

Large, temporary camps of the Little Red Flying-fox at Herberton

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Abstract

The Little Red Flying-fox (*Pteropus scapulatus*) is the ultimate nomadic nectarivore of woodlands and open forests, tracking mass-flowering of eucalypts and other trees over great distances and forming large, temporary day-time camps (roosts) where food is available in quantity. We here report the formation and subsequent disbandment of two such camps along the Wild River in the town of Herberton in north Queensland. The camps were present in the warmer months of 2013/14 and 2016/17 and were associated with unusually extensive flowering of a number of local eucalypts and especially the Inland White Mahogany (*Eucalyptus mediocris* syn. *E. portuensis*). In both periods, the camps occupied, at their peak, more than 500 m of riparian vegetation, and flying-foxes roosted in at least 32 plant species ranging from tall trees to 3-m shrubs. The basis for population estimates are scant, but it is suspected that numbers peaked at c. 50,000 to 100,000 in 2013/14 and c. 10,000 to 15,000 in 2016/17. The occurrence of these large camps in Herberton was short-lived and unusual, and coincided with the mating season. We argue that these events are ecologically important and fascinating, and should be viewed as an asset to the town.

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Introduction

Few if any species of fauna track flowering trees at which to feed over longer distances and in such spectacular abundance as the Little Red Flying-fox (*Pteropus scapulatus*). Occurring throughout the woodlands and open forests of northern and eastern Australia, they track areas where eucalypts (*Eucalyptus*, *Corymbia*, *Angophora*) and other trees such as paperbarks (*Melaleuca* spp.) are flowering abundantly (Richards 1995; Southerton *et al.* 2004). Daytime camps (roosts) have, exceptionally, contained over 500,000 individuals (Southerton *et al.* 2004) and perhaps as many as a million

(R. Plowright in Milne & Pavey 2011). Evidence of movements of hundreds and perhaps thousands of kilometres between camps is strong but inferential based on regional studies of camps (Richards 1995; Vardon & Tidemann 1999) as there have been no satellite radio-tracking studies. The range of the Little Red Flying-fox is larger, and the resources it uses are likely more patchy in time and space than those of the two Australian species that have been radio-tracked extensively, so its movements may be even greater. Individuals of the Grey-headed Flying-fox (*P. poliocephalus*) of south-eastern

Australia use camps up to 800 km apart (Eby 1991; Spencer *et al.* 1991; Roberts *et al.* 2012) and cumulative inter-camp movements of up to 2,000 km have been recorded (Tidemann & Nelson 2004; Roberts *et al.* 2012). A Black Flying-fox (*P. alecto*) satellite-tagged in Papua New Guinea was recorded moving 3,011 km in 342 days (Breed *et al.* 2010), though this appears to include some night-time foraging movements as well as inter-camp displacements.

The Little Red Flying-fox (Fig. 1) is the smallest of the four *Pteropus* species regularly recorded in Australia, weighing on average about 450 g (Menkhorst & Knight 2001). Whilst all Australian flying-foxes have tongues adapted for feeding on nectar and possibly pollen, the rough projections (papillae) on those of the Little Red Flying-fox indicate it is the most specialised to that end (Birt *et al.* 1997). Little Reds also have fewer molar teeth than other flying-foxes and are thus less able to chew fruit (Richards 1995). Of the three flying-



Figure 1. Smallest of the Australian flying-foxes, the Little Red Flying-fox is also the most specialised to a diet of nectar.

All photos are by Don Franklin.

fox species present in north Queensland, the Little Red occurs in drier country and most consistently in eucalypt woodlands and open forests rather than rainforest.

Here, we report the establishment and temporary use of day-time camps by substantial numbers of Little Red Flying-foxes on two occasions along the Wild River in the Herberton area at the western fringe of the Atherton Tablelands. Neither this species nor any other flying-fox routinely camps in the Herberton area, though a smaller but oft-frequented camp in rainforest is known from the Tolga Scrub – a very different environment – 19 km to the north-east.

