

Warrell Creek to Nambucca Heads

Grey-headed Flying Fox Population Monitoring

Operational Phase

Roads and Maritime Services | 2018

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	Revision 6	May 2018 monitoring report
	Revision 7	June 2018 monitoring report
	Revision 8	July 2018 monitoring report
	Revision 9	August 2018 monitoring report
	Revision 10	September 2018 monitoring report
	Revision 11	October 2018 monitoring report
	Revision 12	November 2018 monitoring report

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Appendix 12	November 2018 monitoring report

1. Introduction

Grey-headed Flying Fox population monitoring is a requirement of the approved Warrell Creek to Nambucca Heads Flying-fox management plan and the Ecological Monitoring Program. Following the opening of the Warrell Creek to Nambucca Heads highway upgrade to traffic in December 2017, Roads and Maritime is required to undertake monthly field monitoring for a period of 12 months following the methodology outlined in the Management Plan.

2. Purpose of this report

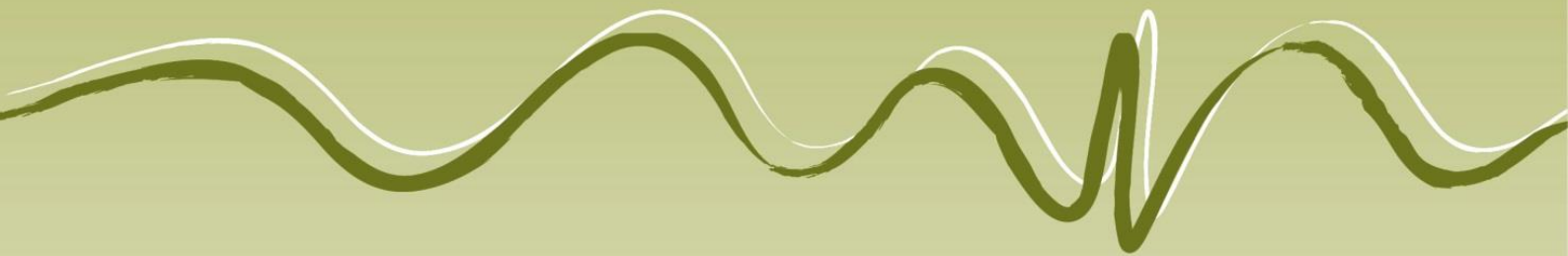
The purpose of this report is to provide the monitoring data for the twelve months from December 2017 to November 2018 inclusive.

This report is updated with the results of the monthly monitoring as they become available. The monthly population monitoring reports are provided in the Appendices.

Appendix 1 December 2017 monitoring report.

Flying-fox Monitoring December 2017

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services have been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp is located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the December 2017 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the December 2017 flying-fox monitoring:

- Tom Pollard (ecologist).
- Frank Makin (ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 21 December 2017. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics.
- Reproductive status.
- Behaviour.

When the site is unoccupied and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the above-mentioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site. Specifically, the two observers were located at the following vantage points:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 30 minutes from sunset until dark (approximately 7:45 pm to 8:15 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street Camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

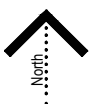
2.2.1 Roost Footprint

No flying-foxes were recorded roosting at the site in the traverse.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over approximately 2.70 hectares (refer to **Illustration 2.2**).

Flying-foxes were not recorded at the Wheatley Street camp in Bellingen or at Bowraville.

Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). The extent of the roost footprint at both Bellingen Island and Gordon Park was similar to that observed in the previous monthly monitoring event.



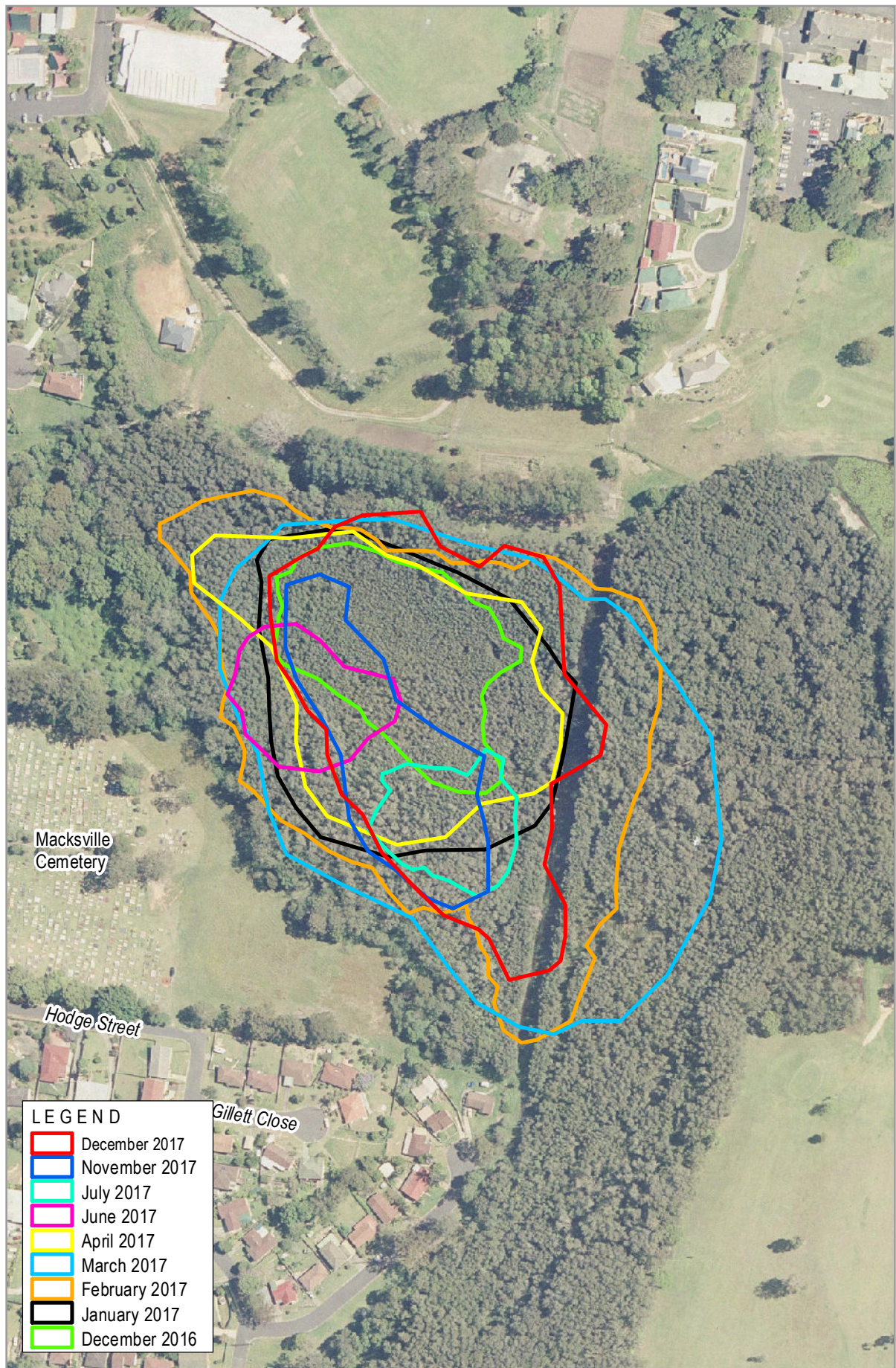
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Location of Regional Flying-fox Camps

Flying-fox Monitoring December 2017 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1075

Illustration 2.1



0 60

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Macksville Cemetery Flying-fox Roost Footprint

Flying-fox Monitoring December 2017 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1076

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 22,000 individuals were recorded exiting the Macksville Cemetery camp in the exit count. The majority of these flying-foxes were exiting in a north to north-westerly stream.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are as follows:

- Gordon Park: approximately 10,000 individuals.
- Bellingen Island: approximately 15,000 individuals.
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 95% GHFF and 5% Black Flying-fox.
- Bellingen Island: 95% GHFF and 5% Black Flying-fox.
- Gordon Park: 80% GHFF and 20% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). During this period of absence the Macksville Cemetery camp has been the alternative site for collection of this data.

Both male and female GHFF were present at the Macksville Cemetery camp. The weather during this part of the monitoring was not ideal for sexing animals, with rain falling and low light levels. Consequently, only five demographic point counts could be completed. Nonetheless, data collected at these demographic point counts indicated that the proportion of female GHFF present was generally high and ranged from 77% to 100% of all individuals (refer to **Table 2.1**). The percentage of females with dependent young GHFF at demographic point counts averaged 54% (ranging between 30% and 70%).

Both male and female GHFF were also present at the Bellingen Island camp. Data collected in demographic point counts indicated that the proportion of female GHFF present was generally moderate to high and ranged between 47% and 91% of all individuals (refer to **Table 2.2**). The percentage of females with dependent young GHFF at demographic point counts averaged 49% (ranging between 10% and 70%).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present, as well as females with dependent young.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492067, 6601756	Broad-leaved Paperbark	10	20	10:3	Yes	60
MC2	492068, 6601743	Broad-leaved Paperbark	12	20	10:0	Yes	70
MC3	492079, 6601733	Broad-leaved Paperbark	10	20	10:3	Yes	30
MC4	492092, 6601710	Broad-leaved Paperbark	12	25	10:1	Yes	50
MC5	492111, 6601672	Broad-leaved Paperbark	15	30	10:2	Yes	60
MC6	Data not collected due to poor weather conditions	Data not collected due to poor weather conditions	Data not collected due to poor weather conditions	Data not collected due to poor weather conditions	Data not collected due to poor weather conditions	Data not collected due to poor weather conditions	Data not collected due to poor weather conditions
MC7	"	"	"	"	"	"	"
MC8	"	"	"	"	"	"	"
MC9	"	"	"	"	"	"	"
MC10	"	"	"	"	"	"	"

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	489956, 6631585	Moreton Bay Fig	10	50	10:9	Yes	10
BI2	489968, 6631574	Creek Sandpaper Fig	10	20	10:2	Yes	40
BI3	489979, 6631565	Creek Sandpaper Fig	8	15	10:3	Yes	50
BI4	489995, 6631551	Creek Sandpaper Fig	8	30	10:5	Yes	50
BI5	490021, 6631538	Moreton Bay Fig	10	35	10:1	Yes	70
BI6	490037, 6631533	Creek Sandpaper Fig	10	15	10:4	Yes	70
BI7	490049, 6631536	Creek Sandpaper Fig	12	20	10:4	Yes	60
BI8	490023, 6631574	Giant Stinging Tree	12	35	10:1	Yes	30
BI9	490023, 6631616	Small-leaved Fig	8	50	10:3	Yes	60
BI10	490009, 6631623	Sandpaper Fig	8	30	10:5	Yes	50

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 45 cm in depth and has been declining since peaking in October (refer to **Figure 2.1**).

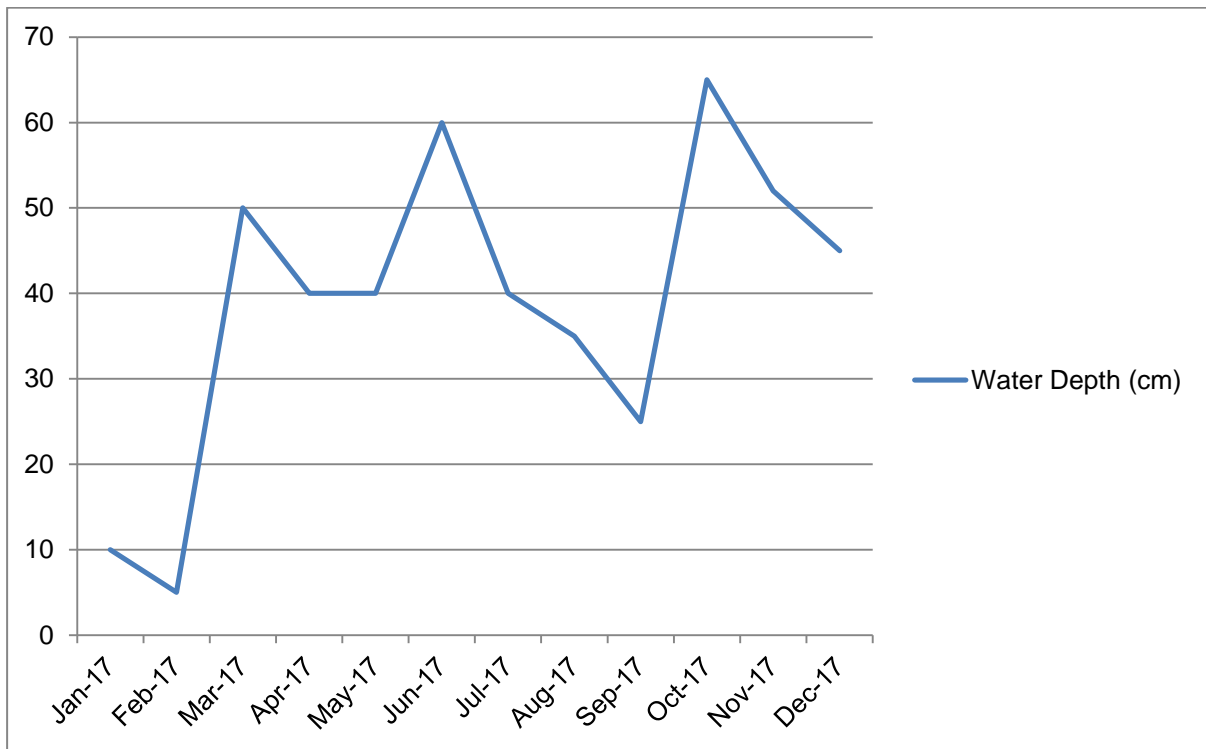


Figure 2.1 Water level measurements at the site

2.3 Discussion


2.3.1 Population Estimates

The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

The number of flying-foxes at the Macksville Cemetery camp has continued to increase from the low levels or absence that typically occurs over winter and early spring at this camp. Less than half the number of flying-foxes observed in the current monitoring event were present at this camp in December 2016 (GeoLINK 2016).

At both the Bellingen Island and Gordon Park camps a similar trend in flying-fox numbers is evident over the past 6 months, with the highest numbers in winter, a brief low in October, and then an increasing trend over the past two months (refer to **Figure 2.2**). These camps were supporting a similar number of individuals at this time last year (GeoLINK 2016).

No flying-foxes were recorded at Bowraville in the current monitoring event. Over the past 12-month period, flying-foxes have only been present at this camp in very low numbers during late spring and early summer of 2016/17.



As can be seen in the 12-monthly population comparisons (refer to **Figure 2.2**), after reaching a low point in October the overall population levels at occupied camps are generally showing an increasing trend.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up between 80% and 95% of all individuals. These proportions are within the range that has been typically observed for these camps in previous monitoring events.

Female GHFF dominated the occupied camps in the current monitoring event, with demographic point counts averaging 74% at Bellingen Island and 84% at Macksville Cemetery. Similar proportions were recorded in the previous monthly monitoring event.

At the Macksville Cemetery camp dependent young were present at a moderate level alongside 54% of all female GHFF (ranging between 30% and 70% at individual demographic point counts). This is a substantial increase from the previous monitoring event where only 23% of female GHFF were recorded with dependent young. In contrast, the results of the December 2016 monitoring recorded no dependent young GHFF at the Macksville Cemetery camp (GeoLINK 2016).

The percentage of female GHFF with dependent young at Bellingen Island in this monitoring event averaged 49% (ranging between 10% and 70% at individual demographic point counts). A similar percentage was recorded in both the previous monitoring event and in the monitoring in December 2016 (GeoLINK 2017; GeoLINK 2016).

2.3.3 Phenology of Trees in the Region

December/January bi-monthly flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes various *Corymbia* spp. (Bloodwoods and Spotted Gums), New England Blackbutt (*Eucalyptus andrewsii*), River Red Gum (*E. camaldulensis*), Coastal Blackbutt (*E. pilularis* - foothills and ranges), Grey Ironbark (*E. siderophloia* - foothills and ranges), Forest Red Gum (*E. tereticornis* – *high altitude*) and Black Bean (*Castanospermum australe*). These are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps recorded light flowering of Pink Bloodwood (*Corymbia intermedia*).

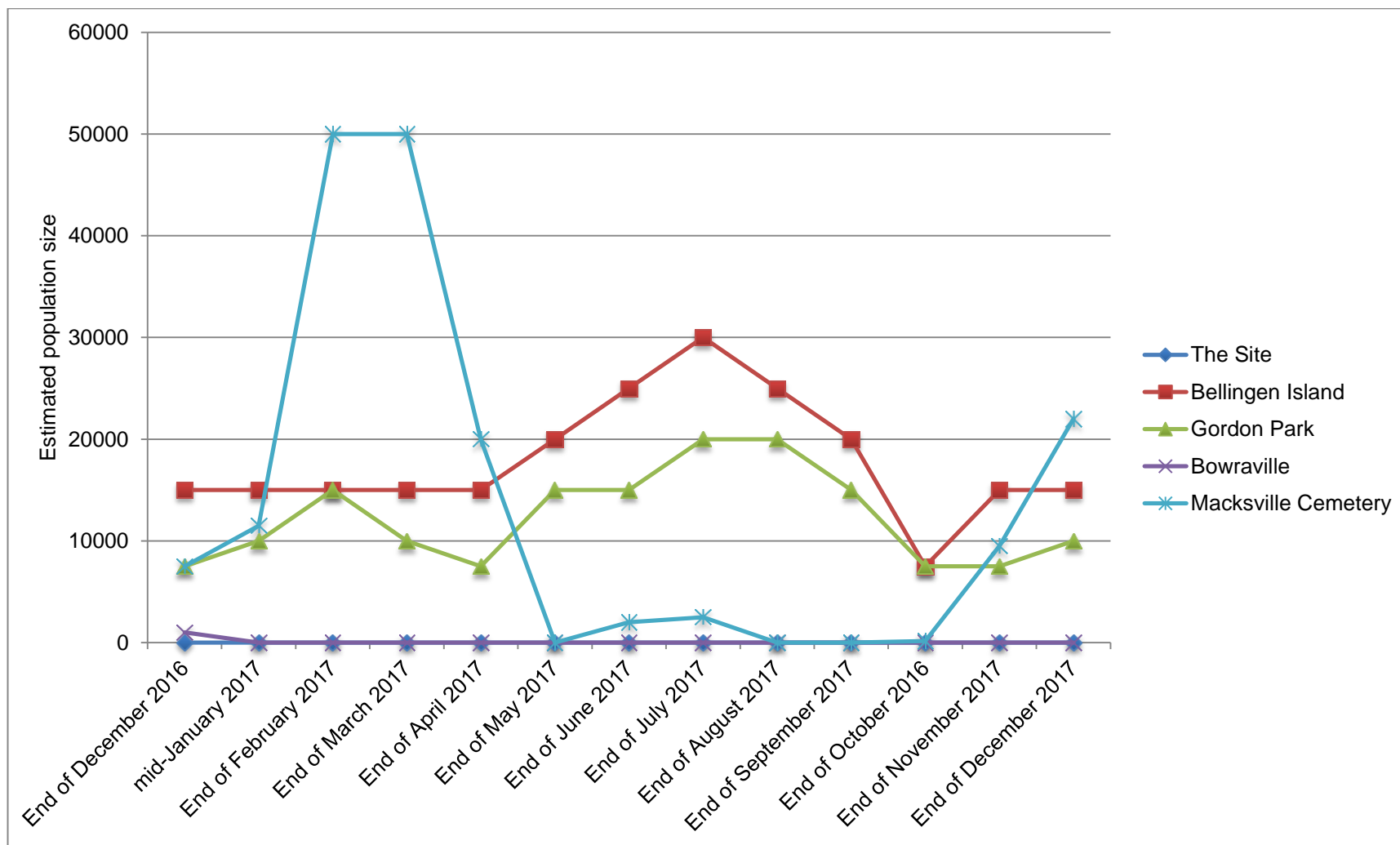


Figure 2.2 Population trends at the site and regional camps over past 12 months



2.4 Summary and Conclusion

The results of the December 2017 flying-fox monitoring indicate that excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014.

The number of flying-foxes at the Macksville Cemetery camp has continued to increase from the low levels/ absence that typically occurs over winter and early spring at this camp.

Over the past 6 months at both the Bellingen Island and Gordon Park camps, flying-fox numbers have followed a similar trend with highest numbers present in winter, a brief low in October, and then an increasing trend over the past two months (late spring/ early summer).

Flying-foxes remain absent from Bowraville and Wheatley Street, Bellingen.

GHFF dominated the species composition of the Bellingen Island and Gordon Park camps making up between 80% and 95% of all individuals present.

Dependent young GHFF were present at a moderate level within occupied camps in the current monitoring event.

Light flowering of Pink Bloodwood, a key diet species for the GHFF, was observed to be currently occurring in the region.



David Andrighetto

Senior Ecologist



References

Eby, P. (2012). *An Assessment of the Flying-fox Camp at Macksville*. Unpublished report to NSW Roads and Maritime Services.

Eby, P. (2013). *A Field Monitoring Program Proposed for the Macksville Flying-fox Roost*. Unpublished report to Sinclair Knight Merz.

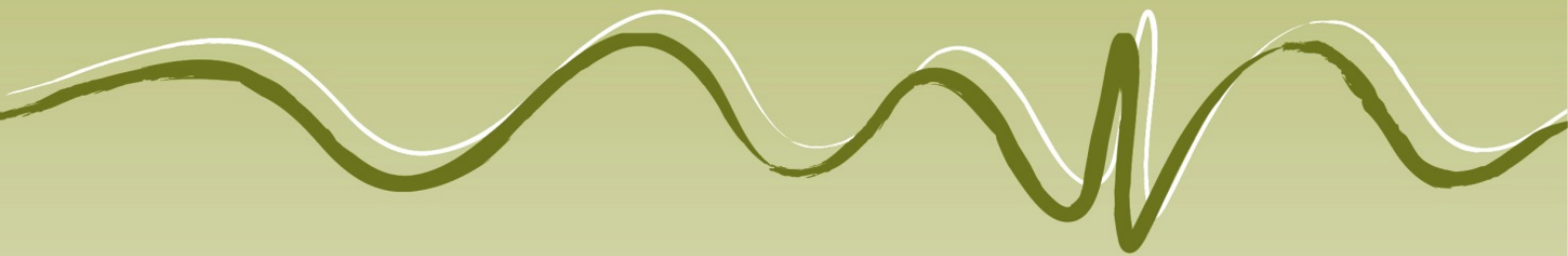
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GeoLINK. (2017). *Flying-fox Monitoring November 2017: Warrell Creek to Nambucca Heads Pacific Highway Upgrade*. Unpublished report to NSW Roads and Maritime Services.

Appendix 2 January 2018 monitoring report.

Flying-fox Monitoring January 2018

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services have been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp is located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the January 2018 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the January 2018 flying-fox monitoring:

- Tom Pollard (ecologist).
- Dylan Hisselli (environmental scientist/ ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 24 January 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics.
- Reproductive status.
- Behaviour.

When the site is unoccupied and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the above-mentioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site. Specifically, the two observers were located at the following vantage points:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 30 minutes from sunset until dark (approximately 7:45 pm to 8:15 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street Camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

No flying-foxes were recorded roosting at the site in the traverse.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over a comparatively large area of approximately 6.1 hectares (refer to **Illustration 2.2**).

Flying-foxes were not recorded at the Wheatley Street camp in Bellingen or at Bowraville.

Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). The extent of the roost footprint at Bellingen Island was observed to be covering a larger area than that recorded in the previous monthly monitoring event (GeoLINK 2017), including substantial roosting in the upper canopy of the emergent fig trees within the rainforest remnant (refer to Plate 2.1). In contrast, at Gordon Park the roost extent had not changed from that recorded in the previous monitoring event.



Plate 2.1 GHFF roosting in the upper canopy of figs at Bellingen Island



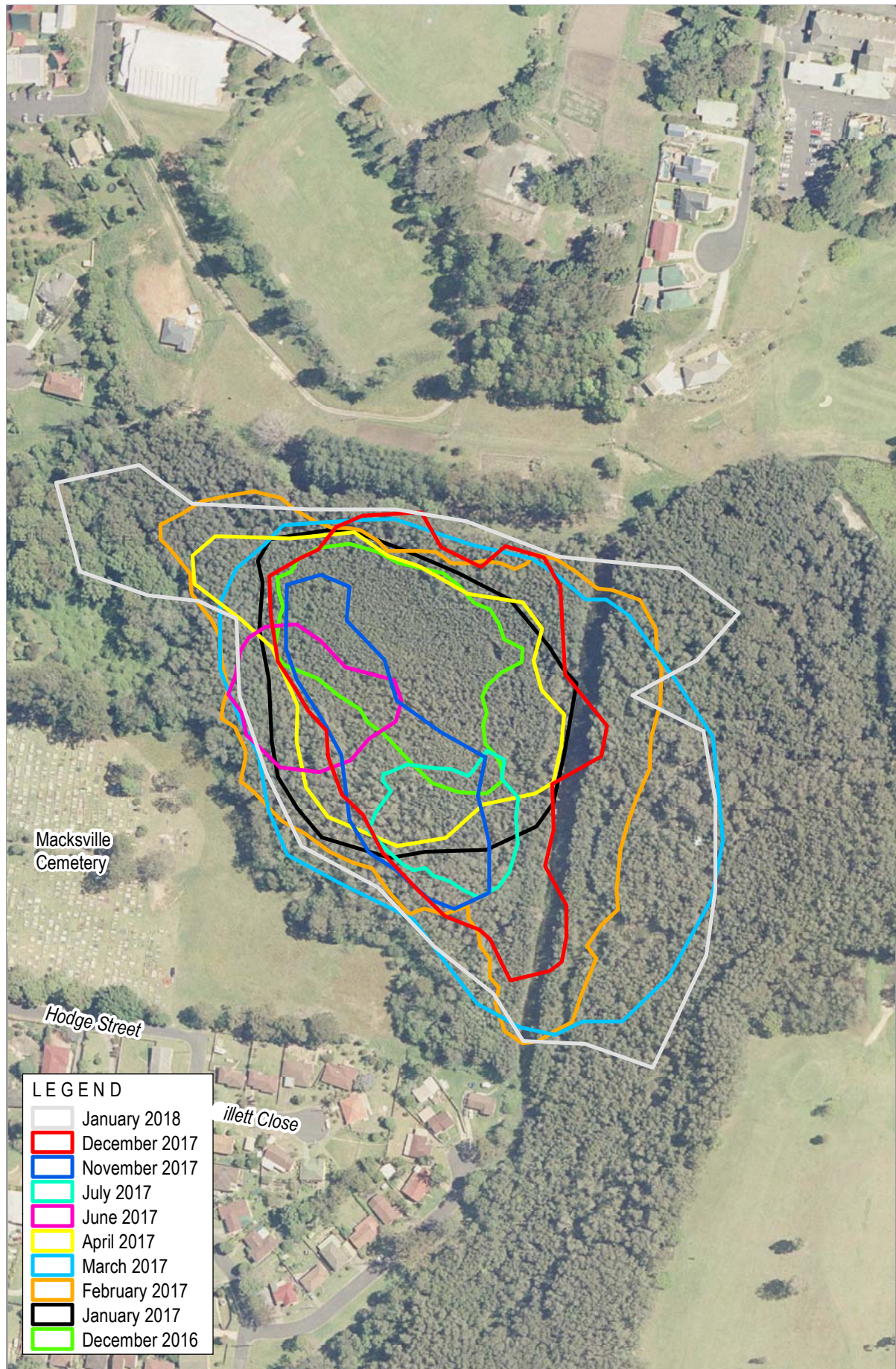
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Location of Regional Flying-fox Camps

Flying-fox Monitoring January 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1079

Illustration 2.1



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Macksville Cemetery Flying-fox Roost Footprint

Flying-fox Monitoring January 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1080

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 50,000 individuals were recorded exiting the Macksville Cemetery camp in the exit count. The flying-foxes were exiting in two broad streams, one in a north to north-westerly direction and another in a south to south-easterly direction

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are as follows:

- Gordon Park: approximately 10,000 individuals.
- Bellingen Island: approximately 30,000 individuals.
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 95% GHFF and 5% Black Flying-fox.
- Bellingen Island: 95% GHFF and 5% Black Flying-fox.
- Gordon Park: 90% GHFF and 10% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). During this period of absence the Macksville Cemetery camp has been the alternative site for collection of this data.

Both male and female GHFF were present at the Macksville Cemetery camp. The data collected indicated that the proportion of female GHFF present was high, ranging between 56% and 100% of all individuals at individual demographic point counts (83% average), (refer to **Table 2.1**). The percentage of females with dependent young GHFF at demographic point counts was moderate, ranging between 30% and 80% (55% average).

Both male and female GHFF were also present at the Bellingen Island camp. Data collected indicated that the proportion of female GHFF present was high, ranging between 58% and 91% of all individuals at individual demographic point counts (83% average), (refer to **Table 2.2**). The percentage of females with dependent young GHFF at demographic point counts was also generally high, ranging between 50% and 80% (70% average).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present. Dependent young were also observed with many of the females.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492036, 6601830	Broad-leaved Paperbark	15	30	10:3	Yes	60
MC2	492047, 6601840	Broad-leaved Paperbark	12	20	10:8	Yes	30
MC3	492036, 6601809	Broad-leaved Paperbark	12	30	10:2	Yes	80
MC4	492058, 6601775	Broad-leaved Paperbark	12	20	10:0	Yes	60
MC5	492080, 6601772	Broad-leaved Paperbark	15	30	10:2	Yes	50
MC6	492073, 6601735	Broad-leaved Paperbark	15	20	10:2	Yes	50
MC7	492107, 6601677	Broad-leaved Paperbark	12	20	10:0	Yes	50
MC8	492124, 6601680	Broad-leaved Paperbark	15	30	10:3	Yes	50
MC9	492117, 6601664	Broad-leaved Paperbark	12	30	10:1	Yes	60
MC10	492145, 6601645	Broad-leaved Paperbark	15	30	10:3	Yes	60

Table 2.2 Demographic Data of GHFF at the Belling Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	489984, 6631558	Creek Sandpaper Fig	12	15	10:1	Yes	70
BI2	489995, 6631544	Creek Sandpaper Fig	10	20	10:3	Yes	80
BI3	490008, 6631528	Unkown sp.	12	30	10:7	Yes	80
BI4	490047, 6631522	White Cedar	12	40	10:2	Yes	50
BI5	490058, 6631496	Giant Stinging Tree	20	100	10:1	Yes	80
BI6	490074, 6631487	White Booyong	20	40	10:3	Yes	70
BI7	490091, 6631489	Creek Sandpaper Fig	12	20	10:3	Yes	70
BI8	490101, 6631503	Giant Stinging Tree	12	20	10:1	Yes	70
BI9	490088, 6631527	Giant Stinging Tree	20	30	10:1	Yes	70
BI10	490097, 6631534	Giant Stinging Tree	15	30	10:1	Yes	60

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 55 cm in depth, which is a 10 cm increase from the level recorded last month (refer to **Figure 2.1**).

