Managing the Grey-headed Flying-fox *Pteropus poliocephalus* as a threatened species: a context for the debate

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ABSTRACT

From the time of European settlement of Australia, flying-foxes have been treated as vermin and their management has focused on attempts to control numbers in local areas by culling and disturbance. The listing of Grey-headed Flying-foxes as vulnerable under the NSW *Threatened Species Conservation Act 1995* (TSC Act) heralded a controversial shift in management to accommodate conservation goals. The decision to list Grey-headed Flying-foxes was based on a decline in numbers related predominately to habitat loss and was taken after a lengthy and thorough review of evidence gathered from a range of experts and the public. Grey-headed Flying-foxes migrate hundreds of kilometres between successive areas of nectar flow, and the numbers present in a local area fluctuate widely between seasons and between years. Intensive episodes of crop damage or conflict at roosts occur intermittently in line with the irregular patterns of nectar flow and migrations. The practice of killing Grey-headed Flying-foxes in crops, and disrupting them at roosts, is carried out on the assumption that the species is organised as discrete local populations whose size can be controlled locally. They continue to be primary management tools despite their failure either to provide consistent protection to the commercial fruit industry or to resolve conflict at controversial camps. There is an urgent need to develop new approaches to flying-fox management. It is our view that effective methods of on-crop control and conflict resolution at camps are essential to the recovery of Grey-headed Flying-foxes.

Introduction

Together with their goods and chattels, European settlers imported to Australia their perceptions of bats as frightening creatures of the night. Australian flying-foxes were described as "winged devils" in 1770 by one of Cook's officers. Colonists considered flying-fox roosts to be dangerous repositories of disease, and the damage they caused to cultivated fruit trees was soon recognised (Anon 1870 and 1890; Darnell-Smith 1917). The response was typical of the 19th century treatment of native fauna. Several documented accounts of mass exterminations of flying-foxes during the 19th and 20th centuries mention the use of guns, explosives and chemicals (Ratcliffe 1931; Lunney and Leary 1988; Lunney and Moon 1997; Tidemann *et al.* 1997). These management practices persisted until recent years. As recently as 1989, crop damage in the Coffs Harbour district was managed by progressively "shooting out" camps, and shooting was used to manage camps near residential areas until 1990 (Ireland 1989; Smith 2002; West 2002).

The listing in NSW of the Grey-headed Flying fox *Pteropus poliocephalus* as Vulnerable under the NSW *Threatened Species Conservation Act 1995* on 4 May 2001 heralded a shift in management goals towards conservation. The social and economic impacts of the species ensure that this shift will be widely scrutinised and debated by a range of people with divergent views. In this chapter we provide an historical and biological context to the debate.

Pages 1 - 15 in *Managing the Grey-headed Flying-fox as a Threatened Species in New South Wales*, edited by Peggy Eby and Daniel Lunney, 2002. Royal Zoological Society of New South Wales, Mosman NSW.

A history of listing of the Grey-headed Flying-fox as a threatened species

The listing of Grey-headed Flying-foxes as Vulnerable in NSW is contrary to the experiences and expectations of some people and thus concern exists over the process used to arrive at the listing (e.g. Comensoli 2002; Biel 2002). Most people reasonably equate threatened species with rare species. However, rarity is only one criterion for identifying a species under threat (IUCN 1994). Abundant fauna in decline are also prone to extinction (Isaac and Mace 1998). Grey-headed Flying-foxes are not rare and interactions between flying-foxes and humans are apparently increasing. It is understandably difficult for some people to accept that the future of a species that seems so abundant and capable of adapting to the presence of humans can be in doubt. However, as abundant as it is, the Grey-headed Flying-fox is in decline and there is evidence that the decline is so rapid as to warrant protection under threatened species legislation.

The NSW *Endangered Fauna (Interim Protection) Act 1991*

The process that lead to listing the Grey-headed Flying-fox as "Vulnerable" under the NSW *Threatened Species Conservation Act 1995* (TSC Act) commenced in the early 1990s. The first official sign that it was a species in trouble arose during the 1992 review of the status of the vertebrate fauna of NSW under the *Endangered Fauna (Interim Protection) Act 1991* (EF(IP) Act), the predecessor to the TSC Act. Of immediate interest was the promulgation of a list of species identified as "Endangered", the term used under the EF(IP) Act for what are called "Threatened" species under the current Act. The EF(IP) Act required that justification be provided not only for including a species on the endangered fauna lists, but also for omitting a species from the lists. Consequently, all species were reviewed with equal diligence.

The scoring procedure and the scores themselves are recorded in detail (Lunney *et al.* 2000). The scores for the Grey-headed Flying-fox highlighted declines in the size of the population and its distribution. The overall score for the species placed it in the top end of the bracket for vulnerable species. However, the balance of professional opinion at the time was that it did not meet the criteria for listing as set out in the Act and so it was omitted from the list. It is noted that at least one professional contributor did consider that it met the criteria to be listed. The Black Flying-fox *P. alecto* met the criteria and it was listed as Vulnerable in 1992, a listing it still retains. The other large flying-fox, the Little Red Flying-fox *P. scapulatus*, was not judged to be eligible for listing.