Methods

Herberton (17°23'S, 145°23'E) is nestled in a valley 900 m above sea level near the head of the Wild River in the ranges on the west of the Atherton Tableland. Mean annual rainfall is 1,175 mm. The town is set on infertile, shallow soils amidst dry eucalypt forest frequently dominated by Inland White Mahogany (*Eucalyptus mediocris* syn. *E. portuensis*, known locally as Yellow Stringybark) and Lemon-scented Gum (*Corymbia citriodora*) but with a wide variety of other eucalypts (*Eucalyptus* and *Corymbia*) species as well. To the north, east and south it is surrounded by higher ranges supporting moist and wet eucalypt forest and upland rainforest, these generally at a minimum of four to five kilometres distance. Within a radius of 10 km, c. 90% of original native forests remain (estimated from Google Earth) notwithstanding a history of disturbance from mining, logging and some land-clearing. The Wild River runs through the town. Here, its riparian vegetation comprises a mix of remnant native vegetation and revegetated areas featuring, in particular, Forest Red Gum (*Eucalyptus tereticornis*, AKA Blue Gum) over an understorey of Weeping Bottlebrush (*Melaleuca viminalis* [formerly *Callistemon viminalis*]).

Little Red Flying-foxes were present in Herberton for a number of months in 2013/14 and again in 2016/17. During these periods, we made general observations on numerous occasions, keeping diary notes of these and taking photographs. In addition, on 10 Jan. 2014 and 16 Dec. 2016, dates when the camps were at or near their maximum extent for the respective periods, we mapped the camps by walking around them at a distance that avoided undue disturbance, plotting the

boundaries on a printed air photo of the area downloaded from Google Earth (www.google.com/earth/). On 16 Dec. 2013 we identified and counted all the plant species used for roosting.

Flying-foxes may be censused during the day at the camp, or as they depart from it at dusk, termed *static* and *flyout* counts respectively by van der Ree *et al.* (2006). Static counts may be constrained by obstructing vegetation and the need to avoid disturbing the animals, whilst flyout counts require a relatively-singular flight path (or series of them) well illuminated against the dusk sky. The position of the Herberton camps in a fairly steep-sided valley and amongst dense tall shrubbery was problematic for static counts especially in 2013/14 when many camped in a broad, dense band of tall shrubs. On both occasions, the lack of singular flight paths once the flying-foxes had achieved sufficient elevation to be evident against the sky constrained our attempts at flyout counts. Further, while flyout counts may be usefully accurate, accuracy declines markedly with camp sizes even of less than 10,000 (Westcott & McKeown 2004; Forsyth *et al.* 2006) such that the numbers present in Herberton especially in 2013/14 would have severely strained the usefulness of this approach to population estimation.

On 17 Dec. 2013 we took a high-resolution digital image of flying-foxes against a clear-sky background during the evening fly-out; this was estimated to contain no more than 10% of the total that flew out that evening. The photo was viewed at actual pixel size in Photoshop Elements (© Adobe Systems Inc.), a grid of 40 x 40 cells imposed on it, and the flying-foxes in it counted cell by cell.

On 26 Dec. 2016, we conducted a static count, walking along the length of the camp on one side and in addition counting some discrete portions from the other side. After initially counting individuals in a sparse end of the roost, serving to calibrate our counting, we then counted the remainder in clusters of 10, or occasionally 5 or 20 where the flying-foxes were particularly dense. During this count, we took two photographs of stand-alone trees with flying-foxes present, and subsequently compared our estimate for those trees with the number we could detect in the photographs. This provided a rough calibration of the accuracy of our count of observed flying-foxes,

but does not account for the substantial portion believed to have been concealed.

Results

Little Red Flying-foxes were present in camps along the Wild River in Herberton at broadly the same times of year – the warmer months – in both 2013/14 and 2016/17 (Tables 1 & 2). Small numbers were heard in the district in late October or November of each period. The camp along the Wild River began to form in mid-November or soon thereafter, with large numbers arriving in early-mid December. The major difference in timing between the periods was with departure, which occurred abruptly in late January 2017 but with large numbers (though perhaps less than peak) remaining present through February 2014 and small numbers present in March 2014. No other species of flying-fox was observed in these camps.

At their peak extent in each period, the camps extended more-or-less continuously along the Wild River for more than 500 m, with several hundred metres of overlap between periods and the 2016/17 camp stretching further downstream (Fig. 2). Though the 2016/17 camp occupied a longer stretch of the river (c. 650 m) than that in 2013/14 (c. 560 m), flying-fox density within the camp was markedly lower in the latter period. In 2013/14, seemingly every tree and shrub more than 3-m tall was occupied, spanning at least 32 species (Table 3) and including dead trees (Fig. 3). Over a substantial portion of the period of their presence, only relatively minor fluctuations in the camp boundary were noted, typically one tree-width laterally or several along the length of the stream.

