

# Management of flying-fox camps: what have we learnt in the last twenty five years?

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## ABSTRACT

The management of flying-fox camps is pivotal to the overall conservation and management of flying-foxes. This paper employs an historical approach to assess the effectiveness of camp removal in the Brisbane area as a tool in the management of flying-foxes. Much of what has been learnt in the last 25 years has been thrust upon us by hasty and unplanned attempts to remove flying-fox camps. There have been many attempts, many failures and only a few claims of success in moving flying-fox camps. None of the claimed successes has ever been monitored in such a way that their effectiveness can be adequately assessed with any confidence. Long term observations suggest that, in moving a flying-fox camp, the problem is merely transferred to other areas, and the whole process starts all over again with a new lot of players. There is still more that we need to know to successfully address camp management. The microclimate of camps needs more research, as does the seeding of new areas with ground litter containing flying-fox droppings, and the location of orphan release cages set up in prospective new camp sites. Nevertheless, it is apparent that in the future it will make more sense to manage flying-fox camps where they are and use strategies to lessen the impact on people who object to their presence.

## Introduction

When Europeans first arrived in Australia they were struck with awe by the large flying-fox camps along the eastern coastline. Early records not only reported the large size of these camps, but soon gave evidence of efforts to disperse or destroy them (Lucas 1895). In 1889, the New South Wales Minister for Mines and Agriculture supplied ammunition for groups of shooters to deal with the problem of “numerous flying-fox haunts containing millions of animals” (Lunney and Moon 1997).

In 1929, Francis Ratcliffe was funded by the New South Wales and Queensland state governments to investigate the problems caused by flying-foxes in orchards. His imposing 80 page report (Ratcliffe 1931) is still widely referred to, and has probably precluded the spending of public money on flying-fox management until recent times (Hall 1987). Ratcliffe’s comments on the management of flying-fox camps are almost exclusively focused on camp removal or destruction. Subsequent attempts at flying-fox camp management by shooting have often been regarded more as sporting events than serious attempts for

management purposes. Lunney and Moon (1997) consider that flying-fox management will remain problematic until the ecology of flying-foxes is better understood.

The status of protection of Grey-headed Flying-foxes *Pteropus poliocephalus* afforded by law in Queensland has changed back and forth over the years, but with the current listing of Vulnerable for *P. poliocephalus* in both New South Wales and nationally, and a similar impending listing for the species in Queensland, management must now focus on non destructive management techniques.

Recently there has been a number of new flying-fox camps appearing in urban areas (Birt *et al.* 1998; Hall and Richards 2000). Some of these camps are reoccupied old, previously non-urban sites which have been overtaken by urban expansion and others appear to be new camp sites altogether. These urban camps are frequently a major source of conflict between flying-foxes and residents and these problems are likely to increase in the future. The gregarious nature of flying-foxes with their formation of daytime camps has been,

and remains, the easiest place to implement management practices. Attempts at moving flying-fox camps has a long and colourful history. However, it is no longer acceptable to use destructive methods such as shooting, explosives, fire and smoke which were used so frequently in the past as camp management techniques (Ratcliffe 1931; Lunney and Moon 1997).

The passive dispersal of camps via disturbance such as noise is still a contentious issue. There has been a number of claims of successful camp dispersals (Tidemann, *pers comm*, Hall, *pers obs*) and many more reports of unsuccessful attempts (Vardon *et al.* 1997, Lunney and Moon 1997; Hall *pers obs*). Many of these attempts lack an historic perspective, and disregard details of the species' biology, such as food availability at the time of removal, and subsequent repercussions of the removal. An exception is Lunney and Moon (1997) who used an historical approach to show that traditionally used methods of flying-fox camp dispersal remain largely ineffective in moving flying-foxes from their camp sites in rainforest remnants in northeastern New South Wales.

Over the years, and even quite recently, there have been passive attempts to move flying-fox camps that the people involved would consider to be a success. What is often not known is: were the flying-foxes on the point of leaving because of lack of food, how far did the colony move, did they cause problems at their new camp site, how long are they going to stay away, and will they come back?

The present paper employs an historical approach to assess the effectiveness of camp removal as a tool in the management of flying-foxes. By looking at the history of flying-fox camps in the Brisbane area, a range of methods for camp dispersal techniques and the subsequent ramifications of the dispersals can be viewed and examined. Some of the camp dispersals were purposeful attempts, others accidental, and there are also examples of attempts that failed. Viewed together over time, these activities represent an enormous amount of effort and money spent on flying-fox management. By using this information, a paradigm may emerge for the successful long term management of flying-fox camps.

