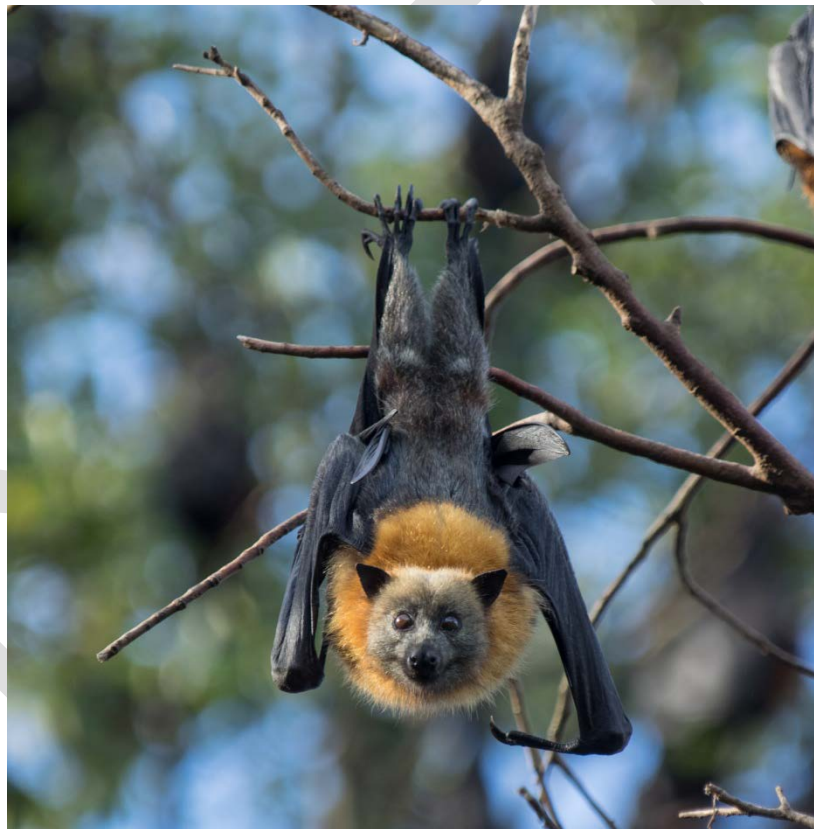




Draft Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus*



January 2017

The Species Profile and Threats Database page linked to this recovery plan is obtainable from:

http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=186

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The Grey-headed Flying-fox (*Pteropus poliocephalus*) © David Westcott

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ACKNOWLEDGEMENTS

This recovery plan has been developed with the involvement and cooperation of a broad range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions.

This recovery plan is based on the extensive work of many flying-fox experts. It has benefited from the diligence of Commonwealth and state government officers, the Commonwealth Threatened Species Scientific Committee, the NSW Flying-fox Consultative Committee, Department of the Environment and Energy facilitated Grey-headed Flying-fox policy workshops and the CSIRO coordinated National Flying-fox Monitoring Program.

The preparation of this plan was funded by an initial grant from the Australian Government and continued support from the NSW State Government. The NSW Office of Environment and Heritage coordinated the initial drafting of this plan on behalf of the Australian Government.

ABBREVIATIONS

CSIRO – Commonwealth Scientific and Industrial Research Organisation

DEHP – Queensland Department of Environment and Heritage Protection

DEWNR – South Australian Department of Environment, Water and Natural Resources

DELWP – Victorian Department of Environment, Land, Water & Planning

DPIPWE – Tasmanian Department of Primary Industries Parks Water and the Environment

EPD – Australian Capital Territory Environment and Planning Directorate

DoEE – Department of the Environment and Energy

EPBC Act – *Environment Protection and Biodiversity Conservation Act 1999*

NFFMP – National Flying-Fox Monitoring Program

OEH – New South Wales Office of Environment and Heritage (part of the Department of Premier and Cabinet)

TSSC – Commonwealth Threatened Species Scientific Committee

EXECUTIVE SUMMARY

Current status of taxon

The Grey-headed Flying-fox is listed as Vulnerable under both the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the New South Wales *Threatened Species Conservation Act 1995*. It is listed as threatened under the Victorian *Flora and Fauna Guarantee Act 1988* and as Rare under the South Australian *National Parks and Wildlife Act 1972*.

Habitat and distribution

The Grey-headed Flying-fox has historically occupied forests and woodlands in the coastal lowlands, tablelands and slopes of south-eastern Australia, from Bundaberg in Queensland to Geelong in Victoria, with rare sightings outside its range. More recently, camps have established in Adelaide, the Australian Capital Territory and inland areas of central and southern New South Wales and Victoria.

Threats to species survival

The primary known threat to the survival of the Grey-headed Flying-fox is loss and degradation of foraging and roosting habitat. Conflict with people, including disturbance in camps and mortality from actions to manage commercial fruit crops, is considered to be a moderate threat, but is increasing in urban areas. The level of threat caused by electrocution on power lines and entanglement in netting and barbed-wire fences is unknown. The impact of climate change on Grey-headed Flying-foxes is also unknown but increasing temperatures and drought conditions are likely to degrade foraging and roosting habitat, influence the frequency of foraging in commercial orchards, cause heat stress and increase heat related mortality.

Recovery objectives and actions

Actions under this plan aim to improve the national population trend; identify, manage and secure key foraging and roosting habitat; improve the community's capacity to coexist with flying-foxes; and increase awareness about flying-foxes, the threats they face and the important ecosystem services they provide as seed dispersers and pollinators.

Criteria for success

Success of this recovery plan will be evaluated against:

- a robust estimate of improved population trend,
- an improved understanding of habitat critical to the survival of the species
- an increase in protection of habitat critical to the survival of the species and nationally important camp sites
- implementation of effective habitat restoration projects
- a reduction in the level of conflict in sections of the community affected by problematic flying-fox camps
- greater uptake of crop netting under existing subsidy schemes, and
- an improved understanding of threats of unknown status; climate change and electrocution/ entanglements.

1 GENERAL INFORMATION

1.1 Conservation status

The Grey-headed Flying-fox is listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The listing advice can be accessed at: www.environment.gov.au/biodiversity/threatened/species/p-poliocephalus.html)

The Grey-headed Flying-fox is listed as Vulnerable in New South Wales under the *Threatened Species Conservation Act 1995*, as Threatened under the Victorian *Flora and Fauna Guarantee Act 1988* and as Rare under the South Australian *National Parks and Wildlife Act 1972*. It is not listed in Queensland or the Australian Capital Territory.

1.2 Purpose of this plan

The purpose of this plan is to set out the management and research actions necessary to stop the decline of, and support the recovery of the Grey-headed Flying-fox over the next ten years.

1.3 International obligations

The Grey-headed Flying-fox is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). A CITES listing subjects international trade in that species to certain controls, and all import and export of the species covered by the Convention must be authorised through a licensing system.

1.4 Affected interests

A wide range of public authorities, organisations and private individuals may be affected by actions to prevent further decline and promote the recovery of the Grey-headed Flying-fox. Managing foraging and roosting habitat falls under the jurisdiction of a range of authorities and is regulated by Commonwealth and State/Territory legislation in the five States and one Territory in the range of the species (Queensland, NSW, ACT, Victoria, Tasmania and South Australia), as well as by the policies of local government areas throughout the range of the species.

Affected interests include but are not limited to:

Commonwealth

- Department of the Environment and Energy
- Commonwealth Scientific and Industrial Research Organisation

State/Territory/Local Government

- Queensland Department of Environment and Heritage Protection
- Queensland Department of Agriculture and Fisheries
- Queensland Department of State Development
- New South Wales Office of Environment and Heritage
- New South Wales Department of Planning and Environment
- New South Wales Department of Primary Industries
- Victorian Department of Environment, Land, Water and Planning
- Parks Victoria
- Tasmanian Department of Primary Industries, Parks, Water and Environment
- South Australian Department of Environment, Water and Natural Resources
- South Australian Department of Primary Industries and Regions

- Australian Capital Territory Government
- Local government areas throughout the range of the species
- Government affiliated natural resource management groups

Non-government organisations and individuals

- Private landholders and organisations whose properties provide foraging or roosting habitat
- People whose homes immediately adjoin camps
- Aboriginal land managers
- Conservation organisations
- Licensed animal rehabilitators and their representative organisations e.g. Zoos South Australia
- Individuals and groups involved in tree-planting and habitat restoration programs and threatened species conservation
- Individual researchers and their representative organisations
- Community based natural resource management groups
- The Australian Wildlife Health Network
- Airports and airport authorities
- Horse owners and their representative organisations

Industry groups and agricultural interests

- NSW Farmers' Association
- Growcom (formerly Queensland Fruit and Vegetable Growers) (Queensland)
- Eastern Metropolitan Fruit Growers Association (Victoria)
- Fruit Growers Victoria
- Victorian Farmers Federation Horticulture Branch
- Horticulture Coalition of SA
- The Apple and Pear Growers Association of South Australia
- Orchardists and growers in all range States impacted by flying-foxes (e.g. Bananas NSW, coffee growers)
- State horse racing organisations

1.5 Interests of indigenous people

The Grey-headed Flying-fox has significance to Aboriginal people as a food source, as a clan totem, as an art subject and as an indicator of particular habitat associations and seasonal and climatic changes, both annually and in the dreaming cycle (Ecobiological 2009).

