shrub and ground cover species within a 20 by 20 metre area. Overall, there was limited native species diversity identified within the rapid assessment sites, which is a result of past extensive clearing of the riparian zone, displaced by exotic species. This area has been subject to extensive revegetation works by Muswellbrook Shire Council and its contractors, including bank stabilization works, weed removal and replanting of vegetation.

Threatened Species & Endangered Ecological Communities

The Muswellbrook Flying-fox Camp contains potential habitat for *Eucalyptus camaldulensis* an endangered population in the Hunter Catchment. The Camp also contains habitat for Hunter Floodplain Red Gum Woodland, listed as an Endangered Ecological Community under the TSC Act.. No other threatened species or populations were recorded during the site assessment undertaken in 2017. It is recommended that a detailed Flora and Fauna assessment be undertaken to identify location and extent of any threatened flora and fauna species which are likely to utilise the riparian habitats. (This was recommended in the last plan and has not yet occurred).

A list of threatened species known to occur within 10 km of the site and are likely to be found on site is provided in Table 1.

Table 1: Threatened species and ecological communities that are likely to occur at the site¹

Species Name	Common Name	NSW Status	Commonwealth Status
Fauna			
<i>Rostratula australis</i>	Australian Painted Snipe	E,P	E
<i>Ninox connivens</i>	Barking Owl	V	
<i>Melithreptus gularis gularis</i>	Black-chinned Honeyeater (eastern subspecies)	V,P	
<i>Falco subniger</i>	Black Falcon	V,P	
<i>Climacteris picum, mus victoriae</i>	Brown Treecreeper (Eastern subspecies)	V,P	
<i>Phascogale tapoatafa</i>	Brush-tailed Phascogale	V,P	
<i>Petrogale penicillata</i>	Brush-tailed Rock-wallaby	E1,P	V
<i>Burhinus grallarius</i>	Bush Stone Curlew	E1,P	
<i>Nyctophilus corbeni</i>	Corben's Long-eared bat	V,P	V
<i>Stagonopleura guttata</i>	Diamond Firetail	V,P	
<i>Artamus cyanopterus cyanopterus</i>	Dusky Woodswallow	V,P	
<i>Vespadelus troughtoni</i>	Eastern Cave Bat	V,P	

Species Name	Common Name	NSW Status	Commonwealth Status
<i>Micronomus norfolkensis</i>	Eastern Coastal Free-tailed bat	V,P	
<i>Falsistrellus tasmaniensis</i>	Eastern False Pipistrelle	V,P	
<i>Petroica phoenicea</i>	Flame Robin	V,P	
<i>Callocephalon fimbriatum</i>	Gang-gang Cockatoo	V,P,3	E
<i>Calyptrorhynchus lathamii</i>	Glossy Black Cockatoo	V,P,2	V
<i>Scoteanax rueppellii</i>	Greater Broad-nosed Bar	V,P	
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V,P	V
<i>Pomatostomus temporalis temporalis</i>	Grey-crowned Babbler (eastern subspecies)	V,P	
<i>Melanodryus cucullata cucullata</i>	Hooded Robin (south-eastern form)	V,P	
<i>Phascolarctos cinerus</i>	Koala	E1,P	E
<i>Chalinolobus dwyeri</i>	Large-eared Pied Bat	V,P	V
<i>Miniopterus orianae oceanensis</i>	Large Bent-wing Bat	V,P	
<i>Miniopterus australis</i>	Little Bent-wing Bat	V,P	
<i>Hieraaetus morphnoides</i>	Little Eagle	V,P	
<i>Loxia pusilla</i>	Little Lorikeet	V,P	
<i>Tyto novaehollandiae</i>	Masked Owl	V,P,3	
<i>Grantiella picta</i>	Painted Honeyeater	V,P	V
<i>Macropus parma</i>	Parma Wallaby	V,P	
<i>Ninox strenua</i>	Powerful Owl	V,P,3	
<i>Anthochaera phrygia</i>	Regent Honeyeater	E4A,P	CE
<i>Petroica boodang</i>	Scarlet Robin	V	
<i>Tyto tenebricosa</i>	Sooty Owl	V,P,3	
<i>Petauroides volans</i>	Southern Greater Glider	E1,P	V
<i>Myotis macropus</i>	Southern Myotis	V,P	
<i>Chthonicola sagittata</i>	Speckled Warbler	V,P	
<i>Circus assimilis</i>	Spotted Harrier	V,P	
<i>Dasyurus maculatus</i>	Spotted-tailed Quoll	V,P	V
<i>Petaurus norfolcensis</i>	Squirrel Glider	V,P	
<i>Lathamus discolor</i>	Swift Parrot	E1, P	CE
<i>Neophema pulchella</i>	Turquoise Parrot	V,P,3	
<i>Daphoenositta chrysoptera</i>	Varied Sitella	V,P	

Species Name	Common Name	NSW Status	Commonwealth Status
<i>Haliaeetus leucogaster</i>	White Bellied Sea Eagle	V,P	
<i>Petaurus australis</i>	Yellow Bellied Glider	V,P	V
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V,P	
Flora			
<i>Acacia pendula</i>	Acacia pendula population in the Hunter catchment	E2	
<i>Commersonia rosea</i>		E1	E
<i>Pomaderris reperta</i>	Denman Pomaderris	CE	CE
<i>Eucalyptus camaldulensis</i>	Eucalyptus camaldulensis population in the Hunter catchment	E2	
<i>Eucalyptus nicholii</i>	Narrow-leaved Black Peppermint	V	V
<i>Lasiopetalum logistamineum</i>		V	V
<i>Diuris Tricolor</i>	Pine Donkey Orchid	V,P,2	
<i>Eucalyptus glaucina</i>	Slaty Red Gum	V	V
<i>Cymbidium canaliculatum</i>	Tiger Orchid (Hunter population)	E2, P,2	
EEC			
Endangered: Hunter Floodplain Redgum Forest Woodland in the Sydney Basin and New South Wales North Coast Bioregions		E3	
Critically Endangered Ecological Community - Box Gum Woodland		CE	

¹ Source: Atlas of Living in Australia accessed 20/03/2023 Bionet – Wildlife atlas accessed 20/3/2023

- 1 Sensitivity Class 1 (Sensitive Species Data Policy)
- 2 Sensitivity Class 2 (Sensitive Species Data Policy)
- 3 Sensitivity Class 3 (Sensitive Species Data Policy)
- CC Collapsed Ecological Community (Biodiversity Conservation Act 2016)
- CH Critical Habitat (Biodiversity Conservation Act 2016)
- E1 Endangered (Biodiversity Conservation Act 2016)
- E2 Endangered Population (Biodiversity Conservation Act 2016)
- E3 Endangered Ecological Community (Biodiversity Conservation Act 2016)
- E4A Critically Endangered Species (Biodiversity Conservation Act 2016)
- P Protected (National Parks & Wildlife Act 1974)
- V Vulnerable (Biodiversity Conservation Act 2016)
- V2 Vulnerable Ecological Community (Biodiversity Conservation Act 2016)

Foraging Areas

Within the Camp

A mature stand of River Redgum (*Eucalyptus camaldulensis*), is located just north of Wilder Street, extending approximately 150m along Muscle Creek. River Redgums extend onto ARTC land north of the Caravan Park, and on Muscle Creek at the end of Gyarran Road, south west of Wilder Street (see Photograph) and within the Caravan Park grounds at Mill Street. River Redgum occurs intermittently along Muscle Creek, the extent and distribution of this species along the entire camp has not been comprehensively mapped.

Other suitable foraging species include Silky Oak (*Grevillea robusta*) Forest Redgum (*Eucalyptus tereticornis*) and Blakely's Redgum (*Eucalyptus blakelyi*) and Prickly-leaved Paperbark (*Melaleuca stypheloides*) which occur intermittently as scattered mature trees or small stands along Muscle Creek (see Photograph).

Flying-foxes are also known to feed on environmental weeds such as Small-leaved Privet, which is widespread at the Denman site and is present close to the Muswellbrook site.



Photograph 4: River Redgum (*Eucalyptus camaldulensis*), an Endangered Population in the Hunter Catchment – preferred Flying-fox foraging habitat at Muscle Creek, near Wilder Street

Within 1km of the Camp

Populations of River Redgum occur within the golf course southwest of the Flying-fox Camp.

Flying-foxes may opportunistically forage on species which occur in backyards including Silky Oaks, Cocos Palms and Broad-leaved Paperbark (*Melaleuca quinquenervia*). Suitable foraging habitat is less evident within residential areas closest to the business district. Flying-foxes will opportunistically feed on planted fruit trees when available.

Several small stands of remnant White Box, Narrow-leaved Ironbark (*Eucalyptus crebra*), Broad-leaved Ironbark (*Eucalyptus fibrosa*), Grey-Box (*Eucalyptus moluccana*), Forest Redgum and Rough-barked Apple occur in residential areas to the south and north of the creek that are likely to attract foraging Flying-foxes.

Within 6km of the Camp

There are a number of remnant native vegetation communities within 6km of the Camp which are known food sources for Flying-foxes, these are:

- Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter and associated with the Listed EPBC Act, Critically endangered: Central Hunter Valley eucalypt forest and woodland (Part)
- White Box - Narrow-leaved Ironbark - Blakely's Red Gum shrubby open forest of the central and upper Hunter and associated with the Listed TSC Act Endangered White Box Yellow Box Blakely's Red Gum Woodland (Part).
- Lower Hunter Valley Dry Rainforests - TSC Act Endangered Ecological Community
- Hunter Floodplain Redgum Woodland - TSC Act Endangered Ecological Community
- Central Hunter Ironbark-Spotted Gum-Grey Box Forest -TSC Act Endangered Ecological Community (Peake 2006).