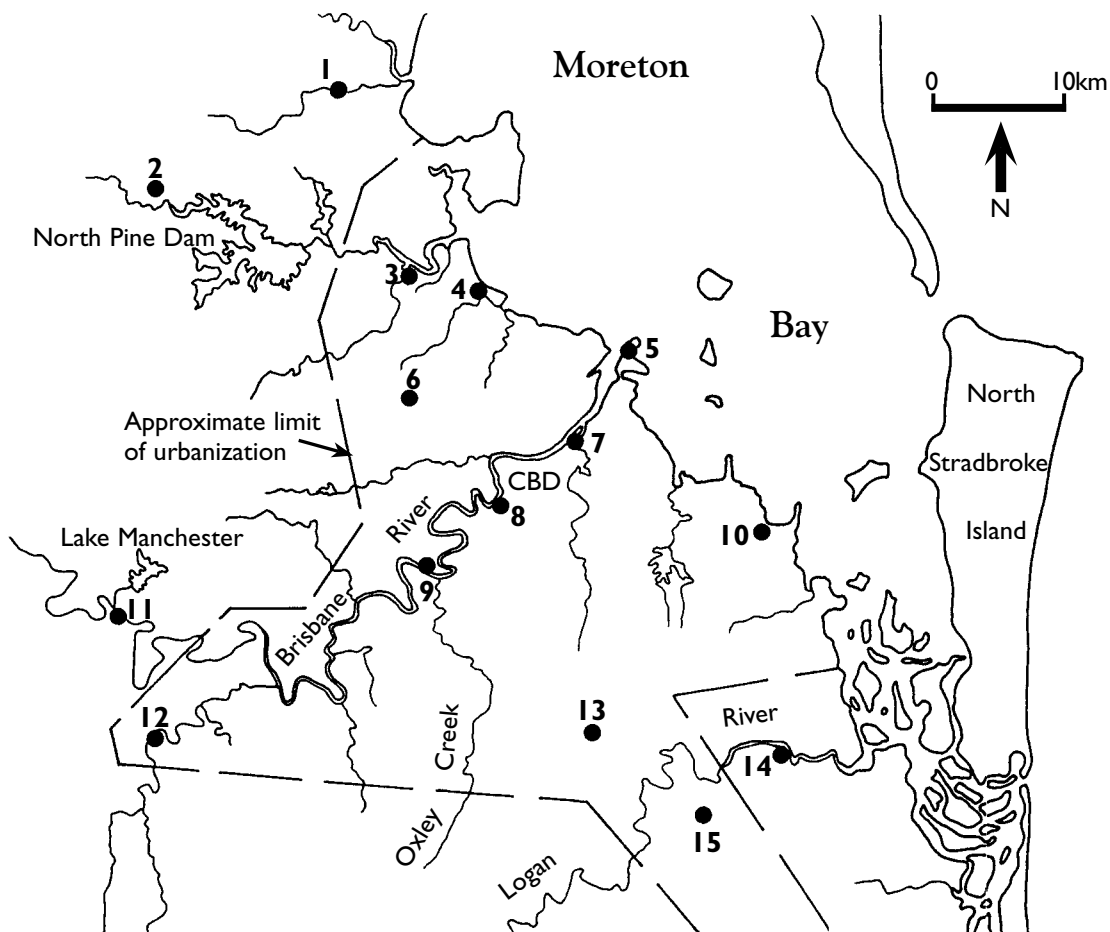


Figure 1: The location of flying-fox camps in and around Brisbane.

1. Burpengary 2. Dayboro 3. Bald Hills 4. Sangate 5. Fisherman Island 6. Everton Park 7. Hemmant 8. Norman Creek 9. Indooroopilly Island 10. Cleveland 11. Camerons Scrub 12. Woodend 13. Slacks Creek 14. Logan River 15. Beenleigh

## Flying-fox camps in and around Brisbane

There is some information on the location of flying-fox camps in southeast Queensland given by Ratcliffe (1931), and information on camps in the Brisbane area is provided by Nelson (1965) who gives locations and occupancy times of camps as well as other biological information on flying-foxes. Personal observations by the author on flying-fox camp sites in the Brisbane area commenced in 1975, and additional information on the occupancy of camps has also been provided by a number of co-researchers and reliable witnesses who live in close proximity to the camps involved. Figure 1 shows the location of flying-fox camps in and around Brisbane. The camps recorded at Fisherman Islands and Beenleigh by Nelson (1965) are no longer inhabited, and those at Bald Hills and Cameron's Scrub, which were apparently missed by Nelson (1965), are also now abandoned.

By following the history of the dispersal of a number of camps over time, the full impact of a camp dispersal can be better appreciated in terms of the long term results. In all cases described below, no marked or radio collared animals were used, and the observations are presented as evidence, rather than proof. In many cases, information has been supplied by reliable witnesses.

Two camps - Fisherman Islands at the mouth of the Brisbane River and Cameron's Scrub located in an area of bushland just west of the urban limits of greater Brisbane (Figure 1) - could be considered to represent the successful dispersal of a flying-fox camp; Fisherman Islands by the total removal of roost trees, and Cameron's Scrub by persistent harassment by noise and shooting.