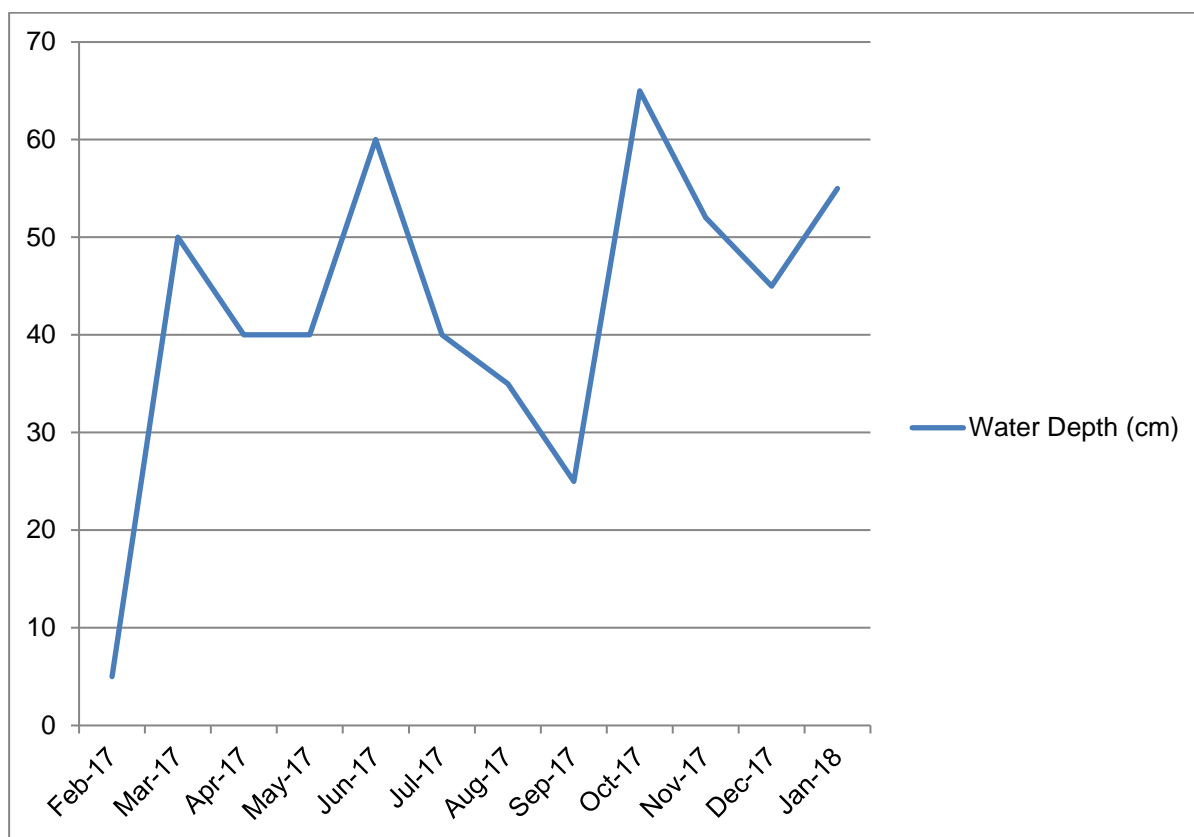


Figure 2.1 Water level measurements at the site


2.3 Discussion

2.3.1 Population Estimates

The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

The number of flying-foxes at the Macksville Cemetery camp has continued to increase from the low levels or absence that typically occurs over winter and early spring at this camp. An estimated 50,000 individuals were recorded in the current monitoring event. A similar increase in flying-fox numbers was also recorded at the Bellingen Island camp over the past month. This relatively high number of flying-foxes at both of these camps is most likely a reflection of the current availability of key food resources in the locality (refer to (**Section 2.3.3**)).

In contrast, at the Gordon Park camp there has not been a recent sharp increase in flying-fox numbers. The comparatively moderate flying-fox numbers at the Gordon Park camp possibly reflects the overall poor condition of the rainforest canopy caused by a consistent flying-fox presence, resulting in an altered (and potentially less favourable) microclimate for roosting.



No flying-foxes were recorded at Bowraville in the current monitoring event. Over the past 12-month period, flying-foxes have only been present at this camp in very low numbers during late spring and early summer of 2016/17.

As can be seen in the 12-monthly population comparisons (refer to **Figure 2.2**), after reaching a low point in October the overall population levels at occupied camps are generally continuing to increase as summer progresses (with the exception of the Gordon Park camp).

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up between 80% and 95% of all individuals, similar to the proportions recorded in the previous monthly monitoring event (GeoLINK 2017).

Female GHFF dominated the occupied camps in the current monitoring event, with demographic point counts averaging 83% at both the Bellingen Island and Macksville Cemetery camps. A similar proportion was recorded in the previous monitoring event (GeoLINK 2017).

At the Macksville Cemetery camp dependent young were present at a moderate level alongside 55% of all female GHFF, similar to the proportion recorded in the previous monitoring event (GeoLINK 2017). In contrast the percentage of female GHFF with dependent young at Bellingen Island has increased substantially from 49% in the previous monitoring event (GeoLINK 2017) to 70% in the current monitoring event.

2.3.3 Phenology of Trees in the Region

December/January bi-monthly flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes various *Corymbia* spp. (Bloodwoods and Spotted Gums), New England Blackbutt (*Eucalyptus andrewsii*), River Red Gum (*E. camaldulensis*), Coastal Blackbutt (*E. pilularis* - foothills and ranges), Grey Ironbark (*E. siderophloia* - foothills and ranges), Forest Red Gum (*E. tereticornis* – *high altitude*) and Black Bean (*Castanospermum australe*). These are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps recorded moderate to heavy flowering of Pink Bloodwood (*Corymbia intermedia*).

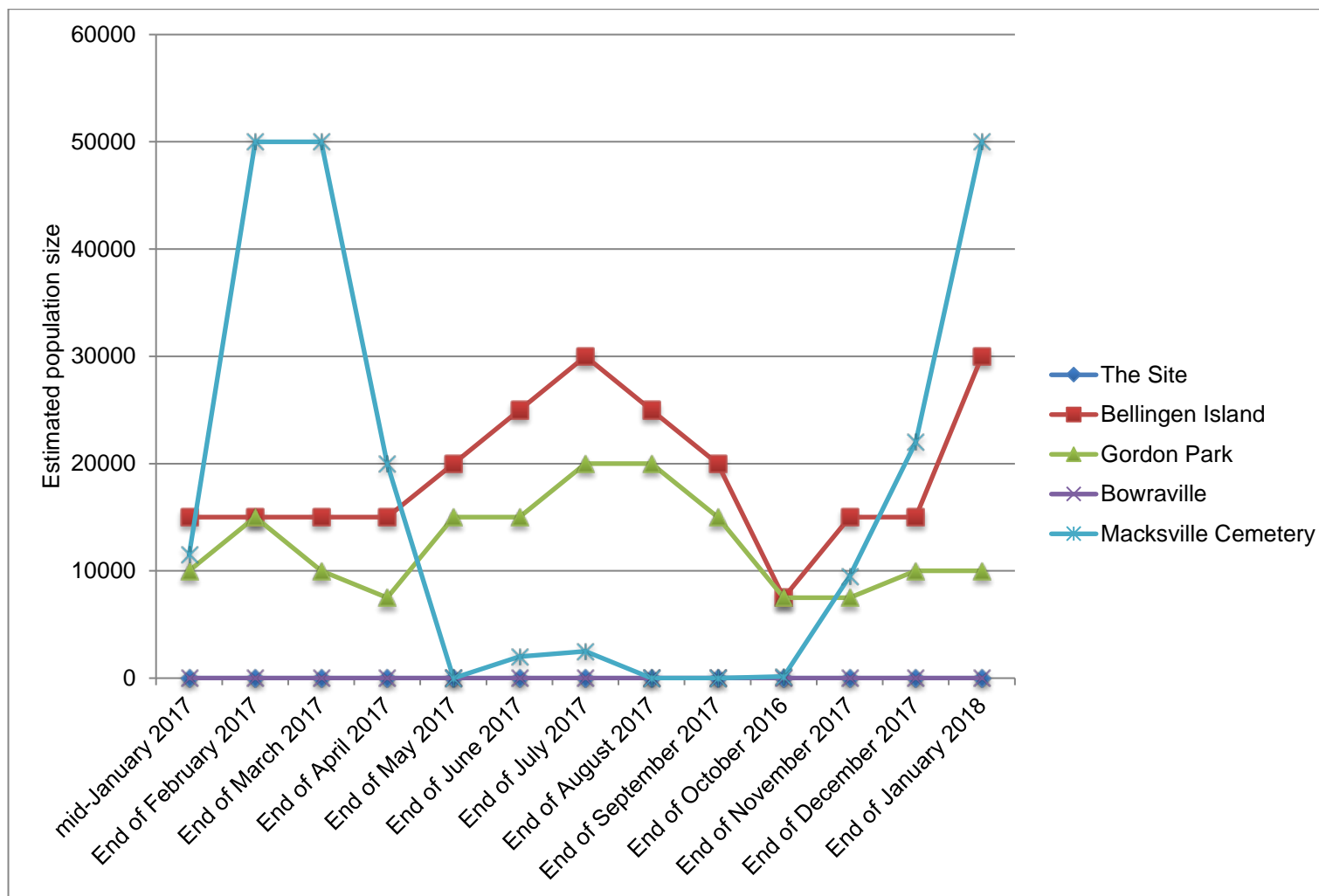


Figure 2.2 Population trends at the site and regional camps over past 12 months



2.4 Summary and Conclusion

The results of the January 2018 flying-fox monitoring indicate that excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014.

The number of flying-foxes at both the Macksville Cemetery and Bellingen Island camps have increased substantially over the last month, and are now at around 50,000 and 30,000 individuals respectively. The relatively high number of flying-foxes at these camps is most likely a reflection of the current availability of key food resources in the locality (e.g. flowering Pink Bloodwood).

The Gordon Park camp has not seen this recent sharp increase in flying-fox numbers. The comparatively moderate flying-fox numbers at the Gordon Park camp possibly reflects the overall poor condition of the rainforest canopy caused by a consistent flying-fox presence, resulting in an altered (and potentially less favourable) microclimate for roosting.

Flying-foxes remain absent from Bowraville and Wheatley Street, Bellingen.

GHFF dominated the species composition at occupied camps making up between 80% and 95% of all individuals present.

Dependent young GHFF were present at a moderate to high level within occupied camps in the current monitoring event.

Moderate to heavy flowering of Pink Bloodwood, a key diet species for the GHFF, was observed to be currently occurring in the region.



David Andrighetto
Senior Ecologist



References

Eby, P. (2012). *An Assessment of the Flying-fox Camp at Macksville*. Unpublished report to NSW Roads and Maritime Services.

Eby, P. (2013). *A Field Monitoring Program Proposed for the Macksville Flying-fox Roost*. Unpublished report to Sinclair Knight Merz.

GeoLINK. (2017). *Flying-fox Monitoring December 2017: Warrell Creek to Nambucca Heads Pacific Highway Upgrade*. Unpublished report to NSW Roads and Maritime Services.

Appendix 3 February 2018 monitoring report

Flying-fox Monitoring February 2018

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services have been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp was located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the February 2018 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the February 2018 flying-fox monitoring:

- Tom Pollard (ecologist).
- Jess O'Leary (ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 28 February 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics.
- Reproductive status.
- Behaviour.

When the site is unoccupied and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the abovementioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site. Specifically, the two observers were located at the following vantage points:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 30 minutes from sunset until dark (approximately 7:30 pm to 8:00 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street Camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

No flying-foxes were recorded roosting at the site in the traverse.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over a relatively large area of approximately 3.3 hectares (refer to **Illustration 2.2**).

Flying-foxes were not recorded at the Wheatley Street camp in Bellingen or at Bowraville.

Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). The extent of the roost footprint at Bellingen Island has remained much the same as that recorded in the previous monthly monitoring event (GeoLINK 2018), with the exception of a minor enlargement of the roost to include isolated trees in the old caravan park grounds alongside Dowle Street. In contrast to the previous monthly monitoring event, only a few small groups of roosting flying-foxes were observed in the upper canopy of the emergent fig trees.

At the Gordon Park camp the roost extent has not substantially changed from that recorded in the previous monitoring event, with a general absence of flying-foxes from the upper canopy of the rainforest that supports nil to sparse foliage cover from previous roosting by large numbers of flying-foxes.



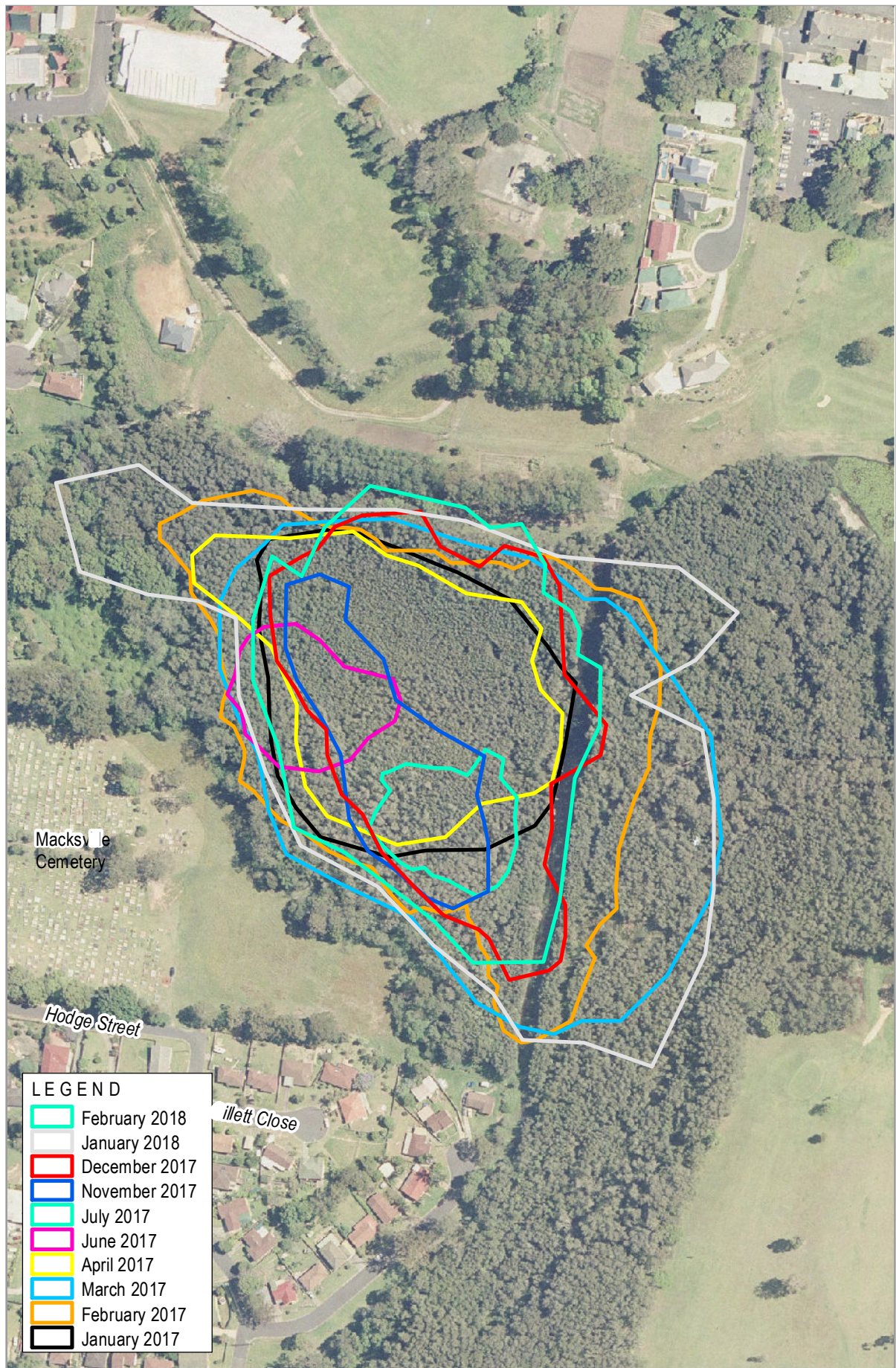
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Location of Regional Flying-fox Camps

Flying-fox Monitoring February 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1086

Illustration 2.1



0 60

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environmental management and design

Macksville Cemetery Flying-fox Roost Footprint

Flying-fox Monitoring February 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1087

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 30,000 individuals were recorded exiting the Macksville Cemetery camp in the exit count. The flying-foxes were exiting in two broad streams, one in a north to north-westerly direction and another in a south to south-easterly direction.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are as follows:

- Gordon Park: approximately 10,000 individuals.
- Bellingen Island: approximately 25,000 individuals.
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 80% GHFF and 20% Black Flying-fox.
- Bellingen Island: 95% GHFF and 5% Black Flying-fox.
- Gordon Park: 80% GHFF and 20% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). During this period of absence, the Macksville Cemetery camp has been the alternative site for collection of this data.

Both male and female GHFF were present at the Macksville Cemetery camp. Young dependent GHFF were present, although some individuals were beginning to display semi-independent behaviour by spending periods of time roosting alongside their mothers. The data collected indicated that the proportion of female GHFF present was high, ranging between 58% and 100% of all individuals at individual demographic point counts (75% average), (refer to **Table 2.1**). The percentage of females with dependent young GHFF at demographic point counts was moderate to high, ranging between 50% and 80% (62% average).

Both male and female GHFF were also present at the Bellingen Island camp. As was observed at the Macksville cemetery camp, dependent young GHFF were present with these individuals showing some semi-independent behaviour by spending time roosting alongside their mothers. Data collected indicated that the proportion of female GHFF present was high, ranging between 76% and 100% of all individuals at individual demographic point counts (91% average), (refer to **Table 2.2**). The percentage of females with dependent young GHFF at demographic point counts was moderate to high, ranging between 60% and 90% (74% average).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present. Dependent young (including semi-independent individuals) were also observed with many of the females.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492137, 6601656	Broad-leaved Paperbark	12	20	10:5	Yes	60
MC2	492126, 6601658	Broad-leaved Paperbark	12	20	10:7	Yes	50
MC3	492098, 6601685	Broad-leaved Paperbark	12	30	10:0	Yes	80
MC4	492081, 6601727	Broad-leaved Paperbark	15	30	10:1	Yes	70
MC5	492065, 6601731	Broad-leaved Paperbark	12	30	10:4	Yes	50
MC6	492057, 6601762	Broad-leaved Paperbark	15	20	10:5	Yes	50
MC7	492036, 6601812	Broad-leaved Paperbark	12	20	10:3	Yes	60
MC8	492044, 6601833	Broad-leaved Paperbark	15	30	10:5	Yes	60
MC9	492095, 6601861	Broad-leaved Paperbark	15	20	10:3	Yes	70
MC10	492103, 6601850	Broad-leaved Paperbark	12	20	10:4	Yes	70

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	489984, 6631555	Stag (dead tree)	8	50	10:3	Yes	70
BI2	489999, 6631549	Creek Sandpaper Fig	8	40	10:2	Yes	80
BI3	490025, 6631541	Creek Sandpaper Fig	10	30	10:0	Yes	80
BI4	490038, 6631535	Creek Sandpaper Fig	8	30	10:1	Yes	70
BI5	490043, 6631514	White Booyong	12	40	10:1	Yes	90
BI6	490069, 6631503	Giant Stinging Tree	12	40	10:0	Yes	70
BI7	490084, 6631491	Giant Stinging Tree	15	50	10:1	Yes	90
BI8	490098, 6631503	Giant Stinging Tree	10	30	10:0	Yes	60
BI9	490098, 6631549	Creek Sandpaper Fig	8	20	10:2	Yes	70
BI10	490086, 6631567	Unidentified sp.	8	30	10:1	Yes	60

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 50 cm in depth, which is a five centimetre decrease from the level recorded last month (refer to **Figure 2.1**).

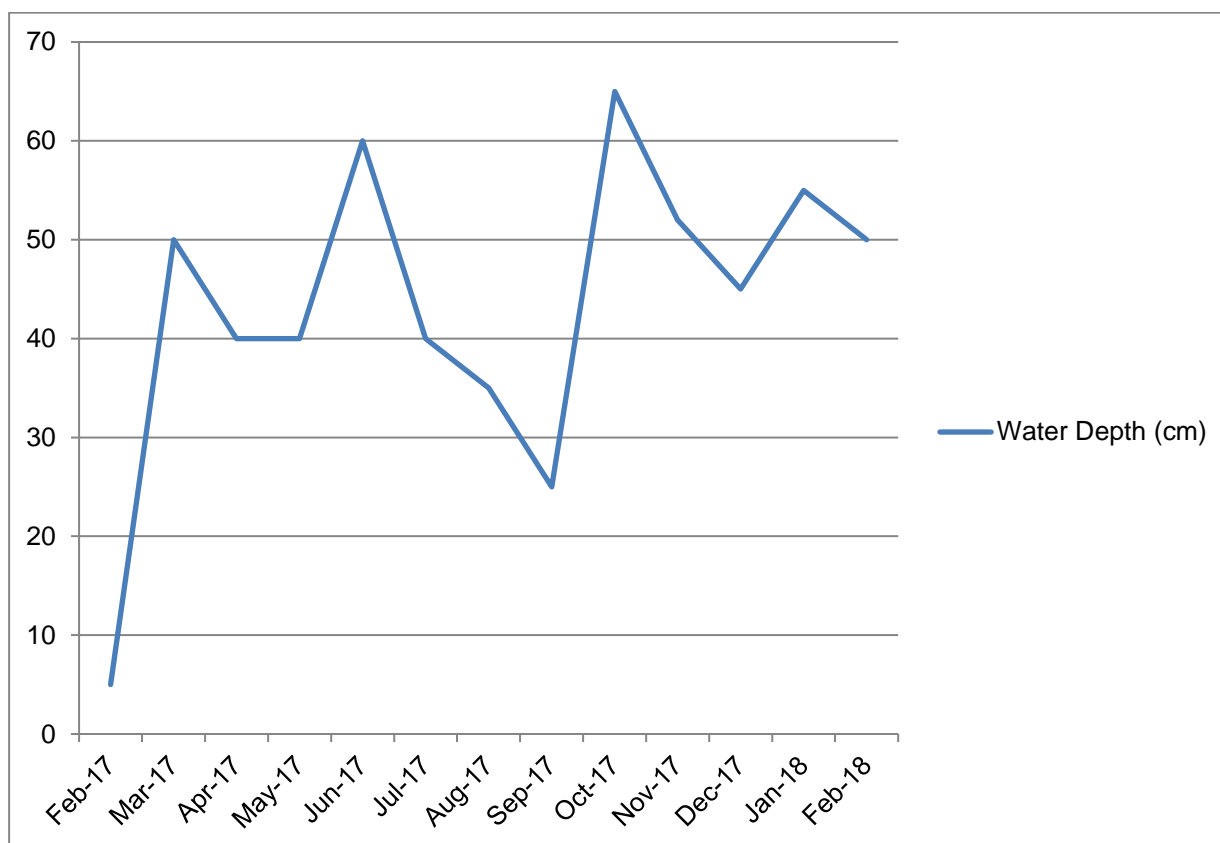



Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

The number of flying-foxes at the Macksville Cemetery camp has decreased from approximately 50,000 individuals in the previous monthly monitoring event to 30,000 in the current monitoring event. In February 2017 flying-fox numbers were still at a summer peak of approximately 50,000 individuals (GeoLINK 2017). It was estimated that approximately 25,000 flying-foxes were present at the Bellingin Island camp in the current monitoring event, which is similar to the number recorded in the previous monthly monitoring event. In February 2017 the estimated number of flying-foxes roosting at the Bellingin Island camp was approximately 15,000 (GeoLINK 2017); substantially fewer than was recorded in the current monitoring event.



The number of flying-foxes estimated to be roosting at the Gordon Park camp has remained steady over the past three months at around 10,000 individuals. A similar population level was present in February 2017, when it was estimated that approximately 15,000 individuals were roosting at this camp (GeoLINK 2017).

No flying-foxes were recorded at Bowraville in the current monitoring event. Flying-foxes have been absent from this site for over 12 months, and were last recorded in December 2016 in low numbers.

As can be seen in the 12-monthly population comparisons (refer to **Figure 2.2**), numbers of flying-foxes at the regional camps appear to have now reached a summer maximum, as is generally the case in response to a seasonal increase in the availability of key foraging resources.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up between 80% and 95% of all individuals, similar to the proportions recorded in the previous monthly monitoring event (GeoLINK 2018).

Female GHFF dominated the occupied camps in the current monitoring event, with demographic point counts averaging 91% the Bellingen Island camp and 75% at the Macksville Cemetery camp. Similarly, high proportions were recorded in the previous monitoring event (GeoLINK 2018).

At both the Macksville Cemetery camp and the Bellingen Island camp dependent young were present at a moderate to high level, and in similar proportions to that recorded in the previous monitoring event, at 62% and 74% respectively (GeoLINK 2018).

2.3.3 Phenology of Trees in the Region

February/ March bi-monthly flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes various *Corymbia* spp. (Bloodwoods and Spotted Gums), New England Blackbutt (*Eucalyptus andrewsii*), Coastal Blackbutt (*E. pilularis* - foothills and ranges), Sydney Blue Gum (*E. saligna*) and Broad-leaved Paperbark (*Melaleuca quinquenervia*). These are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps recorded moderate flowering of Broad-leaved Paperbark.

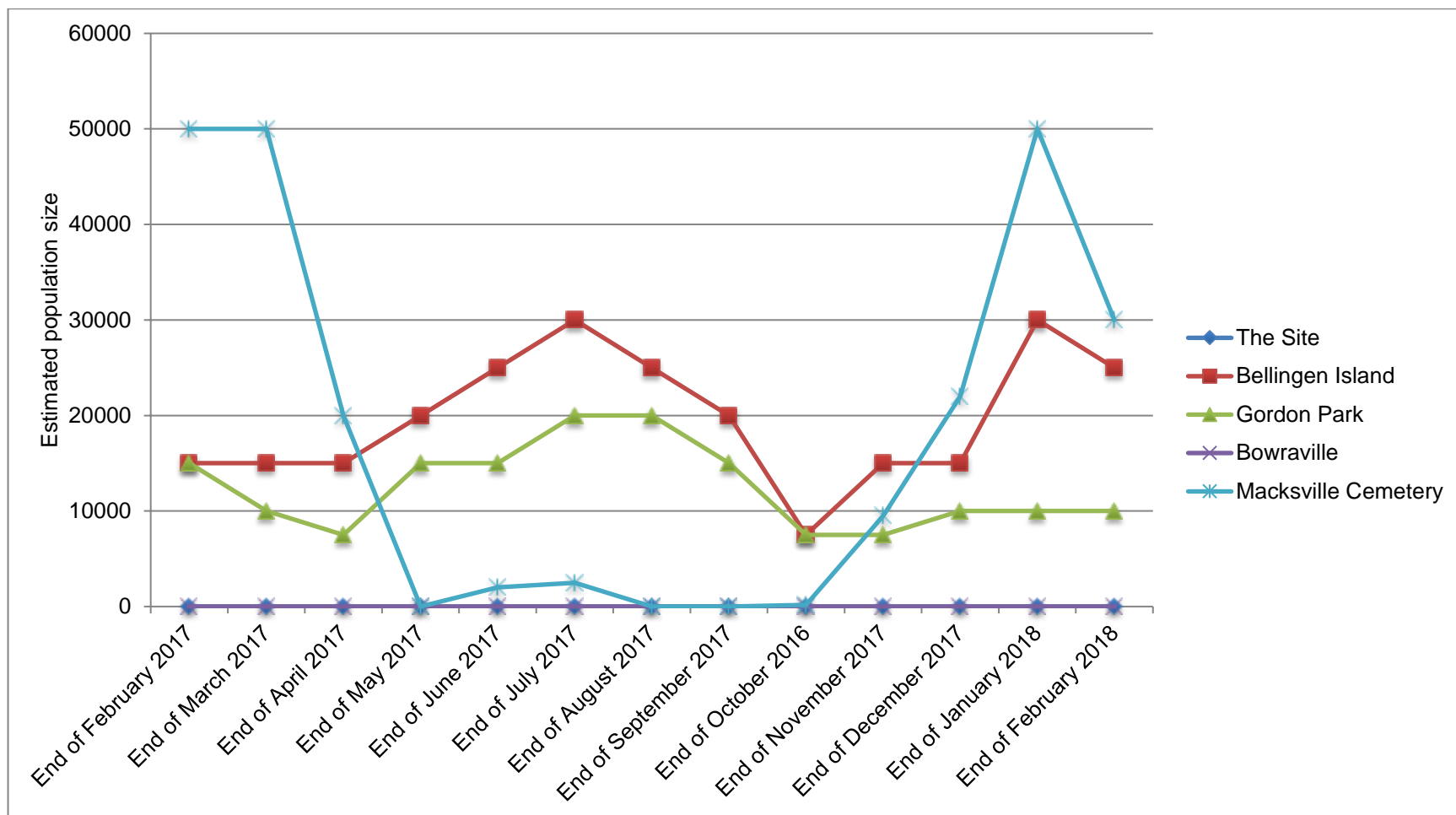


Figure 2.2 Population trends at the site and regional camps over past 12 months



2.4 Summary and Conclusion

The results of the February 2018 flying-fox monitoring indicate that excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014. T

The number of flying-foxes at the Macksville Cemetery camp has decreased from approximately 50,000 individuals in the previous monthly monitoring event to 30,000 in the current monitoring event. Over the same period at the Bellingen Island camp the number of flying-foxes has decreased marginally from 30,000 individuals to 25,000 individuals.

The number of flying-foxes estimated to be roosting at the Gordon Park camp has remained steady over the past three months at around 10,000 individuals.

Flying-foxes remain absent from Bowraville and Wheatley Street, Bellingen.

GHFF dominated the species composition at occupied camps making up between 80% and 95% of all individuals present.

Dependent young GHFF were present at a moderate to high level within occupied camps in the current monitoring event. Some young were displaying semi-independent behaviour (roosting alongside their mothers).

Moderate flowering of Broad-leaved Paperbark, a key diet species for the GHFF, was observed to be currently occurring in the region.



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References

Eby, P. (2012). *An Assessment of the Flying-fox Camp at Macksville*. Unpublished report to NSW Roads and Maritime Services.

Eby, P. (2013). *A Field Monitoring Program Proposed for the Macksville Flying-fox Roost*. Unpublished report to Sinclair Knight Merz.

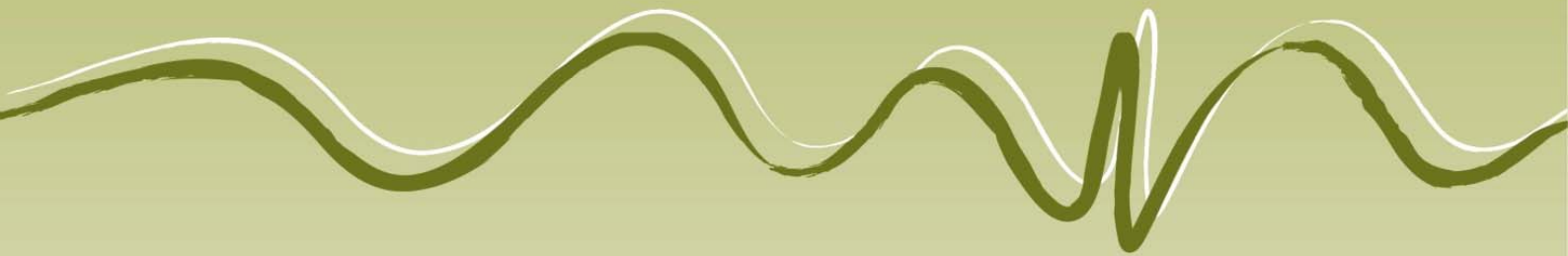
GeoLINK. (2017). *Flying-fox Monitoring February 2017: Warrell Creek to Nambucca Heads Pacific Highway Upgrade*. Unpublished report to NSW Roads and Maritime Services.

GeoLINK. (2018). *Flying-fox Monitoring January 2018: Warrell Creek to Nambucca Heads Pacific Highway Upgrade*. Unpublished report to NSW Roads and Maritime Services.

Appendix 4 March 2018 monitoring report.

Flying-fox Monitoring March 2018

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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<i>UPR</i>	<i>Description</i>	<i>Date Issued</i>	<i>Issued By</i>
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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services has been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp was located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the March 2018 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the March 2018 flying-fox monitoring:

- Tom Pollard (ecologist).
- Frank Makin (ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 26 March 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics.
- Reproductive status.
- Behaviour.

When the site is unoccupied and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the abovementioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site. Specifically, the two observers were located at the following vantage points:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 30 minutes from sunset until dark (approximately 6:50 pm to 7:20 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street Camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

No flying-foxes were recorded roosting at the site in the traverse.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over a relatively large area of approximately 3.9 hectares (refer to **Illustration 2.2**).

Flying-foxes were not recorded at the Wheatley Street camp in Bellingen or at Bowraville.

Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). When compared with observations from the previous monitoring event (GeoLINK 2018), the extent of the roost footprint at Bellingen Island has expanded further to the east to include many of the mature trees in the old caravan park grounds alongside Dowle Street. More individuals were also observed to be roosting in the upper canopy of the emergent fig trees.

At the Gordon Park camp the roost extent has not substantially changed from that recorded in the previous monitoring event. There was a general absence of flying-foxes roosting in the upper canopy of the central rainforest that currently supports nil to sparse foliage cover from previous roosting by large numbers of flying-foxes.