The literature indicates that Aboriginal people traditionally had an intimate understanding of many aspects of Grey-headed Flying-fox ecology, such as breeding and movement patterns, and that they carefully managed flying-fox habitat to protect this important species (Ecobiological 2009).

In NSW, consultation with indigenous people was conducted through Aboriginal Reference Groups associated with the five coastal Catchment Management Authorities (CMAs) and Aboriginal Land Councils within the area. Members of Reference Groups and Aboriginal Land Councils were provided with a questionnaire and a copy of the recovery plan. No comments were received.

In NSW, the following 20 Aboriginal land owner boundaries were identified: Bundjalung, Ngarabal, Gumbainggir, Nganyaywana, Dainggattii, Biripi, Geawegal, Wonnarua,

Worimi, Darkinung, Awabakal, Kuring-gai, Dharug, Eora, Tharawal/Dharawal, Gundungurra, Ngunwal, Yuin, Ngarigo, Bidwell.

In Queensland, a copy of the draft recovery plan was provided to the Indigenous Land Management Facilitator and Indigenous Liaison Officers for Burnett Mary NRM region, Condamine Alliance and South East Queensland. No comments were received.

1.6 Social and economic impacts

The Grey-headed Flying-fox is capable of causing significant damage to commercial fruit crops, public gardens and native vegetation. Flying-fox foraging in cultivated fruit crops and associated crop damage has been known to occur since the time of European settlement (Tidemann *et al.* 1997).

In recent years Grey-headed Flying-foxes have been reported in areas where they were previously only rarely seen. This can result in significant crop damage when the orchardists in these areas do not have measures in place to protect their crops from flying-foxes. Subsidies to install netting to protect crops in NSW have increased the area of crops protected by netting and substantially reduced the number of licences issued to shoot flying-foxes.

Camps in urban areas can have localised negative impacts on amenity when they are located near centres of human activity such as close to schools, or in areas of special cultural significance, such as botanic gardens. Some people living adjacent to camps complain about the noise, smell and perceived disease risk associated with flying-fox camps. Management of these camps can cause conflict between members of the community, government regulators and animal welfare advocates. Foraging flying-foxes have been implicated in the Hendra Virus outbreaks in Queensland and NSW, which aside from infection and subsequent death of domesticated horses, can also potentially lead to the death of humans via infected horses.

2 BIOLOGICAL INFORMATION

2.1 Taxonomy

The taxonomy of Australian flying-foxes is stable (Hall 1987), and the taxonomy of the Grey-headed Flying-fox *Pteropus poliocephalus* (Temminck 1825) is considered unambiguous (Hall 1987, Tidemann 1995, Webb and Tidemann 1996). No intraspecific taxa are recognised.

2.2 Description

The Grey-headed Flying-fox is one of the largest bats in the world. Adult males generally weigh between 750g and 1000g, although masses up to 1133g have been recorded (Ratcliffe 1932, Tidemann 1995). Adult females generally weigh between 650g and 800g. Although males and females differ in body mass, their forearms are of similar length (155mm to 175mm).

Body fur is typically medium to dark grey, with many light-tipped hairs (Hall and Richards 2000). Fur on the head is also grey but varies in shade from near black to silver. An orange or russet-coloured mantle or collar encircles the neck, which is unique to this species (Hall 1987). Leg fur extends to the ankle, and this characteristic distinguishes the Grey-headed Flying-fox from the similarly sized Black Flying-fox, which has bare legs below the knee (Hall 1987). The wing membranes of the Grey-headed Flying-fox are black.

2.3 Ecological function

Due to its role as a pollen and seed disperser, protection of the Grey-headed Flying-fox will contribute to sustaining ecological processes within vegetation communities along the east coast, including three of Australia's World Heritage Areas: Fraser Island, the Gondwana Rainforests and the Greater Blue Mountains.

The Grey-headed Flying-fox interacts with numerous plant communities and assists seed and pollen dispersal of its food plants that occur within these communities (Eby 1996, Southerton *et al.* 2004, Birt 2005b). Grey-headed Flying-foxes feed on over 100 species of flowering trees and fleshy-fruited trees and lianas (Eby and Law 2008).

Actions to manage foraging and roosting habitat will benefit several hundred vegetation communities in Queensland, New South Wales and Victoria (Eby and Law 2008). Nectar- and fruit-feeding bats, birds and mammals will also benefit, as will a range of other fauna that occupy the forest and woodland communities used by the Grey-headed Flying-fox.

Actions to manage roosting habitat and reduce conflict over camps in urban areas will also benefit other species of flying-fox that share camps with Grey-headed Flying-foxes – the Black Flying-fox (*Pteropus alecto*) and the Little Red Flying-fox (*Pteropus scapulatus*) (Birt and Markus 1999, Tidemann 1999, Eby 2004).

2.4 Reproduction

Grey-headed flying-foxes are seasonal breeders, with a single breeding event per year. Females give birth to a single pup and the majority of births occur from October to December (Martin and McIlwee 2002; Divljan 2008). Females generally reach sexual maturity in their second year; however it is thought that few females younger than three years successfully raise young to independence (McIlwee and Martin 2002).

Flying-foxes are prone to abort fetuses and mass abortions and premature births are known to occur in the wild in response to environmental stress (Martin and McIlwee 2002). Flying-foxes are thought to have a maximum natural longevity of 15-20 years. This, combined with slow sexual maturation and a low reproductive rate, is indicative of a species with a low natural mortality rate (Martin and McIlwee 2002). Since European settlement, flying-foxes have suddenly faced a greatly increased mortality due to habitat loss, persecution and culling (Martin and McIlwee 2002). Due to their low reproductive rate, Grey-headed Flying-foxes also have a low population growth rate, even under optimal conditions. This, combined with increased mortality, puts the species at risk of severe population decline.

2.5 Competition and predation

The range of the Grey-headed Flying-fox overlaps with that of two other flying-fox species, the Black Flying-fox (*Pteropus alecto*) and the Little Red Flying-fox (*Pteropus scapulatus*).

Grey-headed Flying-foxes and Black Flying-foxes are closely related species that share many behavioural and ecological characteristics. In regions where their ranges overlap, their diets are equivalent (Hall and Richards 2000, Birt 2005b), although it is unclear whether there are differences in their foraging behaviour.

Both species are highly colonial and share camp sites, within which they segregate spatially (Ratcliffe 1932, Nelson 1965a, McWilliam 1986, Birt and Markus 1999, Eby 2004). In addition, both species are synchronous, seasonal breeders and their annual reproductive cycles are closely aligned at subtropical latitudes (Nelson 1965b, O'Brien 1993, Webb and Tidemann 1995, Martin *et al.* 1996). The Little Red Flying-fox

reproductive cycle is approximately six months out of phase with those of the other two species.

During the past 20 years numbers of Grey-headed Flying-foxes have declined markedly, relative to those of Black Flying-foxes, in coastal areas north from the Clarence Valley and in the tablelands of south-east Queensland (Birt 2000, Hall 2002, Eby 2004).

Expansion of the southern range limit of the Black Flying-fox has increased the area of overlap with the Grey-headed Flying-fox, and the movement of Black Flying-foxes into new areas has consistently been followed by an increase in abundance relative to that of Grey-headed Flying-foxes (Roberts *et al.* 2012). This has occurred in floristically diverse regions east of the escarpment that provide continuous food and suitable camps for both species. The reasons for this range shift of Black Flying-foxes are unclear, and cannot be readily explained by climate or habitat change (Roberts *et al.* 2012). There is currently relatively little information available about both long-term shifts in the distributions of Spectacled and Little Red Flying-foxes, and changes in overlap between the ranges of Grey-headed and Little Red Flying-foxes.

