

10 January 2014
Ref No: 2182-1073

The Manager
Sinclair Knight Merz
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DANGAR NSW 2309

Attention: Vivira Cadungog

Dear Vivira,

January 2014 fortnightly Flying-fox monitoring report

This short report details the findings of the January 2014 fortnightly GHFF monitoring at the Macksville camp 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.

A traverse of the site was undertaken on 9 January 2014. No roosting flying-fox were located during this traverse. Additionally, no flying-fox vocalisations were heard, indicating that the camp is unlikely to have shifted elsewhere within the swamp sclerophyll forest from its previously recorded location.

An exit count was conducted at three vantage points surrounding the site on the night of the 9 January 2014. The results of this exit count supported the findings of the traverse that the camp was essentially un-occupied. Approximately 20 flying-fox were counted exiting the site. Due to the small numbers, no distinct flight-paths were observed. However, most individuals were generally heading in a westerly direction. The small numbers observed suggest that these individuals were using the vegetation as a temporary roost.

Usage of the camp over the last couple of months has been sporadic as shown below:

- 20 November 2013 (Nov 2013 monthly monitoring event) – camp occupied, including females with dependent young, population estimate 1200;
- 4 December 2013 (Dec 2013 fortnightly monitoring event) – flying-fox absent or in very low numbers (<25 individuals);
- 18 December 2013 (Dec 2013 monthly monitoring event) – camp occupied, including females with dependent young, population estimate 2500); and
- 9 January 2014 (Jan 2014 fortnightly monitoring event) – flying-fox absent or in very low numbers (<25 individuals).

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

Yours sincerely
GeoLINK



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Flying-fox Monitoring

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

January 2014

Prepared for: Sinclair Knight Merz
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Introduction

1.1 Introduction

Sinclair Knight Merz (SKM) and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at the Macksville roost (henceforth referred to as 'the site'), which is located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road, Macksville. To date, monthly monitoring has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly on the camp since its establishment in December 2011 (Eby 2012).

This report details the January 2014 monitoring results. The monitoring was undertaken on 28-29 January 2014.

Flying-fox Survey

2.1 Methodology

Fieldwork for the January survey was undertaken by GeoLINK ecologists Dr Tom Pollard and David Andrighetto, flying-fox expert Dr Peggy Eby and RMS Senior Environmental Specialist (Biodiversity) Josie Stokes. In addition, ecologist Terry Tweedie (GeoLINK subcontractor) was also present at the second exit count on 29 January 2014. 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 January 2014 monitoring is provided below.

Over two consecutive evenings on 28-29 January 2014 dusk exit count surveys were undertaken at the site to provide an estimate of the number of flying-foxes currently roosting at the camp. Observers were strategically located where there were clear views over the camp, corresponding to the directions that flight-paths were observed during previous exit counts in 2013.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive);
- west of the Pacific Highway at the junction with Upper Warrell Road;
- to the east of the Pacific Highway near the junction with Bald Hill Road (only on the second exit count night of 29 January 2014);
- on a ridge south of the camp (41 Bald Hill Road); and
- adjacent to Bald Hill Road, approximately 750 m east of the 41 Bald Hill Road vantage point.

The location of these vantage points is shown in **Illustration 2.1**.

The survey extended over approximately one hour from sunset until dark (approximately 7:45 pm to 8:45 pm).

On 29 January, a survey of the site was undertaken on foot to locate and map the flying-fox camp footprint and collect data on species composition, demographics, reproductive status and behaviour (Error! Reference source not found.). For comparison, data was also collected at a control site located at Bellingen Island (approximately 31 km north north-west of the Macksville camp), along with observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to **Illustration 2.2** for location of these regional camps).

The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp.



Plate 2.1 Undertaking a Demographic Count at the Site

2.2 Results

2.2.1 Population Estimate – Exit Count

During the exit count conducted on 28 January approximately 5170 flying-foxes were recorded exiting the camp. Higher numbers were recorded during the exit count conducted on 29 January when approximately 7860 flying-foxes were recorded. Flying-foxes predominantly exited the camp heading in a westerly or northerly direction (refer to **Illustration 2.1**).

No exit counts were conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: >10,000 individuals;
- Bowraville: >10,000 individuals; and
- Bellingen Island: >20,000 individuals.

2.2.2 Roost Footprint

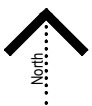
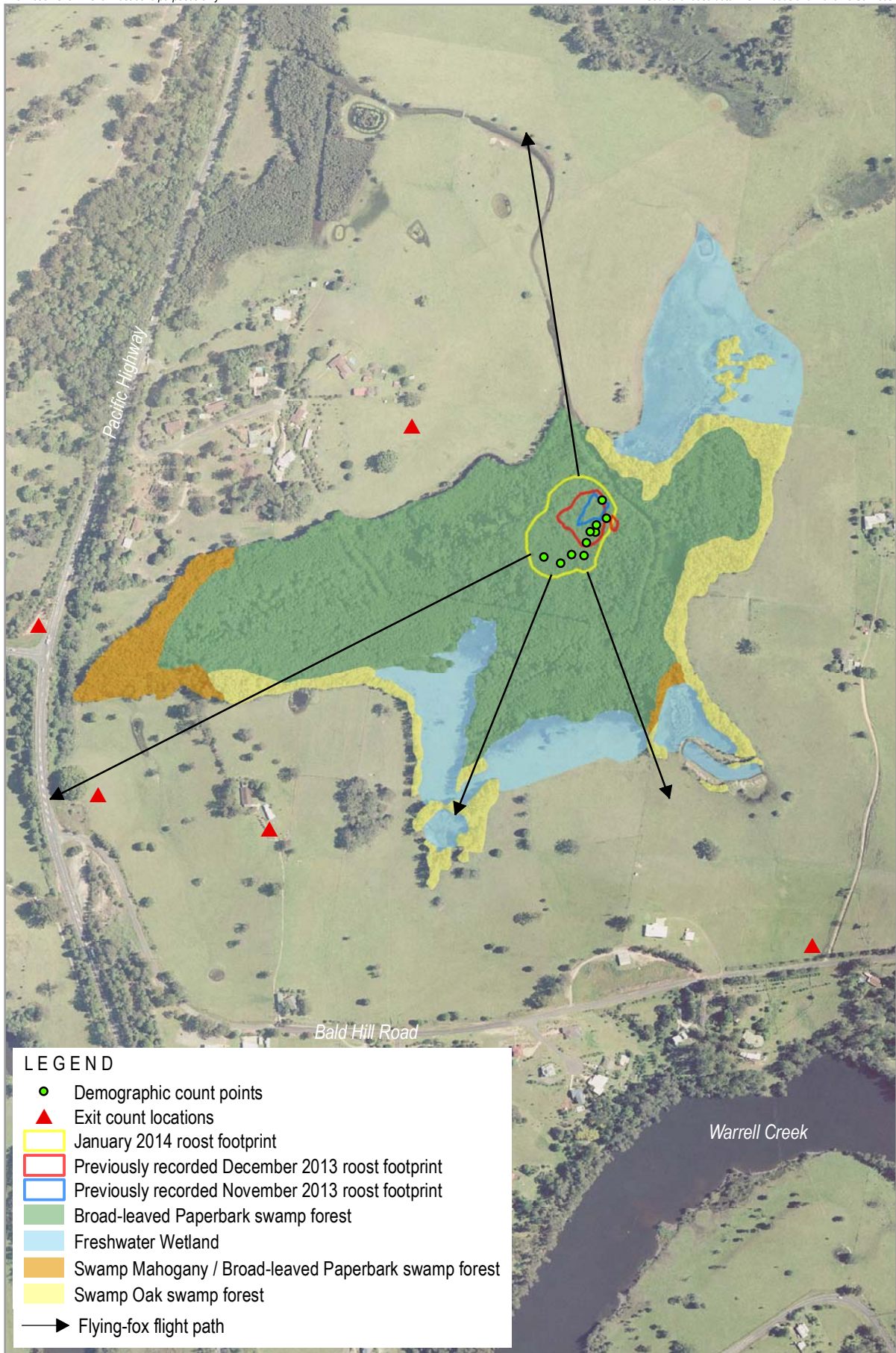
At the time of the survey, the roost occupied an area of approximately 1.11 ha at the site. This is larger than the previous maximum area of 0.89 ha recorded in September 2013.

The occupied roost area has increased substantially over recent months, covering only 0.08 ha in November 2013 and 0.32 ha in December 2013. It should be noted however that these times of flying-fox presence have been punctuated by intervening periods of absence.

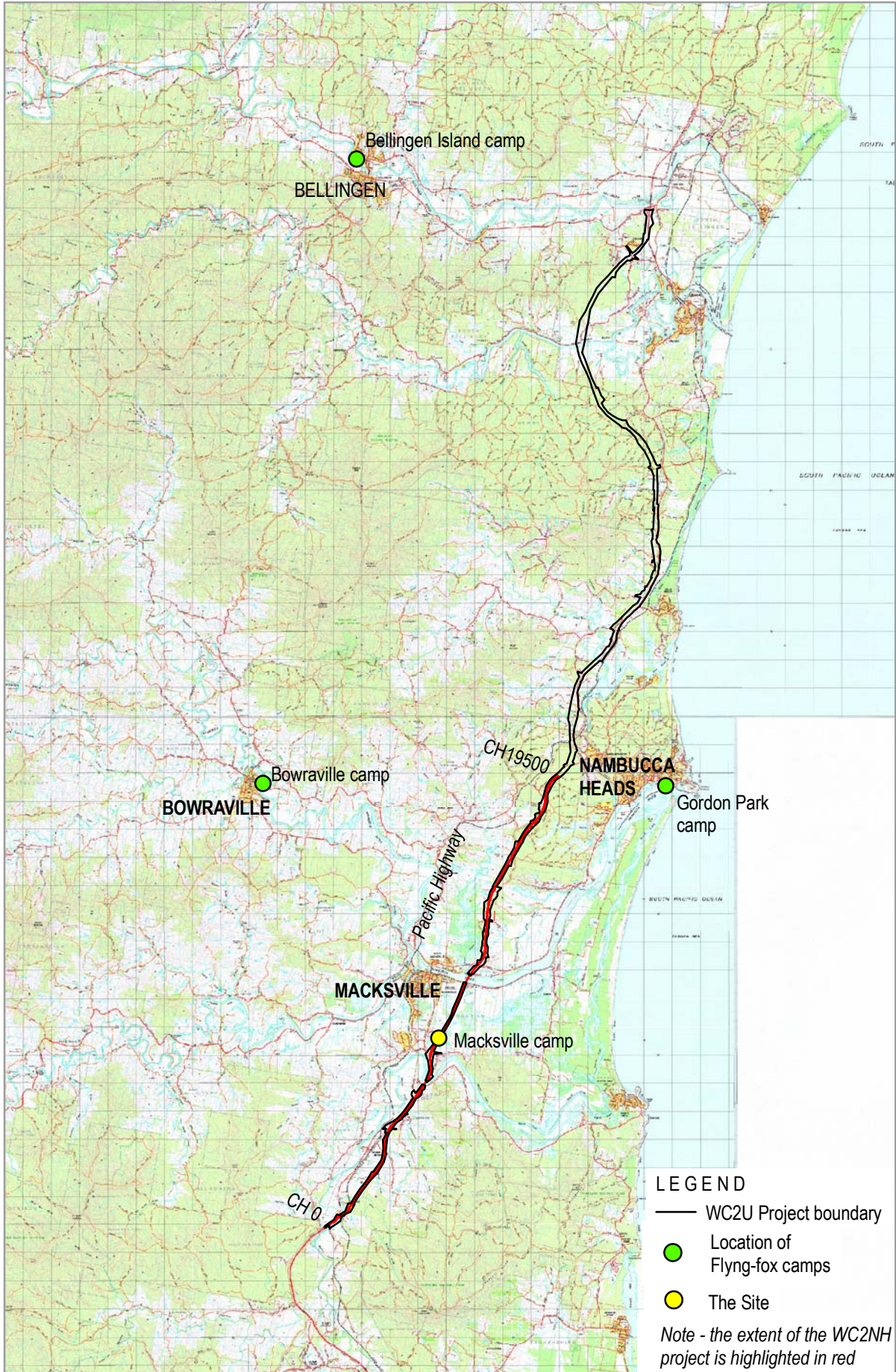
The roost footprint and location of demographic count points is displayed in **Illustration 2.1**.

As has been previously recorded, the flying-fox are roosting in a dense stand of Broad-leaved Paperbark (*Melaleuca quinquenervia*). These trees averaged approximately 6-8 m in height with a diameter at breast height (DBH) less than 20 cm.

Information shown is for illustrative purposes only



Information shown is for illustrative purposes only



0 4 km



2.2.3 Detailed Data

2.2.3.1 Species Composition

Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) and Black Flying-fox (*Pteropus alecto*) were present at both the site and the control site at Bellingin Island. It was estimated that more than 95% of the flying-fox present at the site consisted of GHFF. This figure is in general agreement with the proportion recorded in December 2013. Most Black Flying-fox at the site were observed to be concentrated along the eastern edge of the roost. At Bellingin Island GHFF accounted for approximately 95% of the flying-fox present, also consistent with proportions recorded in previous months. Black Flying-fox typically occurred in small groupings at both the site and Bellingin Island.

Both GHFF and Black Flying-fox were also present at the remaining regional camps. It was estimated that GHFF accounted for approximately 90-95% of the flying-fox present in the Gordon Park camp and >95% of the flying-fox present in the Bowraville camp. These proportions have remained fairly consistent since November 2013. The Black Flying-fox typically occurred in small groupings and were interspersed among the GHFF at these regional camps. However, they appear to show some preference for edge habitats at the Gordon Park camp.

2.2.3.2 Habitat Characteristics and Demographic Composition

Data of habitat characteristics and demographic composition at the site and the Bellingin Island control site are provided in **Table 2.1** and **Table 2.2** respectively.

As has been discussed in previous monthly monitoring reports, roost trees at the site are exclusively Broad-leaved Paperbark. The stand is even aged, consisting of trees 6-8 m in height, with a diameter at breast height (DBH) of less than 20 cm. The stand is relatively dense with trees spaced on average 1-2 m apart. There is no significant discernible difference in tree species, forest structure or water depth in areas immediately adjacent to the camp.

The structure of the vegetation at the Bellingin Island camp consists of a canopy of emergent rainforest species (with some large native figs of substantial diameter and up to 40 m in height) over a relatively open understorey. In recent months at this camp flying-fox have been recorded in roost trees that are generally 5 - 15 m high, and up to 70 cm diameter at breast height (DBH). However, at the time of the current monitoring event the flying-fox numbers have increased substantially. Consequently, roosting individuals are now also present in the upper canopy of the emergent rainforest vegetation. The roost area is extensive at Bellingin Island, occurring in a significant proportion of the available rainforest vegetation.

Table 2.1 displays the results of the demographic data collected at the site. As was recorded in December 2013, the camp was dominated by male GHFF at the time of the survey. The majority of roost trees investigated predominantly supported males. Due to the dispersed nature flying fox within the camp at present, males were generally not in 'bachelor trees' and instead were widely spread and occupied individual mating territories. When females were present they occurred in isolated clumps within areas more broadly occupied by males. The ratio of females to males in roost trees ranged from approximately 1:1 to 1:3. The percentage of GHFF females with dependent young in demographic counts ranged between 50% and 60%, which is consistent with the ratios observed at other regional camps.

Table 2.1 Demographic Data for The Site

Tree Code	GPS Co-ordinates (easting, northing)	Tree Species	Diameter at Breast Height (DBH) (cm)	Height (m)	Sex Ratio (female:male)	Presence of Dependant Young (yes/no)	% females with Dependent Young
M1	6600715, 492967	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	2:7 (incomplete) (predominantly males)	no	n/a
M2	6600693, 492983	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	1:3 (incomplete) (predominantly males)	no	n/a
M3	6600651, 492969	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:10 (females clumped together)	yes	60
M4	6600651, 492966	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	2:17 (predominantly males)	no	n/a
M5	6600644, 492964	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	1:20 (predominantly males)	no	n/a
M6	6600630, 492957	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	1:11 (predominantly males)	no	n/a
M7	6600599, 492940	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	(all male grouping)	no	n/a
M8	6600601, 492917	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	2:17 (predominantly males)	no	n/a
M9	6600597, 492907	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:27 (females clumped together within a mostly male group)	yes	50
M10	6600612, 492843	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	1:15 (predominantly males)	no	n/a

Table 2.2 displays the results of the demographic data collected at the Bellinghen Island camp. Females were more numerous than males in all demographic counts. The ratio of females to males varied considerably in demographic counts ranging from close to 1:1 to 5:1. Females with young were common across the camp; however the proportion of females with young was variable, ranging between 30% and 100%.