Surrounding the Camps (20km)

The number of Flying-foxes present in a camp is primarily driven by the amount and quality of food available in the local area, relative to that available within migration distance (Tidemann 1999; Eby 1991; Roberts et al 2012). Flying-foxes typically feed within 20 km of their roost (Tidemann 1999), and digital maps of feeding habitat for Grey-headed Flying-foxes have been used to summarise feeding resources within 20 km of the Muswellbrook camp (Eby and Law 2008).

The area surrounding the Muswellbrook camp has been heavily cleared for agriculture and mining. Approximately 17% of land within 20 km of the site supports native forests and woodlands, primarily in small remnant patches. While some dry rainforest occurs in the area, it is rare and rainforest fruits provide sparse food resources for Flying-foxes during late summer and autumn.

Approximately 90% of forested land within 20km of Muswellbrook contains flowering trees visited by Flying-foxes. In total, 10 species of trees in the flower diet of Grey-headed Flying-foxes occur within feeding range of the Muswellbrook camp (Table 2). They vary considerably in the amount of nectar they secrete, the frequency and duration of flowering, their seasonal flowering schedules, and their area of distribution. Interactions between these characteristics determine the influence they have on the presence of Flying-foxes in the Muswellbrook camp and the size of the population. Species with restricted distributions or that produce relatively low volumes of nectar are likely to have a minor influence on the number of Flying-foxes feeding in the area.

Three highly productive species are likely to have a substantial influence (Table 2): Spotted Gum, White Box and Grey Ironbark. Remnant vegetation immediately surrounding Muswellbrook and to the north contains box-ironbark grassy woodlands dominated by White Box. To the south and west lie woodlands dominated by Spotted Gum and Grey Ironbark.

The area surrounding the Denman camp has been heavily cleared for housing, mining and agriculture. Approximately 34.6% of land within 20 km of the site supports native forests and woodlands, with approximately 42% of this within the Wollemi National Park.

The irregular influxes of Flying-foxes to the Muswellbrook camp appear to be driven by flowering of Spotted Gum and White Box. Influxes in 2012 and 2015 were associated with significant flowering of White Box during late autumn and winter; a mass flowering of Spotted Gum coincided with the 2012 event. A resource bottleneck for Grey-headed Flying-foxes occurs during winter and flowering of Spotted Gum and White Box are particularly attractive to Grey-headed Flying-foxes. The length of time the camp is occupied is likely to extend to spring and summer in years when Grey Ironbark flowers well.

Table 2: Characteristics of flowering trees in the diet of Grey-headed Flying-foxes that occur within 20 km of the Muswellbrook camp. Nectar abundance is scored in 4 categories from 0 to 1; the approximate frequency of flowering is also scored in 4 categories relating to % of years; duration of flowering is scored in months. Species likely to play a significant role in determining the number of Flying-foxes present in the camp, as assessed by nectar abundance and area of distribution, are highlighted in grey. Species found in <1% of native vegetation have been excluded. See Eby and Law (2008) for further details.

Species	Common Name	% area of native vegetation	flowering characteristics			bi-monthly flowering schedule					
			nectar abundance	frequency (% yrs)	duration (mth)	Dec-Jan	Feb-Mar	Apr-May	Jun-Jul	Aug-Sep	Oct-Nov
<i>Corymbia maculata</i>	Spotted Gum	25%	1	0.25	4-6			X	X		
<i>Eucalyptus albens</i>	White Box	20%	0.7	0.4	4			X	X	X	
<i>E. siderophloia</i>	Grey Ironbark	15%	1	0.7	2	X					X
<i>Angophora floribunda</i>	Rough-barked Apple	5%	0.5	0.4	1	X					
<i>E. acmenoides</i>	White Mahogany	10%	0.3	0.7	1	X					X
<i>E. fibrosa</i>	Broad-leaved Ironbark	10%	0.7	0.4	2	X					
<i>E. moluccana</i>	Grey Box	50%	0.3	0.7	2		X				
<i>E. propinqua</i>	Small-fruited Grey Gum	5%	0.5	0.4	2	X	X				
<i>E. punctata</i>	Large-fruited Grey Gum	20%	0.3	0.7	1	X	X				
<i>E. tereticornis</i> (inland)	Forest Red Gum	15%	0.5	0.4	2	X					X
						7	3	2	2	1	3

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Roosting Areas

In August 2015, the population of grey-headed Flying-foxes peaked at approximately 32,000 animals, they were observed roosting from Scott Street in the north to the Hunter River immediately west of the Caravan Park. Flying-foxes were also roosting on Muscle Creek between residential properties from Wilkinson Avenue to Wilder Street (Refer to Map 6). Flying-foxes were observed roosting on both sites of the creek, with the majority roosting along the eastern side of Muscle Creek.

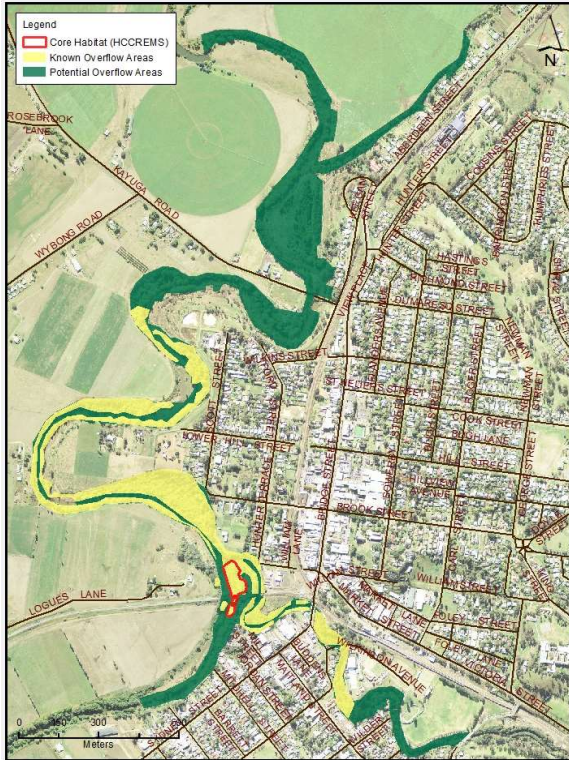
This significant increase in Flying-foxes coincided with the widespread and abundant flowering of Spotted Gums (*Corymbia maculata*). To date, this number of flying-foxes has not returned to Muswellbrook, with population maximums of approximately 10,000 animals since the peak population event. It is likely that these expansions occurred during major flowering events suggesting that the population expansions are resource driven. (Páez et.al, 2018)

Flying-fox roosting locations have been noted for several years since the beginning of the National Flying-fox Monitoring Program which is coordinated by the CSIRO.

The riparian zone throughout the Muswellbrook township is prime Flying-fox roosting habitat. There appears to be limited possible overflow areas within the township, other than along the riparian zone. It is possible however that there may be some large, planted trees within the township that may be suitable enough for flying-foxes to roost in if there were Camp capacity pressures or other reasons why they may feel they have to move camp e.g., disturbance at main Camp. Other potential overflow sites may continue further to the north of the camp and towards Bell Street. Within this area the species and density of the vegetation is consistent with the existing roost area.

The village of Denman is 26 kilometres west of Muswellbrook and recently a camp has been formed there. This could be due to a lack of resources in Muswellbrook.

Map 4: Potential Flying-fox Camp overflow areas



2.2.5 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 maneuvering in flight due to the open nature of the habitat or ease of navigation due to landmarks and lighting.

The vegetation along Muscle Creek whilst improving with rehabilitation and local provenance plantings, features densely infested and widespread noxious and environmental weeds, due to the extensive seedbank, providing suitable habitat for Flying-foxes. Further north, south and west of the camp, riparian vegetation is absent due to widespread industrial land clearing, making the riparian zone in Muswellbrook township the only reliable roosting habitat in the immediate vicinity.

The following threats and hazards to the Muswellbrook Flying-fox Camp have been identified:

- Natural food shortages – due to land clearing in combination with poor flowering seasons
- Fruit tree netting – females with young have been observed trapped in netting (2017)
- Limited potential roosting areas – may have to roost in less desirable areas if population grows.
- Heat events – recent heat waves have seen animal deaths throughout the region.
- Disturbance from local residents.
- Barbed wire – fencing across dams in particular poses a 'death-trap' to Flying-foxes
- Powerlines – when there are food shortages, Flying-foxes are more likely to forage in urban areas and there is therefore an increased risk of electrocution.
- Fireworks – Wildlife Rehabilitators often get calls to attend injured animals after fireworks have been set off.

2.2.6 Flying-foxes 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 through the TSC Act.

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 Grey Headed Flying-fox, including:

- habitat loss and degradation
- conflict with humans (including culling at orchards)
- infrastructure-related mortality (for example, 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).

2.2.7 Flying-foxes and Heat Stress

Heat stress affects Flying-foxes when temperatures reach 42°C or more. Over the past two decades, several documented heat stress events have resulted in significant Flying-fox mortality.

When ambient temperatures rise above 35°C Flying-foxes tend to alter their behaviour to reduce exposure to heat. A range of behaviours may be exhibited, depending on multiple variables in their environment. The impacts of heat stress events are likely to vary site by site and can depend on conditions in the preceding days. Ambient temperature alone may thus not be a sound indicator of a heat stress event, and Flying-fox behaviour may provide more reliable information. As Flying-foxes experience heat stress, they are likely to exhibit a series of behaviours indicating progressive impact of that stress, including:

- clustering or clumping,
- panting,
- licking wrists and wing membranes
- descending to lower levels of vegetation or to the ground.

Some of these behaviours may occur outside of heat stress events.

2.2.8 Human and Animal Health

Flying-foxes, like all animals, carry bacteria, viruses 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.

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 Rehabilitators 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).

More details on diseases and Flying-foxes can be accessed through Muswellbrook Shire Council's website.

2.3 Legislative and Regulatory Context

The Grey-Headed Flying-fox (*Pteropus poliocephalus*) is listed as a vulnerable species under the Federal *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and is therefore considered a 'Matter of National Environmental Significance' and is therefore protected under federal law.