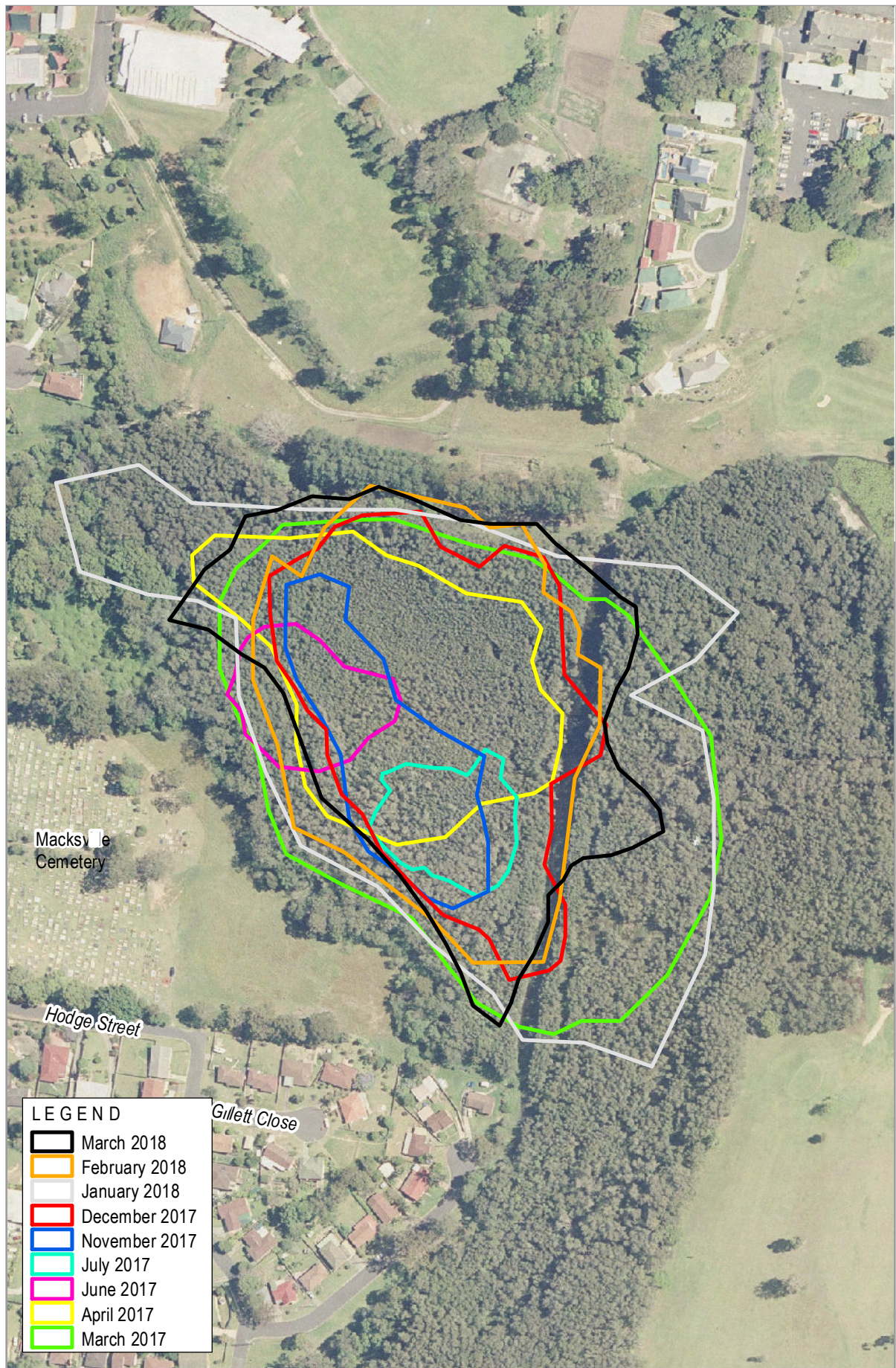
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Location of Regional Flying-fox Camps

Flying-fox Monitoring March 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1095

Illustration 2.1



0 60

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Macksville Cemetery Flying-fox Roost Footprint

Flying-fox Monitoring March 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1096

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 45,000 individuals were recorded exiting the Macksville Cemetery camp in the exit count. As was recorded in the previous monitoring event (GeoLINK 2018), the flying-foxes were exiting in two broad streams, one in a north to north-westerly direction and another in a south to south-easterly direction.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are as follows:

- Gordon Park: approximately 10,000 individuals.
- Bellingen Island: approximately 40,000 individuals.
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 80% GHFF and 20% Black Flying-fox.
- Bellingen Island: 90% GHFF and 10% Black Flying-fox.
- Gordon Park: 90% GHFF and 10% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). During this period of absence, the Macksville Cemetery camp has been the alternative site for collection of this data.

Both male and female GHFF were present at the Macksville Cemetery camp. Young dependent GHFF were observed, as well as semi-independent individuals that were roosting alongside their mothers. The data collected indicated that the proportion of female GHFF present was high, ranging between 67% and 100% of all individuals at individual demographic point counts (86% average), (refer to **Table 2.1**). The percentage of females with dependent young GHFF at demographic point counts was moderate, ranging between 20% and 60% (35% average).

Both male and female GHFF were also present at the Bellingen Island camp. As was observed at the Macksville cemetery camp, dependent young GHFF were present with these individuals showing semi-independent behaviour by spending time roosting alongside their mothers. Data collected indicated that the proportion of female GHFF present was relatively high, ranging between 67% and 91% of all individuals at individual demographic point counts (80% average), (refer to **Table 2.2**). The percentage of females with dependent young GHFF at demographic point counts was moderate, ranging between 30% and 70% (54% average).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present. Dependent young (including semi-independent individuals) were also observed with many of the females.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492064, 6601725	Broad-leaved Paperbark	15	30	10:5	Yes	20
MC2	492094, 6601720	Broad-leaved Paperbark	8	20	10:2	Yes	40
MC3	492052, 6601755	Broad-leaved Paperbark	15	30	10:1	Yes	20
MC4	492061, 6601788	Broad-leaved Paperbark	8	20	10:1	Yes	60
MC5	492068, 6601776	Broad-leaved Paperbark	8	15	10:0	Yes	40
MC6	492024, 6601792	Broad-leaved Paperbark	15	30	10:3	Yes	20
MC7	492046, 6601819	Broad-leaved Paperbark	12	20	10:1	Yes	30
MC8	492044, 6601833	Broad-leaved Paperbark	10	20	10:2	Yes	30
MC9	492036, 6601840	Broad-leaved Paperbark	15	30	10:1	Yes	60
MC10	491999, 6601824	Broad-leaved Paperbark	18	30	10:1	Yes	30

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	489955, 6631588	Creek Sandpaper Fig	8	20	10:2	Yes	40
BI2	489986, 6631557	Creek Sandpaper Fig	8	20	10:2	Yes	70
BI3	490017, 6631519	Creek Sandpaper Fig	8	20	10:5	Yes	70
BI4	490050, 6631507	White Booyong	10	30	10:3	Yes	70
BI5	490066, 6631486	Creek Sandpaper Fig	10	30	10:1	Yes	60
BI6	490087, 6631489	Giant Stinging Tree	12	40	10:3	Yes	60
BI7	490097, 6631499	Giant Stinging Tree	12	40	10:2	Yes	60
BI8	490101, 6631505	White Booyong	8	30	10:2	Yes	30
BI9	490115, 6631506	Giant Stinging Tree	12	40	10:3	Yes	40
BI10	490110, 6631534	Unidentified sp.	8	40	10:2	Yes	30

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 65 cm in depth. This is a 15 cm increase in the level that was recorded in the previous monitoring event, reflecting recent heavy rainfall in the area (refer to **Figure 2.1**).

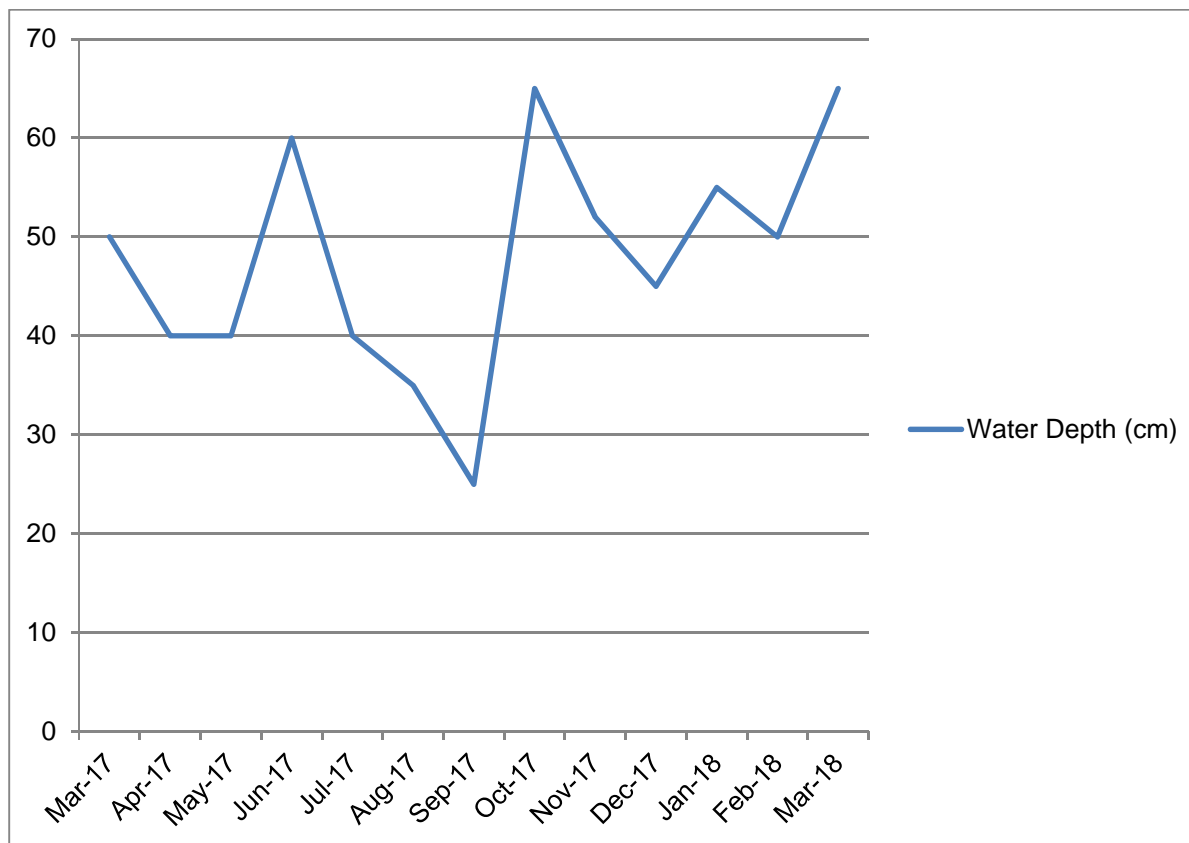



Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

The number of flying-foxes at the Macksville Cemetery camp has increased by 15,000 individuals in February 2018 (from 30,000) and is now approximately 45,000 individuals. Flying-fox numbers at this camp have been between 22,500 and 50,000 individuals over the last three months. In March 2017 flying-fox numbers were similar at approximately 50,000 individuals (GeoLINK 2017). It was estimated that approximately 40,000 flying-foxes were present at the Bellingen Island camp in the current monitoring event, which is a substantial increase from the previous monthly monitoring event when 25,000 individuals were estimated to be present (GeoLINK 2018). In March 2017 the estimated number of flying-foxes roosting at the Bellingen Island camp was approximately 15,000 (GeoLINK 2017); substantially fewer than was recorded in the current monitoring event.



The number of flying-foxes estimated to be roosting at the Gordon Park camp has remained steady over the past three months at around 10,000 individuals. A similar population level was present in February 2017, when it was estimated that approximately 10,000 individuals were roosting at this camp (GeoLINK 2017). This comparatively low number of flying-foxes at this camp is likely the result of the ongoing poor condition of the rainforest canopy and consequent change in roosting suitability.

No flying-foxes were recorded at Bowraville in the current monitoring event. Flying-foxes have been absent from this site for over 12 months, and were last recorded in December 2016 in low numbers.

As can be seen in the 12-monthly population comparisons (refer to **Figure 2.2**), numbers of flying-foxes at the regional camps are still relatively high (apart from the Gordon Park camp), which is likely to be reflecting the regional availability of key foraging resources.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up between 80% and 90% of all individuals, similar to the proportions recorded in the previous monthly monitoring event (GeoLINK 2018).

Female GHFF dominated the occupied camps in the current monitoring event, with demographic point counts averaging 80% the Bellingen Island camp and 80% at the Macksville Cemetery camp. Similarly, high proportions were recorded in the previous monitoring event (GeoLINK 2018).

At both the Macksville Cemetery camp and the Bellingen Island camp dependent young were present at moderate levels (54% and 35% respectively). The number of dependent young has decreased compared with the levels recorded in the previous monitoring event as many young are now becoming independent from their mothers (GeoLINK 2018).

2.3.3 Phenology of Trees in the Region

February/ March bi-monthly flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes various *Corymbia* spp. (Bloodwoods and Spotted Gums), New England Blackbutt (*Eucalyptus andrewsii*), Coastal Blackbutt (*E. pilularis* - foothills and ranges), Sydney Blue Gum (*E. saligna*) and Broad-leaved Paperbark (*Melaleuca quinquenervia*). These are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps recorded moderate flowering of Broad-leaved Paperbark.

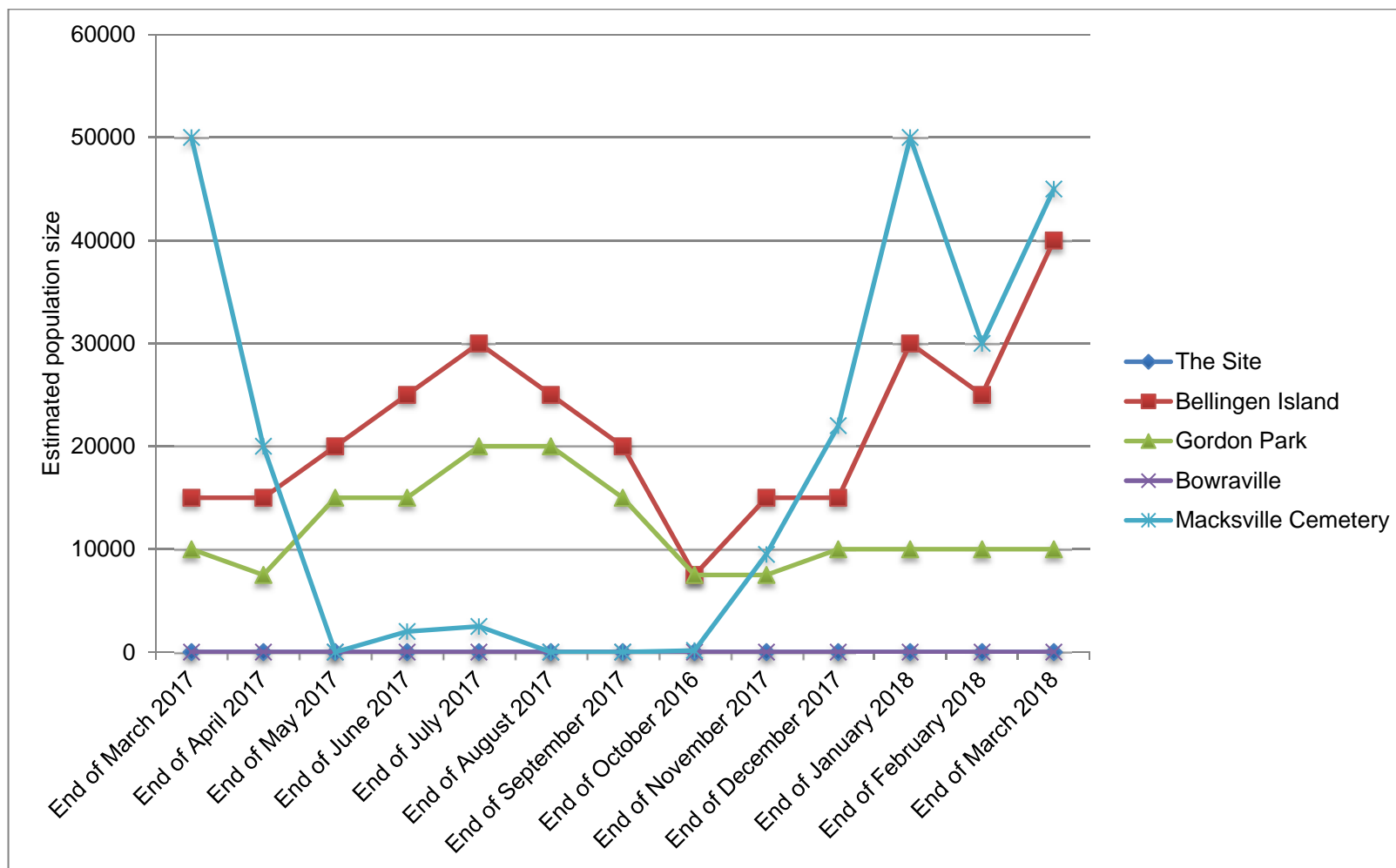


Figure 2.2 Population trends at the site and regional camps over past 12 months



2.4 Summary and Conclusion

The results of the March 2018 flying-fox monitoring indicate that, excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014.

The number of flying-foxes at the Macksville Cemetery camp has increased by 15,000 individuals and is now approximately 45,000 individuals. Flying-fox numbers at this camp have been between 22,500 and 50,000 individuals over the last three months. Similarly, at Bellingen Island camp the number of flying-foxes has increased substantially from approximately 25,000 to 40,000 individuals over the last month.


The number of flying-foxes estimated to be roosting at the Gordon Park camp has remained steady over the past three months at around 10,000 individuals, likely reflecting the poor condition of the rainforest canopy at this camp.

Flying-foxes remain absent from Bowraville and Wheatley Street, Bellingen.

GHFF dominated the species composition at occupied camps making up between 80% and 90% of all individuals present.

The number of dependent young GHFF has decreased at occupied camps compared with the levels recorded in the previous monitoring event as many young are now becoming independent from their mothers.

Moderate flowering of Broad-leaved Paperbark, a key diet species for the GHFF, was observed to be currently occurring in the region.



David Andrichetto
Senior Ecologist



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Eby, P. (2012). *An Assessment of the Flying-fox Camp at Macksville*. Unpublished report to NSW Roads and Maritime Services.

Eby, P. (2013). *A Field Monitoring Program Proposed for the Macksville Flying-fox Roost*. Unpublished report to Sinclair Knight Merz.

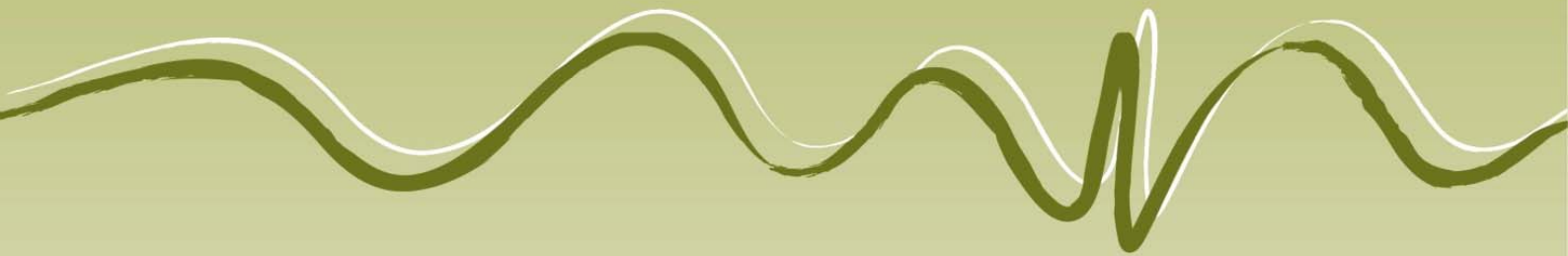
GeoLINK. (2017). *Flying-fox Monitoring March 2017: Warrell Creek to Nambucca Heads Pacific Highway Upgrade*. Unpublished report to NSW Roads and Maritime Services.

GeoLINK. (2018). *Flying-fox Monitoring February 2018: Warrell Creek to Nambucca Heads Pacific Highway Upgrade*. Unpublished report to NSW Roads and Maritime Services.

Appendix 5 April 2018 monitoring report.

Flying-fox Monitoring April 2018

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services has been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp was located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the April 2018 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the April 2018 flying-fox monitoring:

- Tom Pollard (ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).
- Jacob Sickinger (environmental planner).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 30 April 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics.
- Reproductive status.
- Behaviour.

When the site is unoccupied and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the abovementioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site. Specifically, the two observers were located at the following vantage points:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 40 minutes from sunset until dark (approximately 5:50 pm to 6:30 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

No flying-foxes were recorded roosting at the site in the traverse.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over an area of approximately 1.7 hectares (refer to **Illustration 2.2**). The roost has shifted further away from the western edge of the paperbark forest when compared with that recorded in the previous monitoring event.

Flying-foxes were not recorded at the Wheatley Street camp in Bellingen or at Bowraville.

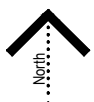
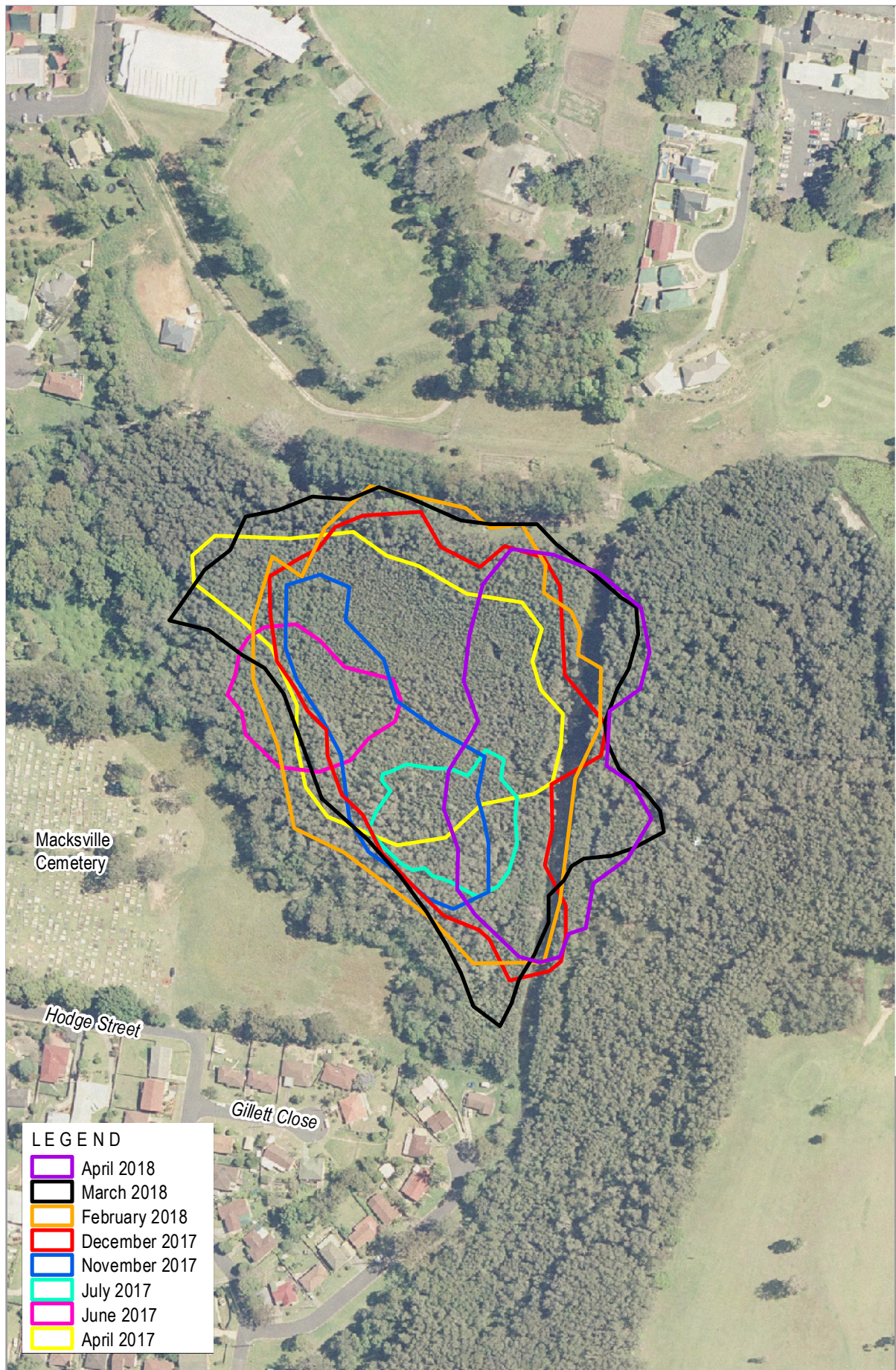
Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). As was observed in the previous monitoring event (GeoLINK 2018), the extent of the roost footprint at Bellingen Island presently includes many of the mature trees in the old caravan park grounds alongside Dowle Street, however a reduction in roosting in the upper canopy of the emergent fig trees on the island was noted.

At the Gordon Park camp the roost extent has not substantially changed from that recorded in the previous monitoring event, with a general absence of flying-foxes roosting in the upper canopy of the rainforest where only sparse foliage cover (or dead branches) remain.



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Macksville Cemetery Flying-fox Roost Footprint

Flying-fox Monitoring April 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1113

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 18,000 individuals were recorded exiting the Macksville Cemetery camp in the exit count. The flying-foxes were exiting in two broad streams, one in a westerly direction and another in a south-easterly direction.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are as follows:

- Gordon Park: approximately 10,000 individuals.
- Bellingen Island: approximately 30,000 individuals.
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 90% GHFF and 10% Black Flying-fox.
- Bellingen Island: 95% GHFF and 5% Black Flying-fox.
- Gordon Park: 90% GHFF and 10% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). During this period of absence, the Macksville Cemetery camp has been the alternative site for collection of this data.

Both male and female GHFF were present at the Macksville Cemetery camp. The data collected indicated that the proportion of female GHFF present was moderate to high, ranging between 66% and 91% of all individuals at individual demographic point counts (79% average). No dependent young GHFF were present (refer to **Table 2.1**).

Both male and female GHFF were also present at the Bellingen Island camp. Data collected indicated that the proportion of female GHFF present was relatively high, ranging between 77% and 91% of all individuals at individual demographic point counts (82% average). No dependent young GHFF were present (refer to **Table 2.2**).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present. No dependent young were observed with the females.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492143, 6601827	Broad-leaved Paperbark	12	20	10:6	No	n/a
MC2	492153, 6601825	Broad-leaved Paperbark	15	30	10:3	No	n/a
MC3	492144, 6601806	Broad-leaved Paperbark	15	30	10:2	No	n/a
MC4	492145, 6601786	Broad-leaved Paperbark	8	20	10:1	No	n/a
MC5	492139, 6601736	Broad-leaved Paperbark	12	20	10:3	No	n/a
MC6	492125, 6601716	Broad-leaved Paperbark	15	30	10:3	No	n/a
MC7	492133, 6601713	Broad-leaved Paperbark	10	20	10:5	No	n/a
MC8	492138, 6601679	Broad-leaved Paperbark	8	15	10:2	No	n/a
MC9	492154, 6601645	Broad-leaved Paperbark	15	30	10:3	No	n/a
MC10	492176, 6601640	Broad-leaved Paperbark	8	20	10:2	No	n/a

Table 2.2 Demographic Data of GHFF at the Bellinghen Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	490058, 6631683	Red Cedar	10	80	10:1	No	n/a
BI2	490085, 6631663	Red Cedar	20	150	10:2	No	n/a
BI3	490034, 6631694	Flame Tree	12	80	10:3	No	n/a
BI4	489986, 6631559	Creek Sandpaper Fig	8	40	10:2	No	n/a
BI5	490034, 6631520	Giant Stinging Tree	15	80	10:3	No	n/a
BI6	490062, 6631507	Creek Sandpaper Fig	8	30	2:10 (male dominated 'bachelor tree')	No	n/a
BI7	490093, 6631526	Creek Sandpaper Fig	10	30	10:2	No	n/a
BI8	490085, 6631560	Giant Stinging Tree	12	60	10:2	No	n/a
BI9	490059, 6631609	Creek Sandpaper Fig	8	30	10:3	No	n/a
BI10	490038, 6631638	Creek Sandpaper Fig	8	20	10:2	No	n/a

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 50 cm in depth. This is a minor decrease on the level that was recorded in the previous monitoring event, reflecting a relatively dry April in the area (refer to **Figure 2.1**).

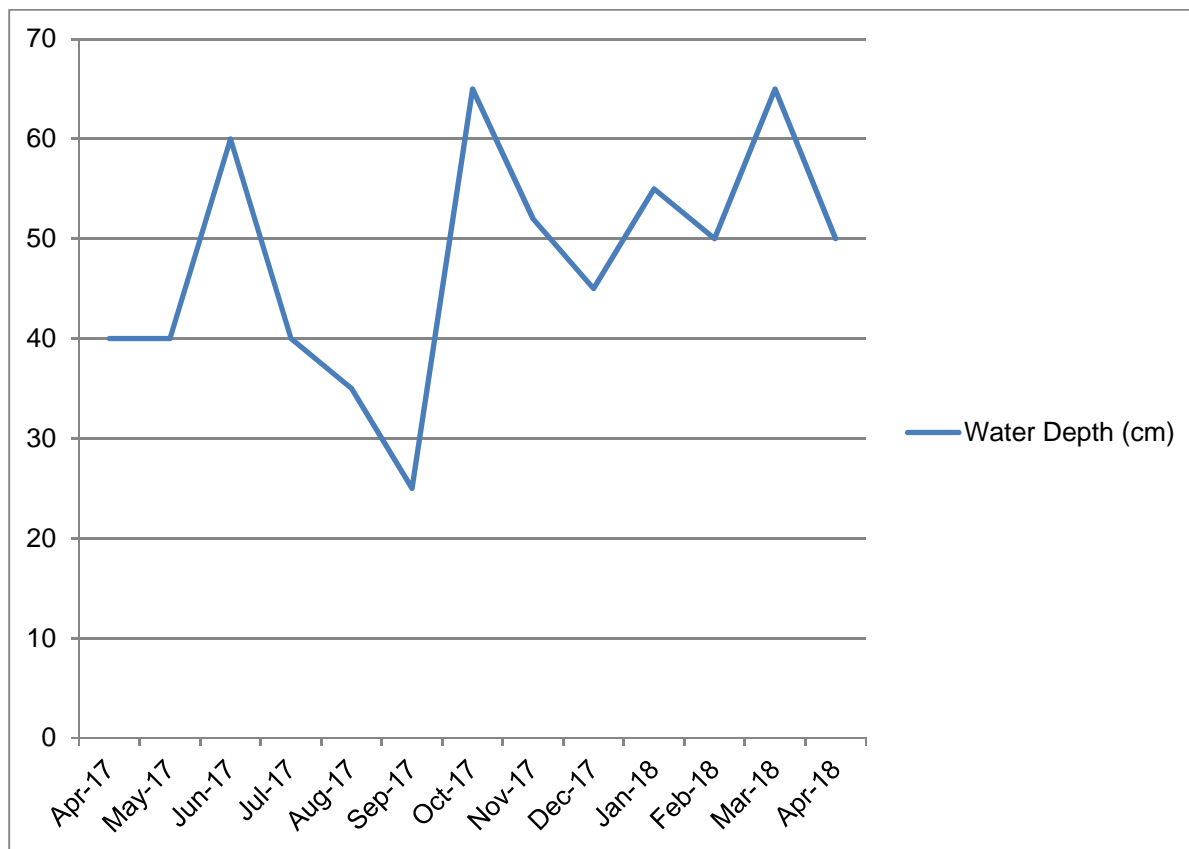


Figure 2.1 Water level measurements at the site


2.3 Discussion

2.3.1 Population Estimates

The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

Following a peak in the number of flying-foxes roosting at the Macksville Cemetery camp in March when approximately 45,000 individuals were present, a substantial decrease has now occurred with approximately half this number of flying-foxes currently roosting at this camp. In April 2017 flying-fox numbers were similar with approximately 20,000 individuals present (GeoLINK 2017).

It was estimated that approximately 30,000 flying-foxes were present at the Bellingen Island camp in the current monitoring event. The number of flying-foxes has ranged between 25,000 and 40,000 during the four months since January of this year. In April 2017 the estimated number of flying-foxes roosting at the Bellingen Island camp was only 15,000 (GeoLINK 2017), which is substantially fewer than was recorded in the current monitoring event.



The number of flying-foxes estimated to be roosting at the Gordon Park camp has remained steady over the past four months at around 10,000 individuals. Slightly fewer flying-foxes were present in April 2017, when it was estimated that approximately 7,500 individuals were roosting at this camp (GeoLINK 2017).

No flying-foxes were recorded at Bowraville in the current monitoring event. Flying-foxes have been absent from this site for over 12 months, and were last recorded in December 2016 in low numbers.

As can be seen in the 12-monthly population comparisons (refer to **Figure 2.2**), numbers of flying-foxes at regional camps now appear to be declining after the typical annual summer peak.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up between 90% and 95% of all individuals. Similar high proportions have consistently been recorded in previous monitoring events.

Female GHFF dominated the occupied camps in the current monitoring event, with demographic point counts averaging 82% at the Bellingen Island camp and 79% at the Macksville Cemetery camp. Very similar proportions were recorded in the previous monitoring event (GeoLINK 2018).

