National recovery plan for the spectacled flying fox *Pteropus conspicillatus*

Queensland Government

Australian Government

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Cover photograph: Spectacled flying fox by Martin Schulz.

Copies may be obtained from:
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Abbreviations

ABLV	Australian Bat Lyssavirus
ABS	Australasian Bat Society
ALGA	Australian Lychee Growers Association
CTTRS	Cape Tribulation Tropical Research Station
CYPDA	Cape York Peninsula Development Association Inc
DEC	Department of Environment, Climate Change and Water (New South Wales)
DIP	Department of Infrastructure and Planning (Queensland)
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
DEEDI	Department of Employment, Economic Development and Innovation (Queensland)
DERM	Department of Environment and Resource Management (Queensland)
DSEWPaC	Australian Government Department of Sustainability, Environment, Water, Population and Communities
EPBC	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
JCU	James Cook University
NCA	Queensland *Nature Conservation Act 1992*
NGRMG	Northern Gulf Resource Management Group
NRM	Natural Resource Management regional groups
NQDT	North Queensland Dry Tropics
QH	Department of Health (Queensland)
QRAA	Queensland Rural Adjustment Authority
RTEGA	Rambutan and Tropical Exotic Growers Association
TBH	Tolga Bat Hospital
TNRM	Terrain Natural Resource Management
TSSC	Threatened Species Scientific Committee
UQ	University of Queensland
WTMA	Wet Tropics Management Authority
WTWHA	Wet Tropics World Heritage Area

Table of Contents

1. Executive summary

Current species status

The spectacled flying fox *(Pteropus conspicillatus*) is listed as 'Vulnerable' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Queensland *Nature Conservation Act 1992* (NCA) includes general restrictions regarding moving of roosts that are relevant to genus *Pteropus.* However *Pteropus conspicillatus* is not listed under the *Nature Conservation Act 1992*.

Habitat and distribution summary

The spectacled flying fox feeds on fruits and blossom, primarily in the canopy vegetation of a wide range of vegetation communities, including closed forest, gallery forest, eucalypt open forest and woodland, *Melaleuca* thickets, coastal swamps, mangroves, vegetation in urban settings, and commercial fruit crops. These foraging activities result in dispersal of pollen and seeds, thereby contributing to the reproductive and evolutionary processes of species and ecological communities.

The species roosts in large aggregations, called camps or colonies, in the exposed branches of canopy trees. Throughout the year an unknown proportion of animals roost away from camps, either solitarily or in small groups.

Within Australia, the spectacled flying fox occurs in north-eastern Queensland, with the largest population known from the *Wet Tropics of Queensland World Heritage Area* between Townsville and Cooktown (DEWHA 2009a). The location of camps on Cape York Peninsula is poorly known and no camps have been located on the islands of the Torres Strait. The spectacled flying fox also occurs on New Guinea and nearby islands (including Woodlark, Alcester, Kiriwana and Halmahera Islands), parts of Indonesia, and also the Solomon Islands (Duncan et al. 1999; Garnett et al. 1999 in DEWHA 2009a). The foraging range of the species is less well understood and further research will provide a better understanding of the foraging distribution of this bat. Telemetry and resource use results from the Wet Tropics indicate that foraging individuals range widely across the Wet Tropics bioregion and extensively into drier forests, including those to the west of the Wet Tropics Region.

Threats to species' survival

Known threats to the spectacled flying fox include loss of habitat, conflict with humans and/or man-made obstacles, entanglement in nets, illegal shooting, electrocution on powerlines, entanglement in barbed wire fencing and backyard drape netting, tick paralysis, genetic disorders (e.g. cleft palate syndrome), agricultural pesticide residue poisoning and vehicle-related mortality.

Recovery objectives

The overall objectives of recovery are to secure the long-term protection of the spectacled flying fox through a reduction in threats to the species' survival and to improve the availability of scientific information to guide recovery. This is the first national recovery plan for *Pteropus conspicillatus.*

2. General information

Conservation status

The spectacled flying fox *Pteropus conspicillatus* is listed as 'Vulnerable' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Queensland *Nature Conservation Act 1992* (NCA) includes general restrictions regarding moving of roosts that are relevant to genus *Pteropus.* However *Pteropus conspicillatus* is not listed under the *Nature Conservation Act 1992.*

International Obligations

The spectacled flying fox is listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Populations of the spectacled flying fox are recognised as values of the Wet Tropics of Queensland World Heritage Area, a World Heritage property under the Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention). The World Heritage values of declared World Heritage properties are protected under the EPBC Act.

Affected interests

A range of public authorities, organisations, commercial interests and private individuals may be affected by actions proposed in this recovery plan:

Australian Government

- Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)
- Rural Industries Research and Development Corporation (RIRDC)
- Department of Agriculture, Fisheries and Forestry (DAFF)
- Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Queensland Government
- Department of Environment and Resource Management (DERM)
- Department of Employment, Economic Development and Innovation (DEEDI)
- Department of Health
- Department of Local Government, Planning, Sport and Recreation (DLGPSR)
- Wet Tropics Management Authority (WTMA)

Local Government

- Cairns Regional Council
- Cassowary Regional Council
- Cook Shire Council
- Hinchinbrook Shire Council
- Tablelands Regional Council

Fruit grower organisations

- Growcom
- Queensland Fruit and Vegetable Growers
- Australian Lychee Growers Association
- Rare Fruits Council of Australia
- Rambutan and Tropical Exotic Growers Association
- Longan Association of Australia
- Banana Association of North Queensland
- Australian Banana Grower's Council Inc
- Avocados Australian Ltd
- Australian Mango Industry Association

- Australian Custard Apples Growers Association

Farmer Groups
- AgForce Queensland
- National Farmer’s Federation (NFF)

Indigenous Councils
- Aboriginal Rainforest Council
- Other aboriginal councils (e.g. Cape York Land Council and Lockhart River Aboriginal Council on Cape York Peninsula).

Regional Natural Resource Management groups
- Cape York Peninsula Development Association Inc. (CYPDA),
- Northern Gulf Resource Management Group (NGRMG),
- North Queensland Dry Tropics (NQDT)
- Terrain Natural Resource Management (TNRM).

Conservation groups
- Queensland Conservation
- Wildlife Preservation Society of Queensland
- Wilderness Society
- WWF-Australia
- Australasian Bat Society
- Tolga Bat Hospital
- Cape Tribulation Tropical Research Centre

Electricity utility providers
- Ergon Energy
- Powerlink

Airports
- Cairns International Airport
- Local airports

Actions proposed as part of this recovery plan may affect the general community including:
- those whose homes immediately adjoin flying fox camps;
- individuals who may come into direct contact with the species e.g. providing assistance to sick or entangled flying foxes;
- licensed animal rehabilitators and their representative organisations;
- individuals and groups involved in tree planting and habitat restoration programs;
- volunteers involved in flying fox surveys and population estimates; and
- individual researchers and their research institutions and funding agencies.

Consultation with Indigenous people

Although flying foxes are hunted for food in parts of Australia, no such use is currently known within the Wet Tropics region, the major centre of distribution for this species in Australia (Garnett et al. 1999). The spectacled flying fox ranges across the land areas of a number of Aboriginal people/s, including (from south to north): the Nyawaygi, Gugu-Badhun, Agwamin, Wargamaygan, Djirbalngan, Yidinjdji, Mbabaram, Djabuganjdji, Kuku-yalanji, Kuuku-yani, Umpila, Kaantju, Uutaalnganu and Kuuku-ya'u (taken from Horton 2000, following the distribution based on Richards 1990a). This recovery plan makes provision for Traditional owners to be represented through various Aboriginal incorporated bodies, the Aboriginal Rainforest Council which represents 18 Traditional Owner groups in the Wet Tropics, other Aboriginal councils and individual communities.

Implementation of recovery actions in the Wet Tropics, including research and monitoring, must incorporate the consultation protocol and include the direct involvement of Aboriginal people as outlined in the *Wet Tropics of Queensland World Heritage Area Regional Agreement* (WTMA. 2005). Outside the Wet Tropics, the implementation of recovery actions must include consultation with other relevant Aboriginal organisations, such as the Cape York Land Council.

Benefits to other species and communities

The spectacled flying fox is widespread in the Wet Tropics Bioregion and its range extends northwards and westwards into adjacent areas, including parts of Cape York Peninsula. Due to its role as a pollen and seed disperser, protection of spectacled flying foxes will contribute to the protection of ecological processes within the vegetation communities of these areas. The protection of habitat used by the spectacled flying fox will also provide protection for other species listed under the EPBC Act.

Actions to reduce flying fox mortality in fruit crops through the introduction of alternate crop management techniques may reduce the mortality of other native vertebrates that damage crops, including the black flying-fox *Pteropus alecto*, little red flying-fox *P. scapulatus*, eastern tube-nosed bat *Nyctimene robinsonii*, sulphur-crested cockatoo *Cacatua galerita*, little corella *C. sanguinea*, rainbow lorikeet *Trichoglossus haematodus*, pale-headed rosella *Platycercus adscitus*, silvereye *Zosterops lateralis* and metallic starling *Aplonis metallica*. Similarly, actions to reduce mortality or injury resulting from entanglement in backyard drape netting will benefit other fruit-tree raiding species.

Actions to reduce mortality of the spectacled flying fox due to entanglement on barbed wire fences at known 'blackspots' may reduce mortality of other species, including other flying fox species, the eastern tube-nosed bat, Queensland blossom bat (*Syconycteris australis*), yellow-bellied sheathtail bat (*Saccolaimus flaviventris*), mahogany glider (*Petaurus gracilis)*, squirrel glider (*Petaurus norfolcensis*) and various bird species.

Social and economic impacts
It is recognised that the spectacled flying fox is capable of causing significant damage to commercial fruit crops. Commercial fruit growers, their peak representative bodies, and the Australian, State and regional Governments have been working together to find cost-effective solutions that do not put the spectacled flying fox at risk of injury or death. The impact that the spectacled flying fox has on individual fruit crops may vary from year to year and region to region, crop to crop. This lack of predictability may also contribute additional costs and uncertainties for fruit growers. Installation, maintenance and upgrading of systems to protect crops from flying foxes reduce the profit margin for fruit producers.