In NSW, the grey-headed Flying-fox was listed as vulnerable under the NSW *Threatened Species Conservation Act 1995* in 2001. This listing is based on scientific evidence indicating a significant decline in the population of the species and that it is "likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate" (NSW Scientific Committee 2001).

This means that if present processes continue, the species could become extinct.

The National Recovery Plan means that any actions that could adversely affect the species generally require approval or licensing, and that impacts on the species require assessment.

The NSW Office of Environment and Heritage (OEH) had prepared the 'Flying-fox Camp Management Policy' 2015, intended to empower land managers, primarily local councils, to work with their communities to manage Flying-fox camps effectively. It provides the framework within which OEH will make regulatory decisions. The Policy encourages local councils and other land managers to prepare camp management plans for sites where the local community is affected.

Additionally, any activities undertaken on Department of Education property, will also need to comply with Local Development Consent and the Infrastructure SEPP.

Parliamentary Inquiry into Flying-fox management in the eastern states

In 2016-17 the House of Representatives Standing Committee on the Environment and Energy undertook an inquiry into the increasing tensions being experienced by residents affected by Flying-fox camps.

To gather evidence from the relevant stakeholders and experts within the agreed timeframe, the Committee conducted a roundtable public hearing in Canberra (February 2017). This enabled productive engagement with a wide range of experts and representatives of affected communities. The Committee also received a range of written submissions and correspondence outlining stakeholder experiences and community concerns about local Flying-fox issues.

The Committee agreed that Flying-foxes act as important pollen and seed dispersers for a wide range of native vegetation across the east coast of Australia. Due to their ecological importance in maintaining some of Australia's most significant ecosystems, work needs to be undertaken to ensure the preservation of Flying-fox species across the country.

The Committee further noted the reduction in suitable foraging and roosting habitat, among other factors, has impacted on the population size of several species, leading the Spectacled Flying-fox and Grey-headed Flying-fox to be listed as 'Vulnerable' under the Environment Protection and Biodiversity Conservation Act 1999. The expansion of human populations across coastal New South Wales and Queensland has led to Flying-fox camps becoming increasingly located in urban and rural residential areas, possibly from movements of camps due to loss of natural habitat, or the expansion of human settlement into traditional Flying-fox habitats.

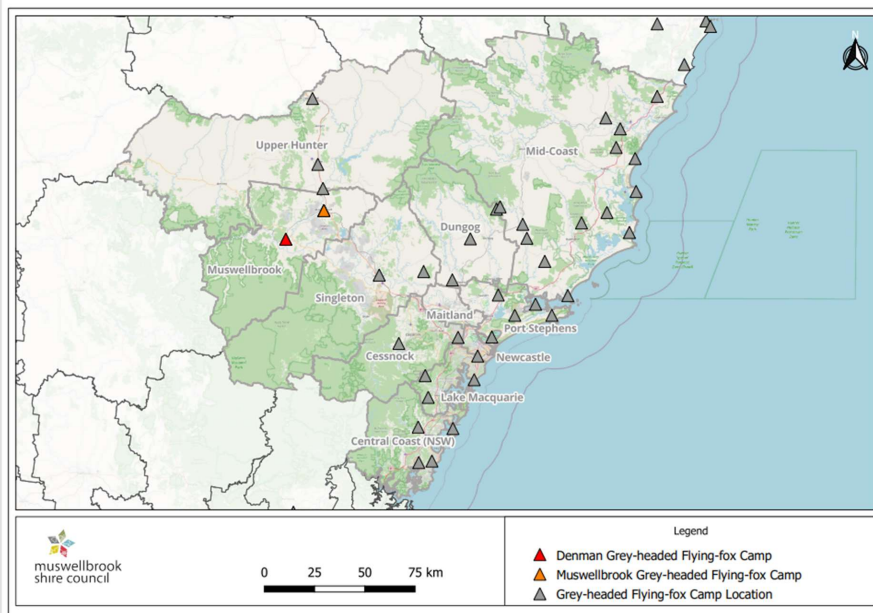
The Committee produced several recommendations that have been forwarded to the Commonwealth Department of Environment & Energy for consideration and action:

1. The Committee recommends that the Australian Government propose a national or eastern states Flying-fox consultative committee or working group to the Council of Australian Governments. The consultative committee or working group would be responsible for centrally compiling information on referrals and management actions, and identifying priorities for legislative harmonisation, research, and funding.
2. The Committee recommends that the Australian Government establish a dedicated funding pool for Flying-fox research and conservation actions, to enable:

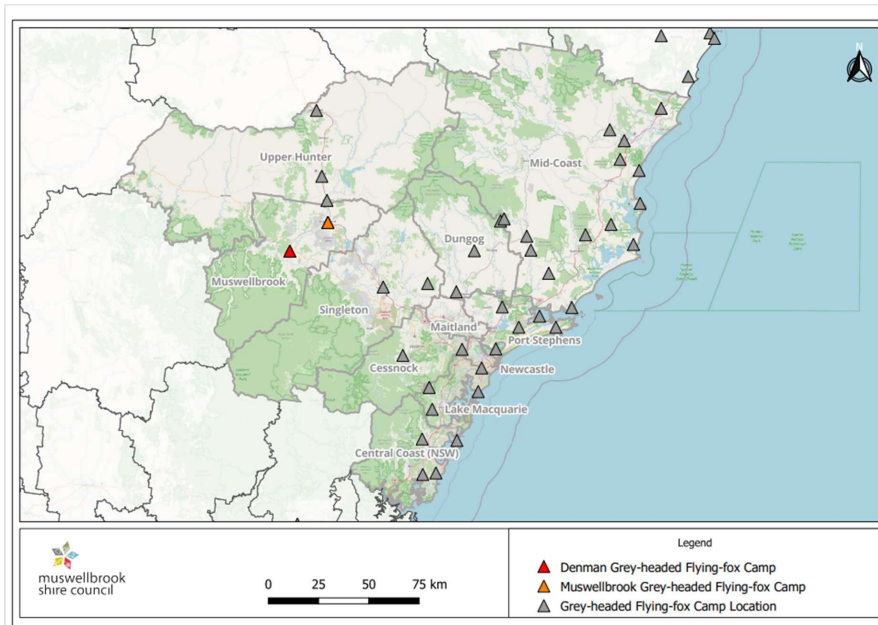
- a. continued funding of the National Flying-fox Monitoring Program for at least the next 10 years.
 - b. committed funding for the priority actions outlined in the recovery.
 - c. plans for both the Spectacled Flying-fox and Grey-headed Flying-fox;
 - d. targeted national research into Flying-fox roosting behaviours and habitat loss impacts; and
 - e. any other research that allows for the timely evaluation of Flying-foxes under the Environment Protection and Biodiversity Conservation Act 1999, informed by rigorous data, at the earliest opportunity.
3. The Committee recommends that the Department of the Environment and Energy develop, in consultation with relevant state and local governments, a tool that assists councils to make decisions on action, referral and education in the most appropriate way, relevant to the Flying-fox impacts in their jurisdiction.
4. The Committee recommends that the Department of the Environment and Energy, in consultation with other relevant organisations, develop a suite of education resources for Australian communities regarding Flying-fox ecology, behaviour, environmental significance, health impacts, and management options. These resources should be promoted by the Australian Government to local councils, communities, businesses and all relevant stakeholders in affected jurisdictions and potentially affected jurisdictions.

2.4 Regional Context

The Hunter & Central Coast Region is home to 83 known Flying-fox Camps (see



Map 5), 54 of which have observed Flying-foxes roosting in them since 2012. It is highly likely that there are additional Camps throughout the vegetated areas (private land and National Parks / State Forest) of the region that are well away from human settlements and are currently unaccounted in the CSIRO National Flying-fox Camp Census.



Map 5: Known Flying-fox Camps throughout the Hunter & Central Coast region.

Ongoing research into Flying-fox behaviours appears to indicate that food shortages precede the abandonment of traditional camps, and the creation of new camps, and many more. Following the 2010 Flying-fox food shortage the number of Camps in Sydney increased from 7 to 22. Occupancy of these new camps did not appear to reduce when food supply increased, suggesting that once roosting and feeding patterns change, the roosting behaviour has been adapted and, in most cases, does not revert to previous behaviours. This has also been played out in the Hunter region.

Overall, the location and scale of Flying-fox Camps in NSW has changed significantly since 2002, when Camps were mostly found in the North of the State, in 2015 following both food shortages, and preferred food flowering events, the Flying-fox populations have spread both South and west, with a number of new camps being created inland, and on the NSW South Coast. Since 2015, most new Camps created have been in vegetated areas quite close to human populations.

Regional Flying-fox Foraging Preferences

In 2019, a report was prepared for Local Government NSW on the mapping of Flying-fox foraging habitat. This report incorporated information vital for Councils to assist in decision making surrounding habitat and foraging plantings. This report will assist Councils with land use planning and will assist Councils to, where possible, preserve areas of high value Flying-fox foraging vegetation, and potentially protect areas suitable for Flying-fox roosting that may have reduced conflict issues (i.e. not be located in close proximity to human settlements). It could also be used for species selection when councils are carrying out planting activities so that preferred foraging species can be planted away from residential areas. Although Flying-foxes are wild animals and it is not possible to predict where they will choose to roost, if there are no alternatives to the current Camp sites, it can be guaranteed the animals will not move on of their own accord.

Management Actions at other Flying-fox Camps

There are 83 known Flying-fox Camps across the region (NSW DPE, 2023), with occupation of the camps varying each season and across each year. This is an increase from the original 59 reported in the first Camp Management Plan. This could be due to increased awareness of Flying-foxes or it could be due to the splintering of larger camps into smaller ones.

The management of Flying-foxes across Councils is a prime issue at present, with councils in the region participating in the development of a Regional Flying-fox Strategy (project being led by the NSW Department of Planning and Environment), party to regional Flying-fox education projects, and participants in a National Australian Research Council Grant project seeking to “link” existing Flying-fox research and solidify knowledge about the species, its value to Australian ecology and how the species can best be supported.