There is no evidence that Black Flying-foxes and Grey-headed Flying-foxes use antagonistic behaviours to compete directly for resources (N. Markus pers. obs., P. Eby pers. obs.). However, the increasing displacement of Grey-headed Flying-foxes suggests that indirect competition favours Black Flying-foxes. The level of threat posed by Black Flying-foxes requires further research.

There is anecdotal evidence that flying-foxes may be preyed upon by a range of animals including carpet pythons, goannas, sea eagles and Powerful Owls. Currawongs and ravens are known to attack flying-foxes found on their own in the daytime. The impact on the flying-fox population from these threats is thought to be insignificant (WPSA 2010).

2.6 Diet

The Grey-headed Flying-fox feeds primarily on blossoms and fruit in canopy vegetation, and supplements this diet with leaves (Parry-Jones and Augee 1991, Eby 1995, Eby 1998, Tidemann 1999, Hall and Richards 2000). Major food plants include the fruit and blossom of rainforest species, especially *Ficus* spp., and blossoms of myrtaceous species such as *Eucalyptus*, *Corymbia* and *Angophora*, melaleucas, banksias (Eby and Law 2008) and *Syzygium* spp. (Roberts 2006, Eby 1991).

The majority of myrtaceous plants in the diet of the Grey-headed Flying-fox flower within a defined season but are not annually reliable and the locations of productive foraging habitat provided by these plants vary (Law *et al.* 2000, Eby and Lunney 2002, Birt 2005b, Eby and Law 2008). In most months it is not possible to predict which localities will be productive, and therefore which localities will provide food for the species. Some roosting and foraging habitat may consist of introduced plants, including environmental weeds that are food sources e.g. camphor laurel, *Celtis* spp., *Ligustrum* spp. and *Psidium* spp. (Roberts 2006).

2.7 Foraging behaviour

The foraging behaviour of the Grey-headed Flying-fox alters when native food sources are scarce. They have no biological adaptations to withstand food shortages (e.g. torpor) and migrate in response to changes in the quantity and location of food (Hall and Richards 2000). The majority of eucalypts have regular seasonal flowering events, but do not flower every year and there are few areas within the Grey-headed Flying-fox's range where nectar is available continuously (House 1997, Wilson and Bennett 1999, Law *et al.* 2000).

Grey-headed Flying-foxes forage over extensive areas and have been known to fly as far as 40 km to feed, before returning to their roost the same night (Eby 1991). However, foraging distances are more often less than 20 km (Tidemann 1999).

Flying-foxes disperse pollen and seeds during their foraging bouts, and in doing so contribute to the reproductive and evolutionary processes of forest communities. The ability of flying-foxes to move freely among habitat types allows them to transport plant genetic material across fragmented, degraded and urban landscapes.

2.8 Roosting behaviour and habitat

Grey-headed Flying-foxes roost in large aggregations, known as camps, in the exposed branches of trees (Nelson 1965a, Parry-Jones and Augee 1992). The locations of camps are generally stable through time, and several sites have documented histories that exceed 100 years (Lunney and Moon 1997). Camps provide resting habitat, sites of social interactions and refuge for animals during significant phases of their annual cycle, such as birth, lactation and conception (Parry-Jones and Augee 1992, Parry-Jones and Augee 2001).

Camps are used as day refuges by animals that forage in surrounding areas over several weeks, as maternity camps, and as short-term stopover sites by migrating animals (Eby 1991, Eby 1995, Tidemann and Nelson 2004).

Patterns of camp occupation vary, ranging from sites that are inhabited continuously to those that are inhabited only rarely (Parry-Jones 1993, Eby 1995). Although many camps have distinguishable seasonal patterns of occupation, annual variations can be extreme and peak population size can exceed 50 000 (Parry-Jones and Augee 1992, Parry-Jones 1993, Eby *et al.* 1999, Birt 2000).

Grey-headed Flying-foxes display a degree of flexibility in their choice of camp vegetation (Tidemann 1999, Peacock 2004, Roberts 2005). Camps occur in vegetation ranging from continuous forest to remnants as small as 1 ha (Eby 2002b, West 2002).

2.9 Habitat critical to the survival of the species

Grey-headed Flying-foxes require a continuous temporal sequence of productive foraging habitats, linked by migration corridors or stopover habitats, and suitable roosting habitat within nightly commuting distance of foraging areas (Fleming and Eby 2003).

Loss of foraging habitat is considered to be the primary threat to the species. Clearing winter forage is of particular concern. Few diet plants flower in winter, and those that flower reliably occur on coastal lowlands in northern New South Wales and southern Queensland (Eby *et al.* 1999, Eby and Lunney 2002). There is evidence that spring forage is currently inadequate to provide reliable resources during critical periods in the reproductive cycle of Grey-headed Flying-foxes (Eby and Law 2008).

The majority of myrtaceous plants in the diet of Grey-headed Flying-foxes flower within a defined season, but are not annually reliable and the location of productive foraging habitat from these plants varies (Law *et al.* 2000, Eby and Lunney 2002, Birt 2005b). In most months it is difficult to predict which locations will be productive for the species. All foraging habitat has the potential to be productive during general food shortages and therefore provide a critical resource. Section 6 outlines important winter and spring vegetation communities for the Grey-headed Flying-fox that should be the focus for protection in any future conservation initiatives or development proposals along the east coast of Australia.

Habitat and associated seasonal resources critical to the survival of the Grey-headed Flying-fox have been mapped, but have yet to be ground-truthed (Eby and Law 2008). Actions under this recovery plan seek to rectify this.

2.10 Population size and trends

The Grey-headed Flying-fox is considered to be a single, mobile population with individuals distributed across Queensland, New South Wales, Victoria, South Australia, Tasmania and the ACT.

Between 1998 and 2005, there were a number of attempts to establish a reliable estimate of national population size. Based on eleven national counts during this time (Eby 2002a, Eby 2003, Eby 2004, Birt 2005a) the accepted estimate was somewhere between 320 000 to 435 000 individuals with variations likely to be the result of a combination of counting error and actual fluctuations in the abundance of the species (Eby 2004).

These national counts illustrated some of the practical difficulties encountered when surveying this highly mobile and widely distributed species. Given this, the DoE commissioned the CSIRO to develop a peer-reviewed field and analytical approach for monitoring the national Grey-headed Flying-fox population and interpreting the results (Westcott *et al.* 2011). The CSIRO was awarded funding as part of the National Hendra Virus Research Program to implement their methodology as part of a National Flying-fox Monitoring Program (NFFMP). The NFFMP methodology involves on-ground static counting of all Grey-headed Flying-foxes in known camps across the entire species' distribution. All camps are surveyed simultaneously over a 3 day period, four times per year (November, February, May and August). The NFFMP also includes a tracking study to reduce and understand the error associated with counting flying-foxes consequently reducing the time required to detect trends in the population.

The NFFMP commenced in 2012 and is ongoing. Quarterly reports from the CSIRO are published on the DoE website. These reports can be viewed at www.environment.gov.au/biodiversity/threatened/species/flying-fox-monitoring.

The NFFMP is working towards providing essential data on trends in population size, structure and dynamics and will eventually enable identification of key drivers of population processes. The data may also be used subsequently to predict risk factors associated with flying-foxes, such as disease transmission, or damage to orchards.

Westcott and colleagues (2015) undertook an analysis of data from the first nine monitoring events and recommended against comparisons with previous estimates (1998-2005) because of the differences in the methods used and uncertainty regarding the survey coverage of the extent of the population. Given the confidence intervals associated with population estimates in the NFFMP, a much longer period of monitoring is required before any trends can be confirmed (Westcott *et al.* 2015).

Further information on current trends of EPBC Act listed flying-foxes is provided in a report on the DoE website and can be accessed at www.environment.gov.au/biodiversity/threatened/species/flying-fox-monitoring.

2.11 Distribution

The Grey-headed Flying-fox is endemic to Australia, with a distribution ranging from Bundaberg in Queensland, to Adelaide in South Australia. They are usually found on the coastal lowlands and slopes of south-eastern Australia below altitudes of 200 m (Figure 1).

Areas of repeated occupation extend from the coast, inland to the tablelands and western slopes of northern New South Wales and the tablelands of southern

Queensland. Breeding camps have been recorded as far north as Mackay in Queensland (Roberts *et al.* 2008). More recently, the species has become established in South Australia, the Australian Capital Territory and inland areas of Victoria and New South Wales. There are records of individuals on Bass Strait islands (Tidemann 1998) and mainland Tasmania (Driessen 2010).