Table 2.2 Demographic Data for Bellingin Island

Tree Code	GPS Co-ordinates (easting, northing)	Tree Species	Diameter at Breast Height (DBH) (cm)	Height (m)	Sex Ratio (female:male)	Presence of Dependant Young (yes/no)	% females with Dependent Young
BI1	6631535, 490084	<i>Dendrocnide excelsa</i>	40	8	10:4	yes	60
BI2	6631651, 490050	<i>Ficus macrophylla</i>	30	6	10:7	yes	80
BI3	6631486, 490084	<i>Dendrocnide excelsa</i>	50	15	10:5	yes	70
BI4	6631613, 490017	Dead tree	30	6	5:2 (incomplete)	yes	100
BI5	6631630, 490011	<i>Ficus coronata</i>	20	6	10:2	yes	70
BI6	6631653, 489994	<i>Dendrocnide excelsa</i>	30	8	10:9	yes	70
BI7	6631655, 489963	<i>Dendrocnide excelsa</i>	40	10	10:8	yes	40
BI8	6631657, 489957	<i>Dendrocnide excelsa</i>	40	10	10:8	yes	60
BI9	6631649, 489935	<i>Ficus obliqua</i>	150	35	10:5	yes	30
BI10	6631630, 489947	<i>Dendrocnide excelsa</i>	40	12	10:5	yes	30

Female GHFF with dependent young were also present at the Gordon Park and Bowraville camps.

2.2.3.3 Presence of dead young flying-fox

Opportunistic observations did not identify the presence of any dead young beneath the camp at the site or at Bellingin Island. However, due to the camp at the site being located above open water covered in a dense cover of the aquatic weed *Salvinia*, any deaths may have been obscured from view.

2.2.3.4 Water level at the site

Water level at the representative measurement location at the site was approximately 42 cm as is shown in **Figure 2.1**. This water level has decreased steadily since water level measurements have been taken in November.

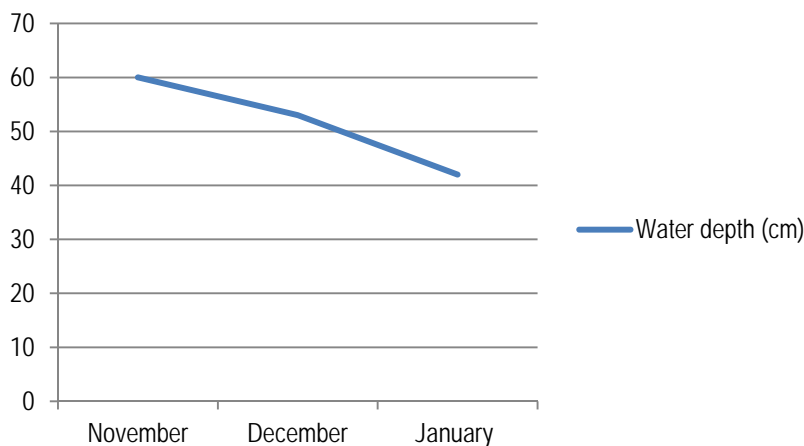


Figure 2.1 Water Level Measurements at The Site

2.3 Discussion

2.3.1 Population Estimate

The flying-fox population estimate at the site of 5170-7860 as recorded in the exit counts on 28-29 January 2014 indicates that there has been an increase in flying-fox numbers since the previous monthly count in December 2013 when 2500 flying fox were counted. It should be noted however that occupation of the site has been sporadic recently, with the following pattern recorded:

- 20 November 2013 (Nov 2013 monthly monitoring event) – camp occupied, including females with dependent young, population estimate 1200;
- 4 December 2013 (Dec 2013 fortnightly monitoring event) – flying-fox absent or in very low numbers (<25 individuals);
- 18 December 2013 (Dec 2013 monthly monitoring event) – camp occupied, including females with dependent young, population estimate 2500);
- 9 January 2014 (Jan 2014 fortnightly monitoring event) – flying-fox absent or in very low numbers (<25 individuals);
- 28-29 January 2014 (January monthly [seasonal] monitoring event) – camp occupied, including females with dependent young, population estimate 5170-7860.

This is also reflected in an increased camp footprint (refer to **Illustration 2.1**). However, the number of individuals is still less than the peak of >10,000 individuals recorded in September 2013. The number of individuals at the site is lower than other regional camps that were visited in January, all of which were estimated to be supporting >10,000 flying-foxes.

Numbers at the Gordon Park appear to have remained relatively stable over recent months. In contrast to this, an obvious increase in numbers of flying-fox was observed in the Bellingen Island and Bowraville camps. Roosting flying-fox at Bowraville now extend for a considerable distance along the riparian zone of the Nambucca River, particularly in Camphor Laurel trees. It should be noted that no exit counts were conducted at these regional camps, and consequently the population estimates for these camps are less reliable than that made for the site.

For comparison with the flying-fox population estimate for the site recorded in the current monitoring event, flying-fox have also been present at the site in January over the last two years. The flying-fox population at the site possibly reached a peak in January 2012 when flying foxes roosted in trees covering approximately 5 hectares and in excess of 10,000 individuals were present and probably >20,000 individuals (Eby 2012). No population estimate of GHFF is available for the site in January of 2013. However, satellite-tracking undertaken by John Martin at the Royal Botanic Garden and Domain Trust (RBGDT) indicates that adult female GHFF individuals were present at the site in January 2013. Satellite-tracked individuals were also recorded at the site in each subsequent month through to May 2013 (data courtesy of John Martin, RBGDT, unpublished).

2.3.2 Species Composition and Demographic Data

Both GHFF and Black Flying-fox were present at all camps sampled in the current monitoring event. GHFF dominated the species composition at all camps, and generally Black Flying-fox only accounted for relatively small numbers <10% at all sites investigated. This is generally consistent with the results from previous monthly monitoring. However, the proportion of GHFF appears to have increased at the site since December 2013 when it was estimated that Black Flying-fox accounted for 20% of individuals.

For GHFF, the percentage of adult females in the population increases in association with population size (Eby 2012). This is supported by the results of the November survey in which the average female to male ratio at the Bellingen Island camp was higher than at the site, where a significantly smaller number of individuals were present (refer to **Table 2.1** and **Table 2.2**). However, in line with the results of the December 2013 monitoring, flying-fox at the site are dominated by male GHFF, with females and young present in relatively low numbers.

The driving factor/s leading to lower female flying-fox numbers at the site during the current monitoring event remain unclear. Strong flowering in the highly productive foraging species Pink Bloodwood (*Corymbia intermedia*) within the broad locality was observed at the time of the monitoring. As is expected a general increase in flying-fox numbers was recorded at both the site and other regional camps corresponding to this foraging resource being readily available at the locality. Despite this, the results of the January 2014 monitoring did not show a corresponding increase in the proportion of females and young occupying the camp as the overall number of individuals at the camp increased.

For the 2013 breeding season, it was surmised that births of GHFF commenced on or around 3 October 2013 within the region (refer to October monthly monitoring report - GeoLINK 2013). The demographic data collected at the site, and at regional camps, indicates that the camp is currently supporting dependent young GHFF that will not be fully independent until approximately March. Flightless young are typically left at a camp while females forage in late November (Eby 2012).

2.3.3 Phenology of Trees in Region

Flowering of *Corymbia* species such as Pink Bloodwood, Red Bloodwood (*C.gummifera*) and Spotted gum (*C. maculata/ C. variegata*), and Grey Ironbark (*Eucalyptus siderophloia*) (foothills and ranges) typically occurs in January in the upper North Coast region of NSW. These trees are recognised as highly productive species in this region and can be considered key diet species for GHFF (Eby 2012; Eby and Law 2008). In most years it is typical that a summer maximum in GHFF population occurs coinciding with the flowering of a number of highly productive nectar producing trees, particularly Pink Bloodwood or Grey Ironbark (Eby 2012).

As mentioned previously, Pink Bloodwood was observed to be flowering strongly in the locality, particularly in the mixed eucalypt forests occurring on low hilly country in the coastal hinterland.

2.4 Conclusion

The results of the January 2014 flying-fox monitoring indicated that flying-foxes have increased in numbers at the site recently, and now are now in the order of 5000 to 8000 individuals. This comes after a variable period of flying-fox presence and absence at the site over the last two months, including an absence in early January 2014.

GHFF dominates the site and other regional camps visited in the monitoring representing over 90% of all individuals and all of the regional camps visited during the monitoring, including the site, were supporting female flying-fox with dependent young at the time of the December 2013 survey.

Due to the dispersed nature flying fox at the site at present, males were generally not in 'bachelor trees' and instead were widely spread and occupied individual mating territories. When females were present they occurred in isolated clumps within areas more broadly occupied by males.

The relatively low proportion of female GHFF recorded occupying the site in the current monitoring is of interest, considering the overall population increase observed at the site and the strong flowering of the highly productive Pink Bloodwood foraging resource locally. It is anticipated that demographic data to be collected at the site in the upcoming summer/ early autumn period, when the GHFF population is expected to be relatively large, will assist in clarifying the recent patterns of usage of the site by female GHFF.



Dr Tom Pollard
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.

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19 March 2014
Ref No: 2182-1084

The Manager
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PO Box 2147
DANGAR NSW 2309

Attention: Rachel Vazey

Dear Rachel,

March 2014 fortnightly Flying-fox monitoring report

This short report details the findings of the March 2014 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.

An exit count was conducted at four vantage points surrounding the site on the evening of 12 March 2014. The majority of flying-fox exited the camp in a westerly direction as has consistently been observed (refer to **Illustration 1.1**). The westerly stream was widespread and indistinct, and consequently estimating numbers exiting via this stream was difficult. It is estimated that the total number of flying-fox counted exiting the camp was between 40,000 and 50,000 individuals.

The large number of flying-foxes recorded in the current monitoring event continues a recent trend over the past 6 weeks of increasing numbers of flying-fox occupying the site. The population estimate of between 40,000 and 50,000 flying-fox at the site represents the largest number of flying-fox that have been recorded since the current round of monitoring began in July 2013.

A traverse of the site was undertaken on 13 March 2014. Roosting flying-foxes were observed to be occupying an area of approximately 3.33 ha (refer to **Illustration 1.1**). This is an increase on the roost footprint of approximately 1.90 ha that was mapped during the last monitoring event conducted in late February 2014, and is approximately equivalent to the maximum roost footprint of 3.60 ha that was mapped in mid-February. A similarly large roost footprint of approximately 5 ha was estimated for the site previously in January 2012 (see Eby [2012] "Assessment of the Flying-fox Camp at Macksville, NSW").

Both GHFF and Black Flying-fox were observed at the site, with GHFF accounting for over 95% of the flying-foxes present. No female flying-fox with dependent young were opportunistically observed at the site indicating that most, if not all young are now fully independent.

General observations made at the other regional flying-fox camps are as follows:

Bellingen Island:

GHFF (>95%) and Black Flying-fox present. Roost area and population similar to that recorded in the last monthly monitoring event.

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Gordon Park (Nambucca Heads):

GHFF (85%), Black Flying-fox (5%) and Little Red Flying-fox (10%) present. Roost area and population may have slightly increased since the last monthly monitoring event reflecting the recent influx of Little Red Flying-fox at the camp.

Bowraville:

Only GHFF were observed. Roost area and population are similar to what was recorded in the last monitoring event, and are reduced compared with the peak observed in January 2014.

Key GHFF diet species (Eby and Law 2008) which are currently flowering in the region include Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Coastal Blackbutt (*Eucalyptus pilularis*) (foothills and ranges). Pink Bloodwood (*Corymbia intermedia*) has now completed its recent heavy flowering.

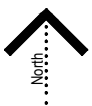
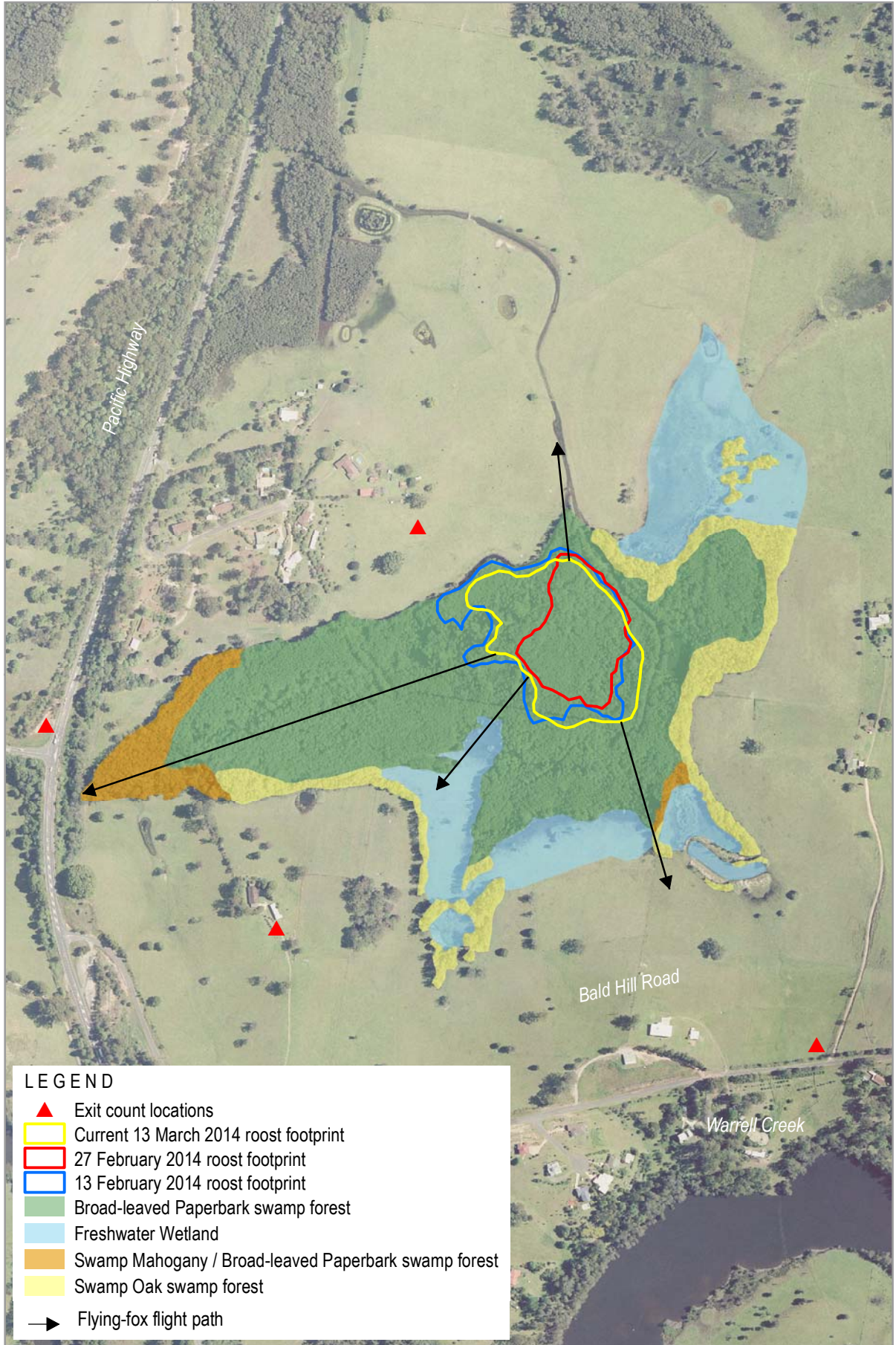
If you have any queries regarding this report, please feel free to call on 02 6687 7666.

