Flying-fox Monitoring
January 2016

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Pacific Highway Upgrade

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Prepared for: Roads and Maritime Services

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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services (RMS) are working to resolve issues relating to a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that has intermittently been 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 vegetation 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 2016 seasonal flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following personnel undertook fieldwork for the January 2016 seasonal flying-fox monitoring:

- Frank Makin (GeoLINK ecologist).
- Jess O'Leary (GeoLINK ecologist).
- Dr Peggy Eby (sub-consultant flying-fox expert).
- Kale Hardie-Porter (GeoLINK environmental scientist).
- Jeremy Clifford (GeoLINK environmental scientist).
- Terry Tweedy (Sub-consultant ecologist)

The fieldwork followed the methodology developed by Dr Eby for this roost (Eby 2013). Refer to that document for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

On 27 January 2016 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-fox 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.

However, as the initial traverse indicated that no flying-foxes were present at the site this data was not collected.

In light of the continued absence of flying-foxes at the site (since early April 2014) and the seasonal occupation of a flying-fox camp within two kilometres of the site adjacent to Macksville cemetery (first observed early in the summer of 2015), this data has recently been collected from the Macksville cemetery camp instead of at the site to provide some information relating to flying-foxes currently camping in the local area. Information for the Macksville cemetery camp was collected on 20 and 27 January 2016.

The water level at the site was also measured (approximate GPS location 492866, 6600756 [GDA 94, Zone 56]). The water level at this location is representative of the average level at the site and was collected on 27 January 2016.

Following the site traverse, a dusk exit count survey was undertaken at the site on the evening of 27 January 2016 to provide an estimate of the number of flying-foxes currently roosting at the camp. Two observers were strategically located for the count on a northern and southern ridge overlooking the camp. In addition to this three observers were also located in proximity to the Macksville cemetery camp to undertake an exit count of this camp.

Two observers were located at the following vantage points for the site:

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

Three observers were located at the following vantage points for the Macksville cemetery camp:

- At the southern end of Nancy Roberts Drive (north of the camp).
- At the entrance to Macksville cemetery on Wallace Street (west of the camp).
- In the car park of the Macksville country club (south of the camp).

Recent observations had shown that the vast majority of flying-foxes are currently exiting the Macksville cemetery camp in a westerly and north-westerly direction and therefore the usual vantage point to the east of the camp adjacent to the Pacific Highway at the edge of the Macksville country club was not used in this exit count. Three observers (rather than two) were employed to more comprehensively capture the north, west and southern streams anticipated to be exiting the Macksville cemetery camp.

The exit count extended over approximately 45 minutes from sunset until dark (approximately 7:30 pm to 8:17 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the Macksville camp), Bowraville and Bellingen Island were visited on 20 and 21 January 2016 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 observed to be roosting at the site in the camp traverse. Flying-foxes were also absent from Bowraville and Wheatley Street in Bellingen.

Regionally, flying-foxes were observed to be roosting at Macksville Cemetery, Bellingen Island, and Gordon Park (Nambucca Heads). The roost footprint recorded at Macksville Cemetery has increased from approximately 4 ha in December 2015 to approximately 6 ha during the current monitoring event and is shown in **Illustration 2.2**.

2.2.2 Population Estimates

2.2.2.1 Exit Count

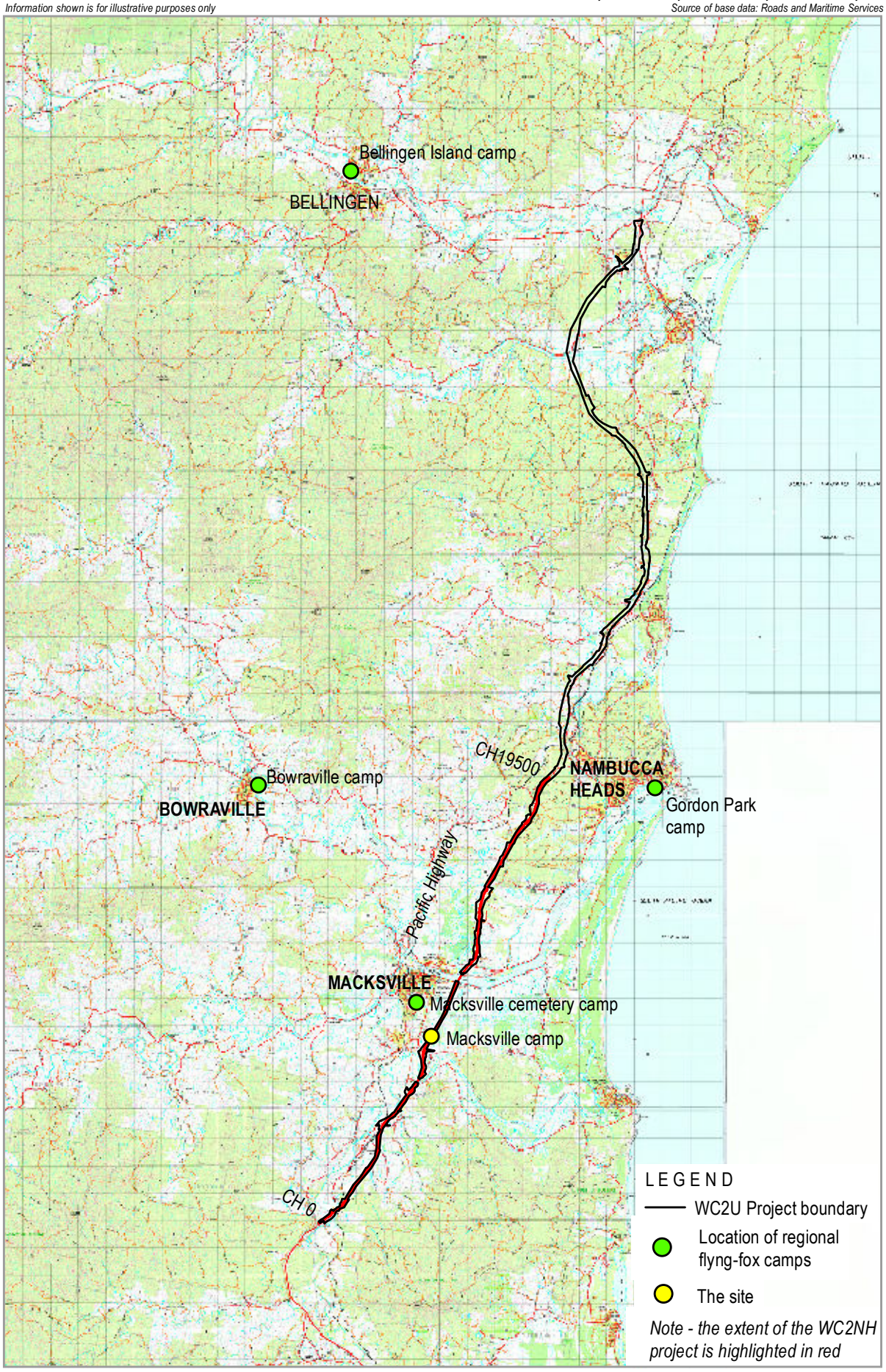
No flying-foxes were observed flying from the site in the exit count. The exit count at the Macksville Cemetery camp recorded over 40,000 flying-foxes. It was not possible to accurately estimate the number of animals as:

- The flying-foxes were utilising four broad fly-out 'streams' to the west, north-west, south-east and north-east. The north-east stream was not present during the previous (December 2015) flying-fox monitoring event.
- Approximately 10% of animals changed direction during the fly-out.

Drawn by: TJP Checked by: MVE Reviewed by: DSA Date: January 2016

Source of base data: Roads and Maritime Services

Information shown is for illustrative purposes only



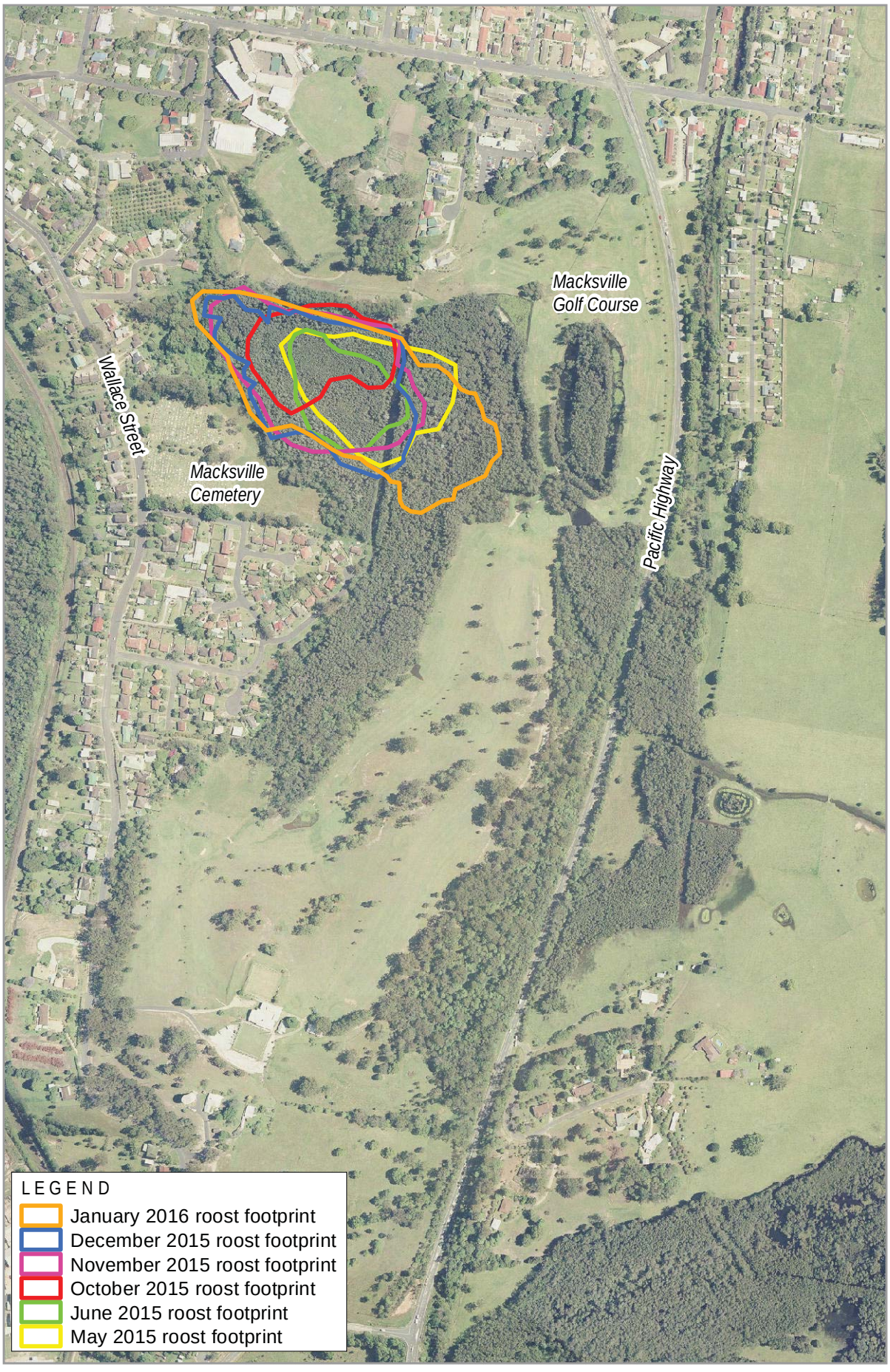
0 4 km

North

Location of Regional Flying-fox Camps

Information shown is for illustrative purposes only

Drawn by: GJM Checked by: DSA Reviewed by: FM Date: 15/02/2016
Source of base data: Roads and Maritime Services



North

0 150

Macksville Cemetery Flying-fox Roost Footprint

GeoLINK environmental management and design

2.2.2.2 Direct Counts

No exit counts were conducted at any of the regional camps (excluding the Macksville Cemetery camp). 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 15,000 individuals (increased from 10,000 in the previous monitoring event).
- Bowraville: no individuals recorded (same as the previous monitoring event).
- Bellingen Island: >20,000 individuals (same as the previous monitoring event).
- Wheatley Street, Bellingen: no individuals recorded (same as the previous monitoring event).

2.2.3 Detailed Data

2.2.3.1 Species Composition

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

- Macksville Cemetery – GHFF >95%, Black Flying-fox <5%.
- Gordon Park – GHFF 90%, Black Flying-fox 10%.
- Bellingen Island – GHFF >95%, Black Flying-fox <5%.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned previously, no flying-foxes were recorded at the site and therefore, no detailed species composition data was collected. Instead, this data was collected at the nearby Macksville Cemetery camp for the current monitoring event.

Results of the demographic counts at the Macksville Cemetery camp indicated that females dominated the counts, making up between 43% and 77% (average 63%) of all individuals present at count locations (which excluded male 'bachelor' trees). Dependent young were observed with the female GHFF at a high level, with the proportion of females with young ranging between 80% and 100% (average 92%) (refer to **Table 2.1**).

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	*Tree Species*	*Height (m); DBH (cm)*	*Demographic Ratio (female:male)*	*Presence of Dependant Young (yes/no)*	*% Females with Dependant Young*
MC1	Broad-leaved Paperbark	15; 30	10:8	yes	90
MC2	Broad-leaved Paperbark	15; 30	10:13	yes	100
MC3	Broad-leaved Paperbark	15; 25	10:6	yes	100
MC4	Broad-leaved Paperbark	20; 30	10:4	yes	90
MC5	Broad-leaved Paperbark	15; 30	10:4	yes	100
MC6	Broad-leaved Paperbark	20; 30	10:3	yes	90
MC7	Broad-leaved Paperbark	15; 25	10:4	yes	80
MC8	Broad-leaved Paperbark	15; 30	10:5	yes	90
MC9	Broad-leaved Paperbark	25; 35	10:8	yes	90

Tree Code	Tree Species	Height (m); DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC10	Broad-leaved Paperbark	20; 30	10:4	yes	90

To provide comparative information relating to flying-foxes occupying the broader region surrounding the site, data of habitat characteristics and demographic composition was collected at Bellingen Island camp (refer to **Table 2.2**).

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	Tree Species	Height (m); DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	White Booyong	10; 20	10:7	yes	90
BI2	Sandpaper Fig	10; 20	10:9	yes	90
BI3	Moreton Bay Fig	20; 20	10:9	yes	100
BI4	Giant Stinging Tree	10; 20	10:9	yes	100
BI5	Giant Stinging Tree	15; 30	10:4	yes	90
BI6	White Booyong	10; 20	10:6	yes	90
BI7	Sandpaper Fig	10; 15	10:7	yes	100
BI8	Giant Stinging Tree	20; 40	10:6	yes	90
BI9	Giant Stinging Tree	15; 30	10:5	yes	90
BI10	Giant Stinging Tree	15; 40	10:4	yes	100

Results of the demographic counts at the Bellingen Island camp indicated that females dominated the counts, making up between 53% and 71% (average 60%) of all individuals present at count locations (which excluded male 'bachelor' trees). Dependent young were observed with the female GHFF at a very high level, with the proportion of females with young ranging between 90% and 100% (average 94%) (refer to **Table 2.2**).

General observations of the flying-foxes present at Gordon Park camp indicated that both female and male GHFF were present and a moderate to high number of female flying-foxes with dependant young were observed.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 70 cm in depth as is shown in **Figure 2.1**. Prior to the January monitoring the water level has been steadily decreasing since February 2015. This monitoring event recorded an increase of 60 cm since the previous monitoring event (December 2015).

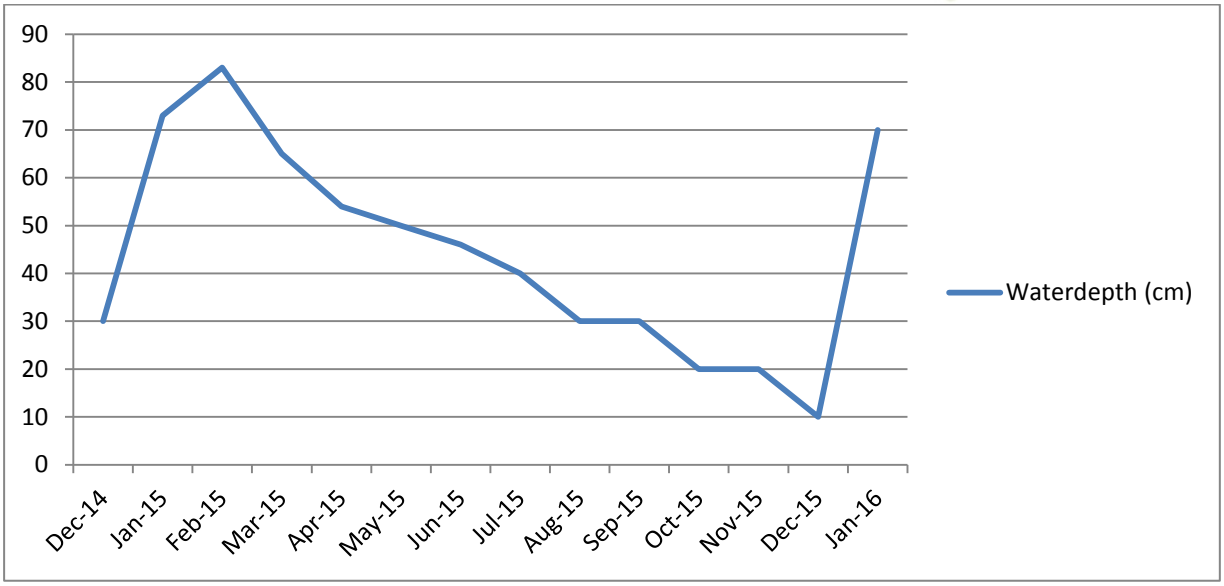


Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse undertaken for the current monitoring event. Nor were any flying-foxes observed to be flying from the site in the exit count. Flying-foxes have not been camped at the site (excluding a brief return in January 2015) since mid-April 2014.

Figure 2.2 shows the trend of flying-fox population at the site and other regional sites between January 2015 and January 2016. The number of flying-foxes roosting at the Macksville Cemetery camp has increased substantially over the last three months, from around 4,500 in October to an estimated >40,000 during the current monitoring event. This is the largest number of individuals recorded at the camp since the camp was detected in February 2015. This camp has been occupied for eight of the 12 months since detected. Flying-foxes were absent from the camp over the winter-early spring period (July-September) of 2015. The Macksville Cemetery camp appears to be used as a replacement camp to the site.

Flying-foxes continue to be absent from the Bowraville camp. No flying-foxes have been recorded roosting at Bowraville since mid-April 2015. For comparison, in January 2015 approximately 3,000-5,000 flying-foxes were roosting at the Bowraville camp (GeoLINK 2015).

The number of flying-foxes roosting at Bellingen Island has remained high with >20,000 individuals during the current monitoring event. In January 2015, approximately 10,000 flying-foxes were recorded (GeoLINK 2015). Bellingen Island was occupied for nine of the last 12 months, with a brief absence between April and June 2015. Small numbers of flying-foxes roosted at the Bellingen Wheatley Street camp that was established over this period and though has largely been vacant since the flying-foxes returned to Bellingen Island.

An estimated 15,000 flying-foxes were recorded at the Gordon Park camp (increase of approximately 5,000 individuals since last month). Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to January 2016). Flying-fox numbers are also generally stable and range between 10,000 and 20,000 individuals, with 10,000 and 15,000 individuals occupying the camp over the last 12 months).

2.3.2 Species Composition and Demographic Data

Both GHFF and Black Flying-foxes were present at all occupied camps. GHFF dominated the species composition comprising between 90-95% of all individuals present. Black Flying-fox accounted for a relatively small proportion (5-10%) of all individuals present.

The proportion of female GHFF with dependent young recorded in demographic counts in the current monitoring event was higher than was recorded in the previous month for the third month in a row. This is likely to be from:

- the birthing period now being finished (i.e. all of this year's young are now born);
- the young being larger and consequently easier to observe; and
- the weather conditions being warm, causing enhanced daytime flying-fox activity.

The proportion of GHFF females with dependent young at the Macksville cemetery camp and Bellingen Island were very high with 92% and 94% respectively, indicative of a breeding season with high reproductive output.

2.3.3 Phenology of Trees in Region

Nectar comprises a key foraging resource for flying-foxes in the region. During the December/ January period, a number of key diet nectar source trees in the upper North Coast region of NSW typically flower, including Black Bean (*Castanospermum australe*), **Red Bloodwood (*Corymbia gummifera*)**, **Pink Bloodwood (*Corymbia intermedia*)**, **Spotted Gum (*Corymbia maculata*)**, **Northern Spotted Gum (*Corymbia variegata*)**, New England Blackbutt (*Eucalyptus andrewsii*), River Red Gum (*Eucalyptus camaldulensis*), **Blackbutt (*Eucalyptus pilularis* – *foothills and ranges*)**, **Grey Ironbark (*Eucalyptus siderophloia – foothills and ranges*)** and **Forest Red Gum (*Eucalyptus tereticornis – high altitude*)** (Eby and Law 2008) (*Note: those in bold occur within a 50 kilometre radius of the site* – Eby 2012). Other flying-fox nectar and pollen diet tree species that occur within a 50 kilometre radius of the site and flower during the December/ January period include Smooth-barked Apple (*Angophora costata*), Rough-barked Apple (*Angophora floribunda*), Small-fruited Grey Gum (*Eucalyptus propinqua*) and Red Mahogany (*Eucalyptus resinifera*) (Eby 2012).

Red Bloodwood (*Corymbia gummifera*) and Pink Bloodwood (*Corymbia intermedia*) were observed exhibiting heavy flowering over the period surveyed.

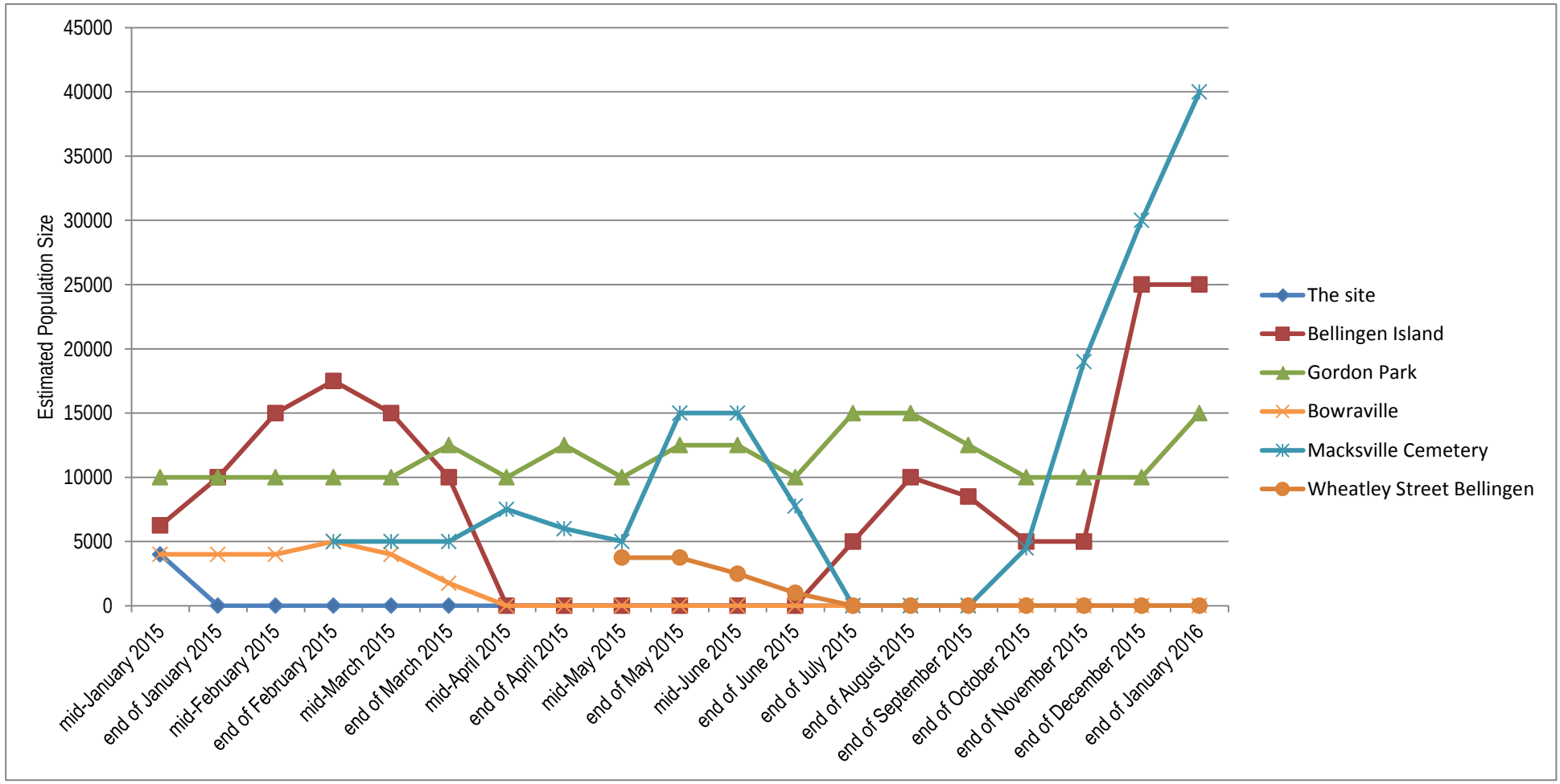


Figure 2.2 Population trends at the site and regional camps between January 2015 and January 2016

2.4 Conclusion

The results of the January 2016 monthly 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 now since mid-April 2014. The nearby Macksville Cemetery camp which was detected in February 2015 and has supported flying-foxes for most months since (excluding three months from July to September 2015), supported large numbers of flying-foxes during the January monitoring event (estimated >40,000). The Macksville Cemetery camp appears to be used as a replacement camp to the site.

Flying-foxes have remained at the Bellingen Island camp following a brief late autumn-winter absence, with substantial number of animals present (>20,000) during the current monitoring event (the largest numbers since the camp returned). Since departing Bowraville in late autumn flying-foxes have not returned yet for the usual occupation of this camp over the warmer period of the year. All regional camps have displayed seasonal absences in the 2015 winter period except for the Gordon Park camp, which has retained a generally steady population of flying-foxes over the past 12 months.

Dependent young GHFF are currently present at all occupied camps. So far this season a greater number of adult females are supporting dependant young at the Bellingen Island camp compared to the 2014/2015 breeding season.

David Andrighetto

Ecologist

References

Eby, P. and Law, B. (2008). *Ranking the feeding habitat of Grey-headed flying foxes for conservation management*. Department of Environment, Heritage, Water and the Arts, Canberra.

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. (2015). *Flying-fox Monitoring January 2015 Warrell Creek to Nambucca Heads Pacific Highway Upgrade*. Unpublished report to NSW Roads and Maritime Services.

Flying-fox Monitoring
February 2016

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Pacific Highway Upgrade

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1. Introduction

1.1 Introduction

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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 2016 seasonal flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following personnel undertook fieldwork for the January 2016 seasonal flying-fox monitoring:

- Frank Makin (GeoLINK ecologist).
- Jess O'Leary (GeoLINK ecologist).
- Kale Hardie-Porter (GeoLINK environmental scientist).
- Jeremy Clifford (GeoLINK environmental scientist).
- Terry Tweedy (Sub-consultant ecologist).

The fieldwork followed the methodology developed by Dr Eby for this roost (Eby 2013). Refer to that document for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

On 25 February 2016 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-fox 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.

However, as the initial traverse indicated that no flying-foxes were present at the site this data was not collected.

In light of the continued absence of flying-foxes at the site (since early April 2014) and the seasonal occupation of a flying-fox camp within two kilometres of the site adjacent to Macksville cemetery (first observed early in the summer of 2015), this data has recently been collected from the Macksville cemetery camp instead of at the site to provide some information relating to flying-foxes currently camping in the local area. Information for the Macksville cemetery camp was collected on 20 and 27 January 2016.

The water level at the site was also measured (approximate GPS location 492866, 6600756 [GDA 94, Zone 56]). The water level at this location is representative of the average level at the site and was collected on 25 February 2016.

Following the site traverse, a dusk exit count survey was undertaken at the site on the evening of 25 February 2016 to provide an estimate of the number of flying-foxes currently roosting at the camp. Two observers were strategically located for the count on a northern and southern ridge overlooking the camp. In addition, three observers were also located in proximity to the Macksville cemetery camp to undertake an exit count of this camp.

Two observers were located at the following vantage points for the site:

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

Three observers were located at the following vantage points for the Macksville cemetery camp:

- At the southern end of Nancy Roberts Drive (north of the camp).
- At the entrance to Macksville cemetery on Wallace Street (west of the camp).
- In the car park of the Macksville country club (south of the camp).

Recent observations had shown that the vast majority of flying-foxes are currently exiting the Macksville cemetery camp in a westerly and north-westerly direction and therefore the usual vantage point to the east of the camp adjacent to the Pacific Highway at the edge of the Macksville country club was not used in this exit count. Three observers (rather than two) were employed to more comprehensively capture the north, west and southern streams anticipated to be exiting the Macksville cemetery camp.

The exit count extended over approximately 45 minutes from sunset until dark (approximately 7:15 pm to 8:00 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the Macksville camp), Bowraville and Bellingen Island were also visited on the 25 February 2016 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 observed to be roosting at the site in the camp traverse. Flying-foxes were also absent from Bowraville and Wheatley Street in Bellingen.

Regionally, flying-foxes were observed to be roosting at Macksville Cemetery, Bellingen Island, and Gordon Park (Nambucca Heads). The roost footprint recorded at Macksville Cemetery was similar to last month (January 2016), occupying approximately 6 hectares during the current monitoring event (refer to **Illustration 2.2**).