Spectacled flying foxes are also viewed in a positive light by many community members who appreciate their presence in their communities. Furthermore, flying fox camps are recognised by nature tour operators as an asset and the dusk fly out over the Cairns Esplanade represents part of the tourist experience in Cairns. Though it has not been quantified spectacled flying foxes contribute to the tourism income of the region.

3. Biological information

Taxonomy
The spectacled flying fox is comprised of two described subspecies, *P. c. conspicillatus* from Australia, south-eastern New Guinea and adjacent islands and *P. c. chrysauchen* from north-western New Guinea and surrounding islands (Mickleburgh et al. 1992; Flannery 1995a, b). However, Bonaccorso (1998) also recorded *P. c. conspicillatus* as occurring more widely in Papua New Guinea, such as along the northern coast and nearby islands. The subspecies *P. c. chrysauchen* has been reported as occurring in north-western New Guinea, Irian Jaya and coastal islands through the Moluccas Islands (Mickleburgh et al. 1992; Flannery 1995a, b; Bonaccorso 1998).

Alternative common names
This species has also been referred to as the spectacled fruit-bat (Richards and Spencer 1995).

Description
At a distance in dull conditions, flying individuals can be confused with sympatric species, such as the little red flying fox *Pteropus scapulatus*. However, at close range, the spectacled flying fox can readily be identified by the rings of pale yellow fur (‘spectacles’) around the eyes (Churchill 1998; Hall and Richards 2000). In individuals that have indistinct markings around the eyes, the species can be identified by the diagnostic pale yellow patch of fur on the upper back, shoulders and hind-neck. Their head and body length ranges between 220 to 240 mm and weight is from 580-860 g for males and 500-650 g for females.

Life history and ecology - diet and foraging

Based on a five-year study that recorded the fruits of 26 native rainforest canopy tree species in its diet, the spectacled flying fox has been described as a frugivorous specialist (Richards 1990b). Subsequently the fruits of a further 61 native plant species have been noted in diet of the spectacled flying fox, although with further research additional foods are likely to be recorded (Westcott et al. CSIRO, unpubl data). The species also feeds on at least 12 commercially grown fruits, particularly lychees, rambutans and longans (Y. Diczbalis, DEEDI, pers. comm.), and 9 exotic weed species, such as the wild tobacco *Solanum mauritanium* and the Weed of National Significance, pond apple *Annona glabra* (Westcott et al., CSIRO, unpubl. data). It is suspected that the spectacled flying fox particularly targets commercial fruit crops in north-eastern Queensland in certain seasons when the fruiting and flowering of native vegetation is poor and availability of supplementary foods e.g. leaves (forest *sirus Albizia procera*; Richard 1990b) and insects (Spencer 2005) is limited.

Spectacled flying foxes have long been considered to be primarily frugivorous and dependent on rainforest for foraging resources (Richards 1990). Recent research, however, suggests that this is not the case. In radio and satellite telemetry studies individual animals were located in non-rainforest habitats a significant proportion of the time. Many of these fixes were obtained from locations tens of kilometres from rainforest and included a range of wet and dry *Eucalyptus*, and *Melaleuca* vegetation types (McKeown et al. in prep). Furthermore, faecal trapping studies at camps (Parsons et al. 2006) and stable isotope studies (Westcott and Krietals 2008; Kreitals et al. in prep) show large proportions of non-rainforest resource use, particularly Myrtaceous flower resources. Stable isotope analysis suggests that these non-rainforest flower resources contribute c. 70% of the metabolized resources (Westcott et al. 2008; Krietals 2008; Kreitals et al. in prep). Sclerophyll vegetation (wet and dry sclerophy and *Melaleuca*) provided c. 45% of metabolized resources and mangroves and orchard/urban areas provided c. 10% each.

The spectacled flying fox also feeds on blossoms. For example, Richards (1990b) found that the flowers of 10 tree species were eaten, comprising three species from rainforest and the remainder from wet or dry sclerophyll forest. Recent studies have shown that the blossom of a variety of tree species in dry sclerophyll forest and grevilleas on the western side of the Great Dividing Range such as in the Dimbula area and as far inland as Chillagoe, provide an important all-year food source (Parsons et al. 2006, Westcott et al. 2008, Kreitals 2008). The contribution of tree species from coastal sclerophyll forests, *Melaleuca* swamps and mangroves in the diet of spectacled flying foxes is important (Parsons et al 2006, Westcott et al 2008, Krietals 2008 and Krietals et al submitted). The majority of myrtaceous plants in the diet of the spectacled flying fox flower within a defined season, but are not annually reliable. While it is not possible to predict resource distribution over the medium to long term; it is becoming more possible to predict flowering periods for the subsequent month from field surveys.

The movement of individuals from camps to feeding areas is poorly understood, and current information is based on radio and satellite-telemetry and dietary studies. This work indicates that individuals generally forage close to camps, mean foraging distance being 11.8 km (±9.2 SD). The longest recorded distance to a foraging site was 43.4 km (McKeown et al., CSIRO, unpubl data). The total distance travelled during foraging by 19 animals was 27.3 km (± 18.3 SD) with a maximum recorded foraging distance of 87 km. For two other closely related Australian *Pteropus* species, the black and grey-headed flying foxes, nightly foraging distances ranged up to approximately 40 km (Eby 1991; Palmer and Woinarski 1999; Tidemann 1999).

Seed dispersal: The spectacled flying fox provides a role in seed dispersal through the deposition of seeds in faeces, ejection of seeds during consumption, and external transportation of fruits and seeds (Richards 1990b; Hall and Richards 2000; Westcott et al. 2001). Large fruits may be removed from a food tree and taken up to 100 m to an adjacent site for consumption (Richards 1990b; Hall and Richards 2000). Ingested seeds are more widely dispersed, with estimated maximum dispersal distances of approximately 80 km (Westcott et al. 2001). Seed dispersal in this bat may be unique in terms of dispersal distance, deposition mode and quantity dispersed when compared to other seed dispersers (Westcott et al. 2001). Although its importance as a seed disperser compared to frugivorous birds is poorly known, the fact that spectacled flying foxes regularly cross and feed in modified habitats means that they may have an important role in seed dispersal in isolated and/or small rainforest fragments (Westcott et al. 2001). Limited foraging records suggest that the species feeds on fruits of 14 rainforest plants for which no other disperser is currently known (Westcott et al., CSIRO, unpubl. data).

Elsewhere, studies have demonstrated that frugivorous bats play an important role in the maintenance of forest ecosystems (Shilton et al. 1999) and are important agents in recolonisation after disturbance, such as forest harvesting (Gorchov et al. 1993), the colonisation of recently formed streambeds (Foster et al. 1986), and recolonising pastures in the Neotropics (Medellin and Gaona 1999).

Pollination Flying foxes act as pollinators throughout their range (e.g. Eby 1996; Southerton et al. 2004) and spectacled flying foxes probably play a similar role in the pollination of a variety of tropical rainforest and savannah plants. As with seed dispersal, pollination by the spectacled flying fox may be most significant in small and/or isolated rainforest fragments. The role of this species as a pollinator in forest and Melaleuca woodland is not known but may be important in various forest types for some tree and shrub species. Birt (2004) reported that some Eucalypt species show characteristics of bat pollinated plants.

Life history and ecology –roosting

Similar to other flying foxes, the spectacled flying fox is highly social and generally roosts during the day on exposed branches or amongst foliage in ‘camps’ that are occupied by up to tens of thousands of individuals. Recent work has shown that not all the animals roost in these known camps. Shilton et al. (2008) show large fluctuations in total population size through the year which can only be attributed to a significant proportion of animals roosting elsewhere; this appears to be most common in the winter. Small groups or individuals are often observed roosting separately to the known camps, raising the question of what proportion of the population use these camps. The spectacled flying fox will often share camps with other *Pteropus* species, including the little red, and black, flying foxes, however during monthly surveys of all known camps in the region since 2004 they have only been observed roosting with little reds (A. McKeown et al., CSIRO). Roosting with other species has led to difficulty in the assessment of *P. conspicillatus* roost size based on dusk fly-out counts. Camps occur in a wide range of vegetation types, including rainforest, gallery forest, *Melaleuca* swamps, mangroves and, eucalypt forest. All camps recorded by Richards (1990) were situated within 6.5 km of the nearest rainforest, however, more recently a camp has been established at Mareeba c. 16 km from rainforest (Shilton et al. 2008). In New Guinea, this species has additionally been recorded roosting in secondary rainforest and plantations of coconut *Cocos nucifera*, she-oaks *Casuarina* spp. and hoop pine *Araucaria cunninghamii* (Bonaccorso 1998). The wide range of habitats utilised for camps may indicate that appropriate vegetation types for camp sites are not limiting (Westcott et al. 2001). This suggestion is supported by climatic similarity analysis using DOMAIN[1] of all known camps, indicating that suitable habitat occurs throughout the Wet Tropics (Garnett et al. 1999). However, no information is available on camp location based on micro-habitat selection (Westcott et al. 2001).

Camps may be occupied for a large number of years and can be abandoned for no apparent reason. It is unclear whether irregularly used camps are re-occupied after years of absence as a result of a well-developed spatial memory in a long-lived species, or due to specific qualities of these locations. Within spectacled flying fox camps, large seasonal changes in numbers have long been observed and were suggested to be in response to changes in resource distribution and breeding activities (Ratcliffe 1931; Richards 1990a; Garnett et al. 1999). Radio and satellite telemetry studies have shown that individuals make frequent, sometimes daily, movements between camps, with an average straight-line distance between used camps of 39 km (range 15 km-85 km) (Westcott et al. 2001; McKeown et al., in prep.).

It is not uncommon to encounter solitary individuals or small groups of spectacled flying foxes roosting away from the large camps. The large apparent population declines observed in the winter months suggest that this behaviour is particularly prevalent during this period outside the mating and birthing seasons (late May to early September). Information about these sites is limited but they may form an important component of the population at all or some parts of the year. This behaviour severely complicates attempts to estimate population sizes and trends (Westcott et al., submitted).

Life history and ecology – breeding
Reproduction in Australian flying foxes is seasonal and synchronous (Ratcliffe 1931; Nelson 1965; O'Brien 1993). Breeding biology of the spectacled flying fox is poorly documented in the wild. As in closely related species, mating in the spectacled flying fox is thought to primarily occur between March and May (Hall and Richards 2000). Observations on the Atherton Tablelands indicate the peak of births occurs between October and December when individuals have formed into large maternity camps, and lactation occurs through to approximately February or March (J. Maclean, Tolga Bat Hospital, pers. comm.). Females generally give birth to one pup per year with 89% of three to seven year old females reproducing in each year (Fox et al. 2008).