**Fisherman Islands:** In the late 1950s and early 1960s there was a large camp of mainly *P. poliocephalus* in the mangroves that composed Fisherman Islands at the mouth of the Brisbane River (Nelson 1965). In 1976 the Port of Brisbane Authority commenced developing the area as a shipping container terminal. By 1977 the islands were linked to the mainland by a causeway and bridges and by 1979 most of the mangroves had been replaced by landfill and concrete (Port of Brisbane Corporation, *pers comm*). During and shortly after the loss of the mangroves at Fisherman Islands, several new flying-fox camp sites appeared and other camp sites, that had only been seasonally occupied, became permanent. In 1978-79 a camp,

15 km southeast of Fisherman Islands at Raby Bay in Cleveland, which had been used by *P. poliocephalus* only in winter months, became permanently occupied. Previously, the camp had been occupied by flying-foxes when there was a good flowering of *Corymbia*, *Eucalyptus* and *Melaleuca* in the area and on North Stradbroke Island. In the late 1980s, Raby Bay began to be developed as a canal estate and marina. Most of the vegetation including mangroves was removed and the flying-fox camp was dispersed from the remaining vegetation by the use of detonators and fire torches. The flying-foxes circled the area for several days before roosting in a stand of tall *Melaleuca quinquenervia* approximately 1 km away in Black Swamp (L. Saunders *pers comm*). Black Swamp is a small reserve (13 ha) and the roosting flying-foxes caused substantial damage to the trees and became a concern to residents and Redlands Shire Council. The Black Swamp camp is now a permanent maternity camp for *P. alecto* and for a smaller number of *P. poliocephalus* whose numbers usually peak in winter months when there is good local flowering.

Two new camps appeared in mangroves upstream from the Fisherman Islands at Hemmant (Doughboy Creek) and Coorparoo (Norman Creek) during and shortly after the loss of Fisherman Islands (Figure 1). Both camps are now used mainly by *P. alecto*, but are often visited by numbers of *P. poliocephalus*, particularly migratory groups which typically stay only for short periods. It is not known if either of these camps were used by flying-foxes in the past. The area of both these camps is restricted but away from human dwellings.

Local residents claim that Indooroopilly Island has been occasionally used by groups of flying-foxes since the 1940s, and there were often large numbers of flying-foxes on the Island in the 1950s. From 1975 to 1977, the Island was regularly used by flying-foxes but it was not regarded as an important maternity site. In October 1978, it became a major maternity site when 120,000 *P. poliocephalus* occupied the camp. Indooroopilly Island was not listed as a permanent camp site by Nelson (1965) during his field work in the Brisbane area from 1959 to 1961. Fisherman Islands had been a maternity site for *P. poliocephalus* in 1960 and 1961 (Nelson 1965) and it appears that Indooroopilly Island had taken over this role by 1978. See the following section on Indooroopilly Island for subsequent history.

**Cameron's Scrub:** This camp site just west of the greater Brisbane urban limits was unknown to

both Ratcliffe (1931) and Nelson (1965). Local information suggests that the camp was known to be there in the 1950s, and it often contained many flying-foxes. It was first seen by the author in 1981 during an aerial reconnaissance. The camp was well known to local shooters and was subjected to frequent shoots. Following the sudden arrival in 1984 of flying-foxes at Woodend, 10 km to the south of Cameron's Scrub, and the establishment of Woodend as a maternity site in 1985, a visit was made to Cameron's Scrub camp in late 1985. There were no bats present in the camp on this visit, but there was evidence of recent shooting in the camp. Cameron's Scrub camp has remained vacant but locals report that occasional flying-foxes are seen in its vicinity.

Both of the above can be viewed as camps that have been abandoned due to disturbance. Fisherman Islands has been abandoned for approximately 30 years, due to the total removal of trees and Cameron's Scrub for 16 years, due to constant harassment and shooting. Long term it is obvious that Fisherman Islands will not be reoccupied, but given the low conflict area with humans, replanting of mangroves in suitable nearby locations could see the return of flying-foxes to the area. There is no long term certainty that Cameron's Scrub will not be reoccupied in the future. It is highly likely that the appearance of new camps at Hemmant and Norman Creek resulted from the loss of Fisherman Islands camp, and that camps at Cleveland and Indooroopilly Island, both of which had been only temporary, became permanent camps. The dispersal of the Cameron's Scrub camp site, and the shift of the flying-foxes to the nearby urban Woodend camp, caused an enormous amount of anxiety to the local Woodend residents and Ipswich City Council.

To assess the long term effectiveness and subsequent ramifications of the dispersals from Fisherman Islands and Cameron's Scrub, it is necessary to follow the history of several of the camps which resulted from the initial dispersals. These camps are Indooroopilly Island and Woodend.

**Indooroopilly Island:** This camp is located in suburban Brisbane in the Brisbane River (Figure 1). Up until 1976 the Island was separated from the banks of the river along Indooroopilly Golf Course by a small channel which has now silted up, and is only apparent during very high tides. In 1995 the Island was gazetted as a conservation park, and is managed to conserve the flying-fox camp site.