No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species.

2.3.3 Phenology of Trees in the Region

April/ May bi-monthly flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Coast Banksia (*Banksia integrifolia*), Coastal Blackbutt (*Eucalyptus pilularis*), Swamp Mahogany (*Eucalyptus robusta*), Blue Gum (*Eucalyptus saligna*) and Broad-leaved Paperbark (*Melaleuca quinquenervia*). These are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps recorded moderate flowering of Broad-leaved Paperbark and light flowering of Swamp Mahogany (*Eucalyptus robusta*).

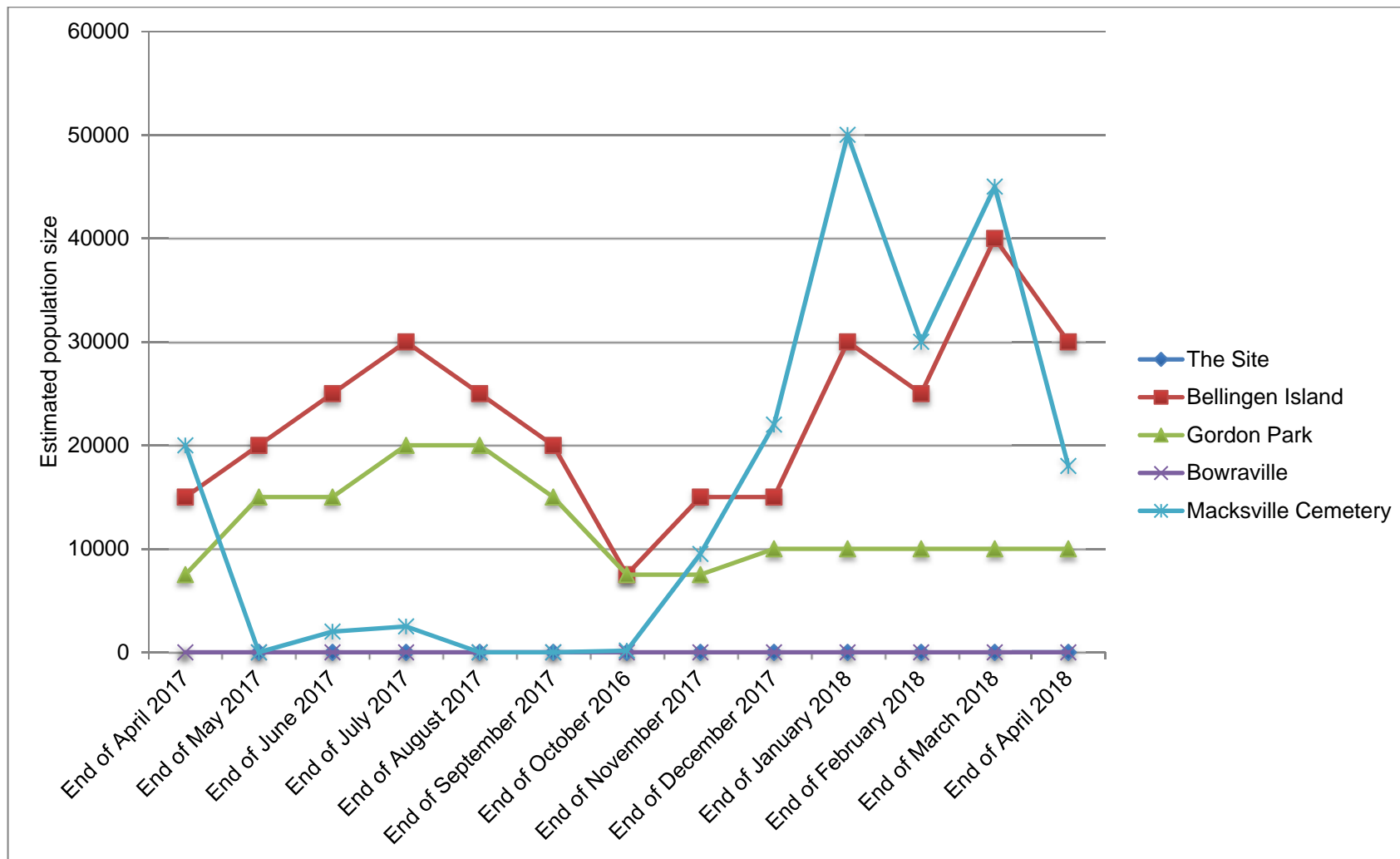


Figure 2.2 Population trends at the site and regional camps over past 12 months



2.4 Summary and Conclusion

The results of the April 2018 flying-fox monitoring indicate that, excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014.

Following a peak in the number of flying-foxes roosting at the Macksville Cemetery camp in March when approximately 45,000 individuals were present, a substantial decrease has now occurred with approximately half this number of flying-foxes currently roosting at this camp. Similarly, at Bellingen Island camp the number of flying-foxes has also decreased over the last month. This decrease in GHFF numbers leading into winter is typical following the annual summer peak in numbers.

The number of flying-foxes estimated to be roosting at the Gordon Park camp has remained steady over the past four months at around 10,000 individuals, possibly reflecting the poor condition of the rainforest canopy at this camp.

Flying-foxes remain absent from Bowraville and Wheatley Street, Bellingen.

GHFF dominated the species composition at occupied camps making up between 90% and 95% of all individuals present.

No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species.

Moderate flowering of Broad-leaved Paperbark and light flowering of Swamp Mahogany, both key diet species for the GHFF, was observed to be currently occurring in the region.



David Andrighetto
Senior Ecologist



References

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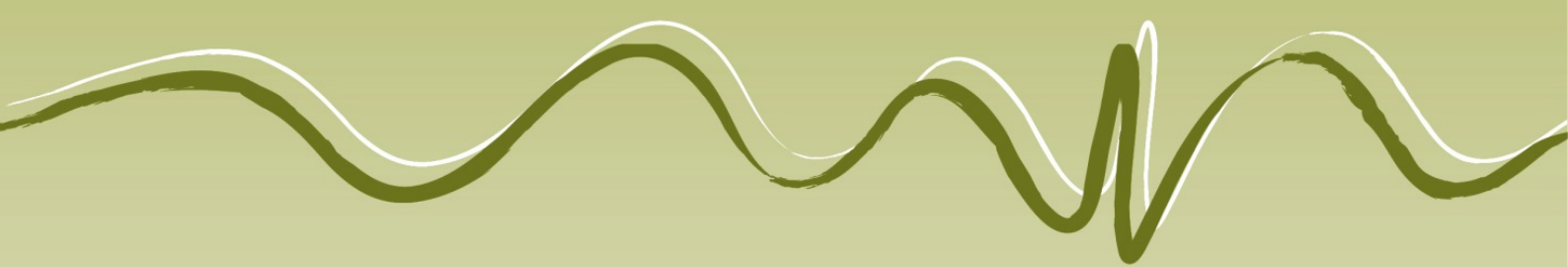
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Appendix 6 May 2018 monitoring report

Flying-fox Monitoring May 2018

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services has been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp was located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the May 2018 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the May 2018 flying-fox monitoring:

- Tom Pollard (ecologist).
- Frank Makin (ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 29 May 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics.
- Reproductive status.
- Behaviour.

When the site is unoccupied and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the abovementioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site. Specifically, the two observers were located at the following vantage points:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 40 minutes from sunset until dark (approximately 5:00 pm to 5:40 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

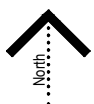
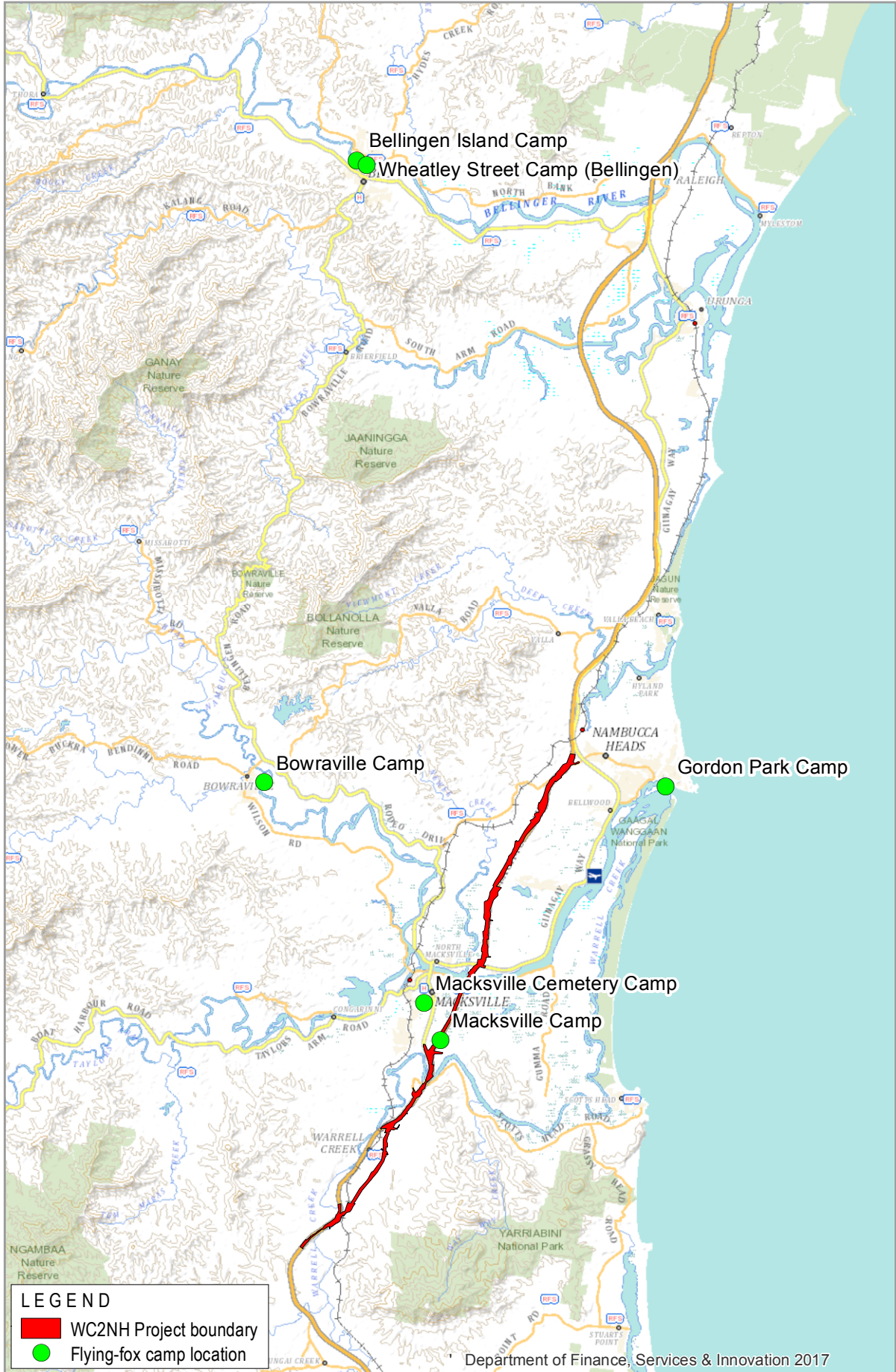
No flying-foxes were recorded roosting at the site in the traverse.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over an area of approximately 0.76 hectares (refer to **Illustration 2.2**). The roost site was located in the southern section of the paperbark forest, between McNeill Place and the Macksville golf course.

Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). As was observed in the previous monitoring event (GeoLINK 2018), the extent of the roost footprint at Bellingen Island included many of the mature trees in the old caravan park grounds alongside Dowle Street (roosting individuals in this part of the roost were observed to be mostly Black Flying-foxes).

At the Gordon Park camp the roost extent covers a larger area than was recorded in the previous monitoring event. In addition, more flying-foxes were observed to be roosting in the upper canopy of the damaged rainforest vegetation.

Flying-foxes were not recorded at the Wheatley Street camp in Bellingen or at Bowraville.



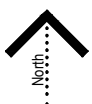
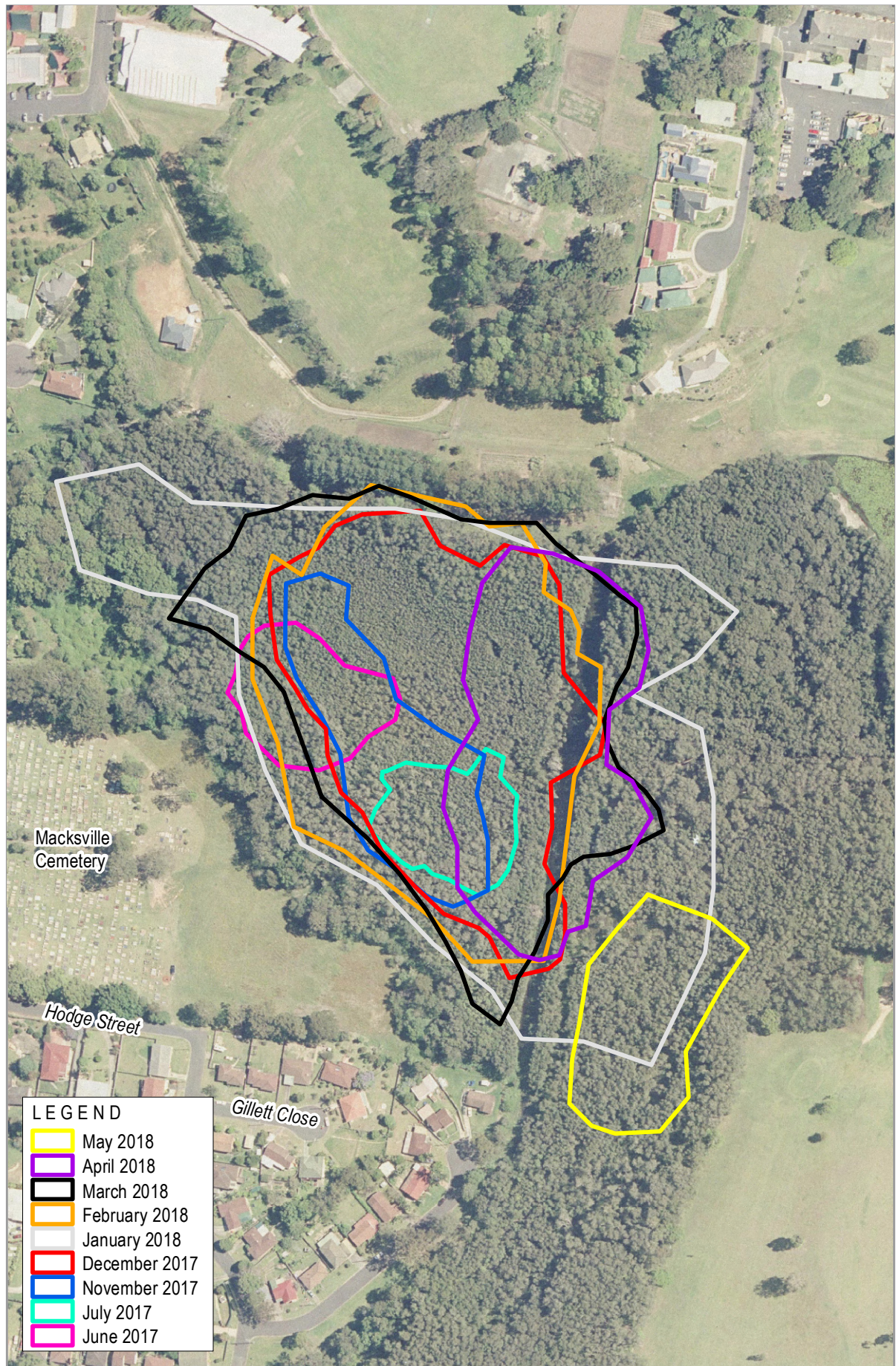
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Flying-fox Monitoring May 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1118

Location of Regional Flying-fox Camps

Illustration 2.1



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Macksville Cemetery Flying-fox Roost Footprint

Flying-fox Monitoring May 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1117

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 10,500 individuals were recorded exiting the Macksville Cemetery camp in the exit count. The flying-foxes were exiting in two broad streams, one in a westerly direction and another in a south-easterly direction.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are as follows:

- Gordon Park: approximately 20,000 individuals.
- Bellingen Island: approximately 30,000 individuals.
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 95% GHFF and 5% Black Flying-fox.
- Bellingen Island: 95% GHFF and 5% Black Flying-fox.
- Gordon Park: 90% GHFF and 10% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). During this period of absence, the Macksville Cemetery camp has been the alternative site for collection of this data.

Both male and female GHFF were present at the Macksville Cemetery camp. The data collected indicated that the proportion of female GHFF present was generally high, ranging between 71% and 100% of all individuals at individual demographic point counts (88% average). No dependent young GHFF were present (refer to **Table 2.1**).

Both male and female GHFF were also present at the Bellingen Island camp. Similar to the Macksville Cemetery camp, data collected indicated that the proportion of female GHFF present was generally high, ranging between 71% and 91% of all individuals at individual demographic point counts (83% average). No dependent young GHFF were present (refer to **Table 2.2**).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present. No dependent young were observed with the females.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492200, 6601607	Broad-leaved Paperbark	12	20	10:3	No	n/a
MC2	492202, 6601622	Broad-leaved Paperbark	8	15	10:2	No	n/a
MC3	492219, 6601622	Broad-leaved Paperbark	8	15	10:4	No	n/a
MC4	492221, 6601637	Broad-leaved Paperbark	12	20	10:1	No	n/a
MC5	492224, 6601648	Broad-leaved Paperbark	12	20	10:1	No	n/a
MC6	492237, 6601649	Broad-leaved Paperbark	12	20	10:3	No	n/a
MC7	492245, 6601650	Broad-leaved Paperbark	8	20	10:0	No	n/a
MC8	492254, 6601637	Broad-leaved Paperbark	10	15	10:0	No	n/a
MC9	492252, 6601628	Broad-leaved Paperbark	8	15	10:0	No	n/a
MC10	492256, 6601614	Broad-leaved Paperbark	10	20	10:1	No	n/a

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	490087, 6631532	White Booyong	15	100	10:0	No	n/a
BI2	490091, 6631552	Foambark	8	20	10:2	No	n/a
BI3	490083, 6631565	Creek Sandpaper Fig	8	30	10:2	No	n/a
BI4	490074, 6631575	Unknown sp.	8	45	10:2	No	n/a
BI5	490068, 6631585	Creek Sandpaper Fig	15	20	10:1	No	n/a
BI6	490065, 6631604	Moreton Bay Fig	12	80	10:4	No	n/a
BI7	490051, 6631612	Creek Sandpaper Fig	8	30	10:1	No	n/a
BI8	490032, 6631633	Moreton Bay Fig	10	40	10:4	No	n/a
BI9	490013, 6631643	Small-leaved Fig	8	40	10:1	No	n/a
BI10	490003, 6631644	Sandpaper Fig	7	30	10:3	No	n/a

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 40 cm in depth. Water depth continues to decrease at the site in response to ongoing dry weather conditions (refer to **Figure 2.1**).

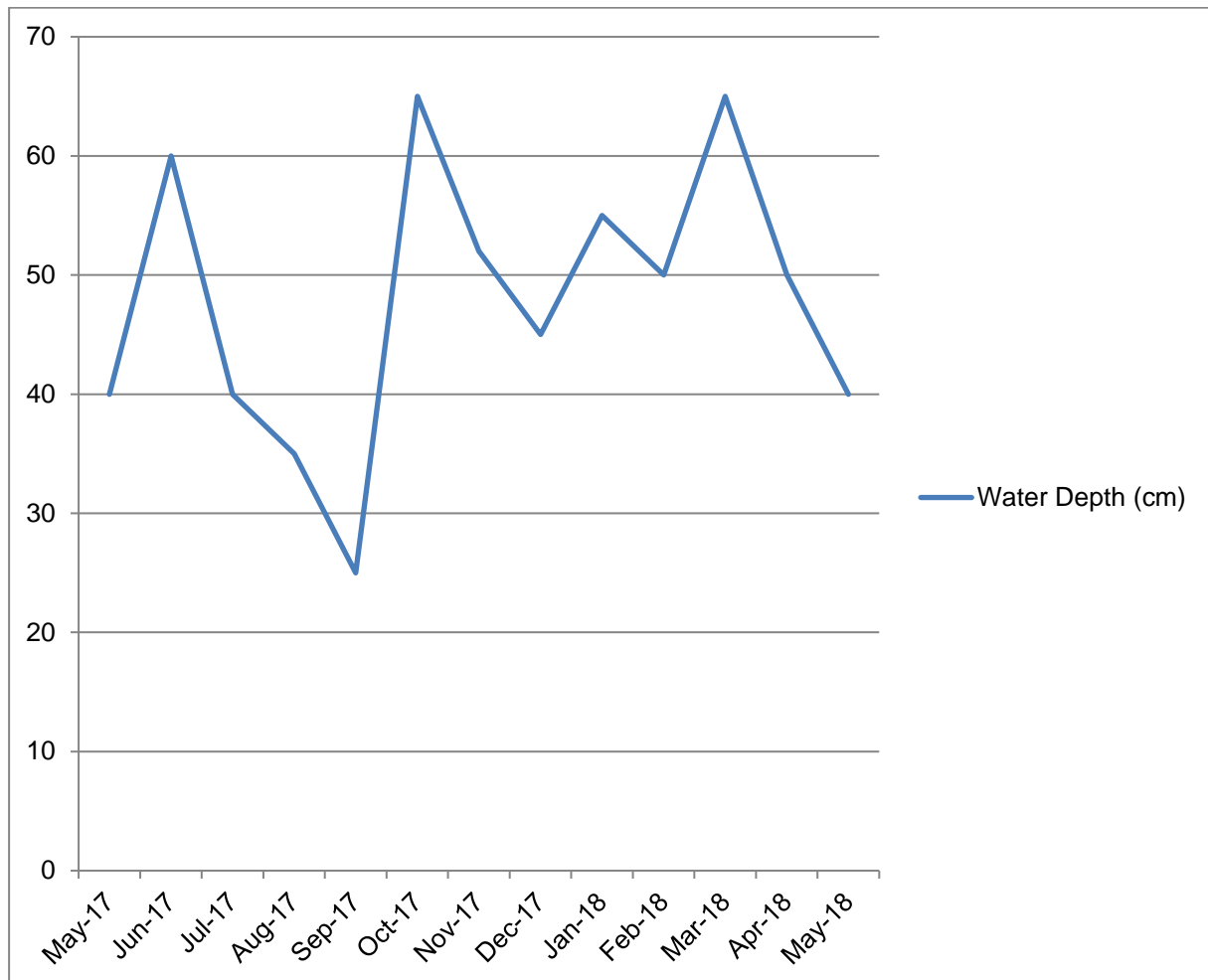



Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

Following a peak in the number of flying-foxes roosting at the Macksville Cemetery camp in March when approximately 45,000 individuals were present, a decrease has occurred to around 10,500 individuals in the current monitoring event. In May 2017, no flying-foxes were recorded roosting at this camp, and very low numbers or an absence was recorded throughout winter until late spring (refer to **Figure 2.2**).



It was estimated that approximately 30,000 flying-foxes were present at the Bellingen Island camp in the current monitoring event, representing no change from the previous monitoring event. The number of flying-foxes has ranged between 25,000 and 40,000 during the five months since January 2018. In May 2017, the estimated number of flying-foxes roosting at the Bellingen Island camp was less at around 20,000 (GeoLINK 2017).

The number of flying-foxes estimated to be roosting at the Gordon Park camp has doubled to around 20,000 individuals, after remaining steady over the previous four months at around 10,000 individuals. Slightly fewer flying-foxes were present a year ago, when it was estimated that approximately 15,000 individuals were roosting at this camp (GeoLINK 2017).

No flying-foxes were recorded at Bowraville in the current monitoring event. Flying-foxes have been absent from this site for over 12 months, and were last recorded in December 2016 in low numbers.

As can be seen in the 12-monthly population comparisons (refer to **Figure 2.2**), there has been a decreasing trend in flying-fox numbers at the Macksville Cemetery camp and Bellingen Island camp since a peak in March 2018. In contrast, no clear trend is evident at Gordon Park, where flying-fox numbers have doubled over the past month.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up between 90% and 95% of all individuals. Similar high proportions have consistently been recorded in previous monitoring events.

Female GHFF dominated the occupied camps in the current monitoring event, with demographic point counts averaging 88% at the Macksville Cemetery camp and 83% at the Bellingen Island camp. Similarly, high proportions of female GHFF were recorded in the previous monitoring event (GeoLINK 2018).

No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species. Subadult only groupings of GHFF were evident at both camps, and particularly along the eastern channel at the Bellingen Island camp.

2.3.3 Phenology of Trees in the Region

April/ May bi-monthly flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Coast Banksia (*Banksia integrifolia*), Coastal Blackbutt (*Eucalyptus pilularis*), Swamp Mahogany (*Eucalyptus robusta*), Blue Gum (*Eucalyptus saligna*) and Broad-leaved Paperbark (*Melaleuca quinquenervia*). These are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps recorded light flowering of Swamp Mahogany (*Eucalyptus robusta*).

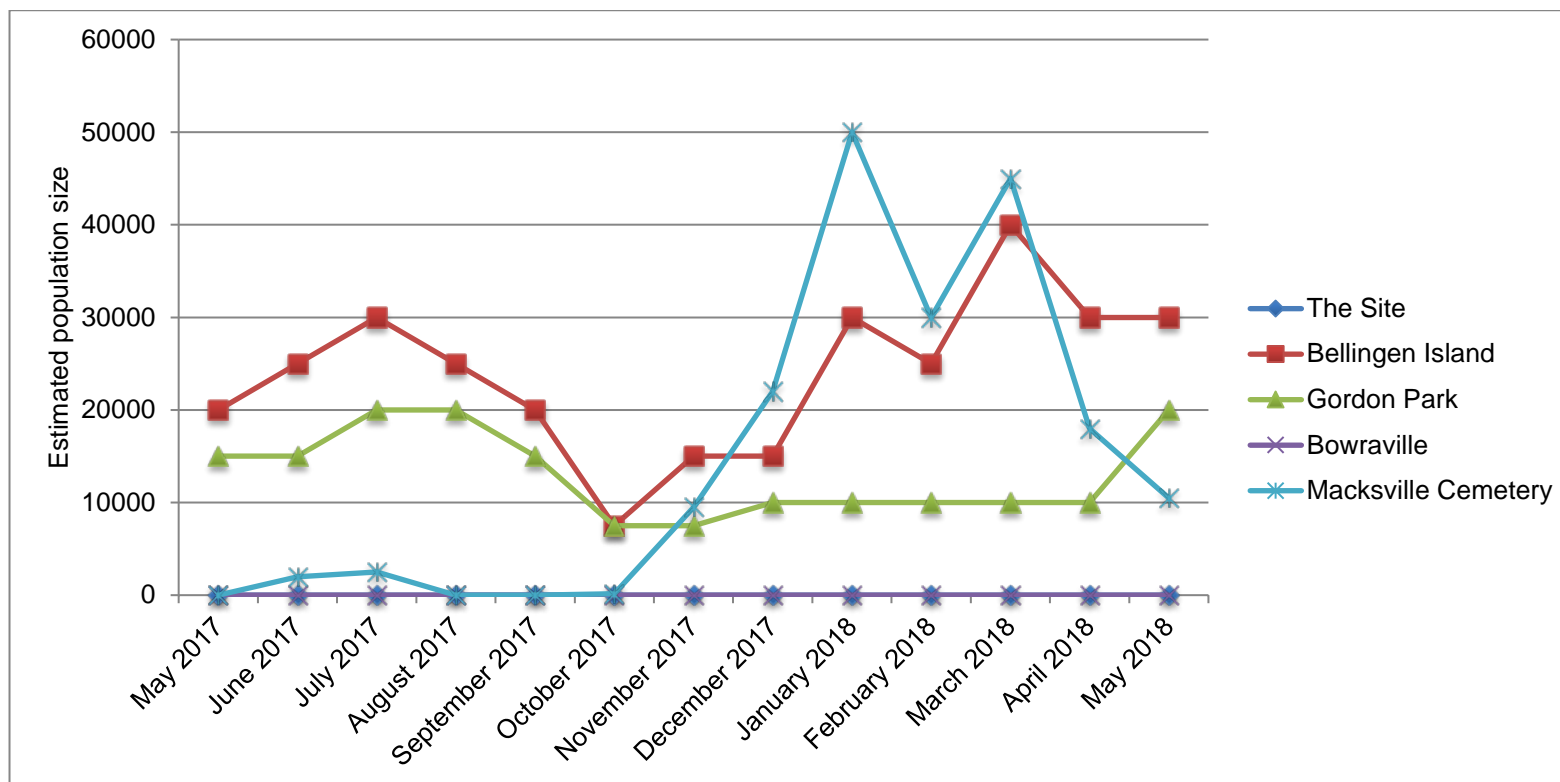


Figure 2.2 Population trends at the site and regional camps over the past 12 months



2.4 Summary and Conclusion

The results of the May 2018 flying-fox monitoring indicate that, excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014.

There has been a general decreasing trend in flying-fox numbers at the Macksville Cemetery camp and Bellingen Island camp since a peak in March 2018. In contrast, no clear trend is evident at Gordon Park, where flying-fox numbers have doubled over the past month.

Flying-foxes remain absent from Bowraville and Wheatley Street, Bellingen.

GHFF dominated the species composition at occupied camps making up between 90% and 95% of all individuals present.

No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species.

Light flowering of Swamp Mahogany, a key diet species for the GHFF, was observed to be currently occurring in the region.



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Senior Ecologist



References

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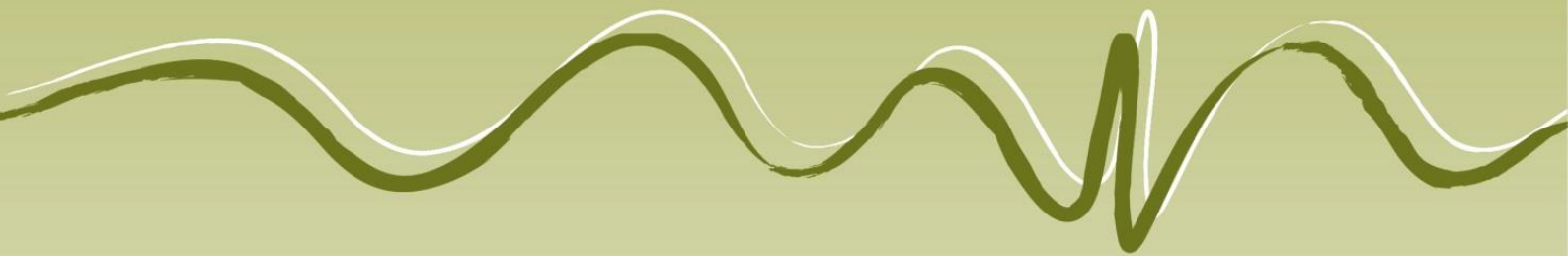
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Appendix 7 June 2018 monitoring report

Flying-fox Monitoring June 2018

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services has been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp was located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the June 2018 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the June 2018 flying-fox monitoring:

- Tom Pollard (ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).
- Jacob Sickinger (environmental planner).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 27 June 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics (avoiding male 'bachelor trees' where possible).
- Reproductive status.
- Behaviour.

When the site is unoccupied and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the abovementioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site. Specifically, the two observers were located at the following vantage points:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 40 minutes from sunset until dark (approximately 4:50 pm to 5:30 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

No flying-foxes were recorded roosting at the site in the traverse.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over an area of approximately 0.66 hectares (refer to **Illustration 2.2**). As was recorded in the previous monitoring event, the flying-fox roost has shifted approximately 200 m further south than is typical and is currently in a narrow section of paperbark swamp forest west of the Macksville golf course near the northern end of McNeill Close.

Flying-foxes were not recorded at the Wheatley Street camp in Bellingen or at Bowraville.

Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). The extent of the roost footprint at Bellingen Island covered the eastern portion of the island, mostly around the channel between the island and the old caravan park. At the Gordon Park camp the roost extent has not substantially changed from that recorded in the previous monitoring event.