Thirty-nine percent of two-year old females have given birth while 80% of three-year old females have given birth (Fox et al. 2008). At birth the male: female sex ratio of pups on females treated for ticks is 1:1, while the sex ratio of adults brought in for tick treatment has been reported as 1:4 (J. Maclean, Tolga Bat Hospital, pers. comm.). However, such a sex bias may be associated with differences in foraging strategies between the sexes or differential susceptibility to tick envenomation. Additionally, studies have shown a biased sex ratio at certain times of the year or in certain sections of camps. For example, at the Powley Road camp (near Atherton), there was a male-biased sex ratio (3.5:1) in November 1992 and a female-biased sex ratio (1:1.6) in March 1993 (Hayden 1992; Bull 1993).

[1] The DOMAIN algorithm is a flexible modelling procedure for mapping potential distributions of plants and animals. DOMAIN was originally developed by Carpenter and Gillieson (1993) at the CSIRO Tropical Forest Research Institute in Atherton, Queensland. Available at: http://digir.austmus.gov.au/biomaps/help.jsp Accessed: 18/05/09

Fox et al. (2008) showed an overall annual mortality rate for the species of 35% and for females alone of 33%. They found that the bulk of the population was aged between two and six years and that the oldest individuals were 13 years old. While this is currently the best data available for animals in the wild it needs to be treated with some caution as it was derived from animals that died due to tick envenomation at Atherton Tableland camps and is unlikely to represent the population overall. Hall (1983) reported captive individuals of this species living up to 17 years, while in other *Pteropus* longevity in the wild has been estimated at seven years for female black flying fox and eight years for grey-headed flying-fox (Tidemann 1999).

Disease: No mass deaths have been reported in spectacled flying fox camps, although this may be due to low visitation rates at most camps (J. Maclean, Tolga Bat Hospital, pers. comm.) and monthly surveys of all known camps conducted over the last five years have failed to note any such occurances (McKeown et al., CSIRO). During the mid-1990s Australian flying foxes, including the spectacled flying-fox, were identified as natural reservoirs of three newly-described zoonotic diseases: a rabies-like disease, Australian Bat Lyssavirus, and two paramyxoviruses, Hendra virus and Menangle virus (Philbey et al. 1998, Halpin et al. 2000, Hanna et al. 2000). The impact of these viruses on the spectacled flying fox population is unknown.

The paralysis tick *Ixodes holocyclus* is responsible for the paralysis and deaths of many spectacled flying foxes on the Atherton Tableland (J. Maclean, Tolga Bat Hospital, pers. comm.).

Current known national distribution

Knowledge of the distribution of the spectacled flying fox is largely based on the location of camps (Figure 1). Richards (1990a) recorded 55 camps associated with rainforest from the Iron Range area south to Mt Bowen on Hinchinbrook Island. Additional seasonal camps have been located south of Hinchinbrook Island in Broadwater State Forest, north of Ingham and Wallaman Falls, west of Ingham (S. Sullivan, QLD DERM, pers comm.). Camps of this species primarily occur in the Wet Tropics bioregion, and account for over 90% of documented camps (Figures 1 and 2). The location of camps on Cape York Peninsula is poorly known and it is likely that a number of camps have been overlooked in the past (G. Richards, consultant, pers. comm.). There are few confirmed records of this species from the islands of the Torres Strait and no camps have been located (G. Richards, consultant, pers comm.; L. Hall, retired UQ, pers comm.).

Telemetry results from the Wet Tropics indicate that foraging individuals range widely, as far west as Dimbulla, north to Cooktown and south to Rollingstone (A. McKeown et al., CSIRO, pers. comm.). These results are corroborated by small numbers of individuals observed roosting amongst black flying foxes even further west at Chillagoe (Richards 1990a; L. Little, QLD DERM, pers comm.). Anomalous outlying records have been recorded from Charters Towers (S. Sullivan, QLD DERM, pers comm.; L. Hall, retired UQ, pers comm.). Records from Brisbane (cited in Richards 1990a) are considered to originate from released individuals that had been rehabilitated by carers (L. Hall, retired UQ, pers comm.).

Extent and geographic location(s) of populations

The extent and geographical boundaries of populations are currently unclear. This species is highly mobile and the extent of interchange with populations between the Wet Tropics bioregion and Cape York Peninsula appears to be limited, based on the genetic studies of Fox (2006). Radio and satellite telemetry studies indicate that individuals generally do not show year round philopatry to specific camps but rather that they regularly move between a number of camps (Westcott et al. 2001; McKeown et al. in prep). Given the current limitations on data, this recovery plan is based on the assumption that the entire distribution of the species in Australia forms a single conservation unit.

Within the Wet Tropics bioregion the extent of movements of individual spectacled flying foxes is not well understood, though telemetry and other studies have begun to provide a picture of long-distance movements across the region (Westcott et al 2001; Shilton et al. 2008; McKeown et al. in prep). Richards (1990a) indicated that individuals in camps on the Atherton Tablelands moved down to the coastal lowlands in winter. Monthly surveys of all known camps conducted since 2004 provide a picture of a highly dynamic population constantly being re-distributed across the region (DA Westcott, CSIRO unpubl. data). This data shows no evidence of a winter movement out of the Atherton Tablelands but does show a decrease in the size of the population resident in known camps during the winter months (Shilton et al. 2008).

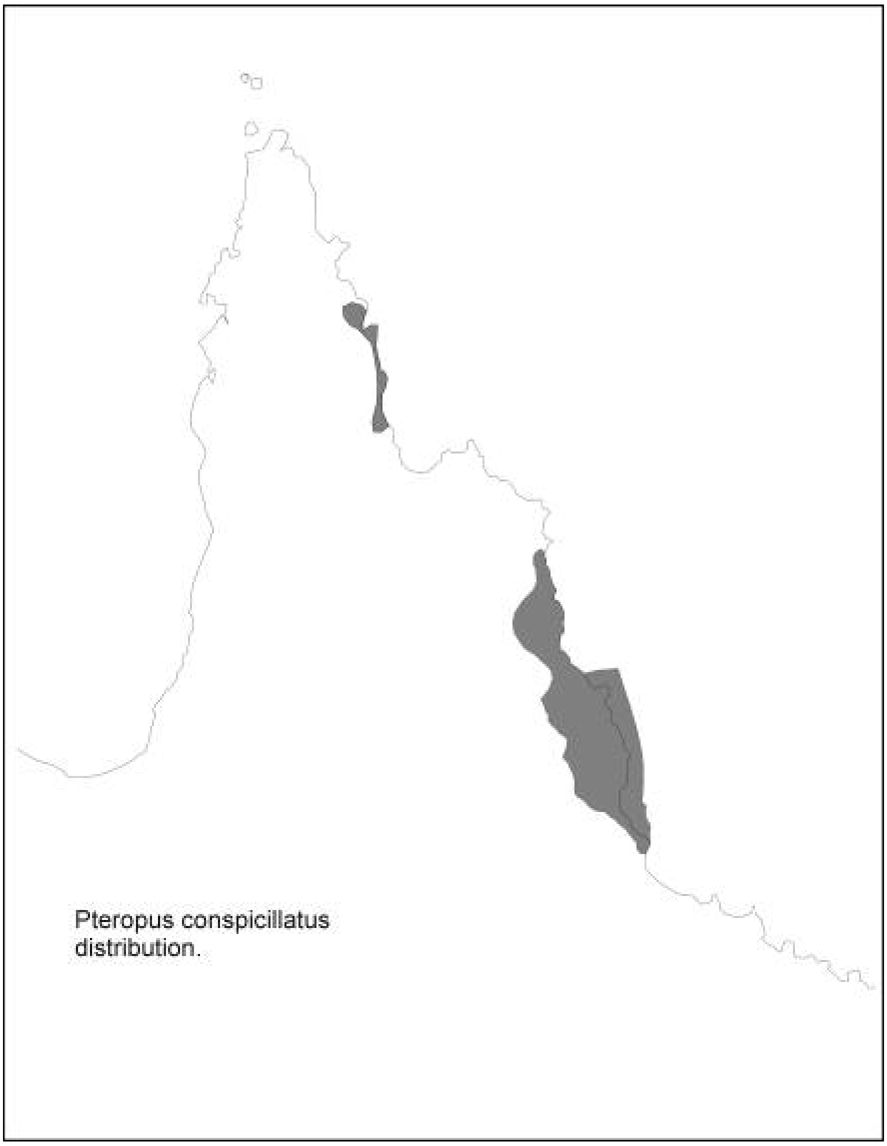

Figure 1 Distribution of the spectacled flying-fox in Australia based on known camps. Note that the extent of the foraging distribution of this species is currently unknown.