Patterns of occupancy and relative abundance within its distribution vary widely seasonally and temporally. When assessed at a local scale, the species is generally present intermittently and irregularly (Eby and Lunney 2002). However, a small number of local areas do support a continuous presence while others are associated with regular, annual patterns of use (Figure 1).

Broad trends in the distribution of plants with similar flowering and fruiting phenology support regular annual cycles of migration that are apparent at regional scales (Eby and Lunney 2002).

An interactive web viewer created to support the National Flying-Fox Monitoring Program shows the location of all known and historic camps of Grey-Headed Flying-Fox across their entire distribution (www.environment.gov.au/webgis-framework/apps/ffc-wide/ffc-wide.jsf). This viewer is updated regularly as information comes in from the NFFMP.

2.10.1 Seasonal patterns

During spring, Grey-headed Flying-foxes are uncommon south of Nowra in New South Wales, but widespread in other areas of their range. In summer they are widespread throughout their range and in autumn they occupy coastal lowlands and are uncommon inland. In winter they congregate in coastal lowlands north of the Hunter Valley and are occasionally found on the south coast of New South Wales (associated with flowering Spotted Gum *Corymbia maculata*) and the northwest slopes (generally associated with flowering White Box *Eucalyptus albens* or Mugga Ironbark *E. sideroxylon*) (Eby and Law 2008).

The metropolitan areas of Brisbane, Newcastle, Sydney and Melbourne are occupied continuously, as are various coastal areas in the north of the species' range (Pallin 2000, Hall 2002, van der Ree *et al.* 2006). Patterns of occupancy and abundance have altered over time. During the past 20 years, the numbers of animals occupying camps in metropolitan Newcastle, inner Sydney and Melbourne/Geelong have increased and several camps in these large urban areas have changed their patterns of occupation from seasonal use to continuous use (Richards 2002, van der Ree *et al.* 2006).

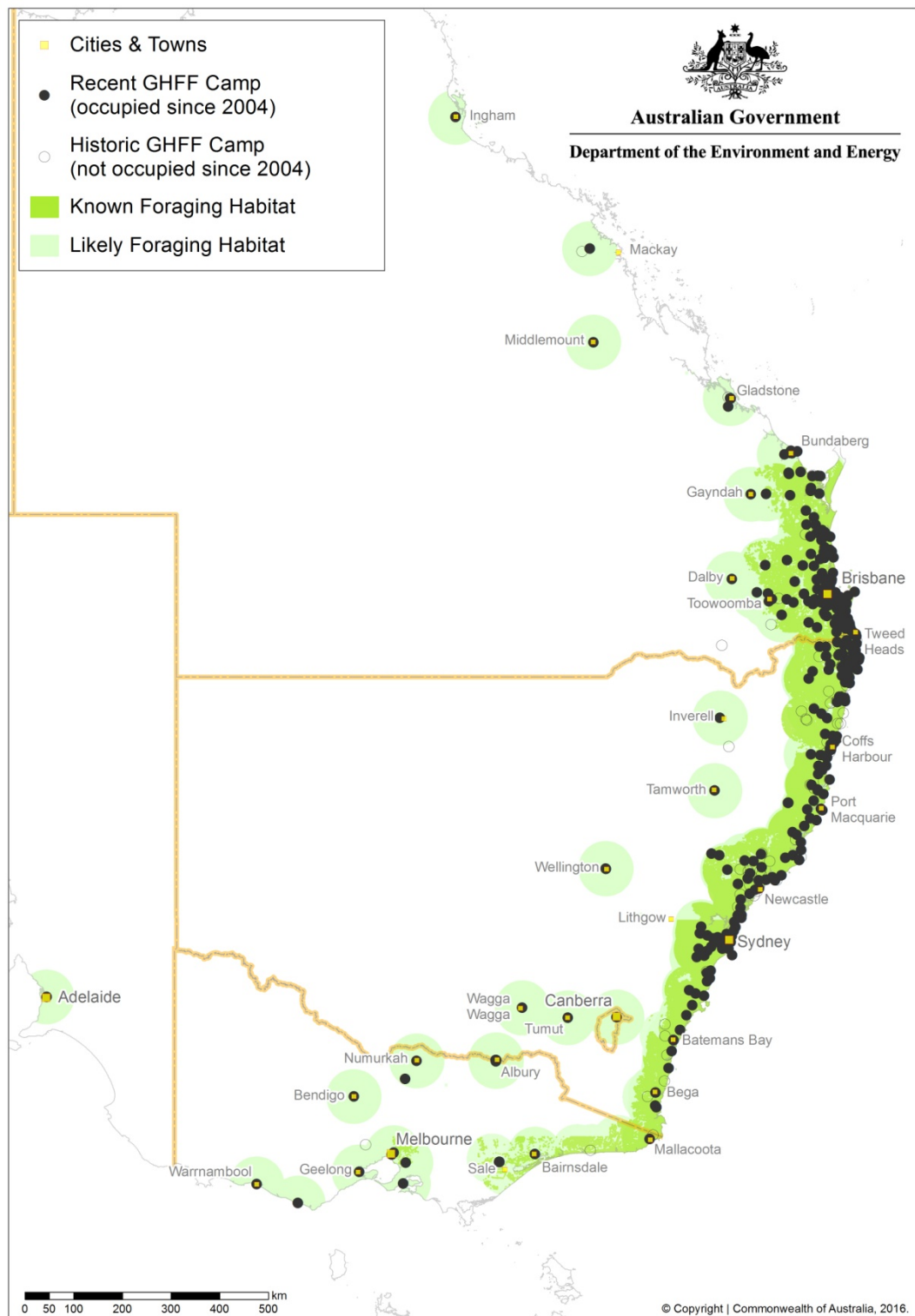
2.10.2 Historical change

It has been suggested that the latitudinal distribution of the Grey-headed Flying-fox has changed during the past 100 years, possibly in response to climate change in eastern Australia. However, recent work suggests there has been no significant change in either the northern or southern range limits of this species (Roberts *et al.* 2012). Insufficient information exists to enable the assessment of change to inland boundaries.

Grey-headed Flying-foxes have recently become more abundant near their southern range limit in urban Melbourne, accompanied by a change in their temporal pattern of occurrence from inconsistent to continuous (Roberts *et al.* 2012). This increased abundance is possibly due to a combination of increased food in urban Melbourne and habitat reduction elsewhere (Roberts *et al.* 2012). The increasing occurrence in Melbourne has resulted in a general increase in sightings in Gippsland and on the south coast of New South Wales, as animals migrate to and from Melbourne (Tidemann and Nelson 2004).

In recent years Grey-headed Flying-foxes have also appeared in areas such as Adelaide, Canberra and Orange in central western New South Wales where they have rarely been seen previously. The factors driving these unusual occurrences, and therefore whether they are a rare events or more permanent shifts, are poorly understood.

Figure 1 Locations of camps used by Grey-headed Flying-foxes



3 OVERVIEW OF THREATS AND ISSUES

3.1 Vulnerability to threats

The processes that threaten Grey-headed Flying-foxes are most prevalent in coastal areas north from the Sydney Basin, which support the greatest natural diversity of food plants and the most consistent presence of the species outside metropolitan areas.

These areas support numerous large and varied commercial fruit growing operations, have rapidly expanding human populations and increasing numbers of Black Flying-foxes, all of which reduce available habitat, increase competition for resources and expose animals to human-induced mortality.

3.2 Key threat

3.3.1 Habitat loss

The Grey-headed Flying-fox requires a continuous temporal sequence of productive foraging habitats and suitable roosting habitat. Loss of foraging habitat is considered the primary threat to the Grey-headed Flying-fox (Tidemann *et al.* 1999, Dickman and Fleming 2002, Eby and Lunney 2002). The species has complex habitat requirements and requires multiple populations of food trees dispersed over a large area. This makes it difficult to protect foraging habitats solely within conservation reserves, such as national parks, and leaves the species vulnerable to land-uses that may clear native vegetation or degrade habitat (Parry-Jones 1993, Pressey 1994, Eby 1996, Tidemann and Vardon 1997).

For example, in New South Wales, less than 15 % of potentially suitable habitat for the Grey-headed Flying-fox occurs in conservation reserves (Murphy *et al.* 2008) and only 5 % of roost sites are protected by some form of conservation status (Murphy *et al.* 2008).

Clearing of winter forage is a particular threat for the species. Few diet plants flower in winter and those that do flower reliably occur on coastal lowlands in northern New South Wales and southern Queensland (Eby *et al.* 1999, Eby and Lunney 2002, Eby and Law 2008). There is evidence that spring forage in remaining habitat is inadequate to provide reliable resources during critical periods in the reproductive cycle of Grey-headed Flying-foxes. The species is subject to recurring food shortages during late gestation, birth and early lactation. These shortages are associated with rapid weight loss in adults and poor reproductive success (Collins 2000, Eby 2000, Parry-Jones and Augee 2001).