2.2.2 Population Estimates

2.2.2.1 Exit Count

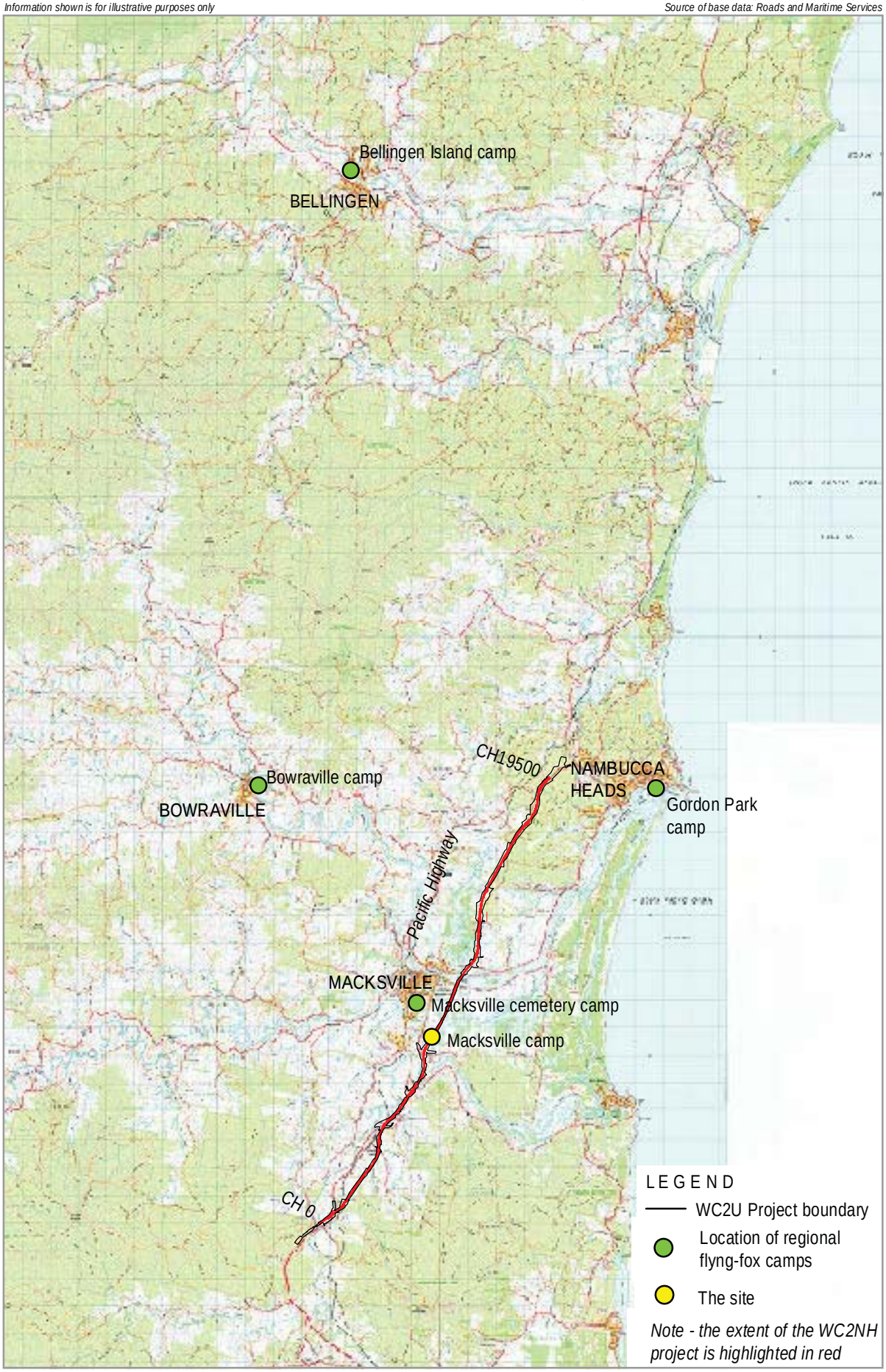
No flying-foxes were observed flying from the site in the exit count. The exit count at the Macksville Cemetery camp recorded over 50,000 flying-foxes (slight increase to last month). It was not possible to accurately estimate the number of animals as:

- The flying-foxes were utilising four broad fly-out 'streams' to the west, north-west, south-east and north-east.
- Approximately 10% of animals changed direction during the fly-out.

Drawn by: DSA Checked by: GJM Reviewed by: GJM Date: February 2016

Information shown is for illustrative purposes only

Source of base data: Roads and Maritime Services



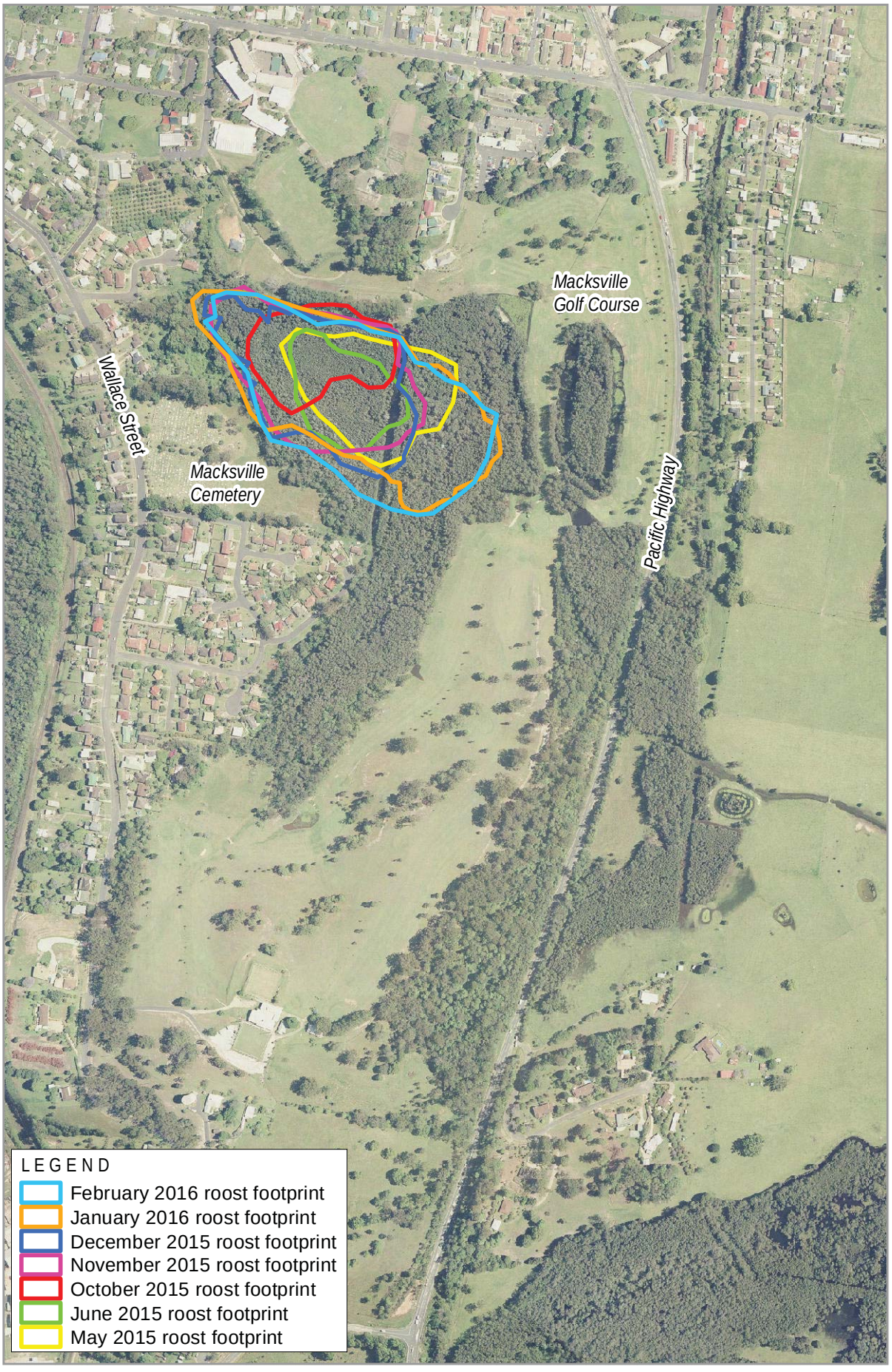
North

0 4 km

Location of Regional Flying-fox Camps

Information shown is for illustrative purposes only

Drawn by: GJM Checked by: DSA Reviewed by: FM Date: 10/03/2016
Source of base data: Roads and Maritime Services



North

0 150

Macksville Cemetery Flying-fox Roost Footprint

2.2.2.2 Direct Counts

No exit counts were conducted at any of the regional camps (excluding the Macksville Cemetery camp). 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 (decreased from 15,000 in the previous monitoring event).
- Bowraville: no individuals recorded (same as the previous monitoring event).
- Bellingen Island: >20,000 individuals (same as the previous monitoring event).
- Wheatley Street, Bellingen: no individuals recorded (same as the previous monitoring event).

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions at occupied camps were the same as last month, as follows:

- Macksville Cemetery – GHFF >95%, Black Flying-fox <5%.
- Gordon Park – GHFF 90%, Black Flying-fox 10%.
- Bellingen Island – GHFF >95%, Black Flying-fox <5%.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned previously, no flying-foxes were recorded at the site and therefore, no detailed species composition data was collected. Instead, this data was collected at the nearby Macksville Cemetery camp for the current monitoring event.

The results of this month's demographic counts (including sex ratios and percentage of females with dependant young), should be considered indicative only. In late February weaning commences and some young become independent. Some may temporarily roost independently from their mother despite being dependant. The seasons young are also almost the same size as adults. These factors make it difficult to determine whether some flying-foxes are dependant or not. Dependant young also often roost on the edges of camps to avoiding (or are pushed out) by breeding adult males (Churchill 2008). This influences the results, particularly at the Macksville Cemetery camp, as it is not possible to go into the camp without causing significant disturbance. Demographic counts are therefore undertaken on the edge of the camp, and are more likely to encounter non-breeding groups.

Results of the demographic counts at the Macksville Cemetery camp indicated that females dominated the counts, making up between 77% and 100% (average 85%) of all individuals present at count locations (which excluded male 'bachelor' trees). Dependent young were observed with the female GHFF at a variable levels, with the proportion of females with young ranging between 30% and 100% (average 74%) (refer to **Table 2.1**).

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	*Tree Species*	*Height (m); DBH (cm)*	*Demographic Ratio (female:male)*	*Presence of Dependant Young (yes/no)*	*% Females with Dependant Young*
MC1	Broad-leaved Paperbark	10; 30	10:2	yes	60
MC2	Broad-leaved Paperbark	10; 25	10:1	yes	100
MC3	Broad-leaved Paperbark	10; 25	10:1	yes	50
MC4	Broad-leaved Paperbark	10; 30	10:2	yes	60
MC5	Broad-leaved Paperbark	10; 25	10:2	yes	30
MC6	Broad-leaved Paperbark	10; 30	10:3	yes	80
MC7	Broad-leaved Paperbark	10; 15	10:3	yes	90
MC8	Broad-leaved Paperbark	10; 15	10:2	yes	70
MC9	Broad-leaved Paperbark	10; 25	10:1	yes	100
MC10	Broad-leaved Paperbark	10; 30	10:0	yes	100

To provide comparative information relating to flying-foxes occupying the broader region surrounding the site, data of habitat characteristics and demographic composition was collected at Bellingen Island camp (refer to **Table 2.2**).

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	*Tree Species*	*Height (m); DBH (cm)*	*Demographic Ratio (female:male)*	*Presence of Dependant Young (yes/no)*	*% Females with Dependant Young*
BI1	Sandpaper Fig	9; 15	10:4	yes	20
BI2	Sandpaper Fig	10; 50	10:3	yes	30
BI3	Giant Stinging Tree	13; 20	10:6	no	0
BI4	Giant Stinging Tree	15; 30	10:2	no	0
BI5	Giant Stinging Tree	13; 30	10:2	yes	10
BI6	Giant Stinging Tree	13; 20	10:3	yes	50
BI7	Giant Stinging Tree	13; 40	10:4	yes	30
BI8	Moreton Bay Fig	10; 30	10:2	yes	60
BI9	Giant Stinging Tree	12; 40	10:4	yes	10
BI10	Giant Stinging Tree	8; 40	10:4	yes	20

Results of the demographic counts at the Bellingen Island camp indicated that females dominated the counts, making up between 63% and 83% (average 75%) of all individuals present at count locations (which excluded male 'bachelor' trees). Female GHFF with dependent young were observed at considerably lower numbers than last month with the proportion of females with young ranging between 0% and 60% (average 23% down from 94 % last month)(refer to **Table 2.2**). This is attributed to weaning behaviour exhibited at this time of year and associated issues/ influences on data collection, as discussed previously.

General observations of the flying-foxes present at Gordon Park camp indicated that both female and male GHFF were present and a moderate number of female flying-foxes with dependant young were observed.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 67 cm in depth as is shown in **Figure 2.1**. This represents a slight decrease since last month, following a significant rise in water level in January 2016.

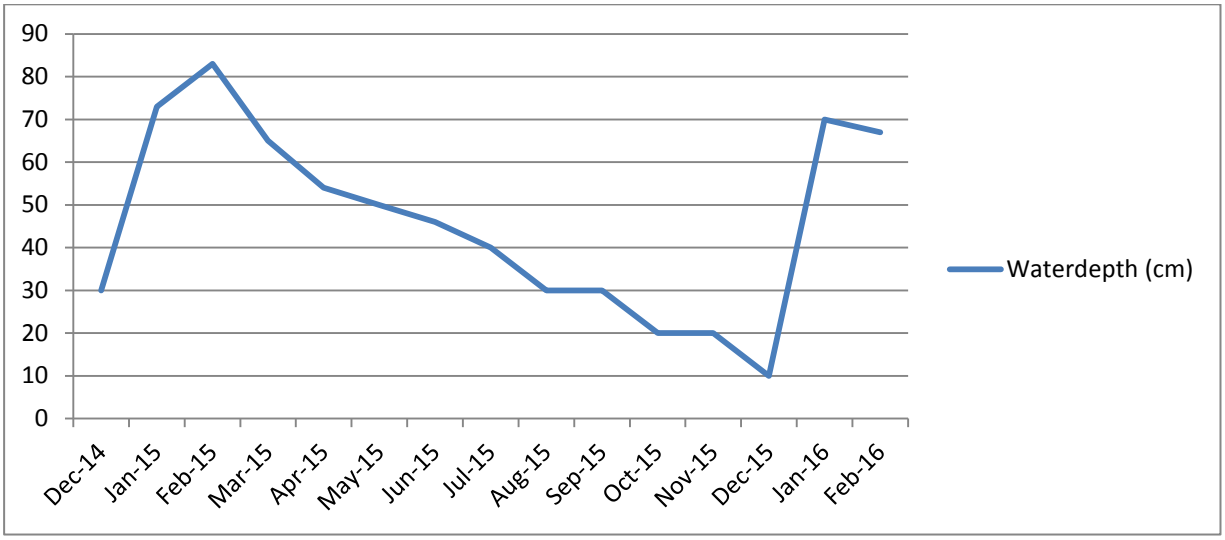


Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse undertaken for the current monitoring event. Nor were any flying-foxes observed to be flying from the site in the exit count. Flying-foxes have not been camped at the site (excluding a brief return in January 2015) since mid-April 2014.

Figure 2.2 shows the trend of flying-fox population at the site and other regional sites between January 2015 and February 2016. The number of flying-foxes roosting at the Macksville Cemetery camp has increased substantially over the last four months, from around 4,500 in October to an estimated >50,000 during the current monitoring event. This is the largest number of individuals recorded at the camp since the camp was detected in February 2015. In addition to flying-foxes following food resources, recent increases in flying-fox numbers are likely to be associated with this seasons young joining the flyout.

Flying-foxes continue to be absent from the Bowraville camp. No flying-foxes have been recorded roosting at Bowraville since mid-April 2015. For comparison, in February 2015 approximately 5,000 flying-foxes were roosting at the Bowraville camp (GeoLINK 2015).

The number of flying-foxes roosting at Bellingen Island has remained high with over 20,000 individuals recorded during the current monitoring event. In February 2015, between 15,000 and 20,000 flying-foxes were recorded at this camp (GeoLINK 2015). Bellingen Island was occupied for 11 of the last 14 months, with a brief absence between April and June 2015. The Bellingen Wheatley Street camp which supported small numbers of flying-foxes mainly when the Bellingen Island was vacant, has

remained vacant since July 2015 (shortly after the flying-foxes returned to Bellingen Island).

An estimated 10,000 flying-foxes were recorded at the Gordon Park camp (a decrease of approximately 5,000 individuals since last month). Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to February 2016). Flying-fox numbers are also generally stable and range between 10,000 and 20,000 individuals, with 10,000 and 15,000 individuals occupying the camp over the last 12 months.

2.3.2 Species Composition and Demographic Data

Both GHFF and Black Flying-foxes were present at all occupied camps. GHFF dominated the species composition comprising between 90-95% of all individuals present. Black Flying-fox accounted for a relatively small proportion (5-10%) of all individuals present.

Small numbers of Little-red Flying-foxes (*Pteropus scapulatus*) have recently been observed in the north-east NSW region. Although not detected, it is possible that small numbers of Little-red Flying-foxes (*Pteropus scapulatus*) may be roosting locally, including at the Macksville Cemetery camp and contributing to the large numbers of flying-foxes recorded at the camp. Due to the large footprint of this camp, high density that Little-red Flying-foxes roost and inability to traverse the centre of the camp during monitoring (which would generate significant disturbance), it is possible for modest numbers of Little-red Flying-foxes (*Pteropus scapulatus*) to be present and avoid detection. The other currently occupied camps (Bellingen Island and Gordon Park) are reasonably easy to inspect comprehensively and no Little-red Flying-foxes (*Pteropus scapulatus*) were detected.

The proportion of female GHFF with dependent young recorded in demographic counts in the current monitoring event was lower than was recorded in the previous month. This is likely to be a result of dependent young transitioning to independence and is supported by the observation of many juvenile/ sub-adult individuals.

2.3.3 Phenology of Trees in the Region

Flower nectar and pollen sources comprise a key foraging resource for flying-foxes in the region. During the February/ March period, a number of key diet nectar source trees in the upper North Coast region of NSW typically flower, including Red Bloodwood (*Corymbia gummifera*), Pink Bloodwood (*Corymbia intermedia*), Spotted Gum (*Corymbia maculata*), Northern Spotted Gum (*Corymbia variegata*), New England Blackbutt (*Eucalyptus andrewsii*), River Red Gum (*Eucalyptus camaldulensis*), Mountain Blue Gum (*Eucalyptus deani*), Grey Box (*Eucalyptus molucanna*), Blackbutt (*Eucalyptus pilularis* – foothills and ranges), Sydney Blue Gum (*Eucalyptus saligna*), Forest Red Gum (*Eucalyptus tereticornis*) and Broad-leaved Paperbark (*Melaleuca quinquinervia*) (Eby and Law 2008).

Key diet species within 50km of the Maclean camp that may flower this time of the year include Spotted Gum (*Corymbia maculata*), Northern Spotted Gum (*Corymbia variegata*), Red Bloodwood (*Corymbia gummifera*), Blackbutt (*Eucalyptus pilularis*), Forest Red Gum (*Eucalyptus tereticornis*) and Broad-leaved Paperbark (*Melaleuca quinquinervia*) (Eby, 2012). Pink Bloodwood and Broad-leaved Paperbark were observed flowering in the area during the monitoring.

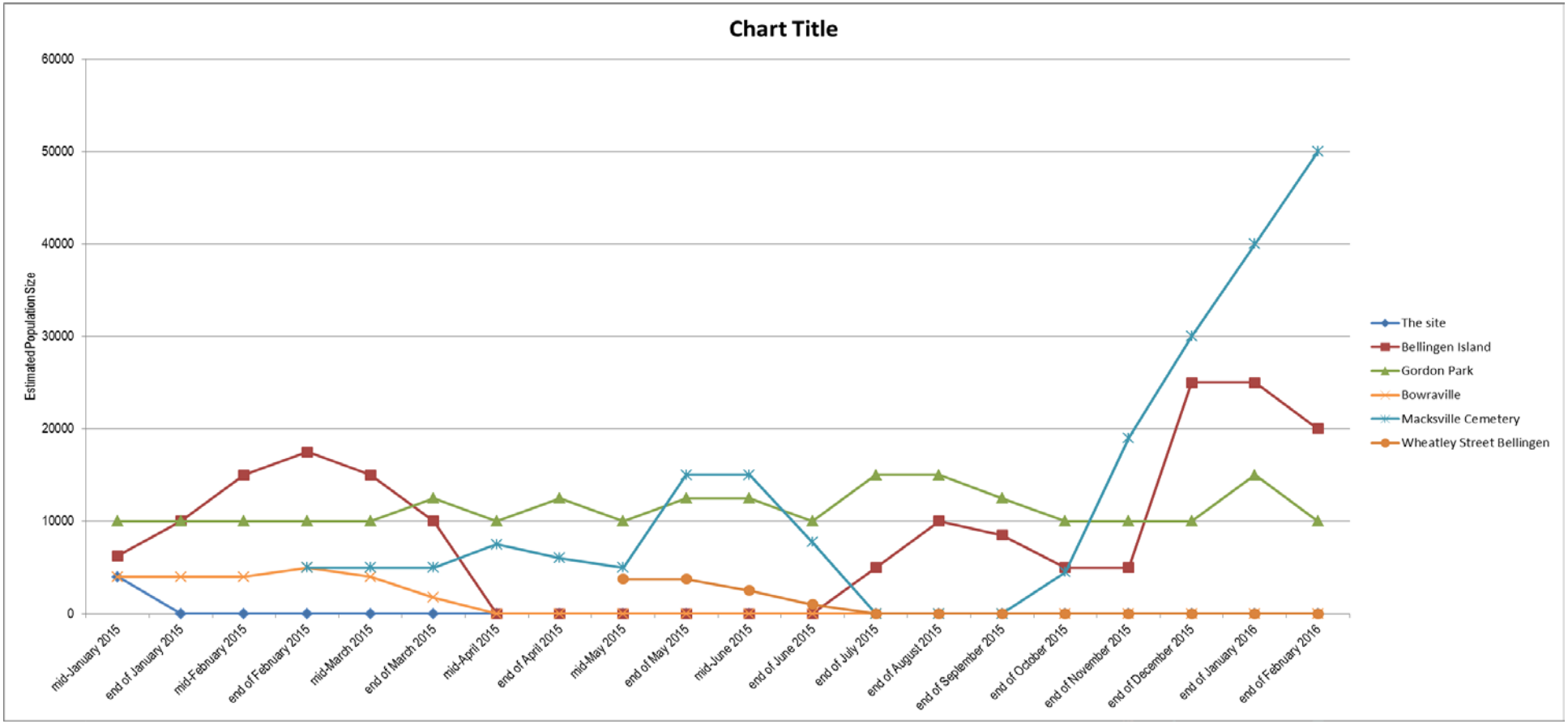


Figure 2.2 Population trends at the site and regional camps between January 2015 and February 2016

2.4 Conclusion

The results of the February 2016 monthly 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 now since mid-April 2014. The nearby Macksville Cemetery camp which was detected in February 2015 and has supported flying-foxes for most months since (excluding three months from July to September 2015), supported large numbers of flying-foxes during the February monitoring event (estimated >50,000). The Macksville Cemetery camp appears to be used as a replacement camp to the site.

Flying-foxes have remained at the Bellingen Island camp following a brief late autumn-winter absence, with substantial number of animals present (> 20,000) during the current monitoring event. Since departing Bowraville in late autumn flying-foxes have not returned yet for the usual occupation of this camp over the warmer period of the year. All regional camps have displayed seasonal absences in the 2015 winter period except for the Gordon Park camp, which has retained a generally steady population of flying-foxes over the past 12 months.

Dependent young GHFF are present at all occupied camps however they are in lesser densities than the previous months monitoring as begin to transition to independence.

David Andrighetto

Ecologist

References

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GeoLINK. (2015). *Flying-fox Monitoring February 2015 Warrell Creek to Nambucca Heads Pacific Highway Upgrade*. Unpublished report to NSW Roads and Maritime Services.

Flying-fox Monitoring
March 2016

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Prepared for: Roads and Maritime Services

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2182-1153	First issue	15/04/2016	David Andrighetto

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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services (RMS) are working to resolve issues relating to a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that is 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 vegetation 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 2016 flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following personnel undertook fieldwork for the March 2016 flying-fox monitoring:

- Frank Makin (GeoLINK ecologist).
- Jess O'Leary (GeoLINK ecologist).
- Kale Hardie-Porter (GeoLINK environmental scientist).
- Jeremy Clifford (GeoLINK environmental scientist).
- Terry Tweedy (Sub-consultant ecologist).

The fieldwork followed the methodology developed by Dr Eby for this roost (Eby 2013). Refer to that document for full details of the methodology. A summary of the main procedures used for the monitoring is provided below.

On 23 March 2016 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-fox 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.

However, as the initial traverse indicated that no flying-foxes were present at the site this data was not collected.

In light of the continued absence of flying-foxes at the site (since early April 2014) and the seasonal occupation of a flying-fox camp within two kilometres of the site adjacent to Macksville cemetery (first observed early in the summer of 2015), this data has recently been collected from the Macksville cemetery camp instead of at the site to provide some information relating to flying-foxes currently camping in the local area. Information for the Macksville cemetery camp was collected on 23 March 2016.

The water level at the site was also measured (approximate GPS location 492866, 6600756 [GDA 94, Zone 56]). The water level at this location is representative of the average level at the site and was collected on 23 March 2016.

Following the site traverse, a dusk exit count survey was undertaken at the site on the evening of 23 March 2016 as an additional measure to identify if flying-foxes are present at the site and subsequently estimate the number of flying-foxes roosting at the camp if present. Two observers were strategically located for the count on a northern and southern ridge overlooking the camp. In addition, three observers were also located in proximity to the Macksville cemetery camp to undertake an exit count of this camp.

Two observers were located at the following vantage points for the site:

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

Three observers were located at the following vantage points for the Macksville cemetery camp:

- At the intersection of Taylors Arm Road and Wallace Street (north-west of the camp).
- At the entrance to Macksville Cemetery on Wallace Street (west of the camp).
- In the car park of the Macksville Country Club (south of the camp).

Recent fly out counts have shown that the vast majority of flying-foxes have been exiting the Macksville cemetery camp in a westerly and north-westerly direction. On this basis, three observers were employed to comprehensively capture the west, north-west and southern streams anticipated to be exiting the Macksville cemetery camp.

The exit count extended over approximately 45 minutes from sunset until dark (approximately 6:45 pm to 7:30 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the Macksville camp), Bowraville and Bellingen Island were also visited on the 23 March 2016 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 observed to be roosting at the site in the camp traverse. Flying-foxes were also absent from Bowraville and Wheatley Street in Bellingen.

Regionally, flying-foxes were observed to be roosting at Macksville Cemetery, Bellingen Island, and Gordon Park (Nambucca Heads). The roost footprint recorded at Macksville Cemetery was smaller than the previous month (February 2016), occupying approximately 3.7 hectares during the current monitoring event (refer to **Illustration 2.2**).

2.2.2 Population Estimates

2.2.2.1 Exit Count

No flying-foxes were observed leaving the site in the exit count. The exit count at the Macksville Cemetery camp recorded approximately 32,000 flying-foxes (a large decrease compared to last month when >50,000 flying-foxes were recorded). The flying-foxes were mostly utilising fly-out 'streams' to the west and south-east, with light streams also observed to the north and north east.

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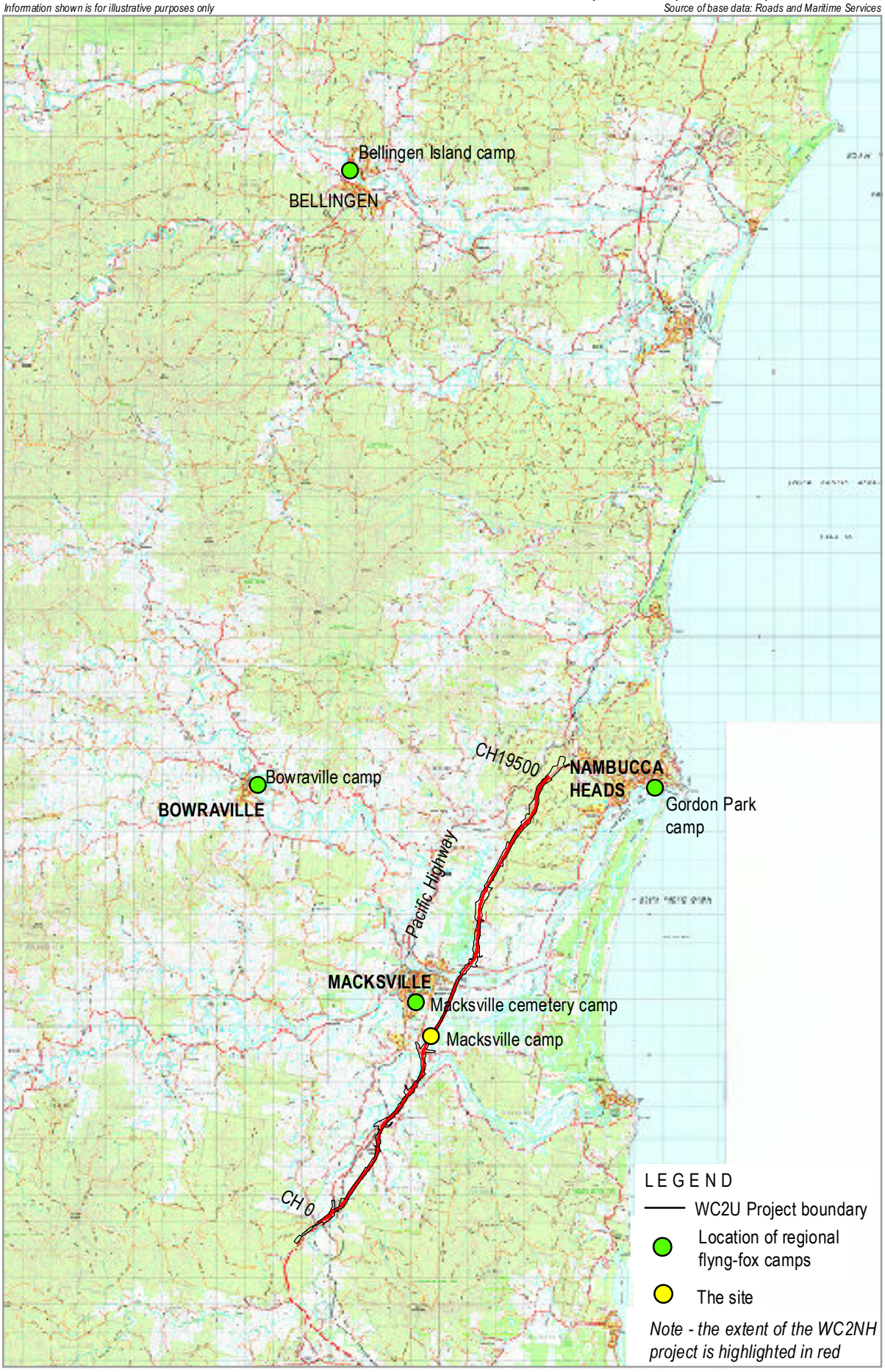
Source of base data: Roads and Maritime Services

Information shown is for illustrative purposes only



0 4 km

North

Location of Regional Flying-fox Camps

Information shown is for illustrative purposes only

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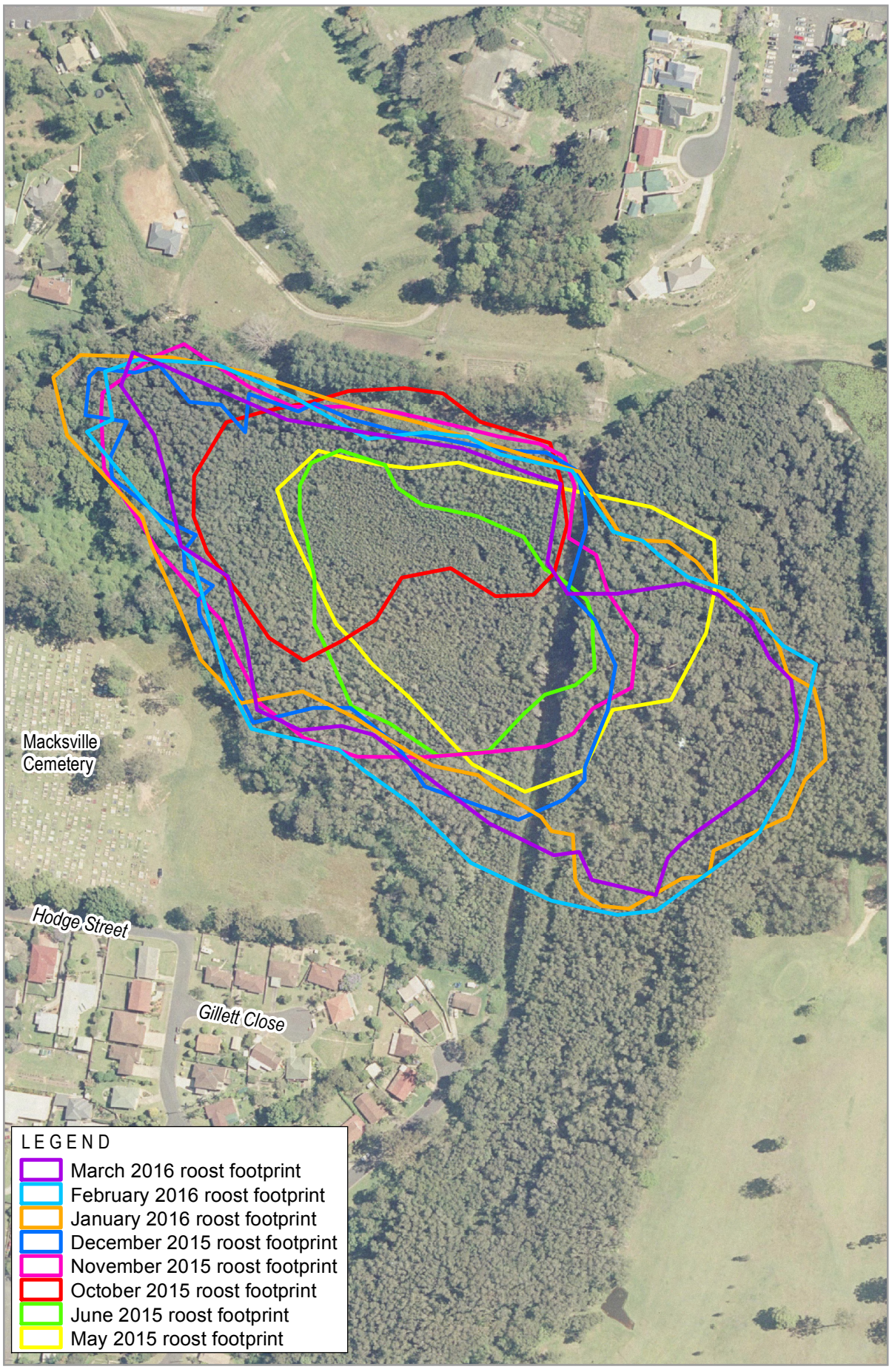
Source of base data: Roads and Maritime Services



North

0 60

Macksville Cemetery Flying-fox Roost Footprint

2.2.2.2 Direct Counts

No exit counts were conducted at any of the regional camps (excluding the Macksville Cemetery camp). 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 7,000 individuals (decreased from 10,000 in the previous monitoring event).
- Bowraville: no individuals recorded (as per the previous monitoring event).
- Bellingen Island: approximately 15,000 individuals (decreased from 20,000 in the previous monitoring event).
- Wheatley Street, Bellingen: no individuals recorded (as per the previous monitoring event).