All councils in the Hunter & Central Coast are currently proceeding on the basis that Flying-fox management activities will not include Level 3 actions. Culling of Flying-foxes is now illegal in New South Wales.

There is an active understanding amongst council staff and senior managers that any move to disperse Flying-foxes from one Camp will undoubtedly place stress on other Camps in the region, or more likely (based on research on previous dispersal activities) create a splinter Camp nearby and ultimately cause a new residential area to conflict with the Flying-foxes.

The region, local councils, DPE, Hunter Local Land Services, NSW Department of Industry – Lands and wildlife rehabilitators worked together to develop regionally consistent community engagement and education products in the hope that this can assist residents to understand why the Flying-foxes are in the region, how long they will stay on their migration, and ways that people can manage their property and level of interaction with them. Part of the engagement project will be to address previous negative media stories related to Flying-foxes. This community engagement tool called “Little Aussie Battlers” was assisted by the New South Wales Government through its Environmental Trust. The website for these products can be found here:

<https://littleaussiebat.com.au/Flying-fox-facts/>

3 Community Engagement

Muswellbrook Shire Council undertook a community engagement process in 2017 in the facilitation of the original Camp Management Plan, as detailed below. Council continues to undertake community engagement in the event of an influx of flying-foxes where numbers increase substantially or when Flying-foxes begin roosting in areas where they have not historically roosted.

3.1 Stakeholders and Interest Groups

There are a range of stakeholders who are directly or indirectly affected by the Flying-fox camp, or who are interested in its management. Stakeholders include those shown in Table 3.

Table 3: Stakeholders and Interest Groups in the camp and Plan

Stakeholder	Interest / Reported Impacts
Residents	Odour, noise and droppings
Business owners	Odour, noise and droppings
Indigenous community	Potential to use some LALC land for creation of flying-fox habitat.
Schools	Odour, noise and droppings
Hospitals	Odour, noise and droppings
Airports	Airport managers have a responsibility to reduce the risk of wildlife–aircraft strike. Scone airport is just outside a 20 km radius from the camp.
Equine facilities and vets	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.
Orchardists and fruit growers	Fruit growers may be impacted by Flying-foxes raiding orchards. While there are fruit trees within a 20 km radius, they are not being grown for commercial purposes.
Other/adjoining landholders; these may include government departments such as Crown Lands, Transport for NSW / Roads and Maritime Services, or neighbouring councils	Camp areas are a mix of council, Australian Rail and Track Corporation and crown land. Neighbouring councils of Singleton and Upper Hunter have also been impacted by flying-foxes.
Civic leaders and influencers (including local, state and federal politicians)	Muswellbrook Mayor Steven Reynolds – 60-82 Bridge Street, Muswellbrook 65493700 State MP Dave Layzell- 20 Bridge St, Muswellbrook NSW 2333 Phone: (02) 6543 1065 Federal MP Dan Repacholi - 3 Edward St, Cessnock NSW 2325 Phone:(02) 4991 1022
Local government	Local government has responsibilities to the community and environment of the area for which it is responsible in accordance with the Local Government Act 1993. Council is also responsible for administering local laws, plans and policies, and appropriately managing assets (including land) for which it is responsible.
Local Government NSW (LGNSW)	LGNSW is an industry association that represents the interests of councils in NSW.

Stakeholder	Interest / Reported Impacts
Department of Planning and Environment	DPE is responsible for administering legislation relating to (among other matters) the conservation and management of native plants and animals, including threatened species and ecological communities.
Commonwealth Department of the Environment (DoE) (relevant to camps with grey-headed Flying-foxes or other matters of national environmental significance)	DoE 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.
Wildlife Rehabilitators and conservation organisations	Wildlife Rehabilitators and conservation organisations have an interest in Flying-fox welfare and conservation of Flying-foxes and their habitat.
Researchers/universities/CSIRO	Researchers have an interest in Flying-fox behaviour, biology, ecology, and conservation.

3.2 Engagement Methods

Effort was made to engage with the community during preparation of the original camp management plan in 2017 to:

- understand the issues directly and indirectly affecting the community.
- raise awareness within the community about Flying-foxes.
- correct misinformation and allay fears.

The types of engagement undertaken included:

- media (print, social media)
- brochures and other educational material
- website pages and links
- direct contact with adjacent residents including letters, brochures and emails
- shopping centre engagement with information stand
- Radio interview
- Flying-fox Engage online survey

Table 4: Details of Community Engagement Activities undertaken in the development of the original Muswellbrook Camp Management Plan

Date	Consultation Activity
November 2016	Brochure developed by Muswellbrook Shire Council Sustainability and Web design teams.
November 2016	Door knock in affected zone with brochures. 10 Face to Face conversations were held with 30 information brochures delivered. Brochures also left at Muswellbrook Library and Council's Administration building.
6 March 2017	Media Release to local newspaper
27 March 2017	Muswellbrook Chronicle's Facebook Page http://www.muswellbrookchronicle.com.au/story/4555892/help-wanted-for-Flying-fox-plan/?cs=1487
28 March 2017	Radio interview on Upper Hunter ABC with Cecilia Connell.
31 March 2017	Article "Help Wanted for Flying-fox Plan" appeared on page 6 of Muswellbrook Chronicle.
11 April 2017	Community Engagement Stand at local shopping centre. Patrons were encouraged to ask questions and complete the Flying-fox Engage Survey.

Since the commencement of this Camp Management Plan, Council has undertaken many community engagement activities.

This includes but is not limited to:

- Ensuring information brochures about flying-foxes are available on Council's website and in Council owned locations such as the administration centre and libraries.
- Door knocking and letterbox drops in areas near Flying-fox camps.
- Regular media releases and engagement with the public when flying-fox numbers increase.
- Offering businesses and residents items such as car covers, washing line covers and the use of a Council owned gurney for the clean-up of flying-fox droppings.
- Running an annual program subsidizing the removal of Cocos Palms and Privet trees from resident's properties.

Council also obtained funding from the state government to assist local motels impacted by the location of flying-foxes. This included assistance with replacing outdoor furniture ruined by flying-fox droppings and property modification including replacing windows in rooms, so odour was reduced and installation of car port like structures over washing lines and other communal areas to prevent flying-fox droppings negatively impacting these areas.

3.3 Community Feedback on Management Options

The use of the Flying-fox Engage online survey was the key engagement tool used to enable Council to receive direct feedback from the community on their experiences living near Flying-foxes and the values they place on them to provide some insight to Council on the management actions they would find acceptable to be employed on site.

Flying-fox engage is an innovative engagement decision support system. The online Flying-fox engage consultation tool was launched in March 2017 and remained open for submissions until the end of May 2017. During this consultation period the Flying-fox Engage website received 51 valid submissions.

Flying-fox Engage is a relatively simple survey methodology that poses 12 questions to users. The response to these questions then produces a ranked list of preferred management options that reflect the values of the survey respondent. The list is then able to be manipulated by the user to manually reorder the preferred list.

The initial ranked list of preferred management options is influenced by a weighting applied to each management option that relates to ease of implementation, cost of implementation, and impact of implementation. The weighting was determined by a panel of experts convened by OEH, and confirmed by Council officers based on any specific issues that affect or influence the Camp at Muswellbrook. Collated responses to the questions are included in Table 5.

When funding becomes available this process should be undertaken again considering the actions that have been undertaken since the last survey.

Table 5: Collated responses to the questions posed in Flying-fox Engage

Question	Responses												
How important is it to you that the Flying-fox camp management option reduces the impact of noise and odour from Flying-foxes roosting at the camp on nearby residents?	<p>How important is it to you that the Flying-fox camp management option reduces the impact of the Flying-fox excrement on the property of nearby residents?</p> <table border="1"> <thead> <tr> <th>Response Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Not important at all</td> <td>12%</td> </tr> <tr> <td>Slightly important</td> <td>4%</td> </tr> <tr> <td>Moderately important</td> <td>18%</td> </tr> <tr> <td>Very important</td> <td>12%</td> </tr> <tr> <td>Extremely important</td> <td>55%</td> </tr> </tbody> </table>	Response Category	Percentage	Not important at all	12%	Slightly important	4%	Moderately important	18%	Very important	12%	Extremely important	55%
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How important is it to you that the Flying-fox camp management option does not move the Flying-fox camp to other areas that may also be near residents or businesses?	<p>How important is it to you that the Flying-fox camp management option ensures the risk of disease transmission remains low?</p> <table border="1"> <thead> <tr> <th>Response Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Not important at all</td> <td>8%</td> </tr> <tr> <td>Slightly important</td> <td>4%</td> </tr> <tr> <td>Moderately important</td> <td>18%</td> </tr> <tr> <td>Very important</td> <td>6%</td> </tr> <tr> <td>Extremely important</td> <td>64%</td> </tr> </tbody> </table>	Response Category	Percentage	Not important at all	8%	Slightly important	4%	Moderately important	18%	Very important	6%	Extremely important	64%
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How important is it to you that the Flying-fox camp management option has a low financial cost to residents living near the Flying-fox camp?	<p>How important is it to you that the Flying-fox camp management option ensures the risk of disease transmission remains low?</p> <table border="1"> <thead> <tr> <th>Response Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Not important at all</td> <td>8%</td> </tr> <tr> <td>Slightly important</td> <td>10%</td> </tr> <tr> <td>Moderately important</td> <td>8%</td> </tr> <tr> <td>Very important</td> <td>12%</td> </tr> <tr> <td>Extremely important</td> <td>62%</td> </tr> </tbody> </table>	Response Category	Percentage	Not important at all	8%	Slightly important	10%	Moderately important	8%	Very important	12%	Extremely important	62%
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How important is it to you that the Flying-fox camp management option has a low financial cost to Council ratepayers?	<p>How important is it to you that the Flying-fox camp management option has a low financial cost to Council ratepayers?</p> <table border="1"> <thead> <tr> <th>Response Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Not important at all</td> <td>10%</td> </tr> <tr> <td>Slightly important</td> <td>8%</td> </tr> <tr> <td>Moderately important</td> <td>2%</td> </tr> <tr> <td>Very important</td> <td>10%</td> </tr> <tr> <td>Extremely important</td> <td>71%</td> </tr> </tbody> </table>	Response Category	Percentage	Not important at all	10%	Slightly important	8%	Moderately important	2%	Very important	10%	Extremely important	71%
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Very important	14%												
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Question	Responses																								
How important is it to you that the Flying-fox camp management option can be implemented quickly?	How important is it to you that the Flying-fox camp management option provides a long term solution?																								
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How important is it to you that the Flying-fox camp management option does not disrupt residents and businesses during implementation?	How important is it to you that the Flying-fox camp management option does not harm the Flying-foxes?																								
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How important is it to you that the Flying-fox camp management option does not degrade the natural or ecological values of the site?	How important is it to you that the Flying-fox camp management option does not change the visual appeal or recreational opportunities currently undertaken at the site?																								
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With all questions posed, most respondents suggested they were extremely important. It was only questions related to management actions not disrupting businesses and residents, not harming Flying-foxes, and not changing the visual appeal of the site that respondent's views changed slightly, and more respondents suggested these were less important.