Evidence of repeated food shortages during winter and spring indicates that inadequate productive foraging habitat exists in these seasons to sustain the current Grey-headed Flying-fox population. Actions under this recovery plan seek to build on the work undertaken by Eby and Law (2008) by mapping Grey-headed Flying-fox foraging habitat and identifying habitat that is critical to the survival of the species.

Loss of roosting habitat has also been identified as a threat to Grey-headed Flying-foxes (Tidemann *et al.* 1999, NSW Scientific Committee 2001). Camp vegetation has been exposed to the same historical patterns of clearing and degradation as foraging habitat (Lunney and Moon 1997, Hall 2002). The roosting requirements of Grey-headed Flying-foxes are not well understood, nor are the impacts on the species of loss of long-term sites which may be selected to meet specific requirements.

3.3 Other threats

3.3.1 Camp disturbance

Conflict between people and Grey-headed Flying-foxes is an ongoing problem that particularly affects camps in coastal areas (Smith 2002, Tidemann 2002, West 2002). A rapid increase in the human population of coastal Queensland and New South Wales has meant that camps that were once isolated from human activities are now increasingly surrounded by urban and rural residential development (Smith 2002, West 2002, Coffs Harbour City Council 2004). The number of camps in urban areas and the number of individual flying-foxes using these urban camps have increased, particularly in urban areas of Qld and NSW in recent years and some are now continuously occupied (Birt *et al.* 1998, Hall 2002, Richards 2002, van der Ree *et al.* 2006, Eby pers.comm).

This trend has been associated with an increase in the density and diversity of food trees in the gardens and streetscapes of cities like Brisbane, Sydney and Melbourne, together with increasing pressures on Grey-headed Flying-foxes in non-urban landscapes from reductions in the availability of native forage and increasing competition from Black Flying-foxes (Birt *et al.* 1998, Hall and Richards 2000, Parry-Jones and Augee 2001, Hall 2002).

Negative perceptions of Grey-headed Flying-foxes can lead to conflict, impacting the population directly through harassment, deliberate destruction and attempts at dispersal, or indirectly by inhibiting community support for conservation initiatives.

People living near camps can find them annoying and unpleasant. Flying-fox camps are often noisy during the day and just before dawn when individuals return from foraging, and can generate a strong smell caused by the dense concentration of animals. People in close proximity can also be concerned about mess from faecal droppings and the potential for transmission of diseases from flying-foxes to people (Eby 1995, Tidemann 1999, Smith 2002). The risk of disease transmission is extremely low and occurrences are rare (Halpin *et al.* 2011). The likelihood of bats being responsible for any large-scale zoonotic disease threat to humans is very low (FAO 2011). Further investment in community education is required in this area to change public perception.

Active disturbances have been used in attempts to remove animals from camps (Lunney and Moon 1997, Tidemann 1999, Hall 2002, Tidemann 2002, Roberts *et al.* 2011, Roberts and Eby 2013). Efforts to break the fidelity of individual Grey-headed Flying-foxes to specific camps have generally been unsuccessful (Roberts *et al.* 2011; Roberts and Eby 2013). In the few situations where the animals have moved, ongoing programs of disturbance and monitoring have been required to keep them away.

Requests for the relocation of camps in urban areas have increased in recent years. It is not possible to determine prior to a disturbance where flying-foxes will relocate to. As a result individuals may set up new camps in unsuitable locations, effectively shifting the problem from one area to another (Hall 2002, Roberts *et al.* 2011). Similarly, attempts to relocate camps may cause stress to flying-foxes, increasing the noise and activity within existing camps, and potentially leading to injury, abortions by pregnant females or death.

While inevitably there will be some situations where dispersal is the best management option to balance conservation of flying-foxes with the needs of local communities, these actions need to be carefully managed and be conducted in accordance with [best practice guidelines](#).

3.3.2 Mortality in commercial fruit crops

Grey-headed Flying-foxes have caused damage to cultivated fruit crops since European settlement (Ratcliffe 1931, Tidemann *et al.* 1997). Crops grown in coastal areas north from the Illawarra in New South Wales are most commonly affected, with damage reported from as far south as Batlow. The increase in occurrence of Grey-headed Flying-foxes in eastern Victoria over the past 20 years has been associated with locally significant and sporadic crop damage in that region (I. Temby pers. comm). Levels of damage vary considerably between localities and years, and there is consistent evidence that the animals increase their use of commercial crops when native food is scarce (Ratcliffe 1931, McWilliam 1986, Teagle 2002). In these circumstances, greater numbers of animals are killed from crop management practices including shooting by orchardists. Conserving habitat that is productive during periods of fruit maturation will reduce the damage to commercial fruit crops and reduce the mortality of flying-foxes (Eby and Law 2008).

There is a long history of flying-foxes feeding in fruit orchards, particularly in Queensland and the north coast of New South Wales. As a result, commercial orchards in these areas have largely invested in full exclusion netting (NSW Flying-fox Licensing Review Panel 2009). Fruit crops in the Sydney Basin are currently most at risk of damage from Grey-headed Flying-foxes (NSW Flying-fox Licensing Review Panel 2009).

Prior to the listing of the species as vulnerable, shooting was the most commonly used method to protect crops against Grey-headed Flying-fox damage (Teagle 2002). A nationally agreed limit for damage mitigation licences of 1.5 % of the population size was put in place in 2002, after Grey-headed Flying-foxes were listed as vulnerable under the EPBC Act (Department of the Environment and Heritage 2003).

In May 2009, an independent review panel was commissioned by the NSW Government to determine whether the current New South Wales licensing policy for the legal harm of flying-foxes, particularly the Grey-headed Flying-fox, remained valid on environmental, economic and social grounds. The review panel concluded the animal welfare issues resulting from shooting as a method of mitigating crop damage caused by flying-foxes were unacceptable ethically and legally; that any shooting would hasten the decline of the species; and that the industry could rely solely on exclusion netting as a means of flying-fox crop damage mitigation (NSW Flying-fox Licensing Review Panel 2009). On 1 July 2011, the NSW Government introduced a \$5-million scheme to subsidise the cost of installing flying-fox exclusion netting for Sydney Basin and Central Coast orchardists - where impacts occur every year - to eliminate the need to issue shooting licences for flying-foxes. This subsidy was extended to cover the whole of NSW with total funding of \$7.1 million.

The states of Queensland and New South Wales do still permit, in certain circumstances, the use of lethal measures (shooting) for controlling flying-fox damage to crops. In 2013, the Queensland Government published an Operational Policy: Ecologically sustainable lethal take of flying-foxes for crop protection. This policy allows the public to apply for Damage Mitigation Permits which allow an annual quota of 1 280 Grey-headed Flying-foxes to be culled.

OEH announced that from 1 July 2015, it only issues licences to shoot flying-foxes as a crop protection measure where it considers that flying-fox damage to orchards is the result of special circumstances. Licences will be issued to shoot flying-foxes for the duration of the incursion, subject to strict limits.

The Commonwealth Government does not promote the lethal take of Grey-headed Flying-foxes and significant lethal take actions have the potential to breach the EPBC Act and be subject to civil and or criminal penalties. Actions in this plan seek to

minimise the impact of mortality in commercial fruit crops by working with orchardists to implement non-lethal crop protection methods and reduce the incidence of illegal shooting.

3.3.3 Heat stress

Exposure to high temperatures results in mortality in Grey-headed Flying-foxes and is known to occur when the surrounding air temperature exceeds 40°C (Parry-Jones 2000, Welbergen *et al.* 2008). This is especially true when the high temperatures are accompanied by low humidity and hot drying winds (DSE 2006). Rates of mortality are lower at ambient temperatures of 41-43.5°C and increase rapidly at temperatures above 43.5°C, predominantly affecting flightless young. An action under this plan aims to improve ways to minimise heat stress on juvenile Grey-headed Flying-foxes.

The NSW government has developed a fact sheet on heat stress events and appropriate responses to the events:

www.environment.nsw.gov.au/animals/flyingfoxes.htm

3.3.4 Entanglement in backyard netting

Animals can become entangled in fine gauge netting that is draped loosely over backyard fruit trees. In Victoria a retrospective analysis was performed on 532 records from two wildlife hospitals. Anthropogenic factors (63.7%) were a major cause of flying fox admissions with entanglement in fruit netting the most significant risk for bats (36.8%) (Scheelings and Frith 2015). Landholders are recommended to use wildlife-friendly netting that is well secured and has an aperture size of less than five millimetres. For more information on bat friendly netting refer to www.wildlifefriendlyfencing.com/WFF/Netting_files/Download.pdf.