Yours sincerely
GeoLINK



Dr Tom Pollard
Ecologist

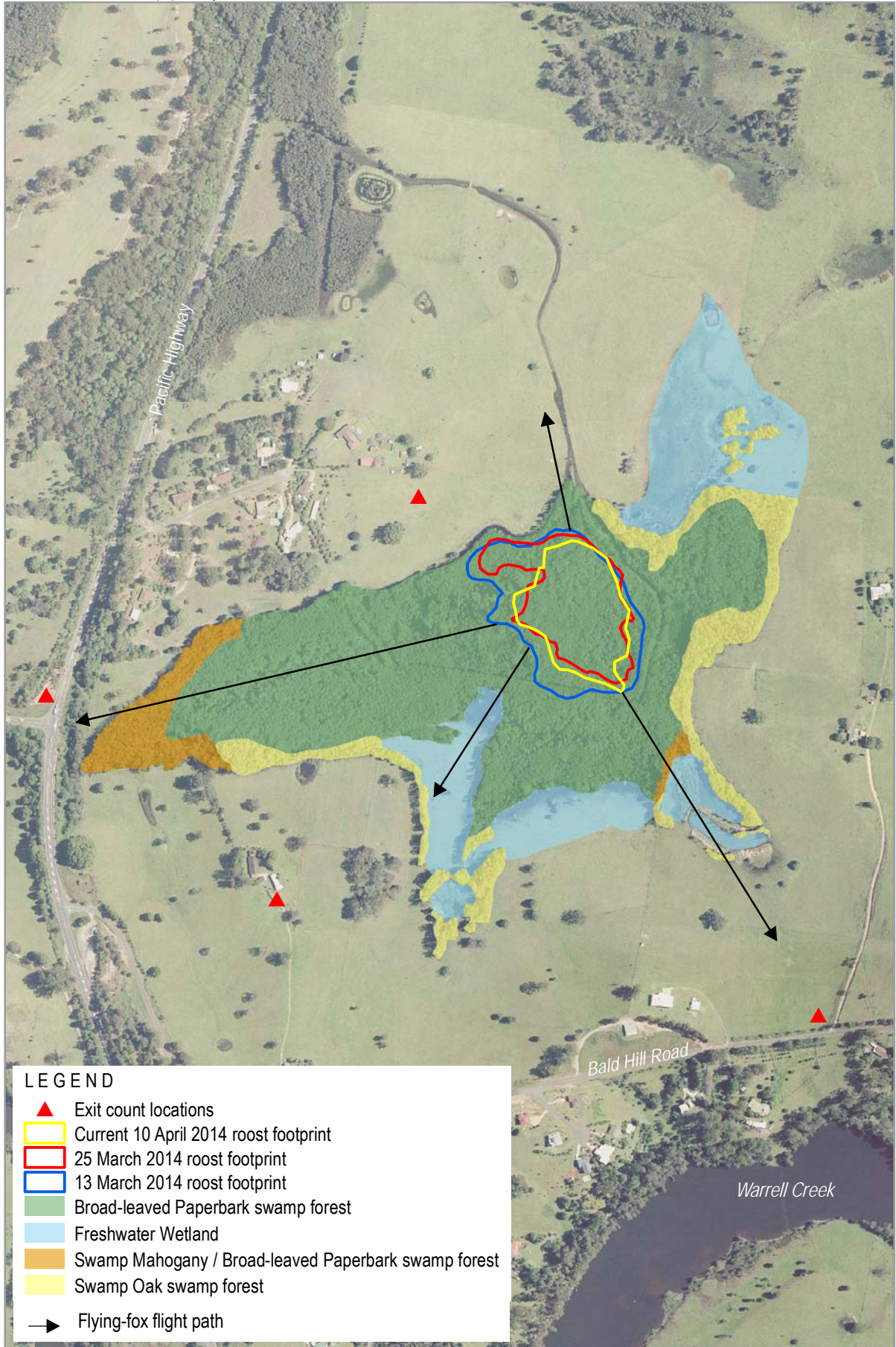
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Flying-fox Monitoring

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

March 2014

Prepared for: Sinclair Knight Merz
© GeoLINK, 2014



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Introduction

1.1 Introduction

Sinclair Knight Merz (SKM) and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at the Macksville roost (henceforth referred to as 'the site'), which is located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road, Macksville. To date, monthly monitoring has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly on the camp since its establishment in December 2011 (Eby 2012).

This report details the March 2014 monitoring results. The monitoring was undertaken on 25 March 2014.

Flying-fox Survey

2.1 Methodology

Fieldwork for the February survey was undertaken by GeoLINK ecologists Dr Tom Pollard and David Andrighetto, GeoLINK environmental scientist Peter Thrift, and ecologist Terry Tweedie (GeoLINK subcontractor). 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 March 2014 monitoring is provided below.

On 25 March a survey of the site was undertaken on foot to locate and map the flying-fox camp footprint and collect data on species composition, demographics, reproductive status and behaviour. For comparison, data was also collected at a control site located at Bellingen Island (approximately 31 km north north-west of the Macksville camp), along with observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to *Illustration 2.2* for location of these regional camps).

The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp.

A dusk exit count survey was undertaken at the site on the evening of 25 March to provide an estimate of the number of flying-foxes currently roosting at the camp. Observers were strategically located where there was a clear view over the camp, corresponding to the directions that flight-paths were observed during previous exit counts.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive);
- west of the Pacific Highway at the junction with Upper Warrell Road;
- on a ridge south of the camp (41 Bald Hill Road); and
- adjacent to Bald Hill Road, approximately 750 m east of the 41 Bald Hill Road vantage point.

The location of these vantage points is shown in *Illustration 2.1*.

The survey extended over approximately one hour from sunset until dark (approximately 7:10 pm to 8:10 pm).

2.2 Results

2.2.1 Population Estimate – Exit Count

The exit count conducted on 25 March resulted in an estimated total of 22,000 flying-foxes present at the camp. Approximately half of the flying-foxes exited the camp heading in a westerly direction and one third exited to the south (refer to Illustration 2.1).

No exit counts were conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: >10,000 individuals (population relatively steady over recent months);
- Bowraville: approximately 10,000 individuals (population relatively steady recently after peaking in February); and
- Bellingen Island: >20,000 individuals (population reduced compared with results from the February monitoring).

2.2.2 Roost Footprint

At the time of the survey, the roost occupied an area of approximately 2.21 ha at the site. This is less than the roost footprint recorded on 13 March (3.30 ha) and slightly larger than that recorded on 27 February (1.90 ha). A maximum roost footprint of 3.60 ha was recorded on 13 February 2014. These results indicate that the area in which the flying-fox are roosting at the site has been fluctuating over recent months.

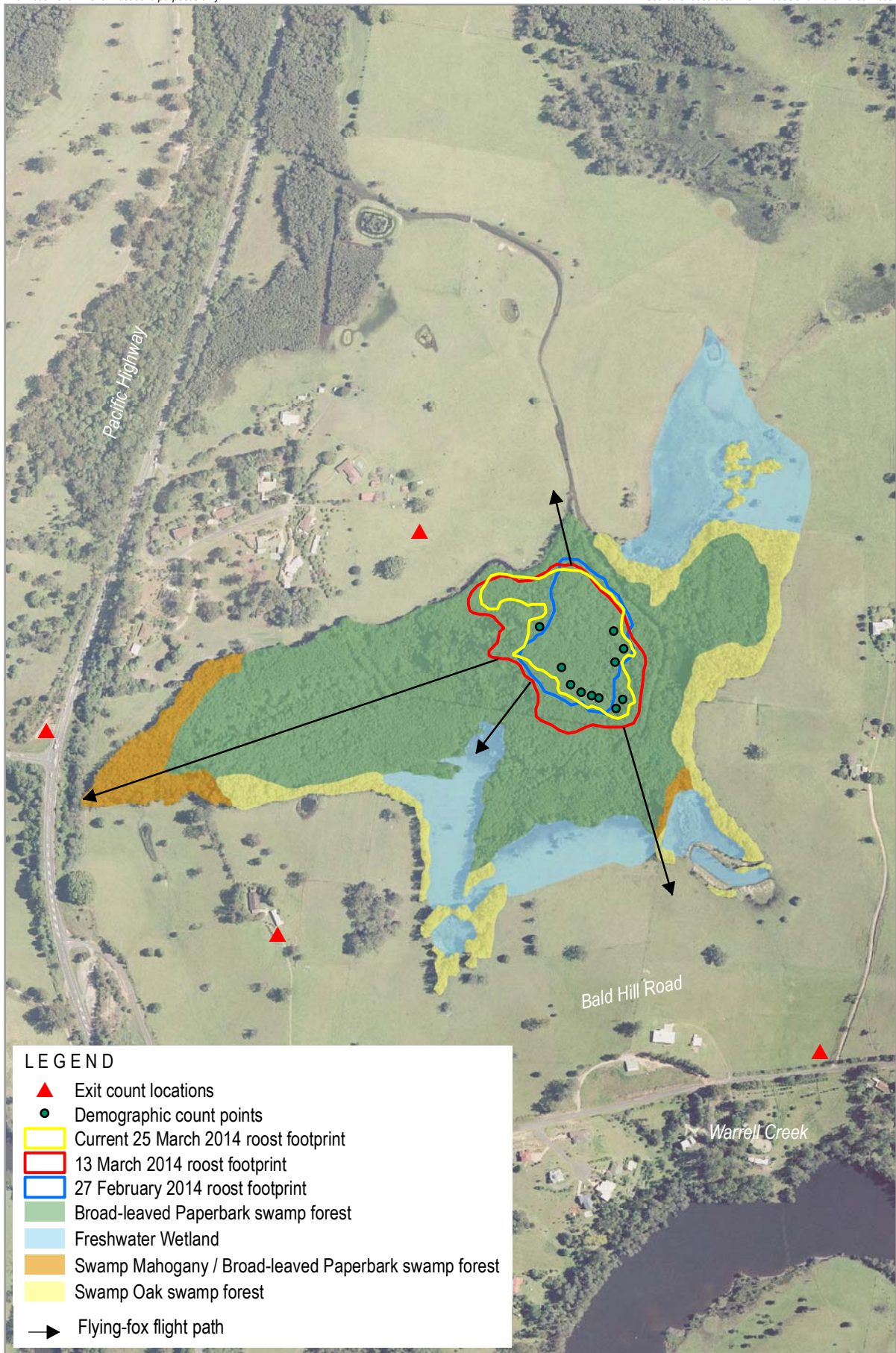
The roost footprint and location of demographic count points is displayed in Illustration 2.1.

As has been previously recorded, the flying-fox are roosting in a dense stand of Broad-leaved Paperbark (*Melaleuca quinquenervia*). These trees averaged approximately 6-8 m in height with a diameter at breast height (DBH) less than 20 cm.

In line with what was recorded in the last monitoring event in mid-March, the roost footprint at Bowraville has remained substantially smaller than the largest extent recorded during February. At that time numerous individuals were roosting in Camphor Laurels extending along the Nambucca River. During the current monitoring event, the only flying-fox roosting on the northern side of the Nambucca River were a small number of Black Flying-fox in two Camphor Laurel trees.

The overall roost footprint does not appear to have changed substantially at the Bellingen Island camp since mid-March. Roosting in the upper canopy of emergent rainforest trees is not as widespread as when the population was peaking during February, indicating that the population has reduced in the intervening period.

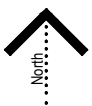
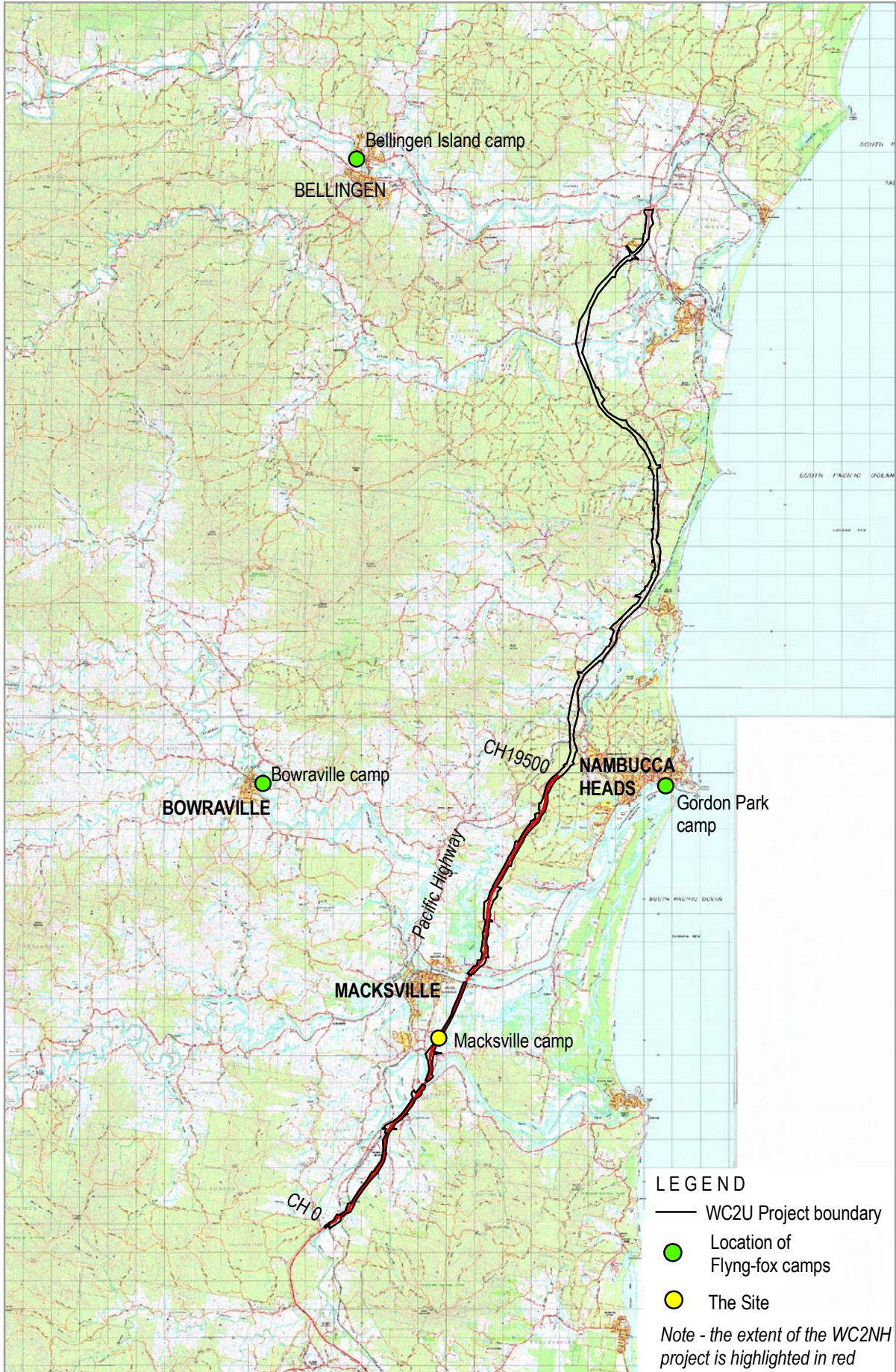
The roost footprint at the Gordon Park camp at Nambucca Heads has expanded over the time covered by the last three monitoring events. This expansion includes individuals roosting in the canopy of Blue Gum and Brush Box trees near the upper section of Wellington Drive and Fraser Street. Damage to the small branches and foliage of rainforest trees by roosting Little Red Flying-fox has resulted in a noticeable thinning of the rainforest canopy.



0 150



Information shown is for illustrative purposes only



0 4 km



2.2.3 Detailed Data

2.2.3.1 Species Composition

Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF), Black Flying-fox (*Pteropus alecto*) and Little Red Flying-fox (*Pteropus scapulatus*) were recorded at the site. It is estimated that between 75% and 90% of all individuals present at the site currently are GHFF. As is discussed in further detail in Section 3 of this report, the relatively large numbers of flying-fox recorded in exit counts since early February may indicate that Little Red Flying-fox was present at the camp over this period despite being undetected. As has been regularly observed at the site previously, Black Flying-fox were observed to be concentrated along the eastern edge of the roost near the drainage channel.

Black Flying-fox were only occasionally observed at Bellinghen Island and Bowraville, with GHFF accounted for >95% of the flying-fox present.

GHFF, Black Flying-fox and Little Red Flying-fox were present at the Gordon Park camp. GHFF accounted for approximately 85% of all individuals present, with Little Red Flying-fox accounting for approximately 10% and Black Flying-fox accounting for approximately 5%. As has been previously recorded, the Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive. The Little Red Flying-fox were observed to be roosting in tight aggregations in the low-mid canopy.

2.2.3.2 Habitat Characteristics and Demographic Composition

Data of habitat characteristics and demographic composition at the site and the Bellinghen Island control site are provided in Table 2.1 and Table 2.2 respectively.

As has been discussed in previous monthly monitoring reports, roost trees at the site are exclusively Broad-leaved Paperbark. The stand is even aged, consisting of trees 6-8 m in height, with a diameter at breast height (DBH) of less than 20 cm. The stand is relatively dense with trees spaced on average 1-2 m apart. There is no significant discernible difference in tree species, forest structure or water depth in areas immediately adjacent to the camp.

The structure of the vegetation at the Bellinghen Island camp consists of a canopy of emergent rainforest species (with some large native figs of substantial diameter and up to 40 m in height) over a relatively open understorey.

Table 2.1 displays the results of the demographic data collected at the site.

The results indicated that some areas of the camp are predominantly supporting male flying-fox (e.g. eastern section of the camp; refer to Illustration 2.1), while other areas had a mixed assemblage, including a substantial proportion of female GHFF, mostly without young (e.g. southern/ western section of the camp; refer to Illustration 2.1). A small number of young with their mothers were observed and these individuals still display partial dependence as evidenced by their clinging to their mothers.

In those parts of the camp in which males dominate (demographic count points M1-M6) the ratio of females to males ranged between 1:2 and 2:9. In other parts of the camp where the proportion of females was higher (demographic count points M7-M10), the ratio of females to males ranged between 10:3 and 5:4. Females with (partially) dependent young were not commonly observed, and when present only made up 10% of the total females. As has been consistently recorded over the 2013-2014 summer, this percentage of females with (partially) dependent young is substantially lower than at the Bellinghen Island control site (refer to Table 2.2).

Table 2.1 Demographic Data for The Site

Tree Code	GPS Coordinates (easting, northing)	Tree Species	Diameter at Breast Height (DBH) (cm)	Height (m)	Sex Ratio (female:male)	Presence of Dependant Young (yes/no)	% females with Dependent Young
M1	6600675, 492979	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	1:5 (predominantly males)	no	n/a
M2	6600649, 492996	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	2:5 (predominantly males)	no	n/a
M3	6600631, 492980	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	1:2 (predominantly males)	no	n/a
M4	6600570, 492984	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	2:3 (predominantly males)	no	n/a
M5	6600555, 492989	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	2:9 (predominantly males)	no	n/a
M6	6600558, 492932	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	1:4 (predominantly males)	no	n/a
M7	6600562, 492931	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:3	no	n/a
M8	6600565, 492915	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	5:4	no	n/a
M9	6600578, 492893	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	5:4	yes (partial - some dependent behaviours)	n/a
M10	6600602, 492874	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	5:4	no	n/a

Table 2.2 displays the results of the demographic data collected at the Bellinghen Island camp. Females were more numerous than males in the majority of demographic counts. Females with (partially) dependent young were also commonly observed across the camp ranging between 30% and 70% of the total number of females recorded at demographic count points.