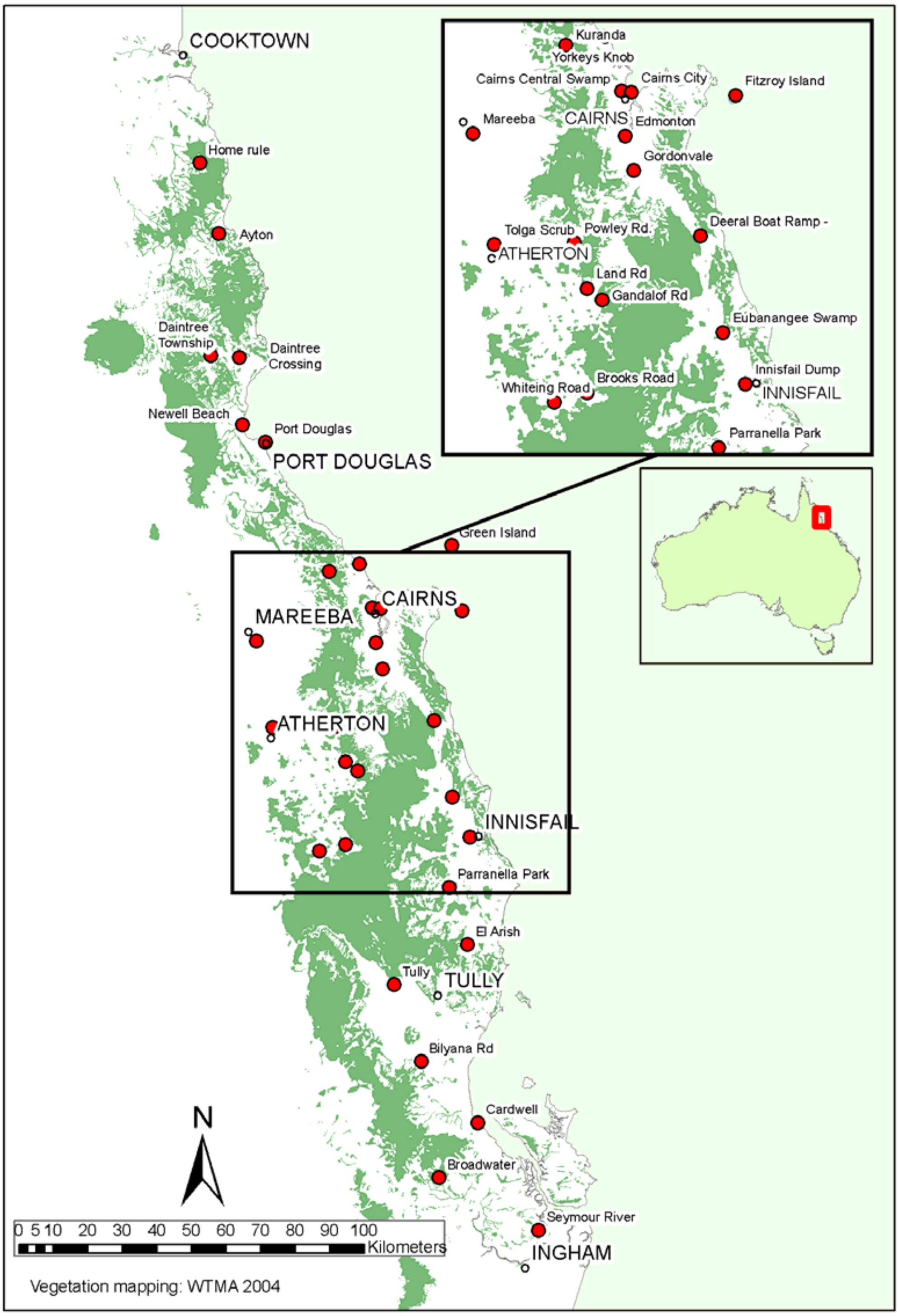

Figure 2 Camps of the spectacled flying-fox in the Queensland Wet Tropics region recorded as being active at some point during monthly surveys since 2004 (CSIRO, unpublished data).

Habitat critical to the survival of the species
The spectacled flying fox requires a continuous temporal sequence of productive foraging habitats and suitable roosting habitat (Westcott et al. 2001). Additionally, the species may require migration corridors/stopover habitats if individuals regularly move between New Guinea and Australia or between Cape York Peninsula and the Wet Tropics. However, any such movements have are yet to be identified.

Essential foraging habitats across this species' range are not completely known, however it is clear that they include the drier forest types found adjacent to and within the foraging range of the species in addition to the rainforests that have traditionally been considered important to the species. It is likely that those vegetation types that show mast flowering will be particularly important (Kreitals et al. 2008). It is currently not possible to predict which localities will be productive in a given month, and therefore which localities will provide food essential to the survival of the species. Camps provide essential resting habitat, opportunity for social interaction, and refuge for animals during significant phases of their annual cycle such as conception, birth, and lactation (Ratcliffe 1932; Richards 1990a; Westcott et al. 2001).

Habitat and associated seasonal resources critical to the survival of the spectacled flying-fox has not been mapped. Actions under this recovery plan seek to rectify this.

Population size
A primary factor in the listing of the spectacled flying fox under the EPBC Act was a significant population decline (Environment Australia 2002). Anecdotal evidence suggests that the species has declined in some areas, based on observers reporting formerly enormous dusk fly-outs of the species from certain localities, such as Cairns (G. Wah-Dai, lychee farmer, pers. comm.; Zappala 2004). However, it is not known whether reduction in dusk fly-out numbers is due to camp dispersal or population decline. Deployment of lethal techniques for reducing impact to commercial fruit orchards has had an unknown impact on the overall population of the spectacled flying fox. Current estimates of the total population size, and population trends, cannot be accurately assessed due to incomplete knowledge of camp location across the species' distribution in north-eastern Queensland, particularly in northern sections of the Wet Tropics bioregion and on Cape York Peninsula.

4. Threats to species' survival

Vulnerability to threats
The spectacled flying fox has a relatively slow reproductive rate. Female spectacled flying foxes give birth to one pup annually. Martin and McIlwee (2001) suggest any mortality rate exceeding 12% may cause the population to decline. It is likely, even allowing for some latitude in the estimates, that the species may be adversely affected by stochastic events such as cyclones and also by human actions such as culling (used in the past as a crop mitigation measure). Historically, larger populations distributed across the greater part of the Wet Tropics and adjacent areas may have been able to buffer the localised effects of such mortality. However, as population size has decreased and available habitat becomes more restricted, it is possible that the population's ability to buffer mass mortality episodes may become progressively more compromised.

Identification of threats
Known and potential threats to the spectacled flying fox in the Wet Tropics area are well documented (e.g. Clague et al. 1999; Hall and Richards 2000; Westcott et al. 2001). Many threats are localised and do not operate across the extent of the species' distribution. For example, tick paralysis tends to be a major issue on the Atherton Tablelands and disturbance of camps is an issue around some residential areas. Many of the threats to survival of the spectacled flying fox in the Wet Tropics are absent or of lesser significance on Cape York Peninsula. For example, habitat is largely intact, no commercial orchards are in operation but mortality from tick paralysis is unknown on Cape York.

Known threats:
Significant threats
- Habitat loss
- Illegal killing and incidental mortality of flying foxes in commercial fruit crops
- Harassment by humans
- Natural events (cyclones)

Moderate threats
- Increased incidence of tick paralysis

Minor threats
- Electrocution on powerlines
- Entanglement in netting and on barbed-wire fences
- Birth abnormalities (e.g. cleft palate syndrome)
- Vehicle-related mortality

Significant threats
Habitat loss
Loss of foraging habitat is consistently identified as the primary threat to the spectacled flying fox (Clague et al. 1999; Hall and Richards 2000; Westcott et al. 2001). The species' requirement for multiple, geographically dispersed populations of food trees makes it difficult to conserve foraging habitats within a system of conservation reserves, and therefore leaves the species vulnerable to land use decisions in remaining unreserved forests. In the Wet Tropics bioregion, large-scale clearing has been substantial and largely historical with clearing rates slowing in the past decade. Habitat loss has been most extensive in the lowland areas. For example approximately 76.9% of remnant regional ecosystems remain in the Wet Tropics bioregion, whereas only approximately 47.5% remains in the lowlands (Herbert, Tully and Innisfail) (Accad et al. 2008). The impact of this large-scale clearing in this area on the spectacled flying fox is unknown and the extent to which other habitats such as commercial orchards have replaced lost foraging resources is also unknown (Garnett et al. 1999, Westcott et al. 2001). However, clearing continues in the drier vegetation communities of the region, particularly along the coast and to the west of the Atherton Tablelands.

Recent radio and satellite telemetry and stable isotope studies have shown that a significant amount of feeding occurs in these adjacent non-rainforest vegetation types. Ninety-two percent of telemetry fixes came from outside continuous rainforest with 78% coming from non-rainforest vegetation types (McKeown et al, in prep). Furthermore, Parsons et al. (2006) found that sclerophyll species made major contributions to the large proportions of pollen found in faeces in camps from across the central Wet Tropics Region. These results are corroborated by the finding that 70% of metabolised resources were sourced from non-rainforest vegetation types (Westcott et al 2008; Krietals 2008; Krietals et al, submitted). Combined, these results suggest that large-scale clearing outside the World Heritage Area have the potential to adversely affect this species and World Heritage values.

Loss of roosting habitat has also been identified as a threat to the spectacled flying-fox (e.g. Hall and Richards 2000; H. Spencer, CTTRS, unpublished data). Camp vegetation has been exposed to the same historical patterns of clearing and degradation as foraging habitat. Figure 3 outlines known camps that have been lost since 1970, primarily as a result of habitat loss. The roosting requirements of the spectacled flying fox at micro-climate level are not known nor are the impacts on the species of loss of long-term sites, which may be selected to meet specific requirements. The degradation of vegetation within small remnant areas threatens longevity and may also reduce the suitability of sites as camps (J. Maclean, Tolga Bat Hospital, pers. comm.).

<u>Illegal killing and incidental mortality of flying foxes in commercial fruit crops</u>

The spectacled flying fox has caused damage to cultivated fruit crops since the time of European settlement in the Wet Tropics bioregion (Anonymous 1892; Ratcliffe 1931, Richards 1990b). Fruit crops affected include lychees, rambutans, longans, bananas, custard apples, mangoes, papaya and a variety of less common tropical fruits (R. Goebel, DPI, pers. comm.). The extent of the damage can vary considerably from year to year, from region to region, crop to crop and even between orchards in the same district. Estimates of financial loss are difficult to verify (P. Birt, formerly UQ, pers. comm.) but have been estimated to be between $3 million and $4 million during the mid-1990s (Tidemann et al. 1997). Lychee growers in north Queensland estimate that between 60% and 90% of unprotected fruit is lost to [unspecified] flying fox species (Rigden et al. 2000). The species was considered such a pest in the region that bounties were offered for destroyed animals prior to 1974 (H. Spencer, CTTRS, pers. comm.).

Prior to September 2008, shooting was the method most commonly used to protect crops against flying fox damage (Ratcliffe 1931), particularly selective shooting that targetted ‘scout’ animals (R. Goebel, DPI, pers. comm.; A. Leu, ALGA, pers comm.). Other methods adopted in the past included the use of poisonous gas, flame guns, explosives and organised shoots at camps (Ratcliffe 1931). From the late 1980s until 2001, electric grids were legally used at various locations to protect crops.

Recent changes to government policy, and growing public pressure, have resulted in the investigation of a wide range of non-lethal deterrents to protect crops. Public support exists for instituting a system of subsidisation to assist fruit growers with managing flying foxes (Ballard 2004) and the approach is supported by industry and by conservation groups. A range of mitigation methods have been trialled. These form two major types: non-lethal crop protection systems; and wildlife exclusion systems.