Actions under this plan include promoting methods of erecting backyard netting to avoid entanglement of flying-foxes.

3.3.5 Electrocutation on power lines

Grey-headed Flying-foxes are vulnerable to accidental injury and death from various artificial obstacles. They are prone to electrocution on power lines, particularly in urban areas, and increasing urbanisation exposes larger numbers of animals to electrocution (Tidemann 1999).

3.4 Potential threats

Other potential threats to Grey-headed Flying-foxes include climate change and disease, however given they are little understood; responding to these threats is beyond the scope of this recovery plan.

3.4.1 Climate change

Climate change has the potential to affect food availability and heat-related mortality in Grey-headed Flying-foxes. Climate change may put further pressure on alternative food sources, commercial fruit crops and urban and botanical gardens.

Current models of climate change predict that mean maximum temperatures in south-eastern Australia will rise (Pittock and Wratt 2001). Many eucalypts have a narrow range of tolerance to temperature and rainfall, and the predicted levels of change are expected to impact distribution and reproduction (Hughes *et al.* 1996, Hughes 2003).

Hudson *et al.* (2010 and 2011) found that temperature and rainfall significantly influence the timing and intensity of eucalypt flowering in complex ways and concluded that climate change will impact flowering regimes. Butt *et al.* (2015) concluded that climate-change impacts on temperature and rainfall extremes in the subtropics alter the timing

of flowering and fruiting events and reduce the continuity of resources for dependent wildlife.

The occurrence of extreme temperatures is also predicted to rise. Fire and drought are potential causes of habitat loss.

3.4.2 Disease

Diseases of Australian flying-foxes have been reviewed (Olsson and Woods, 2008). There is very little information available on the impact of disease on Australian flying-fox populations, including Grey-headed Flying-foxes. The main area of impact of disease appears to be associated with the public perception of bats as a source of some diseases that can affect humans.

Australian flying-foxes, including the Grey-headed Flying-fox, are natural reservoirs for at least three zoonotic diseases, meaning that they carry a disease agent that can affect humans: Australian Bat Lyssavirus (ABL), a rabies-like disease, and two paramyxoviruses – Hendra virus and Menangle virus (Philbey *et al.* 1998, Halpin *et al.* 2000, Hanna *et al.* 2000; Clayton *et al.* 2013). Research suggests that Australian flying foxes may also be carriers for pathogenic *Leptospira* species, although they are not considered to pose a significant risk to humans of leptospirosis (Smythe *et al.* 2001; Cox *et al.* 2005; Tulsiani *et al.* 2011).

The incidence of ABL in the species is low (<1 %). The virus appears to have evolved with the flying-foxes and is generally in equilibrium with the population. However, when flying-foxes are subject to significant ecological stress the incidence of ABL can increase to the point where the disease can impact upon the population (H. Field pers. comm.). The incidence of ABL infection is also higher (5-10%) in sick, injured and orphaned flying foxes (DAFF 2013).

Australian health authorities suggest that ABL poses a low public health risk. Evidence suggests the virus can only be transmitted to humans in saliva from an infected flying-fox via a penetrating bite or scratch, or by contamination of mucous membranes or broken skin. Coming into contact with flying-fox urine or faeces reportedly poses no risk of ABL infection. Effective pre-exposure and post-exposure (prior to clinical signs) protection from ABL is available through a vaccine that can be administered by medical practitioners or, in some cases, post exposure administration of human rabies immunoglobulin (HRIG) (DHA 2012).

There is no evidence that Hendra or Menangle viruses can be transmitted directly from flying-foxes to humans, although each has been transmitted to humans by domestic animals (horses and pigs respectively) (Chant *et al.* 1998; Philbey *et al.* 1998, Selvey *et al.* 1996; Field *et al.* 2001; Clayton *et al.* 2013). As with ABL, current thinking is that the incidence of Hendra virus in the flying-fox population increases when the animals are under stress (Plowright *et al.* 2011; Plowright *et al.* 2008). Research has been commissioned to explore this theory for Hendra virus (QDAFF 2012). Land-use change, urban habituation and decreased flying-fox migratory behaviour have also been implicated as factors that may influence the prevalence of Hendra virus in flying-fox populations (Plowright *et al.* 2011; Plowright *et al.* 2015).

Menangle virus has occurred as a single outbreak in a piggery in NSW in 1997, causing reproductive failure in pigs and significant illness in two piggery workers who subsequently recovered (Clayton *et al.* 2013). Flying-foxes were identified as the likely reservoir of Menangle virus (Clayton *et al.* 2013).

Hendra virus has received extensive media attention, with sporadic cases occurring in horses since the first recorded case in 1994. Outbreaks have involved the death of a number of horses. Although spill-over infection from horses to humans is a very rare event, it may be fatal. The human cases have all been attributed to close exposure of

people to infected horses. There is no evidence that Hendra virus can spread directly from flying-foxes to people (Breed et al. 2006, NSW Department of Health 2011).

Animal disease outbreaks are generally managed by the relevant State agency for primary industry, in conjunction with their health department counterparts. Following an outbreak of Hendra virus in 2011, the Intergovernmental Hendra Virus Taskforce was established with representatives from respective heads of biosecurity agencies in Queensland, New South Wales, Victoria and the Australian Government; chief veterinary officers, chief health officers, chief scientists, and senior environmental representatives from Queensland and New South Wales; and the Australian Chief Veterinary Officer and head of the Australian Animal Health Laboratory CSIRO.

The taskforce was responsible for ensuring a consistent and coordinated approach in responding to the disease, identifying areas for further collaboration and undertaking longer-term planning for managing the disease and its impacts. The National Hendra Virus Research Program was established to fund research leading to strategies that minimise the impact of Hendra virus.

Outcomes of the Taskforce to date include:

- A Hendra virus vaccine for horses released on Thursday 1 November 2012. Vaccination is the single most effective way of reducing the risk of Hendra virus infection in horses. Vaccinating horses is also an important measure to prevent human infection occurring and provides a public health and workplace health and safety benefit (NSW DPI 2015).
- Research identifying that roost disturbance is not likely to precipitate increased HeV infection and excretion in dispersing flying-foxes (Edson et al. 2015a)
- Black Flying-foxes are more likely a vector for Hendra than Grey-headed or Little Red Flying-foxes (Edson et al. 2015b).

White-nosed syndrome, a fungal disease causing widespread concern due to its impact upon bat populations in North America, has only been identified in microchiropterans. The disease has not been identified in Australia. Angiostrongylosis and a number of other diseases have been identified in Grey-headed Flying-foxes (Barrett, 2004; Olssen and Woods, 2008; Reddacliff et al. 1999); however, the impact of these diseases at a population level is unknown. The lack of information available suggests that further work is required to assess and quantify any potential threats that may be posed by disease on Grey-headed Flying-fox populations.

4 RECOVERY OBJECTIVES, PERFORMANCE CRITERIA AND ACTIONS

The overall objectives of this Grey-headed Flying-fox recovery plan are:

- to improve the Grey-headed flying-foxes national population trend by reducing the impact of threatening processes on Grey-headed Flying-foxes through habitat identification, protection, restoration and monitoring, and
- to assist communities and Grey-headed flying-foxes to coexist through better education, stakeholder engagement, research, policy and continued support to fruit growers.

Following are specific objectives intended to be achieved over ten years, actions to achieve them and performance criteria against which achievement can be assessed.

Recovery objective 1: Identify, protect and enhance native foraging habitat critical to the survival of the Grey-headed Flying-fox.

Background: Habitat loss and degradation pose the most significant threat to Grey-headed Flying-foxes. Range-wide, integrated strategies of habitat protection are needed to conserve the species. Priority habitats need to be identified and direct actions taken to incorporate the requirements of the species into pre-existing mechanisms for protecting, enhancing and rehabilitating native vegetation, on both public and private lands.

Clearing of winter foraging habitat is of particular concern. Evidence of repeated food shortages during winter and spring indicates that inadequate productive foraging habitat exists in these seasons to sustain the current Grey-headed Flying-fox population. Pre-existing tree-planting and habitat restoration and rehabilitation programs provide opportunities for increasing the extent and condition of habitats productive in these seasons.

Action 1.1: Building on the work of Eby and Law (2008), through field surveys and spatial analysis identify potential and critical foraging areas used by the Grey-headed Flying-fox and display on the Department of the Environment and Energy interactive web viewer for the National Flying-Fox Monitoring Programme.