Table 2.2 Demographic Data for Bellinghen Island

Tree Code	GPS Co-ordinates (easting, northing)	Tree Species	Diameter at Breast Height (DBH) (cm)	Height (m)	Sex Ratio (female:male)	Presence of Dependant Young (yes/no)	% females with Dependent Young
BI1	6631550, 489985	<i>Ficus coronata</i>	20	8	10:3	yes (partial - some dependent behaviours)	50
BI2	6631525, 490039	<i>Argyrodendron trifoliatum</i>	25	12	1:1	yes (partial - some dependent behaviours)	60
BI3	6631513, 490050	Unknown sp.	25	10	2:1	yes (partial - some dependent behaviours)	40
BI4	6631505, 490061	<i>Ficus macrophylla</i>	30	8	2:1	no	n/a
BI5	6631532, 490059	<i>Ficus coronata</i>	20	8	1:1	yes (partial - some dependent behaviours)	70
BI6	6631530, 490063	<i>Ficus macrophylla</i>	20/20 (2 stems)	9	5:2	yes (partial - some dependent behaviours)	50
BI7	6631523, 490050	<i>Dendrocnide excelsa</i>	35	15	10:9	yes (partial - some dependent behaviours)	50
BI8	6631564, 490094	<i>Ficus coronata</i>	15	8	10:3	yes (partial - some dependent behaviours)	30
BI9	6631588, 490075	<i>Ficus coronata</i>	15	6	10:9	yes (partial - some dependent behaviours)	30
BI10	6631535, 490065	<i>Ficus coronata</i>	20	6	5:3	yes (partial - some dependent behaviours)	40

Female GHFF with (partially) dependent young were also present at the Gordon Park and Bowraville camps.

2.2.3.3 Water level at the site

Water level at the representative measurement location at the site was approximately 38 cm as is shown in Figure 2.1. The decline in the water level at the swamp has stopped during the last month following a return to more average rainfall conditions after a dry spring/ summer period.

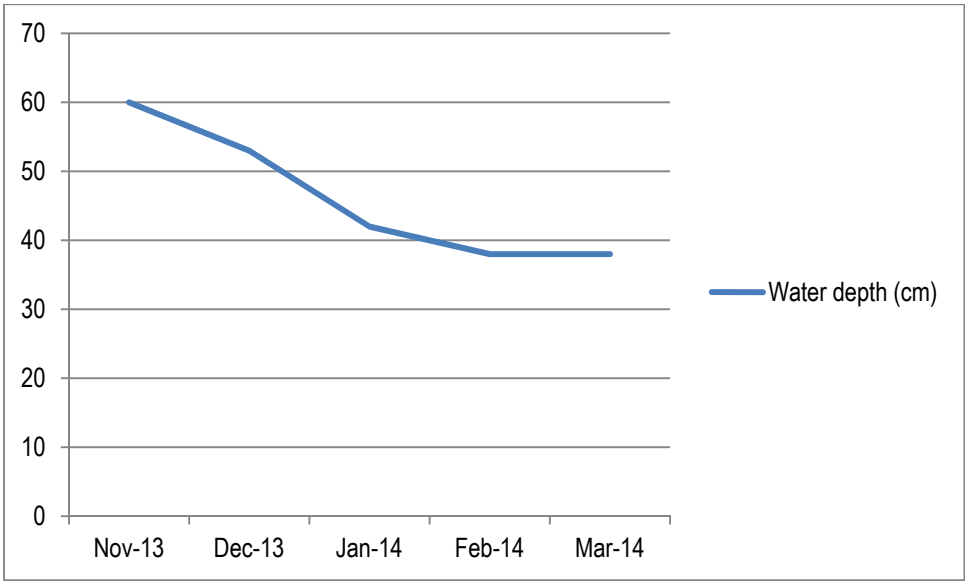


Figure 2.1 Water Level Measurements at The Site

2.3 Discussion

2.3.1 Population Estimate

Conditions were not ideal for undertaking the exit count at the site. Cloud and light rain made distinguishing the flying-fox against the sky difficult. However, despite these challenges the observers all reported that the count resulted in a reasonable estimate of the current population.

The flying-fox population estimate at the site of 22,000 as recorded in the exit count on 25 March indicates that flying-fox numbers are still at a relatively high level. However, there has been a substantial reduction in the population since the last monitoring event on 13 March, when numbers exceeded 40,000 individuals.

Although this is the first monitoring event in which Little Red Flying-fox has been verified at the site, the recent large number of individuals recorded in the exit counts may be an indication that Little Red Flying-fox has been present over a longer period. Due to the propensity of this species to roost in dense aggregations it is feasible that a substantial number of individuals of this species may have been overlooked roosting in the core area of the camp which was not traversed (due to the flying-fox being easily spooked).

In line with the reduction in flying-fox population at the camp since the last monitoring event, the area occupied by the roost has also recently decreased from approximately 3.30 ha on 13 March to approximately 2.21 ha in the current monitoring event. Previous monitoring in January indicated that males were widely spaced within the camp at this time, and occupied individual territories. Following this, monitoring in February indicated that females had arrived at the camp and were roosting within the pre-established male territories, with the overall effect that the density of flying-fox increased at the site. Observations from the current monitoring event indicate a noticeable reduction in the density of flying-fox at the camp compared with what was observed in February.

Observations of flying-fox at the regional camps seem to indicate that a population reduction has occurred at both the Bowraville and Bellingen Island camps recently. In contrast to this, the number of flying-fox at the Nambucca Heads camp appears to have remained relatively stable. However, verifying this by undertaking exit counts the usefulness of these observations is limited. Despite not undertaking exit counts, other flying-fox observers concur that numbers have recently decreased at the Bellingen Island site (pers. comm. Vivian Jones).

Flying-fox are likely to have been present at the site during March over the last two years. A survey of the site by Nambucca Shire Council indicated a flying-fox presence (albeit in a reduced footprint) in March 2012 (Eby 2012). No population estimate of GHFF is available for the site in March 2013. However, satellite-tracking undertaken by John Martin at the Royal Botanic Garden and Domain Trust (RBGDT) indicates that adult female GHFF individuals were present at this time (data courtesy of John Martin, RBGDT, unpublished).

2.3.2 Species Composition, Demographic Data and Behaviour

At the site and all regional camps both GHFF and Black Flying-fox were recorded in the current monitoring event. In addition to these species Little Red Flying-fox were recorded at the site and at the Gordon Park camp. GHFF dominated the species composition at all camps, and generally Black Flying-fox only accounted for relatively small numbers <5% at all sites investigated. As mentioned above, due to the propensity of Little Red Flying-fox to roost in dense aggregations, it is difficult to ascertain the relative proportion of Little Red Flying-fox present. However, based on the recent large number of flying-fox present at the site and the observations gathered during the traverse of the camp, it is estimated that this species is contributing between 10 and 25 percent to the overall size of the flying-fox population at present.

The percentage of adult female flying-fox in a population is known to generally increase in association with population size (Eby 2012). The influx of female flying-fox which occurred at the site during February 2014 corrected the male-dominated demographic composition which had been recorded during the early summer period. This demographic composition is more reflective of what is expected when the flying-fox population is relatively large. However, when compared with Bellingen Island, the relative proportion of females in the camp is still low.

The site currently supports a minor component of young GHFF that are still not fully independent and were observed clinging to their mothers. Independence typically occurs around March (Eby 2012). Therefore, it is expected that these dependent behaviours will become less common over the upcoming monitoring events in April.

GHFF mating behaviours were observed the site and all other regional camps during this monitoring event.

2.3.3 Phenology of Trees in Region

Flowering of a number of highly productive nectar source trees typically occurs in March in the upper North Coast region of NSW including a variety of *Corymbia* species such as Pink Bloodwood, Red Bloodwood (*C. gummifera*) and Spotted gum (*C. maculata*/*C. variegata*), Coastal Blackbutt (*Eucalyptus pilularis*) (foothills and ranges) 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). Of these species, only Broad-leaved Paperbark was observed to be flowering at the time of the current monitoring event when driving between the regional camps. It was also observed that Pink Bloodwood has now completed its recent heavy flowering. Other non-key diet species for GHFF that are known or likely to be currently flowering in the region and supplying a nectar resource for GHFF include Coast Banksia (*Banksia integrifolia*), Old Man Banksia (*Banksia serrata*) and Fern-leaved Banksia (*Banksia oblongifolia*).

2.4 Conclusion

The results of the March 2014 flying-fox monitoring indicate that flying-foxes numbers are still relatively high at the site at 22,000, despite decreasing substantially since the previous monitoring event. This comes after a variable period of flying-fox presence and absence at the site in December 2013 and January 2014, including an absence in early January 2014.

GHFF dominated the site and other regional camps. All camps visited during the monitoring, including the site, supported female flying-fox with (partially) dependent young. However, only a low proportion of females with young were recorded at the site, in line with results from the last monitoring event. Flying-fox mating behaviours were evident at all of the camps visited.

During the traverse of the site, roosting Little Red Flying-fox were observed for the first time. Due to this species habit of densely aggregating, it is feasible that this species could have remained undetected in previous monitoring. If this is the case, Little Red Flying-fox may have been contributing to the relatively large flying-fox population that has been recorded at the site recently.

Observations from the current monitoring event indicate that overall numbers of flying-fox at (most) regional camps have decreased since a peak in February 2014. This is likely to be in response to the current levels of foraging resource availability locally including the cessation of the recent heavy flowering of Pink Bloodwood.



Dr Tom Pollard
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.

22 April 2014
Ref No: 2182-1092

The Manager
Sinclair Knight Merz
PO Box 2147
DANGAR NSW 2309

Attention: Rachel Vazey

Dear Rachel

February 2014 fortnightly Flying-fox monitoring report (second issue)

This short report details the findings of the February 2014 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.

A traverse of the site was undertaken on 13 February 2014. Roosting flying-fox were observed to be occupying an area of approximately 3.60 ha (refer to **Illustration 1.1**). This is a considerable increase on the roost footprint of 1.11 ha that was mapped in the last monitoring event in late January 2014. Flying-fox are also likely to have occupied a large roost footprint of approximately 5 ha in January 2012 when numbers of flying-fox at the site were at a peak (see Eby [2012] "*Assessment of the Flying-fox Camp at Macksville, NSW*").

Both GHFF and Black Flying-fox were observed at the site, with GHFF accounting for over 95% of the flying-foxes present. Female GHFF with young were also observed roosting at the site during the traverse.

An exit count was conducted at four vantage points surrounding the site on the night of the 13 February. This resulted in an estimated count of 30,000 flying-fox occupying the camp. This is the largest number of flying-fox that have been recorded since the current round of monitoring began last July 2013. During the population peak at the site in January 2012, Eby (2012) estimated flying-fox numbers to have been in excess of 20,000 individuals. Most flying-fox were recorded exiting the camp in a westerly direction during the current exit count, with the next most prominent flight-path being to the north (refer to **Illustration 1.1**).

The relatively large numbers of flying-fox currently occupying the site is likely to be in response to recent heavy flowering of Pink Bloodwood (*Corymbia intermedia*) in the region, and to a lesser degree flowering of Broad-leaved Paperbark (*Melaleuca quinquenervia*), which is just beginning.

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

Yours sincerely
GeoLINK



Dr Tom Pollard
Ecologist

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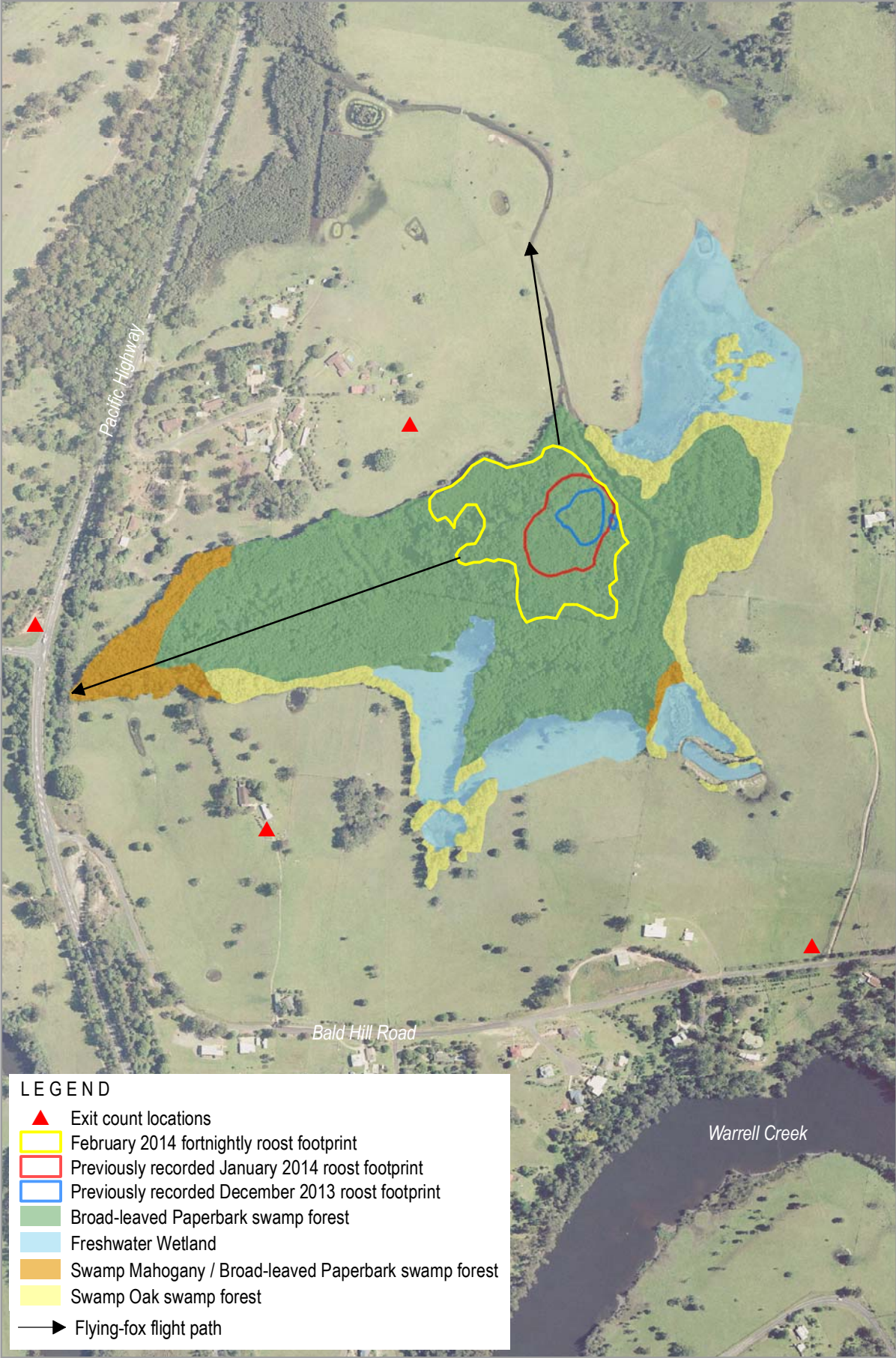
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Flying-fox Monitoring

Warrell Creek to Nambucca Heads

Pacific Highway Upgrade

February 2014

Prepared for: Sinclair Knight Merz
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Introduction

1.1 Introduction

Sinclair Knight Merz (SKM) and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at the Macksville roost (henceforth referred to as 'the site'), which is located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road, Macksville. To date, monthly monitoring has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly on the camp since its establishment in December 2011 (Eby 2012).

This report details the February 2014 monitoring results. The monitoring was undertaken on 27-28 February 2014.

Flying-fox Survey

2.1 Methodology

Fieldwork for the February survey was undertaken by GeoLINK ecologist Dr Tom Pollard, GeoLINK environmental scientists Grant McLean and Peter Thrift, and ecologist Terry Tweedie (GeoLINK subcontractor). 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 February 2014 monitoring is provided below.

A dusk exit count survey was undertaken at the site on the evening of 27 February 2014 to provide an estimate of the number of flying-foxes currently roosting at the camp. Observers were strategically located where there were clear views over the camp, corresponding to the directions that flight-paths were observed during previous exit counts.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive);
- west of the Pacific Highway at the junction with Upper Warrell Road;
- on a ridge south of the camp (41 Bald Hill Road); and
- adjacent to Bald Hill Road, approximately 750 m east of the 41 Bald Hill Road vantage point.

The location of these vantage points is shown in Illustration 2.1.

The survey extended over approximately one hour from sunset until dark (approximately 7:30 pm to 8:30 pm).