2.2.3 Detailed Data

2.2.3.1 Species Composition

The species composition and proportions observed at occupied camps were the same as the previous survey (February 2016), as follows:

- Macksville Cemetery – GHFF >90%, Black Flying-fox 10%.
- Gordon Park – GHFF 90%, Black Flying-fox 10%.
- Bellingen Island – GHFF >95%, Black Flying-fox <5%.

It is plausible that Little Red Flying-foxes (*Pteropus scapulatus*) have been roosting at the Macksville Cemetery camp over the last couple of months (between December 2015 and April 2016). Spotlighting undertaken locally in February and early March observed Little Red Flying-foxes foraging on Pink Bloodwood (*Corymbia intermedia*). It is possible that Little Red Flying-foxes have been roosting at the Macksville Cemetery camp, although were not observed due to the large area occupied by the camp and inability to traverse into the roost centre without causing substantial unnecessary disturbance. Little Red Flying-foxes were previously recorded at the site in February and March 2014 (GeoLINK 2014), which similarly corresponded to significant flying-fox numbers roosting at the site during that period.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned previously, no flying-foxes were recorded at the site and therefore no detailed species composition data was collected. Instead, this data was collected at the nearby Macksville Cemetery camp for the current monitoring event.

The results of this month's demographic counts (including sex ratios and percentage of females with dependant young), should be considered indicative only. During late February and March weaning occurs and young become independent. Some young may temporarily roost independently from their mother despite being dependant. This seasons young are also almost the same size as adults. These factors make it difficult to determine whether some flying-foxes are dependant or not. Dependant young also often roost on the edges of camps to avoid (or are pushed out by) breeding adult males (Churchill 2008). This has potential to influences the survey results, particularly at the Macksville Cemetery camp, as it is not possible to go into the camp without causing significant disturbance. Demographic counts are therefore undertaken on the edge of the camp, and are more

likely to encounter non-breeding groups (though this does not appear to be a significant factor influencing the current monitoring event results).

Results of the demographic counts at the Macksville Cemetery camp indicated that females dominated the counts, making up between 71% and 91% (average 80%) of all individuals present at count locations (which excluded male 'bachelor' trees). Adult female GHFF with associated young showing signs of dependency (ranging from roosting under the wing of the adult female to roosting independently directly adjacent to the adult female) were observed at variable levels, ranging between 30% and 100% (average 70%) (refer to **Table 2.1**).

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	*Tree Species*	*Height (m); DBH (cm)*	*Demographic Ratio (female:male)*	*Presence of Dependant Young (yes/no)*	*% Females with Dependant Young*
MC1	Broad-leaved Paperbark	10; 20	10:2	yes	100
MC2	Broad-leaved Paperbark	10; 25	10:1	yes	100
MC3	Broad-leaved Paperbark	10; 30	10:1	yes	80
MC4	Broad-leaved Paperbark	10; 30	10:1	yes	60
MC5	Broad-leaved Paperbark	10; 20	10:3	yes	90
MC6	Broad-leaved Paperbark	10; 30	10:3	yes	60
MC7	Broad-leaved Paperbark	10; 15	10:4	yes	50
MC8	Broad-leaved Paperbark	10; 25	10:2	yes	30
MC9	Broad-leaved Paperbark	10; 25	10:4	yes	60
MC10	Broad-leaved Paperbark	10; 25	10:3	yes	70

To provide comparative information relating to flying-foxes occupying the broader region surrounding the site (or Macksville Cemetery camp), data of habitat characteristics and demographic composition was collected at Bellingen Island camp (refer to **Table 2.2**).

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	*Tree Species*	*Height (m); DBH (cm)*	*Demographic Ratio (female:male)*	*Presence of Dependant Young (yes/no)*	*% Females with Dependant Young*
BI1	White Booyong	8; 25	10:3	yes	40
BI2	Giant Stinging Tree	13; 40	10:3	yes	40
BI3	Giant Stinging Tree	13; 30	10:6	yes	30
BI4	Giant Stinging Tree	15; 30	10:3	yes	20
BI5	*Syzygium* sp.	8; 20	10:3	yes	30
BI6	Giant Stinging Tree	10; 20	10:3	yes	30
BI7	Giant Stinging Tree	10; 20	10:4	yes	50
BI8	Giant Stinging Tree	12; 30	10:3	no	0
BI9	Giant Stinging Tree	10; 25	10:3	yes	30
BI10	Small-leaved Fig	8; 30	10:5	no	0

Results of the demographic counts at the Bellingen Island camp indicated that females dominated the counts, making up between 63% and 76% (average 74%) of all individuals present at count locations (which excluded male 'bachelor' trees). Adult female GHFF with associated young showing signs of dependency were observed at variable levels between 0% and 50% (average 27%) (refer to **Table 2.2**).

General observations of the flying-foxes present at Gordon Park camp indicated that both female and male GHFF were present and a low-moderate number of female flying-foxes with dependant young were observed.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was approximately 54 cm in depth as is shown in **Figure 2.1**. This represents an 11 cm decrease since last month, following a significant rise in water level in January 2016.

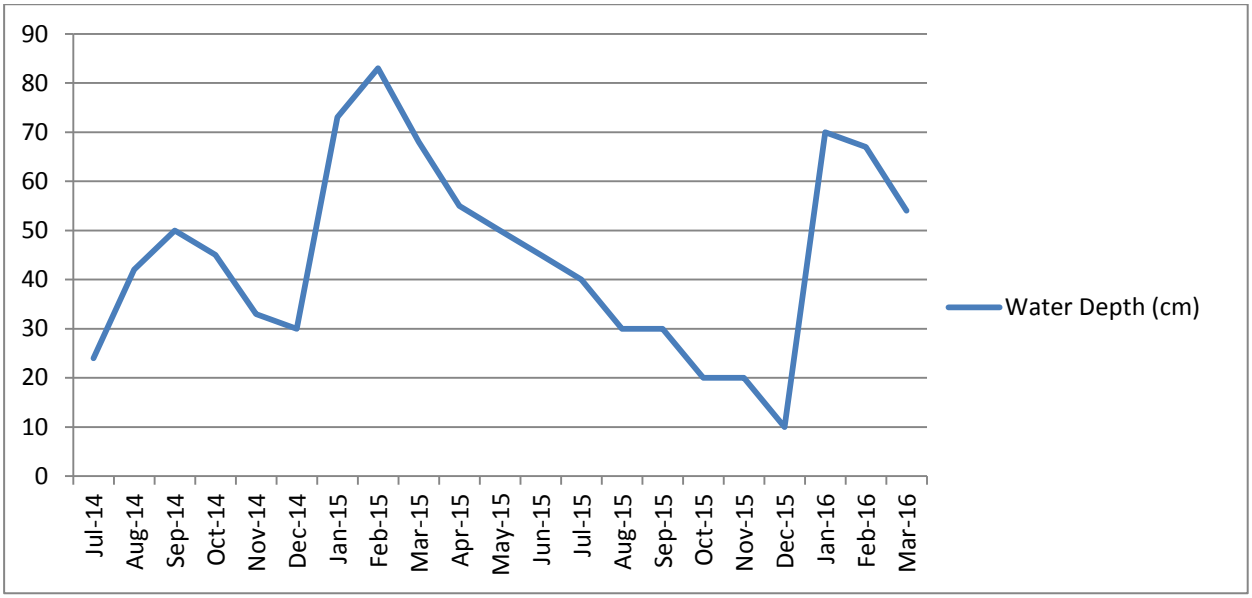


Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse or exit count during the current monitoring event. Flying-foxes have not been camped at the site (excluding a brief return in January 2015) since mid-April 2014.

Figure 2.2 shows the trend of flying-fox population at the site and other regional sites between January 2015 and March 2016. The number of flying-foxes roosting at the Macksville Cemetery camp peaked last month at >50,000 and has since decreased to an estimated 32,000 individuals this month. Reductions in numbers of flying-foxes were also recorded at Bellingen Island and Gordon Park during the March monitoring.

Flying-foxes continue to be absent from the Bowraville camp. No flying-foxes have been recorded roosting at Bowraville since mid-April 2015. For comparison, in March 2015 1,000-2,500 flying-foxes were roosting at the Bowraville camp (GeoLINK 2015).

The number of flying-foxes roosting at Bellingen Island has remained high, however a reduction in the roost population of approximately 25% was recorded with an estimated 15,000 individuals observed during the current monitoring event (down from >20,000 last month). For comparison, in March 2015 approximately 10,000 flying-foxes were recorded at this camp (GeoLINK 2015). Bellingen Island was occupied for 12 of the last 15 months, with a brief absence between April and June 2015. The Bellingen Wheatley Street camp which supported small numbers of flying-foxes mainly when the Bellingen Island was vacant, has remained vacant since July 2015 (shortly after the flying-foxes returned to Bellingen Island).

An estimated 7,000 flying-foxes were recorded at the Gordon Park camp (a decrease of approximately 3,000 individuals since last month). The reduced population recorded at Gordon Park camp constitutes a second consecutive month of decreased counts and represents the lowest numbers recorded during monitoring since January 2014. Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to March 2016). Flying-fox numbers are also generally stable and have (prior to this count) ranged between 10,000 and 20,000 individuals with between 10,000 and 15,000 individuals occupying the camp over the last 12 months.

The reduction in flying-fox numbers at occupied camps in the region since last month is likely to be associated with the completion of local flowering of Pink Bloodwood (*Corymbia intermedia*) and possibly Red Bloodwood (*C. gummifera*).

2.3.2 Species Composition and Demographic Data

Both GHFF and Black Flying-foxes were present at all occupied camps. GHFF dominated the species composition comprising between 90-95% of all individuals present. Black Flying-foxes accounted for a relatively small proportion of all individuals present (5-10%).

As discussed previously, it is possible that some Little Red Flying-foxes may be roosting locally, including at the Macksville Cemetery camp and contributing to the large numbers of flying-foxes recorded at the camp over the summer/early autumn period. Due to the large footprint of this camp, the high density at which Little Red Flying-foxes roost and the inability to traverse the centre of the camp during monitoring (which would generate significant disturbance), it is possible for modest numbers of Little Red Flying-foxesto be present and avoid detection. The other currently occupied camps (Bellingen Island and Gordon Park) are reasonably easy to inspect comprehensively and no Little Red Flying-foxes were detected.

The proportion of female GHFF with dependent young recorded in demographic counts during the current monitoring event was comparable with the previous month (February 2016). It is anticipated that as dependent young transition to independence the proportion of GHFF with young will decrease to zero next month with the completion of weaning.

2.3.3 Phenology of Trees in the Region

Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW typically occurs in the February/March period. Locally, this includes Broad-leaved Paperbark (*Melaleuca quinquenervia*) and a number of *Corymbia* species including Spotted Gum (*Corymbia maculata* and *C. variegata*), Red Bloodwood and Pink Bloodwood. These highly productive nectar source trees can be considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps indicated moderate flowering of Broad-leaved Paperbark occurring. Low-moderate flowering of Flooded Gum (*Eucalyptus grandis*) is also currently occurring and provides nectar resources for flying-foxes. Coast Banksia (*Banksia integrifolia*) was also observed starting to flower in the coastal portion of the region.

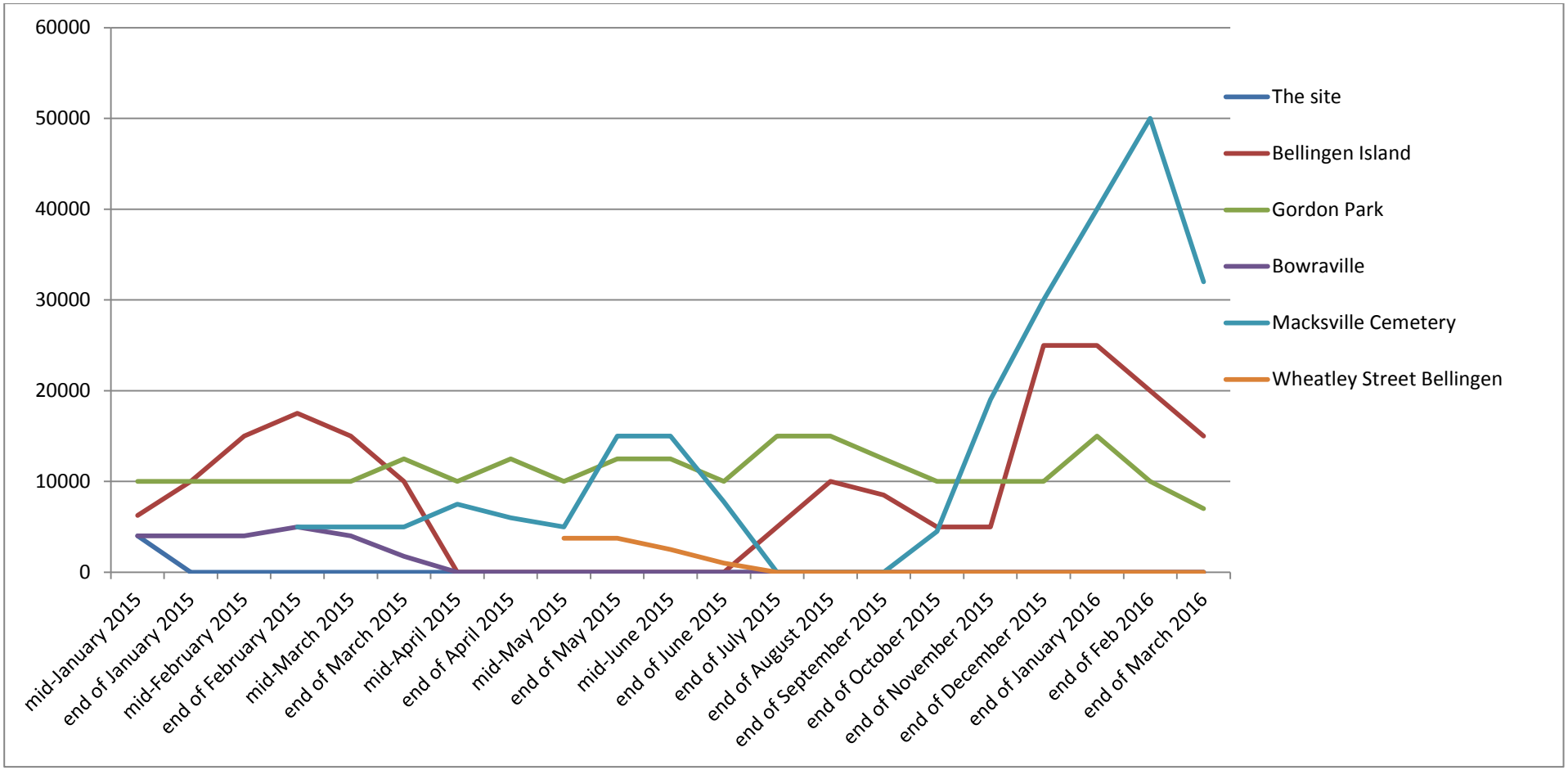


Figure 2.2 Population trends at the site and regional camps between January 2015 and March 2016

2.4 Conclusion

The results of the March 2016 monthly flying-fox monitoring indicate that flying-foxes have largely been absent from the site now since mid-April 2014 (excluding a brief stopover at the site in mid-January 2015). The nearby Macksville Cemetery camp (detected in February 2015) has supported flying-foxes for most months since that time (excluding three months from July to September 2015), with the camp supporting large numbers of flying-foxes since November 2015. During the March monitoring event an estimated 32,000 flying-fox were observed at the Macksville Cemetery camp, suggesting the camp appears to be used as a replacement camp to the site.

Flying-foxes have remained at the Bellingen Island camp following a brief late autumn-winter absence, with a moderate number of animals present (approximately 15,000) during the current monitoring event. Since departing Bowraville in late autumn 2015, flying-foxes have not returned for the usual occupation of this camp over the warmer period of the year. Gordon Park camp has been the only continuously occupied monitored flying-fox camp over the past 12 months.

Dependent young GHFF are present at all occupied camps and are all expected to be independent by the next monitoring event (April 2016).

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Ecologist

References

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Flying-fox Monitoring
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1.1 Introduction

NSW Roads and Maritime Services (RMS) are working to resolve issues relating to a Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp that is 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 vegetation 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 2016 flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following personnel undertook fieldwork for the April 2016 flying-fox monitoring:

- Frank Makin (GeoLINK ecologist).
- Grant McLean (GeoLINK ecologist).
- Kale Hardie-Porter (GeoLINK environmental scientist).

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

On 26 April 2016 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.

The initial traverse during the April 2016 survey indicated that no flying-foxes were present at the site; therefore this data was not collected.

In light of the continued absence of flying-foxes at the site (since early April 2014) and the seasonal occupation of a flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery (first observed early in the summer of 2015), this data has recently been collected from the Macksville Cemetery camp instead of at the site to provide some information relating to flying-foxes currently camping in the local area. Information for the Macksville Cemetery camp was collected on 26 April 2016.

The water level at the site was also measured (approximate GPS location 492866, 6600756 [GDA 94, Zone 56]). The water level at this location is representative of the average level at the site and was collected on 26 April 2016.

Following the site traverse, a dusk exit count survey was undertaken at the Macksville Cemetery camp on the evening of 26 April 2016 as an additional measure to identify the number of flying-fox roosting at the camp. Recent fly out counts have shown that the vast majority of flying-foxes have been exiting the Macksville Cemetery camp in a westerly and north-westerly direction. On this basis, three observers were employed to comprehensively capture the west, north-west and southern streams anticipated to be exiting the Macksville Cemetery camp.

Three observers were located at the following vantage points for the Macksville Cemetery camp:

- At the intersection of Taylors Arm Road and Wallace Street (north-west of the camp).
- At the entrance to Macksville Cemetery on Wallace Street (west of the camp).
- In the car park of the Macksville Country Club (south of the camp).

An additional dusk exit count survey was undertaken at the site on the evening of 27 April 2016 to provide an estimate of the number of flying-foxes currently roosting at the camp. Two observers were strategically located for the count on a northern and southern ridge overlooking the camp.

Two observers were located at the following vantage points for the site:

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

The exit counts extended over approximately 30 minutes from sunset until dark (approximately 5:30 pm to 6:00 pm).

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 kilometres north-east of the Macksville camp), Bowraville and Bellingen Island were also visited on 26 April 2016 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 observed to be roosting at the site during the camp traverse. Flying-foxes were also absent from the Bowraville camp and Wheatley Street camp in Bellingen.

Regionally, flying-foxes were observed to be roosting at Macksville Cemetery, Bellingen Island, and Gordon Park (Nambucca Heads). The roost footprint recorded at Macksville Cemetery was smaller than the previous month (March 2016), occupying approximately 2.6 hectares during the April 2016 monitoring event (refer to **Illustration 2.2**).

2.2.2 Population Estimates

2.2.2.1 Exit Count

No flying-foxes were observed flying from the site during the exit count. The exit count at the Macksville Cemetery camp recorded approximately 12,000 flying-foxes (a large decrease compared to the previous month when approximately 32,000 flying-foxes were recorded). The flying-foxes were mostly utilising fly-out 'streams' to the west, north-west and south.

Information shown is for illustrative purposes only

Drawn by: GJM Checked by: RE Reviewed by: VJS Date: 13/05/2016
Source of base data: Roads and Maritime Services

0 4 km

North

Location of Regional Flying-fox Camps

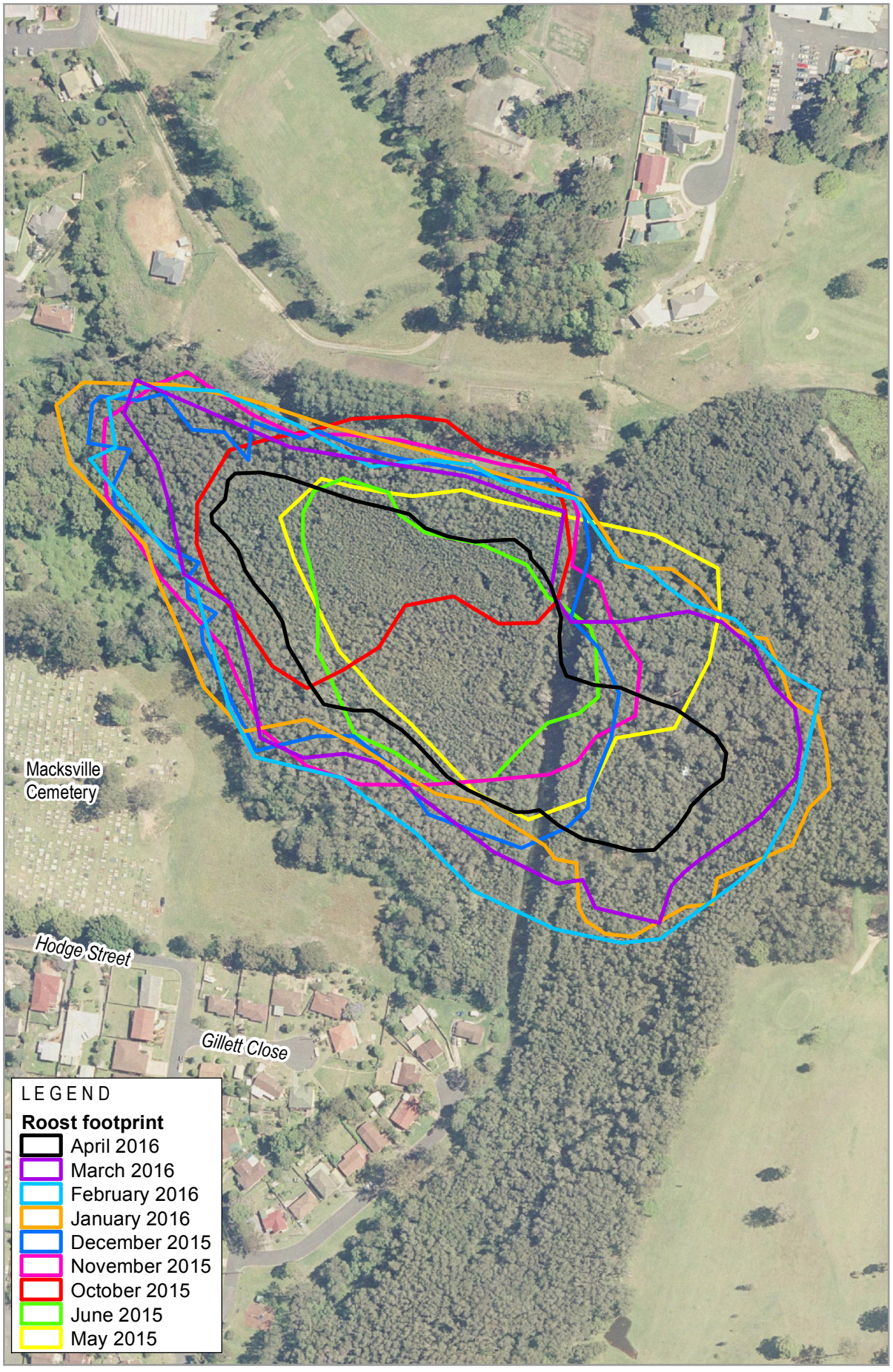
GeoLINK environmental management and design

Flying-fox Monitoring April 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2182-1059

Illustration 2.1

Information shown is for illustrative purposes only

Drawn by: GJM Checked by: RE Reviewed by: VJS Date: 18/05/2016
Source of base data: Roads and Maritime Services



North

0 60

Macksville Cemetery Flying-fox Roost Footprint

GeoLINK environmental management and design

Flying-fox Monitoring April 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2182-1156

Illustration 2.2

2.2.2.2 Direct Counts

No exit counts were conducted at any of the regional camps (except for the Macksville Cemetery camp). 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 15,000 individuals (increased from 7,000 in the previous monitoring event).
- Bowraville: no individuals recorded (as per the previous monitoring event).
- Bellingen Island: approximately 3,000 individuals (decreased from 15,000 in the previous monitoring event).
- Wheatley Street, Bellingen: no individuals recorded (as per the previous monitoring event).

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: GHFF >90%, Black Flying-fox 10%.
- Gordon Park: >60% Little Red Flying-fox, >30% Grey-headed Flying-fox and <10% Black Flying-fox. Little Red Flying-fox have moved into the centre of the camp and pushed the other species to the fringes.
- Bellingen Island: GHFF >95%, Black Flying-fox <5%.

It is plausible that Little Red Flying-foxes (*Pteropus scapulatus*) have been roosting at the Macksville Cemetery camp over the last couple of months (between December 2015 and April 2016), although were not observed due to the large area occupied by the camp and inability to traverse into the roost centre without causing substantial unnecessary disturbance. Spotlighting undertaken locally in February and early March 2016 observed Little Red Flying-foxes foraging on Pink Bloodwood (*Corymbia intermedia*). Little Red Flying-foxes were previously recorded at the site in February and March 2014 (GeoLINK 2014), which similarly corresponded to significant flying-fox numbers roosting at the site during that period.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned previously, no flying-foxes were recorded at the site and therefore no detailed species composition data was collected. Instead, this data was collected at the nearby Macksville Cemetery camp for the current monitoring event.

The results of this month's demographic counts (including sex ratios and percentage of females with dependant young), should be considered indicative only. During late February and March weaning occurs and young become independent. Some young may temporarily roost independently from their mother despite being dependant. This season's young are also almost the same size as adults. These factors make it difficult to determine whether some flying-foxes are dependant or not. Dependant young also often roost on the edges of camps to avoid (or are pushed out by) breeding adult males (Churchill 2008). Black-flying fox adults mate in March and April with the females dispersing from the camps for winter months, with male fertility also peaking in March for the Grey-headed Flying-fox (Churchill 2008). This has potential to influence the survey results, particularly at the Macksville Cemetery camp, as it is not possible to go into the camp without causing significant

disturbance. Demographic counts are therefore undertaken on the edge of the camp, and are more likely to encounter non-breeding groups (though this does not appear to be a significant factor influencing the current monitoring event results).

Results of the demographic counts at the Macksville Cemetery camp in April 2016 indicated that females made between 60% and 70% (average 65%) of all individuals present at count locations (which excluded male 'bachelor' trees). One adult female GHFF was observed to be with dependent young. No other GHFF young showed signs of dependency (refer to **Table 2.1**).

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	*Tree Species*	*Height (m); DBH (cm)*	*Demographic Ratio (female:male)*	*Presence of Dependant Young (yes/no)*	*% Females with Dependant Young*
MC1	Broad-leaved Paperbark	10; 20	10:3	no	0
MC2	Broad-leaved Paperbark	10; 20	10:3	no	0
MC3	Broad-leaved Paperbark	10; 20	10:4	no	0
MC4	Broad-leaved Paperbark	10; 20	10:4	no	0
MC5	Broad-leaved Paperbark	10; 20	10:3	no	0
MC6	Broad-leaved Paperbark	10; 20	10:4	no	0
MC7	Broad-leaved Paperbark	10; 20	10:4	no	0
MC8	Broad-leaved Paperbark	10; 20	10:4	no	0
MC9	Broad-leaved Paperbark	10; 20	10:3	no	0
MC10	Broad-leaved Paperbark	12; 25	10:4	yes	10

To provide comparative information relating to flying-foxes occupying the broader region surrounding the site (or Macksville Cemetery camp), data of habitat characteristics and demographic composition has previously been collected at the Bellingen Island camp. Data for comparative information was unattainable at the time of survey at the Bellingen Island camp due to the following:

- Reduced numbers of flying-fox present in the camp.
- Very thin spreading of flying-fox in the canopy.
- Majority of flying-fox roosting in the mid to upper strata making visual inspection impossible.