Action 1.2: Building on the outcomes of Action 1.1, identify opportunities to protect important foraging resources in native vegetation communities that are poorly represented within current reserves.

Action 1.3: Building on the outcomes of Action 1.1, identify opportunities to protect priority foraging habitats on private land using permanent covenants.

Action 1.4: Increase the extent and viability of foraging habitat for the Grey-headed Flying-fox that is productive during winter and spring by planting appropriate tree species (e.g Eby 2016).

Performance criterion: Foraging habitat critical to the survival of Grey-headed Flying-foxes, including winter and spring foraging habitat, is spatially identified, the extent of this habitat that is protected under conservation management programs is increased by at least 100km², and the condition of this habitat is improved. At least 1000 km² of foraging habitat is created or restored with vegetation communities and species optimised for nectarivorous species including the Grey-headed Flying-fox. More precise performance measures will be developed once a baseline has been established.

Recovery objective 2: Identify, protect and enhance roosting habitat of Grey-headed Flying-fox camps.

Background: As per objective 1.

Action 2.1: Continue to maintain a database of Grey-headed Flying-fox camps.

Action 2.2: Undertake work on the database to include tenure and zoning of the land and land adjoining all camps.

Action 2.3: Protect and enhance roosting habitat for Grey-headed Flying-foxes.

Action 2.4: Develop and implement plans of management for all problematic Grey-headed Flying-fox camps.

Performance criterion: Camps of Grey-headed Flying-foxes are identified and mapped, the number of camps protected under conservation agreements is increased and the condition of roosting habitat is improved in accordance with camp plans of management and conservation agreements, covenants or other forms of legal protection have been established for at least 10 nationally important camp sites.

Recovery objective 3: Determine population trends in Grey-headed Flying-foxes so as to monitor the species' national distribution and conservation status.

Background: A 30 % decline in the national population of Grey-headed Flying-foxes was the key criterion for listing the species as vulnerable to extinction. There has been an ongoing public debate suggesting Grey-headed Flying-fox numbers have increased significantly and that the species is not in decline, questioning the need for legislative protection. An estimation of the national Grey-headed Flying-fox population and trend analysis is seen as a sensible response to the ongoing public debate and will enable more informed management decisions. CSIRO has developed a field and analysis methodology and is monitoring the Grey-headed Flying-fox's national population.

Action 3.1: Continue conducting range-wide assessments of the Grey-headed Flying-fox population as part of the NFFMP being coordinated by the CSIRO (Westcott *et al.* 2015).

Action 3.2: Monitor and report on heat stress events, their locations and frequencies in order to understand the role of climate change and its impact on recovery. Consideration should be given to incorporating this action into action 3.1.

Action 3.3: Develop robust models of Grey-headed Flying-fox life history and population dynamics, to enable predictions of the likely impacts of threats on population viability. The data collected in Action 3.1 will contribute to the development of these models.

Performance criterion: By 2026, the abundance of Grey-headed Flying-foxes is assessed, the error in abundance measures is estimated, and the population trend is identified as stable or improving.

Recovery objective 4: Build community capacity to coexist with flying-foxes and minimise the impacts on urban settlements from existing camps without resorting to dispersal.

Background: Habitats throughout the range of the Grey-headed Flying-fox continue to be substantially modified by human activities (Eby and Law 2008). Coastal development which has overtaken long-standing camps, loss of vegetation away from urban areas and increased urban food supply because of extensive planting of native species in cities, have all led to an increased interaction between humans and flying-foxes in urban areas.

In general, where flying-fox camps exist it is important to build the capacity of the community to live near the animals. This approach recognises that dispersal of flying-fox camps comes with other impacts such as potentially moving a problem camp onto another community, creating further conflict. Efforts to disperse flying-foxes from established camps also affect the wellbeing of the animals concerned and may lead to injury or death.

A range of management strategies can be employed *in situ* to minimise the impact on urban settlements without dispersing the flying-foxes. For example vegetation can be planted to create a buffer around homes, or preferred roosting and foraging trees can be removed from sensitive locations.

Landscape habitat mapping which identifies existing and potential flying-fox habitat can assist future land use planning so that the location of roosting habitat is considered when deciding the placement of new homes, schools and hospitals. Building improvements such as installing double glazed windows and air conditioning have also been effective in enabling residents to live near flying-foxes.

Action 4.1: Undertake community surveys to elicit community values and attitudes towards wildlife, specifically flying-foxes, and also to assess the effectiveness of public awareness-raising under Objective 4.

Action 4.2: Develop and publish information for the community to build their capacity to coexist with Grey-headed Flying-foxes.

Action 4.3: Publish case studies demonstrating how effective *in situ* management of flying-foxes can mitigate impacts on the local community, as well as the difficulties and costs associated with attempting dispersals.

Action 4.4: Work with local governments and private landholders to identify existing flying-fox roosting habitat, implement mitigation measures in areas of conflict and investigate opportunities for creating or rehabilitating habitat away from people, and areas unsuitable for development due to potential conflict.

Performance criterion: Improvement in public attitudes towards Grey-headed Flying-foxes resulting in fewer applications to disperse camps.

Recovery objective 5: Increase public awareness and understanding of Grey-headed Flying-foxes and the recovery program, and involve the community in the recovery program where appropriate.

Background: Recovery of the Grey-headed Flying-fox cannot occur without wide community participation. In several areas, negative public attitudes toward the species act as an impediment to the recovery process. The continued clearing of Grey-headed Flying-fox habitat for urban and rural development both reduces the habitat available for animals to occupy and increases the conflict between flying-foxes and people. As well as protecting flying-fox habitat, strategic programs of public education are needed to reduce this conflict.

Action 5.1: Develop a comprehensive strategy of public education (see recovery objective 4, above).

Action 5.2: Create a website to promote the Grey-headed Flying-fox Recovery Plan to inform the public of the recovery plan, its progress and opportunities for participation in actions.

Action 5.3: Promote public participation in surveys and reporting of camp and foraging locations as part of the NFFMP.

Performance criterion: Improvement in public attitudes towards Grey-headed Flying-foxes and conflict with people reduced as measured by the number of camp dispersals.

Recovery objective 6: Improve the management of Grey-headed Flying-fox camps in sensitive areas.

Background: Management problems can arise when flying-fox camps establish or unexpectedly increase in size in urban environments. In September 2015, the DoEE released a referral guideline for management actions in Grey-headed and Spectacled flying-fox camps. This guideline was developed closely with state, territory and local governments, species experts and the general public to ensure high protection standards for the Grey-headed Flying-fox whilst seeking streamlined assessment outcomes. It provides guidance to proponents on when and how they can act to manage problematic camps whilst ensuring there are no significant impacts on the Grey-headed Flying-fox.

Action 6.1: Ensure the public is aware of the referral guideline and that it is widely available for proponents who are proposing to manage a problematic flying-fox camp.

Action 6.2: Review the referral guideline in collaboration with state and territory governments as significant new information comes to hand around management techniques or population size and trends.

Performance criterion: Problematic camps are managed in accordance with the Department's referral guideline.

Recovery objective 7: Significantly reduce levels of deliberate Grey-headed Flying-fox destruction associated with commercial horticulture.

Background: Flying-foxes cause damage to commercial fruit crops across Queensland, New South Wales and Victoria. The extent and severity of the damage varies from place to place and year to year. Permits/licences to control Grey-headed Flying-foxes in commercial crops are not issued in Victoria or South Australia, and are being phased out in New South Wales. There is anecdotal evidence that Grey-headed Flying-foxes are illegally killed in the vicinity of commercial crops in all range States.

Population control by deliberate destruction is not considered to be an effective method of reducing crop damage in the long-term and poses a threat to the recovery of the Grey-headed Flying-fox.

Action 7.1: Promote practical and cost-effective non-lethal measures to protect commercial crops from flying-fox damage (e.g. netting), particularly in newly occupied areas.

Action 7.2: Undertake an education and compliance program targeting illegal shooting of flying-foxes, particularly in newly occupied areas.

Action 7.3: End licensing to harm flying-foxes for mitigation of commercial crop damage in NSW and QLD.

Performance criterion: The deliberate destruction of Grey-headed Flying-foxes in commercial crops is reduced by 75% compared to 2016 levels, and non-lethal methods are used by horticulturalists to protect their crops.

Recovery objective 8: Support research activities that will improve the conservation status and management of Grey-headed Flying-foxes.