The Island is roughly 1 km long, and 120 m at its widest section, with an area of 6.34 hectares. The vegetation is principally the Grey mangrove *Avicennia marina* and River mangrove *Aegiceras corniculatum* with scattered Forest Red Gum *Eucalyptus tereticornis*. The understorey is tidal or covered by a dense growth of introduced sialto and molasses grass. Along the edge of the Indooroopilly golf course there is a continuous row of exotic Chinese elm *Celtis sinensis*, which is in the process of being removed and replanted with native species, including figs.

Following the loss of the mangroves at Fisherman Islands 25 km downstream, Indooroopilly Island became the major maternity camp for *P. poliocephalus* in southeast Queensland. In the 1978 to 1981 maternity seasons there were around 120,000 *P. poliocephalus* using Indooroopilly Island. By the 1987/8 season the number had dropped to 60,000, and in 2000 the number had dropped to 7,000. At the same time, there had been an increase in the numbers of *P. alecto* using the Indooroopilly Island camp as a maternity site, and in 2000 there were approximately 15,000 *P. alecto* in the camp.

The loss the mangroves at the Bald Hills camp site 25 km north of Indooroopilly Island (Figure 1) in the late 1980s did not seem to affect the numbers of flying-foxes at Indooroopilly Island, even though Bald Hills was a similar distance away as Fisherman Islands. During the 1980s the numbers of flying-foxes at Indooroopilly Island were decreasing, but there was a noticeable increase in flying-foxes numbers at Everton Park, which was only 10 km away from the Bald Hills camp site (Figure 1).

The area of vegetation, in which the flying-foxes roost at the Indooroopilly Island camp, often changes with the arrival of bats at the beginning of the birthing season (September – October). These changes in roosting area have been recorded on a map of the Island that was drawn from an aerial photograph (Figures 2 and 3). Over the 25 years of recording, most roost areas were occupied for a maximum of only 3 years. The longest shifts within the roost site were in 1988 to 1989, and again in 1990 to 1991, when the distance moved was around 300 m (Figure 3). These shifts appear to be determined by recently arrived bats for the birthing season. The over-wintering permanent residents move to the new roosting site. The result of these moves is that the visual appearance of Indooroopilly Island camp is one of minimum vegetation damage by flying-foxes. This scenario is drastically changed

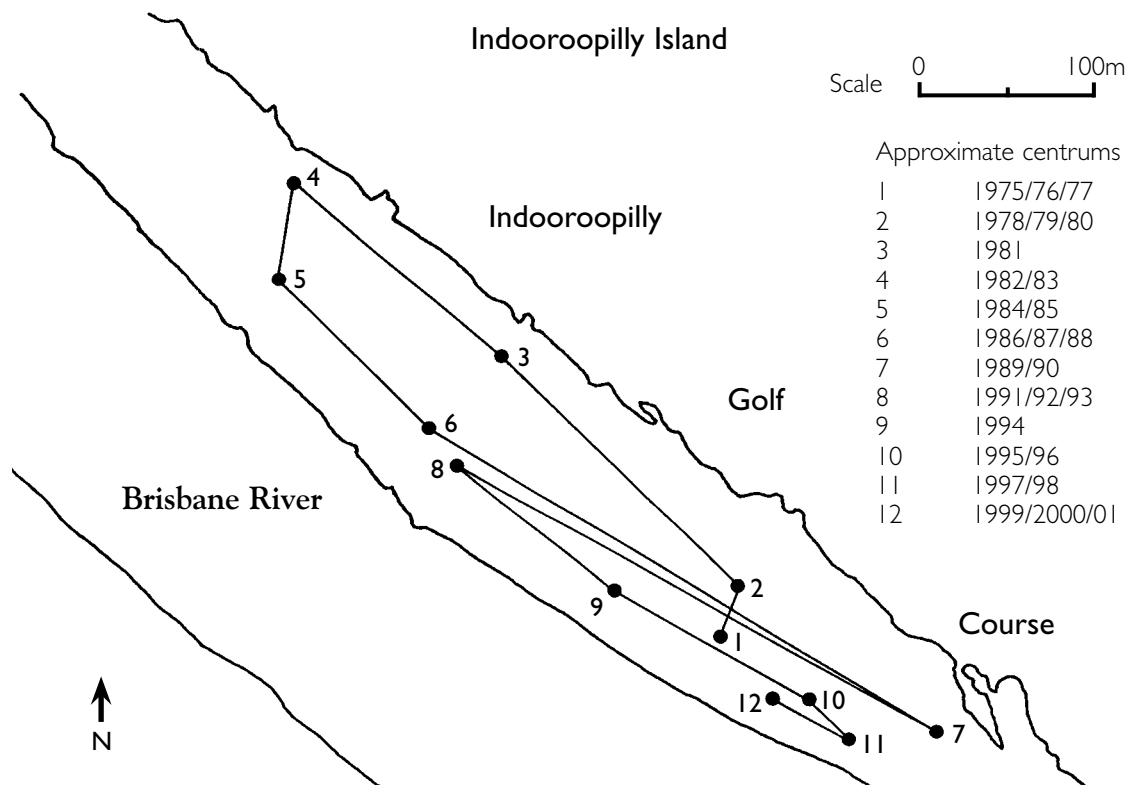


Figure 2: Indooroopilly Island, Brisbane, showing approximate location of roosting groups of flying-foxes from 1975 to 2001.