Based on the responses to the questions, Flying-fox Engage was able to rank the various management options that match the responses. Details of the preferred management actions before and after re-ranking is allowed is provided in Table 6.

Table 6: Top 10 community ranked Management Options based on Flying-fox Engage responses

Rank	Initial Result (values based ranking)	Re-ranked result (emotion based ranking)
1	Land-use planning	Land-use planning
2	Subsidising property modification to reduce the impacts of Flying-foxes	Subsidising property modification to reduce the impacts of Flying-foxes
3	Provision of Flying-fox education and awareness programs	Health and safety guidelines to manage incidents related to the camp
4	Health and safety guidelines to manage incidents related to the camp	Guidelines for carrying out operations adjacent to camps
5	Guidelines for carrying out operations adjacent to camps	Provision of Flying-fox education and awareness programs
6	Subsidising services to reduce the impacts of Flying-foxes	Subsidising services to reduce the impacts of Flying-foxes
7	Do Nothing	Research to improve knowledge of Flying-fox ecology
8	Research to improve knowledge of Flying-fox ecology	Revegetate and manage land to create alternative Flying-fox habitat
9	Revegetate and manage land to create alternative Flying-fox habitat	Do Nothing
10	Routine maintenance to improve the condition of the site	Routine maintenance to improve the condition of the site

As shown in Table 6, initial values based ranking suggests the community were in favour of Level 1 actions, with the top 10 responses including low impact actions such as Council managing impacts through land use planning controls, provision of information to affected residents, appropriate management of the Camp site to reduce impacts (routing management) and possible subsidy to affected residents to reduce the impacts they experience. Even after re-ranking, all actions were the same (all Level 1) although in a slightly different order. Management options could be revised if another Flying-fox Engage Survey was undertaken.

When considering just those residents within 300m of Camps (directly impacted) based on information that could be extracted from the survey, the following preferred management list was created (see Table 7)

Table 7: Top 10 ranked Management Options based on Flying-fox Engage responses from directly affected residents from a survey undertaken in 2017.

Rank	Initial Result (values based ranking)	Re-ranked result (emotion based ranking)
1	Land-use planning	Land-use planning
2	Subsidising property modification to reduce the impacts of Flying-foxes	Subsidising property modification to reduce the impacts of Flying-foxes
3	Provision of Flying-fox education and awareness programs	Provision of Flying-fox education and awareness programs
4	Health and safety guidelines to manage incidents related to the camp	Health and safety guidelines to manage incidents related to the camp
5	Guidelines for carrying out operations adjacent to camps	Guidelines for carrying out operations adjacent to camps
6	Subsidising services to reduce the impacts of Flying-foxes	Subsidising services to reduce the impacts of Flying-foxes
7	Do Nothing	Research to improve knowledge of Flying-fox ecology
8	Research to improve knowledge of Flying-fox ecology	Do Nothing
9	Revegetate and manage land to create alternative Flying-fox habitat	Revegetate and manage land to create alternative Flying-fox habitat
10	Routine maintenance to improve the condition of the site	Routine maintenance to improve the condition of the site

Once again, there are largely only level one actions. Some level two actions are related to appropriate management of vegetation to reduce impacts on the properties. Management actions such as subsidies to affected residents were a prominent action, and unsurprising as these respondents are directly affected by the Camp's proximity to their homes.

Provision of items such as car covers and washing line covers to residents and businesses affected by the proximity of flying-foxes has been welcomed by both residents and businesses, it is recommended that this action continues.

In addition to providing preferential management action lists, respondents to the survey also answered several additional questions (see Table 8).

Table 8: Additional Flying-fox Engage Questions

Question	Responses	Number
Have you experienced the Flying-foxes in the camp?	No, I have not experienced the Flying-foxes	16
	Yes, Flying-foxes from the camp roost in trees that are next to or overhang my home	3
	Yes, Flying-foxes leaving and returning to the camp fly over my home	16
	Yes, Flying-foxes stop me from using the area, surrounding services or businesses	1
	Yes, I enjoy visiting the Flying-foxes	9
	Yes, my home is very close to the camp	2
Open ended Question and responses		
If you want to, you can comment on the Flying-fox camp management options we have explored or you can suggest other solutions.	<ul style="list-style-type: none"> I want long-term options like planting roosting and foraging trees outside of urban centers. stop bulldozing their habitat for coal mines stop destroying habitat for mining What would be the natural Flying-fox population balancing factors? I hate them stop destroying their habitat with ...coal mines and intensive agriculture ... 	
If you want to, please provide comments about this Flying-fox camp	<ul style="list-style-type: none"> Harmless. Concerned about increase in numbers. Noise and smell. Have to deal with droppings on vehicle, house and concrete. Do not want another Singleton Park experience It is relatively small and only present for part of the year. leave them there stop destroying habitat for mining I think that they should be moved from the urban area to another suitable site I have seen the destruction they have made in the community in several locations along Muscle Creek and the Hunter River Near hospital Hate them , whatever works Not bothering me Very smelly and very noisy leave it alone 	

The responses to these questions provided even greater understanding to the responses, as only 3 respondents (6%) had direct impact from roosting Flying-foxes, and 16 respondents (31%) experience Flying-foxes flying over their homes as they head out and return from foraging. The implication to this is over two thirds of respondents have no direct impact from the presence of flying-foxes and are just interested in the management of the species. Given the lack of direct conflict experienced by the survey respondents, it is unsurprising that Level 1 actions were the ones included in the preference lists.

4 Management Opportunities

4.1 Site-specific analysis of camp management options

The NSW Flying-fox Camp Management Policy 2015 and Camp Management Plan Template 2016 provide details on acceptable management activities to manage and mitigate human / bat conflict at Camp Sites. The management actions are grouped into three levels, as discussed following.

Routine camp management actions (Level 1 actions)

Routine camp management actions should be clearly identified as Level 1 camp management actions in the camp management plan.

These include:

- removal of tree limbs or whole trees that pose a genuine health and safety risk, as determined by a qualified arborist.
- weed removal, including removal of noxious weeds under the Noxious Weeds Act 1993 or species listed as undesirable by a council.
- trimming of under-storey vegetation or the planting of vegetation
- minor habitat augmentation for the benefit of the roosting animals
- mowing of grass and similar grounds-keeping actions that will not create a major disturbance to roosting Flying-foxes.
- application of mulch or removal of leaf litter or other material on the ground.

Creation of buffers (Level 2 actions)

Creation of buffers can be effective as management actions to nudge Flying-fox populations away from urban settlements. The intention is to create a physical or visual separation from the camp and actively manage vegetation structure and composition to discourage Flying-foxes from roosting close to built up areas.

Actions include:

- clearing or trimming canopy trees at the camp boundary to create a buffer.
- disturbing animals at the boundary of the camp to encourage roosting away from human settlement.

Camp disturbance or dispersal (Level 3 actions)

Camp dispersal is an action that aims to intentionally move entire camps from one location to another by clearing vegetation or dispersing animals through disturbance by noise, water, smoke or light.

Camp dispersal can remove impacts on local communities and is supported by this policy. However, camp dispersal is challenging for several reasons:

- it can be expensive and can have uncertain outcomes.
- dispersal may result in new residential areas being impacted rather than resolving the issue. Past disturbances in Australia have sometimes failed to remove Flying-foxes from the area or have resulted in Flying-foxes relocating to other nearby areas where similar community impacts have occurred.
- attempts to disperse camps are often contentious.
- disturbing Flying-foxes may have an adverse impact on animal health.
- the cumulative impacts of Flying-fox camp dispersals may negatively impact on the conservation of the species and the ecosystem services Flying-foxes provide.

Table 9 provides details on the various management options available, an assessment of cost and effectiveness of the action to address the various conflict issues. The Table also provides details of the assessment undertaken by Council as to the suitability of the actions to be included in the Camp Management Plan. Section 4.2 provides details of the management actions that will be undertaken through the implementation of the Camp Management Plan.