On 28 February 2014, a survey of the site was undertaken on foot to locate and map the flying-fox camp footprint and collect data on species composition, demographics, reproductive status and behaviour. For comparison, data was also collected at a control site located at Bellingen Island (approximately 31 km north north-west of the Macksville camp), along with observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to Illustration 2.2 for location of these regional camps).

The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp.

2.2 Results

2.2.1 Population Estimate – Exit Count

The exit count conducted on 28 January estimated that 34,000 flying-foxes were recorded exiting the camp. Approximately two-thirds of the flying-foxes exited the camp heading in a westerly direction (refer to Illustration 2.1), with smaller streams to the north and south.

No exit counts were conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: >10,000 individuals;
- Bowraville: 5,000-10,000 individuals; and
- Bellingen Island: >20,000 individuals (however, a reduction in numbers compared with recent months).

Although the flying-fox numbers given at the regional camps are rough estimates only, it should be noted that general observations would seem to indicate that flying-fox numbers at the Gordon Park camp have remained steady since the last monitoring event in mid-January, while numbers at Bellingen Island are somewhat reduced and numbers at Bowraville are noticeably reduced from >10,000 at the last monitoring event.

2.2.2 Roost Footprint

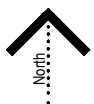
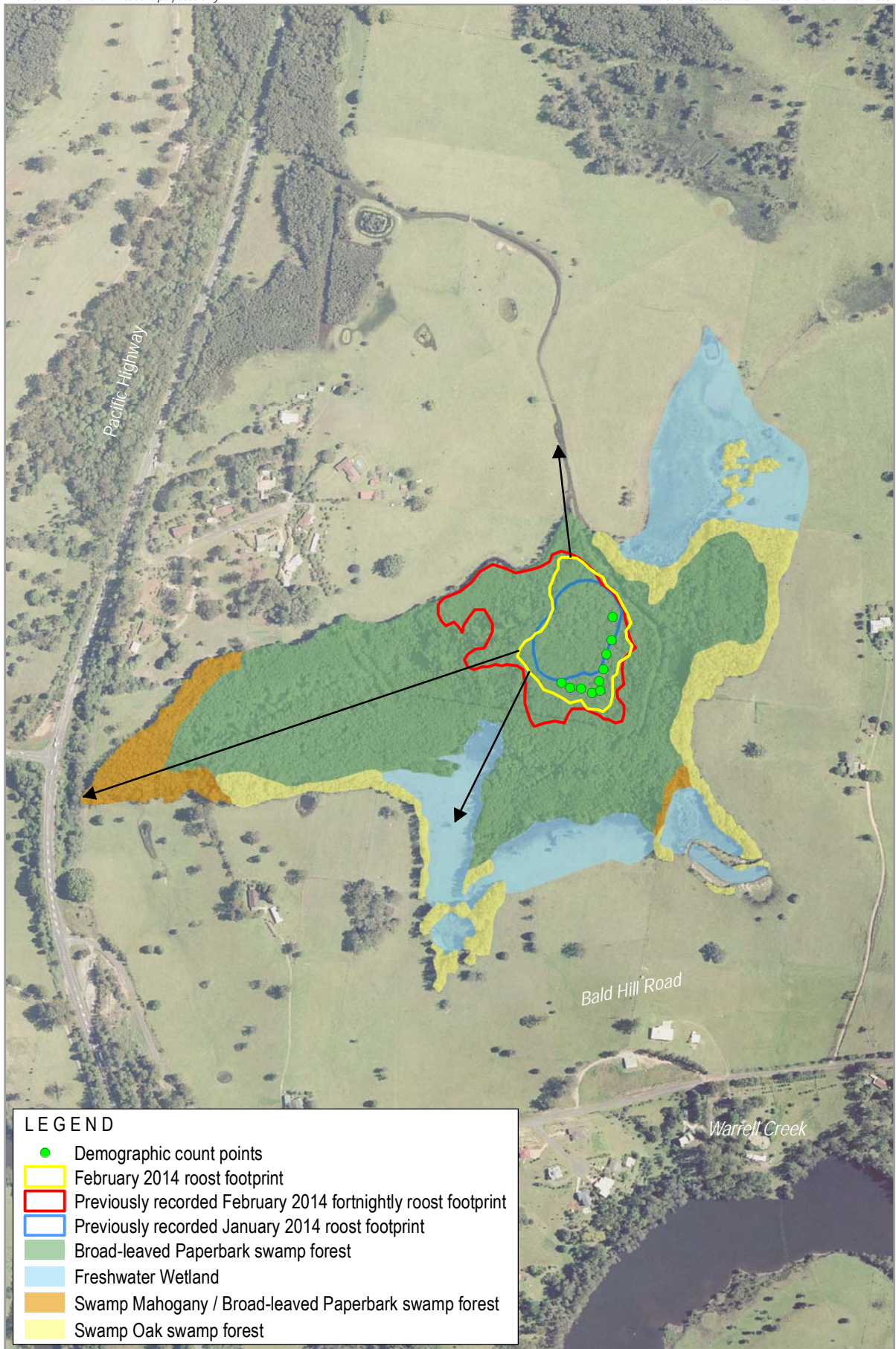
At the time of the survey, the roost occupied an area of approximately 1.90 ha at the site. This roost footprint is less than the maximum roost footprint of 3.60 ha mapped in mid-February 2014, but is nonetheless still relatively extensive compared with the size of roost footprints mapped in monitoring prior to the mid-February maximum.

The roost footprint and location of demographic count points is displayed in Illustration 2.1.

As has been previously recorded, the flying-fox are roosting in a dense stand of Broad-leaved Paperbark (*Melaleuca quinquenervia*). These trees averaged approximately 6-8 m in height with a diameter at breast height (DBH) less than 20 cm.

A substantial reduction in the roost footprint has occurred at Bowraville, with individuals previously recorded in Camphor Laurels extending along the Nambucca River no longer present. Roosting in the upper canopy of the emergent rainforest trees (indicating the camp was at or near capacity), as recorded in the January 2014 monthly monitoring, is also no longer occurring.

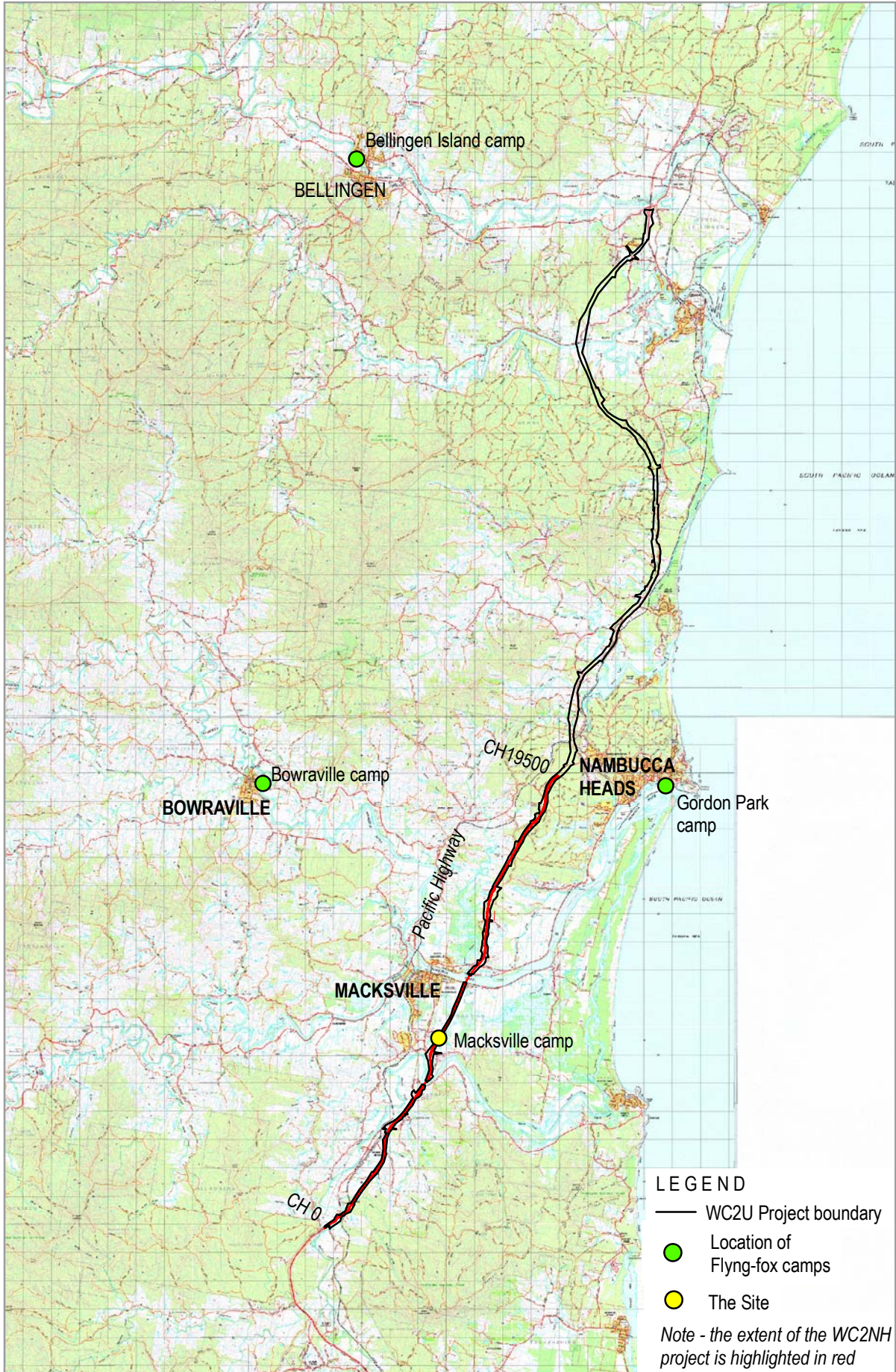
The overall roost footprint did not appear to have changed substantially at the Bellingen Island camp. However, as for Bowraville, roosting in the upper canopy of emergent rainforest was also longer occurring which may indicate that numbers are lower than recorded last month.



0 150

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0 4 km



2.2.3 Detailed Data

2.2.3.1 Species Composition

Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) and Black Flying-fox (*Pteropus alecto*) were both recorded at the site. Black Flying-fox were uncommon, and it was estimated that >95% of the flying-fox present consisted of GHFF. This proportion has remained relatively constant at the site over recent monitoring events. As has been regularly observed at the site previously, Black Flying-fox are typically concentrated along the eastern edge of the roost near the drainage channel.

Similar to the site, at Bellinghen Island Black Flying-fox were only occasionally observed, with GHFF accounted for >95% of the flying-fox present. This is consistent with proportions recorded in recent months.

Only GHFF were observed at the Bowraville camp.

In contrast, GHFF, Black Flying-fox and Little Red Flying-fox were present at the Gordon Park camp. GHFF accounted for approximately 90% of all individuals present, with the other two flying-fox species accounting for approximately 5% each. As has been previously recorded, the Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive. The Little Red Flying-fox were observed clustered together within the core area of the camp.

2.2.3.2 Habitat Characteristics and Demographic Composition

Data of habitat characteristics and demographic composition at the site and the Bellinghen Island control site are provided in Table 2.1 and Table 2.2 respectively.

As has been discussed in previous monthly monitoring reports, roost trees at the site are exclusively Broad-leaved Paperbark. The stand is even aged, consisting of trees 6-8 m in height, with a diameter at breast height (DBH) of less than 20 cm. The stand is relatively dense with trees spaced on average 1-2 m apart. There is no significant discernible difference in tree species, forest structure or water depth in areas immediately adjacent to the camp.

The structure of the vegetation at the Bellinghen Island camp consists of a canopy of emergent rainforest species (with some large native figs of substantial diameter and up to 40 m in height) over a relatively open understorey.

Table 2.1 displays the results of the demographic data collected at the site. The camp is no longer dominated by male GHFF as was recorded in the two previous monthly monitoring events.

A substantial proportion of female GHFF without young were recorded in the demographic counts, and some female GHFF were recorded with young were recorded also. These young were not yet fully independent; sometimes observed roosting on their own, and other times clinging to their mothers. After the exit count was complete young flying-fox were heard calling from the camp, indicating that they are being left at the camp overnight while the mature flying-fox leave to forage. This is normal as young are typically not fully independent until March (Eby 2012).

As mentioned previously, male GHFF are currently not dominating the camp. The ratio of females to males in roost trees ranged from approximately 1:1 to 1:3. The percentage of GHFF females with dependent young in demographic counts was relatively low and ranged between 10% and 20%, which is substantially lower than the Bellinghen Island control site (refer to Table 2.2).

Table 2.1 Demographic Data for The Site

Tree Code	GPS Co-ordinates (easting, northing)	Tree Species	Diameter at Breast Height (DBH) (cm)	Height (m)	Sex Ratio (female:male)	Presence of Dependant Young (yes/no)	% females with Dependent Young
M1	6600583, 492900	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:8	Yes (becoming independent)	20
M2	6600573, 492914	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:6	Yes (becoming independent)	10
M3	6600566, 492930	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:3	no	n/a
M4	6600565, 492949	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:25 (predominantly males)	Yes (becoming independent)	10
M5	6600577, 492950	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:3	no	n/a
M6	6600588, 492954	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:6	no	n/a
M7	6600608, 492954	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:9	Yes (becoming independent)	10
M8	6600634, 492964	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:6	no	n/a
M9	6600651, 492977	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:7	no	n/a
M10	6600681, 492974	<i>Melaleuca quinquenervia</i> (multiple)	10-20	6-8	10:4	no	n/a

Table 2.2 displays the results of the demographic data collected at the Bellinghen Island camp. Females were more numerous than males in all demographic counts, although at four of the demographic count points the ratio of females to males was close to 1:1. Females with young (still partly dependent) were also commonly observed across the camp ranging between 10% and 60% of the total number of females recorded at demographic count points.

Table 2.2 Demographic Data for Belling Island

Tree Code	GPS Co-ordinates (easting, northing)	Tree Species	Diameter at Breast Height (DBH) (cm)	Height (m)	Sex Ratio (female:male)	Presence of Dependant Young (yes/no)	% females with Dependent Young
BI1	6631588, 490044	<i>Dendrocnide excelsa</i>	30	10	10:4	Yes (becoming independent)	20
BI2	6631586, 490052	<i>Argyrodendron trifoliatum</i>	100	25	10:3	Yes (becoming independent)	40
BI3	6631556, 490058	<i>Dendrocnide excelsa</i>	20	10	10:9	Yes (becoming independent)	50
BI4	6631537, 490064	<i>Dendrocnide excelsa/ Ficus coronata</i>	15-20	8-15	10:3	Yes (becoming independent)	30
BI5	6631555, 490084	<i>Dendrocnide excelsa</i>	80	20	10:2	Yes (becoming independent)	50
BI6	6631618, 490040	<i>Melia azedarach</i>	20	8	10:9	Yes (becoming independent)	20
BI7	6631645, 490026	<i>Ficus macrophylla</i>	20	7	10:8	Yes (becoming independent)	50
BI8	6631628, 490001	<i>Dendrocnide excelsa</i>	30	10	10:8	Yes (becoming independent)	10
BI9	6631591, 489951	<i>Dendrocnide excelsa</i>	40	20	10:5	Yes (becoming independent)	60
BI10	6631650, 490070	<i>Waterhousea floribunda</i>	30	12	10:5	Yes (becoming independent)	20

Female GHFF with young (still partly dependent) were also present at the Gordon Park and Bowraville camps.

2.2.3.3 Water level at the site

Water level at the representative measurement location at the site was approximately 38 cm as is shown in Figure 2.1. This water level has been decreasing since water level measurements have been taken in November.

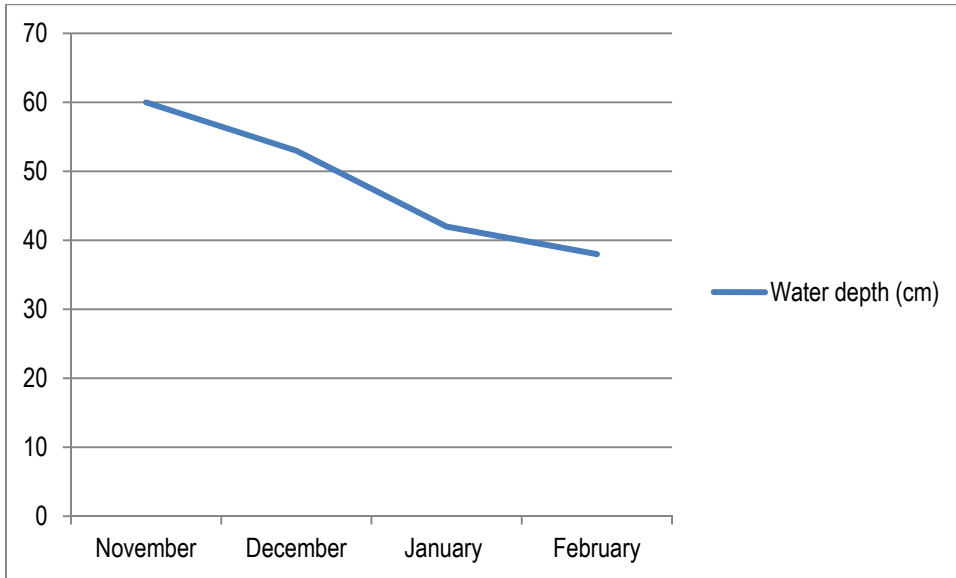


Figure 2.1 Water Level Measurements at The Site

2.3 Discussion

2.3.1 Population Estimate

The flying-fox population estimate at the site of 34,000 as recorded in the exit count on 27 February 2014 indicates that flying-fox numbers have remained at a high level since the mid-February 2014 count when approximately 30,000 individuals were recorded. Overall, flying-fox numbers at the site have been increasing from the end of January 2014, following sporadic occupation during November and December 2013.