The schedules of fauna under the *Endangered Fauna (Interim Protection) Act 1991* were transferred without amendment with the passage of the NSW *Threatened Species Conservation Act 1995*. A new scientific committee was set up to consider the matters specified in the new Act, including a brief to consider the addition of species not listed. What were not transferred were the scores of the species that had been omitted from the initial lists. These scores are useful for inferring near-threatened status. The Grey-headed Flying-fox would have been captured in a schedule of near-threatened fauna, but such a schedule did not exist in the initial Act, nor does it exist in the current Act. Such a list would bring to light species deserving of investigation and management intervention to prevent them from joining threatened species lists. However, the structure of the legislation left Grey-headed Flying-foxes as a species of no concern.

The Commonwealth Action Plan for Australian Bats

In 1990, Environment Australia commenced a lengthy process to assess the conservation status of Australia's bat fauna. The Grey-headed Flying-fox was classified as an endangered species in early assessments (Richards and Hall 1994). In 1997, Environment Australia assembled a national group of experts to consider the status of Australia's bats under the criteria set out in the IUCN Red Book. A list of threatened species was agreed at the meeting and the evidence supporting each listing was reviewed by an editorial panel prior to the publication of the *Action Plan for Australian Bats* (Duncan *et al.* 1999). The Grey-headed Flying-fox was listed as vulnerable in the *Action Plan* under IUCN Criterion A2. (A population reduction of 20% was projected to be met within the next ten years or three generations based on the impacts of habitat decline, exploitation, competition, etc.) The case for listing was primarily based on population reduction in response to the loss of key winter habitat, but additional threatening processes were also identified including generic loss of foraging and roosting habitat, exploitation on crops and in camps, competition and hybridisation with Black Flying-foxes *P. alecto*, and the effects of pollutants and pathogens (Tidemann *et al.* 1999).

All jurisdictions:

As a result of the assessment in the *Action Plan*, formal nominations were submitted for listing the Grey-headed Flying-fox under the threatened species legislation in all relevant jurisdictions, i.e. the Commonwealth and each state in its range (Hughes 2002). Under each Act, whether Commonwealth or state, a committee of independent scientists is convened to review nominations for listing and determine the status of species, populations or other conservation units using standard criteria. The nominations for listing the Grey-headed Flying-fox were subjected to lengthy and thorough reviews. Each committee gathered evidence and views from a range of experts, called for additional information and reviewed submissions from the public before reaching a decision.

During the period of review, information that strengthened the case for listing was gathered from several sources. Data on population size, distribution and demographics were collated from the published and unpublished records of several scientists with experience of the species (Richards 2000). Winter concentrations on coastal lowland habitat were confirmed in synchronous, range-wide surveys (Eby *et al.* 1999; Eby and Lunney 2002), and rates of clearing in those habitats were estimated (Catterall *et al.* 1997; Accad *et al.* 2001; Wilson *et al.* in press; B. Wilson, Qld. Herbarium, unpublished data).

The current legal status through its distribution

On 4 May 2001 the Grey-headed Flying-fox was listed as Vulnerable under the NSW *Threatened Species Conservation Act 1995* and on 4 December 2001, it was listed by the Commonwealth under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In Victoria, the Scientific Advisory Committee under the *Flora and Fauna Guarantee Act 1988* recommended (in February 2001) that it be listed (Flora and Fauna Guarantee – Scientific Advisory Committee 2001). However, the relevant Victorian Minister decided at the time not to act on that recommendation. A decision under the Queensland *Nature Conservation Act 1992* has yet to be announced.

The Threatened Species Scientific Committee under the EPBC Act produced a detailed explanation for its recommendation for listing (reproduced in Appendix 1). The committee concluded that population estimates of Grey-headed Flying-fox indicated that a decline in the order of 30% had occurred between 1989 and the period 1998-2001. The NSW Scientific Committee also detailed the basis for its decision in its Final Determination (Dickman and Fleming 2002), the primary evidence being a dramatic decline in population size in response to several threatening processes, including clearing of winter habitat, fragmentation of native food sources, 'recreational' shooting and the direct culling of animals. Each assessment involved careful processes during which many voices were heard, and in the case of the Commonwealth, social and economic factors were also taken into account.

Biology of the Grey-headed Flying-fox

The Grey-headed Flying-fox has attracted little research effort and its biology, ecology and behaviour are poorly understood. This is despite the fact that it is a conspicuous species that generates considerable public interest. It is a difficult species to study and it is particularly costly of time. However, the research that has been conducted has provided much insight into its status and biology.