Background: A better understanding of flying-foxes will help to assess the impacts of the threats to Grey-headed Flying-foxes identified in this recovery plan, and develop efficient and effective management strategies.

Action 8.1: Continue to monitor and review the current knowledge of the range and distribution of all flying-fox species (Black, Little Red, Spectacled, Grey-headed Flying-foxes; following Roberts *et al.* 2012) to assess whether there have been long-term changes and, if so, to identify the probable causes of those changes.

Action 8.2: Investigate the interactions between the Grey-headed Flying-fox and Black Flying-fox, and identify the level of threat the interactions pose for Grey-headed Flying-foxes.

Action 8.3: Continue research into the ways Grey-headed Flying-foxes use permanent and temporary camps, and methods for recreating/rehabilitating suitable foraging habitats.

Action 8.4: Improve understanding of population dynamics of flying-foxes, including the movement, distribution and behaviour of populations. This encompasses broader research issues such as investigating the determinants of sedentary or transient status of flying-foxes; patterns of juvenile dispersal; and the behaviour of populations under stress from food shortages.

Action 8.5: Engage experts to conduct research into the changing human dimension of interactions with flying-foxes, in order to develop targeted and cost-effective strategies to minimise conflict.

Action 8.6: Conduct research to examine ways of best mitigating the effect of heat stress on juvenile flying-foxes during heat stress events.

Performance criterion: Knowledge of the Grey-headed Flying-fox biology and ecology is improved.

Recovery objective 9: Assess and reduce the impact on Grey-headed Flying-foxes of electrocution on power lines, and entanglement in netting and on barbed-wire.

Background: Grey-headed Flying-foxes are prone to accidental injury and death from various artificial obstacles. Animals can be electrocuted on powerlines, and become entangled in barbed-wire and fine gauge netting draped loosely over fruit trees. The incidence of deaths or injuries to Grey-headed Flying-foxes from electrocution and entanglements is unquantified.

Action 9.1: Assess the impacts on Grey-headed Flying-foxes of electrocution on power lines, and entanglement in barbed-wire and netting, establish a benchmark of impact, and implement strategies to reduce these impacts.

Action 9.2: Promote methods of erecting backyard netting to avoid entangling flying-foxes.

Performance criterion: A benchmark of impact is established and the incidence of deaths and injuries to Grey-headed Flying-foxes from man-made obstacles is reduced by 50 % against the benchmark.

5. PRIORITY ACTIONS AND COSTINGS

The cost of implementation of this plan should be incorporated into the core business expenditure of the affected organisations and through additional funds obtained for the explicit purpose of implementing this recovery plan. It is expected that the Commonwealth, state and local government agencies will use this plan to prioritise actions to protect the species and enhance its recovery, and that projects will be undertaken according to agency priorities and available resources. Whilst an attempt has been made to cost some of the high priority actions in this recovery plan, this shouldn't deflect from any proposal to undertake any other actions outlined in section 4 of this plan. All actions are considered important steps towards ensuring the long-term survival of the species and in certain areas or unique circumstances, some actions not identified in Table 1 may be the highest priority.

The high priority actions are considered those that are necessary in order to quantify long-term population trends and reverse decline, contribute significantly to resolving conflict, inform decision making about development impacts and urban planning and provide a more informed basis for the long-term management and recovery of the species. These actions would be best done collaboratively between the government stakeholders (outlined on page 6) in conjunction with the CSIRO and various private research organisations or individuals. Federal and State strategic funding programmes are the best avenues to implement the priority actions i.e. Australian Landcare and 20 Million Tree Programmes or NSW OEH Environment Trust or Saving our Species Program. Where approvals are given for actions with residual impacts to the Grey-headed Flying-fox, environmental offsets may provide opportunities to increase important habitat and or undertake research.

Actions considered to be priority are as follows:

Action 1.1: Building on the work of Eby and Law (2008) field verify and spatially identify key foraging areas and vegetation communities used by the Grey-headed Flying-fox through an annual cycle (~\$300-500,000).

Action 1.4: Increase the extent and viability of foraging habitat for the Grey-headed Flying-fox that is productive during winter and spring (~\$1,000,000).

Action 3.1: Continue to conduct periodic range-wide assessments of the Grey-headed Flying-fox as part of the National Flying-Fox Monitoring Programme (~\$800,000).

Action 3.3: Develop robust models of Grey-headed flying-fox life history and population dynamics, to enable predictions of the likely impacts of threats on population viability (\$50-100,000).

Action 2.3: Protect and enhance native roosting habitat critical to the survival of the Grey-headed Flying-fox (~\$500,000).

Action 4.2: Develop and publish information for the community to build their capacity to coexist with Grey-headed Flying-foxes (Nil – assumption that it is core business expenditure).

Action 4.4: Work with local governments and private landholders to identify existing flying-fox roosting habitat, opportunities for creating or rehabilitating habitat away from people and areas unsuitable for development due to potential conflict (Nil – assumption that it is core business expenditure).

Action 7.1: Promote practical and cost-effective non-lethal measures to protect commercial crops from flying-fox damage (e.g. netting), particularly in newly occupied areas (Cost to be determined).

DRAFT

6 MANAGEMENT PRACTICES

The recovery of the Grey-headed Flying-fox is primarily dependent on the protection and rehabilitation of foraging habitat and the expansion of forested areas that are productive during winter and spring; and enhancing flying-fox deterrent systems in commercial fruit crops. Management practices or proposed developments that destroy significant foraging habitats, or alter them to the extent that their productivity or suitability to the species is diminished, will have a significant impact. In particular, clearing key winter or spring habitats should be avoided, as should practices that reduce volumes of nectar available to Grey-headed Flying-foxes during those seasons.

Important winter and spring habitats include vegetation communities that contain *Eucalyptus tereticornis*, *E. albens*, *E. crebra*, *E. fibrosa*, *E. melliodora*, *E. paniculata*, *E. pilularis*, *E. robusta*, *E. siderophloia*, *Banksia integrifolia*, *Castanospermum australe*, *Corymbia citriodora citriodora*, *C. eximia*, *C. maculata* (south of Nowra, New South Wales), *Grevillea robusta* or *Melaleuca quinquenervia*. Destroying foraging habitats may also result in increased impacts on commercial orchards when critical native food resources are further reduced. Management practices to reduce conflict at controversial camps should be implemented. Every attempt should be made to resolve conflict through mediation and public education. Site management plans should be developed in conjunction with the community and plans should include both long-term and short-term strategies for ameliorating conflict. Land management authorities should identify camps that are potential sites of conflict and initiate programs of community engagement and public education to reduce the potential for future disputes. Where concerns have been raised, authorities should respond rapidly by providing advice and information to those involved.

The NSW government provides a template for camp management plans. Visit <http://www.environment.nsw.gov.au/threatenedspecies/flyingfoxcampopol.htm>

Attempts to remove flying-foxes from camps are not recommended; particularly camps identified as nationally important camps on the Department's [interactive flying-fox viewer](#). In many cases, problems develop as a result of land-use planning that encourages inappropriate human development close to flying-fox camps. Where the option still exists, limitations should be placed on developments that can occur within approximately 300 m of flying-fox camps.

The Commonwealth's guidance around the management of flying-fox camps is provided in a policy statement on the DoEE flying-fox website at www.environment.gov.au/biodiversity/threatened/species/flying-fox-policy-statement.

Backyard drape nets

Members of the public using drape netting on fruit trees should be encouraged to use the techniques outlined on the OEH website to minimise entanglements in backyard drape nets. These are available at:

<http://www.environment.nsw.gov.au/animals/GreyheadedFlyingfox.htm>

Electrical lines

Electrical utilities should be encouraged to increase spacing between electrical cables when replacing crosspieces as part of their continual upgrade program.

Fencing

When erecting new fences, the use of plain wire on the top strand instead of barbed-wire is advised.

7 DURATION AND EVALUATION OF PLAN

This recovery plan's performance is to be reviewed after five years. Potential contributors to review the plan include the Australian Government Department of the Environment and Energy in conjunction with all relevant State and Territory agencies.

Successful management to ensure the long-term survival of the Grey-headed Flying-fox will require an ongoing commitment from all governments across the species' range.

Success of this recovery plan will be evaluated against:

- a robust estimate of improved population trend,
- an improved understanding of habitat critical to the survival of the species,
- an increase in protection of habitat critical to the survival of the species and nationally important camp sites
- implementation of effective habitat restoration projects
- a reduction in the level of conflict in sections of the community affected by problematic flying-fox camps,
- greater uptake of crop netting under existing subsidy schemes, and
- an improved understanding of threats of unknown status; climate change and electrocution/ entanglements.

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