The camp footprint has reduced from 3.6 ha in mid-February to around 1.9 ha as mapped in this monitoring event (refer to **Illustration 2.1**). Previous monitoring in January 2014 indicated that males were widely spaced within the camp at this time, and occupied individual territories. It is apparent that females have recently arrived since then and are now roosting within the pre-established male territories. Consequently, this influx of females has increased the overall density of flying-fox at the site.

It is evident that the number of flying-fox individuals at the site is now relatively large when compared with estimates of the flying-fox population at some of the other regional camps visited (e.g. Bowraville or Gordon Park). While numbers at the Gordon Park appear to have remained relatively stable over recent months, a decrease in flying-fox numbers appears to have occurred at the Bellingen Island and Bowraville camps, with the latter being the most obvious. The camp no longer extends along the riparian zone of the Nambucca River, instead occupying the main area remnant rainforest vegetation only. The observation that roosting individuals in the upper canopy of emergent rainforest are currently not a feature of the Bellingen Island and Bowraville camps indicates that numbers are likely to be lower at these camps when compared with last month.

Flying-fox are likely to have been present at the site during February over the last two years. Eby (2012) indicates that a large number of flying-fox (probably >20,000) were present at the site in January 2012, and a survey by Nambucca Shire Council indicated a flying-fox presence (albeit in a reduced footprint) at the site in March 2012. Considering the large numbers of flying-fox that were present, it is reasonable to assume that the flying-fox were also present at the site in February 2012. No population estimate of GHFF is available for the site in February of 2013. However, satellite-tracking undertaken by John Martin at the Royal Botanic Garden and Domain Trust (RBGDT) indicates that adult female GHFF individuals were present at the site in February 2013. Satellite-tracked individuals were also recorded at the site in each subsequent month through to May 2013 (data courtesy of John Martin, RBGDT, unpublished).

2.3.2 Species Composition, Demographic Data and Behaviour

At the site and all regional camps apart from Bowraville, both GHFF and Black Flying-fox were present during the current monitoring event. In addition to these species, for the first time Little Red Flying-fox were also recorded at the Gordon Park camp. GHFF dominated the species composition at all camps, and generally Black Flying-fox only accounted for relatively small numbers <5% at all sites investigated. This is generally consistent with the results from previous monthly monitoring.

The percentage of adult female flying-fox in a population is known to generally increase in association with population size (Eby 2012). The recent influx of female flying-fox at the site has corrected the previously male-skewed female to male ratio, and resulted in a demographic composition that is more reflective of what is expected when the flying-fox population is relatively large. As has been recorded for a number of months now, the average female to male ratio at the Bellingen Island camp is higher than at the site. The site currently supports young GHFF that are still not fully independent. This independence typically occurs around March (Eby 2012).

GHFF mating behaviours were observed the site and all other regional camps during this monitoring event.

2.3.3 Phenology of Trees in Region

Flowering of a number of highly productive nectar source trees occurs in February in the upper North Coast region of NSW including *Corymbia* species such as Pink Bloodwood, Red Bloodwood (*C. gummifera*) and Spotted gum (*C. maculata*/*C. variegata*), Coastal Blackbutt (*Eucalyptus pilularis*) (foothills and ranges) 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).

As mentioned previously, Pink Bloodwood was observed to be flowering strongly in the locality, particularly in the mixed eucalypt forests occurring on low hilly country in the coastal hinterland, and Broad-leaved Paperbark was observed to be starting to flower at site. It is typical that a summer maximum in GHFF population occurs coinciding with the flowering of a number of highly productive nectar producing trees, particularly Pink Bloodwood or Grey Ironbark (Eby 2012). This is seen in the current relatively high numbers of flying-foxes present at the site.

2.4 Conclusion

The results of the January 2014 flying-fox monitoring indicate that flying-foxes have increased in numbers at the site over recent months, and now are now in the order of 34,000 individuals. This comes after a variable period of flying-fox presence and absence at the site in December 2013 and January 2014, including an absence in early January 2014.

GHFF dominates at the site and other regional camps, representing over 90% of all individuals present. All camps visited during the monitoring, including the site, were supporting female flying-fox with (semi) dependent young at the time of the current monitoring event. Young flying-fox are still showing some behaviour indicating reliance, and are not typically fully independent until March (Eby 2012).

Results of the monitoring suggest that an influx of female GHFF has recently occurred at the site, mostly consisting of females without young. As these females are now occupying the space within individual mating territories, the overall density of flying-fox at the camp has increased. This has resulting in a minor increase in the population present at the site, despite a significant decrease in the roost footprint.

Flying-fox mating behaviours were evident at all of the camps visited.

Flowering of a range of key foraging resources for the GHFF continues within the region. This is currently supporting the relatively large population at the site.



Dr Tom Pollard
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.

Flying-fox Monitoring

Warrell Creek to Nambucca Heads

Pacific Highway Upgrade

May 2014

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Introduction

1.1 Introduction

Sinclair Knight Merz (SKM) and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at the Macksville roost (henceforth referred to as 'the site'), which is located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road, Macksville. To date, monthly monitoring has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly on the camp since its establishment in December 2011 (Eby 2012).

This report details the May 2014 monitoring results. The monitoring was undertaken on 28-29 May 2014.

Flying-fox Survey

2.1 Methodology

Fieldwork for the May survey was undertaken by GeoLINK ecologist Dr Tom Pollard and ecologist Terry Tweedie (GeoLINK subcontractor). 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 May 2014 monitoring is provided below.

A dusk exit count survey was undertaken at the site on the evening of 28 May 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. Fewer observers were utilised for the exit count compared with recent monitoring of the site in response to known low numbers/ absence of flying-foxes at the camp.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive); and
- on a ridge south of the camp (41 Bald Hill Road).

The survey extended over approximately 30 minutes from sunset until dark (approximately 5:15 pm to 5:45 pm).

On 29 May a survey of the site was undertaken on foot to locate and map any roosting flying-foxes and collect data on species composition, demographics, reproductive status and behaviour. The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp. For comparison, it was intended to collect comparison data at a control site located at Bellingin Island (approximately 31 km north north-west of the Macksville camp), along with observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to (refer to Illustration 2.1) for location of these regional camps).

2.2 Results

2.2.1 Population Estimate – Exit Count

No flying-foxes were observed flying from the site in the exit count conducted on 28 May. A handful of flying-foxes (<10) were observed to be flying overhead on the northern ridge. However, these individuals were flying from north to south, and therefore not exiting the site. It is likely that these individuals were passing through the site after exiting other nearby camps (e.g. Gordon Park camp at Nambucca Heads). Furthermore, Flying-foxes could be heard foraging on flowering Swamp Mahogany that is present in the western section of the Swamp Sclerophyll Forest at the site.

No exit counts were conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: 10,000-20,000 individuals (population may have increased over recent months);
- Bowraville: no individuals recorded (population peaked in February); and
- Bellingen Island: no individuals recorded (however, GHFF estimated to number in the thousands are roosting nearby, north of the showground in Camphor Laurel vegetation behind Wheatley Street).

2.2.2 Roost Footprint

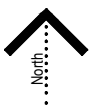
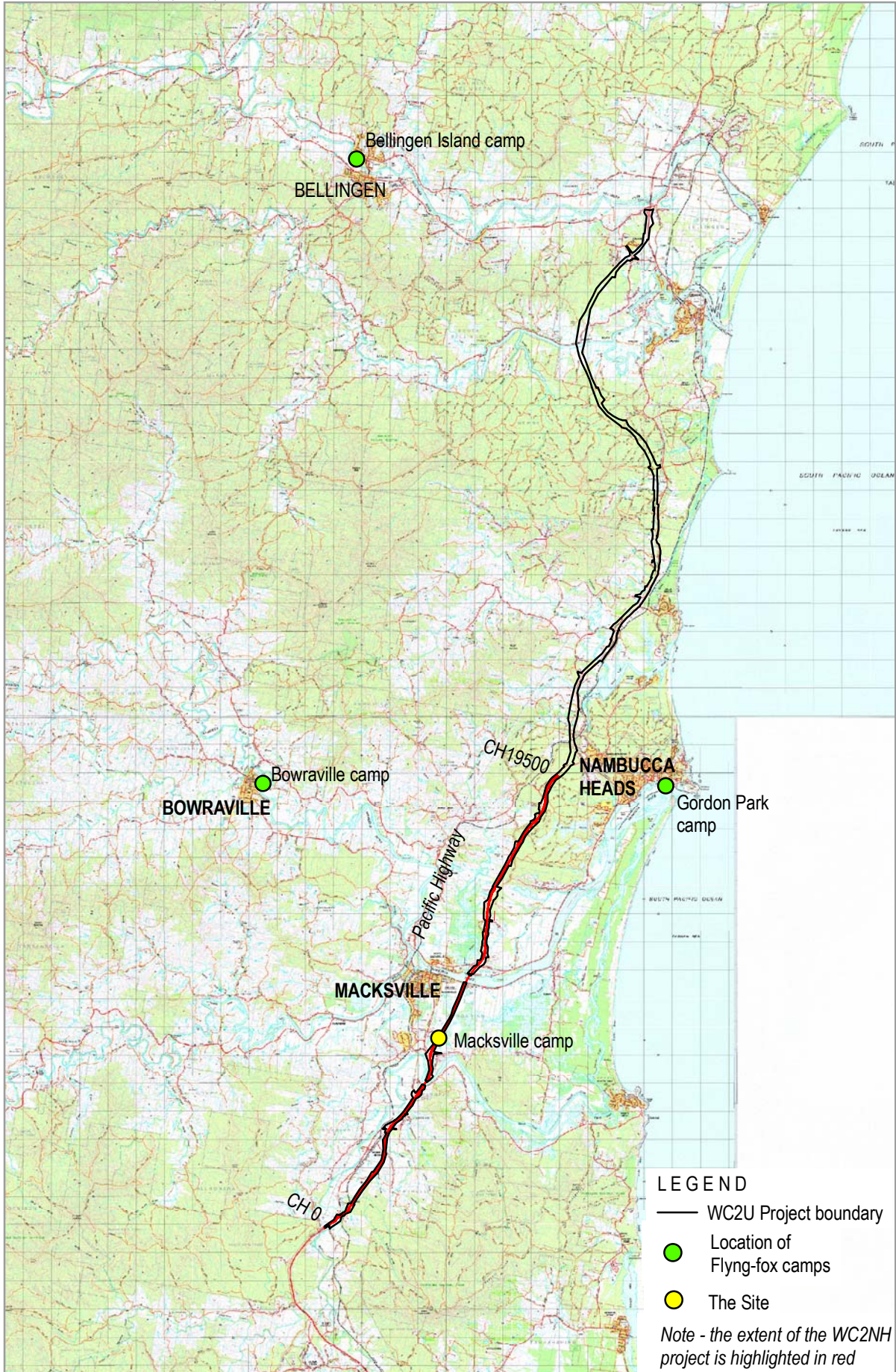
No flying-foxes were observed to be roosting at the site during the roost traverse on 29 May. This absence of flying-foxes at the site now extends from mid-late April 2014 to the current monitoring event.

No roosting flying-foxes were present at Bowraville at the time of the current monitoring event. Corresponding to the observations at the site, this absence of flying-foxes at Bowraville has also extended from mid-late April 2014 to the current monitoring event.

No roosting flying-foxes were present at the Bellingen Island camp. This is the first monitoring event that an absence has been recorded at the Bellingen Island camp, however, numbers were extremely low in the previous monitoring event (<1000). As mentioned previously, despite an absence from Bellingen Island, GHFF estimated to number in the thousands are roosting nearby, north of the showground in Camphor Laurel vegetation behind Wheatley Street.

The roost footprint at the Gordon Park camp at Nambucca Heads was observed to remain relatively extensive, as has been observed during the last few months, reflecting the observation that this camp is currently supporting the largest number of flying-foxes in the region.

Information shown is for illustrative purposes only



0 4 km



Location of Regional Flying-fox camps

2.2.3 Detailed Data

2.2.3.1 Species Composition

No flying-foxes of any species were recorded at the site or at the Bellinghen Island comparison site. Therefore, no detailed species composition data was collected for the current monitoring event. Observations of the Wheatley Street camp in Bellinghen that has established indicated that only GHFF were present (although a detailed traverse of this camp was not undertaken).

No flying-foxes of any species were recorded at Bowraville.

Both GHFF and Black Flying-fox were present at the Gordon Park camp. At the time of the current survey GHFF accounted for approximately 90% of all individuals present, with Black Flying-fox accounting for approximately 10%. As has been previously recorded, the Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned previously, no flying-foxes were present at either the site or Bellinghen Island and consequently no detailed demographic data was collected for the current monitoring event.

General observations of the flying-foxes present at the regional Gordon Park camp indicated that both female and male GHFF are present. No dependent young were observed.

2.2.3.3 Water level at the site

Water level at the representative measurement location at the site was approximately 37 cm in depth as is shown in Figure 2.1. After a brief increase in water levels in April, the general declining trend in water levels has continued, reflecting below average rainfall experienced in the region during May.

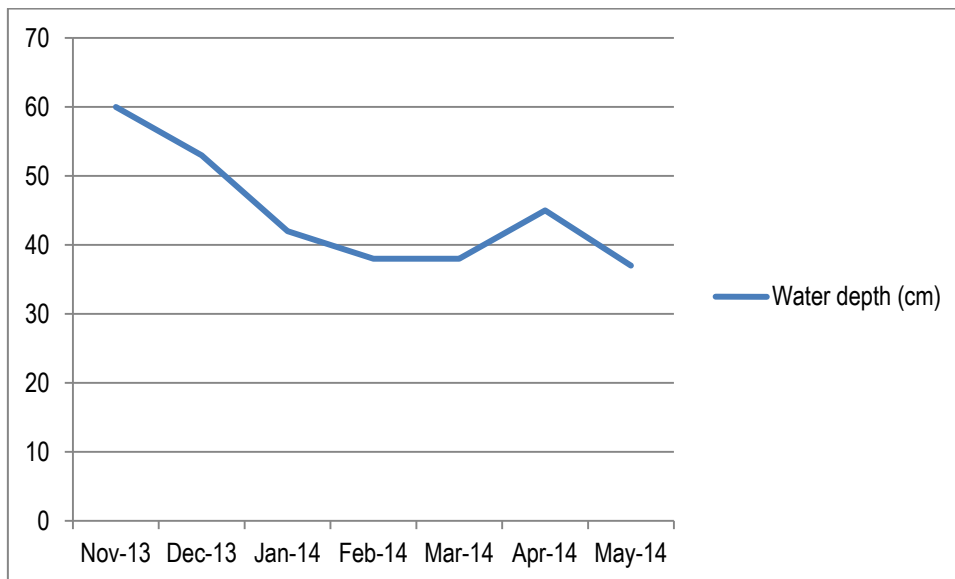


Figure 2.1 Water Level Measurements at The Site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse on 29 May. Nor were any flying-foxes observed to be flying from the site in the exit count. However, a very small number of flying-foxes observed passing by the site (and foraging on flowering Swamp Mahogany) are likely to have originated from other nearby camps (e.g. Gordon Park camp at Nambucca Heads).

No flying-foxes have been recorded at the site since early-mid April 2014, following a sustained period of occupation since late January 2014, including relatively large numbers (>40,000) recorded in early March.

Observations at regional camps indicate that a significant population reduction has occurred at the Bowraville and Bellingen Island camps recently, with no flying-foxes recorded roosting at either camp. However, as mentioned previously, moderate numbers (estimated to be many thousand) GHFF are currently camped nearby at another location in Bellingen between the showground and Wheatley Street. In contrast the occupation of the Gordon Park camp has remained stable since summer, with numbers remaining relatively high (estimated at 10,000-20,000 individuals).

Previous investigations of the site (Eby 2012) indicate that flying-foxes are likely to have been absent from the site in May 2012. However, satellite-tracking undertaken by John Martin at the Royal Botanic Garden and Domain Trust (RBGDT) indicates that an adult female GHFF individual was present at the site in May 2013 (data courtesy of John Martin, RBGDT, unpublished). No population estimate of GHFF is available for 2013.

2.3.2 Species Composition

GHFF and Black Flying-fox were recorded at the Gordon Park camp, while only GHFF were observed at the Bellingen camp (Wheatley Street). GHFF dominated the species composition, with Black Flying-fox accounting for only approximately 10% of all individuals at the Gordon Park camp.