The Grey-headed Flying-fox is one of the largest bats in the world, ranging in adult weight from approximately 650–1000 g and is endemic to the forests of south-eastern Australia where it feeds on blossom and fruit in canopy vegetation (Ratcliffe 1931; Nelson 1965; Parry-Jones and Augee 1991; Eby 1995; Tidemann 1999; Hall and Richards 2000). It is a social species that roosts in large camps throughout the year (Ratcliffe 1931; Eby 1991; Eby *et al.* 1999).

Diet:

The Grey-headed Flying-fox has a diverse native diet, which it supplements with introduced plants (Parry-Jones and Augee 1991; Eby 1995 and 1998; Hall and Richards 2000). Nectar and pollen from eucalypts (genera *Eucalyptus, Corymbia* and *Angophora*), melaleucas and banksias are the primary food for the species. Most eucalypts have regular seasonal flowering schedules but do not flower every year and there are few areas within the range of the Grey-headed Flying-fox where nectar is available continuously (House 1997; Wilson and Bennett 1999; Law *et al.* 2000). The species has no adaptations for withstanding food shortages and migrates in response to changes in the amount and location of flowering (Eby 1991; Spencer *et al.* 1991).

Evidence from broad-scale surveys, radio-telemetry and satellite telemetry shows that individuals can move hundreds of kilometres

within weeks between successive areas of nectar flow (Eby 1991; Spencer *et al.* 1991; Parry-Jones 1993; C. Tidemann pers. comm. 2001, ANU). Distances of 500 – 800 km have regularly been reported. Individuals have been tracked moving between Melbourne and Sydney, between Grafton on the north coast of NSW and Narooma on the south coast, and between the Hunter Valley on the lower north coast of NSW and Bundaberg in southern Queensland. These expansive movements point to one of the extraordinary features of the species.

Migration:

Patterns of migration and distribution vary considerably between seasons and between years. This is in keeping with the irregular nature of their major food source. There is evidence that the majority of individuals are nomadic either continuously or during certain seasons (Ratcliffe 1931; Eby 1991; Spencer *et al.* 1991; Parry-Jones 1993; Fleming and Eby in press). The mechanisms flying-foxes use to locate stands of flowering trees have not been studied and remain a source of surprise and speculation.

There is evidence that not all individuals migrate. In some areas, such as the north coast of NSW, where the landscape is composed of a mosaic of vegetation communities and the diversity of food plants is high, there is a small number of continuously occupied camps (Eby 1991; Eby 1995). The garden and streetscape plantings of major cities also support a diverse range of food plants and camps with continuous populations can be found in Melbourne, Sydney and Brisbane (Eby 1995; Menkhorst 1995; Parry-Jones and Augee 2001; Hall 2002).

The populations seen in roosts or camps are open rather than being a fixed group and comprise some individuals that remain for several months and others that remain for less than five days. The number of flying-foxes in a camp is primarily related to the amount of food available in the local area, although the annual reproductive cycle may also impact on roost stability and size. Camps are used as day refuges by animals that forage in surrounding areas over several weeks, and as short-term stopover sites by migrating animals (Eby 1991 and 1995; C. Tidemann pers. comm. 2001, ANU). The primary determinant of camp size is the quality of food available within nightly foraging distances, commonly within 20 km, but up to 50 km (Eby 1996; Parry-Jones and Augee 1991 and 2001).

When undisturbed, camp locations are generally stable over several decades, with some exceeding a century (Lunney and Moon 1997). This stability is a feature of camps that are used on an annual basis, such as Susan Island at Grafton, and those that are used infrequently, such as a site west of Kempsey that is occupied about one year in five. It is unclear whether the capacity of the species to locate infrequently used sites is a result of a well-developed spatial memory in a long-lived species, or the particular qualities of the camp locations. For example, the Palm Grove in the Royal Botanic Gardens Sydney has held large camps of flying-foxes on a small number of occasions, separated in time by several decades (1858, 1900, 1916, 1920, 1989) (A. Leischman pers. comm. 2000, RBG Sydney). It is unlikely that this pattern of occupation can be attributed to memory alone. Physical characteristics of the site are likely to be attractive to the species.

The evening flights from large camps have long attracted attention and the tourist potential of the species has been recognised at camps in Brisbane, Wingham, Grafton, Bellingen and the Sydney Botanic Gardens. Exit flights are also a feature of the education program in the Sydney suburb of Gordon (Ford 2002; Larsen *et al.* 2002).

Breeding:

Reproduction is seasonal and synchronous. A single pup is born in October or November, lactation lasts approximately to March and conception occurs in April or May (Nelson 1965; O'Brien 1993; Martin *et al.* 1995). This low reproductive potential inhibits the recovery of the Grey-headed Flying-fox from population declines (Martin and McIlwee 2002).