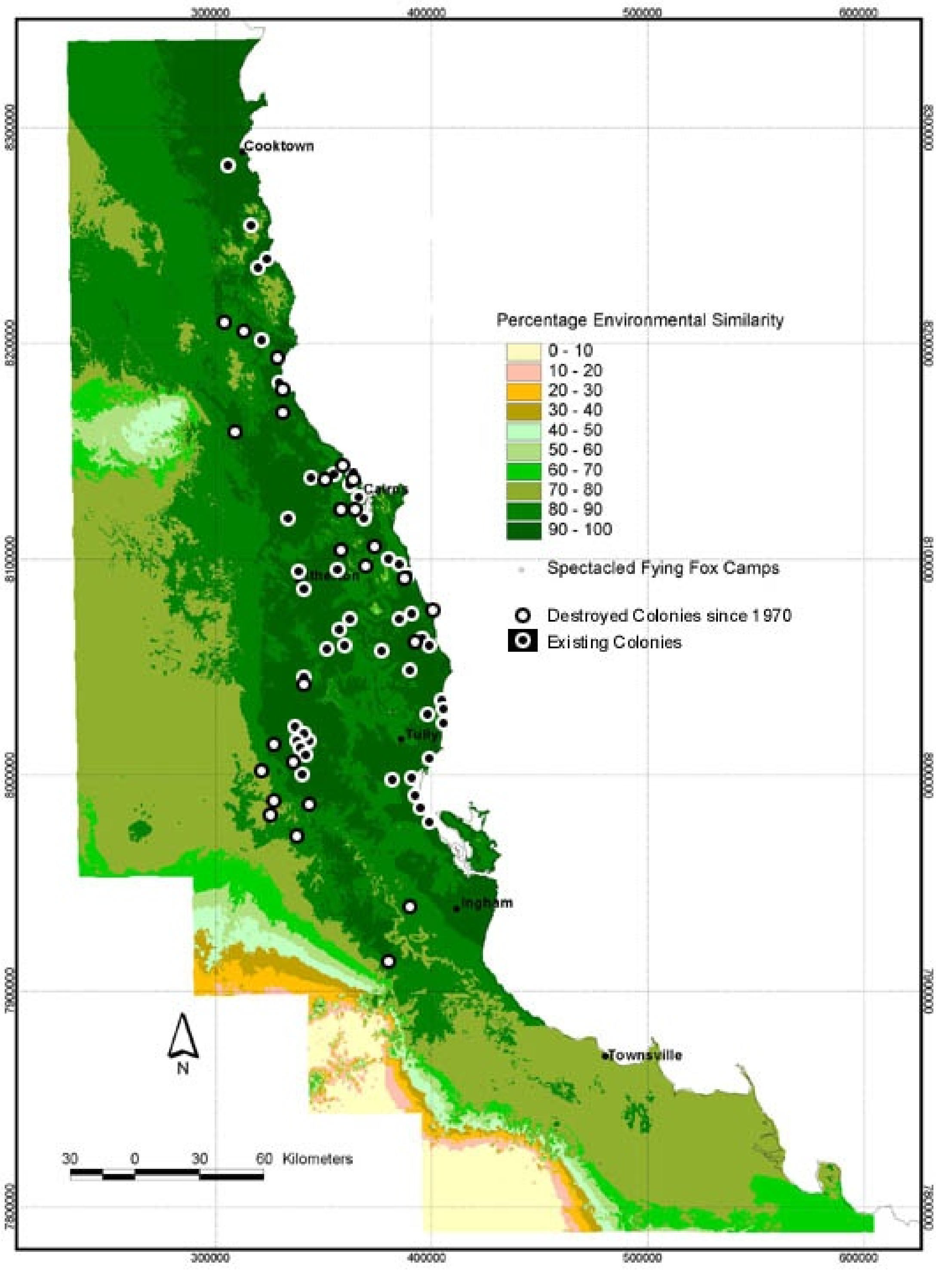

Figure 3 Spectacled flying-fox camps in the Queensland Wet Tropics region that have been destroyed since 1970 in the Wet Tropics region (from H. Spencer, CTTRS, unpublished data).

Non-lethal crop protection systems are based on discouraging flying foxes from accessing crops, and a range of techniques have been developed and adopted with varying levels of success. Such methods include electric light and sound systems, and visual and chemical deterrents (Spencer 2001; Daniels 2002; Rigden and Chapman 2002; Thompson 2002).

Advantages
- cheaper alternative to wildlife exclusion systems
- require less infrastructure
- can in most cases be readily dismantled if a cyclone or other severe weather is imminent.

Disadvantages
- deterrents that involve sight, sound and smell are generally believed to provide a degree of protection when pressure from flying foxes is low but are found to be ineffective when pressure is high (Bicknell 2002; Teagle 2002; Ballard 2004).
- the effectiveness of these systems is uncertain, appears to vary between locations, and their effectiveness has not been scientifically quantified
- habituation by flying foxes is a problem and investigation needs to find methods to negate such behaviour.
- some techniques are not suitable in certain locations e.g. use of powerful strobe lights close to residential areas or roadways.

Wildlife exclusion systems are those that provide an effective physical barrier to accessing crops (Sinclair 1990). Netting systems provide such a barrier and may be:
- full permanent netting that provides protection to entire orchards;
- tunnel netting that protects orchard rows;
- temporary, retractable netting erected during the critical ripening period when fruit are likely to be targetted by flying foxes;
- drape netting to protect single trees or a number of trees (Rigden and Chapman 2002; Figure 4).

The recommended type of netting systems for commercial operations is either full exclusion netting or tunnel netting (Rigden and Chapman 2002). Drape nets hung loosely over trees or support structures often entangle flying foxes and other animals leading to injury or death (L. Hall, retired UQ, pers comm.).

Advantages:
- netting excludes flying foxes and other frugivorous orchard pests including birds and moths
- as a secondary benefit to excluding flying foxes, growers have reported increased productivity, less sunburn damage of some fruit and increased growth rates due to netting providing a ‘greenhouse effect’ (A. Zappala, rambutan grower, pers comm.; G. Wah-Dai, lychee grower, pers. comm.; P. Salleris, rambutan grower pers comm.; Rigden and Chapman 2002)
- temporary net systems have the added advantage that they can be deployed or removed relatively quickly and when not in use can be securely stored, thereby increasing the lifespan of the netting (A. Zappala, pers comm.).

Disadvantages:

- netting requires a substantial capital outlay, and fruit growers may be reluctant or unable to commit the required financial resources
- netting may not be an economically practicable approach for protecting some crops
- possible constraints to obtaining insurance for the netting
- ongoing expense to routinely repair and/or replace damaged nets and additional concern regarding potential impact of extreme weather systems (eg. Cyclones) on netting infrastructure.
- some nets do not exclude flying foxes: flying foxes will either go under the net if not set to the ground, use small holes to access crops or, in some cases, chew through the netting (R. Goebel, DPI, pers comm.).
- netting infrastructure may be difficult to establish over old trees and construction of netting systems can be complex and difficult, particularly in steep terrain. Pruning large trees so that they can be netted may result in loss of income to growers.


a)

b)

Figure 4 a) Longan orchard netting (Photo: from Rigden et al. 2000); b). Rambutan netting (Photos: Martin Schulz).

The spectacled flying-fox also impacts other commercial crops. For example, flying foxes can damage banana flowers and scratch banana skins while feeding on the flowers (G. Daniels, DPI, pers comm.). The usual response of growers is to place bunch covers to exclude flying-foxes before the bracts lift on the flowers (G. Daniels, DPI, pers comm.). However, claw punctures through plastic bunch covers can damage the covered bananas (Tidemann and Nelson 1987)

Harassment by humans

Harassment of flying foxes by humans is an ongoing problem, particularly where flying-fox camps are adjacent to residential areas. In recent decades, rapid increases in the human population, particularly within the coastal zone of the Wet Tropics region has resulted in flying fox camps that were once isolated from human activities being increasingly surrounded by urban and rural residential development. There is also reason to believe that spectacled flying foxes are not averse to roosting in urban areas, as is the case with *P. poliocephalus* (Roberts et al 2006). For example, despite a lack of evidence that roosting habitat outside urban areas is limited, bats from camps that are being actively dispersed will often relocate to nearby urban areas rather than to readily accessible non-urban locations.

The impacts on spectacled flying foxes of having their camps disturbed is poorly known, but may cause disruption to male harem associations during mating. This may lead to reduced birth rates. The disturbance of pregnant or lactating females with dependent young at maternity camps may cause reduced juvenile survival (L. Hall, retired UQ, pers comm.).

People living near flying fox camps are exposed to a range of nuisance, including noise from the animals; the pungent smell created by the dense concentration of animals; damage caused by faeces soiling paintwork, swimming pool liners, roofs and other structures; damage to clothes on washing lines; and concerns about disease.

The Local Government Association of Queensland, together with individual regional councils, is working with the Queensland Department of Environment and Resource Management to assess the best method of managing flying foxes in urban areas. A public education component is included within this investigation.

The Queensland Department of Environment and Resource Management has produced a procedural guide, *Management of Flying fox colonies in Urban Areas* that specifies under what circumstances colonies cannot be disturbed, but also allows for the movement/translocation of flying fox camps under certain circumstances.

<u>Natural events</u>
Natural events such as cyclones can have a major impact on food and roost availability to the spectacled flying-fox. While cyclones are uncontrollable, the impacts to flying-fox species may be considered in management planning.

Moderate threats

<u>Increase incident of tick paralysis</u>
The spectacled flying fox displays little resistance to the toxin of the paralysis tick *Ixodes holocyclus* and can be paralysed before the tick is fully distended (Eggert 1994). Paralysed animals fall to the ground, and may die from the effects of the venom, fly strike or predation (Eggert 1994; Westcott et al. 2001). Paralysis ticks are mainly found on pregnant or lactating females in the months of October to December (Hall and Richards 2000; J. Maclean, Tolga Bat Hospital, pers comm.).