2.3.3 Phenology of Trees in Region

May 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) 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). Of these species, local observations when driving between regional camps indicated that Broad-leaved Paperbark was sparsely flowering and Swamp Mahogany was flowering strongly. As was also observed in early May, during the exit count flying-foxes could be heard foraging at the western end of the Swamp Sclerophyll forest at the site where a stand of Swamp Mahogany is present. Other non-key diet species for GHFF observed to be flowering well in the region and supplying a nectar resource for GHFF include Coast Banksia (*Banksia integrifolia*).

2.4 Conclusion

The results of the May 2014 flying-fox monitoring indicate that flying-foxes continue to be absent from the site following a departure in early-mid April 2014. This comes after a variable period of flying-fox presence and absence at the site in December 2013 and January 2014, including an absence in early January 2014, and a peak in numbers during March 2014 (numbers >40,000). Flying-foxes were also absent from both the Bowraville camp and the Bellingen Island camp. However, GHFF are still camped in a separate nearby camp in Bellingen. In contrast to these population declines, the numbers of flying-foxes at Gordon Park remain relatively high.

Where occupied, GHFF dominates the species composition, with Black Flying-fox present in low numbers at the Gordon Park camp. Although no detailed demographic data was collected due to an absence of flying-foxes at the site and the Bellingen Island comparison site, general observations at Gordon Park indicate that both male and female GHFF are present. No dependent young were observed.

Observations from the current monitoring event indicate that overall numbers of flying-foxes at (most) regional camps have decreased since the peak in February 2014, with flying-foxes now absent at the site, Bellingen Island and Bowraville. In contrast, numbers at Gordon Park have remained relatively high. This is likely to reflect the current foraging resource availability at a local level, including strong flowering of Swamp Mahogany and Coast Banksia in the coastal lowlands.



Dr Tom Pollard
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.

12 June 2014
Ref No: 2182-1097

The Manager
Sinclair Knight Merz
PO Box 2147
DANGAR NSW 2309

Attention: Rachel Vazey

Dear Rachel,

May 2014 fortnightly Flying-fox monitoring report

This short report details the findings of the May 2014 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.

A traverse of the site was undertaken on 14 May 2014. No roosting flying-foxes were located, as was the case in the previous monitoring event undertaken in late April 2014. The last time that flying-foxes were recorded roosting at the site was in early April 2014, when an estimated 25,000 individuals were present.

An exit count was conducted at three vantage points surrounding the site on the evening of 14 May 2014. Less than 100 flying-foxes were recorded in the exit count. Most of these flying-foxes were observed to be flying in a southerly direction. This result is similar to the previous monitoring event in late April when approximately 300 flying-foxes were recorded. Considering the small number of flying-foxes that were counted and the result of the site traverse which failed to locate any roosting individuals, it is likely that these individuals were not roosting at the site but were instead passing by the site (and may have stopped at the site to forage on flowering Swamp Mahogany) after exiting other nearby camps (e.g. Gordon Park camp at Nambucca Heads). Therefore, the site population estimate for this monitoring event was recorded as zero.

General observations made at the other regional flying-fox camps are as follows:

Bellingen Island:

Only GHFF were present. The roost area and population count was substantially reduced since the last monthly monitoring event. Roosting flying-foxes were observed to be restricted to a small area in the south-eastern part of the island, and numbered less than 1000.

Gordon Park (Nambucca Heads):

GHFF (>90%) and Black Flying-fox (<10%) present. Roost area and population similar to that recorded during the last monthly monitoring event (estimated at 10,000 – 20,000 individuals).

Bowraville:

No flying-foxes were observed to be roosting at Bowraville. As for the site, the last time that flying-foxes were recorded roosting at Bowraville was in early April 2014.

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May 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) 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). Of these species, local observations when driving between regional camps indicated that Broad-leaved Paperbark was sparsely flowering and Swamp Mahogany was flowering strongly. During the exit count flying-foxes could be heard foraging at the eastern end of the Swamp Sclerophyll forest at the site where a stand of Swamp Mahogany is present. 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*).

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

Yours sincerely
GeoLINK



Dr Tom Pollard
Ecologist

12 June 2014
Ref No: 2182-1098

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DANGAR NSW 2309

Attention: Rachel Vazey

Dear Rachel,

June 2014 fortnightly Flying-fox monitoring report

This short report details the findings of the June 2014 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.

A traverse of the site was undertaken on 11 June 2014. No roosting flying-foxes were located, as was the case in the previous monitoring events undertaken in late April and May 2014. The last time that flying-foxes were recorded roosting at the site was in early April 2014, when an estimated 25,000 individuals were present.

An exit count was conducted at two vantage points north and south of the site on the evening of 10 June 2014. Less than 100 flying-foxes were recorded in the exit count. Most of these flying-foxes were observed to be flying in a southerly direction. Similarly low numbers of flying-fox were also recorded in recent monitoring events in late April and May 2014. Considering the small number of flying-foxes that were counted in the current monitoring event and the result of the site traverse which failed to locate any roosting individuals, it is likely that these individuals were not roosting at the site but were instead passing by the site (and may have stopped at the site to forage on flowering Swamp Mahogany) after exiting other nearby camps (e.g. Gordon Park camp at Nambucca Heads). Therefore, the site population estimate for this monitoring event was recorded as zero.

General observations made at the other regional flying-fox camps are as follows:

Bellingen Island:

Only GHFF were present. Flying-fox have returned to the Bellingen Island camp after a brief absence in late May, however, numbers are low and estimated to be less than 1000. As was reported in the previous monitoring report, GHFF estimated to number in the thousands are roosting nearby, north of the showground in Camphor Laurel vegetation behind Wheatley Street.

Gordon Park (Nambucca Heads):

GHFF (>90%) and Black Flying-fox (<10%) are present. Roost area and population similar to that recorded during the last monthly monitoring event (estimated at 10,000 – 20,000 individuals).

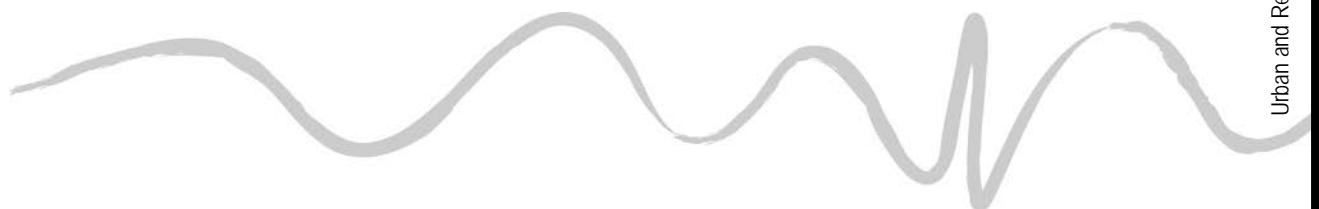
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Bowraville:

No flying-foxes were observed to be roosting at Bowraville. As for the site, the last time that flying-foxes were recorded roosting at Bowraville was in early April 2014

June 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 (*E. pilularis*) (coastal lowlands), Forest Red Gum (*E. 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). Of these species, local observations when driving between regional camps confirmed flowering in Broad-leaved Paperbark and Swamp Mahogany. As has been recorded previously during the exit count, flying-foxes could be heard foraging at the eastern end of the Swamp Sclerophyll forest at the site where a stand of Swamp Mahogany is present. Flying-fox calls emanating from this area were neither as loud nor as persistent as recorded in recent monitoring events, possibly indicating that the peak in flowering for these Swamp Mahogany trees has now passed. 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*).

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

Yours sincerely

GeoLINK



Dr Tom Pollard
Ecologist

Flying-fox Monitoring

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

April 2014

Prepared for: Sinclair Knight Merz
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Introduction

1.1 Introduction

Sinclair Knight Merz (SKM) and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at the Macksville roost (henceforth referred to as 'the site'), which is located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road, Macksville. To date, monthly monitoring has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly on the camp since its establishment in December 2011 (Eby 2012).

This report details the April 2014 monitoring results. The monitoring was undertaken on 28-29 April 2014.

Flying-fox Survey

2.1 Methodology

Fieldwork for the April survey was undertaken by Dr Peggy Eby, GeoLINK environmental scientists Grant McLean and Peter Thrift, and ecologist Terry Tweedie (GeoLINK subcontractor). 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 April 2014 monitoring is provided below.

A dusk exit count survey was undertaken at the site on the evening of 28 April to provide an estimate of the number of flying-foxes currently roosting at the camp. Observers were strategically located where there was a clear view over the camp, corresponding to the directions that flight-paths were observed during previous exit counts.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive);
- west of the Pacific Highway at the junction with Upper Warrell Road;
- on a ridge south of the camp (41 Bald Hill Road); and
- adjacent to Bald Hill Road, approximately 750 m east of the 41 Bald Hill Road vantage point.

The survey extended over approximately 30 minutes from sunset until dark (approximately 5:45 pm to 6:15 pm).

On 29 April a survey of the site was undertaken on foot to locate and map the flying-fox camp footprint and collect data on species composition, demographics, reproductive status and behaviour. The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp. For comparison, data was also collected at a control site located at Bellingin Island (approximately 31 km north north-west of the Macksville camp), along with observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to **Illustration 1.1** for location of these regional camps).

2.2 Results

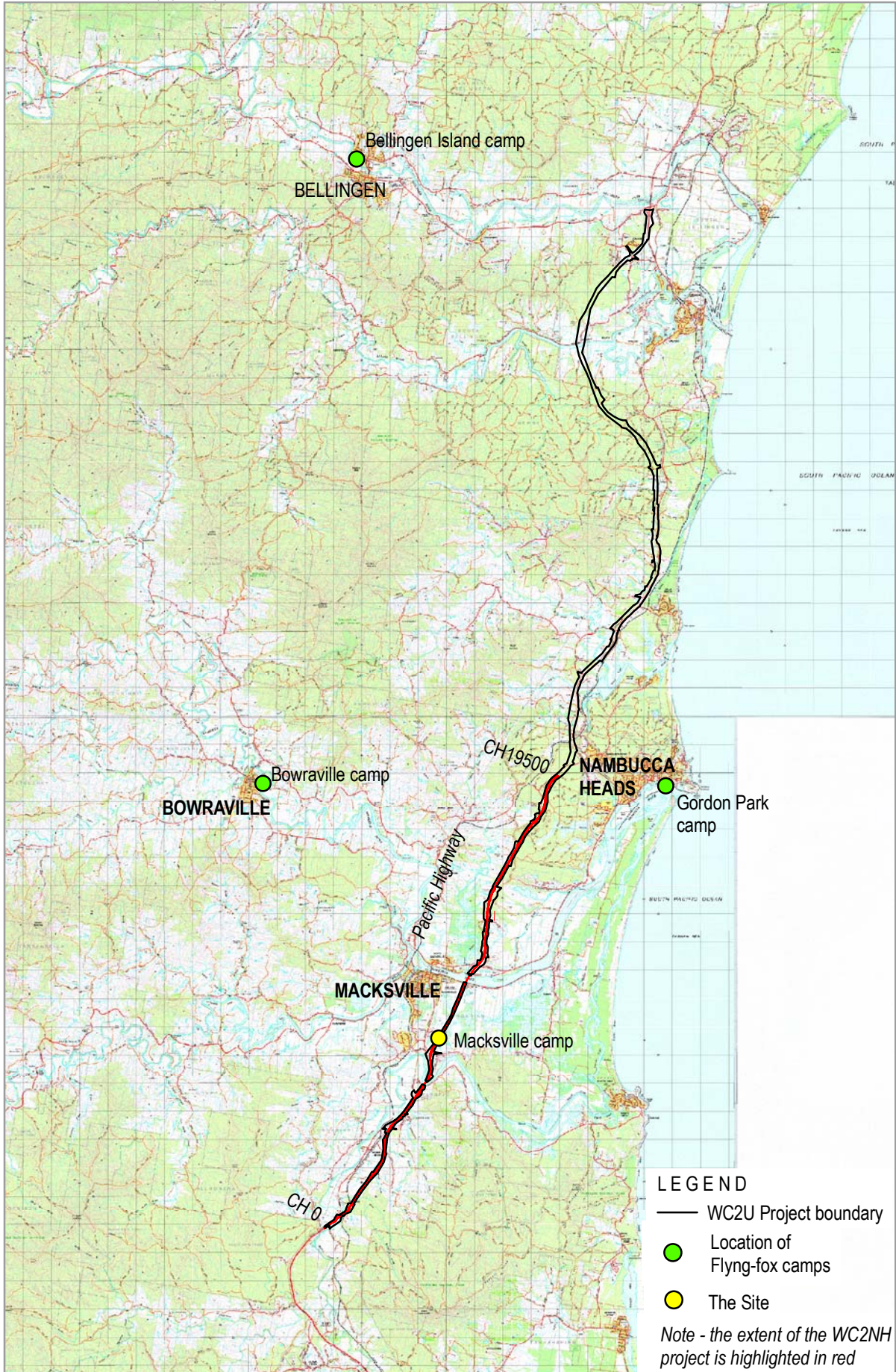
2.2.1 Population Estimate – Exit Count

In the exit count conducted on 28 April an estimated total of 300 flying-foxes were recorded and the roost traverse the following day on 29 April failed to locate any roosting individuals. These results indicate that these individuals were not roosting at the site but were instead passing by the site (and may have stopped at the site to forage on flowering Swamp Mahogany) after exiting other nearby camps (e.g. Gordon Park camp at Nambucca Heads). Therefore, the site population estimate for this monitoring event was recorded as zero.

No exit counts were conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: 10,000-20,000 individuals (population may have increased over recent months);
- Bowraville: no individuals recorded (population peaked in February); and
- Bellingin Island: approximately 10,000 individuals (population reduced compared with results from the March monitoring).

Information shown is for illustrative purposes only



0 4 km



2.2.2 Roost Footprint

No flying-fox were observed to be roosting at the site during the roost traverse on 29 April. This absence follows a sustained occupation of the site since late January 2014.

No roosting flying-fox were present at Bowraville at the time of the current survey. There has been a gradual decrease in the roost footprint from a maximum extent recorded during February 2014. At that time numerous individuals were roosting in Camphor Laurels extending along the Nambucca River.

The overall roost footprint does not appear to have changed substantially at the Bellingen Island camp since mid-March. Roosting in the upper canopy of emergent rainforest trees is not as widespread as when the population was peaking during February, indicating that the population has reduced in the intervening period.

The roost footprint at the Gordon Park camp at Nambucca Heads was observed to remain relatively extensive, as has been observed during the last few months, reflecting the observation that this camp is currently supporting the largest flying-fox numbers in the region.

2.2.3 Detailed Data

2.2.3.1 Species Composition

No flying-fox of any species were recorded at the site. Therefore, no detailed species composition data was collected for the site. In addition to this, no flying-fox of any species were recorded at Bowraville.

At the Bellingen Island camp observations suggest that Black Flying-fox numbers may have recently increased since the previous monitoring, with this species occurring commonly in the mid-upper canopy. It was estimated that GHFF accounted for 70-85% of all individuals present and Black Flying-fox accounted for between 15-30%.

Both GHFF and Black Flying-fox were present at the Gordon Park camp and Little Red Flying-fox have now departed following summer occupation of this camp. At the time of the current survey GHFF accounted for approximately 85% of all individuals present, with Black Flying-fox accounting for approximately 15%. As has been previously recorded, the Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive.

2.2.3.2 Habitat Characteristics and Demographic Composition

Data of habitat characteristics and demographic composition at the Bellingen Island camp is provided in **Table 2.1** (no data was collected for the site as no flying-fox were present).

The structure of the vegetation at the Bellingen Island camp consists of a canopy of emergent rainforest species (with some large native figs of substantial diameter and up to 40 m in height) over a relatively open understorey.

Table 2.1 displays the results of the demographic data collected at the Bellingen Island camp. Females were more numerous than males in the majority of demographic counts. Low numbers of females with (partially) dependent young were observed across the camp, ranging between 10% and 30% of the total number of females recorded at demographic count points. Note that some demographic count points were dominated by Black Flying-fox and are recorded in **Table 2.1** as such. Also, no GPS points were recorded during the current survey due to difficulty in finding satellites beneath the dense rainforest canopy.

Table 2.1 Demographic Data for Bellinghen Island

Tree Code	Tree Species	Sex Ratio (female:male)	Presence of Dependiant Young (yes/no)	% females with Dependent Young	Notes
BI1	Unknown sp.	7:5	no	n/a	(incomplete count)
BI2	Unknown sp.	10:7	yes (some dependent behaviours)	30	Black Flying-fox dominated tree
BI3	<i>Dendrocnide excelsa</i>	10:7	yes (some dependent behaviours)	10	
BI4	<i>Dendrocnide excelsa</i>	10:6	yes (some dependent behaviours)	10	
BI5	Unknown sp.	10:4	no	n/a	
BI6	Unknown sp.	10:5	yes (some dependent behaviours)	30	Black Flying-fox dominated tree
BI7	Unknown sp.	10:2	no	n/a	Black Flying-fox dominated tree
BI8	Unknown sp.	10:3	no	n/a	
BI9	<i>Dendrocnide excelsa</i>	10:5	yes (some dependent behaviours)	10	
BI10	Unknown sp.	10:5	yes (some dependent behaviours)	20	(Difficult to determine if young were roosting separately)

Similar to the Bellinghen Island results, a relatively low proportion of female flying-fox present at the Gordon Park camp had (partially) dependent young.