Of the flying-foxes observed at the Bellingen Island camp notable observations included:

- A large proportion of juvenile males.
- Three female GHFF with young.
- Demographic data obtained (generally from five trees or more) indicated a female to male ratio of 8:10.

General observations of the flying-foxes present at Gordon Park camp indicated that both female and male GHFF were present. No females were observed supporting dependant young. The roost habit of the Little Red Flying-fox where they hang close together (in tear drop formation) makes it difficult to determine the presence of mothers with young.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was 60 cm in depth as shown in **Figure 2.1**. This represents a 6 cm increase since last month.

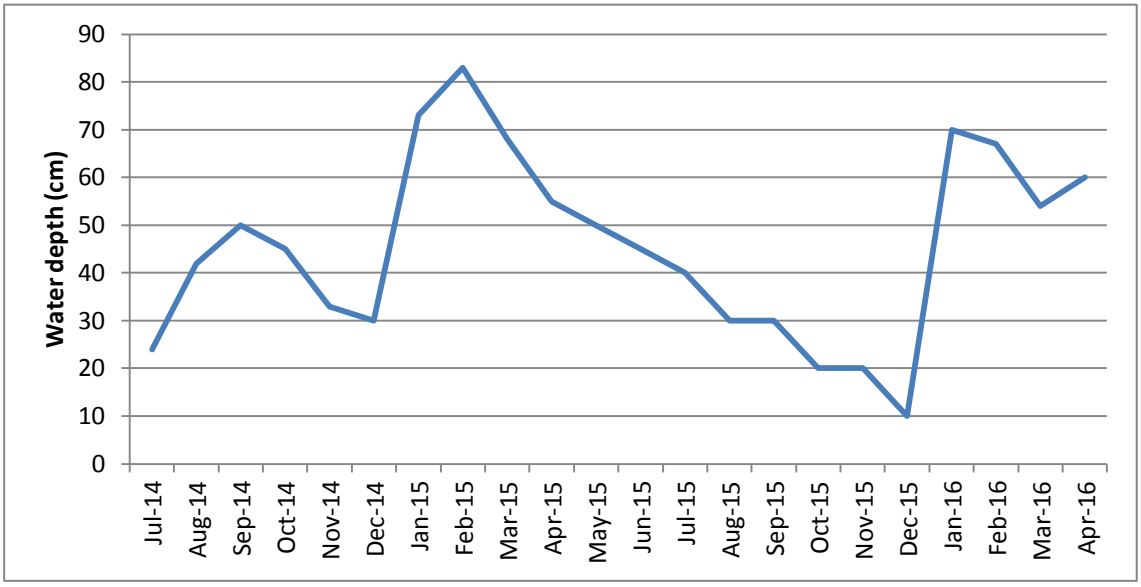


Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse during the current monitoring event. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

Figure 2.2 shows the trend of flying-fox population at the site and other regional sites between January 2015 and April 2016. The number of flying-foxes roosting at the Macksville Cemetery camp peaked in February 2016 at >50,000 and has since decreased to an estimated 12,000 individuals this month. Reductions in numbers of flying-foxes were also recorded at Bellingen Island during the April 2016 monitoring. The roosting flying-fox population at Gordon Park more than doubled since the previous monitoring event from 7,000 to 15,000 individuals. This can be attributed to the dense groupings of Little Red Flying-fox which have colonised the central parts of the camp.

Flying-foxes continue to be absent from the Bowraville camp. No flying-foxes have been recorded roosting at Bowraville since mid-April 2015.

The number of flying-foxes roosting at Bellingen Island has reduced significantly with an estimated 3,000 individuals observed during the current monitoring event (down from 15,000 last month). For comparison, in April 2015 no flying-foxes were recorded at this camp (GeoLINK 2015). Bellingen Island was occupied for 13 of the last 15 months, with a brief absence between April and June 2015. The Bellingen Wheatley Street camp which supported small numbers of flying-foxes mainly when the Bellingen Island was vacant, has remained vacant since July 2015 (shortly after the flying-foxes returned to Bellingen Island).

An estimated 15,000 flying-foxes were recorded at the Gordon Park camp (an increase of approximately 8,000 individuals since last month). Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to March 2016). Flying-fox numbers are also generally stable and have ranged between 7,000 and 20,000 individuals with between 10,000 and 15,000 individuals occupying the camp over the last 12 months.

2.3.2 Species Composition and Demographic Data

Both GHFF and Black Flying-foxes were present at all occupied camps. Little Red Flying-fox were only present at Gordon Park. GHFF dominated the species composition comprising between 90-95% of all individuals present at all camps, with Gordon Park being an exception. At Gordon Park, Little Red Flying-foxes comprised >60% of all individuals present. Black Flying-foxes at all camps accounted for a relatively small proportion of all individuals present (5-10%).

As discussed previously, it is possible that modest numbers of Little Red Flying-foxes may be roosting locally, including at the Macksville Cemetery camp however due to the large footprint of this camp, the high density at which Little Red Flying-foxes roost and the inability to traverse the centre of the camp during monitoring (which would generate significant disturbance) some may have avoided detection.

Four GHFF with dependent young (three at the Bellingen Island camp and one at the Macksville Cemetery camp) were recorded in demographic counts during the current monitoring event. This coincides with dependent young transitioning to independence and the completion of weaning.

The survey was undertaken at the end of the maternity period of the Grey-headed Flying-fox and Black Flying-fox (October to March).

Little Red Flying-fox follow a similar pattern of reproduction to Black and Grey-headed Flying-fox however are out of phase by six months. Young are born in March or April in predominantly female camps from which the males have dispersed (Churchill 2008).

2.3.3 Phenology of Trees in the Region

Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW typically occurs in the April /May period. Locally, this includes Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Swamp Mahogany (*Eucalyptus robusta*). These highly productive nectar source trees can be considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps indicated prolific flowering of Broad-leaved Paperbark occurring.

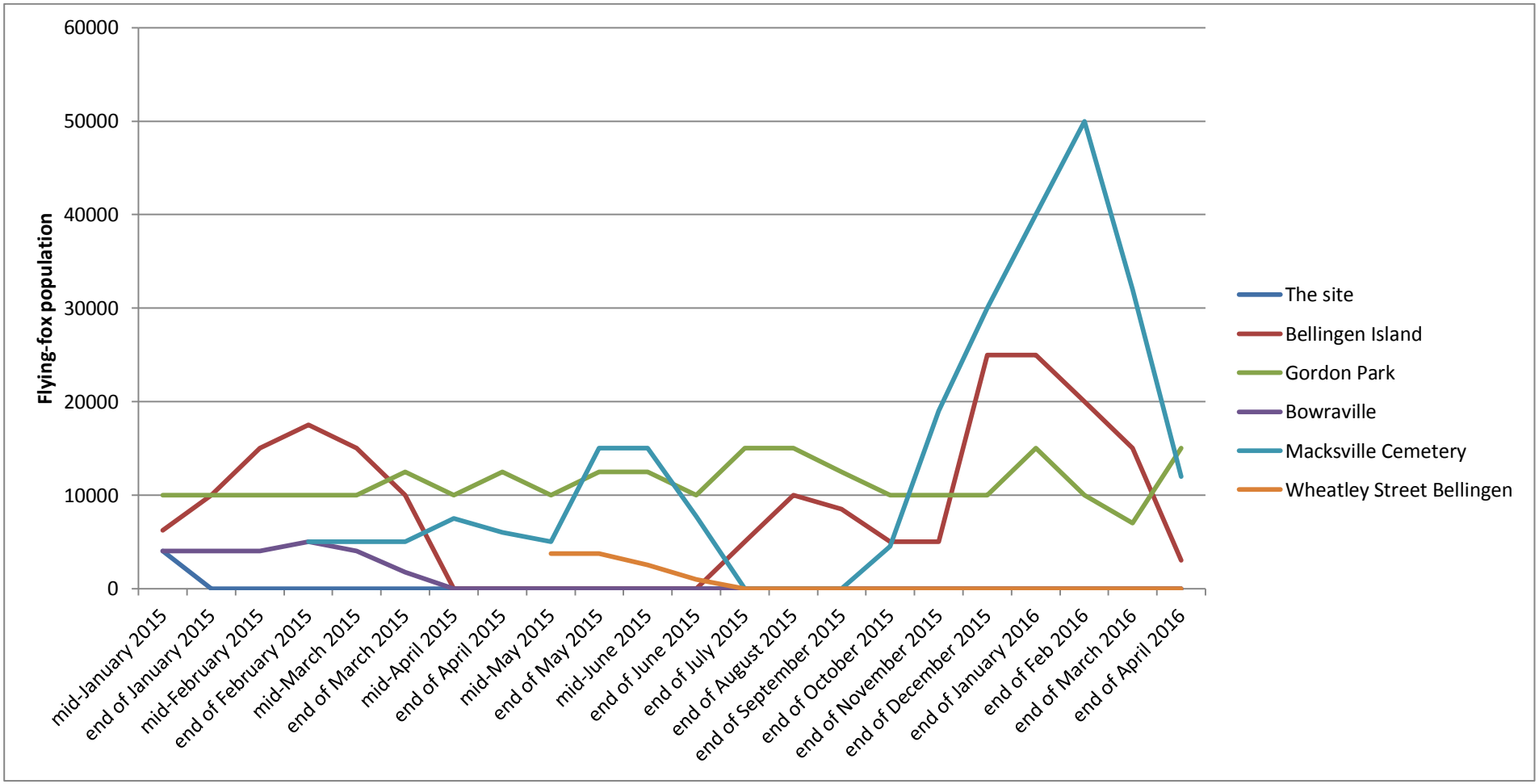


Figure 2.2 Population trends at the site and regional camps between January 2015 and April 2016

2.4 Conclusion

The results of the April 2016 monthly flying-fox monitoring indicate that flying-foxes have largely been absent from the site now since mid-April 2014 (excluding a brief stopover at the site in mid-January 2015). The nearby Macksville Cemetery camp (detected in February 2015) has supported flying-foxes for most months since that time (excluding three months from July to September 2015), with the camp supporting large numbers of flying-foxes since November 2015. During the April 2016 monitoring event an estimated 12,000 flying-fox were observed at the Macksville Cemetery camp, suggesting the camp appears to be used as a replacement camp to the site.

Flying-foxes have remained at the Bellingen Island camp following a brief late autumn-winter absence, however only a low number of animals were present (approximately 3,000) during the current monitoring event. Since departing Bowraville in late autumn 2015, flying-foxes have not returned for the usual occupation of this camp over the warmer period of the year. Gordon Park camp has been the only continuously occupied monitored flying-fox camp over the past 12 months.

Four dependent young GHFF were observed (three at Bellingen Island camp and one at Macksville Cemetery camp). All other camps did not support dependent young. It is expected all GHFF to be independent by the next monitoring event (May 2016).

Grant McLean

Ecologist

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Flying-fox Monitoring
May 2016

Warrell Creek to Nambucca Heads
Pacific Highway Upgrade

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Prepared for: Roads and Maritime Services

UPR	Description	Date Issued	Issued By
2182-1159	First issue	08/06/2016	Frank Makin

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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services (RMS) 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 vegetation 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 2016 flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following personnel undertook fieldwork for the May 2016 flying-fox monitoring:

- Frank Makin (GeoLINK ecologist).
- Kale Hardie-Porter (GeoLINK environmental scientist).
- Terry Tweedie (Sub consultant ecologist)

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

On 19 and 20 May 2016 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.

The initial traverse during the May 2016 survey indicated that no flying-foxes were present at the site; therefore this data was not collected.

In light of the continued absence of flying-foxes at the site (since early April 2014) and the seasonal occupation of a flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery (first observed early in the summer of 2015), this data has recently been collected from the Macksville Cemetery camp instead of at the site to provide some information relating to flying-foxes currently camping in the local area. Information for the Macksville Cemetery camp was collected on 19 May 2016.

The water level at the site was also measured (approximate GPS location 492866, 6600756 [GDA 94, Zone 56]). The water level at this location is representative of the average level at the site and was collected on 20 May 2016.

Following the site traverse, a dusk exit count survey was undertaken at the Macksville Cemetery camp on the evening of 19 May 2016 as an additional measure to identify the number of flying-fox roosting at the camp. Recent fly out counts have shown that the vast majority of flying-foxes have been exiting the Macksville Cemetery camp in a westerly and north-westerly direction. On this basis, three observers were employed to comprehensively capture the west, north-west and southern streams anticipated to be exiting the Macksville Cemetery camp. Specifically, three observers were located at the following vantage points for the Macksville Cemetery camp:

- At the cul-de-sac of Nancy Roberts Lane (north of the camp).
- At the entrance to Macksville Cemetery on Wallace Street (west of the camp).
- In the car park of the Macksville Country Club (south of the camp).

An additional dusk exit count survey was undertaken at the site on the evening of 20 May 2016 to provide an estimate of the number of flying-foxes currently roosting at the site. Two observers were strategically located for the count on a northern and southern ridge overlooking the site. Specifically, the two observers were located at the following vantage points for the site:

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

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

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 km north-east of the site), Bowraville (approximately 10.5 km north-west of the site), Bellingen Wheatley Street Camp (approximately 30 km north of the site) and Bellingen Island (approximately 31 km north of the site) were also visited on 19 May 2016 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 observed to be roosting at the site during the camp traverse. Flying-foxes were also absent from the Bowraville camp and Wheatley Street camp in Bellingen.

Regionally, flying-foxes were observed to be roosting at Macksville Cemetery, Bellingen Island and Gordon Park (Nambucca Heads). The roost footprint recorded at Macksville Cemetery was considerably smaller than the previous month (April 2016), occupying approximately 0.4 hectares during the May 2016 monitoring event (refer to **Illustration 2.2**). In April 2016, the camp occupied approximately 2.6 ha.

2.2.2 Population Estimates

2.2.2.1 Exit Count

No flying-foxes were observed flying from the site during the exit count. The exit count at the Macksville Cemetery camp recorded approximately 1,000 flying-foxes (a large decrease compared to the previous month when approximately 12,000 flying-foxes were recorded). The flying-foxes were mostly utilising fly-out 'streams' to the north-east and south.

Information shown is for illustrative purposes only

Drawn by: KHP Checked by: FM Reviewed by: VJS Date: 8/06/2016
Source of base data: Roads and Maritime Services

0 4 km

North

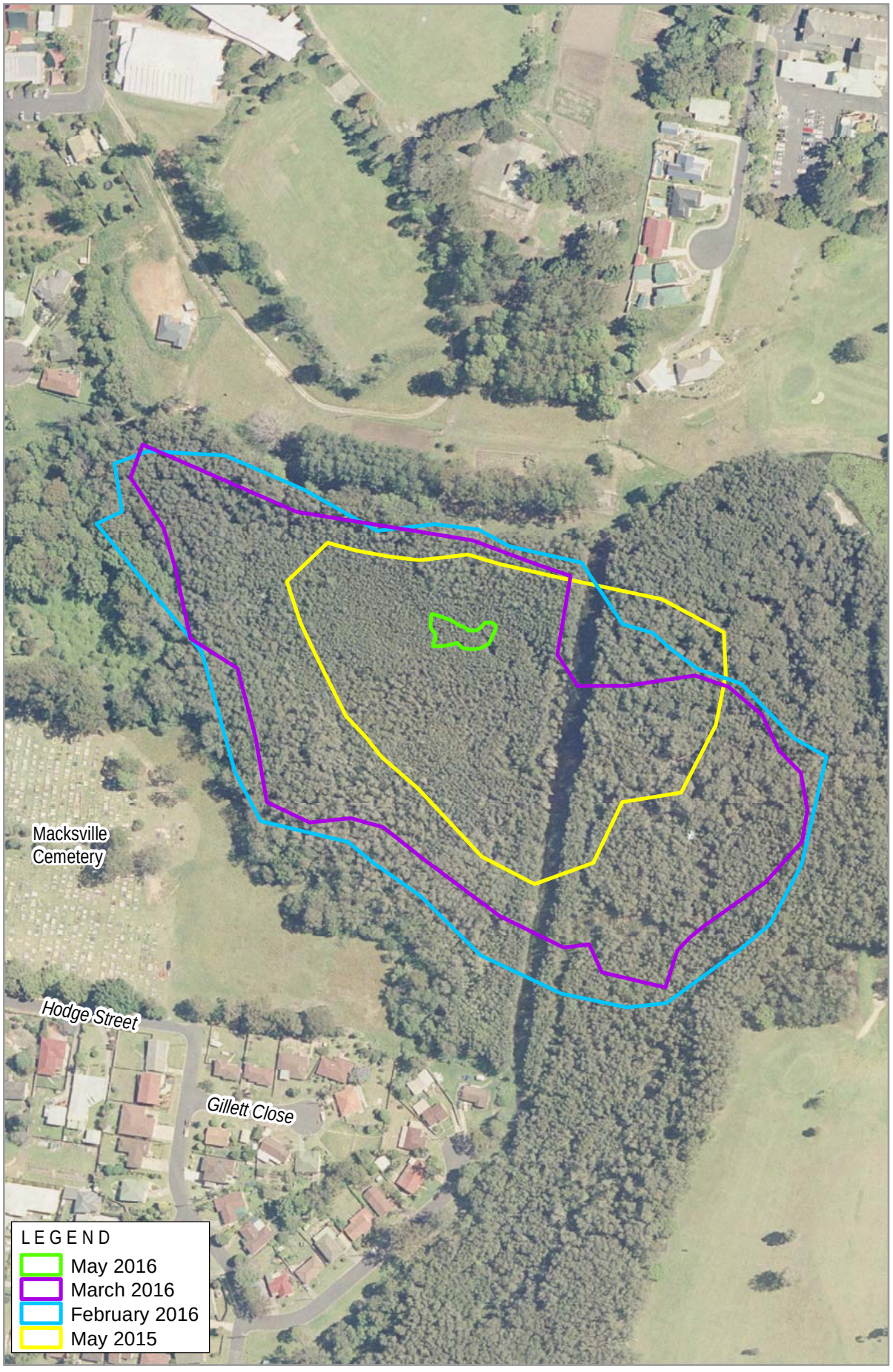
Location of Regional Flying-fox Camps

Flying-fox Monitoring May 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2182-1062

Illustration 2.1

Information shown is for illustrative purposes only

Drawn by: KHP Checked by: FM Reviewed by: DSA Date: 6/06/2016
Source of base data: Roads and Maritime Services



North

0 60

Macksville Cemetery Flying-fox Roost Footprint

GeoLINK environmental management and design

Flying-fox Monitoring May 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2182-1161

Illustration 2.2

2.2.2.2 Direct Counts

No exit counts were conducted at any of the regional camps (except for the Macksville Cemetery camp). 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 30,000 individuals (increased from 15,000 in the previous monitoring event).
- Bowraville: no individuals recorded (as per the previous monitoring event).
- Bellingen Island: approximately 7,000 individuals (increased from 3,000 in the previous monitoring event).
- Wheatley Street, Bellingen: no individuals recorded (as per the previous monitoring event).

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: GHFF >95%, Black Flying-fox <5%.
- Bellingen Island: GHFF >95%, Black Flying-fox <5%.
- Gordon Park: >60% Little Red Flying-fox, >35% Grey-headed Flying-fox and <5% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned previously, no flying-foxes were recorded at the site and therefore no detailed species composition data was collected. Instead, this data was collected at the nearby Macksville Cemetery camp for the current monitoring event.

Comprehensive demographic data collection for May at the Macksville Cemetery site was not possible to collect as the roost was very sparsely occupied (refer to **Plate 2.1**). Only three demographic point counts were obtained rather than the usual ten. Whilst attempting to obtain roost data, a White Bellied Sea Eagle (*Haliaeetus leucogaster*) was observed trying to capture an individual flying-fox, which greatly unsettled the already scattered colony.

Of the flying-foxes present at the Macksville Cemetery camp, notable observations included:

- A large proportion of males.
- An average female to male ratio of 4:10 at the three collected demographic points.

Plate 2.1 Sparsely occupied Macksville Cemetery camp

Results of the demographic counts at the Macksville Cemetery camp in May 2016 indicated that females made between 23% and 33% (average 29%) of all individuals present at count locations (refer to **Table 2.1**).

Table 2.1 Demographic Data of GHFF at the Macksville Cemetery Camp

Tree Code	*Tree Species*	*Height (m); DBH (cm)*	*Demographic Ratio (female:male)*	*Presence of Dependant Young (yes/no)*	*% Females with Dependant Young*
MC1	Broad-leaved Paperbark	10; 20	10:4	no	0
MC2	Broad-leaved Paperbark	9; 15	10:8	no	0
MC3	Broad-leaved Paperbark	12; 22	10:4	no	0

Results of the demographic counts at the Bellingen Island camp indicated that females dominated the counts, making up between 55% and 83% (average 65%) of all individuals present at count locations (which excluded male 'bachelor' trees). No adult with dependant young were present (refer to **Table 2.2**).

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	Tree Species	Height (m); DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
MC1	Giant Stinging Tree	15; 50	10:8	no	0
MC2	Giant Stinging Tree	13; 40	10:4	no	0
MC3	Giant Stinging Tree	17; 50	10:7	no	0
MC4	White Booyong	20; 60	10:5	no	0
MC5	Giant Stinging Tree	10; 30	10:5	no	0
MC6	Giant Stinging Tree	12; 45	10:8	no	0
MC7	White Booyong	22; 55	10:6	no	0
MC8	White Booyong	18; 50	10:2	no	0
MC9	Giant Stinging Tree	10; 20	10:5	no	0
MC10	Giant Stinging Tree	12; 25	10:4	no	0

General observations of the flying-foxes present at Gordon Park camp indicated that both female and male GHFF, Black Flying-fox and Little Red Flying-foxes were present. No females were observed supporting dependant young. The roost habit of the Little Red Flying-fox where they roost close together makes it difficult to determine the presence of mothers with young, although they are in the maternity period.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was 57.5 cm in depth as shown in **Figure 2.1**. This represents 2.5 cm decrease since last month.

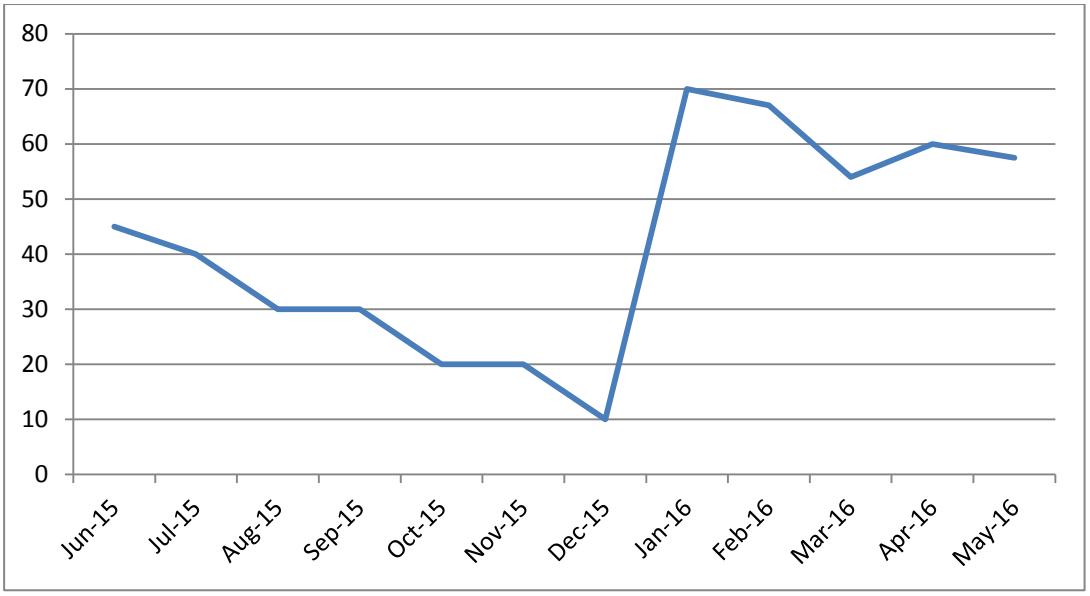


Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse or exit count during the current monitoring event. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

Figure 2.2 shows the trend of flying-fox population at the site and other regional sites between January 2015 and May 2016. The number of flying-foxes roosting at the Macksville Cemetery camp peaked in February 2016 at >50,000 and has decreased steadily each month to an estimated 1,000 individuals this month. The roosting flying-fox population at Gordon Park has dramatically increased for several consecutive months from 7,000 individuals in March, 15,000 individuals in April and 30,000 individuals in May. This can be attributed to the dense groupings of Little Red Flying-fox which have recently colonised the central portion of the camp. This is only the second time that Little Red Flying-foxes have been recorded at Gordon Park during the subject monitoring program. The last recording was between February and March 2014.

Flying-foxes continue to be absent from the Bowraville camp. No flying-foxes have been recorded roosting at Bowraville since mid-May 2015.

The number of flying-foxes roosting at Bellingen Island has fluctuated in previous months from 15,000 in March to 3,000 in April, then up to 7,000 individuals in May. For comparison the results for March April and May 2015 were 5,000, 6,000, and 0 respectively. Bellingen Island has been occupied continuously since the brief absence between April and June 2015. The Bellingen Wheatley Street camp which supported small numbers of flying-foxes mainly when the Bellingen Island was vacant, has remained vacant since July 2015 (shortly after the flying-foxes returned to Bellingen Island). (GeoLINK 2015).

An estimated 30,000 flying-foxes were recorded at the Gordon Park camp (doubling the number of flying-foxes since last month). Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to March 2016). Flying-fox numbers have between relatively stable between 7,000 and 20,000 individuals however the May monitoring has seen a significant rise in the population to approximately 30,000 individuals, which is attributed to the presence of Little Red Flying-foxes.

2.3.2 Species Composition and Demographic Data

Both GHFF and Black Flying-foxes were present at all occupied camps. Little Red Flying-fox were only present at Gordon Park. GHFF dominated the species composition comprising >95% of all individuals present at all camps, with Gordon Park being an exception. At Gordon Park, Little Red Flying-foxes comprised >60%, GHFF made up> 35% of all individuals present. Black Flying-foxes at all camps accounted for a relatively small proportion of all individuals present <5%.

The survey was undertaken post maternity period of the Grey-headed Flying-fox and Black Flying-fox (October to March). Little Red Flying-fox follow a similar pattern of reproduction to Black and Grey-headed Flying-fox however are out of phase by six months. Young are born in March or April in predominantly female camps from which the males have dispersed (Churchill 2008).

2.3.3 Phenology of Trees in the Region

Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW typically occurs in the April /May period. Locally, this includes Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Swamp Mahogany (*Eucalyptus robusta*). These highly productive nectar source trees can be considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps indicated prolific flowering of Broad-leaved Paperbark and a light flowering of Swamp Mahogany was present.

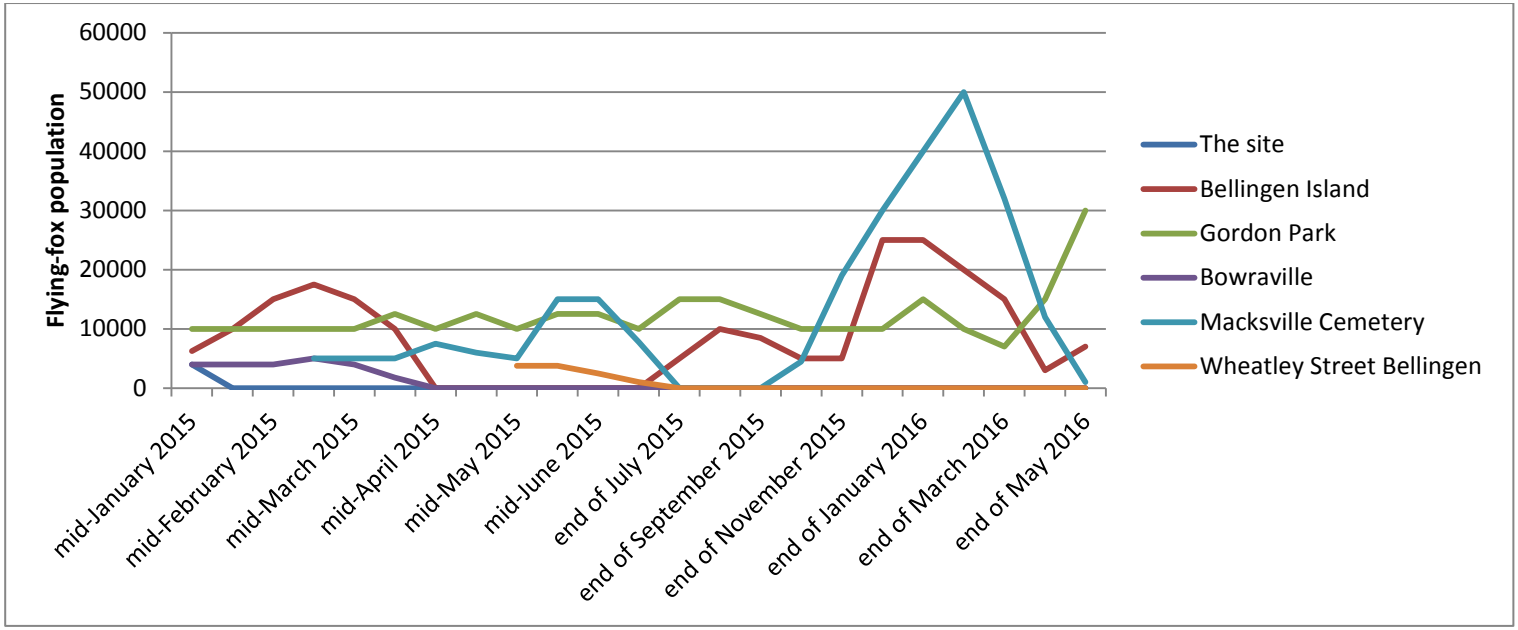


Figure 2.2 Population trends at the site and regional camps between January 2015 and April 2016

2.4 Conclusion

The results of the May 2016 monthly flying-fox monitoring indicate that flying-foxes have largely been absent from the site now since mid-April 2014 (excluding a brief stopover at the site in mid-January 2015). The nearby Macksville Cemetery camp (detected in February 2015) has supported flying-foxes for most months since that time (excluding three months from July to September 2015), with the camp supporting varying numbers of flying-foxes since November 2015. During the May 2016 monitoring event an estimated 1,000 flying-foxes were observed at the Macksville Cemetery camp.

Flying-foxes have remained at the Bellingen Island camp following a brief late autumn-winter 2015 absence, with approximately 7,000 individuals present during the current monitoring event. Since departing Bowraville in late autumn 2015, flying-foxes have not returned for the usual occupation of this camp over the warmer period of the year. Gordon Park camp has been the only continuously occupied monitored flying-fox camp over the past 12 months, and has seen a dramatic increase in flying-fox numbers strongly attributed to the influx of Little Red Flying-foxes.

No dependent GHFF were observed during this month's monitoring. Young from the 2015/16 maternity period are now independent.