Incidence of tick paralysis appears confined to parts of the Atherton Tableland, and varies in severity between years, possibly correlated with high rainfall (J. Maclean, Tolga Bat Hospital, pers comm.). For example, in some years paralysis can affect up to 10% of the Tableland’s flying-fox population. Tick paralysis is suggested to be a recent phenomenon associated with a shift in diet to include the colonising weed, wild tobacco *Solanum mauritanium* (Spencer et al. 1992; Eggert 1994; J. Maclean, Tolga Bat Hospital, pers comm.). Richards (1990b) found no wild tobacco in the diet of the spectacled flying fox on the Atherton Tableland, but since that time wild tobacco has spread widely in the region and recent investigations have found this plant to be a common dietary item (A. Dennis, pers comm.). Paralysis ticks have been found to climb as high 3m to 4m above the ground, a height that enables them come in contact with feeding flying foxes (A. Dennis, pers comm.; J. Maclean, Tolga Bat Hospital, pers comm.). Given the spread of the tobacco weed by frugivorous birds and bats it is likely that the incidence of tick paralysis may increase unless management of wild tobacco is initiated.

Minor threats

- Injury and death from man-made structures
  The spectacled flying-fox may suffer accidental injury and death from man-made structures, although the mortality rate is unknown and likely to be relatively low based on the number of cases referred to bat carers (J. Maclean, Tolga Bat Hospital, pers comm.).

- Electrocution
  P. conspicillatus is prone to electrocution on powerlines when undertaking foraging flights, particularly in urban areas adjacent to camps. The incidence of flying fox electrocution on the Atherton Tableland is approximately 30 individuals per year (J. Maclean, Tolga Bat Hospital, pers comm.). A greater incidence of electrocution has been recorded in some lowland localities, for example on some nights, up to four individuals are electrocuted at the Gordonvale colony (J. Fay, resident, pers comm.).

- Entanglement in backyard netting
  Individuals may become entangled in fine gauge netting that is draped loosely over backyard fruit trees (L. Hall, retired UQ, pers comm.). The incidence rate is unknown but is likely to be rising with the increased use of backyard nets, particularly thin nylon monofilament net (J. Maclean, Tolga Bat Hospital, pers comm.; L. Hall, retired, UQ, pers. comm.; Saunders 2004; Beck 2004).

- Entanglement on barbed wire fences
  Individual bats may become entangled on barbed wire fences. The frequency of entanglement is unknown, although between 12 and 20 bats are taken into care each year on the Atherton Tableland as a result of barbed-wire entrapment (J. Maclean, Tolga Bat Hospital, pers comm.). Approximately 80% of entanglements occur on the top strand of a barbed-wire fence, with the majority of the remaining entrapments on the second-top strand. Identified barbed-wire fence 'blackspots' occur adjacent to fruiting trees or where the wire is higher than surrounding vegetation, particularly on the ridge above gently sloping valleys which drain to a lake or wetlands (J. Maclean, Tolga Bat Hospital, pers comm.). The use of plastic flags and metal tags to make the fences more visible has been effective in reducing entanglement of flying-foxes elsewhere in Queensland (L. Hall, retired UQ, pers comm.).

  There is a potential public health issue associated with disentangling flying foxes from netting or barbed wire. Releasing entangled bats may expose the person to the possibility of being bitten and potential infection from viruses, particularly Australian Bat Lyssavirus (ABLV). Queensland Health has produced information leaflets and broadcast messages on the radio (particularly around flying fox breeding time) that strongly recommend people do not try to free entangled bats. The recommended action is to contact wildlife carers or Department of Environment and Resource Management personnel who have been inoculated for ABLV. Queensland Health also recommends that any person who is scratched or bitten by a flying fox receive post-exposure prophylaxis for ABLV as a precautionary measure.

- Birth abnormalities
  There are an increasing number of cases of abnormalities in newborn flying foxes (Hall and Richards 2000). The abnormalities most commonly seen are craniofacial and fluid on the brain (hydrocephaly, hydranencephaly and porancephaly), and involve cleft palate and an enlarged cranium. Cleft palate syndrome was first noticed in the Tolga and Powley Road maternity camps in 1998 (J. Maclean, Tolga Bat Hospital, pers comm.). This syndrome is characterised by wiry facial hair, weak and deformed claw development, and a cleft in the palate that may range in severity from a small hole in the hard palate to a full cleft that extends from the hard palate to the soft palate and down the throat (J. Maclean, Tolga Bat Hospital, pers comm.). Almost all young with this syndrome die shortly after birth, although some individuals with mild symptoms have been sustained in captivity. It is unlikely that these animals would survive in the wild population (J. Maclean, Tolga Bat Hospital, pers comm.) The incidence of cleft palate in newborn bats on the Atherton Tableland varies between years, with between 30 and 40 cases reported in 1998 and 2001 (J. Maclean, Tolga Bat Hospital, pers comm.). The cause of the high incidence of cleft palate in these years is unknown, but has been postulated to be associated with: a) a change in the diet that involves the consumption, or increased consumption, of native or exotic food plants (e.g. wild tobacco) containing toxic agents that have never previously been consumed; b) a decrease in the availability of ripe fruits, forcing the consumption of unripe fruits that contain toxic secondary compounds; c) Vitamin A toxicoses; d) increased levels of stress hormones; e) an infectious agent; f) the ingestion of pesticides or fungicides used in agriculture or g) any combination of these factors. The incidence of cleft palate syndrome at colonies away from the Atherton Tableland is not known.

- Road and air traffic
  The incidence of spectacled flying foxes killed or injured by cars is low (J. Maclean, Tolga Bat Hospital, pers comm.). There is a reported bat strike incident at Cairns airport (H. Spencer, CTTRS, pers comm.).

  Spectacled flying foxes are involved in collisions with aircraft at regional airfields (CSIRO)

Likely threats

<u>Agricultural pesticide residue poisoning</u>

When foraging on agricultural crops, the spectacled flying-fox can come into contact with pesticides and herbicides. Banana Growers have reported deaths of spectacled flying foxes after bats have come into contact with organophosphate poisons that are used to control insect damage in developing fruits. The number of deaths is unknown.

<u>Disease</u>

Flying foxes, like other animals and humans, host a wide range of micro-organisms, most of which have little effect on their hosts. However, if animals are already stressed by starvation or other factors, serious disease or death may result (Duncan et al. 1999a). Only a few individuals will be affected by disease in wild populations most of the time, but during unusual climatic events (possibly characterised by reduced food supply and constant roost disruption), localised or widespread outbreaks of disease may occur. Various authors have suggested infectious disease as a possible cause of mass mortality and abortion in bats in Australia and overseas (e.g. Hall and Richards 2000).

The spectacled flying-fox is a reservoir of three recently described zoonotic diseases: Australian Bat Lyssavirus (ABLV), Hendra virus and Menangle virus. These viruses appear well adapted to this species and do not threaten flying fox populations under normal conditions (H. Field, DPI, pers. comm.). Where there are adverse changes in population structure or dynamics, such as through food shortages or constant camp disturbances, the prevalence of these viruses may alter and result in a threat to spectacled flying foxes.

Climate change
Climate change has the potential to impact on the availability of food resources and roost sites for the spectacled flying fox. 'Loss of terrestrial climatic habitat [such as tropical forests] caused by anthropogenic emissions of greenhouse gases' has been identified as a key threatening process under the EPBC Act 1999 (TSSC 2001u). The response of the spectacled flying fox to such changes is unknown.

Insufficient Data
Quantitative data regarding flying fox damage to fruit crops, injury and/or mortality rates of *Pteropus conspicillatus* associated with commercial fruit production, and the effectiveness of flying fox deterrence systems are needed. These data will assist all stakeholders to make informed decisions about securing commercial fruit harvests, while achieving long term benefits for the protection and survival of *Pteropus conspicillatus.*

5. Recovery objectives, performance criteria and actions

The overall objectives of recovery are to secure the long-term protection of the spectacled flying fox through a reduction in the impact of threats to species' survival and to improve the standard of information available to guide recovery.

Recovery Objective 1: Research practicable and cost effective flying fox deterrent systems for commercial fruit growers.

Performance criteria: Increase in investigations, on-site trials, promotion and uptake of non-lethal flying fox deterrent systems.

Action 1.1 Investigate the effectiveness and economic viability of non-lethal flying fox deterrent systems, including new applications for technology such as long wavelength lasers and intelligent systems for crop protection, and other innovative systems. Testing to be conducted at a range of sites within the species' range, and under varying conditions. The impact of such technology on impacts on flying fox behaviour in the vicinity of the deterrent systems should also be documented.

Potential contributors: CSIRO, DEEDI, DERM, grower organisations, industry groups, other research institutions.

Action 1.2 Investigate the feasibility of planting native food species (e.g. Eucalypts) for the spectacled flying-fox adjacent or near to orchards as an alternative food supply, and determine whether this is a viable means of mitigating the damage to orchard fruit crops.

Potential contributors: DERM, DEEDI, CSIRO, Grower organisations

Action 1.3 In partnership with all stakeholders, design and implement practicable methods to obtain robust quantitative data on:

- The nature and locality of commercial fruit industries impacted by the spectacled flying fox;
- Frequency, seasonality, degree of crop damage and other trends regarding impacts of flying foxes on fruit crops on an orchard by orchard basis;
- Aggregated industry-wide levels and trends of flying-fox damage to commercial fruit crops.

Potential contributors: DERM, DEEDI, CSIRO, Grower organisations

Action 1.4 Investigate the effectiveness of netting systems in terms of cyclone damage, deterioration by UV radiation, tear/chew resistance, materials used, type of netting system, and extent of crop coverage, period of installation of nets (e.g. permanent or seasonal), and level of bat deterrence provided.

Potential contributors: DEEDI, Grower organisations

Recovery Objective 2: Identify and protect native foraging habitat critical to the survival of the spectacled flying fox.

Performance criteria: The native foraging habitat critical or essential to survival is identified and protected.

Action 2.1 Continue telemetry studies of individuals from different camps, including Cape York Peninsula, to accurately identify and map key foraging areas and vegetation communities used by the spectacled flying fox through an annual cycle. Outcomes of these studies to be compared with data obtained from Action 1.2 regarding alternative food supplies adjacent to or near commercial fruit crops.

Potential contributors: CSIRO, other research institutions.

Action 2.2 Building on the outcome of Action 2.1, identify opportunities to protect important foraging resources in native vegetation communities that are poorly represented within current reserves.

Potential contributors: CSIRO, DERM, other research institutions, CYPDA, NGRMG, NQDT, Terrain NRM.