A history of conflict management

The programs of culling favoured by those wishing to reduce flying-foxes in crops or in camps were devised and implemented at a local scale in response to immediate management problems. Shoots, or battues, at camps were often arranged by advertisement in newspapers and were based on the premise that the species was organised as discrete local populations whose size could be controlled (Anon 1870; Lunney and Moon 1997). Large and rapid shifts in the numbers of flying-foxes in an area were believed to be the result of population explosions, i.e. rapid breeding. However, the species has a low rate of reproduction (Martin and McIlwee 2002) and functions as a single inter-breeding population rather than a series of spatially-separated populations. Thus, fluctuations that occur at a camp are primarily the result of migration governed by the distribution of resources over

hundreds of kilometres (Eby 1991; Spencer *et al.* 1991; Webb and Tidemann 1995). This knowledge has only been newly acquired by researchers in small aircraft following bats carrying radiotelemetry devices (Eby 1991; Spencer *et al.* 1991). The open nature of the population of Grey-headed flying-foxes and the geographic scale at which it functions was a revelation that helps to explain the failure of local culling programs to control numbers. It appears that this ecological attribute of flying-foxes has yet to be fully incorporated into management practice, both from the practical point of view that a local shoot-out is a waste of time, and that any local culling, such as on a farm or in a camp, is taking numbers from the one migratory population.

There are several parallels in the way the public perceive problems arising at camps and on crops. The problems occur irregularly and are sometimes extreme. They commence with little or no warning and seem to conclude for no apparent reason. They usually affect isolated localities. The irregular, intensive nature of the episodes generates frustration and anger, but it also, incorrectly, has encouraged the view that once an episode is over it is unlikely to recur. This view discourages investment of increasingly rare research funds into long-term solutions by industry and government. The killing of Grey-headed Flying-foxes in crops, and disruption at roosts, continue to be primary management tools. Logically, these practices are incompatible with managing a species in decline. There is an urgent need to develop new approaches (*e.g.* Teagle 2002).

Crop damage by flying-foxes

The damage flying-foxes cause commercial fruit crops has been a primary cause of rural dislike of the animal. Unfortunately, the amount of damage has not been documented in a consistent or systematic way. Various surveys of producers and opportunistic observations of industry and agricultural agencies indicate depredation varies widely in space, in time and between crops (Slack 1990; Ullio 1992; Campbell and Greer 1994; Tidemann *et al.* 1999; and the contributions to this forum). In NSW, flying-fox damage is an annual feature of at least two major fruit-growing districts, the Far North Coast and the Sydney Basin (Waples 2002). When assessed on an industry-wide basis, a relatively low amount of damage occurs in these areas every year. However, the average is not the point for many growers. It is the irregular high levels of damage considered by industry to be economically unsustainable that lie behind so much of the demand for control. For example, in the spring of 1986, 1989 and 1994, stone fruit and banana growers on the Far North Coast of NSW experienced high losses from flying-foxes (Slack 1990; Slack and Reilly 1994). Similar high levels of loss occurred in the Sydney Basin in the spring and summer of 1991/1992 (Blade 1992). In the spring of 1998 intensive damage was widespread from the Manning River on the mid-north coast of NSW to central Queensland and affected all crops that are eaten by flying-foxes (McLachlan 2002; Rogers 2002; Teagle 2002).

The First National Flying Fox Symposium and beyond

The practices used to control flying-foxes were reviewed in the late 1920s (Ratcliffe 1931). Reviews since the mid-1980s reveal little change in many districts despite the failure of traditional techniques to provide consistent protection to a commercial fruit industry increasing in size and diversity (Slack 1990; Blade 1992; Turner 1994; Hall and Hughes 1987; Teagle 2002). The *First National Flying Fox Symposium* was held in Brisbane on 30-31 August 1986 (Hall and Hughes 1987). It "provided a venue for fruit growers, fauna authorities and researchers to articulate new perspectives for future research into crop protection and flying-fox (*Pteropus* spp.) management" (Hughes 1987). This theme was repeated in several other meetings instigated in response to "bad flying-fox years" in northern NSW (Slack 1990), the Sydney Basin (Blade 1992) and south-east Queensland (Turner 1994). All these symposia focused on crop damage and mitigation options. At each meeting, calls were made for research into better management tools.

The systems of full exclusion netting developed in the late 1980s provided the first method of eliminating crop damage caused by flying-foxes and birds (Slack 1990). However, netting is currently limited by high capital costs, which have been difficult to justify in areas where damage is infrequent, the return for crops is low, or where topographic constraints, such as steep slopes, demand extensive structures (Ullio 2002). Further, there are locations where farmers are disinclined to make substantial capital investments on their land, for example farmland on the urban fringe that is likely to be developed as residential areas. High rates of netting have been reported for high return crops, such as low-chill stone fruit in northern NSW (Slack and Ullio 2000; McLachlan 2002).