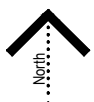
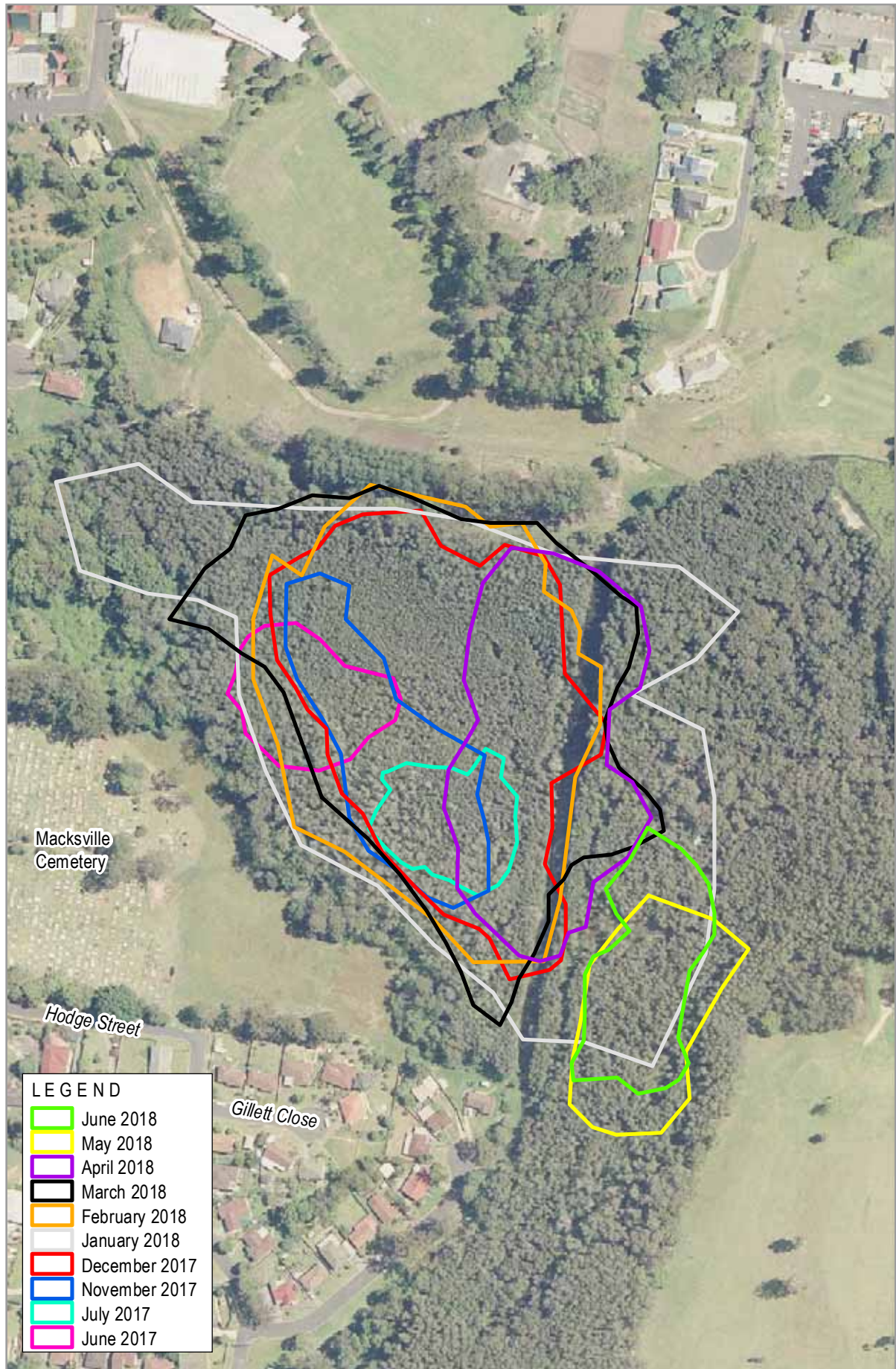
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Location of Regional Flying-fox Camps

Illustration 2.1



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Macksville Cemetery Flying-fox Roost Footprint

Flying-fox Monitoring June 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1126

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 7,500 individuals were recorded exiting the Macksville Cemetery camp in the exit count. The flying-foxes were exiting in two broad streams, one in a westerly direction and another in a south-easterly direction.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are provided. These flying-fox population estimate results (from this and past monitoring as part of this program) should not be relied on for accuracy or other purposes. Population estimates are provided in line with the Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories:

- 1 = 1 – 499
- 2 = 500 – 2,499
- 3 = 2,500 – 9,999
- 4 = 10,000 – 15,999
- 5 = 16,000 – 49,999
- 6 = >50,000.

Regional camp count estimates are as follows:

- Gordon Park: approximately 10,000 individuals (category 4).
- Bellingen Island: approximately 12,500 individuals (category 4).
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 80% GHFF and 20% Black Flying-fox.
- Bellingen Island: 95% GHFF and 5% Black Flying-fox.
- Gordon Park: 90% GHFF and 10% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). During this period of absence, the Macksville Cemetery camp has been the alternative site for collection of this data.

Both male and female GHFF were present at the Macksville Cemetery camp. The data collected indicated that the proportion of female GHFF present was moderate to high, ranging between 67% and 100% of all individuals at individual demographic point counts (84% average). No dependent young GHFF were present (refer to **Table 2.1**).

Both male and female GHFF were also present at the Bellingen Island camp. Data collected indicated that the proportion of female GHFF present was relatively high, ranging between 77% and 100% of all individuals at individual demographic point counts (91% average). No dependent young GHFF were present (refer to **Table 2.2**).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present. No dependent young were observed with the females.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492192, 6601576	Broad-leaved Paperbark	15	30	10:3	No	n/a
MC2	492198, 6601610	Broad-leaved Paperbark	15	20	10:2	No	n/a
MC3	492203, 6601627	Broad-leaved Paperbark	12	30	10:0	No	n/a
MC4	492206, 6601635	Broad-leaved Paperbark	10	20	10:1	No	n/a
MC5	492217, 6601643	Broad-leaved Paperbark	12	30	10:2	No	n/a
MC6	492211, 6601670	Broad-leaved Paperbark	15	30	10:1	No	n/a
MC7	492219, 6601678	Broad-leaved Paperbark	12	20	10:3	No	n/a
MC8	492226, 6601689	Broad-leaved Paperbark	15	30	10:5	No	n/a
MC9	492236, 6601688	Broad-leaved Paperbark	15	20	10:2	No	n/a
MC10	492242, 6601687	Broad-leaved Paperbark	15	30	10:2	No	n/a

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	490087, 6631559	Creek Sandpaper Fig	10	30	10:1	No	n/a
BI2	490078, 6631570	Giant Stinging Tree	8	15	10:0	No	n/a
BI3	490064, 6631589	Unidentifiabl e sp.	15	60	10:2	No	n/a
BI4	490061, 6631595	Creek Sandpaper Fig	8	40	10:0	No	n/a
BI5	490050, 6631597	Creek Sandpaper Fig	8	30	10:1	No	n/a
BI6	490065, 6631604	Moreton Bay Fig	15	120	10:1	No	n/a
BI7	490033, 6631627	Creek Sandpaper Fig	10	30	10:2	No	n/a
BI8	490016, 6631636	Creek Sandpaper Fig	8	40	10:0	No	n/a
BI9	490013, 6631643	Giant Stinging Tree	12	30	10:3	No	n/a
BI10	489991, 6631649	Creek Sandpaper Fig	8	20	10:1	No	n/a

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 40 cm in depth; no change from the level recorded in the previous monitoring event (refer to **Figure 2.1**).

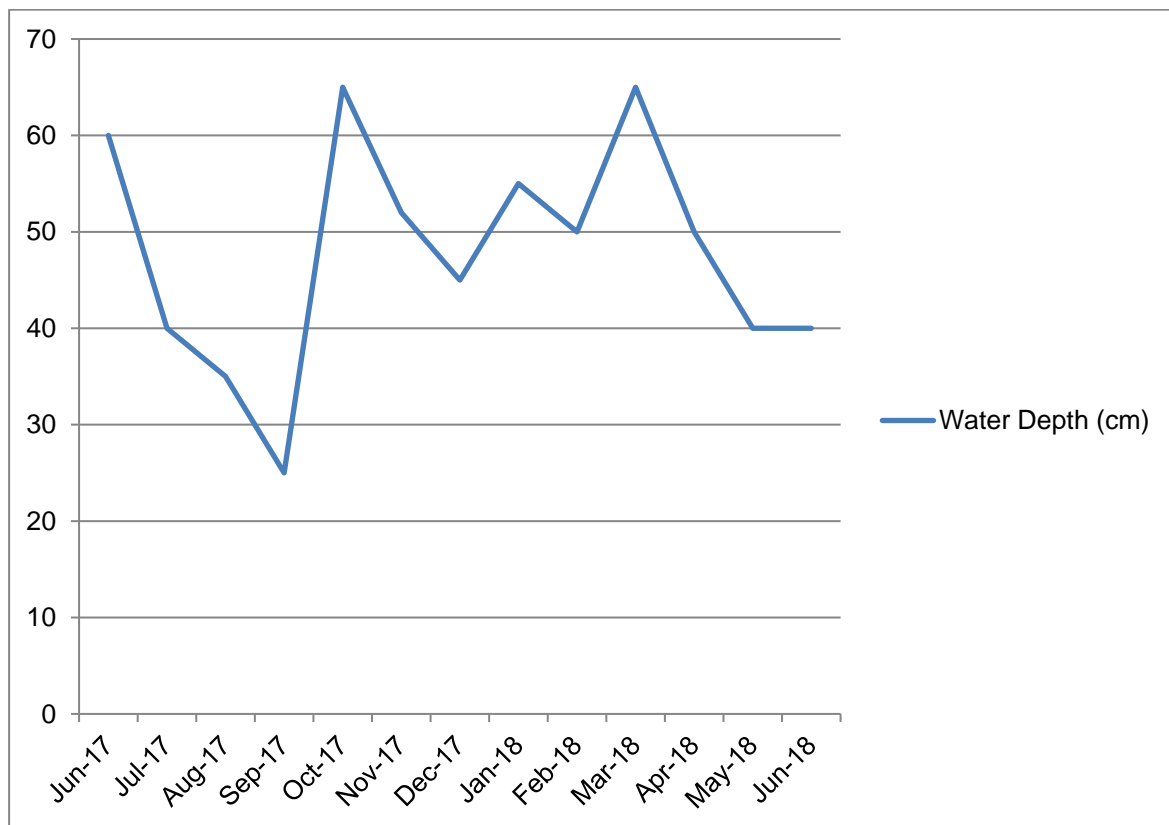


Figure 2.1 Water level measurements at the site


2.3 Discussion

2.3.1 Population Estimates

The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

Following a peak in the number of flying-foxes roosting at the Macksville Cemetery camp in March when approximately 45,000 individuals were present, a substantial decrease has been recorded with approximately 7,500 individuals recorded at this camp in the current monitoring event. In June 2017 flying-fox numbers were even lower with approximately 2,000 individuals present (GeoLINK 2017).

It was estimated that approximately 12,500 flying-foxes were present at the Bellingen Island camp in the current monitoring event. A substantial decrease in numbers has been observed from an estimated 30,000 individuals roosting at this camp in the previous monitoring event. In June 2017 the estimated number of flying-foxes roosting at the Bellingen Island camp was substantially higher at approximately 25,000 (GeoLINK 2017).



The number of flying-foxes estimated to be roosting at the Gordon Park camp has remained relatively steady over the past four months at around 10,000 individuals (with the exception of a temporary spike in numbers in May). The estimated number of flying-foxes roosting at this camp was similar in June 2017, when approximately 15,000 individuals were recorded (GeoLINK 2017).

No flying-foxes were recorded at Bowraville in the current monitoring event. Flying-foxes have been absent from this site for over 18 months, and were last recorded in December 2016 in low numbers.

As can be seen in the 12-monthly population comparisons (refer to **Figure 2.2**), numbers of flying-foxes at regional camps now appear to be declining after a summer/ autumn peak.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up between 80% and 95% of all individuals. The highest proportion of Black Flying-foxes was recorded at the Macksville Cemetery camp. Similar high proportions of GHFF have consistently been recorded in previous monitoring events.

Female GHFF dominated the occupied camps in the current monitoring event, with demographic point counts averaging 91% at the Bellingen Island camp and 84% at the Macksville Cemetery camp. Similar high proportions of female GHFF were recorded in the previous monitoring event (GeoLINK 2018).

No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species.

2.3.3 Phenology of Trees in the Region

June/ July bi-monthly flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Coast Banksia (*Banksia integrifolia*), Coastal Blackbutt (*Eucalyptus pilularis*), Swamp Mahogany (*Eucalyptus robusta*), Forest Red Gum (*Eucalyptus tereticornis*), and Broad-leaved Paperbark (*Melaleuca quinquenervia*). These are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps recorded light flowering of Forest Red Gum and Grey Ironbark (usually flowers later in the year), and moderate flowering of Broad-leaved Paperbark and Swamp Mahogany (*Eucalyptus robusta*).

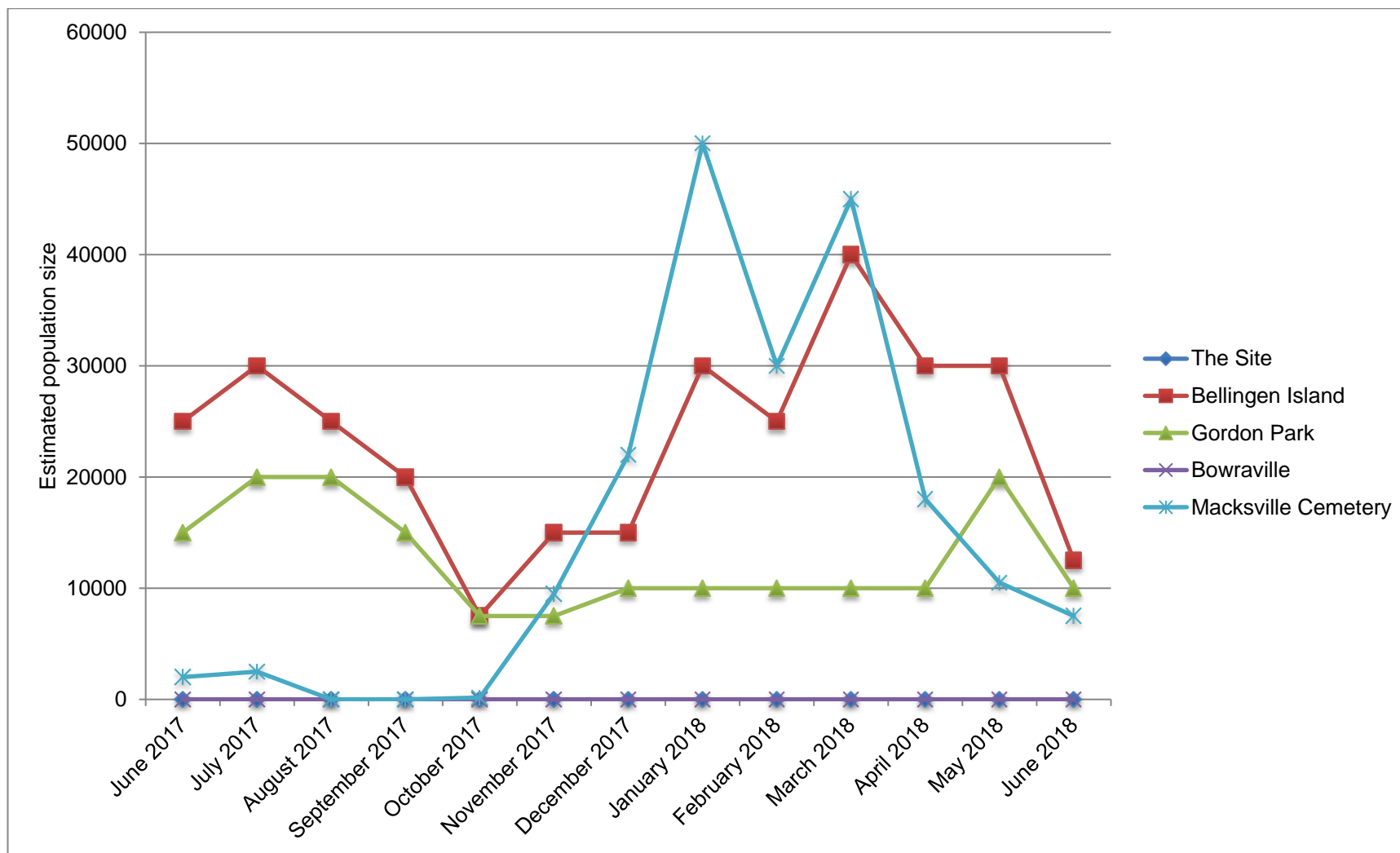
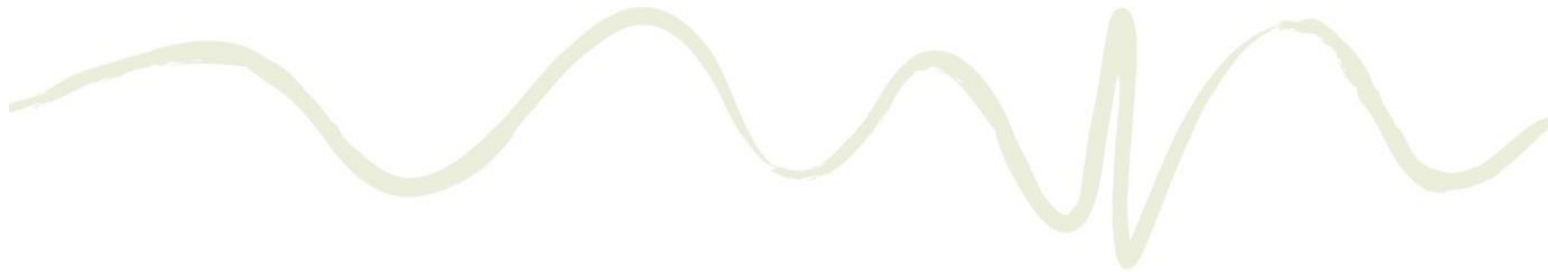


Figure 2.2 Population trends at the site and regional camps over past 12 months



2.4 Summary and Conclusion

The results of the June 2018 flying-fox monitoring indicate that, excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014.

There has been a general decreasing trend in flying-fox numbers at the Macksville Cemetery camp and Bellingen Island camp since a peak in March 2018. In contrast, no clear trend is evident at Gordon Park, where flying-fox numbers have remained relatively steady over the past 6 months (excluding a temporary peak in May).

Flying-foxes remain absent from Bowraville and Wheatley Street, Bellingen.

GHFF dominated the species composition at occupied camps making up between 80% and 95% of all individuals present.

Female GHFF dominated the demographic composition at both the Macksville cemetery and Bellingen Island camps, making up between 84% and 91% of all GHFF individuals respectively.

No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species.

Light flowering of Forest Red Gum and Grey Ironbark, and moderate flowering of Swamp Mahogany and Broad-leaved Paperbark was observed to be currently occurring in the region. These are key diet species for the GHFF.



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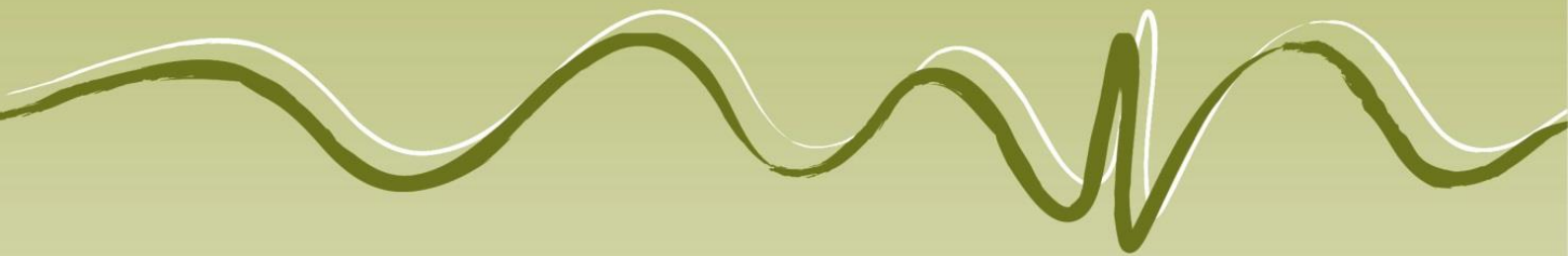
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Flying-fox Monitoring July 2018

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services has been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp was located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the July 2018 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the July 2018 flying-fox monitoring:

- Tom Pollard (ecologist).
- Frank Makin (ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 26 July 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics (avoiding male 'bachelor trees' where possible).
- Reproductive status.
- Behaviour.

When the site is unoccupied and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the abovementioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site. Specifically, the two observers were located at the following vantage points:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 45 minutes from sunset until dark (approximately 5:15 pm to 6:00 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

No flying-foxes were recorded roosting at the site in the traverse.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over an area of approximately 0.30 hectares (refer to **Illustration 2.2**). As has been recorded in the previous two monitoring events, the flying-fox roost is currently located in a narrow section of paperbark swamp forest west of the Macksville golf course near the northern end of McNeill Close.

Flying-foxes were not recorded at the Wheatley Street camp in Bellingen or at Bowraville.

Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). The extent of the roost footprint at Bellingen Island was observed to have decreased since the previous monthly monitoring event (GeoLINK 2018), and was only covering the northern section of the channel between the island and the old caravan park in the current monitoring event. At the Gordon Park camp the roost extent has not substantially changed from that recorded in the previous monitoring event, however more Black Flying-foxes appear to be currently roosting in upper canopy, leading to an overall increase in the number of flying-foxes at this camp.



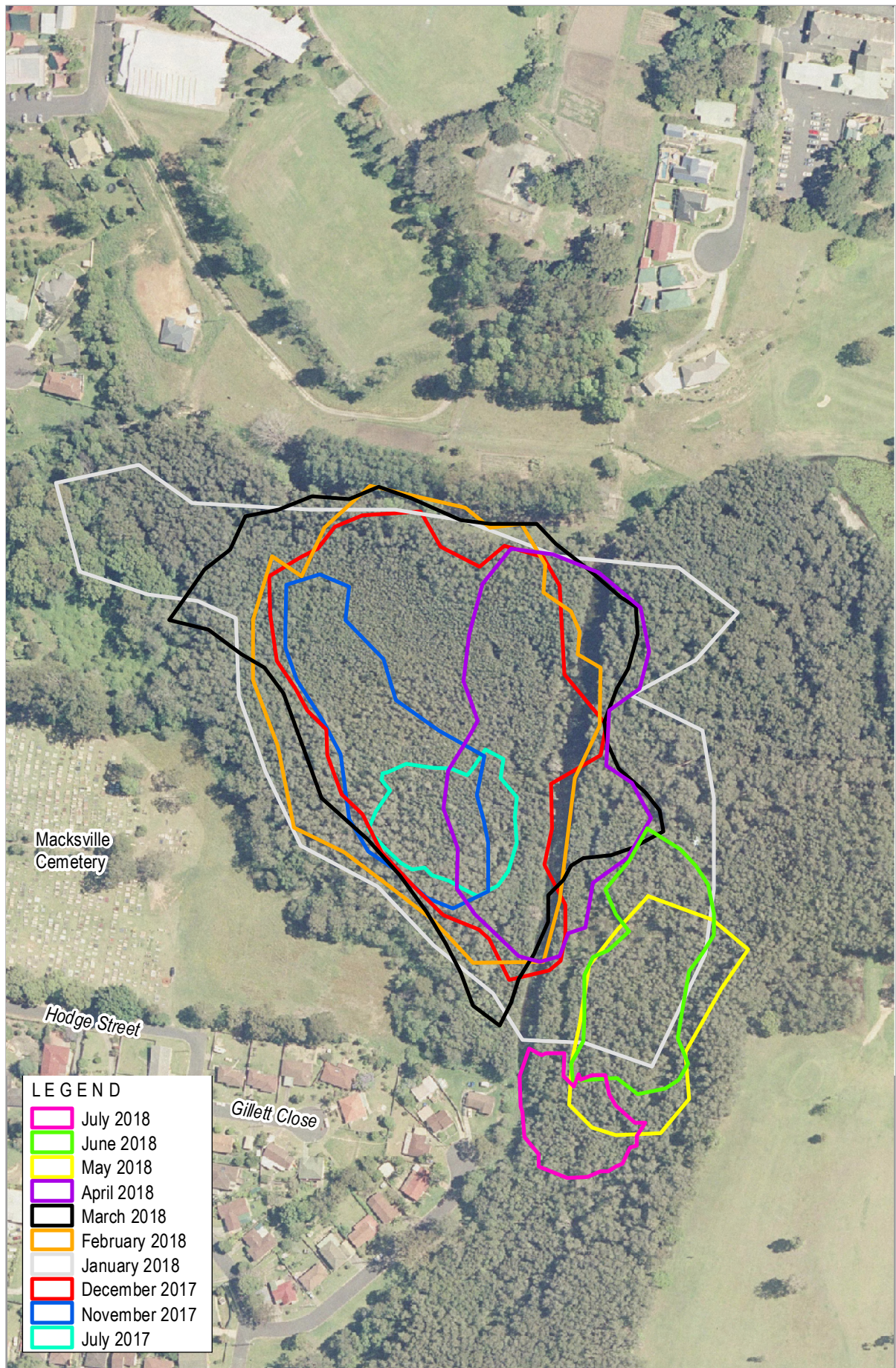
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Location of Regional Flying-fox Camps

Illustration 2.1



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Macksville Cemetery Flying-fox Roost Footprint

Flying-fox Monitoring July 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1137

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 1,000 individuals were recorded exiting the Macksville Cemetery camp in the exit count. The flying-foxes were mostly exiting in a southerly direction.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are provided. These flying-fox population estimate results (from this and past monitoring as part of this program) should not be relied on for accuracy or other purposes. Population estimates are provided in line with the Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories:

- 1 = 1 – 499
- 2 = 500 – 2,499
- 3 = 2,500 – 9,999
- 4 = 10,000 – 15,999
- 5 = 16,000 – 49,999
- 6 = >50,000.

Regional camp count estimates are as follows:


- Gordon Park: approximately 15,000 individuals (category 4).
- Bellingen Island: approximately 7,500 individuals (category 3).
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 70% GHFF and 30% Black Flying-fox.
- Bellingen Island: 95% GHFF and 5% Black Flying-fox.
- Gordon Park: 80% GHFF and 20% Black Flying-fox.



2.2.3.2 *Habitat Characteristics and Demographic Composition*

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). During this period of absence, the Macksville Cemetery camp has been the alternative site for collection of this data.

Both male and female GHFF were present at the Macksville Cemetery camp. Data could only be successfully collected from six demographic point counts, as the small number of flying-foxes present were easily disturbed and were changing roosting position frequently. The data collected indicated that the proportion of female GHFF present was moderate to high, ranging between 77% and 100% of all individuals at individual demographic point counts (89% average). No dependent young GHFF were present (refer to **Table 2.1**).

Both male and female GHFF were also present at the Bellingen Island camp. Data collected indicated that the proportion of female GHFF present was relatively high, ranging between 71% and 100% of all individuals at individual demographic point counts (85% average). No dependent young GHFF were present (refer to




Table 2.2).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present. No dependent young were observed with the females.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492164, 6601572	Broad- leaved Paperbark	12	20	10:0	No	n/a
MC2	492161, 6601558	Broad- leaved Paperbark	10	25	10:0	No	n/a
MC3	492163, 6601551	Broad- leaved Paperbark	12	30	10:2	No	n/a
MC4	492169, 6601538	Broad- leaved Paperbark	12	20	10:3	No	n/a
MC5	492174, 6601525	Broad- leaved Paperbark	12	20	10:1	No	n/a
MC6	492193, 6601524	Broad- leaved Paperbark	15	30	10:2	No	n/a
MC7	No data recorded	No data recorded	No data recorded	No data recorded	No data recorded	No data recorded	No data recorded
MC8	“	“	“	“	“	“	“
MC9	“	“	“	“	“	“	“
MC10	“	“	“	“	“	“	“

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	490047, 6631633	Moreton Bay Fig (<i>Ficus macrophylla</i>)	15	100	All males - 'bachelor tree'	No	n/a
BI2	490035, 6631624	White Aspen (<i>Acronychia oblongifolia</i>)	12	20/20 (multiple trunks)	10:3	No	n/a
BI3	490044, 6631618	Unidentified sp.	12	20	10:1	No	n/a
BI4	490038, 6631627	Dead tree	10	40	10:0	No	n/a
BI5	490035, 6631630	Moreton Bay Fig (<i>Ficus macrophylla</i>)	8	40	10:4	No	n/a
BI6	490005, 6631648	Moreton Bay Fig (<i>Ficus macrophylla</i>)	12	90	10:2	No	n/a
BI7	490017, 6631633	Giant Stinging Tree (<i>Dendrocnide excelsa</i>)	12	30	10:2	No	n/a
BI8	490029, 6631612	Giant Stinging Tree (<i>Dendrocnide excelsa</i>)	10	90	10:4	No	n/a
BI9	490041, 6631615	Creek Sandpaper Fig (<i>Ficus coronata</i>)	10	20	10:0	No	n/a
BI10	490057, 6631615	C Creek Sandpaper Fig (<i>Ficus coronata</i>)	10	20	10:2	No	n/a

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 45 cm in depth; similar to the level recorded in the previous monitoring event (refer to **Figure 2.1**).

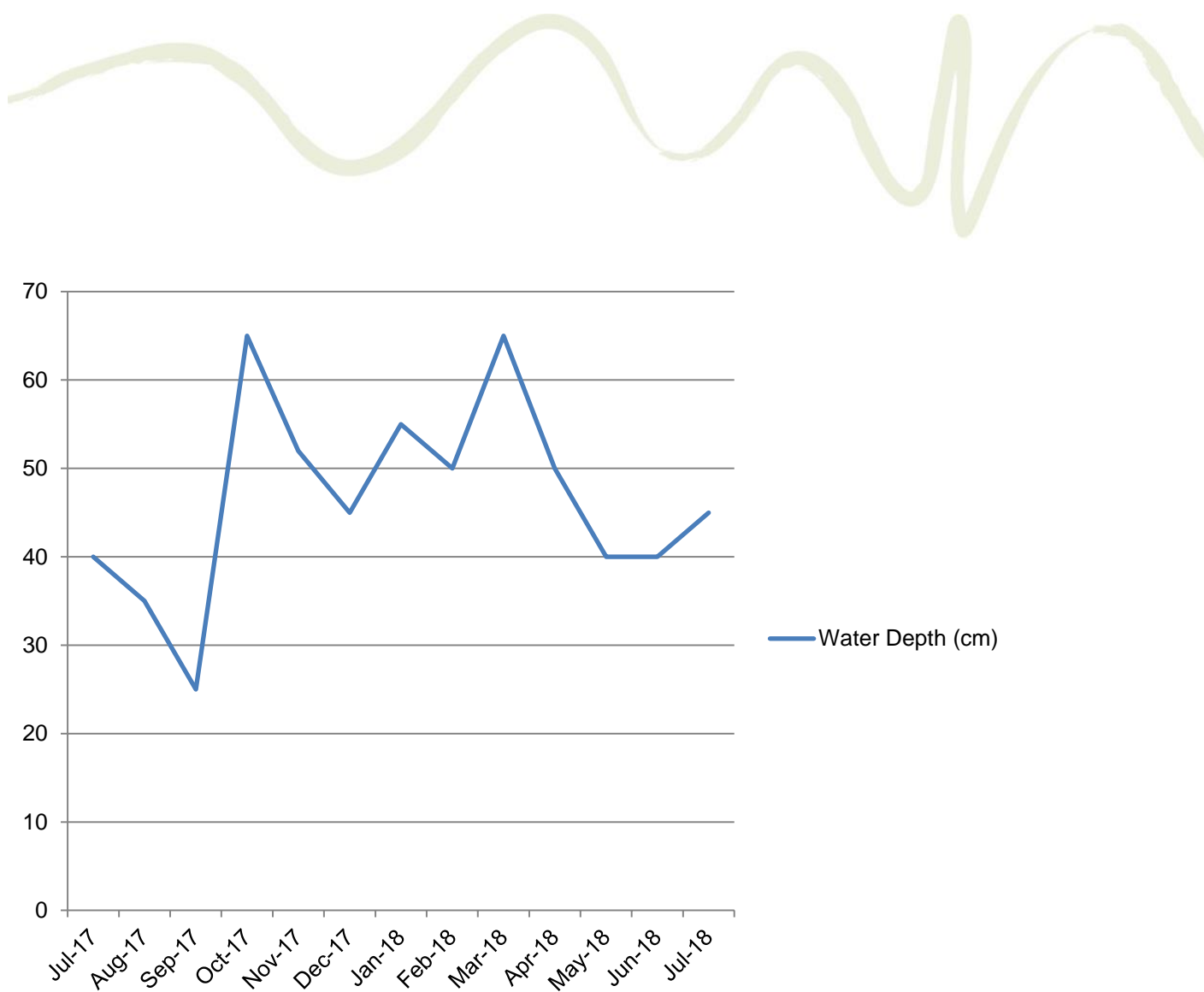


Figure 2.1 Water level measurements at the site


2.3 Discussion

2.3.1 Population Estimates

The following discussion refers to the following Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories:

- 1 = 1 – 499
- 2 = 500 – 2,499
- 3 = 2,500 – 9,999
- 4 = 10,000 – 15,999
- 5 = 16,000 – 49,999
- 6 = >50,000.