Action 2.3 Building on the outcome of Action 2.1, identify opportunities to protect priority foraging habitats on private land using for example, voluntary conservation agreements such as the Queensland Department of Environment and Resource Management Nature Refuges Program.

Potential contributors: DERM, CYPDA, NGRMG, NQDT, Terrain NRM.

Recovery Objective 3: Accurately assess the short and long term population size and population trends of the spectacled flying-fox.

Performance criteria: Census methodology is devised that can provide an overall population assessment and be used to monitor population trends.

Action 3.1 Conduct monthly daytime counts of camps by experienced observers using standardised, readily repeatable methods, to derive an understanding of the variability of camp occupancy over time, including gender ratio, and the proportion of other flying fox species utilising these camps. Compare these results with data collected from daytime remote sensing activities (Action 2.1).

Potential contributors: CSIRO, other research institutions, conservation groups, CYPDA, NGRMG, NQDT, Terrain NRM, DERM.

Action 3.2 Conduct systematic surveys in known and potential *P. conspicllatus* habitat on Cape York Peninsula between October and December to locate and document maternity camps.

Potential contributors: DERM, CSIRO, ABS, CYPDA, other research institutions, community stakeholders

Action 3.3 Promote participation in locating previously unrecorded spectacled flying-fox camps, including on Cape York Peninsula.

Potential Contributors: DERM, DEEDI, CSIRO, CYPDA NGRMG, NQDT, Terrain NRM, Grower organisations, community.

Action 3.4 Identify the frequency of occupancy of satellite camps to provide the basis of forming a correction factor when making overall population estimates and investigating population trends.

Potential contributors: CSIRO, other research institutions.

Action 3.5 Using outcomes of Actions 3.1 to 3.4, determine whether changes in the southern extent of this species' range are occurring.

Potential contributors: CSIRO, DERM, DEEDI, other research institutions.

Recovery Objective 4: Improve the public perception of the spectacled flying-fox and the standard of information available to guide recovery.

Performance criteria:
There is an increased awareness and understanding of the spectacled flying fox and P. *conspicillatus* camps in urban areas are protected.

Action 4.1 Promote understanding and awareness of the spectacled flying fox through field days, regular items in print, electronic, radio and television media regarding the role of the spectacled flying fox in the ecosystem and challenges for management, including techniques to minimise entanglements in backyard drape nets and barbed-wire fences.

Potential contributors: DERM, DEEDI, CSIRO, ABS, CYPDA, NGRMG, NQDT, Terrain NRM grower organisations, Tolga Bat Hospital.

Action 4.2 Develop information packages for local government planners and other land managers aimed at encouraging protection of flying fox camps including through maintenance of appropriate buffer zones in proximity to permanent camps. Promote the value of this approach to local councils, NRM regional groups, and other stakeholders. Include information on flying-fox biology, issues of community concern such as noise and disease, and summaries of recent management experiences at flying-fox camps. Ensure all information aligns with the *Far North Queensland Regional Plan 2009-2031*.

Potential contributors: DERM, DEEDI, CSIRO, CYPDA, NGRMG, NQDT, Terrain NRM local government, DIP

Action 4.3 Commercial growers, Traditional owners and the community encouraged to participate in on-ground management actions for the protection of spectacled flying foxes.

Potential contributors: Grower organisations Aboriginal Rainforest Council, other Indigenous councils and organisations, and Aboriginal Land Management Facilitators of CYPDA, NGRMG, NQDT and Terrain NRM, community stakeholders.

Action 4.4 Continue actions associated with the DERM policy on managing flying fox colonies in urban areas.

Potential contributors: DERM, local government.

Recovery Objective 5: Increase knowledge of *P conspicillatus* roosting requirements and protect important camps.

Performance criteria: The characteristics of spectacled flying-fox roosts are documented and important camps are protected.

Action 5.1 Characterise roosts, including landscape features, aspect, whether within urban, peri-urban, rural or undeveloped landscape, microclimate, floristic composition, vegetation structure, distance to man-made objects including buildings and to utility/transport corridors, to provide a better understanding of roost locations and assist in the protection of potential habitat.

Potential contributors: CSIRO, DERM, other research institutions.

Action 5.2 Identify camps critical to the survival of the spectacled flying fox and investigate the appropriateness of adopting the camp protection criteria used for the closely related grey-headed flying-fox (Eby 2005):

- Is used as a camp either continuously or seasonally in >50% of years;
- Has been used as a camp at least once in the last ten years and is known to have contained >10,000 individuals; or
- Has been used as a camp at least once in the last ten years and is known to have contained >5,000 individuals, including reproductive females during the final stages of pregnancy, lactation or the period of conception (i.e. September – May).

Potential contributors: CSIRO, DERM, Terrain NRM.

Action 5.3 With reference to the *Far North Queensland Regional Plan 2009-2031*, promote protection of vegetation within flying fox camps and the surrounding buffer zones using protocols such as local government environmental plans and development assessments, natural resource management plans and voluntary conservation agreements.

Potential contributors: DERM, CYPDA, NGRMG, NQDT, Terrain NRM, local government.

Recovery Objective 6: Improve understanding of incidence of tick paralysis and actions to minimise paralysis mortality in flying foxes.

Performance criteria: Environmental, climatic and physiological conditions associated with the incidence of tick paralysis are better understood.

Action 6.1 Investigate environmental, climatic and physiological conditions associated with the incidence of tick paralysis, including an investigation of the importance of wild tobacco and an assessment of whether tick paralysis in *P. conspicillatus* is limited to the Atherton Tableland.

Potential contributors: CSIRO, DERM, DEEDI, Tolga Bat Hospital, other research institutions.

Recovery Objective 7: Implement strategies to reduce incidence of electrocution and entanglement of *P. conspicillatus.*

Performance criteria: Incidence of entanglement and electrocution have been reduced.

Action 7.1 Promote methods of protecting backyard fruit crops outlined in Saunders (2004) to minimise entanglement of flying foxes in backyard drape nets and investigate additional techniques to reduce mortality (Available at: http://www.epa.qld.gov.au/nature_conservation/wildlife/living_with_wildlife/flyingfoxes/netting_fruit_trees/ Accessed: 2009 05-06).

Potential contributors: DERM, DEEDI, Queensland Health, local government.

Action 7.2 Work together with landowners to increase the visibility of fences in areas where spectacled flying-fox entanglements occur.

Potential contributors: DERM, DEEDI, CYPDA, NGRMG, NQDT, Terrain NRM, Tolga Bat Hospital, local government.

Action 7.3 Encourage landowners erecting new fences in north-eastern Queensland, particularly the Wet Tropics region, to use plain wire on the top strand instead of barb-wire to reduce the incidence of flying fox entanglement.

Potential contributors: DERM, DEEDI, CYPDA, NGRMG, NQDT, Terrain NRM, Tolga Bat Hospital, Queensland Health, local government, fencing contractors.

Action 7.4 Encourage electricity suppliers to increase the spacing between individual wires on overhead transmission lines when replacing/upgrading infrastructure.

Potential contributors: DERM, conservation groups, electricity utilities

Recovery Objective 8 Investigate the causes of birth abnormalities such as cleft palate syndrome.

Performance criteria: Likely causes of birth abnormalities such as cleft palate syndrome have been identified.

Action 8.1 Assess the impacts of birth abnormalities such as cleft palate syndrome on spectacled flying fox populations. Undertake research to identify the likely causes of these abnormalities.

Potential contributors: CSIRO, DERM, DEEDI, Tolga Bat Hospital, other research institutions.

Summary of Actions to Promote Recovery of the Spectacled Flying Fox

Note: H = High, M = Moderate, L = Low

Objective	Performance criteria	Action	Potential contributors	Priority
1: Research effective flying fox deterrent systems that are practicable and cost effective for commercial fruit growers	Increase in investigations, on-site trials, promotion and uptake of non-lethal flying fox deterrent systems.	1.1:Investigate the effectiveness and economic viability of non-lethal flying fox deterrent systems.	CSIRO, DEEDI, DERM, industry groups, other research institutions.	H
		1.2: Investigate the feasibility of planting native food species (e.g. Eucalypts) for the spectacled flying fox adjacent or near to orchards as an alternative food supply, and determine whether this is a viable means of mitigating the damage to orchard fruit crops.		
		1.3: In partnership with all stakeholders, design and implement practicable methods to obtain robust quantitative data.	DERM, DEEDI, Grower organisations	H
		1.4: Investigate the effectiveness of netting systems and level of bat deterrence provided.	DEEDI, Grower organisations	H
2: Identify and protect native foraging habitat critical or essential to the survival of the spectacled flying fox	The native foraging habitat critical or essential to survival is identified and protected	2.1: Continue telemetry studies of individuals from different camps to identify and map key foraging areas and vegetation communities used by the spectacled flying fox.	CSIRO, other research institutions	H
		2.2: Identify opportunities to protect important foraging resources in native vegetation communities that are poorly represented within current reserves.	CSIRO, DERM other research institutions, CYPDA, NGRMG, NQDT, Terrain NRM	H
		2.3: Identify opportunities to protect priority foraging habitats on private land.	DERM, CYPDA, NGRMG, NQDT, Terrain NRM	H

3: Accurately assess the short and long term population size and population trends of the spectacled flying fox.	Census methodology is devised that can provide an overall population assessment and be used to monitor population trends.	3.1: Conduct monthly daytime counts of camps by experienced observers using standardised, readily repeatable methods.	CSIRO, other research institutions, conservation groups, CYPDA, NGRMG, Terrain NRM, NQDT.	H
		3.2: Conduct systematic surveys in known and potential *P. conspicillatus* habitat on Cape York Peninsula.	DERM, CSIRO, ABS, CYPDA, other research institutions, community stakeholders	H
		3.3: Promote participation in locating previously unrecorded spectacled flying fox camps, including on Cape York Peninsula.	DERM, DEEDI, CSIRO, Terrain NRM, NQDT, NGRMG, CYPDA, Grower organisations, community stakeholders.	M
		3.4: Identify the frequency of occupancy of satellite camps.	CSIRO, other research institutions	H
		3.5: Using outcomes of Actions 3.1 to 3.4 determine whether changes in the southern extent of this species' range are occurring.	CSIRO, DERM, DEEDI, other research institutions	L
4: Improve the public perception of the spectacled flying-fox and the standard of information available to guide recovery.	Increased awareness and understanding of the spectacled flying fox *P. conspicillatus* camps in urban areas are protected.	4.1: Promote understanding and awareness of the spectacled flying fox through field days, regular items in print, electronic, radio and television media regarding aspects of the role of the spectacled flying fox in the ecosystem and challenges for management.	DERM, DEEDI, CSIRO, ABS, CYPD, Terrain NRM, NQDT, NGRMGABS, TBH	M
		4.2: Develop information packages for local government planners and other land managers aimed at encouraging protection of flying fox camps, including through maintenance of appropriate buffer zones in proximity to permanent camps.	DERM, DEEDI, CYPDA, NGRMG, NQDT, Terrain NRM ABS, local government, DIP, TBH	M