However, in mid-January 2014, the camp contracted to occupy only the area upstream of the bridge over the Wild River on the main road into Herberton from Atherton. It is unclear whether this represented a drop in population because the density of individuals in that area increased even further to quite extraordinary levels (Fig. 4). At this elevated density, branches of trees and shrubs were broken apparently by the weight of many individuals, and the camp further contracted to the less-affected understorey shrubs (Fig. 5). Subsequent further contraction was clearly associated with a drop in numbers (Table 1). A similar marked contraction with clear drop in numbers was noted shortly before the abrupt departure in late January 2017, with the camp then

Table 1. Diary of events associated with occurrence of Little Red Flying-foxes around Herberton in 2013/14.

The river is the Wild River and the bridge (17°22.92'S, 145°23.05'E) is in Herberton on the main road from Atherton.

Date	Event
c. 28 November	several hundred flying-foxes noted flying high over the river
29 November	small camp heard on the river well downstream from the bridge
11 December	many thousands noted flying and settling along the river in the late afternoon. The activity stretched from c. 100 m upstream of the bridge to c. 200 m downstream of it
12 December	camp limits upstream and downstream identified: the camp is c. 560 m long
16 December	camp is of similar extent to 12 Dec.
18 December	evening fly-out observed; thought to be more than 50,000 individuals
21 December	similarly huge numbers in the evening fly-out
27 December	at least as many present in camp and fly-out as previous, possibly even more
10 January	mapped the camp; minor changes only since mid December
18 January	250 m upstream retraction of the downstream limit of the camp (no change to upstream limit), but even greater concentration of flying-foxes in the remaining area so that it isn't clear that there's been any decline in population
19 January	the evening fly-out is still a massive spectacle of similar proportions to previous
2 February	much disturbance during the day and clear lateral expansion of the camp
11-25 February	<i>no observations made</i>
c. 28 February	100 m further contraction of roost upstream; its downstream limit is now a few metres upstream from the bridge. Upper canopy of trees in camp now mostly defoliated and many branches broken; the camp is now concentrated in bent-over tall shrubs and lower branches of trees
5 March	massive reduction in numbers, with perhaps only 15-20% remaining of those present a week ago; camp contracted to c. 100 m in length upstream from immediately upstream of the bridge
9 March	further substantial decline in numbers and retraction in area of camp
c. 17 March	numbers and area similar to 9 March
20 March	numbers perhaps to 9 March similar but the camp has moved c. 60 m upstream
22 March	perhaps only 500 remaining; camp in small area 160 m upstream from bridge
30 March	DCF walked the full length of the camp and found no flying-foxes

confined to two small areas 70 m apart (Table 2). The downstream of these consisted of a very-dense packed group in just two trees, and much agitation was evident among the flying-foxes in it.

An image containing a small proportion (thought to be less than 10%) of the evening flyout from the 2013/14 camp (Fig. 6) contains 6,063 identifiable individuals. At this time, flying-foxes initially formed a 'swarm' high above the river that appeared to us to be over a kilometre long before breaking up and dispersing in varied directions.

A static (daytime) count on 26 Dec. 2016 yielded 6,374 individuals. Two calibration photos

suggested that the count of visible individuals was underestimated by 26%, though this is an average of two quite discrepant counts (50 estimated, 86+ in photo; 120 estimated, 133+ in photo) so the level of confidence in this estimate is low. Applying this correction factor nevertheless, it is estimated that 8,987 individuals were observable. The number that were not visible is unknown (obviously) but likely to have been substantial.

The arrival of flying-foxes in Herberton was associated in time in both periods with the onset of mass-flowering of Inland White Mahogany in the open forests surrounding Herberton (see Franklin

Table 2. Diary of events associated with occurrence of Little Red Flying-foxes around Herberton in 2016/17.

The river is the Wild River and the bridge is that in Herberton (17°22.92'S, 145°23.05'E) on the main road from Atherton.