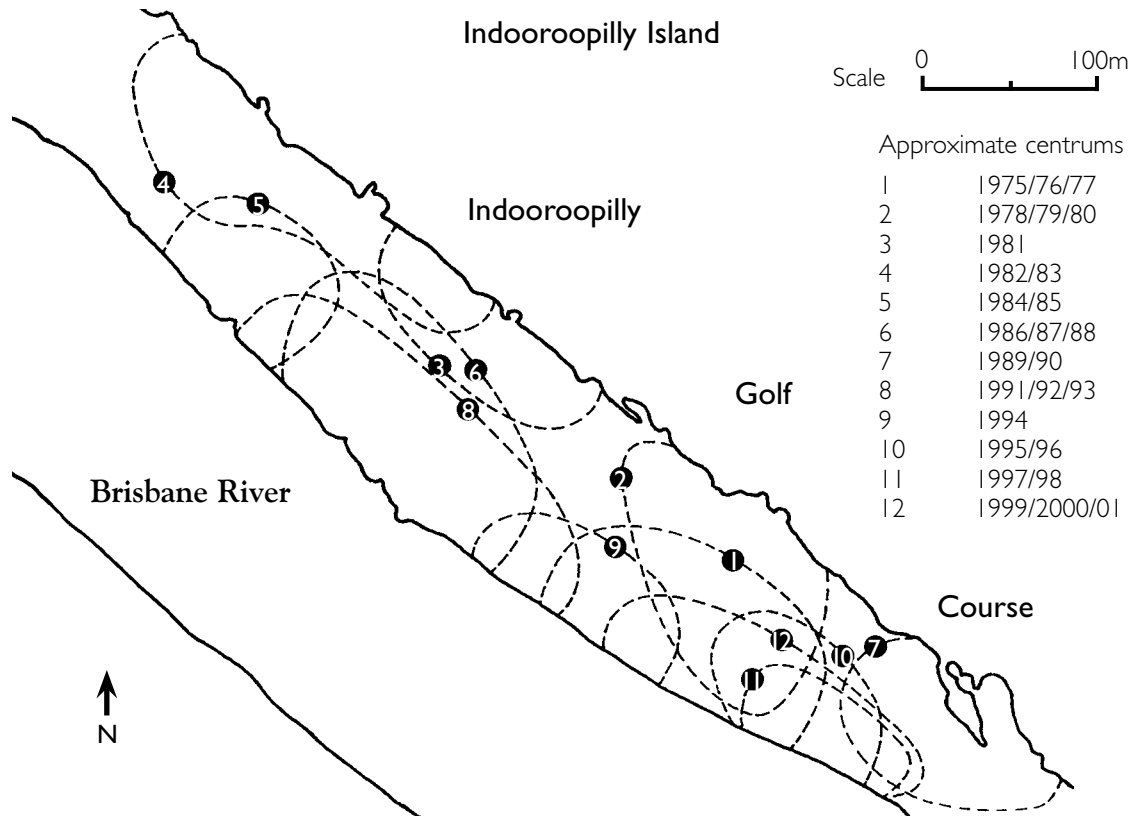


Figure 3: Indooroopilly Island, Brisbane, showing movements of approximate centurms of roosting groups of flying-foxes from 1975 to 2001.

when large numbers of nomadic Little Red Flying-foxes *P. scapulatus* use the camp site. This occurred at Indooroopilly Island in March 1978 and again in November 1986. Damage to the vegetation due to *P. scapulatus* was extensive and involved large branches and sometimes whole trees collapsing under their combined weight. In contrast, damage to vegetation at Indooroopilly Island by *P. poliocephalus* is more confined to the upper and outer smaller branches, which are stripped of leaves, or broken by the weight of pregnant females and young, and the persistent territorial marking of branches by males during the mating season.

As a result of flying-foxes changing their roost area within the camp, damaged vegetation regenerates and recovers, usually within the next growing season. There is a danger at Indooroopilly Island that the fast growing siatro and molasses grass, which has spread from the river bank to the edge of the flying-fox camp, will spread through the mangroves. If left unchecked, these grasses will eventually destroy the roost area, and the flying-foxes are likely to move their camp to another location. This emphasizes the need to constantly monitor the vegetation in flying-fox camps. Flying-foxes also introduce exotic plants to the camp, such as palms, mulberry, guava and Chinese elm by way of seeds in droppings and food brought back in their mouth after feeding.