Frank Makin
Ecologist

References

Churchill, S. (2008). *Australian Bats (Second Edition)*. Allen & Unwin, NSW.

Eby, P. and Law, B. (2008). *Ranking the feeding habitat of Grey-headed flying foxes for conservation management*. Department of Environment, Heritage, Water and the Arts, Canberra.

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Flying-fox Monitoring
June 2016

Warrell Creek to Nambucca Heads
Pacific Highway Upgrade

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Prepared for: Roads and Maritime Services

UPR	Description	Date Issued	Issued By
2182-1163	First issue	20/07/2016	Frank Makin

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1. Introduction

1.1 Introduction

NSW Roads and Maritime Services (RMS) 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 vegetation 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 2016 flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following personnel undertook fieldwork for the June 2016 flying-fox monitoring:

- Frank Makin (GeoLINK ecologist).
- Kale Hardie-Porter (GeoLINK environmental scientist).
- Jess O'Leary (GeoLINK ecologist).
- Terry Tweedie (Sub consultant ecologist)

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.

On 30 June 2016 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.

The initial traverse during the June 2016 survey indicated that no flying-foxes were present at the site; therefore this data was not collected.

In light of the continued absence of flying-foxes at the site (since early April 2014) and the seasonal occupation of a flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery (first observed early in the summer of 2015), this data has recently been collected from the Macksville Cemetery camp instead of at the site to provide some information relating to flying-foxes currently camping in the local area. However upon inspection of the Macksville Cemetery site on the 30 June 2016 no flying-foxes were present; therefore this data was not collected.

The water level at the site was measured (approximate GPS location 492866, 6600756 [GDA 94, Zone 56]). The water level at this location is representative of the average level at the site and was collected on 30 June 2016.

Following the site traverse, dusk exit count surveys were undertaken at the site and the Macksville Cemetery camp on the evening of 30 June 2016 as an additional measure to confirm the presence/ absence of flying-fox roosting at both locations.

At the site, 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 ridge south of the camp (41 Bald Hill Road).

Recent fly-out counts at the Macksville Cemetery camp have observed the vast majority of flying-foxes exiting the Macksville Cemetery camp in westerly and north-westerly directions. Two observers were employed to capture the west, north-west streams anticipated to be exiting the Macksville Cemetery camp. Specifically, the two observers were located at the following vantage points for the Macksville Cemetery camp:

- At the cul-de-sac of Nancy Roberts Lane (north of the camp).
- At the entrance to Macksville Cemetery on Wallace Street (west of the camp).

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

Other regional flying-fox camps at Gordon Park, Nambucca Heads (approximately 12 km north-east of the site), Bowraville (approximately 10.5 km north-west of the site), Bellingen Wheatley Street Camp (approximately 30 km north of the site) and Bellingen Island (approximately 31 km north of the site) were also visited on 30 June 2016 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 observed to be roosting at either the site or at the Macksville Cemetery roost during the camp traverses and exit counts on the 30 June. As such no roost footprint data has been recorded as a part of the June monitoring. Flying-foxes were also absent from the Bowraville camp and Wheatley Street camp in Bellingen. Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads).

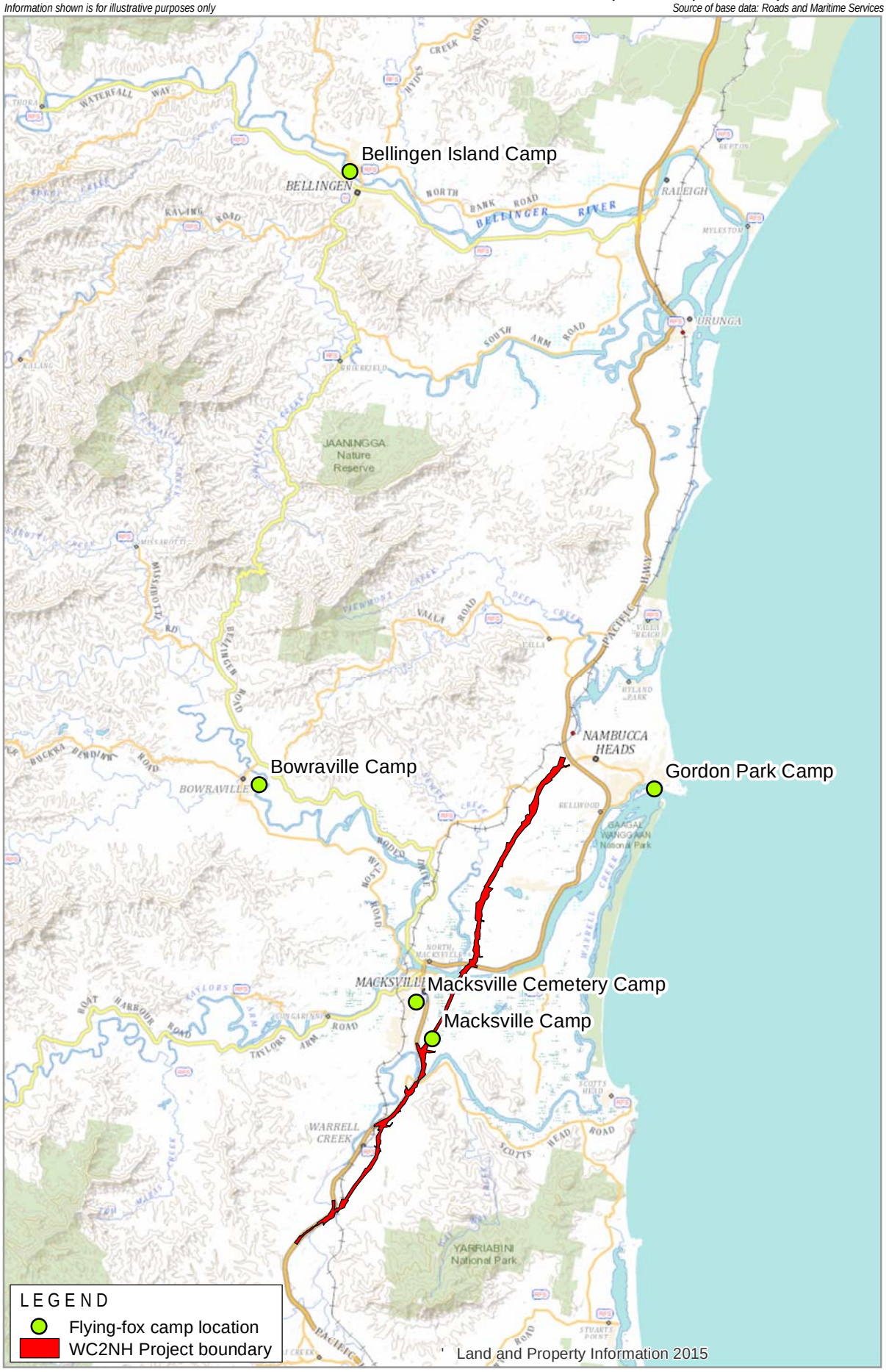
2.2.2 Population Estimates

2.2.2.1 Exit Count

No flying-foxes were observed flying from the site during the exit count. The exit count at the Macksville Cemetery camp also recorded an absence of flying-foxes (a decrease from 1,000 flying-foxes in the previous month).

Information shown is for illustrative purposes only

Drawn by: KHP Checked by: DSA Reviewed by: VJS Date: 20/07/2016
Source of base data: Roads and Maritime Services



0 4 km

North

Location of Regional Flying-fox Camps

Flying-fox Monitoring June 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2182-1165

Illustration 2.1

2.2.2.2 Direct Counts

No exit counts were conducted at any of the regional camps (except for the Macksville Cemetery camp). 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 (decreased from 30,000 in the previous monitoring event).
- Bowraville: no individuals recorded (as per the previous monitoring event).
- Bellingen Island: approximately 10,000 individuals (increased from 7,000 in the previous monitoring event).
- Wheatley Street, Bellingen: no individuals recorded (as per the previous monitoring event).

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: GHFF >95%, Black Flying-fox <5%.
- Gordon Park: GHFF >95%, Black Flying-fox <5%.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned previously, no flying-foxes were recorded at the site and therefore no detailed demographic composition data was collected. This has been the case since April 2014 (excluding a brief return in January 2015) and Macksville Cemetery camp has been the alternative site for collection of this data. However as no flying-fox were present at the Macksville Cemetery camp (the first time since September 2015) demographic composition data was recorded at Gordon Park for the current monitoring event.

Results of the demographic counts at the Gordon Park camp in June 2016 indicated that females made between 56 % and 83% (average 67%) of all individuals present at count locations (refer to **Table 2.1**).

Table 2.1 Demographic Data of GHFF at the Gordon Park Camp

Tree Code	Tree Species	Height (m); DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
GP1	Stag	12;10	10:6	no	0
GP2	Stag	15;10	10:2	no	0
GP3	Stag	12;10	10:2	no	0
GP4	Stag	12;10	10:2	no	0
GP5	Stag	10;15	10:5	no	0
GP6	Ficus sp.	14;25	10:6	no	0
GP7	Stag	12;15	10:9	no	0
GP8	Stag	15;50	10:8	no	0
GP9	Unidentified	18;45	10:4	no	0
GP10	Stag	18;30	10:6	no	0

Results of the demographic counts at the Bellingen Island camp indicated that females dominated the counts, making up between 67% and 91% (average of 76%) of all individuals present at count locations (which excluded male 'bachelor' trees). No adult with dependant young were present (refer to **Table 2.2**).

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	Tree Species	Height (m); DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BIC1	White Booyong	10;30	10:5	no	0
BIC2	Giant Stinging Tree	12;20	10:5	no	0
BIC3	Giant Stinging Tree	10;30	10:4	no	0
BIC4	White Booyong	12;40	10:3	no	0
BIC5	Giant Stinging Tree	15;35	10:3	no	0
BIC6	Stag	12;40	10:3	no	0
BIC7	Giant Stinging Tree	15;35	10:2	no	0
BIC8	White Booyong	10;15	10:4	no	0
BIC9	Giant Stinging Tree	12;30	10:2	no	0
BIC10	White Booyong	8;30	10:1	no	0

General observations of the flying-foxes at Bellingen Island camp indicated that both female and male GHFF were present. No females with dependant young were present.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was 75.5 cm in depth as shown in **Figure 2.1**. This represents an 18 centimetre increase since last month, attributed to two significant rainfall events since the May 2016 monitoring.

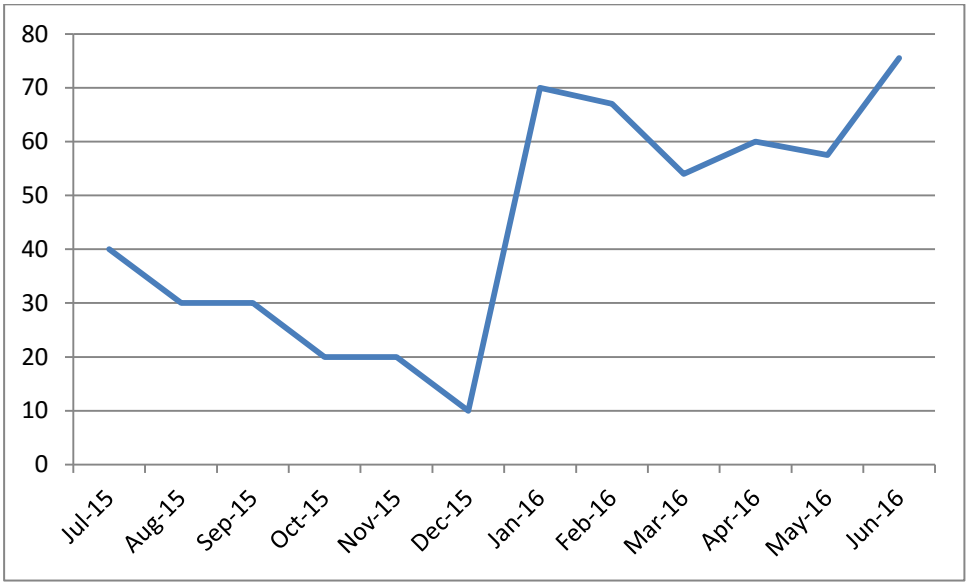


Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse or exit count during the current monitoring event. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

Figure 2.2 shows the trend in flying-fox numbers at the site and other regional sites between January 2015 and June 2016. The number of flying-foxes roosting at the Macksville Cemetery camp peaked in February 2016 at >50,000 and has decreased steadily each month since. This month recorded no flying-fox at the Macksville Cemetery for the first time since September 2015. At the same time last year approximately 7,750 Flying-foxes were recorded at the Macksville Cemetery site.

The number of flying-foxes roosting at Gordon Park peaked last month at approximately 30,000 individuals and has dropped significantly to approximately 10,000 this month. This is largely attributed to the Little Red Flying-fox leaving the camp since the May monitoring event.

Flying-foxes continue to be absent from the Bowraville camp. No flying-foxes have been recorded roosting at Bowraville since mid-May 2015.

The number of flying-foxes roosting at Bellingen Island has increased from 7,000 in May to 10,000 in June. At the same time last year, the camp was vacant. Bellingen Island has been occupied continuously since a brief absence between April and June 2015. The Bellingen Wheatley Street

camp which supported small numbers of flying-foxes mainly when Bellingen Island was vacant, has remained vacant since July 2015 (shortly after the flying-foxes returned to Bellingen Island - GeoLINK 2015).

Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to March 2016). Flying-fox numbers have fluctuated between 7,000 and 30,000 individuals.

2.3.2 Species Composition and Demographic Data

Both GHFF and Black Flying-foxes were present at the occupied camps (Gordon Park and Bellingen Island). GHFF dominated the species composition comprising >95% of all individuals present. Black Flying-foxes accounted for a relatively small proportion of all individuals present <5%. Little Red Flying-fox were absent from both sites, after being recorded at Gordon Park last month. The survey was undertaken outside the maternity period (October to March) for the Grey-headed Flying-fox and Black Flying-fox (Churchill 2008), as such no young or young were observed during the June survey.

2.3.3 Phenology of Trees in the Region

Flowering of a number of highly productive nectar source trees for GHFF within 50 km of the site occur in June, including Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Swamp Mahogany (*E. robusta*). These highly productive nectar source trees can be considered key diet species for GHFF (Eby 2012). GHFF diet tree species observed flowering when travelling between regional flying-fox camps include Swamp Mahogany, Broad-leaved Paperbark and Coast Banksia (*Banksia integrifolia*).

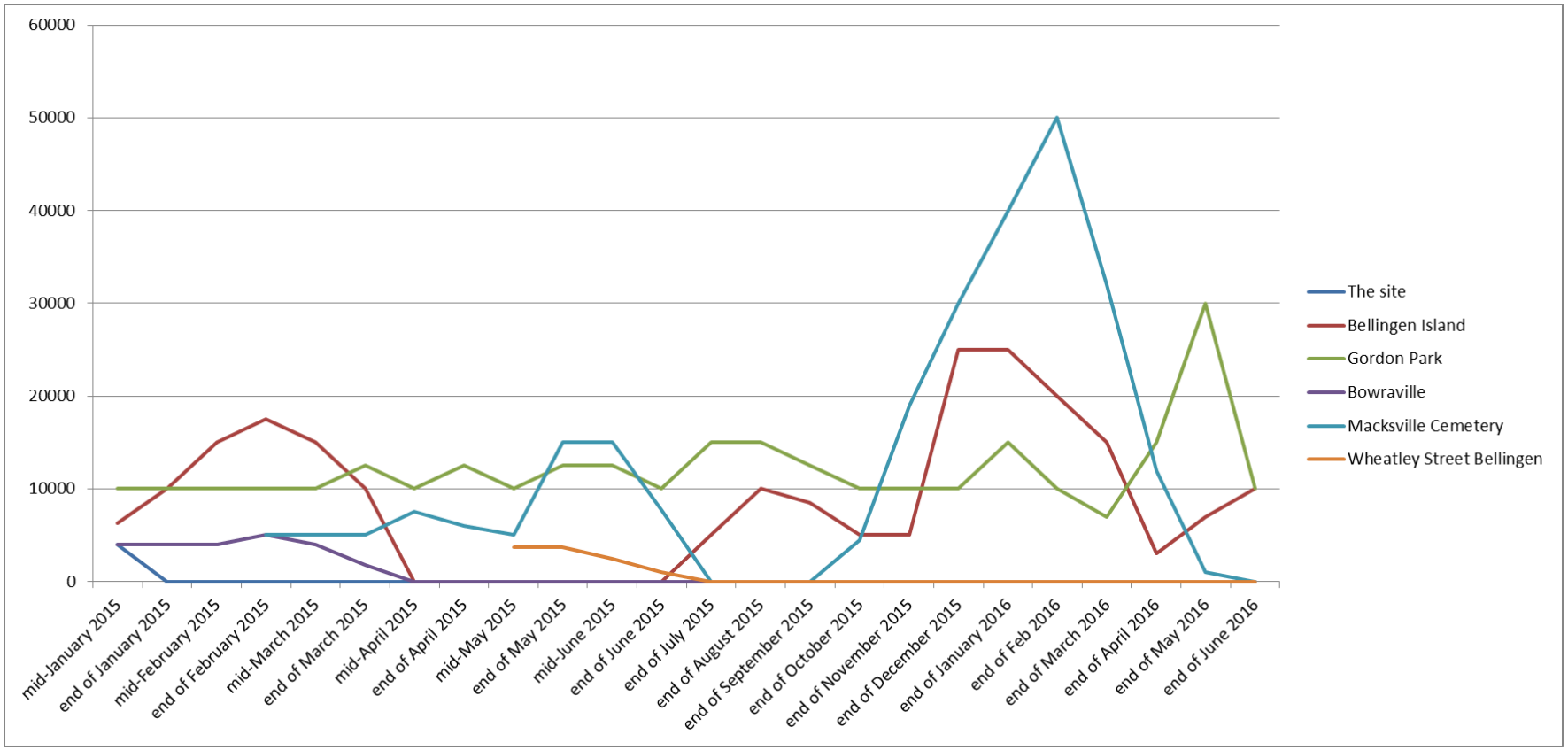


Figure 2.2 Population trends at the site and regional camps between January 2015 and June 2016

2.4 Conclusion

The results of the June 2016 monthly flying-fox monitoring indicate that flying-foxes have largely been absent from the site now since mid-April 2014, excluding a brief stopover in mid-January 2015. The nearby Macksville Cemetery camp (detected in February 2015) which has been the default site for data collection is also absent of flying-fox for the first time since September 2015.

Flying-foxes have remained at the Bellingen Island camp following a brief late autumn-winter 2015 absence, with approximately 10,000 individuals present during the current monitoring event. Since departing Bowraville in late autumn 2015, flying-foxes have not been observed at this site. Gordon Park camp has been the only continuously occupied monitored flying-fox camp over the past 12 months, and has seen fluctuations in flying-fox numbers strongly influenced by the arrival and departure of Little Red Flying-foxes.

No dependent GHFF were observed during this month's monitoring, which is outside the maternity period.

Frank Makin
Ecologist

References

Churchill, S. (2008). *Australian Bats (Second Edition)*. Allen & Unwin, NSW.

Eby, P. and Law, B. (2008). *Ranking the feeding habitat of Grey-headed flying foxes for conservation management*. Department of Environment, Heritage, Water and the Arts, Canberra.

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Flying-fox Monitoring
July 2016

Warrell Creek to Nambucca Heads
Pacific Highway Upgrade

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Prepared for: Roads and Maritime Services

UPR	*Description*	*Date Issued*	*Issued By*
2692-1006	First issue	8 August 2016	Frank Makin

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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 vegetation 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 2016 flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following personnel undertook fieldwork for the July 2016 flying-fox monitoring:

- Frank Makin (GeoLINK ecologist).
- Kale Hardie-Porter (GeoLINK environmental scientist).
- Dylan Hisselli (GeoLINK ecologist).
- Jeremy Clifford (Sub consultant ecologist).

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.

On 28 July 2016 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.

The initial traverse during the July 2016 survey indicated that no flying-foxes were present at the site; therefore this data was not collected.

In light of the continued absence of flying-foxes at the site (since early April 2014) and the seasonal occupation of a flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery (first observed early in the summer of 2015), this data has recently been collected from the Macksville Cemetery camp instead of at the site to provide some information relating to flying-foxes currently camping in the local area. However upon inspection of the Macksville Cemetery site on 28 July 2016, no flying-foxes were present; therefore this data was not collected.

The water level at the site was measured (approximate GPS location 492866, 6600756 [GDA 94, Zone 56]). The water level at this location is representative of the average level at the site and was collected on 28 July 2016.

Following the site traverse, dusk exit count surveys were undertaken at the site and the Macksville Cemetery camp on the evening of 28 July 2016 as an additional measure to confirm the presence/ absence of flying-fox roosting at both locations.

At the site, 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 ridge south of the camp (at 41 Bald Hill Road).

Two observers were strategically located at the Macksville Cemetery camp to observe the northern and southern exit streams utilised by flying-foxes at the Macksville Cemetery camp. Specifically, the two observers were located at the following vantage points for the Macksville Cemetery camp:

- At the Macksville Country Club car park off Wallace Street (south of the camp).
- At the cul-de-sac of Nancy Roberts Lane (north 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 on 28 July 2016 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 observed to be roosting at either the site or at the Macksville Cemetery roost during the camp traverses and exit counts on 28 July 2016. As such no roost footprint data has been recorded as a part of the July 2016 monitoring. Flying-foxes were also absent from the Bowraville camp and Wheatley Street camp in Bellingen. Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads).

2.2.2 Population Estimates

2.2.2.1 Exit Count

No flying-foxes were observed flying from the site during the exit count. The exit count at the Macksville Cemetery camp also recorded an absence of flying-foxes for the second consecutive month.

Information shown is for illustrative purposes only

Drawn by: KHP Checked by: FM Reviewed by: VJS Date: 8/08/2016
Source of base data: Roads and Maritime Services

0 4 km

North

Location of Regional Flying-fox Camps

Flying-fox Monitoring July 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1008

Illustration 2.1

2.2.2.2 Direct Counts

No exit counts were conducted at any of the regional camps (except for the Macksville Cemetery camp). 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 15,000 individuals (increased from 10,000 in the previous monitoring event).
- Bowraville: no individuals recorded (as per the previous monitoring event).
- Bellingen Island: approximately 4,000 individuals (decreased from 10,000 in the previous monitoring event).
- Wheatley Street, Bellingen: no individuals recorded (as per the previous monitoring event).

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: more than 85% GHFF and less than15% Black Flying-fox.
- Gordon Park: more than 95%GHFF and less than 5% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned previously, no flying-foxes were recorded at the site and therefore no detailed demographic composition data was collected. This has been the case since April 2014 (excluding a brief return in January 2015) and Macksville Cemetery camp has been the alternative site for collection of this data. However as no flying-fox were present at the Macksville Cemetery camp (for the second consecutive month) demographic composition data was recorded at Gordon Park for the current monitoring event.

Results of the demographic counts at the Gordon Park camp in June 2016 indicated that females made between 52% and 91% (average 65%) of all individuals present at count locations (refer to **Table 2.1**).

Table 2.1 Demographic Data of GHFF at the Gordon Park Camp

Tree Code	*Tree Species*	*Height (m)*	*DBH (cm)*	*Demographic Ratio (female:male)*	*Presence of Dependant Young (yes/no)*	*% Females with Dependant Young*
GP1	*Stag*	18	25	10:7	no	0
GP2	*Stag*	18	25	10:4	no	0
GP3	*Melaleuca quinquenervia*	12	25	10:5	no	0
GP4	*Ficus* sp	12	30	10:4	no	0

Tree Code	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
GP5	*Stag*	12	28	10:9	no	0
GP6	*Eucalyptus microcorys*	18	40	10:6	no	0
GP7	*Ficus* sp.	25	50	10:9	no	0
GP8	*Ficus* sp.	28	85	10:1	no	0
GP9	*Casuarina glauca*	25	50	10:6	no	0
GP10	*Stag*	25	25	10:3	no	0

Results of the demographic counts at the Bellingen Island camp indicated that females dominated the counts, making up between 55% and 83% (average of 70%) of all individuals present at count locations (which excluded male 'bachelor' trees). No adults with dependant young were present (refer to **Table 2.2**).

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	*Ficus coronata*	10	30	10:5	no	0
BI2	*Ficus coronata*	12	45	10:4	no	0
BI3	Stag	25	45	10:3	no	0
BI4	*Ficus coronata*	12	30	10:4	no	0
BI5	*Ficus* sp	12	50	10:3	no	0
BI6	*Ficus coronata*	15	30	10:4	no	0
BI7	*Ficus coronata*	15	50	10:5	no	0
BI8	*Dendrocnide excelsa*	20	60	10:4	no	0
BI9	*Ficus coronata*	15	30	10:8	no	0
BI10	*Pittosporum undulatum*	15	30	10:2	no	0

General observations of the flying-foxes at Bellingen Island camp indicated that both female and male GHFF were present. No females with dependant young were present.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was 68 centimetres in depth as shown in **Figure 2.1**. This represents a 7.5 centimetre decrease since last month, attributed to relatively dry conditions since the June 2016 monitoring.

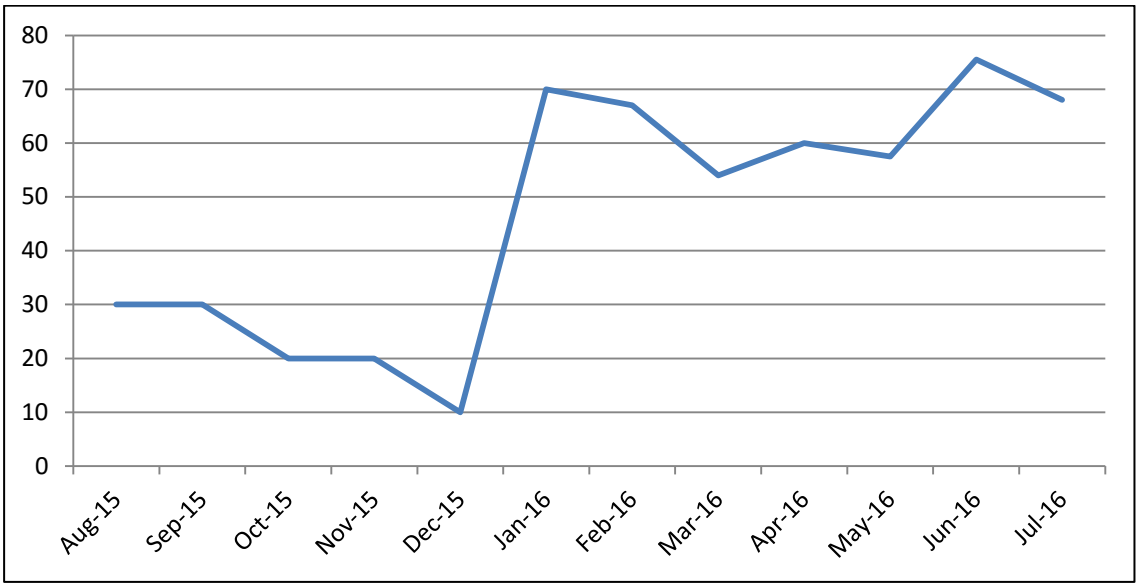

Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse or exit count during the current monitoring event. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

Figure 2.2 shows the trend in flying-fox numbers at the site and other regional sites between January 2015 and July 2016. The number of flying-foxes roosting at the Macksville Cemetery camp peaked in February 2016 at more than 50,000 and has decreased steadily each month since. This month recorded no flying-fox at the Macksville Cemetery for the second consecutive month. At the same time last year, flying-foxes were also absent at the Macksville Cemetery site.

Flying-foxes continue to be absent from the Bowraville camp. No flying-foxes have been recorded roosting at Bowraville since mid-May 2015.

The number of flying-foxes roosting at Bellingen Island has decreased from 10,000 in June 2016 to 4,000 in July 2016. At the same time last year, the camp was estimated to be supporting 5,000 individual GHFF. Bellingen Island has been occupied continuously since a brief absence between April and June 2015.

The Bellingen Wheatley Street camp, which supported small numbers of flying-foxes mainly when Bellingen Island was vacant, has remained vacant since July 2015 (shortly after the flying-foxes returned to Bellingen Island, GeoLINK 2015).

Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to July 2016). Flying-fox numbers have fluctuated between 7,000

and 30,000 individuals. This month saw an increase of individual GHFF to 15,000 from 10,000 in June 2016.

2.3.2 Species Composition and Demographic Data

Both GHFF and Black Flying-foxes were present at the occupied camps (Gordon Park and Bellingen Island). GHFF dominated the species composition again this month however a minor variation from recent surveys was observed at the Bellingen Island with GHFF representing approximately 85% of all individuals (decreased from 95% last month). GHFF represented 95% of all individuals at Gordon Park. Black Flying-foxes accounted for a relatively small proportion of all individuals present less than 5% at Gordon Park and approximately 15% at Bellingen Island. Little Red Flying-fox were absent from both sites, after being recorded at Gordon Park in the May 2016 monitoring. The survey was undertaken outside the maternity period (October to March) for the GHFF and Black Flying-fox (Churchill 2008), as such no young were observed during the July 2016 survey.

2.3.3 Phenology of Trees in the Region

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

GHFF diet tree species observed to be flowering when travelling between regional flying-fox camps include Swamp Mahogany, Broad-leaved Paperbark, Forest Red Gum and Coast Banksia (*Banksia integrifolia*).