Date	Event
late Oct.–Nov.	a few heard after dark associated with flowering Cadaghi (<i>Corymbia torelliana</i>) in Herberton
mid. November	at some point after Nov. 12, a camp began to form along the Wild River well downstream from the bridge; numbers built up after that time
9 December	camp is now large; upstream limit identified to be c. 20 m downstream from the bridge continuous to a downstream limit c. 120 m upstream from the Morris Road ford, a distance of 650 m; however, they are much less densely-packed within this area than they were in the 2013/14 camp - evening flyout observed distantly; there are many thousands of individuals but much fewer than in 2013/14
16 December	camp mapped; it is similar extent to 9 Dec., with a small retreat from the downstream end; individuals roosting from 3 to c. 25 m above ground.
18 December	evening flyout observed from near upstream end, but they flew downstream low over the river, rising out of valley from near the other end of the camp
23 December	evening flyout observed from the downstream end; they do indeed fly at about tree-top height along the valley until rising almost the southern end to cross Morris Road above tree-top height. The stream passed Morris Road on exit for about five minutes
24 December	evening flyout observed from the downstream end; numbers seem higher than the previous evening, with dispersal beginning before they reach Morris Road and some continuing fairly low further along the river. The fly-out commenced at 7:06PM and was more-or-less completed at 7:16PM though there were still a few stragglers emerging. Numbers peaked rapidly after emergence commenced, and continued at peak numbers for about 6 minutes before tailing off
26 December	static count attempt. The roost has retracted c. 50 m from the downstream end and they appear relatively sparse in most of the roost
31 December	evening flyout observed from the downstream end; they remain very abundant
19 January	first check for some time following a spell of wet weather; the upstream half of the roost, at least, is of similar extent
30 January	few remaining. These were mapped and found to be in two discrete patches of c. 50 and 25 m length 70 m apart and confined to one bank of the river. The smaller, downstream patch, however, was extremely dense-packed and there was much agitation in the group
31 January	checked thoroughly; none present

et al. 2016 for the 2013/14 event) and also flowering of Red Mahogany (*E. resinifera*) in moister open forests in the surrounding ranges. Nocturnal activity of the Little Red Flying-fox was frequently associated with flowering trees of the former species, and numerous broken flower-bearing branchlets were evident on the ground below them. Temporal association of the presence of the Little Red Flying-fox with flowering of Red

Mahogany was noted at property level (David Johnson, personal communication). In both periods, a number of other eucalypts flowered from c. late December on, most prominently including Lemon-scented Gum and Pink Bloodwood (*C. intermedia*). Whilst it was likely that these also provided food for the flying-foxes, we have no direct confirmation of this nor indirect evidence to support it.