There are few options available to fruit growers who choose not to net their crops, and none that are as reliable as exclusion netting (Teagle 2002). New developments are rare and there is no standardised method for assessing their effectiveness (Teagle 2002). Prior to recent initiatives of the Queensland Flying-fox Consultative Committee, no formal research had been conducted into non-lethal deterrents for flying-flying foxes in fruit crops. The use of deterrents, such as noise and light, was guided by personal experience and anecdotal information. The lack of research remained an issue despite years of effort by individuals and groups who lobbied government, NSW Agriculture, NSW NPWS and industry for research funds (e.g. Bicknell 2002). In our opinion, the conflict between the commercial fruit industry and flying-foxes will not diminish until effective on-crop control methods are adopted, i.e. netting (Bower 2002; Gough 2002; Teagle 2002), and the surrounding issues have also been addressed (e.g. Biel 2002; Comensoli 2002; McLachlan 2002; and the first plenary debate).

Management at camps

The level of conflict that arises at flying-fox camps in NSW is consistently related to the distance between roosting animals and areas of human activity, and the numbers of animals in a camp (Hall 2002; Larsen *et al.* 2002; Richards 2002; Smith 2002; West 2002). This too is an issue dogged by lack of rigorous investigation and innovation (Tidemann 2002; West 2002).

While many camps have distinguishable seasonal cycles of occupation, annual variations can be extreme (Parry-Jones and Augee 1992; Eby 1995). Recent surveys of camps in coastal NSW conducted in April and July have documented the variations that occur between seasons and between years (Eby *et al.* 1999; Eby and Lunney 2002; Eby unpublished data). In six surveys of 114 camps, 48% were not occupied in any survey period and 27% were occupied once only. Only 8% contained flying-foxes in each survey. The size of populations also varied. Estimates showed 7% of camps had populations exceeding 30,000 Grey-headed Flying-foxes in at least one survey, but in only seven camps were populations this size recorded twice. This degree of inconsistency in camp use can be difficult to interpret and frustrating to live near. Neighbours generally tolerate camps of small size. However, large influxes are noisy at inconvenient hours and generate a pungent smell. A number of known camps in NSW are rarely occupied by large numbers of flying-foxes so it is possible for neighbours to acquire land and build houses while remaining naïve of the camp and the disruption that will eventually occur (Smith 2002). The rapid growth in the human population and the high rates of residential development along the NSW coast ensure that more and more camps will generate conflict.

Occasionally, new campsites are established and they create further problems. There is often a link between human interference with one camp and the establishment of a new site nearby, with unfortunate consequences in urban and semi-urban areas (Hall 2002; Smith 2002; Tidemann 2002; West 2002). In the past 20 years there has been an increase in the number of urban camps, notably in Brisbane, Sydney and Melbourne (Menkhorst and Dixon 1985; Hall 2002; Richards 2002). Camps in urban areas may follow a different pattern of occupation to camps in non-urban areas. Population peaks are not necessarily associated with use of flowers and, increasingly, urban camps are occupied continuously (Parry-Jones and Augee 2001; Larsen *et al.* 2002; Smith 2002). These changes have occurred during a period of ongoing loss of non-urban habitat and an increase in the presence of mature eucalypts and other diet plants in private and public urban plantings. It has been suggested that the flying-foxes are using the urban areas as refuge (Birt *et al.* 1998; Parry-Jones and Augee 2001; Hall 2002).

The ongoing and frustrating nature of the conflicts that arise at urban camps is testimony to the ineffectiveness of past management strategies, even such drastic strategies as shooting in the camps and attempting to burn them (Lunney and Moon 1997). These practices have repeatedly proven unsuccessful in breaking the fidelity of flying-foxes to camp locations. New strategies are needed to manage conflict when it occurs and to prevent new sites of conflict from developing. Camps that are currently surrounded by development will continue to challenge managers, requiring ongoing programs of conflict resolution and community education (Ford 2002; Larsen *et al.* 2002; Smith 2002; Tidemann 2002; West 2002), and there is an argument for regulating the use of undeveloped land on the perimeter of roost vegetation to restrict activities likely to generate conflict (Eby 2002; Larsen *et al.* 2002). This needs far more attention than has been given to it in the past, especially as it

addresses a number of concurrent issues. Separating the flying-foxes and people by a critical few hundred metres of open space gives an opportunity to develop other options. For example, it provides green space while adding to the conservation outcomes of local biodiversity strategies, particularly as most camps are located along creeks and rivers.

The lack of progress in developing innovative tools to manage conflict between flying-foxes and humans may seem surprising given the intensity of interest. What it does reflect is the paralysis that can set in when there is conflict in the community over a wildlife management matter. Resolution will require articulating the problems, listening to the proposed solutions and developing a plan of management that both reflects the local voices and takes the region, state and Commonwealth into account. Grey-headed Flying-foxes are challenging animals – intelligent and adaptable. Again, there is need for research to see just how adaptable. It is unlikely that the conflicts will be resolved without a concerted and strategic approach (Tidemann 2002). Vigorous action and new ideas are essential to break the impasse created by reverting to the ineffective 'traditional' methods or just hoping that the problem will fly away.

Vexatious species: koalas, dingoes, large kangaroos and flying-foxes

There are some striking similarities among koalas, dingoes, large kangaroos and flying-foxes from a wildlife manager's viewpoint. Each of these mammals has a high public profile, has been shot for commercial reasons, has been or still is a pest somewhere in its distribution, has issues of threatened species to contend with and animal welfare matters to consider and, most importantly, in each case it has taken a long time for the importance of careful planning to be recognised nationally.