**Woodend:** This camp site is located in a small dry gully running into the Bremer River in suburban Ipswich. The Ipswich City Council has listed the area as the Woodend Nature Reserve to be used for scientific and educational purposes. The vegetation of the Woodend camp has been described by Birt and Markus (1998). In 1950 the camp site was a grass covered horse paddock with a few old *E. tereticornis*. Following the removal of the horses, a grove of Sheoak *Allocasuarina glauca* became established and Chinese elm appeared along the creek bank. Regenerating *E. tereticornis* now grows higher up on the banks. Replanting of trees by Ipswich City Council (ICC) has occurred along the Bremer River, in several areas adjacent as well as in the flying-fox camp. The Woodend camp is unusual in that it has three species of flying-foxes (*P. alecto*, *P. poliocephalus* and *P. scapulatus*) present over the majority of the year. Woodend is now a major maternity site for *P. poliocephalus* in southeast Queensland.

In October 1984 a large number of *P. poliocephalus* arrived and bred at Woodend. There had been no previous records of flying-foxes roosting in the area for at least 40 years. Over the next few years

their numbers increased and in 1988 and 1989 a large colony of *P. scapulatus* also arrived. The appearance of this large number of flying-foxes caused considerable anxiety among the residents, and the ICC was asked to move the flying-fox camp. During the same period a large camp of flying-foxes at Cameron's Scrub 10 km due north (Figure 1) disappeared. Ground inspection of the abandoned site showed a lot of evidence of shooting and it was common knowledge that the camp had been subjected to many shoots. Due to its location, the Cameron's Scrub camp site has not been regularly visited, but it appears to have been abandoned, and flying-foxes are now only occasionally seen in its vicinity.

The ICC commenced a disturbance program in 1989 based on noise to move the flying-foxes out of the Woodend camp site. The initial reaction by residents to the council's proposal was divided. Loud noises, including bird fright cartridges, gas guns, stockwhips, drum and can beating were used, but these only dispersed the flying-foxes into backyards and along the banks of the Bremer River. Following the cessation of noise, the flying-foxes returned to their original roost sites. The dispersal noise caused caged birds to die of fright and domestic cats and dogs ran away from their homes. Meanwhile the bats just kept moving away from the noise and then returning. An Air Force helicopter was brought in to hover over the camp site. This finally resulted in a resident successfully taking out a court injunction preventing the council from continuing its flying-fox dispersal campaign (Jill Nelson *pers comm.*). The ICC ceased their disturbance activities, set up an advisory committee and decided to make the area a nature reserve and manage the flying-foxes at the site.

The ICC formed a management committee comprising council staff, local residents (both pro and anti flying-fox), Queensland National Parks and Wildlife Service officers (QNPWS), animal care groups and flying-fox researchers. One property adjacent to the flying-fox camp was purchased and the house converted into a community centre. Fact sheets to educate the residents about basic biology of flying-foxes, their role in public health issues and wildlife regulations were produced. A hot line was set up at the council to answer questions from residents requesting information on flying-foxes. The hot line was provided with an extensive list of answers for questions related to living in proximity

to a flying-fox camp. Regular community meetings were held where management options were discussed and residents were able to ask questions to councillors, QNPWS and researchers. This system of community involvement proved to be highly successful, and resulted in several people who were strong advocates for removal of the camp becoming very pro the retaining of the flying-fox camp in a nature reserve. They now visit new residents and inform them about living near a flying-fox camp. A management plan was produced (Low 1996), and very few problems have arisen since.

The management plan recommended an immediate tree planting program to extend the camp site away from residents' yards. Currently these trees are nearing a height suitable for flying-foxes, which is fortunate as the density of flying-foxes roosting in the centre of the camp has killed a significant number of *A. glauca* trees. It is obvious that a weed program will also need to be implemented as the death of the trees has promoted a dense understorey of weed species.

As a result of the ICCs management policy, Woodend has received much publicity. The site has been used for research by Griffith University, The University of Queensland, Queensland Department of Primary Industries and Queensland Health. Published articles containing information on the Woodend camp have appeared in overseas and local scientific journals as well as in more general publications. BBC TV (Wildlife) has produced two documentaries, where Woodend featured prominently, and recently the camp was visited by David Attenborough as part of his new TV series on mammals. Woodend is visited regularly by eco-tour operators, school biology groups and interested naturalists.