The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.



Since a peak in the number of flying-foxes roosting at the Macksville Cemetery camp in March 2018 when approximately 45,000 individuals were present (category 5), a steady decrease in numbers has been recorded. The current monitoring event recorded only 1,000 flying-foxes (category 2), the lowest number since October 2017. In July 2017 flying-fox numbers were at a similar level, with approximately 2,500 individuals present (category 3; GeoLINK 2017).

At Bellingen Island it was estimated that approximately 7,500 flying-foxes (category 3) were present in the current monitoring event. A steep decrease in numbers has been observed at this camp over the past four months following a peak of around 40,000 individuals (category 5) roosting at this camp in March 2018 (refer to **Figure 2.2**).

The number of flying-foxes at the Gordon Park camp has remained relatively steady over the past eight months, estimated at between 10,000 and 15,000 individuals (category 4) with the exception of a temporary spike in numbers in May 2018 to category 5 levels.

No flying-foxes were recorded at Bowraville in the current monitoring event. Flying-foxes have been absent from this site for over 18 months, and were last recorded in December 2016 in low numbers.

As can be seen in the 12-monthly population comparisons (refer to **Figure 2.2**), numbers of flying-foxes at regional camps are generally decreasing (with the exception of the Gordon Park camp following a summer/ autumn peak).

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up between 70% and 95% of all individuals. Similar high proportions of GHFF have consistently been recorded in previous monitoring events. The highest proportion of Black Flying-foxes was recorded at the Macksville Cemetery camp.

Female GHFF dominated the occupied camps in the current monitoring event, with demographic point counts averaging 85% at the Bellingen Island camp and 89% at the Macksville Cemetery camp. Similar high proportions of female GHFF were recorded in the previous monitoring event (GeoLINK 2018).

No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species.

2.3.3 Phenology of Trees in the Region

June/ July bi-monthly flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Coast Banksia (*Banksia integrifolia*), Coastal Blackbutt (*Eucalyptus pilularis*), Swamp Mahogany (*Eucalyptus robusta*), Forest Red Gum (*Eucalyptus tereticornis*), and Broad-leaved Paperbark (*Melaleuca quinquenervia*). These are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps recorded light to moderate flowering of Forest Red Gum, light flowering of Grey Ironbark. The moderate flowering of Broad-leaved Paperbark that was recorded in the previous monitoring event has now ended.

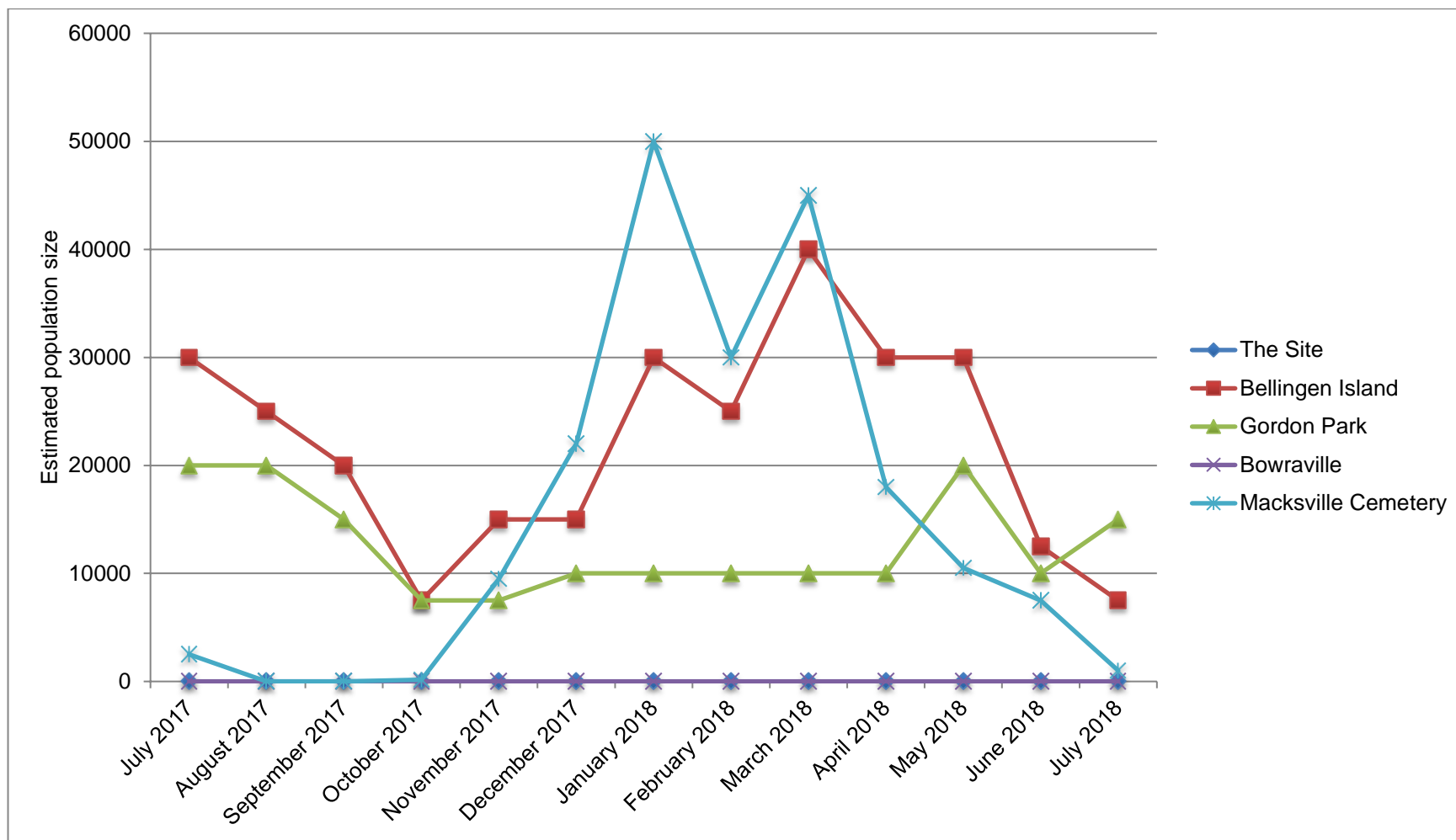


Figure 2.2 Population trends at the site and regional camps over past 12 months



2.4 Summary and Conclusion

The results of the July 2018 flying-fox monitoring indicate that, excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014.

There has been a general decreasing trend in flying-fox numbers at the Macksville Cemetery camp and Bellingen Island camp since a peak in March 2018. In contrast, no clear trend is evident at Gordon Park, where flying-fox numbers have remained relatively steady over the past 8 months (excluding a temporary peak in May).

Flying-foxes remain absent from Bowraville and Wheatley Street, Bellingen.

GHFF dominated the species composition at occupied camps making up between 70% and 95% of all individuals present.

Female GHFF dominated the demographic composition at both the Bellingen Island and Macksville cemetery camps, making up between 85% and 89% of all GHFF individuals respectively.

No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species.

Light to moderate flowering of Forest Red Gum and moderate flowering of Grey Ironbark was observed to be currently occurring in the region. Flowering of Broad-leaved Paperbark has now generally ended in the region. These are all key diet species for the GHFF.



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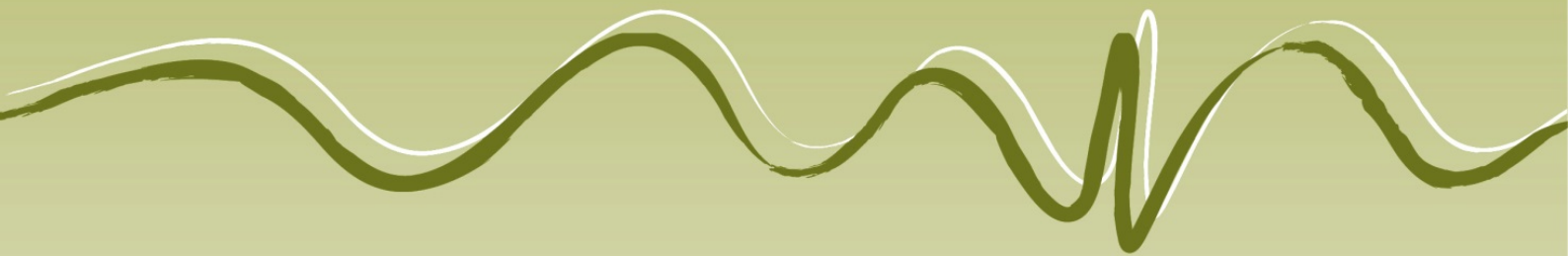
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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services has been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp was located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the August 2018 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the August 2018 flying-fox monitoring:

- Tom Pollard (ecologist).
- Frank Makin (ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 30 August 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics (avoiding male 'bachelor trees' where possible).
- Reproductive status.
- Behaviour.

When the site is unoccupied and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the abovementioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site. Specifically, the two observers were located at the following vantage points:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 45 minutes from sunset until dark (approximately 5:40 pm to 6:25 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

No flying-foxes were recorded roosting at the site in the traverse.

No flying-foxes were observed to be roosting at the Macksville Cemetery camp. Nor were there any flying-foxes recorded at the Wheatley Street camp in Bellingen or at the Bowraville camp.

Regionally, flying-foxes were observed to be roosting at the Bellingen Island camp and Gordon Park camp (Nambucca Heads). The extent of the roost footprint at both of these camps was generally similar to that recorded in the previous monthly monitoring event (GeoLINK 2018).



0 4 km

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Flying-fox Monitoring August 2018 - Warrell Creek to Nambucca
Heads Pacific Highway Upgrade
2692-1138

Location of Regional Flying-fox Camps

Illustration 2.1



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from either the site or the Macksville Cemetery camp during the exit count.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are provided. These flying-fox population estimate results (from this and past monitoring as part of this program) should not be relied on for accuracy or other purposes. Population estimates are provided in line with the Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories:

- 1 = 1 – 499
- 2 = 500 – 2,499
- 3 = 2,500 – 9,999
- 4 = 10,000 – 15,999
- 5 = 16,000 – 49,999
- 6 = >50,000.

Regional camp count estimates are as follows:


- Gordon Park: approximately 15,000 individuals (category 4).
- Bellingen Island: approximately 10,000 individuals (category 4).
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Bellingen Island: 90% GHFF and 10% Black Flying-fox.
- Gordon Park: 80% GHFF and 20% Black Flying-fox.



2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). During this period of absence, the Macksville Cemetery camp has been the alternative site for collection of this data. However, flying-foxes were also not present at the Macksville Cemetery camp in the current monitoring event and therefore detailed demographic composition data was therefore not collected for this alternative site.

Both male and female GHFF were present at the Bellingen Island camp. Data collected indicated that the proportion of female GHFF present was variable, ranging between 59% and 100% of all individuals at individual demographic point counts (77% average). No dependent young GHFF were present (refer to **Table 2.1**).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present. No dependent young were observed with the females.

Table 2.1 Demographic Data of GHFF at the Bellingin Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	490035, 6631612	Unidentified sp.	8	15	10:5	No	n/a
BI2	490017, 6631609	Creek Sandpaper Fig (<i>Ficus coronata</i>)	8	15	10:2	No	n/a
BI3	490005, 6631621	Creek Sandpaper Fig (<i>Ficus coronata</i>)	10	20	10:6	No	n/a
BI4	490051, 6631624	Creek Sandpaper Fig (<i>Ficus coronata</i>)	8	15	10:4	No	n/a
BI5	490054, 6631624	Giant Stinging Tree (<i>Dendrocnide excelsa</i>)	15	40	10:0	No	n/a
BI6	490060, 6631618	Creek Sandpaper Fig (<i>Ficus coronata</i>)	12	20	10:7	No	n/a
BI7	490069, 6631630	Unidentified sp.	10	25	10:1	No	n/a
BI8	490054, 6631639	Moreton Bay Fig (<i>Ficus macrophylla</i>)	15	100	10:7	No	n/a
BI9	490035, 6631639	Unidentified sp.	12	20	10:1	No	n/a
BI10	490011, 6631648	Creek Sandpaper Fig (<i>Ficus coronata</i>)	10	20	10:2	No	n/a

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 45 cm in depth; similar to the level recorded in the previous monitoring event (refer to **Figure 2.1**).

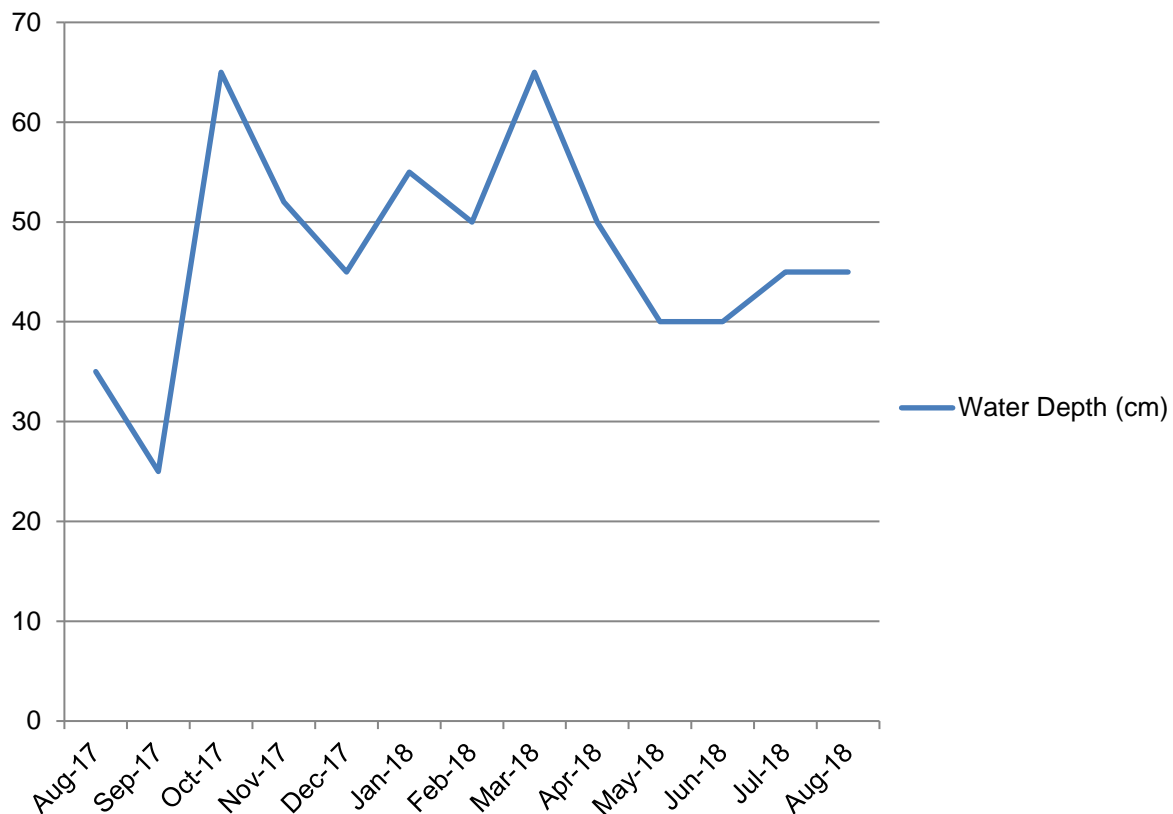


Figure 2.1 Water Level Measurements at the Site


2.3 Discussion

2.3.1 Population Estimates

The following discussion refers to the following Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories (refer to **Section 2.2.2.2**).

The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

Since a peak in the number of flying-foxes roosting at the Macksville Cemetery camp in March 2018 when approximately 45,000 individuals were present (category 5), a steady decrease in numbers has been recorded down to zero flying-foxes in the current monitoring event. This is consistent with the monitoring results from 2017, when flying-foxes were absent from this camp over the August to October period (refer to **Figure 2.2**).



At the Bellingen Island camp it was estimated that approximately 10,000 flying-foxes (category 4) were present. A similar number of flying-foxes were recorded in the previous monitoring event. The number of flying-foxes at both the Bellingen Island and Gordon Park camps in August 2017 was higher than that estimated in the current monitoring event (category 5; GeoLINK 2017), possibly indicating that key foraging resources were more readily available locally at that time of year in 2017 (refer to **Figure 2.2**).

The number of flying-foxes at the Gordon Park camp has remained relatively steady over the past nine months, estimated at between 10,000 and 15,000 individuals (category 4) with the exception of a temporary spike in numbers in May 2018 to category 5 levels.

No flying-foxes were recorded at Bowraville in the current monitoring event. Flying-foxes have been absent from this site for over 18 months, and were last recorded in December 2016 in low numbers.

As can be seen in the 12-monthly population comparisons (refer to **Figure 2.2**), numbers of flying-foxes at occupied regional camps is now at relatively low to moderate levels following a summer/autumn peak.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up between 80% and 90% of all individuals. Similar high proportions of GHFF have consistently been recorded in previous monitoring events.

The proportion of female GHFF decreased from 85% to 77% at the Bellingen Island camp over the last month (GeoLINK 2018). Despite this minor decrease, female GHFF nonetheless strongly dominated the demographic composition.

No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species.

2.3.3 Phenology of Trees in the Region

August/ September bi-monthly flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Coast Banksia (*Banksia integrifolia*), Coastal Blackbutt (*Eucalyptus pilularis*), Narrow-leaved Red Gum (*Eucalyptus seeana*), Grey Ironbark (*Eucalyptus siderophloia*) and Forest Red Gum (*Eucalyptus tereticornis*). These are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps recorded moderate flowering of Coast Banksia, Forest Red Gum and Grey Ironbark.

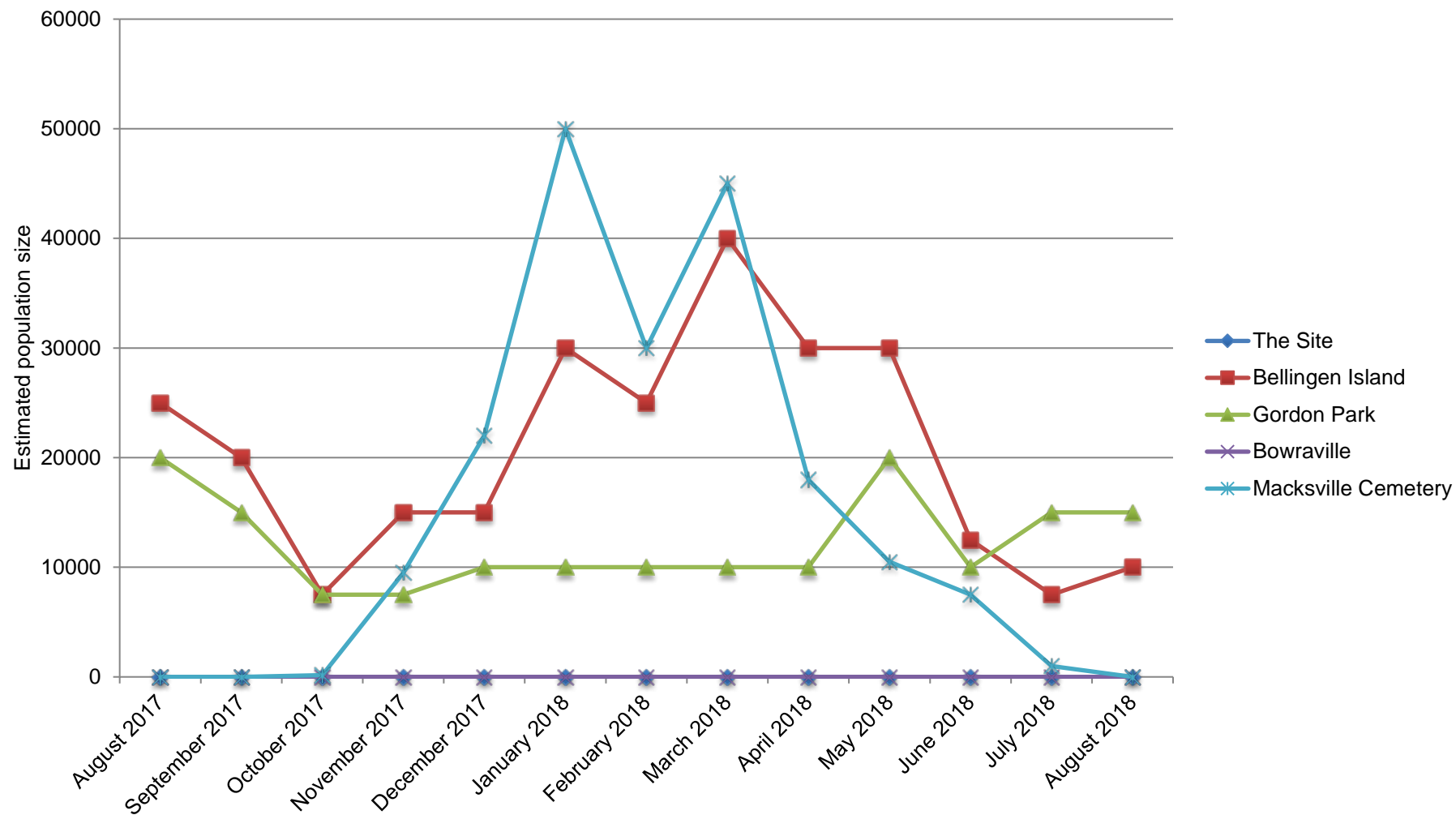


Figure 2.2 Population Trends at the Site and Regional Camps Over Past 12 Months



2.4 Summary and Conclusion

The results of the August 2018 flying-fox monitoring indicate that, excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014. Flying-foxes were also absent from the Macksville Cemetery, Bowraville, and Wheatley Street camps.

Only the Bellingen Island and Gordon Park camps were occupied. The number of flying-foxes at these occupied regional camps is now at relatively low to moderate levels following a summer/ autumn peak. GHFF dominated the species composition at occupied camps at between 80% and 90% of all individuals present. The proportion of female GHFF remains relatively high. No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species.

Moderate flowering of Coast Banksia, Forest Red Gum and Grey Ironbark was observed to be currently occurring in the region. These are all key diet species for the GHFF.



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Senior Ecologist



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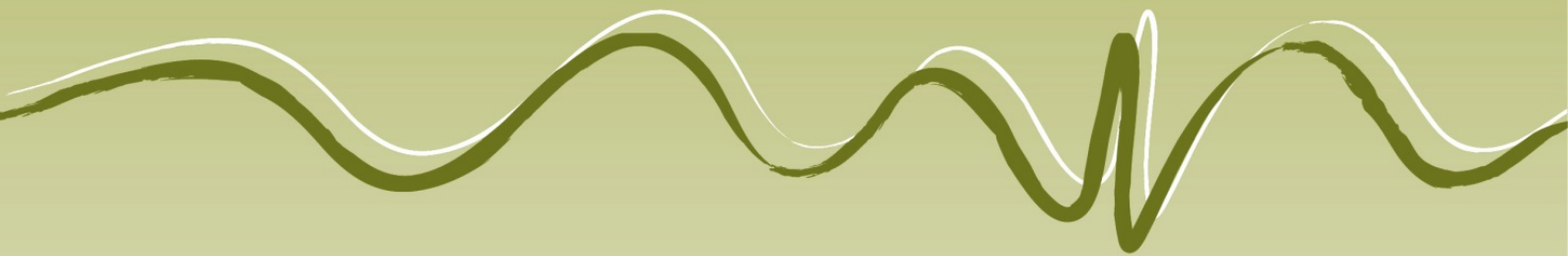
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Appendix 10 September 2018 monitoring report

Flying-fox Monitoring September 2018

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services has been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp was located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the September 2018 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the September 2018 flying-fox monitoring:

- Jessica O’Leary (ecologist).
- Frank Makin (ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 25 September 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics (avoiding male ‘bachelor trees’ where possible).
- Reproductive status.
- Behaviour.

When the site is unoccupied and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the abovementioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site, as follows:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 45 minutes from sunset until dark (approximately 5:50 pm to 6:35 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

No flying-foxes were recorded roosting at the site in the traverse.

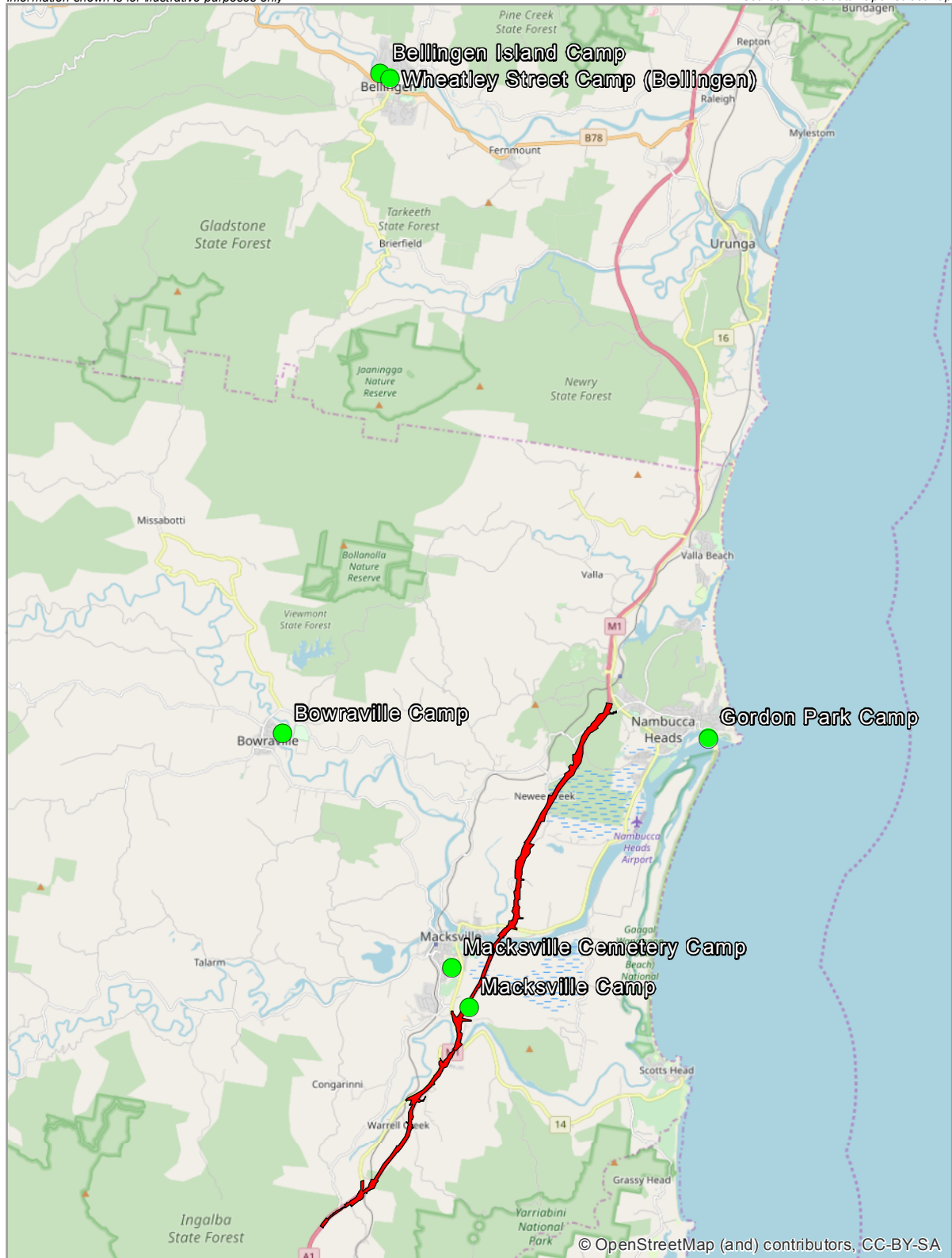
Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over an area of approximately 0.39 hectares (refer to **Illustration 2.2**). The flying-fox roost is currently located in a narrow section of paperbark swamp forest west of the Macksville golf course near the northern end of McNeill Close.

No flying-foxes were observed at the Wheatley Street camp in Bellingen or at the Bowraville camp.

Regionally, flying-foxes were observed to be roosting at the Bellingen Island camp and Gordon Park camp (Nambucca Heads). The extent of the roost footprint at both of these camps was generally similar to that recorded in the previous monthly monitoring event (GeoLINK 2018).

Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). The extent of the roost footprint at Bellingen Island was observed to have increased since the previous monthly monitoring event (GeoLINK 2018), this month covering a broader area of the island including the north and southern edges of the island vegetation. At the Gordon Park camp, the roost extent has not substantially changed from that recorded in the previous monitoring event.

Information shown is for illustrative purposes only



LEGEND

- █ WC2NH Project boundary
- Flying-fox camp location

0 4 Km



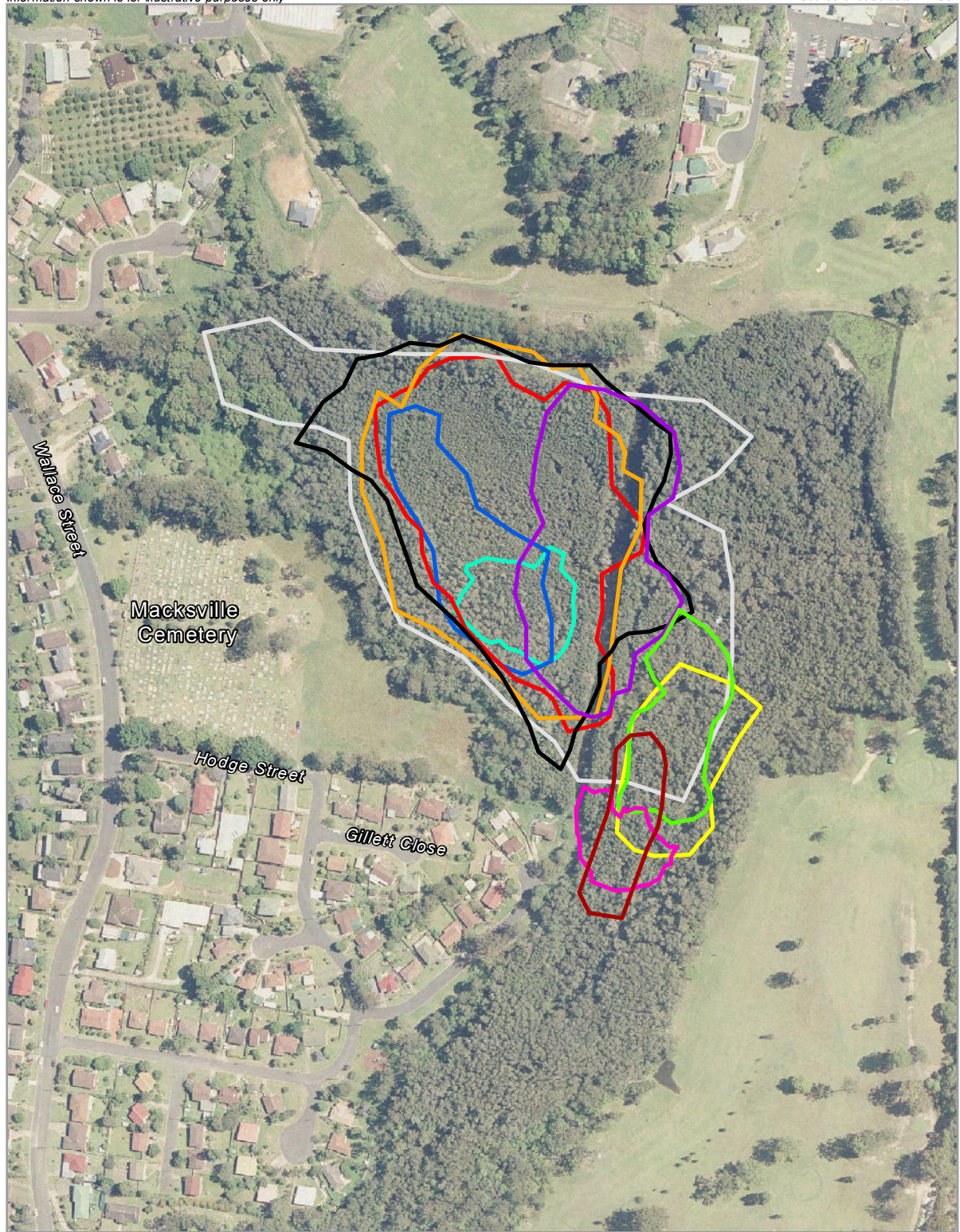
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Location of Regional Flying-fox Camps

Flying-fox Monitoring September 2018 - Warrell Creek to Nambucca Heads Pacific Highway Upgrade
2692-1144

Illustration 2.1

Information shown is for illustrative purposes only



LEGEND

	September 2018		December 2017
	July 2018		November 2017
	June 2018		July 2017
	May 2018		
	April 2018		
	March 2018		
	February 2018		
	January 2018		

0 80

Macksville Cemetery Flying-fox Roost Footprint



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Flying-fox Monitoring September 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1145

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 2,334 individuals were recorded exiting the Macksville Cemetery camp in the exit count. The flying-foxes were mostly exiting in a westerly direction.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are provided. These flying-fox population estimate results (from this and past monitoring as part of this program) should not be relied on for accuracy or other purposes. Population estimates are provided in line with the Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories:

- 1 = 1 – 499
- 2 = 500 – 2,499
- 3 = 2,500 – 9,999
- 4 = 10,000 – 15,999
- 5 = 16,000 – 49,999
- 6 = >50,000.