Table 9: Analysis of management options

Management Option	Relevant Impacts	Cost	Advantages	Disadvantages	Suitability Determination
Level 1 Actions					
Education and awareness programs	Fear of disease Noise Smell Faecal drop	\$	Low cost, promotes conservation of FFs, contributes to attitude change which may reduce general need for camp intervention, increasing awareness and providing options for landholders to reduce impacts can be an effective long-term solution, can be undertaken quickly, will not impact on ecological or amenity value of the site.	Education and advice itself will not mitigate all issues, and may be seen as not doing enough.	This action was deemed suitable. Responses from Flying-fox Engage indicated a strong desire from the community for more information on Flying-foxes.
Property modification (e.g. car cover, pool cover, clothesline cover, air conditioners, double glaze windows, etc.)	Noise Smell Faecal drop Health/wellbeing Property devaluation Lost rental return	\$--\$	Property modification is one of the most effective ways to reduce amenity impacts of a camp without dispersal (and associated risks), relatively low cost, promotes conservation of FFs, can be undertaken quickly, will not impact on the site, may add value to the property.	May be cost-prohibitive for private landholders, unlikely to fully mitigate amenity issues in outdoor areas.	This action was deemed suitable for residents adjacent to the Camp – to be limited to car covers, clothesline covers, and pool covers. Individual motels affected by Flying-foxes can put proposal to Council to be considered pending available budget. In the past this action has included the replacement of air conditioners, outdoor furniture and windows. It has also included the construction of carport like structures to cover laundry.
Fully-fund/subsidise property modification	Noise Smell Faecal drop Health/wellbeing Property devaluation Lost rental return	\$--\$	Potential advantages as per property modification, but also overcomes issue of cost for private landholders.	Costs to the land manager will vary depending on the criteria set for the subsidy including proximity to site, term of subsidy, level of subsidy. Potential for community conflict when developing the criteria and may lead to expectations for similar subsidies for other issues.	This action has limited applicability due to funding constraints. Should funding become available, this option can be further explored. This was the second preference from Flying-fox Engage
Service subsidies (e.g. rate rebates, access to water gurney, etc.)	Noise Smell Faecal drop Health/wellbeing Property devaluation Lost rental return	\$--\$	May encourage tolerance of living near a camp, promotes conservation of FFs, can be undertaken quickly, will not impact on the site, would reduce the need for property modification.	May be costly across multiple properties and would incur ongoing costs, may set unrealistic community expectations for other community issues, effort required to determine who would receive subsidies.	This action was deemed suitable. Access to a water gurney could be made available to residents affected by flying-fox droppings with preference given to those within 300m of roosting sites.

Management Option	Relevant Impacts	Cost	Advantages	Disadvantages	Suitability Determination
Routine camp management	Health/wellbeing	\$	Will allow property maintenance, likely to improve habitat, could improve public perception of the site, will ensure safety risks of a public site can be managed. Weed removal has the potential to reduce roost availability and reduce numbers of roosting FFs. To avoid this, weed removal should be staged and alternative roost habitat planted, otherwise activities may constitute a Level 3 action.	Will not generally mitigate amenity impacts for nearby landholders.	This action was deemed suitable
Provision of artificial roosting habitat	All	\$--\$	If successful in attracting FFs away from high conflict areas, artificial roosting habitat in low conflict areas will assist in mitigating all impacts, generally low cost, can be undertaken quickly, promotes FF conservation.	Would need to be combined with other measures (e.g. buffers/alternative habitat creation) to mitigate impacts, previous attempts have had limited success.	This action was not deemed suitable
Protocols to manage incidents	Health/wellbeing	\$	Low cost, will reduce actual risk of negative human/pet-FF interactions, promotes conservation of FFs, can be undertaken quickly, will not impact the site.	Will not generally mitigate amenity impacts.	This action will be included as a risk management response by all responsible land managers
Research	All	\$	Supporting research to improve understanding may contribute to more effectively mitigating all impacts, promotes FF conservation.	Generally cannot be undertaken quickly, management trials may require further cost input.	This action was deemed more suitable to be included in a regional strategy or plan
Appropriate land-use planning	All	\$	Likely to reduce future conflict, promotes FF conservation. Identification of degraded sites that may be suitable for long-term rehabilitation for FFs could facilitate offset strategies should clearing be required under Level 2 actions.	Under current legislation, the environmental impact of new development, including mines, must assess impact on threatened species like flying-foxes. Will not generally mitigate current impacts, land-use restrictions may impact the landholder.	This action was deemed suitable
Property acquisition	All for specific property owners Nil for broader community	\$\$\$	Will reduce future conflict with the owners of acquired property.	Owners may not want to move, only improves amenity for those who fit criteria for acquisition, very expensive.	This action was not deemed suitable due to excessive cost, and limited concern of impacts from neighbouring residents.

Management Option	Relevant Impacts	Cost	Advantages	Disadvantages	Suitability Determination
Do nothing	Nil	Nil	No resource expenditure.	Will not mitigate impacts and unlikely to be considered acceptable by the community.	Due to commitment of Council, this action is not suitable.
Level 2 Actions					
Buffers through vegetation removal	Noise Smell Health/wellbeing Property devaluation Lost rental return	\$-\$	Will reduce impacts, promotes FF conservation, can be undertaken quickly, limited maintenance costs.	Will impact the site, will not generally eliminate impacts, vegetation removal may not be favoured by the community.	Only weed species will be considered for removal (such as privet and willows)
Buffers without vegetation removal	Noise Smell Health/wellbeing Damage to vegetation Property devaluation Lost rental return	\$	Successful creation of a buffer will reduce impacts, promotes FF conservation, can be undertaken quickly, options without vegetation removal may be preferred by the community.	May impact the site, buffers will not generally eliminate impacts, maintenance costs may be significant, often logistically difficult, limited trials so likely effectiveness unknown.	Could be undertaken but needs time to become effective.
Level 3 Actions					
Nudging	All	\$-\$ \$\$\$	If nudging is successful, this may mitigate all impacts.	Costly, FFs will continue attempting to recolonise the area unless combined with habitat modification/deterrents.	Not deemed suitable due to excessive cost.

Management Option	Relevant Impacts	Cost	Advantages	Disadvantages	Suitability Determination
Passive dispersal through vegetation management	All at that site but not generally appropriate for amenity impacts only (see Section 8)	\$\$– \$\$\$	If successful can mitigate all impacts at that site, compared with active dispersal: less stress on FFs, less ongoing cost, less restrictive in timing with ability for evening vegetation removal.	Costly, will impact site, risk of removing habitat before outcome known, potential to splinter the camp creating problems at other locations (although less than active dispersal), potential welfare impacts, disturbance to community, negative public perception, unknown conservation impacts, unpredictability makes budgeting and risk assessment difficult, may increase disease risk (see Section 7.1), potential to impact on aircraft safety.	Not deemed suitable due to excessive cost and the likelihood of shifting the problem onto another section of the community, is high
Passive dispersal through water management	All at that site but not generally appropriate for amenity impacts only (see Section 8)	\$\$– \$\$\$	Potential advantages as per with passive dispersal through vegetation removal, however likelihood of success unknown.	Potential disadvantages as per passive dispersal through vegetation removal, however likelihood of success unknown.	Not deemed suitable for the site as on the Hunter River and cannot change water availability
Active dispersal	All at that site but not generally appropriate for amenity impacts only (see Section 8)	\$\$\$	If successful can mitigate all impacts at that site, often stated as the preferred method for impacted community members.	May be very costly, often unsuccessful, ongoing dispersal generally required unless combined with habitat modification, potential to splinter the camp creating problems in other locations, potential for significant animal welfare impacts, disturbance to community, negative public perception, unknown conservation impacts, unpredictability makes budgeting and risk assessment difficult, may increase disease risk (see Section 7.1), potential to impact on aircraft safety.	Not deemed suitable due to excessive cost and limited likelihood of success.

Management Option	Relevant Impacts	Cost	Advantages	Disadvantages	Suitability Determination
Early dispersal before a camp is established at a new location	All at that site	\$\$– \$\$\$	Potential advantages as per other dispersal methods, but more likely to be successful than dispersal of a historic camp.	Potential disadvantages as per other dispersal methods, but possibly less costly and slightly lower risk than dispersing a historic camp. Potential to increase pressure on FFs that may have relocated from another dispersed camp, which may exacerbate impacts on these individuals.	Not applicable to this Camp, however the plan should address the potential likely sites that may be established in the future.

4.2 Planned Management Approach

The planned management approach included in Table 10 have been determined after consideration of community views, ecological requirements, and legislative / policy controls. The Actions have been grouped into the major thematic areas of:

- Governance
- Routine Management
- Infrastructure
- Restoration & Rehabilitation
- Monitoring
- Flying-fox Species Management
- Resident Assistance
- Community Education

The actions included in Table 10 are directly linked to the management actions discussed in Table 9, but have been directly tailored to actions that will be planned for implementation at the Flying-fox Camp, depending on conditions and funding provision. Responsibility for the implementation of these actions is indicated in the table.

Table 10: Management Actions

Action ID	Issue	Actions & guidelines	Responsibility	Trigger / Catalyst for commencement	Budget
1. Resident Assistance					
1.1	Car / Clothes-line / swimming pool covers	Provision of these items based upon selection criteria during times of high population occupancy	Muswellbrook Shire Council	Items available on request from Council. Preference given to but not limited to those who live within a 300 metre of the camp.	Covers for cars, clotheslines, and swimming pools. \$5000 per annum Gemi for hire – 2 already purchased \$400.
1.2	Assistance with costs for tree removal.	Will only assist with the removal of Privet or Cocos Palms. Preference given to those living near a camp but all properties within the LGA will be considered.	Muswellbrook Shire Council	Will be offered where budget is available.	Between \$5000-10000
1.3	Financial assistance with Biodiversity Conservation License.	Resident / business responsible for development of licence, and required to ensure it complies with the intent of the CMP	Muswellbrook Shire Council	Only applicable to properties within 300m of Camp boundary	Free of charge to residents who live within 300 m radius of the camp. Application costs to be covered by Council.