Koalas:

In 1984 alarm bells were sounded about the status of the koala on a nationally broadcast ABC television program, "Countrywide". The Commonwealth government responded by instigating and supporting a national survey. In NSW the population was found to have declined and a summit was convened in 1988 to consider its management options (Lunney *et al.* 1990). In 1992 it was recognised as a vulnerable species in NSW (Lunney *et al.* 2000), and in 1995 a legal planning instrument was promulgated (SEPP 44). By 1998 a national strategy for koala conservation had been agreed on (ANZECC 1998). However, the management of the koala remains inconsistent across its distribution.

The most difficult public issue currently is the options for managing koalas where they are overabundant, such as in habitat isolates at Framlingham in Victoria, and on Kangaroo Island in South Australia. From an ecological viewpoint, shooting excess koalas makes sense, but from a political perspective, it has been ruled out as an option. These koala populations are largely an outgrowth of earlier translocation events, and the animals moved have bred beyond the capacity of the eucalypts to support the burgeoning population. While we grapple with that matter, other populations, such as at Iluka on the north coast of NSW, are sliding to extinction (Lunney *et al.* 2002). The wildlife management lesson here is that in different parts of the distribution of a species, the management problems can vary widely. However, it is the public debate over shooting koalas (e.g. 'Koala Wars' on ABC Catalyst 9 April 2002) that is seizing the public attention, not the extinction episode.

Dingoes:

Tough wildlife matters surface in the media when there is human conflict. On the '7.30 report' (ABC 16 April 2002), as this book was in production, there was a detailed coverage of the wild dog problem in south-western Queensland. The report indicated that so savage was the problem that many local sheep farmers were getting out of the business. The person who was travelling and repairing the dingo fence along the NSW/Queensland border noted that on one side of the fence there were 20 wild dogs compared with 800 on the other. The fence might be expensive to maintain, but it kept the problem at bay.

One can imagine how the local graziers in south-western Queensland would react to the suggestion that the dingo is a threatened species and should be managed as such. Stock losses to wild dogs/dingoes in NSW are also a serious matter for sheep farmers, and the concept of protecting dingoes does not rest easily in rural NSW. Yet an application has been received by the NSW Scientific Committee to consider it as threatened species. The subject provided the basis for a lively forum convened by the Royal Zoological Society of NSW (Dickman and Lunney 2001), and while the determination has yet to be made, it does

provide some pointed parallels with flying-foxes. The scientific evidence is that the dingo is becoming endangered by being swamped by the genes of domestic dog breeds, so even though wild dogs numbers may be high (which was the issue in south-western Queensland), the dingo is endangered as a species. Also, if all wild dogs, whether dingoes or crosses or domestic animals gone feral, were to be eliminated, then there would be an ecological problem caused by the loss of the ecological function of a top predator. One of the options that is beginning to be adopted is the concept of reserving core forest areas for dingoes, while elsewhere all wild canids would be regarded as potential threats to stock and shot or poisoned. The immediate comparison with Grey-headed Flying-foxes is that dingoes perform an important ecological function, that they are declining, and yet they are still a major pest to some people. It also appears that exclusion netting provides the best long-term answer, and that the issues stretch beyond the border of one state. A co-ordinated national approach may present extra opportunities for a comprehensive wildlife policy to be devised.

The large kangaroos:

Kangaroo management is possibly the most testing wildlife management matter to have been dealt with in Australia. The pest status of kangaroos in agricultural land has been the basis for the issuing of licences to shoot millions of them each year. The debate continues to broaden, with the proposal to utilize kangaroos in preference to sheep, particularly on the degraded sheep rangelands (Grigg 2002). This matter of using wildlife to assist in its own survival has strong support as there is a growing recognition that existing formulae for conserving our biodiversity are inadequate for the task (Archer 2002). This debate provided yet another spirited forum convened by the Royal Zoological Society of NSW (Lunney and Dickman 2002). Kangaroos are currently managed in NSW under a detailed plan that regulates the commercial take. Part of the aim of a commercial take is to enable these species to regain ground as their habitat rehabilitates. In this respect the kangaroo would gain value in both monetary and biological terms. It is the pest status of kangaroos that has been an impediment to seeing other options, yet a re-orientation of our thinking may turn a pest into an asset. While it is hard at the moment to see flying-foxes achieving that turn around, there is always a case for trying to see matters from new perspectives.