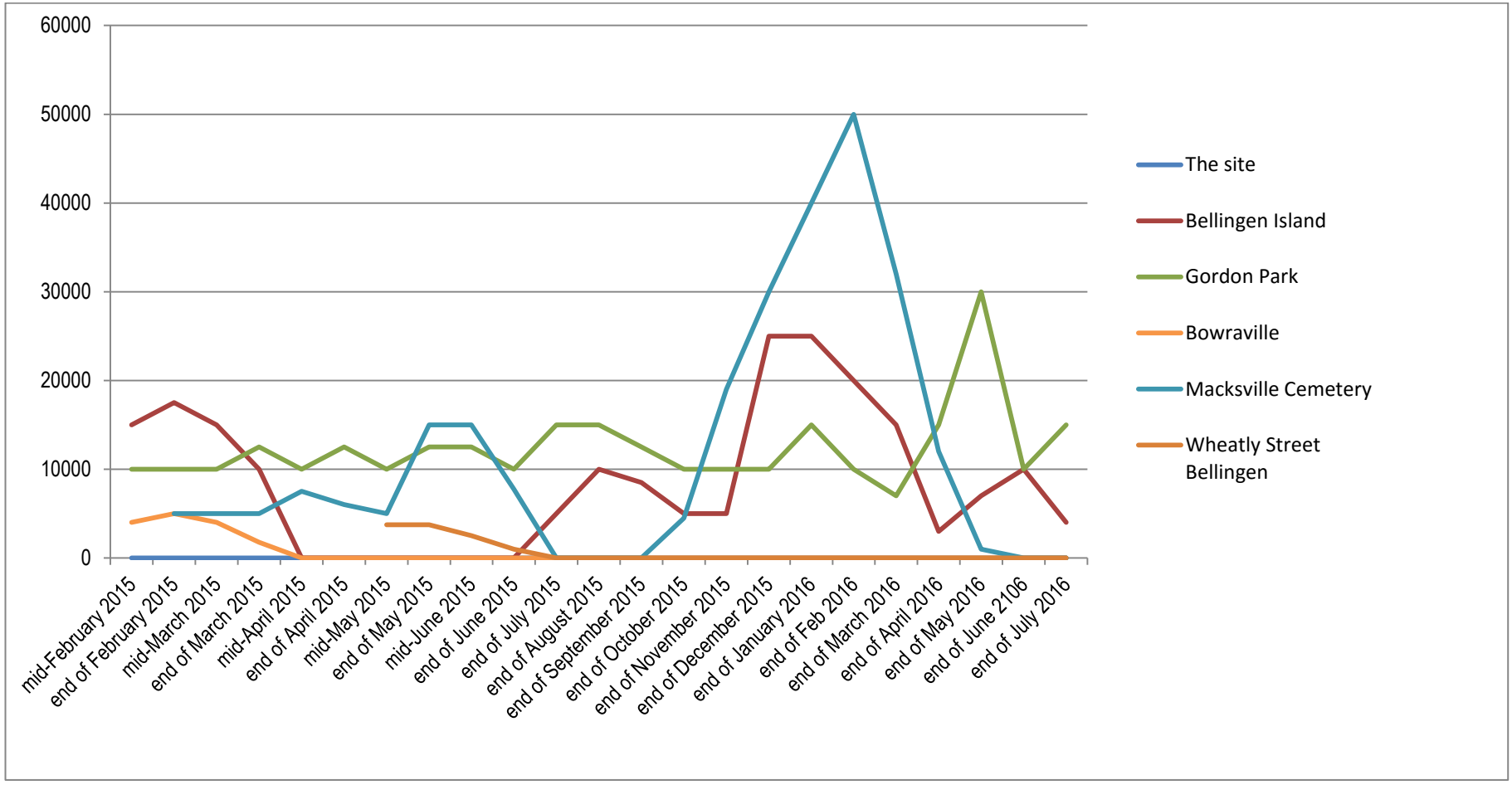

Figure 2.2 Population trends at the site and regional camps between February 2015 and July 2016

2.4 Conclusion

The results of the July 2016 monthly flying-fox monitoring indicate that flying-foxes have largely been absent from the site now since early-mid April 2014, excluding a brief stopover in mid-January 2015. The nearby Macksville Cemetery camp (detected in February 2015) which has been the default site for data collection is also absent of flying-fox for the second consecutive month.

Flying-foxes have remained at the Bellingen Island camp following a brief late autumn-winter 2015 absence, with approximately 4,000 individuals present during the current monitoring event. Since departing Bowraville in late autumn 2015, flying-foxes have not been observed at this site. Gordon Park camp has been the only continuously occupied monitored flying-fox camp over the past 12 months with approximately 15,000 individuals present In July 2016.

No dependent GHFF were observed during this month's monitoring, which is outside the maternity period (including birthing, lactation and weaning).

Frank Makin
Ecologist

References

Churchill, S. (2008). *Australian Bats (Second Edition)*. Allen & Unwin, NSW.

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22 August 2016
Ref No.: 2692-1010

Roads and Maritime Services
101 Miller Street
NORTH SYDNEY NSW 2060

Attention: Mr Andrew Mula

Dear Andrew

Fortnightly Flying-fox Monitoring Report, August 2016 – Warrell Creek to Nambucca Heads Pacific Highway Upgrade

This short report details the findings of the August 2016 fortnightly Grey-headed Flying-fox (GHFF) monitoring at the Macksville camp (the site) undertaken between standard monthly monitoring events. The purpose of collecting additional data more frequently is to form a clearer picture of short-term population fluctuations at the camp. For more detailed information on methodology used for this monitoring, refer to the monthly flying-fox monitoring reports.

1. Observations

1.1 The Site

The site was visually inspected for flying-foxes on 15 August. No flying-foxes were recorded in this inspection. This absence of flying-foxes at the site has now extended from mid-April 2014 until present, with the exception of a temporary occupation by a small number of flying-foxes in mid-January 2015.

An exit count was conducted on the eventing of 15 August from two vantage points to the north and south of the site. No flying-foxes were observed in this exit count.

1.2 Regional Flying-fox Camps

Other regional flying-fox camps were also visited. General observations made at these camps are provided below.

1.2.1 Macksville Cemetery

No flying-foxes were observed at the Macksville cemetery camp in the current monitoring event as has been the case for the past two months.

1.2.2 Bowraville

No flying-foxes were observed at the Bowraville camp in the current monitoring event. No flying-foxes have been recorded roosting at Bowraville since mid-May 2015.

1.2.3 Bellingen Island

It is estimated that approximately 5,000 flying-foxes were camped at Bellingen Island. The species present consisted of approximately 95% GHFF and 5% Black Flying-fox.

No flying-foxes were observed to be camped nearby at Wheatley Street, Bellingen where previously recorded.

1.2.4 Gordon Park (Nambucca Heads)

It is estimated that approximately 10,000 flying-foxes were camped at Gordon Park. A similar population level has been consistently recorded at the Gordon Park site for the past 18 months. The species present consisted of approximately 90% GHFF and 10% Black Flying-fox.

2. Demographic Observations

Both female and male flying-fox were recorded at occupied camps. No dependent young flying-fox were recorded. Both of these observations are typical for this time of year.

3. Flowering of Key Foraging Resources

August flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Coastal Blackbutt (*Eucalyptus pilularis*) (coastal lowlands), Forest Red Gum (*Eucalyptus tereticornis*) (coastal lowlands and inland low altitude) and Grey Ironbark (*Eucalyptus siderophloia*) (coastal lowlands). These highly productive nectar source trees can be considered key diet species for GHFF (Eby 2012; Eby and Law 2008).

Other non-key diet species for GHFF observed to be flowering in the region and supplying a nectar resource for GHFF include Coast Banksia (*Banksia integrifolia*). Observations when travelling between regional flying-fox camps indicated minor flowering of Swamp Mahogany, Broad-leaved Paperbark, Forest Red Gum and Coast Banksia (*Banksia integrifolia*).

If you have any queries regarding this report, please feel free to contact me on 02 6687 7666.

Yours sincerely
GeoLINK

David Andrighetto
Senior Ecologist

References

Eby, P. and Law, B. (2008). *Ranking the feeding habitat of Grey-headed flying foxes for conservation management*. Department of Environment, Heritage, Water and the Arts, Canberra.

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

Issue Log

UPR	*Description*	*Date Issued*	*Issued By*
2692-1010	First issue	22/08/2016	VJS

Flying-fox Monitoring August 2016

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Prepared for: Roads and Maritime Services

UPR	*Description*	*Date Issued*	*Issued By*
2692-1012	First issue	6 September 2016	Veronica Silver

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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 vegetation 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 2016 flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following personnel undertook fieldwork for the August 2016 flying-fox monitoring:

- Frank Makin (GeoLINK ecologist).
- Kale Hardie-Porter (GeoLINK environmental scientist).
- Jessica O'Leary (GeoLINK ecologist).
- Jeremy Clifford (sub-consultant ecologist).

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.

On 30 August 2016 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.

The initial traverse during the August 2016 survey indicated that no flying-foxes were present at the site; therefore this data was not collected.

In light of the continued absence of flying-foxes at the site (since early April 2014) and the seasonal occupation of a flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery (first observed early in the summer of 2015), this data has recently been collected from the Macksville Cemetery camp instead of at the site to provide some information relating to flying-foxes currently camping in the local area. However upon inspection of the Macksville Cemetery site on 30 August 2016, no flying-foxes were present; therefore this data was not collected.

The water level at the site was measured at GPS location E492866, N6600756 (GDA 94, Zone 56). The water level at this location is representative of the average level at the site and was collected on 30 August 2016.

Following the site traverse, dusk exit count surveys were undertaken at the site and the Macksville Cemetery camp on the evening of 30 August 2016 as an additional measure to confirm the presence/ absence of flying-fox roosting at both locations.

At the site, 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 ridge south of the camp (at 41 Bald Hill Road).

Two observers were strategically located at the Macksville Cemetery camp to observe the northern and southern exit streams utilised by flying-foxes at the Macksville Cemetery camp. Specifically, the two observers were located at the following vantage points for the Macksville Cemetery camp:

- At the Macksville Country Club car park off Wallace Street (south of the camp).
- At the cul-de-sac of Nancy Roberts Lane (north of the camp).

The exit counts extended over approximately 45 minutes from sunset until dark (approximately 5:30 pm to 6:15 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 on 30 August 2016 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 observed to be roosting at either the site or at the Macksville Cemetery roost during the camp traverses and exit counts on 30 August 2016. As such no roost footprint data has been recorded as a part of the August 2016 monitoring. Flying-foxes were also absent from the Bowraville camp and Wheatley Street camp in Bellingen. Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads).

2.2.2 Population Estimates

2.2.2.1 Exit Count

No flying-foxes were observed flying from the site during the exit count. The exit count at the Macksville Cemetery camp also recorded an absence of flying-foxes for the third consecutive month.

Information shown is for illustrative purposes only

Drawn by: KHP Checked by: FM Reviewed by: VJS Date: 6/09/2016
Source of base data: Roads and Maritime Services

0 4 km

North

Location of Regional Flying-fox Camps

GeoLINK environmental management and design

Flying-fox Monitoring August 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1008

Illustration 2.1

2.2.2.2 Direct Counts

No exit counts were conducted at any of the regional camps (except for the Macksville Cemetery camp). 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 (decreased from 15,000 in the previous monitoring event).
- Bowraville: no individuals recorded (as per the previous monitoring event).
- Bellingen Island: approximately 1,000 individuals (decreased from 4,000 in the previous monitoring event).
- Wheatley Street, Bellingen: no individuals recorded (as per the previous monitoring event).

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: more than 85% GHFF and less than15% Black Flying-fox.
- Gordon Park: more than 95%GHFF and less than 5% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned previously, no flying-foxes were recorded at the site and therefore no detailed demographic composition data was collected. This has been the case since April 2014 (excluding a brief return in January 2015) and Macksville Cemetery camp has been the alternative site for collection of this data. However as no flying-fox were present at the Macksville Cemetery camp (for the third consecutive month) demographic composition data was recorded at Gordon Park for the current monitoring event. Demographic data that is usually recorded from Bellingen Island for comparative purposes was unable to be collected during August 2016 as they were located within dense canopy foliage and they were more flighty than usual possibly due to the lower numbers (only 1,000).

Results of the demographic counts at the Gordon Park camp in August 2016 indicated that females made between 63% and 83% (average 75%) of all individuals present at count locations (refer to **Table 2.1**).

Table 2.1 Demographic Data of GHFF at the Gordon Park Camp

Tree Code	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
GP1	*Ficus* sp.	12	30	10:5	no	0
GP2	Stag	14	20	10:6	no	0
GP3	Stag	16	40	10:3	no	0
GP4	Stag	16	30	10:2	no	0
GP5	*Ficus* sp.	14	40	10:2	no	0
GP6	Stag	15	30	10:4	no	0
GP7	Stag	12	25	10:4	no	0
GP8	*Ficus* sp.	18	90	10:2	no	0
GP9	Stag	14	30	10:6	no	0
GP10	Stag	16	40	10:4	no	0

General observations of the flying-foxes at Bellingen Island camp indicated that both female and male GHFF were present. No females with dependant young were present. BHFF made up more than 85% of the flying- foxes present at Bellingen Island.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was 74 centimetres in depth as shown in **Figure 2.1**. This represents a six centimetre increase since last month attributable to rain events between 23 and 25 August 2016 (BoM 2016).

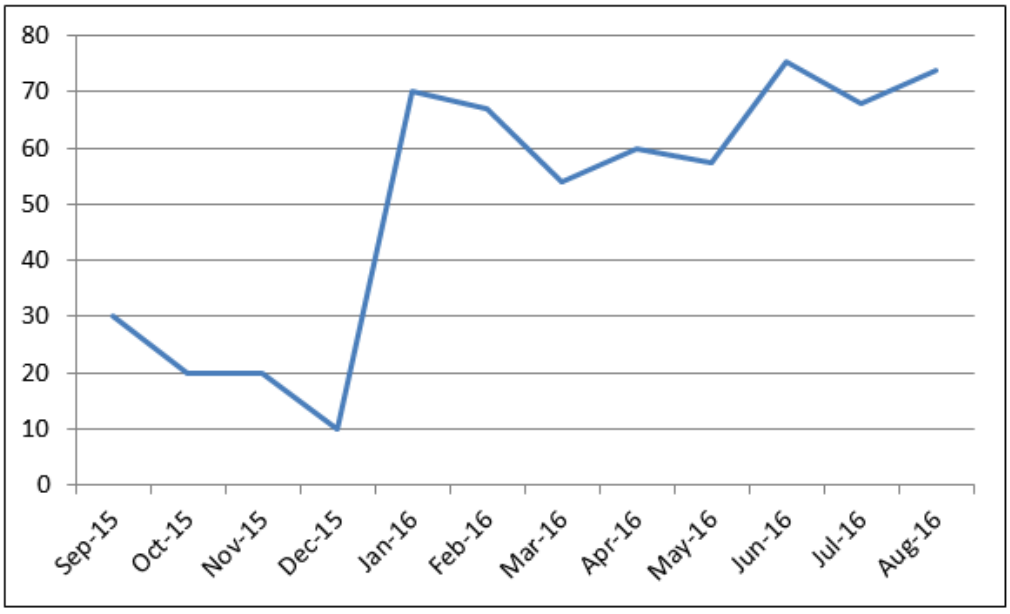

Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse or exit count during the current monitoring event. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

The trend in flying-fox numbers at the site and other regional sites between February 2015 and August 2016 is shown in **Figure 2.2**. The number of flying-foxes roosting at the Macksville Cemetery camp peaked in February 2016 at more than 50,000 and has decreased each month since. This month recorded no flying-fox at the Macksville Cemetery for the third consecutive month. At the same time last year, flying-foxes were also absent at the Macksville Cemetery site.

Flying-foxes continue to be absent from the Bowraville camp. No flying-foxes have been recorded roosting at Bowraville since mid-May 2015.

The number of flying-foxes roosting at Bellingen Island has decreased from 4,000 in July 2016 to 1,000 in August 2016. At the same time last year, the Bellingen Island camp was estimated to be supporting 10,000 individual GHFF. Bellingen Island has been occupied continuously since a brief absence between April and June 2015.

The Bellingen Wheatley Street camp, which supported small numbers of flying-foxes mainly when Bellingen Island was vacant, has remained vacant since July 2015 (shortly after the flying-foxes returned to Bellingen Island, GeoLINK 2015).

Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to August 2016). Flying-fox numbers have fluctuated between 7,000 and 30,000 individuals. This month saw a decrease of individual GHFF to 10,000 from 15,000 in July 2016.

2.3.2 Species Composition and Demographic Data

Both GHFF and Black Flying-foxes were present at the occupied camps (Gordon Park and Bellingen Island). GHFF dominated the species composition again this month with 85% and Black Flying-foxes making up approximately 15% of the flying–foxes present at Bellingen Island (increased from approximately 5%). GHFF represented 95% of all individuals at Gordon Park. Black Flying-foxes accounted for a relatively small proportion of all individuals present less than 5% at Gordon Park and approximately 15% at Bellingen Island. Little Red Flying-fox were absent from both sites, after being recorded at Gordon Park in the May 2016 monitoring. The survey was undertaken outside the maternity period (October to March) for the GHFF and Black Flying-fox (Churchill 2008), as such no young were observed during the August 2016 survey.

2.3.3 Phenology of Trees in the Region

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

GHFF diet tree species observed to be flowering when travelling between regional flying-fox camps include Swamp Mahogany (*Eucalyptus robusta)* and Coast Banksia (*Banksia integrifolia*).

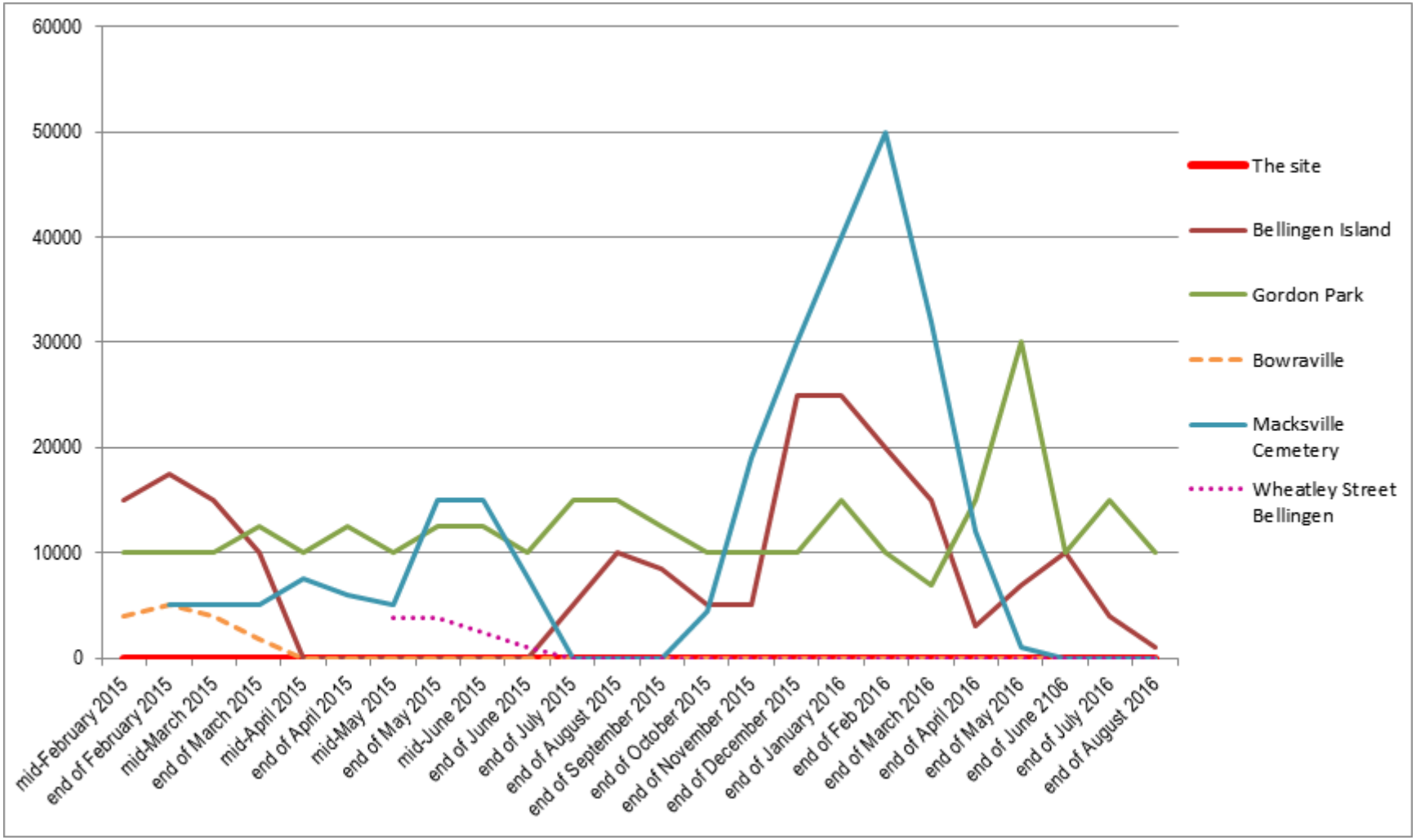

Figure 2.2 Population trends at the site and regional camps between February 2015 and August 2016

2.4 Conclusion

The results of the August 2016 monthly flying-fox monitoring indicate that flying-foxes have largely been absent from the site now since early-mid April 2014, excluding a brief stopover in mid-January 2015. The nearby Macksville Cemetery camp (detected in February 2015) which has been the default site for data collection is also absent of flying-fox for the third consecutive month.

Flying-foxes have remained at the Bellingen Island camp following a brief late autumn-winter 2015 absence, with approximately 1,000 individuals present during the current monitoring event. Since departing Bowraville in late autumn 2015, flying-foxes have not been observed at this site. Gordon Park camp has been the only continuously occupied monitored flying-fox camp over the past 12 months with approximately 10,000 individuals present in August 2016.

No dependent GHFF were observed during this month's monitoring, which is outside the maternity period (including birthing, lactation and weaning).

Frank Makin
Ecologist

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21 September 2016
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Roads and Maritime Services
101 Miller Street
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Attention: Mr Andrew Mula

Dear Andrew

Fortnightly Flying-fox Monitoring Report, September 2016 – Warrell Creek to Nambucca Heads Pacific Highway Upgrade

This short report details the findings of the September 2016 fortnightly Grey-headed Flying-fox (GHFF) monitoring at the Macksville camp (the site) undertaken between standard monthly monitoring events. The purpose of collecting additional data more frequently is to form a clearer picture of short-term population fluctuations at the camp. For more detailed information on methodology used for this monitoring, refer to the monthly flying-fox monitoring reports.

1. Observations

1.1 The Site

The site was visually inspected for flying-foxes on 14 September. No flying-foxes were recorded in this inspection. This absence of flying-foxes at the site has now extended from mid-April 2014 until present, with the exception of a temporary occupation by a small number of flying-foxes in mid-January 2015.

An exit count was conducted on the evening of 14 September from two vantage points to the north and south of the site. No flying-foxes were observed in this exit count.

1.2 Regional Flying-fox Camps

Other regional flying-fox camps were also visited. General observations made at these camps are provided below.

1.2.1 Macksville Cemetery

No flying-foxes were observed at the Macksville cemetery camp in the current monitoring event. The last time that flying-foxes were observed roosting at the Macksville cemetery was at the end of April 2016, over four months ago.

1.2.2 Bowraville

No flying-foxes were observed at the Bowraville camp in the current monitoring event. No flying-foxes have been recorded roosting at Bowraville since mid-May 2015.

1.2.3 Bellingen Island

It is estimated that approximately 5,000 flying-foxes were camped at Bellingen Island. A similarly low population level of less than 10,000 individuals has been recorded consistently since April 2016. The species present consisted of approximately 95% GHFF and 5% Black Flying-fox.

No flying-foxes were observed to be camped nearby at Wheatley Street, Bellingen where previously recorded.

1.2.4 Gordon Park (Nambucca Heads)

It is estimated that approximately 10,000 flying-foxes were camped at Gordon Park. A similar population level has been consistently recorded at the Gordon Park site for the past 18 months. The species present consisted of approximately 80% GHFF and 20% Black Flying-fox. This may indicate that a minor increase in the number of Black Flying-foxes roosting at this camp has occurred recently.

2. Demographic Observations

Both female and male flying-fox were recorded at occupied camps. As would be expected for this time of year no dependent young flying-fox were recorded. Females are now conspicuously pregnant, and births of new young can be expected around October.

3. Flowering of Key Foraging Resources

September flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Coastal Blackbutt (*Eucalyptus pilularis*) (coastal lowlands), Forest Red Gum (*Eucalyptus tereticornis*) (coastal lowlands and inland low altitude), Narrow-leaved Red Gum (*Eucalyptus seeana*), Grey Ironbark (*Eucalyptus siderophloia*) (coastal lowlands) and Coast Banksia (*Banksia integrifolia*). These species are among 17 highly productive nectar source trees that are considered key diet species for GHFF (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps indicated minor flowering of Grey Ironbark, Forest Red Gum, and Coast Banksia (*Banksia integrifolia*) is currently occurring.

If you have any queries regarding this report, please feel free to contact me on 02 6687 7666.

Yours sincerely
GeoLINK

David Andrighetto
Senior Ecologist

References

Eby, P. and Law, B. (2008). *Ranking the feeding habitat of Grey-headed flying foxes for conservation management*. Department of Environment, Heritage, Water and the Arts, Canberra.

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2692-1015	First issue	21/09/2016	DSA

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21 September 2016
Ref No.: 2692-1015

Roads and Maritime Services
101 Miller Street
NORTH SYDNEY NSW 2060

Attention: Mr Andrew Mula

Dear Andrew

Fortnightly Flying-fox Monitoring Report, September 2016 – Warrell Creek to Nambucca Heads Pacific Highway Upgrade

This short report details the findings of the September 2016 fortnightly Grey-headed Flying-fox (GHFF) monitoring at the Macksville camp (the site) undertaken between standard monthly monitoring events. The purpose of collecting additional data more frequently is to form a clearer picture of short-term population fluctuations at the camp. For more detailed information on methodology used for this monitoring, refer to the monthly flying-fox monitoring reports.

1. Observations

1.1 The Site

The site was visually inspected for flying-foxes on 14 September. No flying-foxes were recorded in this inspection. This absence of flying-foxes at the site has now extended from mid-April 2014 until present, with the exception of a temporary occupation by a small number of flying-foxes in mid-January 2015.

An exit count was conducted on the evening of 14 September from two vantage points to the north and south of the site. No flying-foxes were observed in this exit count.

1.2 Regional Flying-fox Camps

Other regional flying-fox camps were also visited. General observations made at these camps are provided below.

1.2.1 Macksville Cemetery

No flying-foxes were observed at the Macksville cemetery camp in the current monitoring event. The last time that flying-foxes were observed roosting at the Macksville cemetery was at the end of April 2016, over four months ago.

1.2.2 Bowraville

No flying-foxes were observed at the Bowraville camp in the current monitoring event. No flying-foxes have been recorded roosting at Bowraville since mid-May 2015.

1.2.3 Bellingen Island

It is estimated that approximately 5,000 flying-foxes were camped at Bellingen Island. A similarly low population level of less than 10,000 individuals has been recorded consistently since April 2016. The species present consisted of approximately 95% GHFF and 5% Black Flying-fox.

No flying-foxes were observed to be camped nearby at Wheatley Street, Bellingen where previously recorded.

1.2.4 Gordon Park (Nambucca Heads)

It is estimated that approximately 10,000 flying-foxes were camped at Gordon Park. A similar population level has been consistently recorded at the Gordon Park site for the past 18 months. The species present consisted of approximately 80% GHFF and 20% Black Flying-fox. This may indicate that a minor increase in the number of Black Flying-foxes roosting at this camp has occurred recently.

2. Demographic Observations

Both female and male flying-fox were recorded at occupied camps. As would be expected for this time of year no dependent young flying-fox were recorded. Females are now conspicuously pregnant, and births of new young can be expected around October.

3. Flowering of Key Foraging Resources

September flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Coastal Blackbutt (*Eucalyptus pilularis*) (coastal lowlands), Forest Red Gum (*Eucalyptus tereticornis*) (coastal lowlands and inland low altitude), Narrow-leaved Red Gum (*Eucalyptus seeana*), Grey Ironbark (*Eucalyptus siderophloia*) (coastal lowlands) and Coast Banksia (*Banksia integrifolia*). These species are among 17 highly productive nectar source trees that are considered key diet species for GHFF (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps indicated minor flowering of Grey Ironbark, Forest Red Gum, and Coast Banksia (*Banksia integrifolia*) is currently occurring.

If you have any queries regarding this report, please feel free to contact me on 02 6687 7666.

Yours sincerely
GeoLINK

David Andrighetto
Senior Ecologist

References

Eby, P. and Law, B. (2008). *Ranking the feeding habitat of Grey-headed flying foxes for conservation management*. Department of Environment, Heritage, Water and the Arts, Canberra.

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Issue Log

UPR	*Description*	*Date Issued*	*Issued By*
2692-1015	First issue	21/09/2016	DSA

Flying-fox Monitoring September 2016

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UPR	Description	Date Issued	Issued By
2692-1016	First issue	11/10/2016	David Andrighetto

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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 vegetation 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 2016 flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following personnel undertook fieldwork for the September 2016 flying-fox monitoring:

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

On 27 September 2016 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.

The initial traverse during the September 2016 survey indicated that no flying-foxes were present at the site; therefore this data was not collected.

In light of the continued absence of flying-foxes at the site (since early April 2014) and the seasonal occupation of a flying-fox camp within two kilometres of the site adjacent to Macksville Cemetery (first observed early in the summer of 2015), this data has recently been collected from the Macksville Cemetery camp instead of at the site to provide some information relating to flying-foxes currently camping in the local area. However upon inspection of the Macksville Cemetery site on 27 September 2016, no flying-foxes were present; therefore this data was not collected.

The water level at the site was measured at GPS location E492866, N6600756 (GDA 94, Zone 56). The water level at this location is representative of the average level at the site and was collected on 28 September 2016.

Following the site traverse, dusk exit count surveys were undertaken at the site and the Macksville Cemetery camp on the evening of 27 September 2016 as an additional measure to confirm the presence/ absence of flying-fox roosting at both locations.

At the site, 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 ridge south of the camp (at 41 Bald Hill Road).

Two observers were strategically located at the Macksville Cemetery camp to observe the northern and southern exit streams utilised by flying-foxes at the Macksville Cemetery camp. Specifically, the two observers were located at the following vantage points:

- At the Macksville Country Club car park off Wallace Street (south of the camp).
- At the cul-de-sac of Nancy Roberts Lane (north of the camp).

The exit counts extended over approximately 45 minutes from sunset until dark (approximately 5:45 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 on 28 September 2016 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 observed to be roosting at either the site or at the Macksville Cemetery roost during the camp traverses and exit counts on 27 September. As such no roost footprint data has been recorded as a part of the September 2016 monitoring event. Flying-foxes were also absent from the Bowraville camp and Wheatley Street camp in Bellingen. Regionally, flying-foxes were observed to be roosting at Bellingen Island and Gordon Park (Nambucca Heads).

2.2.2 Population Estimates

2.2.2.1 Exit Count

No flying-foxes were observed flying from the site during the exit count. The exit count at the Macksville Cemetery camp also recorded an absence of flying-foxes for the fourth consecutive month.

Information shown is for illustrative purposes only

Drawn by: KHP Checked by: JOL Reviewed by: DSA Date: 10/10/2016
Source of base data: Roads and Maritime Services

0 4 km

North

Location of Regional Flying-fox Camps

GeoLINK environmental management and design

Flying-fox Monitoring September 2016 - Warrell Creek to Nambucca Heads Pacific Highway Upgrade
2692-1017

Illustration 2.1

2.2.2.2 Direct Counts

No exit counts were conducted at any of the regional camps (except for the Macksville Cemetery camp). 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 25,000 individuals (increased from 10,000 in the previous monitoring event).
- Bowraville: no individuals recorded (as per the previous monitoring event).
- Bellingen Island: approximately 15,000 individuals (increased from 5,000 in the previous monitoring event).
- Wheatley Street, Bellingen: no individuals recorded (as per the previous monitoring event).

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: more than 90% GHFF and less than10% Black Flying-fox.
- Gordon Park: more than 95%GHFF and less than 5% Black Flying-fox.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned previously, no flying-foxes were recorded at the site and therefore no detailed demographic composition data was collected. This has been the case since April 2014 (excluding a brief return in January 2015) and Macksville Cemetery camp has been the alternative site for collection of this data. However as no flying-fox were present at the Macksville Cemetery camp (for the fourth consecutive month) demographic composition data was recorded at Gordon Park for the current monitoring event.