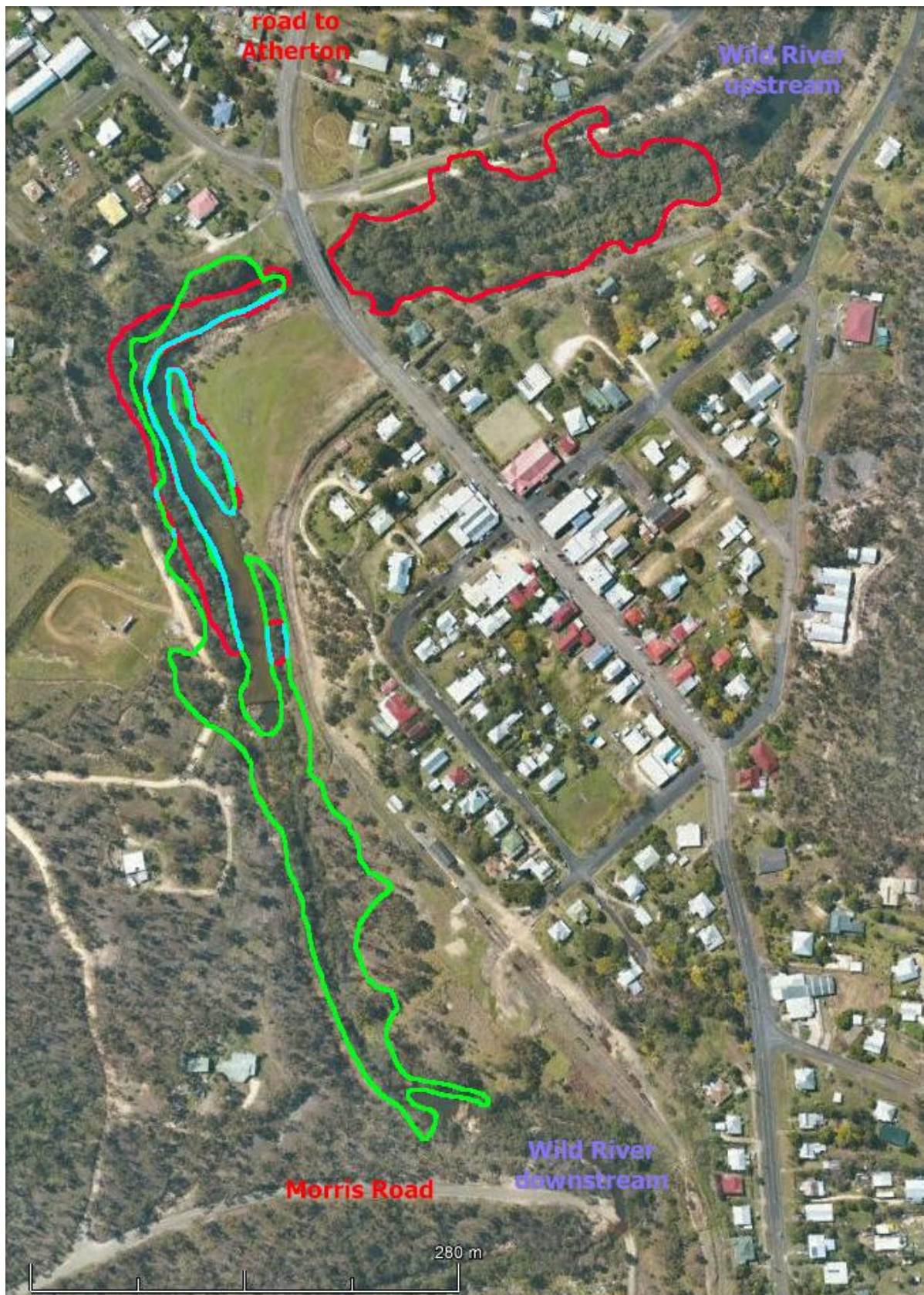


Figure 2. Extent of camps of the Little Red Flying-fox in Herberton at or near peak extent for each period; red lines – 10 Jan. 2014; green lines – 16 Dec. 2016; pale blue lines – common boundaries on both dates.

The base image, taken on 13 Sept. 2013, is from Queensland Globe (© State of Queensland 2016), downloaded via Google Earth.

Table 3. Tree and shrub species in which Little Red Flying-foxes were roosting at Herberton, 16 Dec. 2013.

n is the number of plants, total 328+. *Melaleuca viminialis* was dominant and crowded in the understorey along the stream line and individuals could not be adequately distinguished nor the presence of flying-foxes necessarily confirmed.

Tree species	growth form	n
Forest Red Gum (Blue Gum), <i>Eucalyptus tereticornis</i>	tree with sparse foliage	67
Dryland Salwood, <i>Acacia disparrima</i>	bushy shrub	46
Inland White Mahogany, <i>Eucalyptus mediocris</i>	tree with sparse foliage	44
River She-oak, <i>Casuarina cunninghamiana</i>	tree	36
Weeping Bottlebrush, <i>Melaleuca viminialis</i>	bushy shrub, sometimes a small tree	34+
Blackwood, <i>Acacia melanoxylon</i>	small tree with dense foliage	16
Weeping Paperbark, <i>Meleleuca leucadendra</i>	tree	12
Lemon-scented Gum, <i>Corymbia citriodora</i>	tree with sparse foliage	12
Sweet Honey-myrtle, <i>Lophostemon suaveolens</i>	tree	10
Sweet Blackthorn, <i>Bursaria tenuifolia</i>	small tree	9
other live trees and shrubs, 22 species, including rainforest trees, eucalypts, exotic species, bamboo	various	38
dead trees	dead tree	4



Figure 3. In 2013/14, even dead trees were occupied as roost sites by the Little Red Flying-fox.

Photo: Wild River, Herberton, 15 Dec. 2013.

In 2013/14, a coincident camp of Little Red Flying-foxes was reported from the lake in Irvinebank (Brian Cherry, personal communication); this is 20.2 km WSW from the Herberton camp. On 20 Dec. 2016, we located a roost of Little Red Flying-foxes at Moomin, 5.5 km ENE from the Herberton Camp. The camp formed a narrow band in small (regenerating) trees on the edge of moist sclerophyll forest of Red Mahogany and Tindal's Stringybark (*Eucalyptus tindaliae* syn. *E. reducta*) (Fig. 7). The camp was estimated to be c. 250 m long by matching field observations to a Google Earth image, and although no counts were conducted, it was estimated that quite a few thousand flying-foxes were present. Numerous Red Mahogany trees were flowering in the area but a causal link was not established. No flying-foxes were present when the site was re-examined on 1 Jan. 2017, nor on 3 Feb. 2017 shortly after they departed from the Herberton camp.

A few trees died in the area upstream from the bridge on the main road from Atherton that was severely damaged in Feb. 2014 evidently by weight of flying-foxes, but most had already begun to resprout by late March of that year (Fig. 8).



Figure 4. Dense packing of the Little Red Flying-fox camp after marked contraction in its area in mid-January 2014.