Regional camp count estimates are as follows:

- Gordon Park: approximately 15,000 individuals (category 4).
- Bellingen Island: approximately 15,000 individuals (category 4).
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 95% GHFF and 5% Black Flying-fox.
- Bellingen Island: 95% GHFF and 5% Black Flying-fox.
- Gordon Park: 90% GHFF and 10% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). During this period of absence, the Macksville Cemetery camp has been the alternative site for collection of this data.

Both male and female GHFF were present at the Macksville Cemetery camp. Data could only be successfully collected from four demographic point counts, as the small number of flying-foxes present were easily disturbed and were changing roosting position frequently. The data collected indicated that the proportion of female GHFF present was moderate to high, ranging between 66% and 83.3% of all individuals at individual demographic point counts (74.4% average). No dependent young GHFF were present (refer to **Table 2.1**).

Both male and female GHFF were present at the Bellingen Island camp. Data collected indicated that the proportion of female GHFF present was variable, ranging between 58% and 91% of all individuals at eight individual demographic point counts (70.5% average). *Note: Ten females were unable to be found at two point counts, most likely due to the harem being surrounded by bachelor groups/ trees. Their values excluded from the female ratio counts.* No dependent young GHFF were present (refer to **Table 2.2**).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present. No dependent young were observed with the females.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492198, 6601613	Broad-leaved Paperbark	12	20	10:2	No	n/a
MC2	492191, 6601600	Broad-leaved Paperbark	12	25	10:5	No	n/a
MC3	492191, 6601585	Broad-leaved Paperbark	12	25	10:3	No	n/a
MC4	492184, 6601561	Broad-leaved Paperbark	12	20	10:4	No	n/a

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	490035, 6631612	Unidentified sp.	10	15	10:5	No	n/a
BI2	490017, 6631609	Giant Stinging Tree (<i>Dendrocnide excelsa</i>)	10	40	10:5	No	n/a
BI3	490005, 6631621	Creek Sandpaper Fig (<i>Ficus coronata</i>)	10	20	7:10*	No	n/a
BI4	490051, 6631624	Creek Sandpaper Fig (<i>Ficus coronata</i>)	8	15	4:10*	No	n/a
BI5	490054, 6631624	Creek Sandpaper Fig (<i>Ficus coronata</i>)	10	7	10:7	No	n/a
BI6	490060, 6631618	Red Cedar (<i>Toona ciliata</i>)	12	20	10:6	No	n/a
BI7	490069, 6631630	Creek Sandpaper Fig (<i>Ficus coronata</i>)	10	20	10:5	No	n/a
BI8	490054, 6631639	Creek Sandpaper Fig (<i>Ficus coronata</i>)	12	25	10:3	No	n/a
BI9	490035, 6631639	Giant Stinging Tree (<i>Dendrocnide excelsa</i>)	25	70	10:3	No	n/a
BI10	490011, 6631648	Moreton Bay Fig (<i>Ficus macrophylla</i>)	8	40	10:1	No	n/a

* denotes trees where occurrences of females was limited and surrounded by bachelor male groups.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 50 cm in depth; similar to the level recorded in the previous monitoring event (refer to **Figure 2.1**).

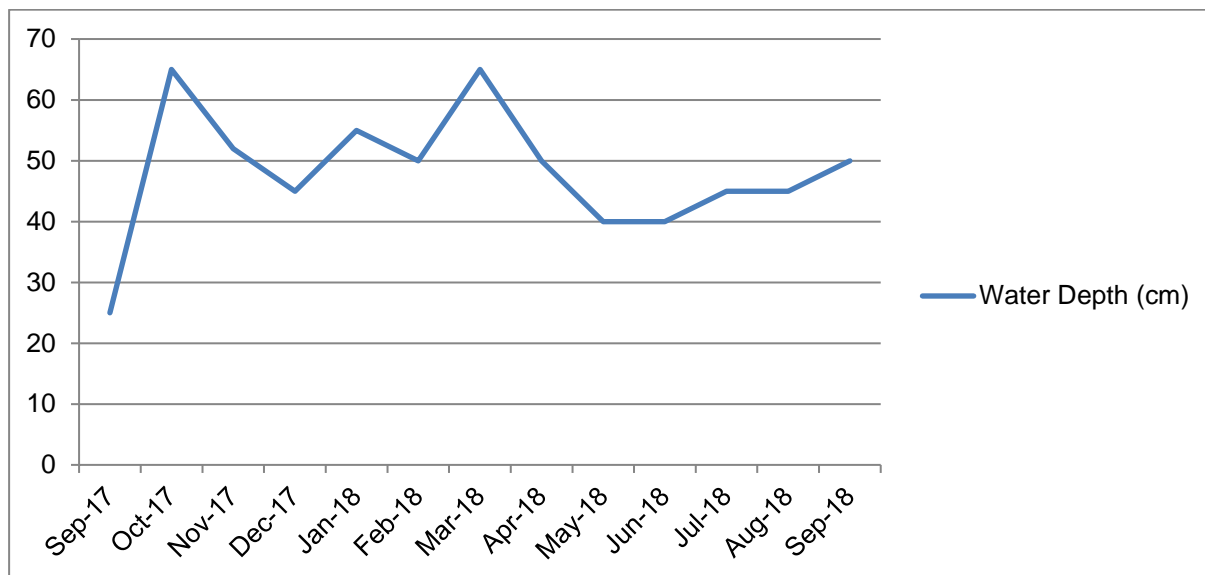


Figure 2.1 Water Level Measurements at the Site

2.3 Discussion


2.3.1 Population Estimates

The following discussion refers to the following Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories (refer to **Section 2.2.2.2**). The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

Since a peak in the number of flying-foxes roosting at the Macksville Cemetery camp in March 2018 when approximately 45,000 individuals were present (category 5), a steady decrease in numbers was recorded down to zero in August 2018. The current monitoring event has shown a return of relatively small numbers of flying-fox to the camp. The seasonal trend of summer/ autumn peaks and late autumn to spring reductions (including periodic absences) in the camp population has been consistently observed throughout the monitoring program; though the durations and the exact timing of the peak and reductions has varied slightly.

At the Bellingen Island camp it was estimated that approximately 15,000 flying-foxes (category 4) were present. This represents an increase in numbers of flying-foxes since the August monitoring event when an estimated 10,000 flying-foxes were recorded. Bellingen Island numbers are slightly lower than that estimated same time last year (GeoLINK 2017).

The number of flying-foxes at the Gordon Park camp has remained relatively steady over the past nine months, estimated at between 10,000 and 15,000 individuals (category 4) with the exception of a temporary spike in numbers in May 2018 to category 5 levels.



No flying-foxes were recorded at Bowraville in the current monitoring event. Flying-foxes have been absent from this site for over 18 months, and were last recorded in December 2016 in low numbers.

As can be seen in the 12-monthly population comparisons (refer to **Figure 2.2**), numbers of flying-foxes at occupied regional camps is now at relatively low to moderate levels following a summer/autumn peak.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up between 90% and 95% of all individuals. Similar high proportions of GHFF have consistently been recorded in previous monitoring events.

The proportion of female GHFF decreased from 77% to 70.5% at the Bellingen Island camp over the last month (GeoLINK 2018). Despite this minor decrease, female GHFF nonetheless strongly dominated the demographic composition.

No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species. Young are likely to be seen during the next monitoring event in late October 2018.

2.3.3 Phenology of Trees in the Region

August/ September bi-monthly flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Coast Banksia (*Banksia integrifolia*), Coastal Blackbutt (*Eucalyptus pilularis*), Narrow-leaved Red Gum (*Eucalyptus seeana*), Grey Ironbark (*Eucalyptus siderophloia*) and Forest Red Gum (*Eucalyptus tereticornis*). These are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps recorded moderate flowering of Coast Banksia, Forest Red Gum and Grey Ironbark. Tallowwood is also in flower locally.

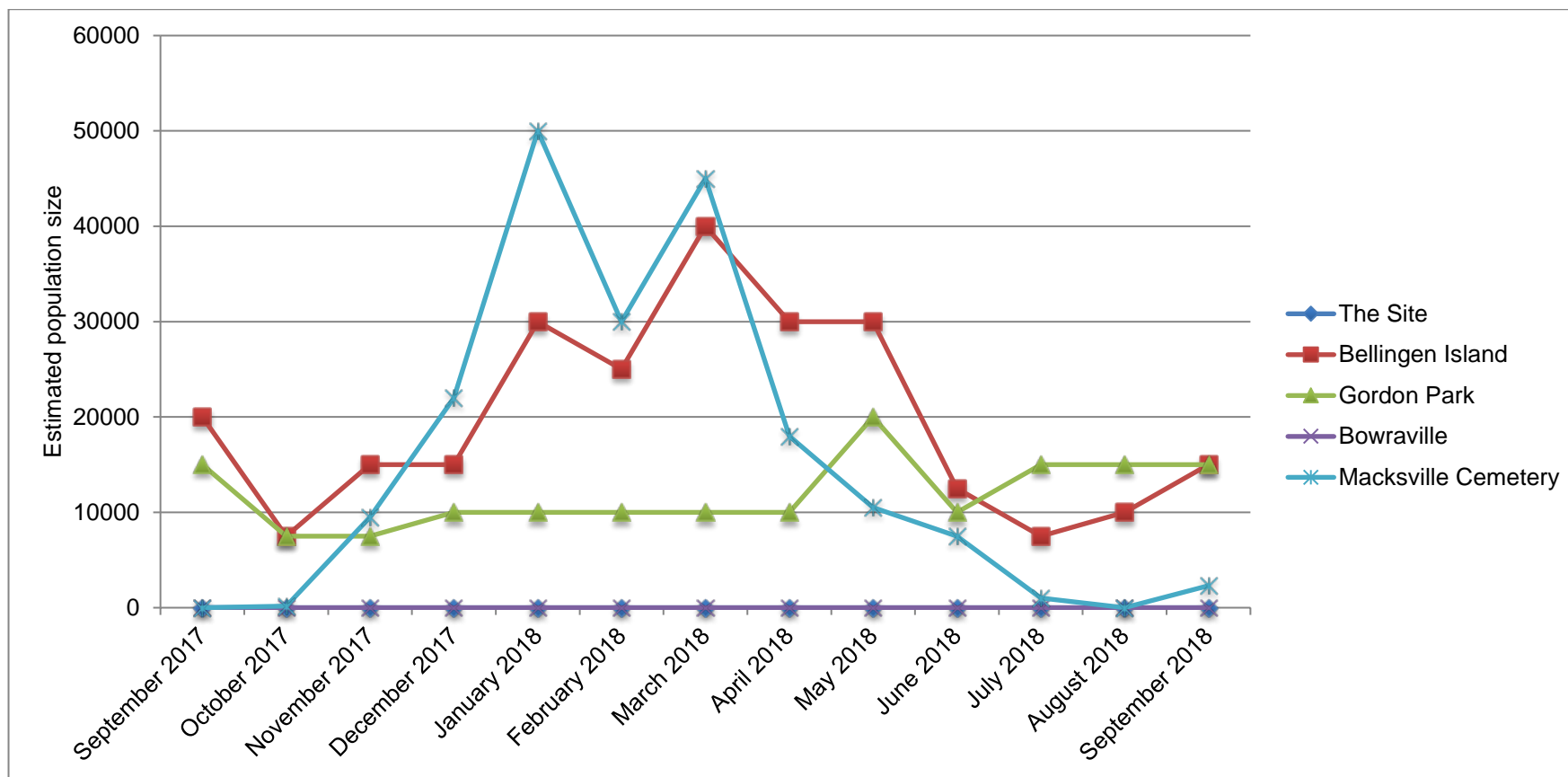


Figure 2.2 Population Trends at the Site and Regional Camps Over Past 12 Months



2.4 Summary and Conclusion

The results of the September 2018 flying-fox monitoring indicate that, excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014. Flying-foxes were also absent from the Bowraville and Wheatley Street camps.

Bellingen Island, Gordon Park and Macksville Cemetery camps were occupied. The number of flying-foxes at these occupied regional camps is now at relatively low to moderate levels following a summer/ autumn peak.

GHFF dominated the species composition at occupied camps at between 90% and 95% of all individuals present. The proportion of female GHFF remains relatively high. No dependent young GHFF were recorded at any of the occupied camps in the current monitoring event, in line with the reproductive cycle of this species.

Moderate flowering of Coast Banksia, Forest Red Gum and Grey Ironbark was observed to be currently occurring in the region. These are all key diet species for the GHFF.



David Andrighetto
Senior Ecologist



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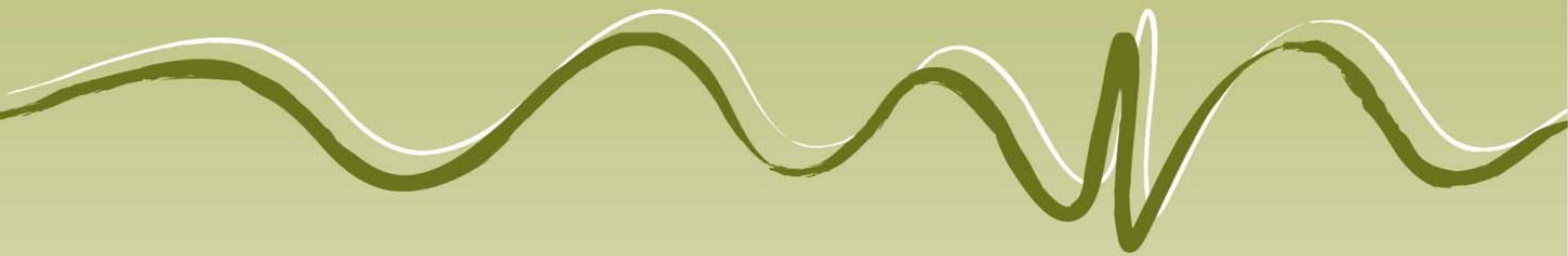
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Appendix 11 October 2018 monitoring report

Flying-fox Monitoring October 2018

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services has been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp was located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012).

This report details the October 2018 flying-fox monitoring results.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the October 2018 flying-fox monitoring:

- Jessica O’Leary (ecologist)
- Frank Makin (ecologist)
- Jeremy Clifford (environmental scientist)
- Kale Hardie-Porter (environmental scientist).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 30 October 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS)
- Species composition
- Demographics (avoiding male ‘bachelor trees’ where possible)
- Reproductive status
- Behaviour.

When the site is unoccupied, and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the abovementioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and is tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site, as follows:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive)
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp)
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 45 minutes from sunset until dark (approximately 7:00 pm to 7:45 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

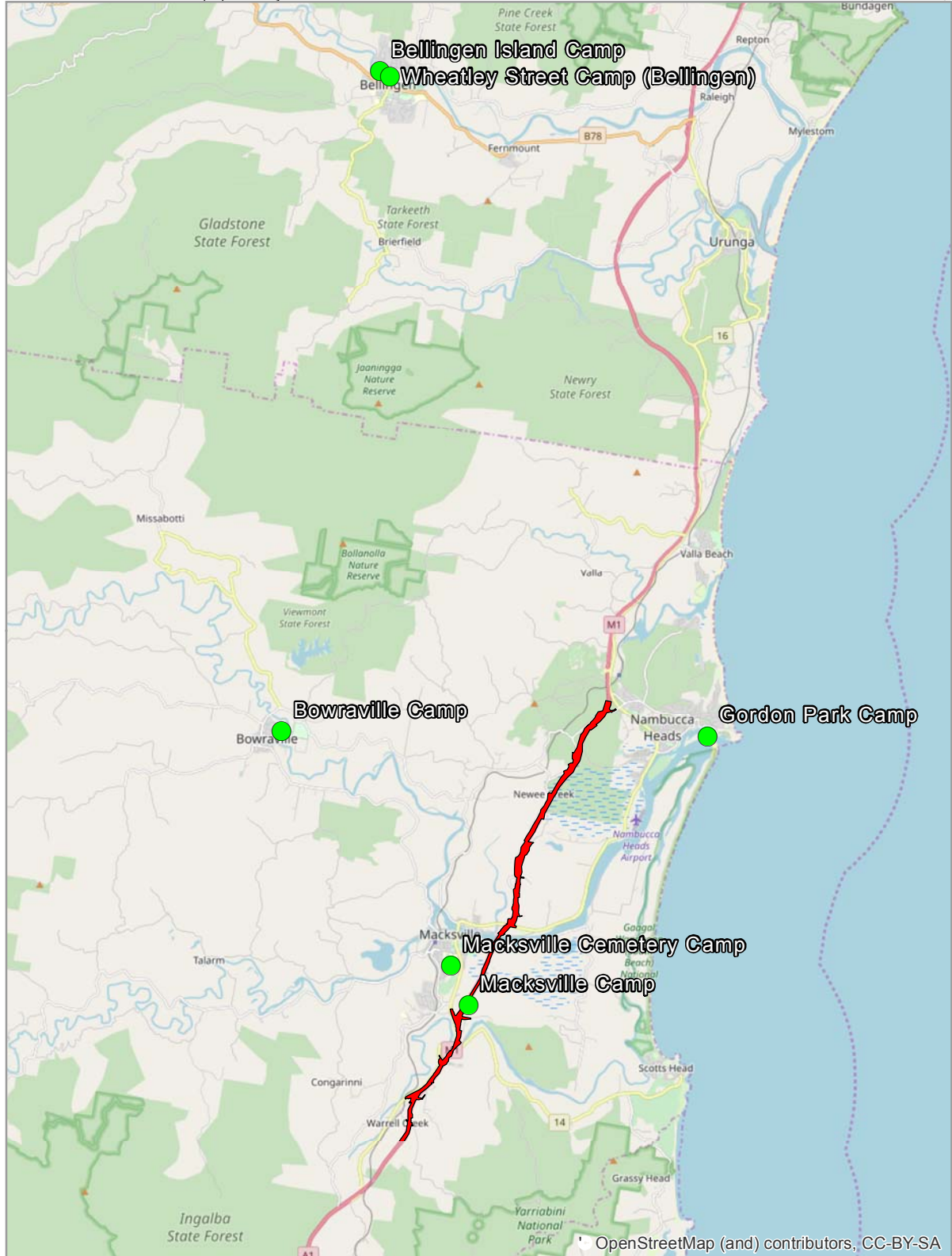
No flying-foxes were recorded roosting at the site in the traverse.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over an area of approximately 1.91 hectares (refer to **Illustration 2.2**). The flying-fox roost is currently located in a section of paperbark swamp forest west of the Macksville golf course near the northern end of McNeill Close.

Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). The extent of the roost footprint at Bellingen Island was observed to have increased since the previous monthly monitoring event (GeoLINK 2018), this month covering a broader area of the island including the north and southern edges of the island vegetation. At the Gordon Park camp, the roost extent has not substantially changed from that recorded in the previous monitoring event even with significantly less numbers of bats occupying the camp.

No flying-foxes were observed at the Wheatley Street camp in Bellingen or at the Bowraville camp.

Information shown is for illustrative purposes only



LEGEND

- █ WC2NH Project boundary
- Flying-fox camp location

0 4 Km



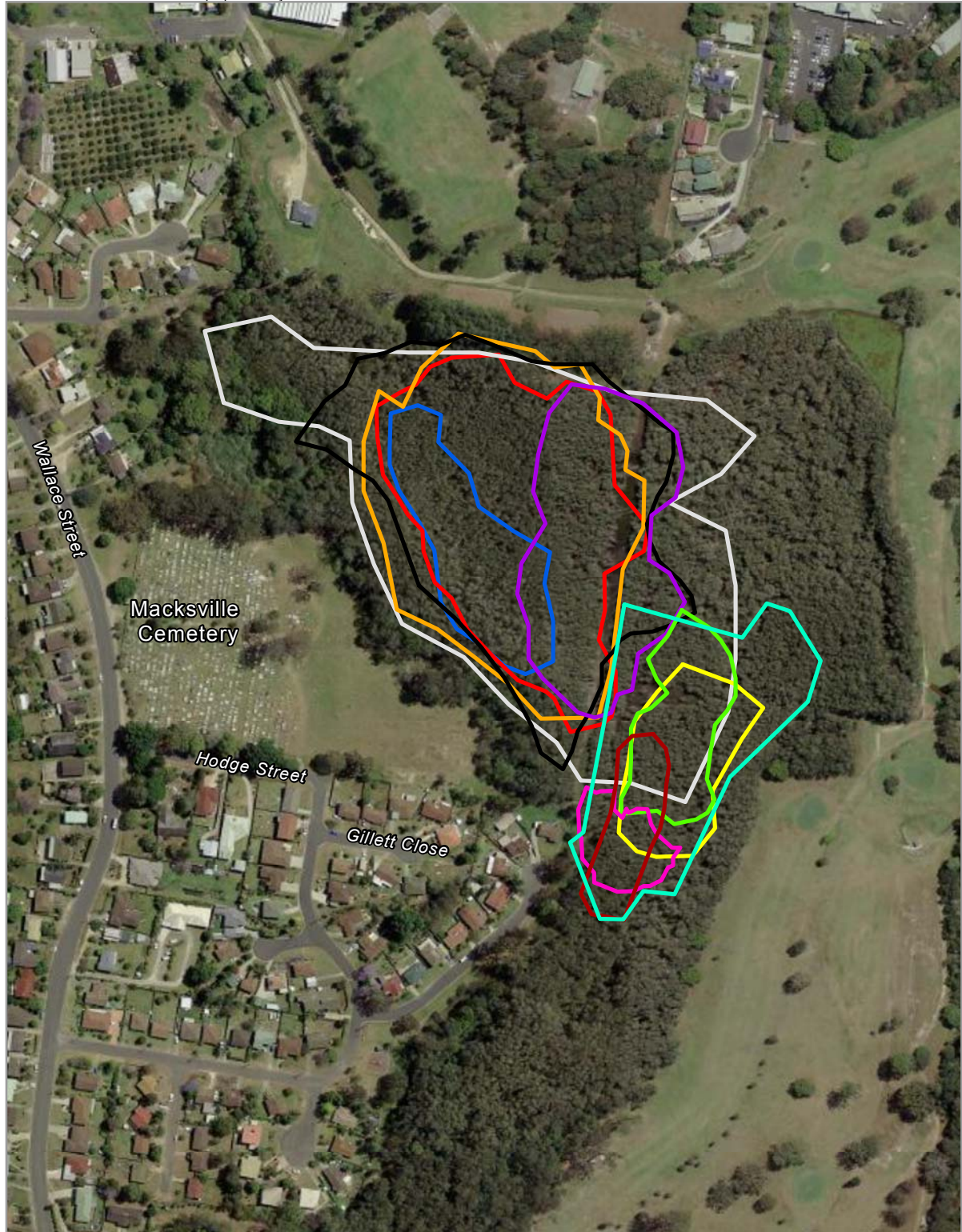
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Location of Regional Flying-fox Camps

Flying-fox Monitoring October 2018 - Warrell Creek to Nambucca Heads Pacific Highway Upgrade
2692-1152

Illustration 2.1

Information shown is for illustrative purposes only



LEGEND

	October 2018		February 2018
	September 2018		January 2018
	July 2018		December 2017
	June 2018		November 2017
	May 2018		
	April 2018		
	March 2018		

0 80



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environmental management and design

Macksville Cemetery Flying-fox Roost Footprint

Flying-fox Monitoring October 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1151

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 10,300 individuals were recorded exiting the Macksville Cemetery camp in the exit count. Approximately 7,600 flying-foxes were observed exiting the camp in a western direction with the remaining numbers exiting in north-east and south-east streams. Due to the direction of the streams and giving consideration of observed flying-fox densities and the roost footprint; it is likely that the exit count result underestimated the number of flying-foxes at the camp.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are provided. These flying-fox population estimate results (from this and past monitoring as part of this program) should not be relied on for accuracy or other purposes. Population estimates are provided in line with the Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories:

- 1 = 1 – 499
- 2 = 500 – 2,499
- 3 = 2,500 – 9,999
- 4 = 10,000 – 15,999
- 5 = 16,000 – 49,999
- 6 = >50,000.

Regional camp count estimates are as follows:

- Gordon Park: approximately 7,500 individuals (category 3)
- Bellingen Island: approximately 20,000 individuals (category 5)
- Wheatley Street, Bellingen: no individuals recorded
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 95% GHFF and 5% Black Flying-fox
- Bellingen Island: 95% GHFF and 5% Black Flying-fox
- Gordon Park: 95% GHFF and 5% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). Due to this absence, the Macksville Cemetery camp has been the alternative site for collection of this data.

Both male and female GHFF were present at the Macksville Cemetery camp. Data collected in demographic point counts (which excluded bachelor male roost trees) indicated that the proportion of female GHFF present was generally high and ranged from 71% to 90% (average 81%) of all individuals (refer to **Table 2.1**). The percentage of females with dependent young GHFF at demographic point counts averaged 70% (ranging between 50% and 90%).

Both male and female GHFF were present at the Bellingen Island camp. Data collected in demographic point counts indicated that the proportion of female GHFF present was generally high and ranged from 71% to 83% (average 77%) of all individuals. The percentage of females with dependent young GHFF at demographic point counts averaged 66% (ranging between 50% and 90%) (refer to **Table 2.2**).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present as well as females with dependent young.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492198, 6601613	Broad-leaved Paperbark (<i>Melaleuca quinquenervia</i>)	12	20	10:2	Yes	60
MC2	492191, 6601600	Broad-leaved Paperbark	12	25	10:1	Yes	90
MC3	492191, 6601585	Broad-leaved Paperbark	12	15	10:3	Yes	80
MC4	492184, 6601561	Broad-leaved Paperbark	12	20	10:4	Yes	80
MC5	492199, 6601620	Broad-leaved Paperbark	12	25	10:3	Yes	50
MC6	492311, 6601664	Broad-leaved Paperbark	12	10	10:2	Yes	60
MC7	492272, 6601626	Broad-leaved Paperbark	12	20	10:2	Yes	80
MC8	492251, 6601594	Broad-leaved Paperbark	12	20	10:1	Yes	50
MC9	492237, 6601562	Broad-leaved Paperbark	12	15	10:2	Yes	80
MC10	492219, 6601530	Broad-leaved Paperbark	12	20	10:3	Yes	70

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	490035, 6631612	Creek Sandpaper Fig (<i>Ficus coronata</i>)	10	20	10:2	Yes	60
BI2	490017, 6631609	Creek Sandpaper Fig	10	35	10:4	Yes	70
BI3	490005, 6631621	Giant Stinging Tree (<i>Dendrocnide excelsa</i>)	18	10	10:4	Yes	60
BI4	490051, 6631624	Giant Stinging Tree	18	80	10:2	Yes	60
BI5	490054, 6631624	Giant Stinging Tree	15	70	10:3	Yes	60
BI6	490060, 6631618	Creek Sandpaper Fig	14	20	10:3	Yes	50
BI7	490069, 6631630	Creek Sandpaper Fig	12	25	10:2	Yes	80
BI8	490054, 6631639	Giant Stinging Tree	15	40	10:2	Yes	70
BI9	490035, 6631639	Giant Stinging Tree	13	40	10:3	Yes	60
BI10	490011, 6631648	Moreton Bay Fig (<i>Ficus macrophylla</i>)	10	40	10:3	Yes	90

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 55 cm in depth; a slight increase to the level recorded in the previous monitoring event (refer to **Figure 2.1**).

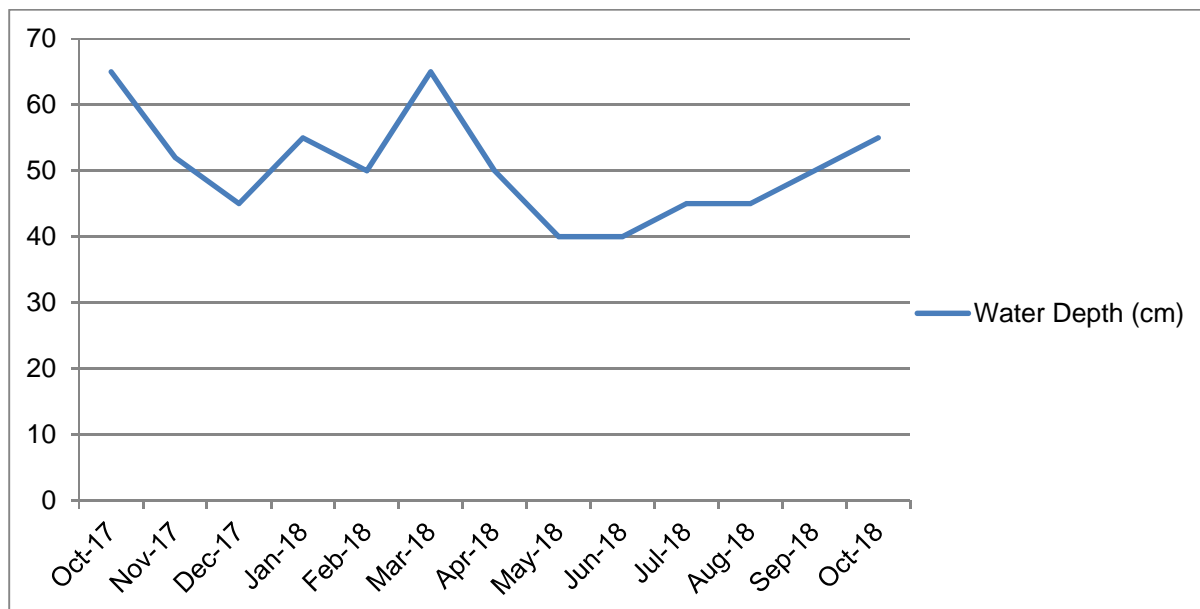


Figure 2.1 Water Level Measurements at the Site


2.3 Discussion

2.3.1 Population Estimates

The following discussion refers to the Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories (refer to **Section 2.2.2.2**). The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps is shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

Since a peak in the number of flying-foxes roosting at the Macksville Cemetery camp in March 2018 when approximately 45,000 individuals were present (category 5), a steady decrease in numbers was recorded down to zero in August 2018. The current monitoring event has shown a return of relatively small-moderate numbers of flying-foxes to the camp. The seasonal trend of summer/ autumn peaks and late autumn to spring reductions (including periodic absences) in the camp population has been consistently observed throughout the monitoring program; though the durations and the exact timing of the peaks and reductions has varied slightly.

At the Bellingen Island camp it was estimated that approximately 20,000 flying-foxes (category 5) were present. This represents an increase in numbers compared to the September 2018 monitoring where 15,000 flying-foxes were recorded. This month the general footprint of the roost was the same however the bats were positioned more sparsely throughout the camp. Bellingen Island numbers are higher than numbers recorded during October 2017 where an estimated 7,500 flying-foxes were recorded (GeoLINK 2017).



The number of flying-foxes at the Gordon Park camp has decreased since last month to 7,500 during October 2018. This observation is consistent with the same time during 2016 and 2017 where 7,500 flying-foxes were recorded during October. During May 2018 numbers spiked to 20,000 (category 5), then between May 2018 and September 2018 the flying-fox numbers have remained relatively steady at between 10,000 and 15,000 individuals (category 4).

No flying-foxes were recorded at Bowraville in the current monitoring event. Flying-foxes have been absent from this site for nearly two years and were last recorded in December 2016 in low numbers.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up approximately 95% of all individuals. Similar high proportions of GHFF have consistently been recorded in previous monitoring events. Female flying-foxes dominated the demographic composition at both the Macksville Cemetery and Bellingen Island camps (81% and 77% of individuals excluding bachelor male groups respectively).

The October 2018 monitoring recorded that female GHFF had given birth since the September 2018 monitoring event, with moderate levels of females supporting dependent young at both the Macksville Cemetery (70%) and Bellingen Island camps (66%).

2.3.3 Phenology of Trees in the Region

October flowering of highly productive nectar source trees in the upper North Coast region of NSW includes Narrow-leaved Red Gum (*Eucalyptus seeana*), Grey Ironbark (*E. siderophloia* – coastal lowlands and foothills and ranges), Forest Red Gum (*E. tereticornis* – inland low and altitude and high altitude), Black Bean (*Castanospermum australe*) and Silky Oak (*Grevillea robusta*). These plants are considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps indicated that light flowering of Grey Ironbark and moderate flowering of Silky Oak is currently occurring. Tallowwood (*Eucalyptus microcorys*) is also in flower locally.