Results of the demographic counts at the Gordon Park camp in September 2016 indicated that females made between 55% and 83% (average of 67%) of all individuals present at count locations (refer to **Table 2.1**).

Table 2.1 Demographic Data of GHFF at the Gordon Park Camp

Tree Code	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
GP1	Giant Stinging Tree	18	40	10:4	No	0
GP2	Stag	20	35	10:5	No	0
GP3	Stag	22	45	10:6	No	0
GP4	Stag	22	50	10:3	No	0
GP5	Giant Stinging Tree	20	45	10:6	No	0
GP6	Ficus sp.	16	25	10:2	No	0
GP7	Ficus sp.	18	30	10:7	No	0
GP8	Giant Stinging Tree	19	40	10:5	No	0
GP9	Stag	18	30	10:2	No	0
GP10	Stag	20	40	10:8	No	0

Results of the demographic counts at the Bellingen Island camp indicated that females dominated the counts, making up between 52% and 76% (average of 63%) of all individuals present at count locations (which excluded male 'bachelor' trees). No adults with dependant young were present (refer to **Table 2.2**).

Table 2.2 Demographic Data of GHFF at the Bellingen Island Camp

Tree Code	Tree Species	Height (m)	DBH (cm)	Demographic Ratio (female:male)	Presence of Dependant Young (yes/no)	% Females with Dependant Young
BI1	*Ficus coronata*	12	25	10:3	No	0
BI2	*Ficus coronata*	13	30	10:8	No	0
BI3	*Ficus coronata*	21	30	10:9	No	0
BI4	*Ficus coronata*	15	30	10:4	No	0
BI5	*Dendrocnide excelsa*	15	35	10:5	No	0
BI6	*Dendrocnide excelsa*	16	40	10:6	No	0
BI7	*Ficus coronata*	15	35	10:3	No	0
BI8	*Ficus obliqua*	18	40	10:4	No	0
BI9	*Dendrocnide excelsa*	18	50	10:7	No	0
BI10	*Dendrocnide excelsa*	18	60	10:9	No	0

General observations of the flying-foxes at Bellingen Island camp indicated that both female and male GHFF were present. No females with dependant young were present.

General observations of the flying-foxes at Bellingen Island camp indicated that both female and male GHFF were present. No females with dependant young were present. GHFF made up more than 90% of the flying- foxes present at Bellingen Island.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was 59 centimetres in depth as shown in **Figure 2.1**. This represents a 15 centimetre decrease since last month.

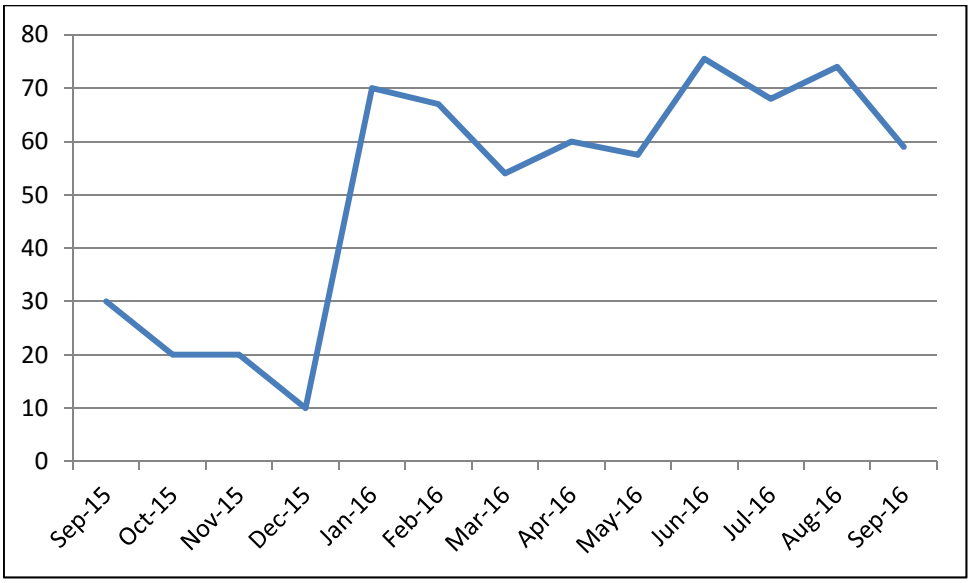

Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse or exit count during the current monitoring event. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

The trend in flying-fox numbers at the site and other regional sites between February 2015 and September 2016 is shown in **Figure 2.2**. The number of flying-foxes roosting at the Macksville Cemetery camp peaked in February 2016 at more than 50,000 and has decreased each month since. This month recorded no flying-fox at the Macksville Cemetery for the fourth consecutive month. At the same time last year, flying-foxes were also absent at the Macksville Cemetery site.

Flying-foxes continue to be absent from the Bowraville camp. No flying-foxes have been recorded roosting at Bowraville since mid-May 2015.

The number of flying-foxes roosting at Bellingen Island has increased from 1,000 in August 2016 to 15,000 in September 2016. At the same time last year, the Bellingen Island camp was estimated to be supporting 8,500 individual GHFF. Bellingen Island has been occupied continuously since a brief absence between April and June 2015.

The Bellingen Wheatley Street camp, which supported small numbers of flying-foxes mainly when Bellingen Island was vacant, has remained vacant since July 2015 (shortly after the flying-foxes returned to Bellingen Island, GeoLINK 2015).

Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to September 2016). Flying-fox numbers have fluctuated between 7,000 and 30,000 individuals. This month saw an increase of individual GHFF to 25,000 from 10,000 in August 2016.

2.3.2 Species Composition and Demographic Data

Both GHFF and Black Flying-foxes were present at the occupied camps (Gordon Park and Bellingen Island). GHFF dominated the species composition again this month with 90% and Black Flying-foxes making up approximately 10% of the flying–foxes present at Bellingen Island (decreased by approximately 5%). GHFF represented 95% of all individuals at Gordon Park. Black Flying-foxes accounted for a relatively small proportion of all individuals present less than 5% at Gordon Park and approximately 10% at Bellingen Island. Little Red Flying-fox were absent from both sites, after being recorded at Gordon Park in the May 2016 monitoring. The survey was undertaken outside the maternity period (October to March) for the GHFF and Black Flying-fox (Churchill 2008), as such no young were observed during the September 2016 survey.

2.3.3 Phenology of Trees in the Region

September 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*) (coastal lowlands), Narrow-Leaved Red Gum (*Eucalyptus seeana*), Grey Ironbark (*Eucalyptus siderophloia*) (coastal lowlands) and Forest Red Gum (*Eucalyptus tereticornis*) (coastal lowlands). These highly productive nectar source trees can be considered key diet species for GHFF in the region (Eby 2012; Eby and Law 2008).

GHFF key diet tree species observed to be flowering when travelling between regional flying-fox camps include Forest Red Gum (*Eucalyptus tereticornis*) and Coast Banksia (*Banksia integrifolia*).

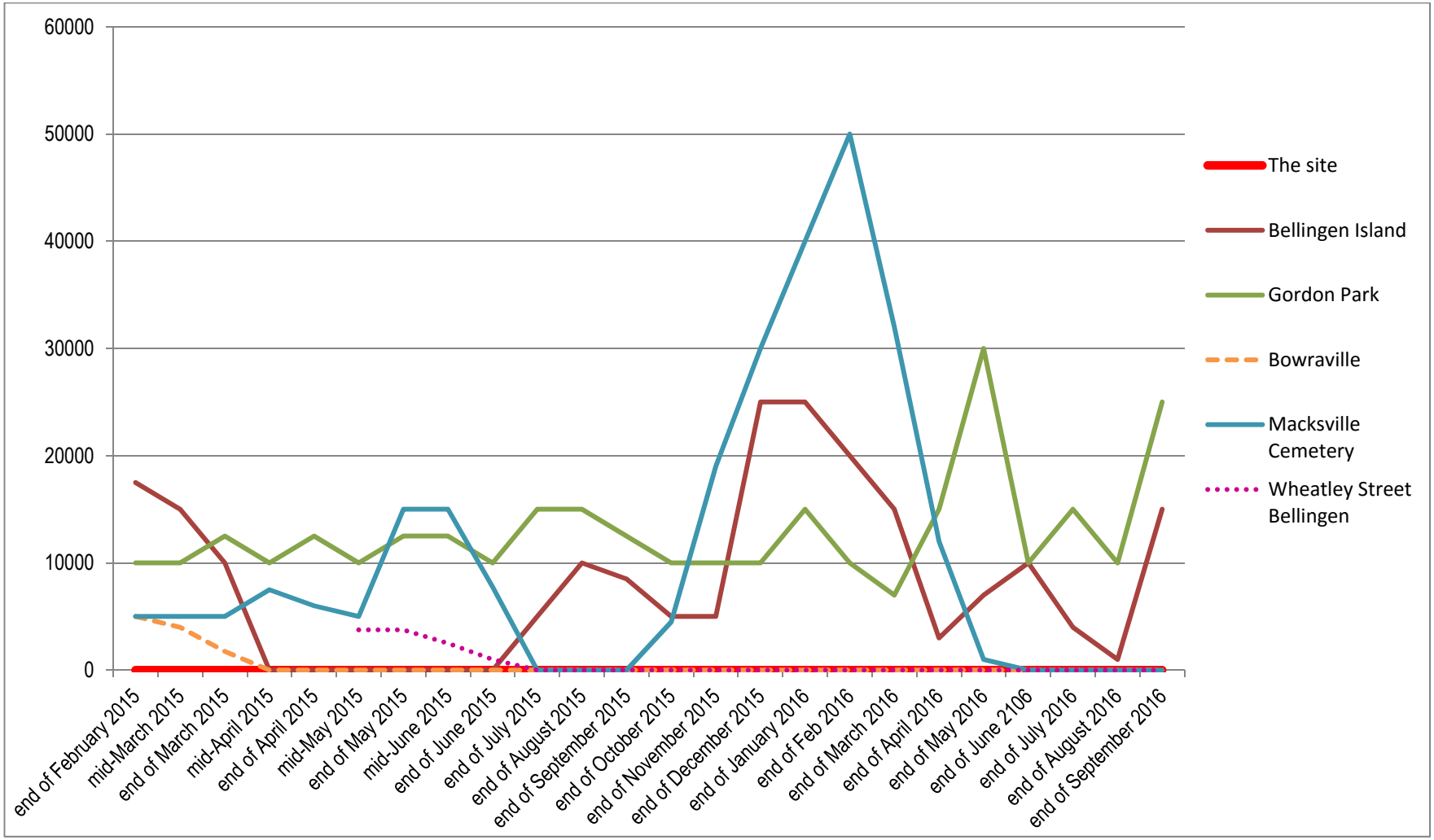

Figure 2.2 Population trends at the site and regional camps between February 2015 and August 2016

2.4 Conclusion

The results of the September 2016 monthly flying-fox monitoring indicate that flying-foxes have largely been absent from the site now since early-mid April 2014, excluding a brief stopover in mid-January 2015. The nearby Macksville Cemetery camp (detected in February 2015) which has been the default site for data collection was also absent of flying-fox for the fourth consecutive month.

Flying-foxes have remained at the Bellingen Island camp following a brief late autumn-winter 2015 absence, with approximately 15,000 individuals present during the current monitoring event. Since departing Bowraville in late autumn 2015, flying-foxes have not been observed at this site. Gordon Park camp has been the only continuously occupied monitored flying-fox camp over the past 12 months with approximately 25,000 individuals present in September 2016.

No dependent GHFF were observed during this month's monitoring, which is outside the maternity period (including birthing, lactation and weaning).

Jessica O'Leary
Ecologist

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21 October 2016
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Attention: Mr Andrew Mula

Dear Andrew

Fortnightly Flying-fox Monitoring Report, October 2016 – Warrell Creek to Nambucca Heads Pacific Highway Upgrade

This short report details the findings of the October 2016 fortnightly Grey-headed Flying-fox (GHFF) monitoring at the Macksville camp (the site) undertaken between standard monthly monitoring events. The purpose of collecting additional data more frequently is to form a clearer picture of short-term population fluctuations at the camp. For more detailed information on methodology used for this monitoring, refer to the monthly flying-fox monitoring reports.

1. Observations

1.1 The Site

The site was visually inspected for flying-foxes on 13 October. No flying-foxes were recorded in this inspection. This absence of flying-foxes at the site has now extended from mid-April 2014 until present, with the exception of a temporary occupation by a small number of flying-foxes in mid-January 2015.

An exit count was conducted on the eventing of 13 October from two vantage points to the north and south of the site. The vantage point to the north of the site was located to facilitate a count of any flying foxes exiting the nearby Macksville cemetery camp.

No flying-foxes were observed flying from the site in the exit count. However, a small number of less than 250 individuals were observed to be traversing over the site from the north, originating from the nearby Macksville cemetery camp which is currently occupied.

1.2 Regional Flying-fox Camps

Other regional flying-fox camps were also visited. General observations made at these camps are provided below.

1.2.1 Macksville Cemetery

Large numbers of GHFF were recorded roosting in an area covering approximately 2.84 ha at Macksville cemetery in the current monitoring event.

This represents a return of flying-foxes to this camp following a break of approximately 4 months over the winter/ early spring period. Only a minor proportion (<10%) of the flying-foxes present were Black Flying-foxes.

It is estimated that more than 30,000 flying-foxes were roosting at this camp, as recorded in the exit count.

1.2.2 Bowraville

No flying-foxes were observed at the Bowraville camp in the current monitoring event. No flying-foxes have been recorded roosting at Bowraville since mid-May 2015.

1.2.3 Bellingen Island

It is estimated that approximately 15,000 flying-foxes were camped at Bellingen Island, consistent with the numbers recorded in the previous (September) monthly monitoring event.

The species present consisted of approximately 95% GHFF and 5% Black Flying-fox.

No flying-foxes were observed to be camped at Wheatley Street, Bellingen where previously recorded.

1.2.4 Gordon Park (Nambucca Heads)

It is estimated that approximately 7,000 flying-foxes were camped at Gordon Park. This is a substantial reduction in the number recorded in the previous monthly monitoring event of approximately 25,000 individuals. It was noted that the canopy of the rainforest at Gordon Park is currently in very poor condition relating to the roosting flying-foxes with little foliage cover remaining.

The species present consisted of approximately 80% GHFF and 20% Black Flying-fox.

2. Demographic Observations

Both female and male flying-fox were recorded at occupied camps. Dependent young flying-fox were also recorded with their mothers for the first time this breeding season.

3. Flowering of Key Foraging Resources

October flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Large-leaved Spotted Gum (*Corymbia henryi*), Narrow-leaved Red Gum (*Eucalyptus seeana*), Grey Ironbark (*Eucalyptus siderophloia*) (coastal lowlands, foothills and ranges), Forest Red Gum (*Eucalyptus tereticornis*) (inland low altitude and high altitude) and Silky Oak (*Grevillea robusta*). These highly productive nectar source trees can be considered key diet species for GHFF (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps indicated that minor to moderate flowering of Forest Red Gum, Grey Ironbark, and Silky Oak (cultivated) is currently occurring.

If you have any queries regarding this report, please feel free to contact me on 02 6687 7666.

Yours sincerely
GeoLINK

David Andrighetto
Senior Ecologist

References

Eby, P. and Law, B. (2008). *Ranking the feeding habitat of Grey-headed flying foxes for conservation management*. Department of Environment, Heritage, Water and the Arts, Canberra.

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2692-1019	First issue	21/10/2016	DSA

Flying-fox Monitoring
October 2016

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Pacific Highway Upgrade

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Prepared for: Roads and Maritime Services

UPR	Description	Date Issued	Issued By
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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 vegetation 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 2016 flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the October 2016 flying-fox monitoring:

- Tom Pollard (ecologist).
- Frank Makin (ecologist).
- Dylan Hisselli (environmental scientist/ ecologist).
- 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.

On 27 October 2016 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) on 27 October 2016. 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 on the evening of 27 October 2016 to confirm the presence/ absence of flying-fox 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 strategically located adjacent to the Macksville Cemetery camp. Specifically, the two observers were located 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 7:15 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 on 27 October 2016 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 also absent from both the Bowraville camp and Wheatley Street camp in Bellingen.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp in the northern section of the paperbark swamp forest. The extent of the roost covered 0.57 hectares and is shown in **Illustration 2.2**.

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 generally equivalent to that recorded in the previous monthly monitoring event, and occupied most of the northern half of the rainforest area of the 'island'. The Gordon Park camp also occupied a generally similar area to that recorded in the previous monitoring event, but the density of occupation within this area is substantially less, reflecting a substantial reduction in the population at this camp (from over 25,000 flying-foxes to less than 10,000 within a single month).

2.2.2 Population Estimates

2.2.2.1 Exit Count

No flying-foxes were observed flying from the site during the exit count. However, a small number of <100 individuals were observed to be flying over the site in a north-south direction. These flying-foxes presumably originated from one of the other nearby regional flying-fox camps and were passing over the site on the way to nightly foraging areas.

The exit count conducted for the Macksville Cemetery camp indicated that an estimated 4,000 flying-foxes were roosting at the site. Nearly all of these individuals exited the camp in a westerly stream.

Drawn by: AB Checked by: RE Reviewed by: DSA Date: 3/11/2016

Information shown is for illustrative purposes only

Source of base data: Roads and Maritime Services

North

0 4 km

Location of Regional Flying-fox Camps

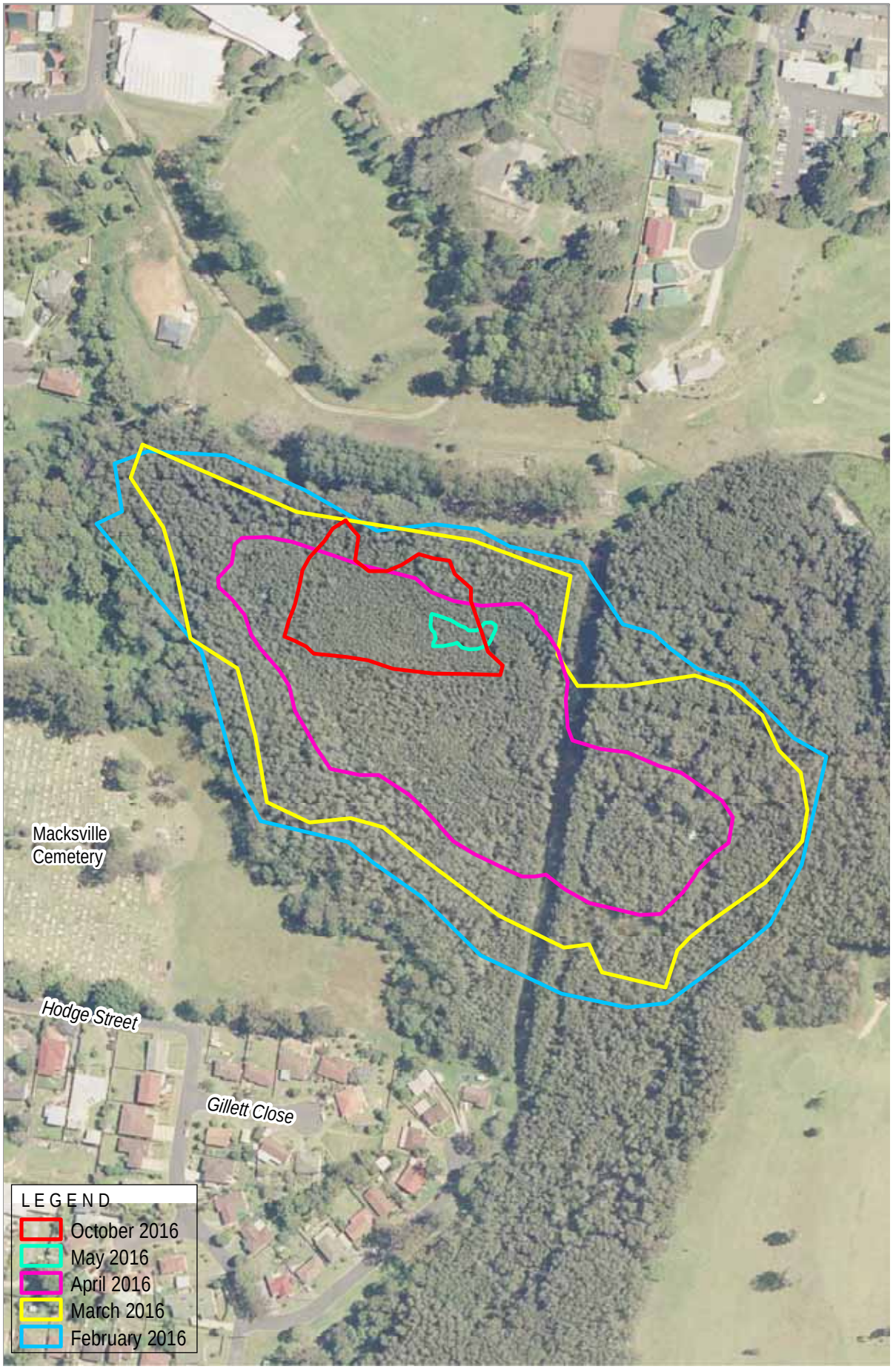
GeoLINK environmental management and design

Flying-fox Monitoring October 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1022

Illustration 2.1

Drawn by: AB Checked by: RE Reviewed by: DSA Date: 3/11/2016
Source of base data: Roads and Maritime Services

Information shown is for illustrative purposes only



North

0 60

Macksville Cemetery Flying-fox Roost Footprint

GeoLINK environmental management and design

Flying-fox Monitoring October 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1026

Illustration 2.2

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 7,500 individuals.
- Bowraville: no individuals recorded.
- Bellingen Island: approximately 15,000 individuals.
- Wheatley Street, Bellingen: 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: 80-90% GHFF and 10-20% Black Flying-fox.
- Bellingen Island: 90-95% GHFF and 5-10% Black Flying-fox.
- Gordon Park: 70-80% GHFF and 20-30% Black Flying-fox.

It is worth noting that since the previous monitoring event in mid-October, the proportion of Black Flying-fox roosting at Gordon Park camp has increased, with these individuals mainly occupying the higher parts of the rainforest canopy.

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) and during this period of absence Macksville Cemetery camp has been the alternative site for collection of this data.

The roost area was small at the Macksville Cemetery camp and the flying-fox were easily spooked and constantly shifting their location within the camp in response to the slightest noise or movement. Consequently, collection of the demographic data was difficult and only successfully collected at four out of ten trees that were observed.

Data collected in demographic point counts at the Macksville Cemetery camp indicated that the proportion of female GHFF present was variable making up between 38% and 63% of all individuals (excluding one count of a 'bachelor tree' supporting only male GHFF). The proportion of female GHFF with dependant young was at a low to moderate level and ranged between 20% and 60% (average 40%) (refer to **Table 2.1**).

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	492133, 6601805	Broad-leaved Paperbark	10	20	10:6	Yes	20
MC2	492116, 6601842	Broad-leaved Paperbark	12	20	0:10 (bachelor tree – males only)	No	n/a
MC3	492082, 6601836	Broad-leaved Paperbark	12	20	10:6	Yes	40
MC4	492042, 6601822	Broad-leaved Paperbark	12	20	10:4	Yes	60
MC5	*Data collection not completed*	*Data collection not completed*	*Data collection not completed*	*Data collection not completed*	*Data collection not completed*	*Data collection not completed*	*Data collection not completed*
MC6	"	"	"	"	"	"	"
MC7	"	"	"	"	"	"	"
MC8	"	"	"	"	"	"	"
MC9	"	"	"	"	"	"	"
MC10	"	"	"	"	"	"	"

Data collected in demographic point counts at the Bellingen Island camp indicated that the proportion of female GHFF present was between 53% and 77% of all individuals (excluding one count of a 'bachelor tree' supporting only male GHFF). The proportion of female GHFF with dependant young was variable and ranged between 20% and 100% (average 64%) (refer to **Table** 2.2).

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	489939, 6631612	Creek Sandpaper Fig	12	25	10:6	Yes	70

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
BI2	489973, 6631692	Creek Sandpaper Fig	12	30	10:8	Yes	40
BI3	489989, 6631610	Creek Sandpaper Fig	15	25	10:4	Yes	80
BI4	490001, 6631592	Creek Sandpaper Fig	15	30	10:6	Yes	60
BI5	489939, 6631574	Creek Sandpaper Fig	15	40	10:9	Yes	50
BI6	489995, 6631570	Giant Stinging Tree	12	30	0:10 (bachelor tree – males only)	No	n/a
BI7	490021, 6631558	Giant Stinging Tree	12	25	10:7	Yes	20
BI8	490033, 6631594	Creek Sandpaper Fig	8	25	10:3	Yes	70
BI9	490039, 6631624	Creek Sandpaper Fig	12	25	10:3	Yes	100
BI10	490031, 6631640	Small-leaved Fig	12	50	10:7	Yes	90

General observations of the GHFF currently roosting at the Gordon Park camp indicated that both female and male GHFF were present, along with dependant young.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was 50 centimetres in depth as shown in **Figure 2.1**. This represents a nine centimetre decrease since last month.

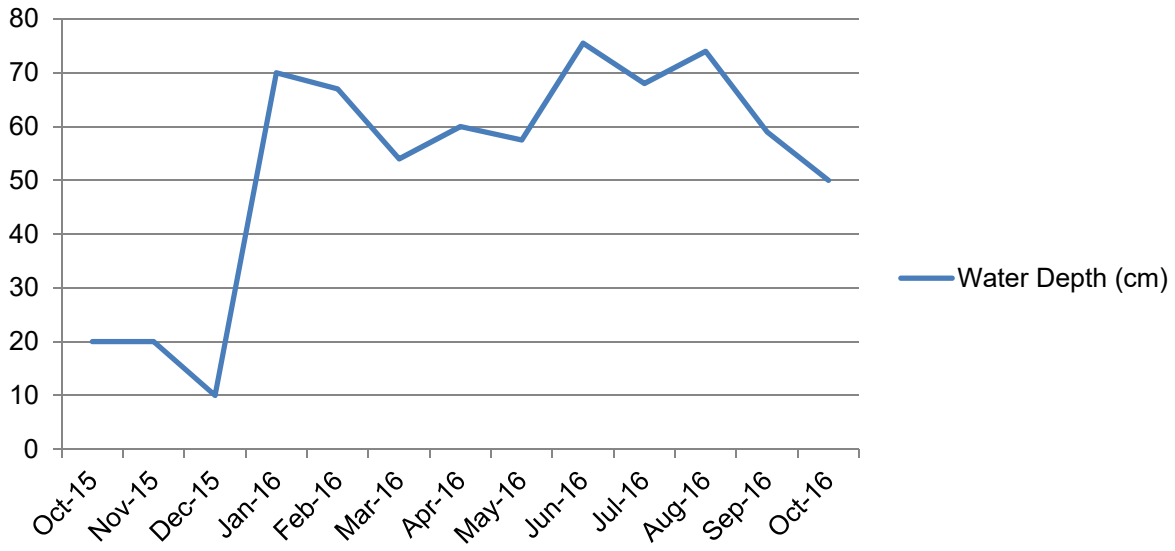


Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

The number of flying-foxes presently roosting at the Macksville Cemetery camp has decreased substantially over a short period from over 30,000 individuals in mid-October to approximately 4,000 individuals in the current monitoring event. This year flying-foxes were absent from this camp over the period of June to September. Prior to this numbers had peaked in February when an estimated 50,000 individuals were present. At the same time last year, the Macksville Cemetery camp was estimated to be supporting approximately 4,500 flying-foxes.

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**.

Flying-foxes continue to be absent from the Bowraville camp. No flying-foxes have been recorded roosting at Bowraville since mid-May 2015. Similarly, the Bellingen Wheatley Street camp, which supported small numbers of flying-foxes mainly when Bellingen Island was vacant, has remained unoccupied since July 2015.

The number of flying-foxes presently roosting at the Bellingen Island camp has remained steady at around 15,000 individuals over the last two months, following a period of relatively low numbers over the winter period. At the same time last year, the Bellingen Island camp was estimated to be supporting approximately 5,000 flying-foxes.

Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to October 2016). Following a brief increase in the number of flying-foxes at this camp in August 2016 when an estimated 25,000 individuals were present, a decrease has been observed, with the current monitoring event indicating an estimated population of approximately 7,500 individuals. The rainforest canopy is heavily degraded in Gordon Park at present as a result of flying-fox activity. It is possible that the more open canopy will have an influence on the overall microclimate of the site, and result in overall lower occupation levels. This may become apparent in monitoring over the summer period, when the flying-fox numbers at regional camps is typically at a peak.

2.3.2 Species Composition and Demographic Data

At occupied camps GHFF dominated the species composition, with Black Flying-fox accounting for between 5% and 30% of all individuals present. The proportion of Black Flying-fox was highest at the Gordon Park camp. The proportion of Black Flying-fox at occupied camps in October 2015 was similar to that recorded in the current monitoring event (GeoLINK 2015).

As is expected, dependent young GHFF are currently present at occupied camps and are being carried to feeding sites by their mothers (Department of Environment 2015).

The proportion of female GHFF with dependent young recorded at Bellingen Island in the current monitoring event was variable and ranged between 20% and 100% (average 64%). This is higher than at the same time last year, when the proportion of female GHFF with dependent young at Bellingen Island ranged between 30% and 70% (average 45%) (GeoLINK 2015).

At the Macksville Cemetery camp current monitoring indicted that the proportion of female GHFF with dependent young was lower than that recorded at the Bellingen Island camp, ranging between 20% and 60% (average 40%). This proportion is approximately the same as was recorded for this camp at the same time last year (GeoLINK 2015).

2.3.3 Phenology of Trees in the Region

October flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Large-leaved Spotted Gum (*Corymbia henryi*), Narrow-leaved Red Gum (*Eucalyptus seeana*), Grey Ironbark (*Eucalyptus siderophloia*) (coastal lowlands, foothills and ranges), Forest Red Gum (*Eucalyptus tereticornis*) (inland low altitude and high altitude) and Silky Oak (*Grevillea robusta*). These highly productive nectar source trees can be considered key diet species for GHFF (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps indicated that minor flowering of Grey Ironbark and Forest Red Gum, and heavy flowering of Silky Oak (cultivated) is currently occurring.