### **Is there long term evidence that flying-foxes return to camps after being dispersed?**

The Slack's Creek camp (Figure 1) was occupied by large numbers of *P. poliocephalus* in the winter of 1960 and 1961 (Nelson 1965). It was abandoned sometime in the mid to late 1970s during the construction of the nearby southeast freeway. The camp site remained vacant until 1998, when it was reoccupied by a mixture of approximately 12,000 *P. poliocephalus* and *P. alecto*. The minimum time period when the camp was empty is about 20 years. This raises several questions: i) Do flying-foxes live long enough in

the wild to remember 20 years? ii) Are there physical features which flying-foxes use to select (or reselect) camp sites? iii) Were flying-fox food resources in the Slacks Creek area depleted in the 1970s and 1980s during an intense period of urban expansion and development? iv) Is the Logan City Council's tree planting program, and the vegetation planted in local back yards, now providing a reliable food resource for a flying-fox camp to be re-established in the area?

The abandonment of the Barr's Scrub camp, 10 km south east at Beenleigh (Figure 1), due to loss of vegetation and urban expansion during the 1980s, was too early to account for the sudden reappearance of flying-foxes at Slack's Creek. Beenleigh was a major camp from October 1961 until at least August 1962 (Nelson 1965), and in the breeding season of 1978 there were approximately 12,000 *P. poliocephalus* in the camp. It is possible that the Logan River camp (Figure 1) also served as a temporary camp for the displaced Beenleigh flying-foxes as this camp was occupied from the mid 1980s until recently (2000), when it became abandoned.

### **Management of flying-fox camps - lessons from the past**

The management of flying-fox camps is pivotal to the overall conservation and management of the species. Much of what has been learnt about their management in the last 25 years has been thrust upon us by hasty and unplanned attempts to remove flying-fox camps. Information has also come from examining activities which resulted in the unintentional removal of flying-fox camps.

By taking an historical view of the appearance and disappearance of flying-fox camps in and around Brisbane, a wide range of management options has been addressed. This paper has focused on the long term results of moving camps. All methods of dispersal considered in this paper were human induced, although it has been claimed that flying-fox camps will move of their own accord following fire, floods and cyclones (Tidemann *et al.* 1999). Little is known about this aspect of flying-fox biology and there appears to be no long term information on camps dispersed by such means. With the changing availability and uncertainty of natural food resources, it is reasonable to expect that flying-foxes may have to change their pattern of camp use and establish new camp sites as a consequence. It is important that we use past experiences to plan for the future.

Some information has emerged on camp removal attempts. Camps that contain flying-foxes on the point of migrating will move. Total removal of vegetation obviously results in the loss of a camp. Restricted camps that can be totally surrounded during a disturbance have a better chance of being moved. Less restricted camps, where flying-foxes are able to move into surrounding vegetation during dispersal attempts, are very difficult to disperse. Camps containing females that have recently given birth are difficult to move by disturbance. Most of the camps that are difficult to move are those where males have established mating areas.

There have been many attempts, many failures and only a few claims of success in moving flying-fox camps. None of the claimed successes has ever been monitored in such a way that their effectiveness can be adequately assessed with any confidence. Often there are no data on the species involved, local flowering, social structure of the camp (i.e. resident or migrant bats), location of nearest flying-fox camp, did the numbers increase at that camp, was there food available, lack of radio tracking or other forms of identifying animals, or whether the bats were feeding locally or elsewhere.

### **Management of flying-fox camps – the future**

In looking at the results of the efforts and subsequent long term ramifications of camp removal as an option for management, it is apparent that in the future it will make most sense to manage flying-fox camps where they are and use strategies to lessen the impact on people who object to their presence. This approach removes the contentious and stressful activity of trying to move the camp to somewhere else. Long term observations suggest that in moving a flying-fox camp, the problem is merely transferred to other areas, and the whole process starts all over again with a new lot of players. As yet, there is no way of pre-determining the location of where a disturbed camp will settle. Most camps will be re-occupied at their original site after the disturbance ceases. Also, there are flying-foxes in other locations, with a geographical knowledge of the camp site, which could return to the camp at any time.

With the current state of our environment and the tendency for new flying-fox camps to be established in urban areas, it is likely that new camps resulting from the disturbance of an unwanted camp are highly likely to be in urban

areas. Also, new camp locations are often established near to the old camp due to the presence of a reliable local food resource, and increasingly these locations are in less suitable sites than the previous camp. There are fewer and fewer suitable locations for new flying-fox camps where conflicts are unlikely to occur. This is shown by the continual harassment that shifted the Cameron's Scrub camp to Woodend. The camp location at Cameron's Scrub was in a remote area of bushland away from any human dwellings and the new camp is now in the backyards of residents at Woodend. Likewise, the total destruction of the Fisherman Islands camp that was in mangroves appears to have resulted in two new urban camps at Hemmant and Norman Creek and two permanent camps at Indooroopilly Island and Cleveland, which had previously been only spasmodically used.

Another reason to manage flying-fox camps where they are, rather than try to move them, is that attempts to disperse flying-fox camps can be expensive and may not be successful (Vardon *et al.* 1997, Woodend see above). A wide range of noise generating techniques was used unsuccessfully to remove the camp from Woodend. The principal reason for the failure was that the flying-foxes could move into nearby vegetation and then return after the disturbance ceased. A management program involving local residents, council staff, fauna authorities and researchers was successfully implemented. It provides a good model for the future as demonstrated by the success of the program, including tree planting, rezoning and an information centre and brochures resulting in the camp attracting extensive publicity and its use for education and research and by the media and ecotour operators.