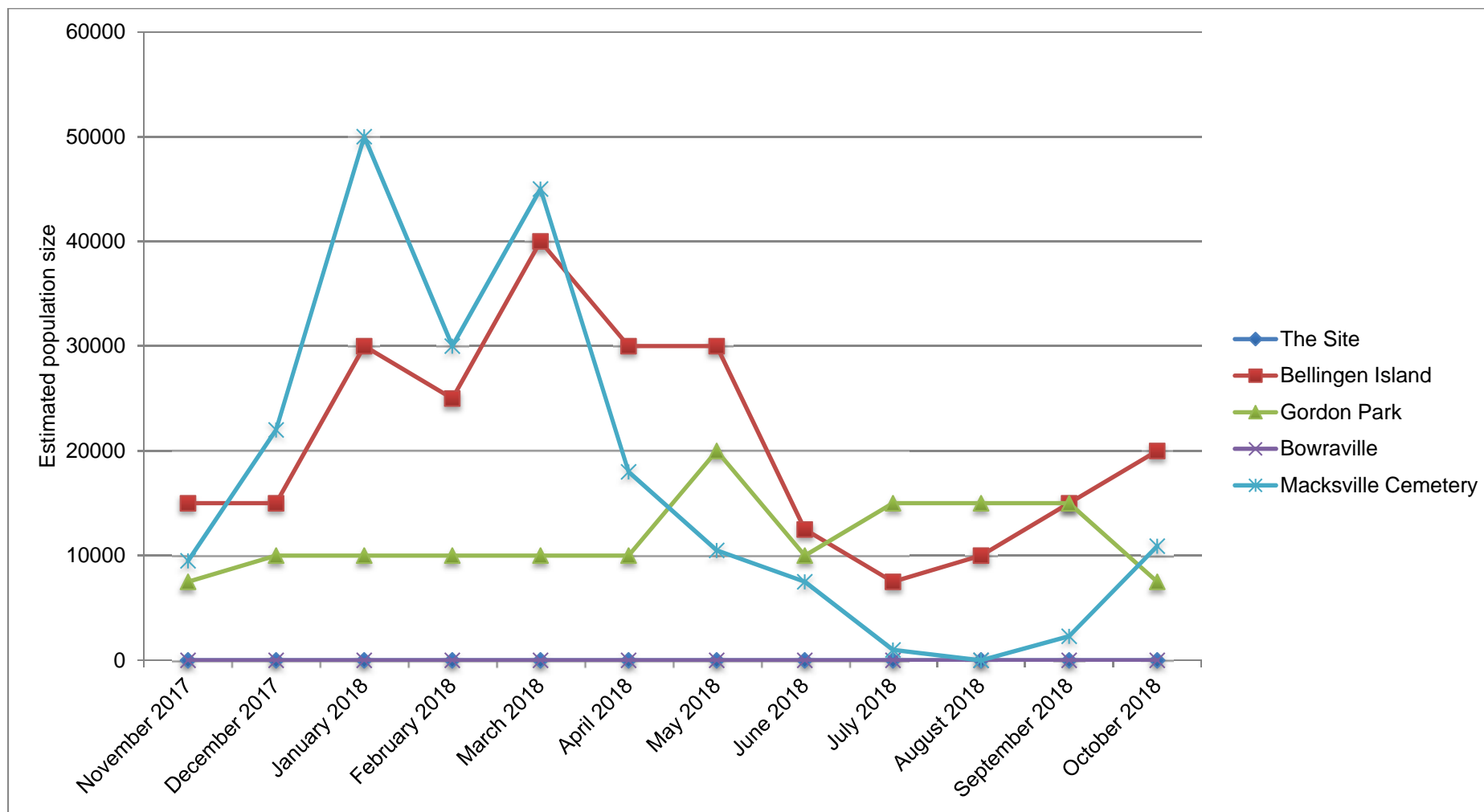



Figure 2.2 Population Trends at the Site and Regional Camps Over Past 12 Months



2.4 Summary and Conclusion

The results of the October 2018 flying-fox monitoring indicate that, excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014. Flying-foxes were also absent from the Bowraville and Wheatley Street camps.

Bellingen Island, Gordon Park and Macksville Cemetery camps were occupied. The number of flying-foxes at these occupied regional camps is now at relatively low to moderate levels. Flying-fox numbers are expected to increase over the coming months in line with the historical trends that show summer/ autumn peaks.

GHFF dominated the species composition at occupied camps at approximately 95% of all individuals present. The proportion of female GHFF remains relatively high. Dependent young GHFF were present at a moderate level within occupied camps in the current monitoring event.

Flowering of Grey Ironbark and Silky Oak, key diet species for the GHFF, is currently occurring in the region.



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Ecologist



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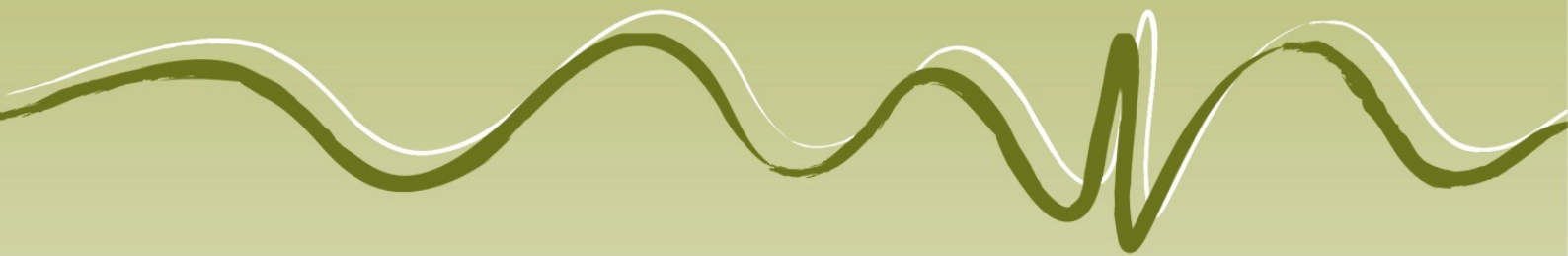
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Appendix 12 November 2018 monitoring report

Flying-fox Monitoring November 2018

Warrell Creek to Nambucca Heads Pacific Highway Upgrade



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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services has been monitoring a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that was intermittently present within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project near Macksville. The camp was located in a patch of swamp sclerophyll forest north of Bald Hill Road (henceforth referred to as 'the site').

GeoLINK has undertaken monitoring at the site on at least a monthly basis since July 2013. Prior to this, irregular monitoring of flying-foxes at the site has been undertaken since the initial establishment of the camp in December 2011 (Eby 2012). This report details the November 2018 flying-fox monitoring results which was the final monitoring event for the WC2NH project.



2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the November 2018 flying-fox monitoring:

- Jessica O’Leary (ecologist).
- Frank Makin (ecologist).
- Jeremy Clifford (environmental scientist).
- Kale Hardie-Porter (environmental scientist).

Fieldwork followed the methodology developed by Dr Eby for the project. Refer to Eby (2013) for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

The fieldwork was undertaken on 28 November 2018. The presence of flying-foxes at the site was assessed by undertaking a traverse of the area previously known to support flying-foxes in conjunction with a few sharp handclaps aimed at eliciting a vocal response from any flying-foxes roosting at the site.


When flying-foxes are present at the site, the following data is collected:

- The area of the roost footprint (mapped by GPS).
- Species composition.
- Demographics (avoiding male ‘bachelor trees’ where possible).
- Reproductive status.
- Behaviour.

When the site is unoccupied, and flying-foxes are present at the nearby seasonally-occupied flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery, the abovementioned data is collected here instead. This data provides relevant information on the status of flying-foxes that are camped in the Macksville area.

The water level at the site was measured at GPS location 492866, 6600756 (UTM coordinates, GDA 94, Zone 56). The water level at this location is representative of the average level at the site and tracked over time to provide information on water level fluctuations that occur at the site.

A dusk exit count survey was undertaken at both the site and the Macksville Cemetery camp to confirm the presence/ absence of flying-foxes and to provide an estimate of the current population at each camp.



Two observers were strategically located for the exit count on a northern and a southern ridge overlooking the site, as follows:

- In a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive).
- On a prominent ridge to the south (at 41 Bald Hill Road).

Two observers were also located adjacent to the Macksville Cemetery camp at the following vantage points:

- At the Macksville Cemetery gate off Wallace Street (west of the camp).
- Adjacent to the Macksville Golf Course next to the Pacific Highway (east of the camp).

The exit counts extended over approximately 50 minutes from sunset until dark (approximately 7:30 pm to 8:20 pm).

Other regional flying-fox camps at Gordon Park Nambucca Heads (approximately 12 kilometres north-east of the site), Bowraville (approximately 10.5 kilometres north-west of the site), Bellingen Wheatley Street camp (approximately 30 kilometres north of the site) and Bellingen Island (approximately 31 kilometres north of the site) were also visited and observational comments made. Refer to **Illustration 2.1** for the location of the subject regional camps.

2.2 Results

2.2.1 Roost Footprint

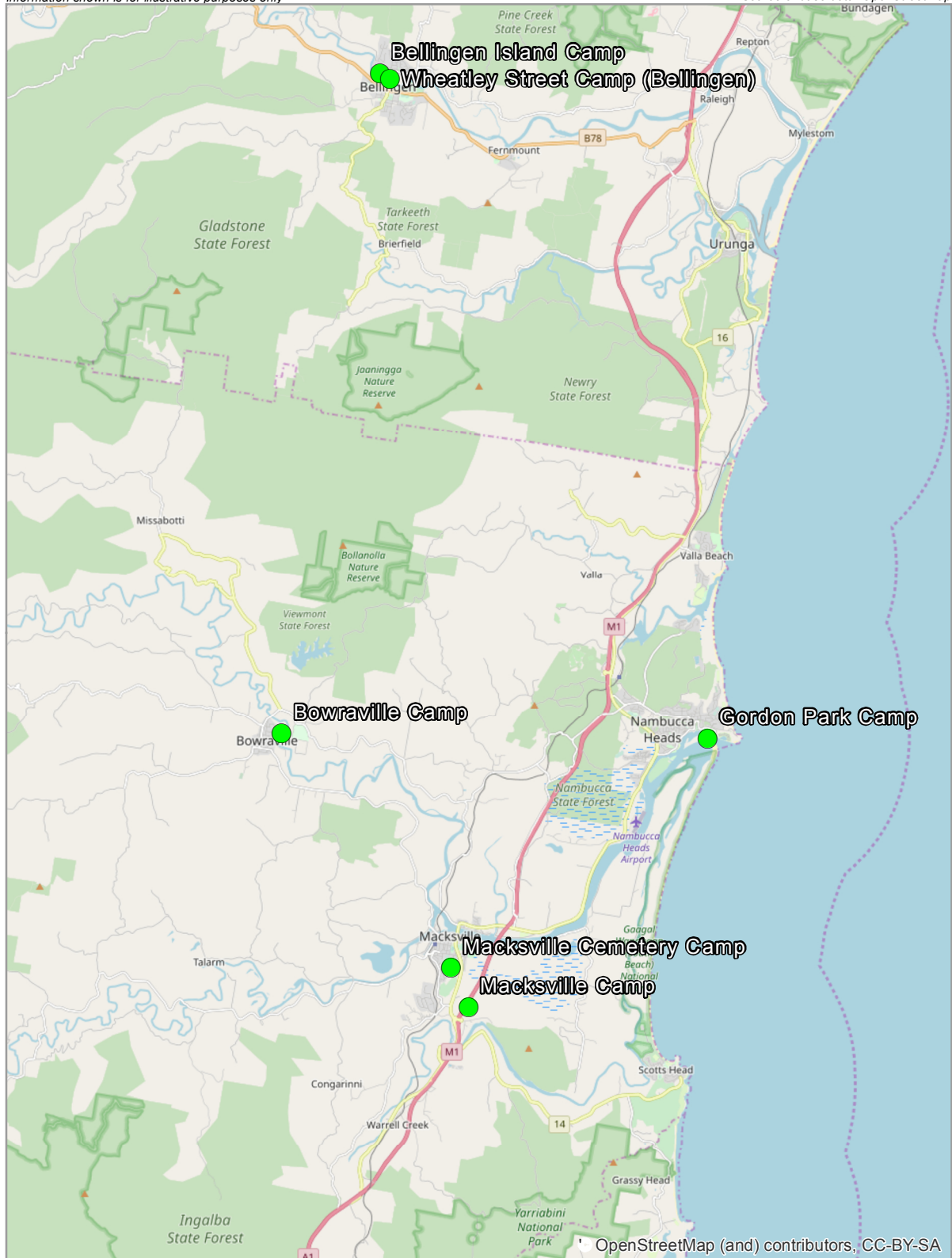
No flying-foxes were recorded roosting at the site in the traverse.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The roost extended over an area of approximately 5.19 hectares (refer to **Illustration 2.2**). The flying-fox roost was located in a section of paperbark swamp forest west of the Macksville golf course near the northern end of McNeill Close.

Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads). The extent of the roost footprint at Bellingen Island was similar to the previous monthly monitoring event (GeoLINK 2018), where the roost covered the central area of the island including the north and southern edges of the island's vegetation. At the Gordon Park camp, the roost footprint has substantially decreased from that recorded in the previous monitoring event with significantly less numbers of bats occupying the camp. The roost footprint was centralised to the lower gully area of Gordon Park

No flying-foxes were observed at the Wheatley Street camp in Bellingen or at the Bowraville camp.

Information shown is for illustrative purposes only



LEGEND

- WC2NH Project boundary
- Flying-fox camp location

0 4 Km



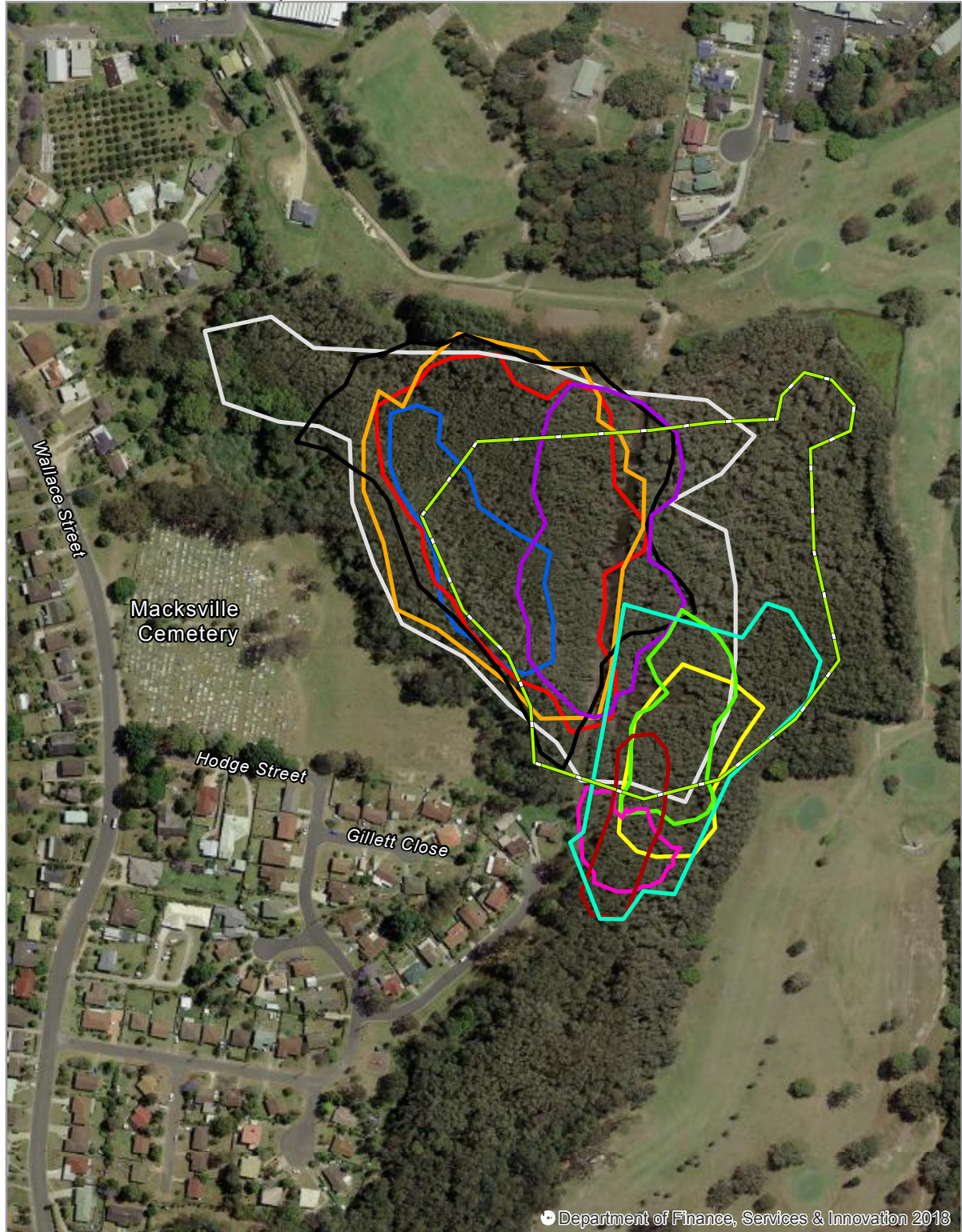
GeoLINK
environmental management and design

Location of Regional Flying-fox Camps

Flying-fox Monitoring November 2018 - Warrell Creek to Nambucca Heads Pacific Highway Upgrade
2692-1158

Illustration 2.1

Information shown is for illustrative purposes only



LEGEND

	November 2018		April 2018
	October 2018		March 2018
	September 2018		February 2018
	July 2018		January 2018
	June 2018		December 2017
	May 2018		November 2017

0 80



GeoLINK
environmental management and design

Macksville Cemetery Flying-fox Roost Footprint

Flying-fox Monitoring November 2018 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1159

Illustration 2.2



2.2.2 Population Estimates

2.2.2.1 Exit Counts

No flying-foxes were observed flying from the site during the exit count.

Approximately 40,800 flying-foxes were recorded exiting the Macksville Cemetery camp in the exit count. Approximately 31,800 (80%) were observed exiting the camp in a western direction with the remaining numbers exiting in south-west (15%) and north-east (5%) streams.

2.2.2.2 Direct Counts

With the exception of the Macksville Cemetery camp, no exit counts were conducted at any of the remaining regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the roost footprint are provided. These flying-fox population estimate results (from this and past monitoring as part of this program) should not be relied on for accuracy or other purposes. Population estimates are provided in line with the Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories:

- 1 = 1 – 499
- 2 = 500 – 2,499
- 3 = 2,500 – 9,999
- 4 = 10,000 – 15,999
- 5 = 16,000 – 49,999
- 6 = >50,000.

Regional camp count estimates are as follows:

- Gordon Park: approximately 3,000 individuals (category 3).
- Bellingen Island: approximately 5,000 individuals (category 3).
- Wheatley Street, Bellingen: no individuals recorded.
- Bowraville: no individuals recorded.

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were as follows:

- Macksville Cemetery: 90% GHFF and 10% Black Flying-fox.
- Bellingen Island: 95% GHFF and 5% Black Flying-fox.
- Gordon Park: 95% GHFF and 5% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As flying-foxes were not recorded at the site in the current monitoring event, detailed demographic composition data was not collected. This has been the case since April 2014 (excluding a brief return in January 2015). Due to this absence, the Macksville Cemetery camp has been the alternative site for collection of this data.


Both male and female GHFF were present at the Macksville Cemetery camp. Data collected in demographic point counts (which excluded bachelor male roost trees) indicated that the proportion of female GHFF present was generally high and ranged from 67% to 100% (average 90%) of all individuals (refer to **Table 2.1**). The percentage of females with dependent young GHFF at demographic point counts averaged 74% (ranging between 0% and 100%). One group did not record any females with dependant young, while between 60% and 100% of females at the remaining nine point count groups supported dependant young.

Both male and female GHFF were present at the Bellingen Island camp. Data could only be successfully collected from five demographic point counts, as the small number of flying-foxes present were roosting high in the canopy in areas of dense canopy cover that was impeding view. Data collected in demographic point counts indicated that the proportion of female GHFF present was generally high and ranged from 67% to 91% (average 76%) of all individuals. The percentage of females with dependent young GHFF at demographic point counts averaged 56% (ranging between 50% and 60%) (refer to **Table 2.2**).

General observations of the GHFF currently roosting at the Gordon Park camp indicated that males and females were present as well as females with dependent young.

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	492301, 6601860	Broad-leaved Paperbark (<i>Melaleuca quinquenervia</i>)	12	15	10:5	No	n/a
MC2	492199, 6601547	Broad-leaved Paperbark	12	20	10:1	Yes	80
MC3	492194, 6601545	Broad-leaved Paperbark	12	15	10:0	Yes	70
MC4	492200, 6601560	Broad-leaved Paperbark	12	25	10:3	Yes	60
MC5	492179, 6601565	Broad-leaved Paperbark	12	15	10:1	Yes	60
MC6	492181, 6601566	Broad-leaved Paperbark	12	10	10:0	Yes	100



Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC7	492184, 6601569	Broad-leaved Paperbark	12	15	10:0	Yes	90
MC8	492180, 6601569	Broad-leaved Paperbark	12	20	10:3	Yes	80
MC9	492164, 6601574	Broad-leaved Paperbark	12	15	10:0	Yes	100
MC10	492183, 6601573	Broad-leaved Paperbark	12	15	10:0	Yes	100

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	GPS Location (UTM coordinates GDA94, Zone 56)	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	490044, 6631571	Giant Stinging Tree (<i>Dendrocnide excelsa</i>)	14	30	10:5	Yes	60
BI2	490036, 6631544	Creek Sandpaper Fig (<i>Ficus coronata</i>) and stag	15/ 13	35/ 18	10:5	Yes	50
BI3	490045, 6631518	Giant Stinging Tree	15/ 18	40/ 90	10:3	Yes	60
BI4	490083, 6631510	Giant Stinging Tree	16/ 19	60/ 90	10:3	Yes	60
BI5	490104, 6631526	Giant Stinging Tree	10	90	10:1	Yes	50

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 53 cm in depth; a slight decrease in when compared to the previous monitoring event (refer to **Figure 2.1**).

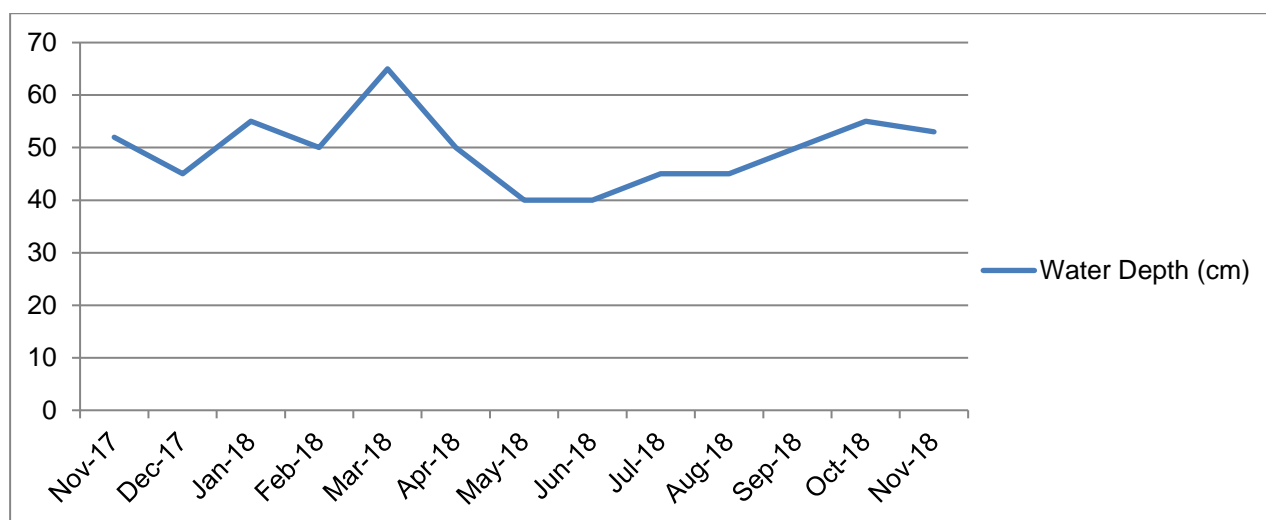


Figure 2.1 Water Level Measurements at the Site



2.3 Discussion

2.3.1 Population Estimates

The following discussion refers to the Australian Government Department of the Environment and Energy (DEE)/ CSIRO *Monitoring flying-fox Populations* (DEE 2018) categories (refer to **Section 2.2.2.2**). The trend in flying-fox numbers over the last 12-month period at the site and other monitored regional flying-fox camps are shown in **Figure 2.2**. No flying-foxes were recorded at the site again this month. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

At the Macksville Cemetery camp, since flying-foxes were absent in August 2018 numbers have increased each month. A sharp increase has been recorded in the last month from 10,900 flying-foxes (category 4) in October 2018 to 40,800 (category 5) in November 2018. The seasonal trend of summer/ autumn peaks and late autumn to spring reductions (including periodic absences) in the camp population has been consistently observed throughout the monitoring program at the Macksville Cemetery camp; though the durations and the exact timing of the peaks and reductions has varied slightly.


At the Bellingen Island camp, it was estimated that approximately 5,000 flying-foxes (category 3) were present. This represents a decrease in numbers compared to the October 2018 monitoring where approximately 20,000 flying-foxes (category 5) were recorded. The camp footprint was similar to that recorded in October 2018, however the flying-foxes were roosting more sparsely throughout the camp and higher in the vegetation canopy. Current flying-fox numbers at Bellingen Island are at their lowest since mid-September 2016 when an estimated 5,000 flying-foxes were also recorded (GeoLINK 2016a).

The number of flying-foxes at the Gordon Park camp has decreased since last month to 3,000 flying-foxes from 7,500 during October 2018 (both within DEE 2018 category 3). This observation is lower than the same time during 2016 and 2017 where 15,000 (category 4) and 7,500 (category 3) flying-foxes were recorded respectively during November. Gordon Park numbers are currently at their lowest since June 2016 monthly monitoring where an estimated 1,000 flying-foxes (category 2) were recorded (GeoLINK 2016b).

No flying-foxes were recorded at Bowraville during the current monitoring event. Flying-foxes have been absent from this site for nearly two years and were last recorded in December 2016 in low numbers.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition making up approximately 90 to 95% of all individuals. High proportions of GHFF have consistently been recorded throughout the monitoring program. Female flying-foxes dominated the demographic composition at both the Macksville Cemetery and Bellingen Island camps (90% and 76% of individuals excluding bachelor male groups respectively).



The first recording of dependant flying-foxes at the camp this 2018/19 breeding season was recorded during the October 2018 monitoring. Moderate levels of females supporting dependent young were recorded in November 2018 at both the Macksville Cemetery (74%) and Bellingen Island camps (56%).

2.3.3 Phenology of Trees in the Region

October/ November bimonthly flowering of highly productive nectar source trees in the upper North Coast region of NSW includes the following key GHFF diet species: Blackbutt (*Eucalyptus pilularis*), Grey Ironbark (*E. siderophloia*), Forest Red Gum (*E. tereticornis*) and Silky Oak (*Grevillea robusta*). Opportunistic observations when travelling between regional flying-fox camps did not record any key GHFF diet species in flower. Smooth-barked Apple (*Angophora costata*) was however in heavy flower locally.

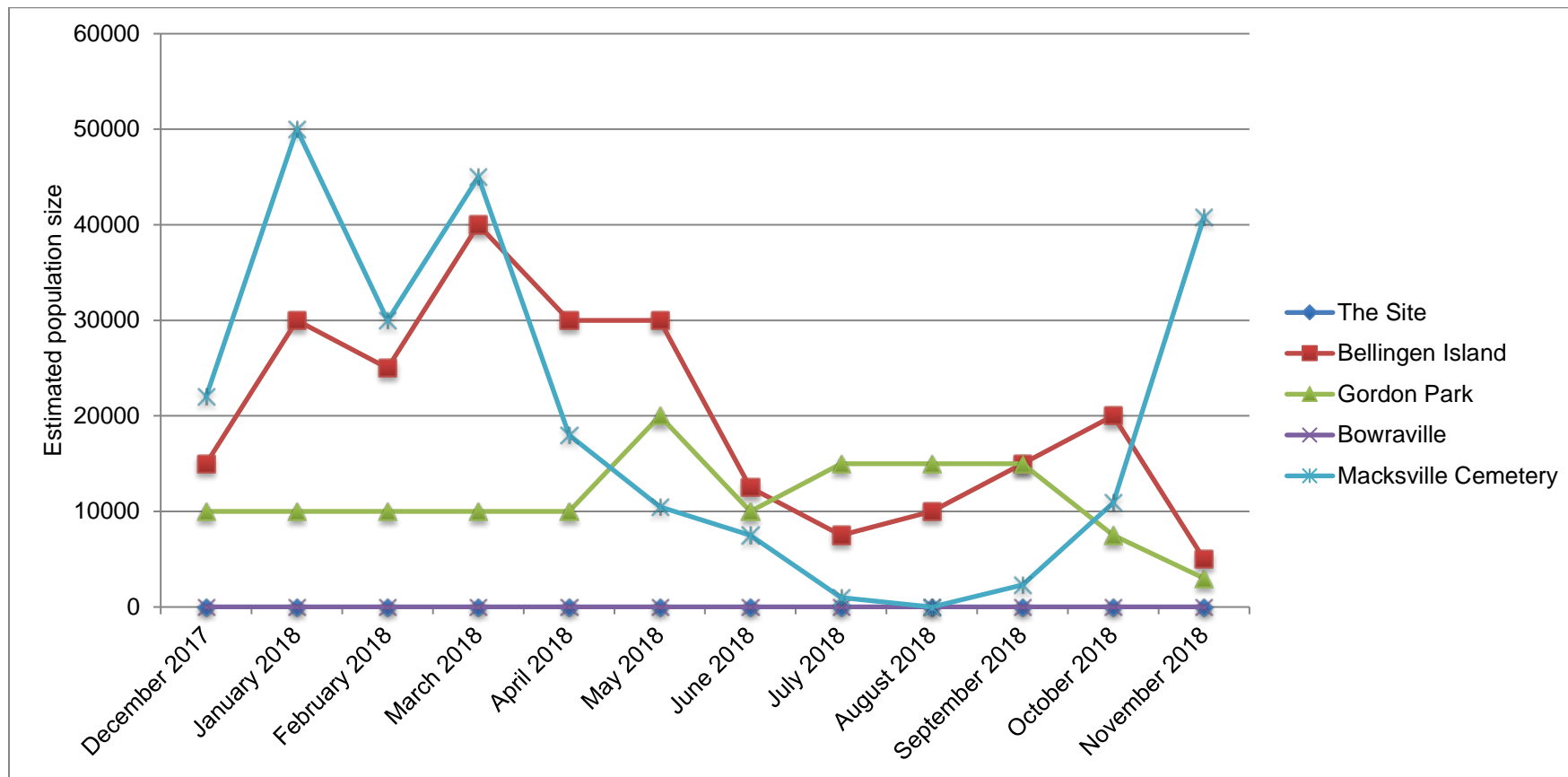


Figure 2.2 Population Trends at the Site and Regional Camps Over Past 12 Months



2.4 Summary and Conclusion

The results of the November 2018 flying-fox monitoring indicate that, excluding a brief stopover at the site observed in mid-January 2015, flying-foxes have been absent from the site since April 2014. Flying-foxes were also absent from the Bowraville and Wheatley Street camps.

Bellingin Island, Gordon Park and Macksville Cemetery camps were occupied. The number of flying-foxes at Bellingin Island and Gordon Park are at the lowest levels recorded since September and June 2016 respectively.

Flying-fox numbers at the Macksville Cemetery have increased by approximately 30,000 since the October 2018 monitoring. This increase is in line with the recorded population trends that show summer/ autumn peaks.

GHFF dominated the species composition at occupied camps at approximately 90 to 95% of all individuals present. The proportion of female GHFF remains relatively high. Dependent young GHFF were present at a moderate level within occupied camps in the current monitoring event.

Heavy flowering of Smooth-barked Apple was recorded within the region however no GHFF key diet species were observed in flower at the time of the November 2018 monitoring.

The November 2018 flying-fox monitoring event concludes the flying-fox monitoring program for the WC2NH project. A summary assessment of the broad trends recorded throughout the monitoring program will be provided in a separate report.



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