Conclusions

Grey-headed Flying-foxes belong to a vexatious list of national icons in need of special attention. In the coming years management practices for the species will continue to change in orientation towards conservation. Those anxious to arrest the decline in numbers are likely to find the change too slow. Those concerned with economic damage and social impact may find it confusing or confronting. Both sides must acknowledge that the opportunities for conflict to develop are likely to grow as flying-foxes increasingly use fruit crops and urban areas as refuges. Therefore, the process of recovery must include methods to resolve conflict in crops and in camps. Most of the observations made here have been presented in symposia since Ratcliffe, 70 years ago. That we are still making these observations and recommendations is a cause for concern to everyone with an interest in conservation and management of Australia's biodiversity. Of even greater concern is that the options and opportunities before us are diminishing rapidly as habitat loss continues.

Calls for adequately funded research to support flying-fox management have been made repeatedly in a succession of forums and by people with a range of objectives, but the necessary support has not been forthcoming. The research needs to cover the many facets of flying-fox biology and not be limited to the most obvious. The research also needs to cover the landscape in which flying-foxes need to move to survive, the vegetation associations on which they depend and the social environment of camps and their neighbours.

This forum on managing the Grey-headed Flying-fox as a threatened species in NSW gives both the seasoned player and the new recruit a good glimpse of the level of biological, economic and bureaucratic complexity involved in conserving the rich resources of NSW in an equitable manner. Wildlife management in the 21st century will become increasingly concerned with conflict resolution as native habitats continue to be replaced by landscapes configured and inhabited by humans. The cost of resolving the conflicts will be carried unevenly through the community and we must continue to develop mechanisms to equitably distribute responsibilities. Until these substantial issues are dealt with, species like the Grey-headed Flying-fox will continue to decline. This is not a pessimistic observation, but it is a rallying call for policy that incorporates more research, increased education and better practical management.

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Appendix 1. Advice to the Commonwealth Minister for the Environment and Heritage from the Threatened Species Scientific Committee (TSSC) on Amendments to the list of Threatened Species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)

APPENDIX

"1. Scientific name, common name (where appropriate), major taxon group

Pteropus poliocephalus (Grey-headed Flying-fox)

2. National Context

This species is endemic to Australia, with a distribution ranging from Bundaberg in Queensland to Melbourne in Victoria. The species range extends from the coast inland to the western slopes of New South Wales. There have also been recent reports of *P. poliocephalus* present in South Australia.

3. How judged by TSSC in relation to the EPBC Act criteria

The Grey-headed Flying-fox has been nominated as vulnerable and was identified as vulnerable in the 1999 Bat Action Plan. The issue of threat classification and management for Grey-headed Flying-foxes has been controversial, due both to the perceived extent and contraction of the population and the interactions Grey-headed Flying-foxes continue to have with the orchard industry and other human activities.

The robustness of data presented to support listing has been challenged by some scientists. A thorough investigation of survey methodologies, data and expert discussion has been undertaken in order to verify data and estimates of population decline.

TSSC judges the species to be eligible for listing as vulnerable under the EPBC Act. The justification against the criteria is as follows:

Criterion 1 – Decline in numbers

Population size data obtained by fly-out count surveys contain a degree of error that is difficult to quantify. Two key sources of error have been considered in relation to assessing the robustness of the available data. Firstly, the survey methodology and secondly the comparability of the survey results for the purpose of calculating trends in population size or species abundance.

Fly-out counts are acknowledged by the scientific community to be the best method currently available of obtaining reliable and reproducible

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estimates of abundance (if not actual population counts) for flying-foxes. The available data for 1989 and 1998-2001 has been obtained using the same survey techniques that are widely acknowledged to be appropriate for estimating the abundance of this species. The data available from the fly-out counts conducted should be regarded as estimates of abundance, rather than precise population counts.

The 1989 estimate of abundance is notably incomplete in the survey coverage, lacking data from Qld, where the species is known to occur throughout the year in significant numbers, and several sites in NSW that were known to be occupied at the time. The 1989 estimate of abundance is therefore likely to be a significant underestimate of abundance of the species at that time. Use of the 1989 estimate of abundance provides a minimum indication of population decline when related to maximum estimates of populations sizes obtained during the 1998-2001 surveys.

The surveys of 1998-2001 have been much more comprehensive than the 1989 survey in terms of the number of roosts and extent of geographical range included. Despite the significantly increased knowledge of the species roost sites and survey effort, the estimates of abundance obtained indicate a decline in the abundance of the species. Using the maximum estimate from the 1998-2001 surveys (400,000) and the minimum estimate of abundance in 1989 (566,000), the rate of decline since 1989 has been in the order of 30%.

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

Therefore, the species is eligible **for listing as** vulnerable **under this criterion.**

Criterion 2 –Geographic distribution

The distribution of the species is not precarious for the survival of the species nor limited, the range of the species extending from Bundaberg in Queensland to Melbourne in Victoria and from the coast inland to the western slopes of New South Wales. There have also been recent reports of *P. poliocephalus* present in South Australia.

The threat to the species of a projected loss of habitat and associated winter food resources from northern NSW has been discussed under criterion 1.

The northern geographic range of Grey-headed Flying-foxes appears to be contracting. In the late 1800's and early 1900's, specimens were recorded from far north Queensland. In 1929 there were camp-sites occupied permanently or regularly around Rockhampton. Grey-headed Flying-foxes are no longer found in the Rockhampton area and known sites have experienced a northern contraction of about 300 kilometres.