1.4	Access to gurney / water cleaners to remove bat excrement	Actioned upon request from residents with affected properties. Whilst preference is given to residents within a 300 m radius of a camp, it is not limited to them. Any resident in the shire can access the gurney. There is yet to be an occasion when the gurney cannot be loaned.	Muswellbrook Shire Council	A phone call from an affected resident. Residents within a 300 m radius from the boundary of a camp have received a letter from Council informing them of this access. However, gurney available to all residents in the shire, with preference given to those who live within a 300 metre radius of the camp.	Purchased with grant money from LGNSW. The grant was given to assist residents impacted by the presence of flying-foxes.
2. Community Education					
2.1	Advice on backyard vegetation management	Advice on which trees residents may wish to remove (introduced or naturalised foraging species such as Cocos Palms, Poplars and Silky Oaks) Advice on trees to plant if residents want to encourage bats to forage in their properties. Advice on native fragrant trees that will assist to screen smells from Camp	Muswellbrook Shire Council – Sustainability Officers or Ecologist.	Enquiry from resident.	In kind- flying-fox recurring budget.
2.2	Health and disease management	Website was developed to deliver regional education on health and disease management. "Little Aussie Battlers" can be found at: https://littleaussiebat.com.au/	Muswellbrook Shire Council Hunter Joint Organisation of Councils Department of Planning and Environment Hunter Local Land Services	Was delivered through regional Grant funded project	Funded by NSW Environmental Trust for 2017-19
2.3	Lifecycle and nomadic timing of bat arrival	Website was developed which provides consistent regional information regarding Flying-fox nomadic behaviour.	Muswellbrook Shire Council Hunter Joint Organisation of Councils Department of Planning and Environment Hunter Local Land Services	Was delivered through regional Grant funded project	Funded by NSW Environmental Trust for 2017-19
2.4	Implement Regional Flying-fox educational kit	Community education kit was developed to assist residents to understand Flying-fox movement patterns and reduce conflicts with Camps	Muswellbrook Shire Council Hunter Joint Organisation of Councils Department of Planning and Environment Hunter Local Land Services	Was delivered through regional Grant funded project	Funded by NSW Environmental Trust for 2017-19

2.5	How to manage dead or injured Flying-foxes	Information on who to call when sick, injured or dead Flying-foxes are seen	Muswellbrook Shire Council	Sustainability staff at Council have contacted wildlife rescue groups in Muswellbrook to confirm their ability to care for injured flying-foxes/ abandoned flying-foxes. Still need a plan in case of mass deaths such as those seen in Singleton.	NA
3. Restoration & Rehabilitation					
3.1	Encourage camping away from residential and business uses	Assessment of vegetation condition improvement in core of site, to make boundary less attractive for roosting.	Muswellbrook Shire Council	When budget is available	NA
3.2	Rehabilitation of damaged areas (from Flying-fox occupation)	Removal of damaged vegetation and establishment of replacement vegetation.	Muswellbrook Shire Council	When 30000 animals arrive and then depart from the area with available budget.	As Required
3.3	Creation of wider vegetated areas in the riparian zone, away from residential properties	Planting of appropriate native species in the riparian zone to create Flying-fox roosting habitat	Muswellbrook Shire Council	Part of Riparian Planning	Grant funding
3.4	Plant appropriate foraging species in areas of the Camp away from residential properties	strategically plant endemic foraging habitat trees away from residential areas along the southern side of the reserve.	Muswellbrook Shire Council	Part of Riparian Planning	With available budget
3.5	Manage buffer zone to reduce conflict between residents and Flying-foxes	Planting of native fragrant trees and shrubs adjacent to dwellings to reduce the noise and smell directly behind	Muswellbrook Shire Council	Part of Riparian Planning	With available budget
3.6	Weed Control	Noxious and environmental weed control throughout the Camp area - targeting exotic tree species known to act as potential roosting and foraging habitat (e.g. Camphor Laurel as most on site are immature or have not reached maximum height)	Muswellbrook Shire Council	Part of Riparian Planning	With available budget
3.7	Dangerous Trees	Assessments for potentially dangerous trees	Muswellbrook Shire Council	30000 animals arrive and then depart the area.	As Required
3.8	Buffer Maintenance	Create buffer to residential and business uses	Muswellbrook Shire Council	30000 animals arrive and then depart the area.	With available budget
4. Flying-fox Species Management					
4.1	Flying-fox rehabilitators response	Respond to calls of injured or dead Flying-foxes	Flying-fox rehabilitators	As required	NA

4.2	Rehabilitators alerts (notification of upcoming events, e.g. management activities, heat stress, etc.)	Council to notify rehabilitators of any events that will impact on Camp Site or Flying-fox population.	Flying-fox rehabilitators	As required	NA
5. Monitoring					
5.1	Flying-fox Census	Quarterly Flying-fox animal counts to assist with determining likely national population	CSIRO DPE Muswellbrook Shire Council	Quarterly monitoring Monthly monitoring in the Hunter/Central Coast region.	CSIRO funded by Commonwealth Government Undertaken and funded in kind by Muswellbrook Shire Council.
5.2	Wildlife / Rehabilitation rehabilitators data collection	Collection and provision of count information, and other data collected when responding to calls	Wildlife / Rehabilitation rehabilitators	State of environmental reporting	NA
5.3	Hunter Bird Observers data collection	Collection and provision of count information, and other data collected	Hunter Bird Observers	As reported	NA
5.4	Muswellbrook Shire Council management data	Collection and dissemination of data related to Flying-foxes, and vegetation that may impact on local or regional Flying-fox populations.	Muswellbrook Shire Council	Quarterly monitoring as part of CSIRO monitoring plus extra monitoring if numbers increase to 30000.	NA
6. Governance					
6.1	Land Use Planning	Review new development applications for impact on threatened species	Muswellbrook Shire Council	As per legislation	Recurrent budget activity
6.2	Camp Management Plan review	Review currency and suitability of CMP	Muswellbrook Shire Council	Review in 5 years / when FF numbers increase past current capacity	Recurrent budget activity
6.3	Protocol Development	Fire	Rural Fire Service	Guidelines developed and on Department of Planning and Environment website. See	Developed, no recurring budget required.
		Heat Stress	Department of Planning and Environment / Wildlife Rehabilitators	Helping flying-foxes in emergencies	
		Community Response to dead / injured animals	Wildlife Rehabilitators	Code of practice for injured, sick and orphaned Flying-foxes (nsw.gov.au)	
		Equine	Hunter Local Land Services	Heat stress in Flying-fox camps NSW Environment and Heritage Hendra virus (nsw.gov.au)	

5 Assessment of Impacts to Flying-foxes

5.1 Flying-fox Habitat to be affected

Based on the actions included in Table 10 it is expected there would be little to no negative impacts on the Flying-fox population that utilises the Muswellbrook Flying-fox Camp.

Most actions approved in this Camp Management Plan are considered Level 1 (routine management actions), as the Land Managers have determined the cost and ongoing issues with drastic management actions including nudging, dispersal or culling are inappropriate for the Muswellbrook Camp and will not be undertaken whilst this current Camp Management Plan is in force.

It is expected that if Council is able to secure restoration and rehabilitation funding, the quality and condition of the site will increase, and encourage Flying-foxes to move away from the margins of the site and nearby residential properties. These measures can be implemented at a time when Flying-foxes are not present, and therefore will not disturb or harm individual Flying-foxes.

5.2 Assessment of Impacts to Other Threatened Species or Communities

All required Environmental Assessments will be conducted by Council as part of its normal Environmental Assessment Legislative Responsibilities, prior to works being undertaken.

6 Evaluation and Review

The Plan will have a scheduled review annually, which will include evaluation of management actions against Actions included in Table 10.

The following will trigger a reactive review of the Plan:

- Flying-fox population in excess of 30,000 animals (counted utilising approved CSIRO monitoring methodology) for a period of 6 months or more.
- changes to relevant policy/legislation
- new management techniques becoming available
- outcomes of research that may influence the Plan
- incidents associated with the camps.

Results of each review will be included in reports to Council, and the NSW DPE.

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 NSW DPE.

7 Plan administration

7.1 Monitoring of the camp

Muswellbrook Shire Council will continue to assist the CSIRO to undertake their quarterly Flying-fox census activities. Wildlife Rehabilitators can access the site as required to attend to the animals, and record information of relevance to Council, the Department of Planning and Environment and CSIRO. Monthly counts will be undertaken as a part of the Department of Planning and Environment Threatened Species Project if time and workload of staff permits. These counts will be made available to the Threatened Species Team at the Department of Planning and Environment.

Additional monitoring and data collection will occur as opportunities arise.

7.2 Reporting

Quarterly reports (following publication of the CSIRO Census Count) will be developed by Muswellbrook Shire Council providing details on management activities at the site, and the Flying-fox population during the quarter.

7.3 Funding commitment

Muswellbrook Shire Council has a responsibility to ensure funding is available to undertake management actions included in this plan. The Plan will operate from 2023 – 2027, forward planning for management actions should be included in each responsible agencies annual budgets. development.

8 References and additional resources

Aich, P, Potter, AA and Griebel, PJ 2009, 'Modern approaches to understanding stress and disease susceptibility: A review with special emphasis on respiratory disease', *International Journal of General Medicine*, vol. 2, pp. 19–32.

AIHW 2012, *Risk factors contributing to chronic disease*, Cat no. PHE 157, Australian Institute of Health and Welfare, viewed 12 January 2016, www.aihw.gov.au/WorkArea/DownloadAsset.aspx?id=10737421546.

Australian Museum 2010, *Little Red Flying-fox*, viewed 12 January 2016, australianmuseum.net.au/little-red-flying-fox.

AVA 2015, *Hendra virus*, Australian Veterinary Association, viewed 12 January 2016, www.ava.com.au/hendra-virus.

Birt, P 2000, 'Summary information on the status of the Grey-headed (*Pteropus poliocephalus*) and Black (

CDC 2014, *Hendra virus disease (HeV): Transmission*, Centers for Disease Control and Prevention, updated 17 March 2014, viewed 12 January 2016, www.cdc.gov/vhf/hendra/transmission/index.html.

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

DECCW 2009, *Draft National Recovery Plan for the Grey-headed Flying-fox* *Pteropus poliocephalus*, prepared by Dr Peggy Eby for Department of Environment, Climate Change and Water NSW, Sydney, viewed 12 January 2016, www.environment.nsw.gov.au/resources/threatenedspecies/08214dnrpflyingfox.pdf.

DoE 2013, *Matters of National Environmental Significance: Significant Impact Guidelines 1.1*, Environment Protection and Biodiversity Conservation Act 1999, Australian Government Department of the Environment, www.environment.gov.au/system/files/resources/42f84df4-720b-4dcf-b262-48679a3aba58/files/nes-guidelines_1.pdf.