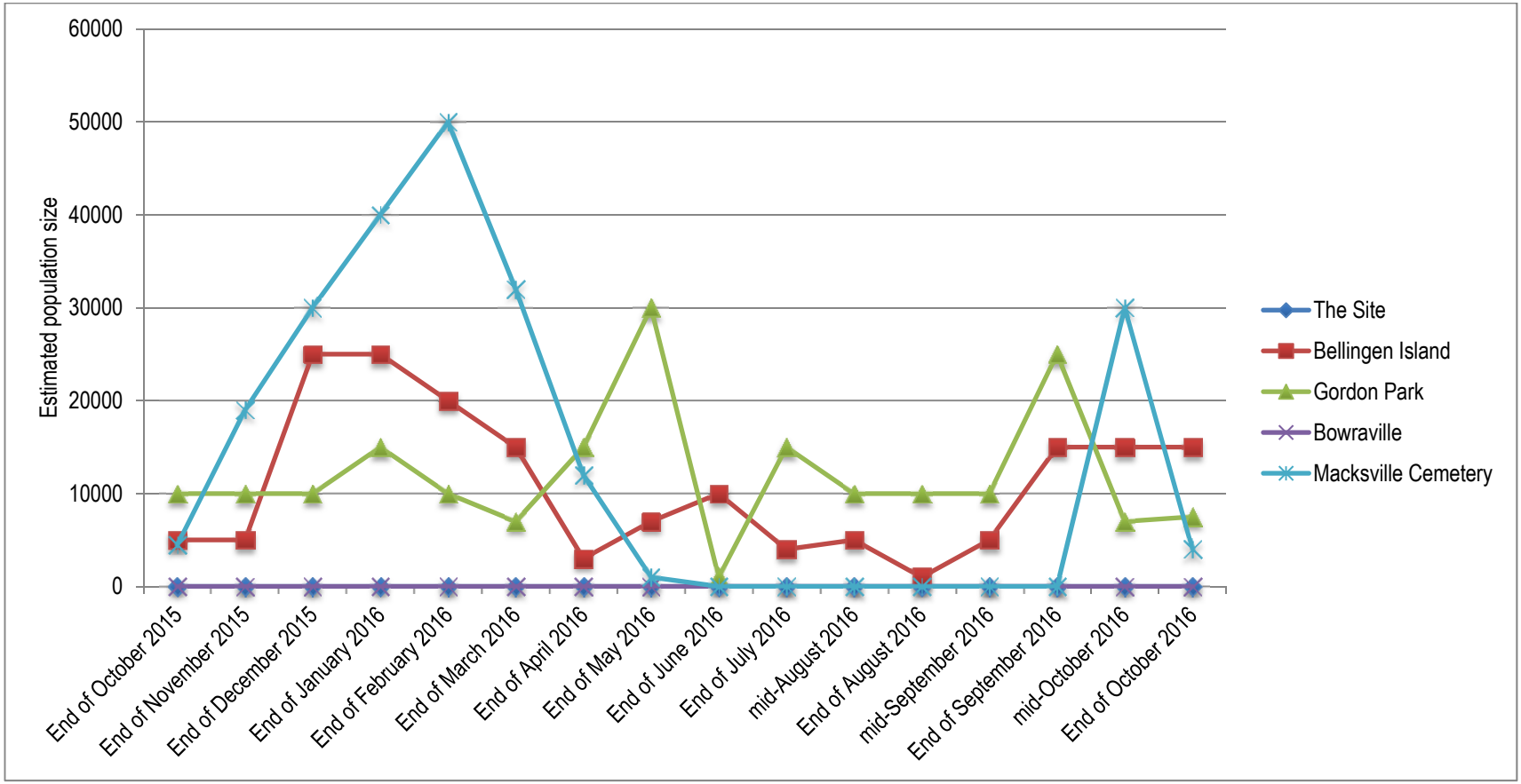


Figure 2.2 Population trends at the site and regional camps over past 12 months

2.4 Conclusion

The results of the October 2016 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 now for approximately 2 ½ years.

The nearby Macksville Cemetery camp (detected in February 2015) has recently been re-occupied by flying-foxes following an absence over the winter period. Similarly, following a period of relatively low numbers over the winter period (including a brief absence at the end of August), numbers of flying-foxes at the Bellingen Island camp have now stabilised at moderate levels.

All other regional camps have displayed seasonal absences in the winter period except for the Gordon Park camp. The rainforest canopy is currently heavily degraded at Gordon Park as a result of flying-fox activity and may influence future occupation levels due to changed microclimate.

Dependent young GHFF are currently present at occupied camps at moderate levels.

David Andrighetto
Senior Ecologist

References

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

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11 November 2016
Ref No.: 2692-1028

Roads and Maritime Services
101 Miller Street
NORTH SYDNEY NSW 2060

Attention: Mr Andrew Mula

Dear Andrew

Fortnightly Flying-fox Monitoring Report, November 2016 – Warrell Creek to Nambucca Heads Pacific Highway Upgrade

This short report details the findings of the November 2016 fortnightly Grey-headed Flying-fox (GHFF) monitoring at the Macksville camp (the site) undertaken between standard monthly monitoring events. The purpose of collecting additional data more frequently is to form a clearer picture of short-term population fluctuations at the camp. For more detailed information on methodology used for this monitoring, refer to the monthly flying-fox monitoring reports.

1. Observations

1.1 The Site

The site was visually inspected for flying-foxes on 10 November 2016. No flying-foxes were recorded in this inspection. This absence of flying-foxes at the site has now extended from mid-April 2014 until present, with the exception of a temporary occupation by a small number of flying-foxes in mid-January 2015.

An exit count was conducted on the eventing of 10 November 2016 from two vantage points to the north and south of the site. The vantage point to the north of the site was located to facilitate a count of any flying foxes exiting the nearby Macksville cemetery camp.

No flying-foxes were observed flying from the site in the exit count. However, a small number of <50 individuals were observed to be flying over the site from the north, likely originating from the nearby Macksville cemetery camp which is currently occupied.

1.2 Regional Flying-fox Camps

Other regional flying-fox camps were also visited. General observations made at these camps are provided below.

1.2.1 Macksville Cemetery

It is estimated that approximately 2,500 flying-foxes are currently roosting at the camp, as recorded in the exit count. These flying-foxes exited the camp predominantly heading in a westerly direction.

Flying-foxes were recorded roosting in an area covering approximately 0.30 ha in the current monitoring event. Both a reduction in the number of flying-foxes present and the roost area has occurred since the previous monthly monitoring event, when approximately 4,000 flying-fox were recorded within a roost area of 0.57 ha.

Only a relatively minor proportion (<10%) of the flying-foxes present were Black Flying-foxes.

1.2.2 Bowraville

A small number of GHFF, estimated to number <250 individuals were recorded roosting in a single tree in the midstorey of the rainforest at Bowraville in the current monitoring event. Prior to this, flying-foxes had been absent from the Bowraville camp for a considerable period, since mid-May 2015.

1.2.3 Bellingen Island

It is estimated that approximately 15,000 flying-foxes were camped at Bellingen Island, consistent with the numbers recorded in the previous monthly monitoring event. No flying-foxes were observed to be camped at Wheatley Street, Bellingen where previously recorded.

The species present consisted of approximately 90% GHFF and 10% Black Flying-fox.

1.2.4 Gordon Park (Nambucca Heads)

It is estimated that approximately 7,500 flying-foxes were camped at Gordon Park, as was recorded in the previous monthly monitoring event. The canopy of the rainforest at Gordon Park remains in very poor condition relating to the roosting flying-foxes with little foliage cover remaining.

The species present consisted of approximately 70% GHFF and 30% Black Flying-fox. These proportions are consistent with those recorded in the previous monthly monitoring event.

2. Demographic Observations

Both female and male flying-fox were recorded at all occupied camps. Dependent juvenile flying-fox were also recorded with their mothers at all occupied camps except for Bowraville.

3. Flowering of Key Foraging Resources

November flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Blackbutt (*Eucalyptus pilularus*), Narrow-leaved Red Gum (*Eucalyptus seeana*), Grey Ironbark (*Eucalyptus siderophloia*) (coastal lowlands, foothills and ranges), Forest Red Gum (*Eucalyptus tereticornis*) (inland low altitude and high altitude) and Silky Oak (*Grevillea robusta*). These highly productive nectar source trees can be considered key diet species for GHFF (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps indicated that minor to moderate flowering of Grey Ironbark and Silky Oak (cultivated) is currently occurring.

If you have any queries regarding this report, please feel free to contact me on 02 6687 7666.

Yours sincerely
GeoLINK

David Andrighetto
Senior Ecologist

References

Eby, P. and Law, B. (2008). *Ranking the feeding habitat of Grey-headed flying foxes for conservation management*. Department of Environment, Heritage, Water and the Arts, Canberra.

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

Issue Log

UPR	*Description*	*Date Issued*	*Issued By*
2692-1028	First issue	14/11/2016	DSA

Flying-fox Monitoring December 2016

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

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Prepared for: Roads and Maritime Services

UPR	Description	Date Issued	Issued By
2692-1034	First issue	17/01/2017	David Andrighetto

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Illustrations

Tables

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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 2016 flying-fox monitoring results.

2. Flying-fox Survey

2.1 Methodology

The following GeoLINK personnel undertook fieldwork for the December 2016 flying-fox monitoring:

- Tom Pollard (ecologist).
- Frank Makin (ecologist).
- Dylan Hisselli (environmental scientist/ ecologist).
- 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.

On 22 December 2016, 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) on 22 December 2016. 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 on the evening of 22 December 2016 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 strategically located adjacent to the Macksville Cemetery camp. Specifically, the two observers were located 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 7:45 pm to 8:30 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 on 22 December 2016 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 also absent from and Wheatley Street camp in Bellingen.

Flying-foxes were observed to be roosting at the Macksville Cemetery camp. The extent of the roost covered 1.05 hectares and is shown in **Illustration 2.2**.

Regionally, flying-foxes were observed to be roosting at Bellingen Island, Bowraville and Gordon Park (Nambucca Heads). The extent of the roost footprint at Bellingen Island was consistent with that recorded in the previous monitoring event. The Gordon Park camp now only occupies the eastern section of the rainforest vegetation, as was recorded in the previous monitoring event.

2.2.2 Population Estimates

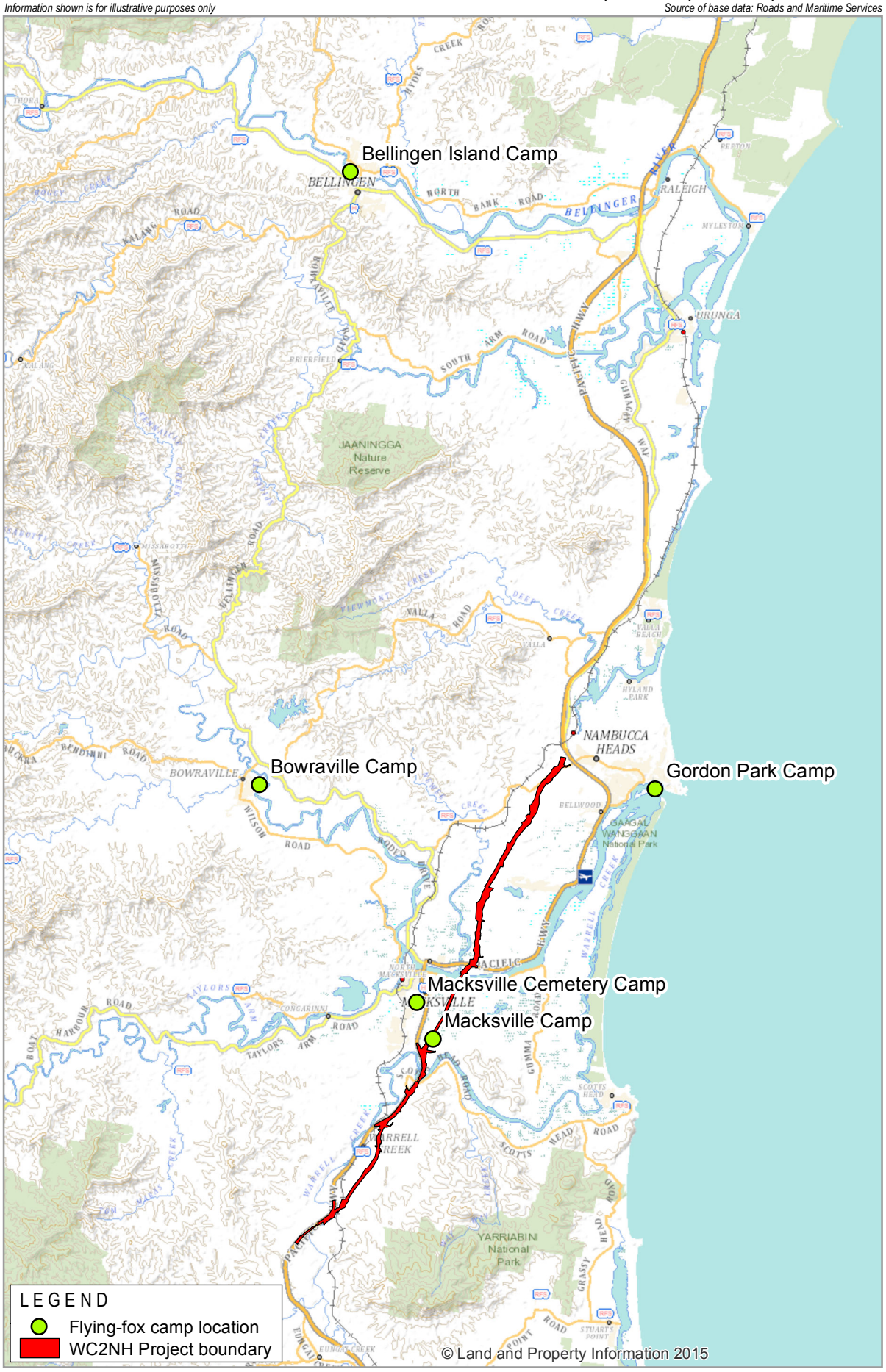
2.2.2.1 Exit Count

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

The exit count conducted for the Macksville Cemetery camp indicated that an estimated 7,500 flying-foxes were roosting at the site. Most of these individuals exited the camp in a westerly stream while approximately one third exited in a south-easterly direction.

Information shown is for illustrative purposes only

Drawn by: KHP Checked by: FM Reviewed by: VJS Date: 17/01/2017
Source of base data: Roads and Maritime Services



0 4 km

North

Location of Regional Flying-fox Camps

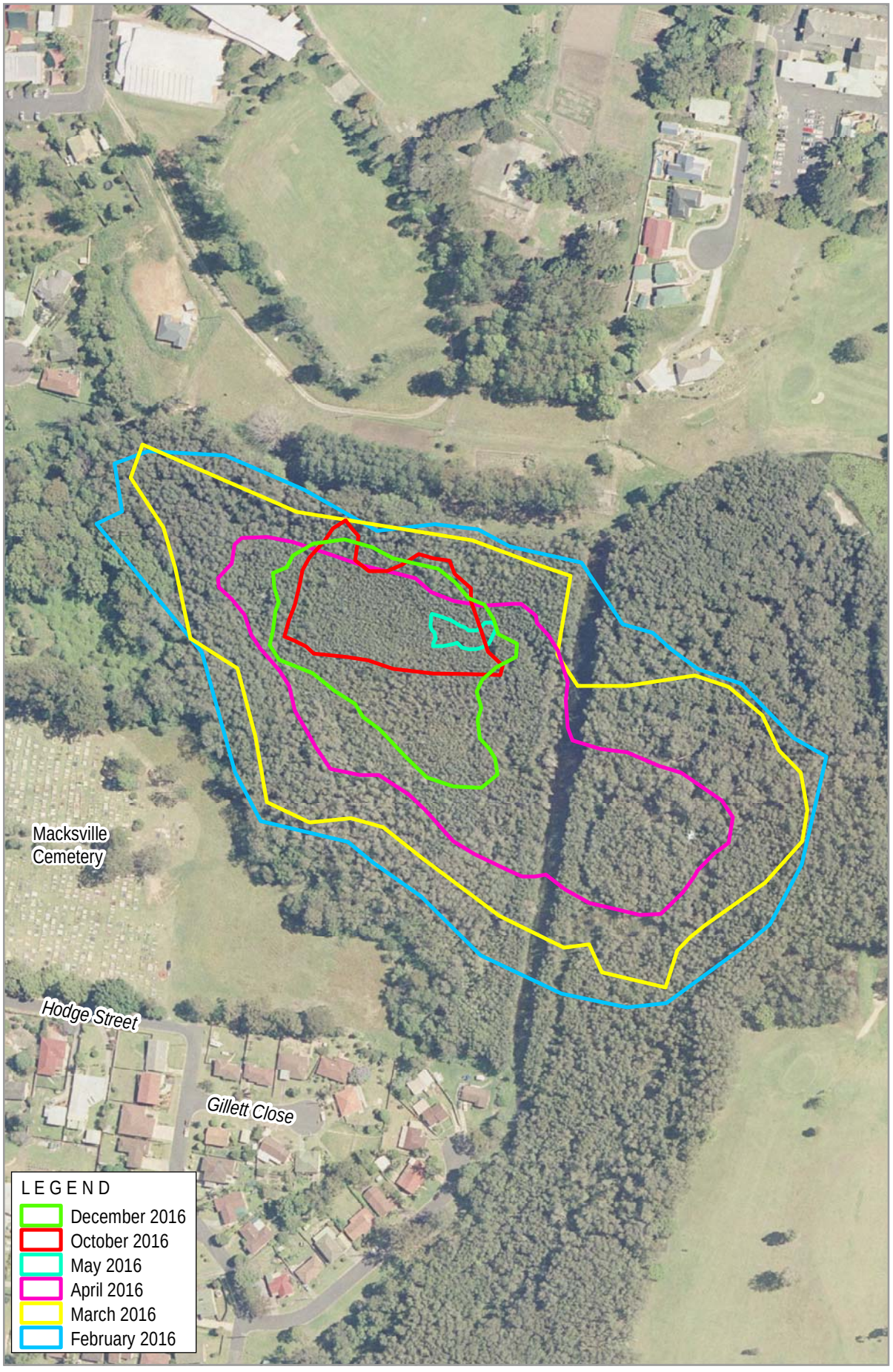
GeoLINK environmental management and design

Flying-fox Monitoring December 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1008

Illustration 2.1

Information shown is for illustrative purposes only

Drawn by: KHP Checked by: RE Reviewed by: VJS Date: 17/01/2017
Source of base data: Roads and Maritime Services



North

0 60

Macksville Cemetery Flying-fox Roost Footprint

GeoLINK environmental management and design

Flying-fox Monitoring December 2016 - Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
2692-1035

Illustration 2.2

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 7,500 individuals.
- Bowraville: approximately 1,000 individuals.
- Bellingen Island: approximately 15,000 individuals.
- Wheatley Street, Bellingen: 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: 60-70% GHFF and 30-40% Black Flying-fox.
- Bellingen Island: 90-95% GHFF and 5-10% Black Flying-fox.
- Gordon Park: 70% GHFF and 30% 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) and during this period of absence Macksville Cemetery camp has been the alternative site for collection of this data.

Data collected in demographic point counts at the Macksville Cemetery camp indicated that the proportion of female GHFF present was very low. Most counts consisted of exclusively 'bachelor trees' with only male flying-foxes present, while the remainder of counts were male-dominated, but also included a few female flying-foxes. The proportion of female GHFF present was between 0% and 23%. No female GHFF with dependant young were recorded (refer to **Table 2.1**).

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	492104, 6601834	Broad-leaved Paperbark	12	20	(bachelor tree – males only)	No	n/a
MC2	492085, 6601841	Broad-leaved Paperbark	12	20	(bachelor tree – males only)	No	n/a
MC3	492079, 6601845	Broad-leaved Paperbark	15	20	2:10	No	n/a
MC4	492073, 6601843	Broad-leaved Paperbark	12	30	(bachelor tree – males only)	No	n/a
MC5	492038, 6601833	Broad-leaved Paperbark	15	25	(bachelor tree – males only)	No	n/a
MC6	492032, 6601810	Broad-leaved Paperbark	12	20	(bachelor tree – males only)	No	n/a
MC7	492029, 6601800	Broad-leaved Paperbark	12	15	(bachelor tree – males only)	No	n/a
MC8	492054, 6601782	Broad-leaved Paperbark	12	20	(bachelor tree – males only)	No	n/a
MC9	492084, 6601756	Broad-leaved Paperbark	15	30	3:10	No	n/a
MC10	492172, 6601723	Broad-leaved Paperbark	15	30	1:10	No	n/a

Data collected in demographic point counts at the Bellingen Island camp indicated that the proportion of female GHFF present was between 50% and 83% of all individuals (excluding one count of a 'bachelor tree' supporting only male GHFF). The proportion of female GHFF with dependant young was variable and ranged between 30% and 70% (average 48%) (refer to **Table 2.2**).

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	489947, 6631599	Unknown sp.	10	15	10:5	Yes	70
BI2	489947, 6631577	Creek Sandpaper Fig	12	20	10:2	Yes	40
BI3	489976, 6631555	Creek Sandpaper Fig	10	30	10:5	Yes	50
BI4	490014, 6631577	Giant Stinging Tree	12	30	10:5	Yes	30
BI5	490014, 6631599	Giant Stinging Tree	12	80	10:10	Yes	30
BI6	490024, 6631577	Creek Sandpaper Fig	10	30/20/20 (multiple trunks)	10:4	Yes	50
BI7	490062, 6631566	Giant Stinging Tree	12	40	10:3	Yes	40
BI8	490053, 6631577	Giant Stinging Tree	12	40	(bachelor tree – males only)	No	n/a
BI9	490062, 6631588	Giant Stinging Tree	12	50	10:4	Yes	50
BI10	490014, 6631654	Lilly Pilly	8	40	10:2	Yes	70

General observations of the GHFF currently roosting at the Gordon Park and Bowraville camp indicated that both females and males were present. However, dependant young were only recorded at the Gordon Park camp.

2.2.3.3 Water Level at the Site

Water level at the site measured at the representative measurement location was 17 cm in depth as shown in **Figure 2.1**. This represents a 5 cm decrease since last month reflecting the dry early summer conditions.

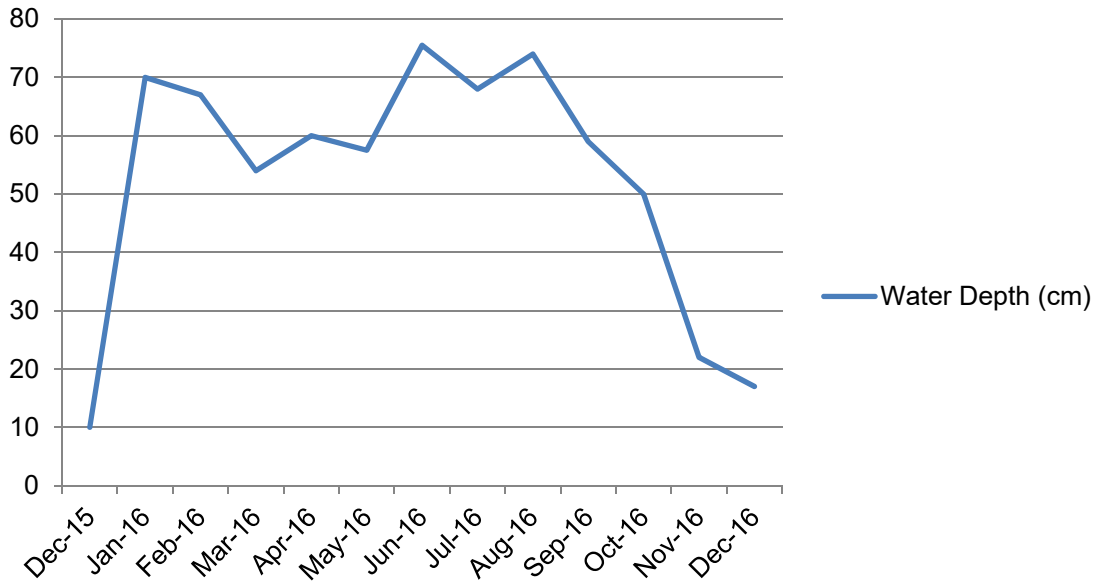


Figure 2.1 Water level measurements at the site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse. Flying-foxes have not occupied the site (excluding a brief return in January 2015) since mid-April 2014.

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**.

The number of flying-foxes presently roosting at the Macksville Cemetery camp has been variable over the last three months of 2016, ranging from a maximum of 30,000 individuals in mid-October to a low of 500 individuals in November, and has again risen to a moderate level of approximately 7,500 individuals recorded in the current monitoring event. In December 2015, this camp was supporting a much larger number of flying-foxes, estimated to be at least 30,000 individuals.

Flying-foxes have returned to the Bowraville camp in low numbers in November 2016 following an absence since mid-May 2015. The number of flying-foxes has remained small and is currently less than 1,000 individuals.

The number of flying-foxes presently roosting at the Bellingen Island camp has remained steady at around 15,000 individuals over the last three months, following a period of relatively low numbers over winter. In December 2015, the Bellingen Island camp was estimated to be supporting approximately 25,000 flying-foxes; a substantially larger number than were recorded in the current monitoring event. The Bellingen Wheatley Street camp, which supported small numbers of flying-foxes mainly when Bellingen Island was vacant, remains unoccupied.

Of the camps monitored as part of this project, the Gordon Park camp has been the only continuously occupied flying-fox camp (July 2013 to November 2016). Following a brief increase in the number of flying-foxes at this camp in August 2016 when an estimated 25,000 individuals were present, the population level has been lower and variable in the last four months of 2016, ranging between 7,500 and 15,000 individuals. As was observed in the previous monitoring event, the roost area recorded in the current monitoring event has also reduced and now only occupies the eastern section of the rainforest vegetation. This may be linked to the poor health of the rainforest canopy at Gordon Park at present as a result of flying-fox activity.

2.3.2 Species Composition and Demographic Data

At occupied camps, GHFF dominated the species composition, with Black Flying-fox accounting for between 5% and 40% of all individuals present. The proportion of Black Flying-fox was highest at the Macksville Cemetery camp. The proportion of Black Flying-fox at occupied camps in December 2015 was lower than that recorded in the current monitoring event at 5-20% (GeoLINK 2015).

Despite the impact of recent deaths of substantial numbers of young dependent flying-foxes at regional camps in relation to a resource shortage (refer to monitoring reports GeoLINK 2016a, GeoLINK 2016b), young GHFF were nonetheless observed to be surviving at least at a moderate level at the Bellingen Island camp in the current monitoring event. The proportion of females with dependent young at Bellingen Island has experienced a minor decrease over the past month from 56% in November to 48% in the current monitoring event.

2.3.3 Phenology of Trees in the Region

December 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, River Red Gum, Coastal Blackbutt and Grey Ironbark (foothills and ranges). These can be considered key diet species for GHFF (Eby 2012; Eby and Law 2008).

Observations when travelling between regional flying-fox camps indicated minor flowering of Pink Bloodwood is currently occurring in the region. Minor to moderate flowering of Spotted Gum was observed to the north in the Clarence Valley.

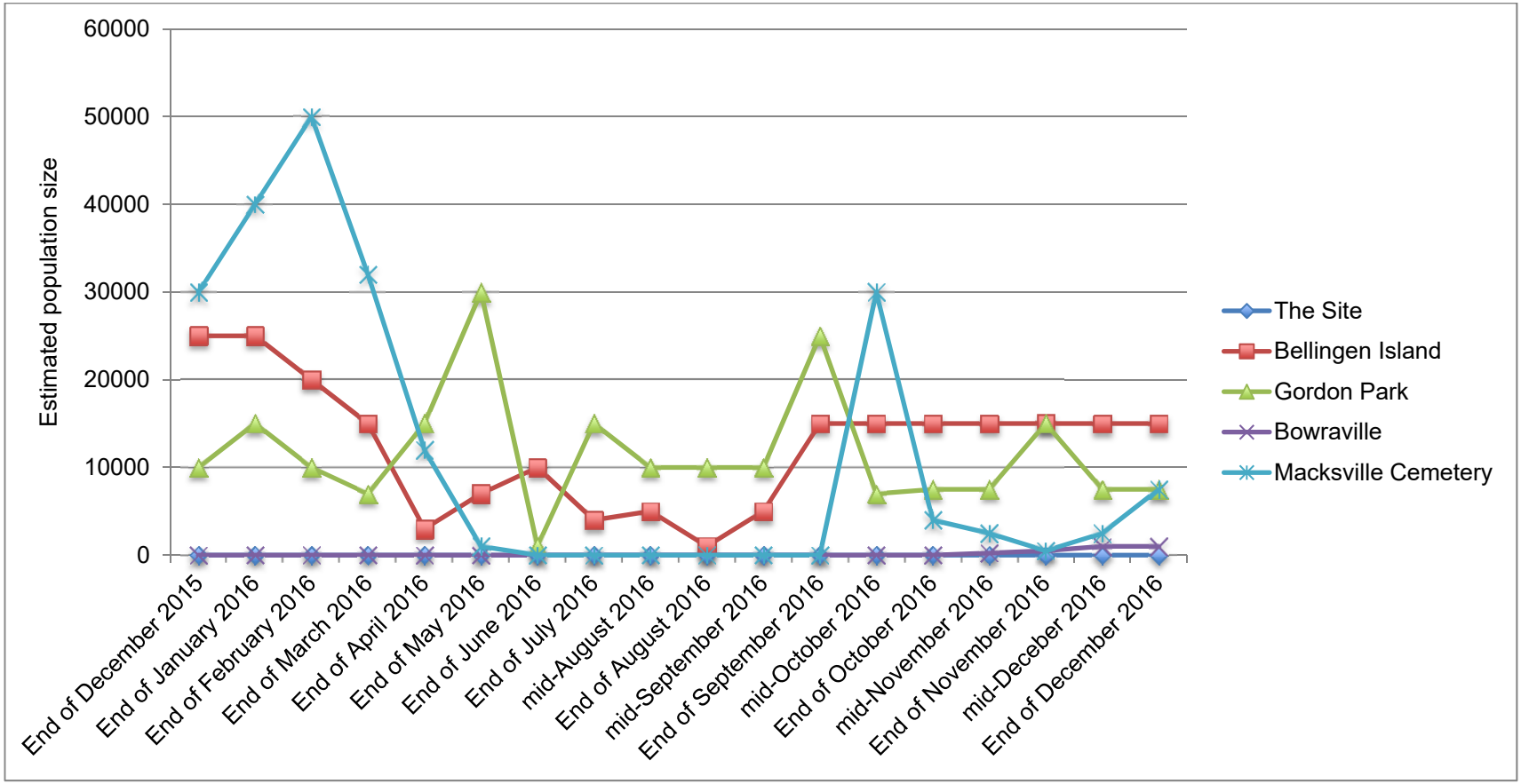


Figure 2.2 Population trends at the site and regional camps over past 12 months

2.4 Conclusion

The results of the December 2016 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 now for approximately two and a half years.

The nearby Macksville Cemetery camp (detected in February 2015) has recently been re-occupied by flying-foxes following an absence over the winter period, and the numbers of flying-foxes have been variable ranging from 500 to 30,000 individuals. A small number of GHFF have also returned to Bowraville after a long absence. Similarly, following a period of relatively low numbers over the winter period (including a brief absence at the end of August), numbers of flying-foxes at the Bellingen Island camp have now stabilised at moderate levels.

Male flying-foxes dominated the demographic composition of the Macksville Cemetery camp, where no dependent young flying-fox were recorded. In contrast, dependent young flying-foxes are still present at a moderate level at the Bellingen Island camp, despite the death of a substantial number of young recently in relation to resource shortage.

Summer flowering of trees that are key diet species has begun recently in the region, including Pink Bloodwood and Spotted Gum.

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