However, Grey-headed Flying-foxes have expanded in the south of their range as evidenced by the permanent colonies in Melbourne and their recent detection in South Australia. It has been hypothesised that the northern contraction and the southern expansion relates to temperature changes over the last 30 years, as the average temperature has increased by approximately 2-3 degrees Celsius across the range of the species. However, the adaptability of Grey-headed Flying-

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foxes to exploit a wide range of food resources could also be a causative factor in their southerly range expansion.

It has been purported that habitat degradation in the north of its range is responsible for its disappearance from this area. However, it should be noted that the Black Flying-fox, *Pteropus alecto*, exploits similar niches as Grey-headed Flying-foxes in terms of camp-sites and food resources, and yet it is still abundant in areas of southern Queensland formerly occupied by Grey-headed Flying-foxes.

It is important to note that Grey-headed Flying-foxes are highly mobile and appear to be a highly adaptable species in response to changes in their habitat and surrounding environment. A number of "urban" roost sites that are occupied year-round (Sydney suburbs, Botanic Gardens in Sydney and Melbourne) have become established due to consistently available food resources and suitable roosting habitat. At other "non-permanent" roost sites, Grey-headed Flying-foxes have shown themselves to be able to respond rapidly to the presence/absence of food availability.

Given the current extent of the species range, and clear evidence of its capacity to expand its range, the geographic distribution is not considered precarious for the survival of the species.

Therefore, the species is **not eligible** for listing under this criterion.

Criterion 3 – Population size and decline in numbers or distribution

The estimated abundance of this species is not limited, survey figures obtained during the period 1998-2001 indicating abundance to be in excess of 320,000 – 400,000 individuals. Discussion of historic or potential declines and geographic distribution is provided respectively under criterion 1 and 2 above.

Therefore the species is **not eligible** for listing under this criterion.

Criterion 4 – Population size

The estimated abundance of this species is not low, survey figures obtained during the period 1998-2001 indicating abundance to be in excess of 320,000 – 400,000 individuals.

Therefore, the species is **not eligible** for listing under this criterion.

Criterion 5 – Probability of extinction in the wild

There is no quantitative evidence available against this criterion. However, two experts have recently modeled the vulnerability of both the Grey-headed Flying-fox and the Spectacled Flying-fox, *Pteropus conspicillatus*, to decline and extinction using basic parameters of reproduction obtained from captive breeding data. This analysis shows that flying-fox populations have a low capacity for increase and depend on low levels of natural mortality and high survival of adults to maintain stable population levels. These experts conclude that current death rates of the Grey-headed Flying-fox imposed by fruit orchardists and other management approaches place populations at risk.

One expert challenged the validity of the inputs to the model, in particular, the fecundity of two year old animals, and the assumed sex ratio of 1:1. The model essentially assumes that flying-foxes do not breed until three years of age, based on observations of captive animals, but field based data is available for the closely related Black Flying-fox that indicates this is not the case. The sex ratio of flying-foxes in most camps is also closer to 70:30 (females:males). Changes to these and other inputs to the model should be made to further explore the impacts of these influences on the population survival.

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However, whilst the modelling is imperfect, it provides clear messages about the likely impact of increased mortality to adults. Sustained high levels of mortality additional to natural mortality would undoubtedly increase the probability of extinction in the medium-term in virtually most scenarios. However, the current level of mortality at the hands of orchardists is unquantified, but has been substantially reduced through NSW government subsidised netting of orchards. This, combined with the equivocal nature of the data on population size, renders it difficult to be confident that current levels of non-natural mortality are likely to lead to negative population growth.

Based upon the population modelling, likely recruitment rates, and other characteristics such as its adaptability and mobility, there is not a 10% probability that the Grey-headed Flying-fox will become extinct in the wild in the medium-term future.

Therefore, the species is **not eligible** for listing under this criterion.

4. Conclusion

The estimates of abundance derived from surveys conducted in 1989 and during the period 1998-2001 indicate a rate of decline in abundance of the species in the order of 30%.

Given the limitations of the available data, research into both accurate estimates of abundance and mortality associated with human activities (eg orchard control) should be encouraged. For this reason, the decision on this species conservation status should be reviewed in three years time.

5. Recommendation

The Committee is of the view that priority should be given to the generation of more data and that this matter be revisited in 2004 or when significant new data becomes available. However, this review should only be initiated if substantial work is undertaken which significantly clarifies the conservation status of the species. In particular:

- count techniques need to be standardised and conducted annually across the range of this species;
- population modelling should be refined to incorporate field-derived data if possible; and
- quantification of the level of mortality currently occurring through the protection of fruit crops.

TSSC recommends that the list referred to in section 178 of the EPBC Act be amended by **including** in the list in the **vulnerable** category:

Pteropus poliocephalus (Grey-headed Flying-fox)"