		4.3: Commercial fruit growers, Traditional owners and the community encouraged to participate in on-ground management actions for the protection of spectacled flying foxes.	Grower organisations, Aboriginal Rainforest Council, other Indigenous councils and organisations, Aboriginal Land Management Facilitators from: Terrain NRM, NGRMG, NQDT and Terrain NRM, community stakeholders.	M
		4.4: Continue actions associated with the QLD DERM policy on managing flying-fox colonies in urban areas	DERM, local government	H
5: Increase knowledge of *P conspicillatus* roosting requirements and the protection of important camps.	The characteristics of spectacled flying-fox roosts are documented and important camps are protected.	Action 5.1: Characterise roosts to provide a better understanding of roost locations.	CSIRO, DERM, other research institutions	H
		5.2: Identify camps critical to the survival of the spectacled flying fox.	CSIRO, DERM, Terrain NRM	H
		5.3: Promote protection of vegetation within flying fox camps and the surrounding buffer zones.	DERM, Terrain NRM, CYPDA, NGRMG, NQDT, local government.	H

6: Improve understanding of incidence of tick paralysis and actions to minimise paralysis mortality in flying foxes.	Environmental and climatic and physiological conditions associated with the incidence of tick paralysis are better understood.	6.1: Investigate environmental, climatic and physiological conditions associated with the incidence of tick paralysis. Devise management strategies to minimise the incidence of tick paralysis in spectacled flying foxes.	CSIRO, DERM, DEEDI, TBH, other research institutions	M
7: Implement strategies to reduce incidence of electrocution and entanglement of *P. conspicillatus*..	Incidence of entanglement and electrocution have been reduced.	7.1: Promote methods of protecting backyard fruit crops to minimise entanglement of flying foxes in backyard drape nets and investigate additional techniques to reduce mortality.	DERM, DEEDI, Queensland Health, local government	M
		7.2: Work together with landowners to increase the visibility of fences in areas where spectacled flying fox entanglements occur.	DERM, DEEDI, CYPDA, NGRMG, NQDT, Terrain NRM, local government	M
		7.3: Encourage landowners erecting new fences in north-eastern Queensland, to use plain rather than barbed wire on the top strand.	DERM, DEEDI, CYPDA, NGRMG, NQDT, Terrain NRM, Queensland Health, local government, fencing contractors.	M
		7.4: Encourage electricity suppliers to increase the spacing between individual wires on overhead transmission lines when replacing/upgrading infrastructure.	DERM, Conservation groups, electricity utilities	M
8: Investigate the likely causes of birth abnormalities such as cleft palate syndrome.	Likely causes of birth abnormalities such as cleft palate syndrome in flying foxes have been identified.	8.1: Assess the impacts of birth abnormalities such as cleft palate syndrome on spectacled flying fox populations. Undertake research to identify the likely causes of these abnormalities.	CSIRO, DERM, DEEDI, other research institutions, TBH	M

6. Management practices

The recovery of the spectacled flying fox is primarily dependent on the protection of foraging habitat and enhancing bat deterrent systems at commercial fruit orchards in north-eastern Queensland. Management practices that destroy significant foraging habitats, or alter them to the extent that their productivity or suitability to the species is diminished, will have an adverse impact on species' survival. Such actions may also result in increased impacts on commercial orchards when critical native food resources are further reduced.

Management practices to reduce conflict at controversial urban flying fox camps need to be implemented. The following options to reduce conflict need to be considered (after Eby 2005):

- camps in remnant vegetation should be isolated from human habitation by a management zone. The extent of the management zone should be included in the definition of the camp. It should comprise habitat unsuitable for roosting by flying foxes (cleared land, low shrubs or isolated trees). Residential development, schools and other structures that might lead to conflict should be excluded.
- where possible the area of vegetation defined as a camp should be large enough to accommodate seasonal influxes of individuals and enable the colony to change location.

<u>Backyard drape nets</u>
Members of the public using drape netting on fruit trees should be encouraged to use the techniques outlined on the Queensland Department of Environment and Resource Management website to minimise entanglements in backyard drape nets. Available from:
http://www.epa.qld.gov.au/nature_conservation/wildlife/living_with_wildlife/flyingfoxes/netting_fruit_trees/ Accessed 2009-05-06.

<u>Electrical lines</u>
Electricity utilities encouraged to increase the spacing between electrical cables when replacing crosspieces as part of their continual upgrade program.

<u>Fencing</u>
When erecting new fences in north-eastern Queensland, particularly the Wet Tropics, use of plain wire on the top strand instead of barbed-wire is advised. This action will also contribute to reduced entanglements of other threatened species such as the mahogany glider.

7. Evaluation of recovery plan

The recovery plan will be reviewed and evaluated on an ongoing basis. This will enable potential contributors to assess the success of recovery action implementation against the prescribed criteria. A review of the recovery plan may be conducted five years after adoption and in accordance with the Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra.

8. Costs and timelines of recovery

The total estimated cost for all recovery actions identified is $1,412,000.

Estimated Cost and Timelines of Recovery

Recovery Action	Year of Implementation 1 ($)	2 ($)	3 ($)	4 ($)	5 ($)	Total ($)
Action 1.1 Investigate the effectiveness and economic viability of non-lethal flying fox deterrent systems.	100,000	100,000	100,000			300,000
Action 1.2 Investigate the feasibility of planting native food species (e.g. Eucalypts) for the spectacled flying fox adjacent or near to orchards as an alternative food supply, and determine whether this is a viable means of mitigating the damage to orchard fruit crops.	30,000	30,000				60,000
Action 1.3 In partnership with all stakeholders, design and implement practicable methods to obtain robust, quantitative data relevant to the impact of the spectacled flying fox on commercial fruit crops.	20,000	5,000	5,000	5,000	5,000	40,000
Action 1.4 Investigate the effectiveness of netting systems and level of bat deterrence provided.	30,000	30,000				60,000
Action 2.1 Continue telemetry studies of individuals from different camps to identify and map key foraging areas and vegetation communities used by the spectacled flying fox.	100,000	100,000	100,000	25,000		325,000
Action 2.2 Identify opportunities to protect important foraging resources in native vegetation communities that are poorly represented within current reserves.	10,000	10,000	10,000			30,000
Action 2.3 Identify opportunities to protect priority foraging habitat on private land.	10,000	10,000	10,000			30,000
Action 3.1 Conduct monthly daytime counts of camps by experienced observers using standardised, readily repeatable methods.	30,000	30,000	30,000	30,000	30,000	150,000
Action 3.2 Conduct systematic surveys in known and potential *P. conspicillatus* habitat on Cape York Peninsula.	30,000	30,000	30,000			90,000
Action 3.3 Promote participation in locating previously unrecorded spectacled flying fox camps, including on Cape York Peninsula.	15,000	15,000	15,000			30,000
Action 3.4 Identify the frequency of occupancy of satellite camps.	10,000	10,000	10,000			30,000

Action 3.5 Using outcomes of Action 3.1 to 3.4, determine whether contractions in the southern extent of this species' range are occurring.	5,000	5,000	5,000	5,000	5,000	25,000
Action 4.1 Promote understanding and awareness of the spectacled flying fox through field days, regular media items in print, electronic, radio and television media regarding aspects of the role of the spectacled flying fox in the ecosystem and challenges for management.	13,000	8,000	5,000	8,000	8,000	42,000
Action 4.2 Develop information packages for local government planners and other land managers aimed at encouraging protection of flying fox camps including through maintenance of appropriate buffer zones in proximity to permanent camps.	10,000	5,000	5,000	5,000	5,000	30,000
Action 4.3 Commercial fruit growers, Traditional owners, and the community encouraged to participate in on-ground management actions for the protection of spectacled flying foxes.	10,000	5,000	5,000	5,000	5,000	30,000
Action 4.4 Continue actions associated with the QLD DERM policy on managing flying fox colonies in urban areas.	5,000	5,000	5,000	5,000	5,000	25,000
Action 5.1 Characterise roosts to provide a better understanding of roost locations.	5,000	5,000				10,000
Action 5.2 Identify camps critical to the survival of the spectacled flying fox.	10,000	10,000				20,000
Action 5.3 Promote protection of vegetation within flying fox camps and the surrounding buffer zones.	3,000	3,000	3,000	3,000	3,000	15,000
Action 6.1 Investigate environmental, climatic and physiological conditions associated with the incidence of tick paralysis. Devise management strategies to minimise the risk of tick paralysis in spectacled flying fox populations.	20,000	20,000	20,000	20,000		80,000
Action 7.1 Promote methods of protecting backyard fruit crops to minimise entanglement in backyard drape nets.	3,000	3,000	3,000	3,000	3,000	15,000
Action 7.2 Work together with landowners to increase the visibility of fences in areas where spectacled flying fox entanglement occurs.	3,000	3,000	3,000	3,000	3,000	15,000
Action 7.3 Encourage landowners erecting new fences in north-eastern Queensland to use plain rather than barbed wire on the top strand.	3,000	3,000	3,000	3,000	3,000	15,000

Action 7.4 Encourage electricity suppliers to increase the spacing between individual wires on overhead transmission lines when replacing/upgrading infrastructure.	3,000	3,000	3,000	3,000	3,000	15,000
Action 8.1 Assess the impacts of birth abnormalities such as cleft palate syndrome on spectacled flying fox populations. Undertake research to identify the likely cause of these abnormalities.	10,000	10,000	10,000			30,000
Total Estimated Cost of Recovery	**488,000**	**458,000**	**380,000**	**123,000**	**78000**	**1,527,000**

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