DoE 2015, *Referral guideline for management actions in grey-headed and spectacled Flying-fox camps*, Australian Government Department of the Environment, Canberra, viewed 12 January 2016, www.environment.gov.au/system/files/resources/6d4f8ebc-f6a0-49e6-a6b6-82e9c8d55768/files/referral-guideline-flying-fox-camps.pdf.

DoE 2016a, *Pteropus poliocephalus in Species Profile and Threats Database*, Australian Government Department of the Environment, Canberra, viewed 12 January 2016, www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=186.

DPE 2023 *Monitoring Flying-foxes in NSW. An introduction to the National Flying-fox Monitoring Program (NFFMP)* (Presentation conducted on)

DPI 2013, *Australian bat lyssavirus*, June 2013 Primefact 1291 2nd edition, Department of Primary Industries, NSW, viewed 12 January 2016, www.dpi.nsw.gov.au/_data/assets/pdf_file/0011/461873/Australian-Bat-lyssavirus.pdf.

DPI 2014, *Hendra virus*, June 2014 Primefact 970 9th edition, Department of Primary Industries, NSW, viewed 12 January 2016, www.dpi.nsw.gov.au/_data/assets/pdf_file/0019/310492/hendra_virus_primefact_970.pdf.

DPI 2015a, *Hendra virus*, Department of Primary Industries, NSW, viewed 12 January 2016, www.dpi.nsw.gov.au/agriculture/livestock/horses/health/general/hendra-virus.

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

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

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

Ecosure 2016 missing

Edson, D, Field, H, McMichael, L, Jordan, D, Kung, N, Mayer, D and Smith, C 2015, 'Flying-fox Roost Disturbance and Hendra Virus Spillover Risk', *PLoS ONE*, vol. 10, no. 5, viewed 12 January 2016, www.ncbi.nlm.nih.gov/pmc/articles/PMC4446312/pdf/pone.0125881.pdf.

EHP 2012, *Living with Wildlife – Flying-foxes*, Department of Environment and Heritage Protection, Queensland, updated 14 May 2012, viewed 12 January 2016, www.ehp.qld.gov.au/wildlife/livingwith/flyingfoxes/importance.html.

ELW&P 2015, *Flying-foxes*, Department of Environment, Land, Water and Planning, State of Victoria.

EPA 2013, *Noise Guide for Local Government*, Environment Protection Authority, Sydney.

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

Henry, JP and Stephens-Larson, P 1985, 'Specific effects of stress on disease processes' in Moberg, GP (ed.), *Animal Stress*, American Physiological Society, pp.161–175.

IUCN 2015, *Little red Flying-fox*, International Union for the Conservation of Nature, www.iucnredlist.org.

Lindenmayer, D. B., & Fischer, J. (2013). *Habitat fragmentation and landscape change: an ecological and conservation synthesis*. Island Press.

Lunn, T. J., Eby, P., Brooks, R., McCallum, H., Plowright, R. K., Kessler, M. K., & Peel, A. J. (2021). Conventional wisdom on roosting behavior of Australian flying-foxes—A critical review, and evaluation using new data. *Ecology and evolution*, 11(19), 13532-13558.

Lunney, D, Richards, G and Dickman, C 2008, *Pteropus poliocephalus*, The IUCN Red List of Threatened Species 2008: e.T18751A8554062, dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T18751A8554062.en.

Markus, N 2002, 'Behaviour of the Black Flying-fox *Pteropus alecto*: 2. Territoriality and courtship', *Acta Chiropterologica*, vol. 4, no. 2, pp.153–166.

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

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

McCall, BJ, Field, H, Smith, GA, Storie, GJ and Harrower, BJ 2005, 'Defining the risk of human exposure to Australian bat lyssavirus through potential non-bat animal infection', *CDI*, vol. 29, no. 2, pp. 200–203, [www.health.gov.au/internet/main/publishing.nsf/content/cda-cdi2902-pdf-cnt.htm/\\$FILE/cdi2902k.pdf](http://www.health.gov.au/internet/main/publishing.nsf/content/cda-cdi2902-pdf-cnt.htm/$FILE/cdi2902k.pdf).

McConkey, KR, Prasad, S, Corlett, RT, Campos-Arceiz, A, Brodie, JF, Rogers, H and Santamaria, L 2012, 'Seed dispersal in changing landscapes', *Biological Conservation*, vol. 146, pp. 1–13, doi:10.1016/j.biocon.2011.09.018.

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

McIlwee, AP and Martin, IL 2002, 'On the intrinsic capacity for increase of Australian Flying-foxes', *Australian Zoologist*, vol. 32, no. 1.

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

NSW Health 2013, *Rabies and Australian Bat Lyssavirus Infection*, NSW Health, North Sydney, viewed 12 January 2016, www.health.nsw.gov.au/Infectious/factsheets/Pages/Rabies-Australian-Bat-Lyssavirus-Infection.aspx.

OEH 2011a, *Grey-headed Flying-fox vulnerable species listing: NSW Scientific Committee final determination*, Office of Environment and Heritage, Sydney, viewed 12 January 2016, www.environment.nsw.gov.au/determinations/GreyheadedFlyingFoxVulSpListing.htm.

OEH 2011b, *NSW Code of Practice for Injured, Sick and Orphaned Protected Fauna*, Office of Environment and Heritage, Sydney, viewed 12 January 2016, www.environment.nsw.gov.au/resources/wildlifelicences/110004FaunaRehab.pdf.

OEH 2012, *NSW Code of Practice for Injured, Sick and Orphaned Flying-foxes*, Office of Environment and Heritage, Sydney, viewed 12 January 2016, www.environment.nsw.gov.au/resources/wildlifelicences/120026flyingfoxcode.pdf.

OEH 2015a, *Flying-fox Camp Management Plan Template 2015*, Department of Planning and Environment, Sydney, viewed 12 January 2016, www.environment.nsw.gov.au/resources/threatenedspecies/150102-flyingfoxcamp-template.pdf.

OEH 2015b, *Flying-fox Camp Management Policy 2015*, Office of Environment and Heritage, Sydney, viewed 12 January 2016, www.environment.nsw.gov.au/resources/threatenedspecies/150070-flyingfoxcamp-policy.pdf.

OEH 2015d, *GHFF threatened species profile*, Office of Environment and Heritage, Sydney, viewed 12 January 2016, www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10697

Páez David J., Restif Olivier, Eby Peggy and Plowright Raina K. (2018) Optimal foraging in seasonal environments: implications for residency of Australian flying-foxes in food-subsidized urban landscapes. *Phil. Trans. R. Soc. B* **373**: 20170097

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

Pierson, ED and Rainey, WE 1992, 'The biology of flying-foxes of the genus *Pteropus*: A Review', in: Wilson, DE and GL Graham (eds), *Pacific Island Flying-foxes: Proceedings of an International Conservation Conference*, US Department of the Interior – Biological Report no. 90, pp. 1–17.

Qld Health 2016, *Bats and Human Health*, Queensland Health, viewed 12 January 2016, www.health.qld.gov.au/communicablediseases/hendra.asp

Ratcliffe, F 1932, 'Notes on the Fruit Bats (*Pteropus* spp.) of Australia', *Journal of Animal Ecology*, vol. 1, no. 1, pp. 32–57.

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

Roberts, BJ, Catterall, CP, Eby, P and Kanowski, J 2012, 'Long-Distance and Frequent Movements of the Flying-fox *Pteropus poliocephalus*: Implications for Management', *PLoS ONE*, vol. 7, no. 8, e42532.

Roberts, B, Kanowski, J and Catterall, C 2006, *Ecology and Management of Flying-fox Camps in an Urbanising Region*, Rainforest CRC Tropical Forest Landscapes, Issue 5, viewed 12 January 2016, www.rainforest-crc.jcu.edu.au/issues/ITFL_flyingfox.pdf.

Rosenzweig, C., Karoly, D., Vicarelli, M. *et al.* Attributing physical and biological impacts to anthropogenic climate change. *Nature* **453**, 353–357 (2008). <https://doi.org/10.1038/nature06937>

SEQ Catchments 2012, *Management and Restoration of Flying-fox Roosts: Guidelines and Recommendations*, SEQ Catchments Ltd funded by the Australian Government's Caring for Our Country, viewed 12 January 2016, www.environment.nsw.gov.au/resources/animals/Flying-fox-2014-sub/flyingfoxsub-jenny-beatson-part3.pdf.

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

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

Tait, J, Perotto-Baldivieso, HL, McKeown, A and Westcott, DA 2014, 'Are Flying-foxes Coming to Town? Urbanisation of the Spectacled Flying-fox (*Pteropus conspicillatus*) in Australia', *PLoS ONE*, vol. 9, no. 10, e109810, doi:10.1371/journal.pone.0109810.

Tidemann, C. R., & Nelson, J. E. (2004). Long-distance movements of the grey-headed flying-fox (*Pteropus poliocephalus*). *Journal of Zoology*, 263(2), 141-146.

Timmiss Libby A., Martin John M., Murray Nicholas J., Welbergen Justin A., Westcott David, McKeown Adam, Kingsford Richard T. (2020) Threatened but not conserved: Flying-fox roosting and foraging habitat in Australia. *Australian Journal of Zoology* 68, 226-233.

<https://doi.org/10.1071/ZO20086>

Todd, C.M., Westcott, D.A., Martin, J.M. et al. (2022) Body-size dependent foraging strategies in the Christmas Island Flying-fox: implications for seed and pollen dispersal within a threatened island ecosystem. *Movement Ecology* 10, 19

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

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

Webb, NJ and Tidemann, CR 1996, 'Mobility of Australian Flying-foxes, *Pteropus* spp. (Megachiroptera): evidence from genetic variation', *Proceedings of the Royal Society London Series B*, vol. 263, pp. 497–502.

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

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