Photographed along the Wild River at Herberton, 2 Feb. 2014.



Figure 5. As tree branches broke under evident weight of the Little Red Flying-foxes, the camp contracted to the arched but unbroken branches of understory plants, mainly Weeping Bottlebrush (*Melaleuca viminalis*).

Photographed along the Wild River at Herberton, 5 March 2014.



Figure 6. A small portion of the evening flyout, 17 Dec. 2013.
At the time, it was 'guesstimated' that this photo contained no more than 10% of those that flew out that evening. 6,063 individuals were identified in this image.



Figure 7. A substantial camp of Little Red Flying-foxes was present in the tall shrub / small tree layer on the edge of this moist eucalypt forest at Moomin, 20 Dec. 2016.



Figure 8. Trees stripped of branches and foliage by the weight of Little Red Flying-foxes roosting in them in February 2014 had already begun to resprout when this photo was taken on 30 March 2014.

Discussion

Discussion among residents of Herberton at the time indicated that the 2013/14 event was an exceptional one. Most had no memory of any large camp of Little Red Flying-foxes in the town, although we received one second hand report of a similar occurrence 'about 40 years ago'. That the species should visit the region from time to time is not surprising, though, because the extensive eucalypt open forests that surround the town are expected to provide nectar and pollen as food for the Little Red Flying-fox during occasional major flowering events.

The 2013/14 event was extraordinary; the evening flyout (of which Fig. 6 was but a small part) demanding the attention of all town residents and the scent from the camp permeating much of the town (to varied responses from townsfolk!). We can make only a rough estimate of the numbers involved, but inferring from our count of individuals in Fig. 6 and the rate of bat 'throughput' at the time, there may have been from 50,000 to 100,000 flying-foxes in the camp. We suspect this estimate is conservative but have insufficient data to support this. There were clearly much fewer flying-foxes present in 2016/17 such that some town (human!) residents seemed unaware of their presence, but the camp was still substantial; upward adjustment to our static count to allow for those not visible suggests a figure of 10,000 to 15,000.

The arrival in, and to a lesser extent the departure of the Little Red Flying-fox from Herberton seemed clearly associated with exceptional flowering of the Inland White Mahogany and perhaps also of Red Mahogany, the latter in the nearby higher ranges. Inland White Mahogany is an abundant tree in the dry sclerophyll forests on infertile soils around Herberton, and flowers sparingly if at all in most years. Mass-flowering in Inland White Mahogany typically occurs about once per decade and the cues or drivers of these events are unknown (Franklin *et al.* 2016). That the species flowered *en masse* again three years later, though not as strongly as in 2013/14, is somewhat surprising but quite consistent with Franklin *et al.*'s proposition that it is a masting species. Masting species flower *en masse* at intervals greater than one year. It seems likely that many eucalypts in the Herberton area and elsewhere are masting species, though

this is poorly documented (reviewed in Franklin *et al.* 2016). It is possible that similar triggers promoted strong flowering by a number of eucalypt species in succession in the same years, providing foraging options for the Little Red Flying-fox around Herberton, though this suggestion is speculative on a number of counts. Infertile soils of granitic, rhyolitic and metamorphic origin in the vicinity of Herberton do not appear to favour frequent flowering by eucalypts (DCF personal observation).

Little Red Flying-fox mate seasonally in late spring–early summer, at which time testes enlarge more than threefold (O'Brien *et al.* 1993). This coincides with their arrival and early presence in Herberton. We observed a number of males with evidently-enlarged testes (Fig. 9), suggesting that mating may indeed have occurred in Herberton. Births occur in autumn (Plowright *et al.* 2008) and we did not observe any evidence of dependent young in the Herberton camps.



Figure 9. Testes of the Little Red Flying-fox enlarge seasonally at mating time.
Photographed at Herberton, 16 Dec. 2016.

Our observations suggest that Little Red Flying-foxes aggregate more densely in camps and become agitated prior to departure, but further observations are needed to test this proposition.

Conclusion

The Herberton camps were temporary, with large numbers present for from two to three months, and it is evident (DCF personal observations) that the surrounding forests are incapable of providing a food supply for large numbers on other than an infrequent basis. When they do visit the area, it is likely that they provide an important pollination service for eucalypts (Southerton *et al.* 2004) – the trees that feature so prominently in the Herberton area as in many other parts of Australia. We note also that flying-foxes are ecologically interesting and attractive, and that their evening flyouts can be spectacular events that might well be promoted as tourist attractions.

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