Evidence is accumulating that there are successful methods for manipulating flying-fox numbers in select areas of their camp, or in particular trees (Richards 2002). Replanting new areas with suitable quick-growing and roost-providing tree species for flying-foxes will entice them to occupy new areas in camps. Clearing away the understorey and removing low branches from roost trees will help to discourage flying-foxes from roosting in unwanted areas. We are only just beginning to understand the dynamics of flying-fox camps and how they are structured socially and seasonally. A fuller understanding of these aspects of flying-fox biology should lead to further ways of manipulating flying-foxes within camps.



As well as complaints regarding noise and smell, the damage caused to camp vegetation has been a major problem. The major cause of vegetation damage is when successive breeding and mating seasons occur in the same trees/branches. The size of Indooroopilly Island, and the general uniform growth of mangroves over a large part of the Island, have allowed the movement of flying-foxes from one area to another and have minimized damage to the vegetation. Movements of the maternity camp area by 300 m from one year to the next year have allowed damaged vegetation to recover. These intra-camp movements appear to be determined by the migratory segment of the population, and could be used as a management tool.

Flying-fox camp sites are dynamic places. Large and trouble-free camp sites are typified by having a sufficient area for the flying-foxes to move their roosting area around, which lessens damage to vegetation. Flying-foxes seem to seek areas out of the wind, particularly in winter. Breeding males appear to select trees with bare horizontal perches for marking and display. Females with young prefer some leafy cover for protection and a high stem density for group roosting. There is still a lot more that we need to know to successfully address camp management. The microclimate of camps needs more research. The translocation of male breeding perches to entice flying-foxes into new areas, seeding new areas with ground litter containing flying-fox droppings, or the location of orphan release cages set up in prospective new camp sites all need to be tested.

The Grey-headed Flying-Fox population is in a continual state of flux, with broadscale movement of individuals from camps occurring throughout the year. At any one time animals that occupy a particular camp can be anywhere between Bundaberg, Queensland and Melbourne, Victoria (Eby 1991, Spencer *et al.* 1991). These absentee

bats have the geographic knowledge of the camp's location. Who tells them that they are not wanted back at the camp site? When food runs out, these animals will return to their old camp site. If there are no other flying-foxes in the camp site, then they may go elsewhere only to cause problems by establishing a camp in a new site.

It is the predictability of the location of flying-fox camps that makes them the most sensible and reliable place as a starting point for management. If it is not known where a flying-fox camp is going to appear, it is difficult to make management preparations. If a new (or old) camp is dispersed to another area, it is likely that the whole problem of managing a new camp will start all over again with a new group of people. On a number of occasions, disturbances have resulted in flying-foxes establishing a temporary camp in a highly undesirable location (e.g. in back yards, hospital grounds, near airports) causing more serious problems than the previous camp site. The possibility of litigation by residents or fruit growers who suddenly have a flying-fox camp in their midst will also encourage some forward planning for flying-fox camp management by local councils and fauna authorities.

With the increasing urbanization of flying-foxes, it is essential that all local councils start planning by identifying suitable prospective flying-fox camp sites and making other areas potentially suitable, lest flying-foxes make the decision themselves and decide to camp in an undesirable place. Recently a National Heritage grant was made to a group including the Brisbane City Council, Greening Australia and a local environmental group to survey the state of vegetation and replenish trees in old and current flying-fox camp sites as a precaution for future occupancy (N. Markus *pers comm*). Revegetation and expansion of flying-fox roost sites is an essential part of camp management.

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## QUESTIONS & ANSWERS

**SANDY TEAGLE:** Thanks very much, Les.

**JOHN BICKNELL** (orchardist): Les, has any work been done on attractants as an aversion agent.

**LES HALL:** Yes, this is some of the work that Greg and I are doing in the Botanic Gardens - and again I'd like to thank the Botanic Gardens in Sydney for supporting this sort of work, it really has opened up our minds a lot and we are still in the process of developing some ideas for areas that we want to protect. If you look at Indooroopilly Island, you'll see that this sort of thing happens. Over the years the camp moves around and there are outlines of occupancy. If you look just at the centrums, where colonies are found, you'll see that there are big movements. One year they're here, then three years there, then they go over there, then they go way down here, and so on, then they're centering around here. Now, what we're looking at trying to do is make some areas, such as near a school or a hospital, a bit undesirable. We would like to be able to use our information about how to make these areas undesirable for flying foxes, rather than try to move flying foxes. Apart from that being a lost cause, it also causes a lot of anxiety, and costs a lot of money, so basically, John, that's what we're working on with these repellents.

**SANDY TEAGLE:** In the interests of afternoon tea, I might not call for any more questions.