2.2.3.3 Water level at the site

Water level at the representative measurement location at the site was approximately 45 cm as is shown in Figure 2.1. The decline in the water level at the swamp has now stopped following a return to more average rainfall conditions after a dry spring/ summer period and water levels have risen slightly.

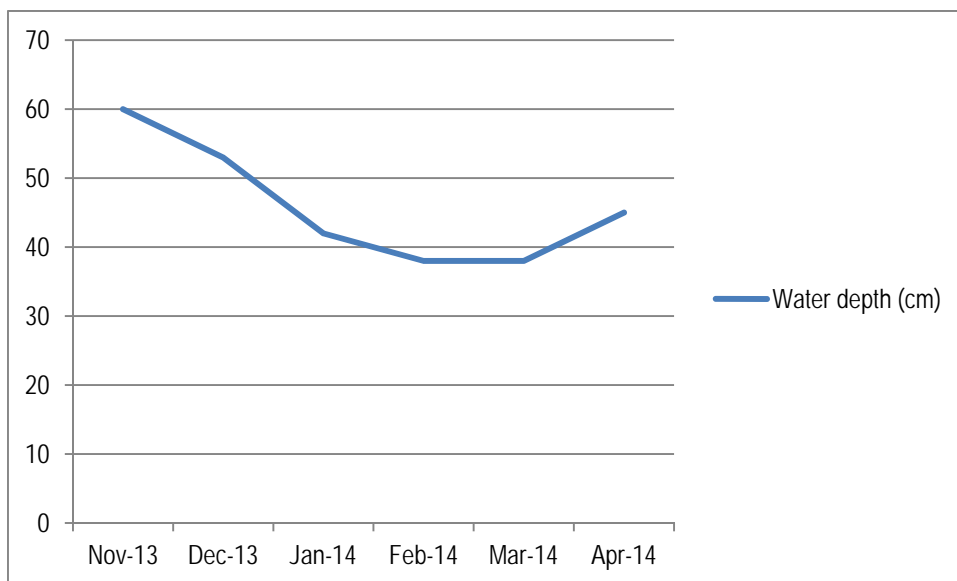


Figure 2.1 Water Level Measurements at The Site

2.3 Discussion

2.3.1 Population Estimate

No flying-fox were observed to be roosting at the site during the roost traverse on 29 April and only a small number of flying-foxes were counted in the exit count (approximately 300). These results indicate that these individuals were not roosting at the site but were instead passing by the site after exiting other nearby camps (e.g. Gordon Park camp at Nambucca Heads).

This absence of flying-fox at the site follows a sustained occupation since late January 2014, including relatively large numbers (>40,000) recorded in early March.

Observations of flying-fox at the regional camps seem to indicate that a population reduction has occurred at most regional camps, particularly at Bowraville, where no flying-fox were recorded in the current monitoring event. In contrast to this, the number of flying-fox at the Nambucca Heads camp have remained the same or increased over the last few months (despite Little Red Flying-fox having now left this camp).

Flying-fox are likely to have been present at the site during April over the last two years. The site is known to have been occupied in April 2012 (Eby 2012) and satellite-tracking undertaken by John Martin at the Royal Botanic Garden and Domain Trust (RBGDT) indicates that adult female GHFF individuals were present at the site in April 2013 (data courtesy of John Martin, RBGDT, unpublished). No population estimate of GHFF is available for either year.

2.3.2 Species Composition, Demographic Data and Behaviour

At the camps that were occupied by flying-fox both GHFF and Black Flying-fox were recorded in the current monitoring event. Little Red Flying-fox were not recorded in the current monitoring after being recorded at Gordon Park camp and the site in the previous month. GHFF dominated the species composition at occupied camps, and Black Flying-fox accounted for between 15-30% of all individuals, which may represent an increase (particularly at the Bellingen Island camp, where Black Flying-fox have recently accounted for a much lower proportion).

The site and other regional camps currently support a relatively small component of young GHFF that are still not fully independent. It is expected that these dependent behaviours will become less common as the young mature.

GHFF mating behaviours were observed the site and all occupied regional camps during this monitoring event.

2.3.3 Phenology of Trees in Region

Flowering of a number of highly productive nectar source trees typically occurs in April in the upper North Coast region of NSW including a variety of Swamp Mahogany (*Eucalyptus robusta*), Coastal Blackbutt (*Eucalyptus pilularis*) (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). Of these species, Broad-leaved Paperbark was observed to be sparsely flowering and Swamp Mahogany was flowering well when driving between the regional camps. 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*).

2.4 Conclusion

The results of the April 2014 flying-fox monitoring indicate that flying-fox have recently departed the site since the last monitoring event in early April. This comes after a variable period of flying-fox presence and absence at the site in December 2013 and January 2014, including an absence in early January 2014, and a peak in numbers during March 2014 (numbers >40,000). At regional camps flying fox numbers appear to have decreased at Bellinghen Island, remained relatively high at Gordon Park and flying-fox were also absent from Bowraville.

At regional camps where flying-fox were present (Bellinghen Island and Gordon Park) GHFF dominated with Black Flying-fox present in lesser numbers. Little Red Flying-fox have now departed Gordon Park, although overall flying-fox numbers here remain relatively high. Female flying-fox with (partially) dependent young were present at Bellinghen Island and Gordon Park, and the proportion of females with young at the Bellinghen site has decreased since the previous monitoring event reflecting a greater number of young now becoming fully independent. Flying-fox mating behaviours were evident at all of the camps visited.

Observations from the current monitoring event indicate that overall numbers of flying-fox at (most) regional camps have decreased since the peak in February 2014, with flying-fox now absent at the site and Bowraville. This is likely to be in response to the current levels of foraging resource availability locally.



Dr Tom Pollard
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.

Flying-fox Monitoring

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

June 2014

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Introduction

1.1 Introduction

Sinclair Knight Merz (SKM) and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at a camp near Macksville, located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road (henceforth referred to as 'the site'). To date, monthly monitoring at the site has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly at the site since occupation commenced in December 2011 (Eby 2012).

This report details the June 2014 monitoring results. The monitoring was undertaken on 30 June 2014.

Flying-fox Survey

2.1 Methodology

Fieldwork for the June survey was undertaken by GeoLINK ecologists Dr Tom Pollard and Jess O'Leary. 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 June 2014 monitoring is provided below.

On 30 June a survey of the site was undertaken on foot to locate and map any roosting flying-foxes. When flying-fox are present, data on species composition, demographics, reproductive status and behaviour are also collected. The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp.

When flying-fox are present, comparative data on species composition, demographics, reproductive status and behaviour is also collected at a control site located at Bellingen Island (approximately 31 km north north-west of the Macksville camp), along with observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to (refer to **Illustration 2.1**) for location of these regional camps).

A dusk exit count survey was undertaken at the site on the evening of 30 June 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.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive); and
- on a ridge south of the camp (41 Bald Hill Road).

The survey extended over approximately 30 minutes from sunset until dark (approximately 5:15 pm to 5:45 pm).

2.2 Results

2.2.1 Population Estimate – Exit Count

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

No exit count was conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: 10,000-20,000 individuals (population has remained relatively steady over recent months);
- Bowraville: no individuals recorded (population peaked in February and has declined since); and
- Bellingen Island: no individuals recorded (population peaked in February and has declined since. However, GHFF estimated to number in the low thousands are roosting nearby, north of the showground in Camphor Laurel vegetation behind Wheatley Street).

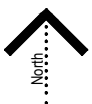
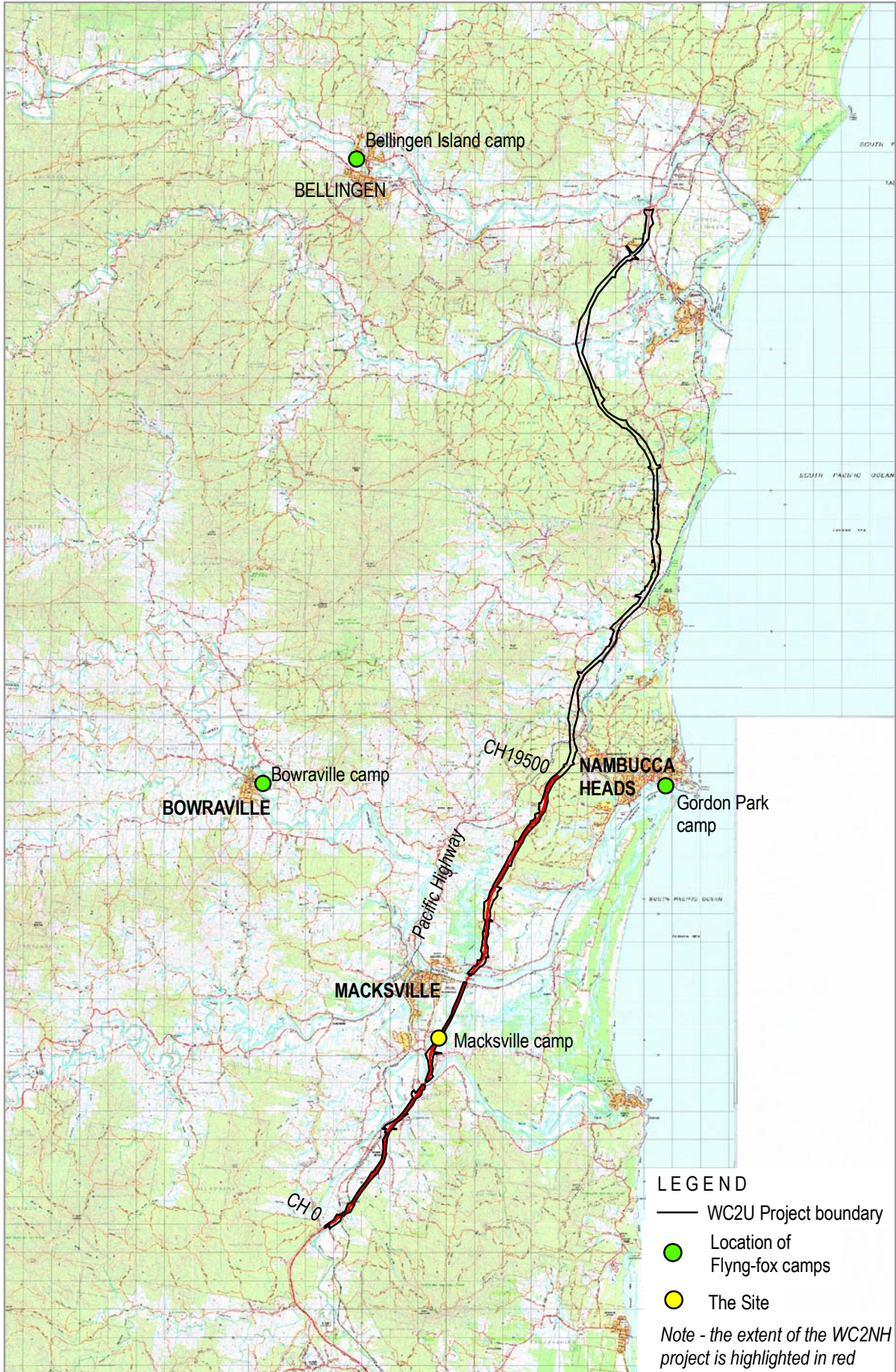
2.2.2 Roost Footprint

No flying-foxes were observed to be roosting at the site in the camp traverse. No flying-foxes have been recorded at the site during monitoring events since mid-late April 2014.

Likewise, no roosting flying-foxes were recorded at either Bellingen Island or Bowraville in the current monitoring event. Flying-fox have not been observed to be roosting at Bowraville since mid-late April 2014 and numbers have been low (<1000) at Bellingen Island since mid-May 2014. As mentioned previously, despite an absence from Bellingen Island, GHFF estimated to number at least several thousand are roosting nearby north of the showground in Camphor Laurel regrowth behind Wheatley Street.

The flying-fox roost footprint at Gordon Park (Nambucca Heads) remains relatively extensive, as has been observed during the last few months, reflecting the observation that this camp is currently supporting the largest number of flying-foxes in the region.

Information shown is for illustrative purposes only



0 4 km

2.2.3 Detailed Data

2.2.3.1 Species Composition

No flying-foxes were recorded at either the site or at the Bellinghen Island comparison site. Therefore, no detailed species composition data was collected for the current monitoring event. General observations of the Wheatley Street camp in Bellinghen indicated that both GHFF and Black Flying-fox were present (although a detailed traverse of this camp was not undertaken), as was also the case in the Gordon Park camp.

Likewise, no flying-foxes of any species were recorded at Bowraville.

It was estimated that GHFF accounted for approximately 90% of all individuals present at the Gordon Park camp, with Black Flying-fox accounting for approximately 10%. At the Wheatley Street roost Black Flying-fox were estimated to make up approximately 5% of all individuals present. As has been previously recorded, Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive.

2.2.3.2 Demographic Composition

As mentioned in above, no flying-foxes were present at either the site or Bellinghen Island and consequently no detailed demographic composition data was collected for the current monitoring event.

General observations of the flying-foxes present at the regional Gordon Park camp indicated that both female and male GHFF are present. No dependent young were observed.

2.2.3.3 Water level at the site

Water level at the representative measurement location at the site was approximately 32 cm in depth as is shown in **Figure 2.1**. After a brief increase in water levels in April, the general declining trend in water levels has continued, reflecting ongoing relatively dry conditions experienced in the region during May and June.

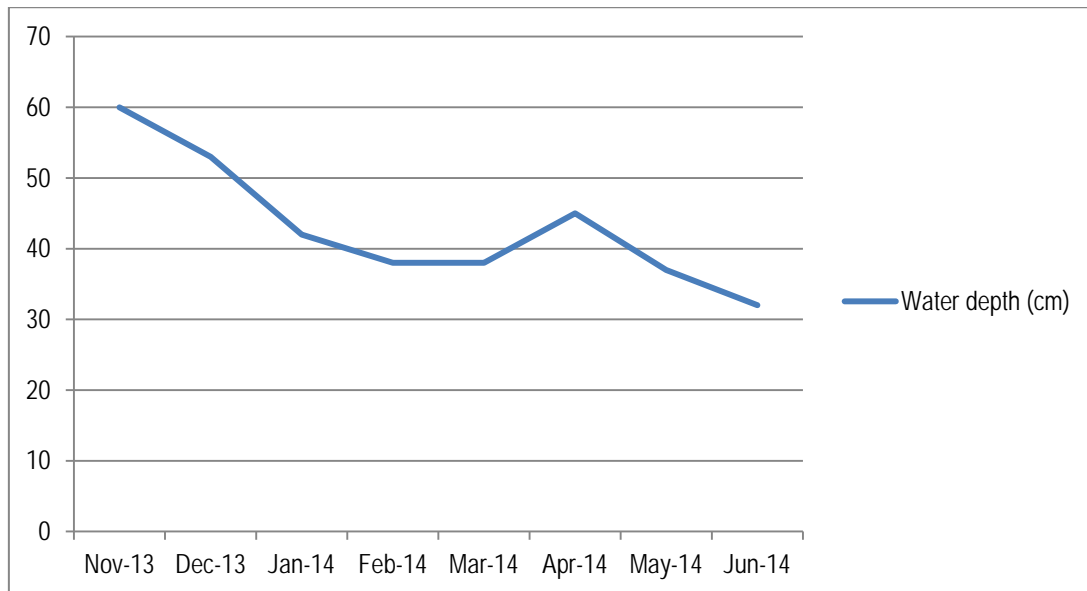


Figure 2.1 Water Level Measurements at The Site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed to be roosting at the site during the roost traverse on 30 June. Nor were any flying-foxes observed to be flying from the site in the exit count. No flying-foxes have been recorded at the site since early-mid April 2014, following a sustained period of occupation since late January 2014, including relatively large numbers (>40,000) recorded in early March.

Although no flying-foxes were observed to be roosting at the site in the current monitoring event, previous investigations of the site in June 2012 (Eby 2012) indicate that approximately 2000 flying-foxes were present at that time. No population estimate of GHFF at the site is available for June 2013.

Observations at regional camps indicate that a significant population reduction has occurred at the Bowraville and Bellingen Island camps recently, with no flying-foxes recorded roosting at either camp in the current monitoring event. However, as mentioned previously, moderate numbers (estimated at several thousand) of GHFF are currently camped nearby at another location in Bellingen between the showground and Wheatley Street. In previous years, the Wheatley Street roost has typically been occupied by flying-fox as an 'overflow' roost when flying-fox occupying Bellingen Island are in large numbers (V. Jones pers. comm.). Due to the proximity of Wheatley Street to Bellingen Island (< 1 km), the Wheatley Street roost could be considered to be part of the broader Bellingen Island camp, and for this reason it may warrant more detailed investigation as a comparison site if the Bellingen Island camp remains unoccupied.

In contrast the occupation of the Gordon Park camp has remained stable since summer, with numbers remaining relatively high (estimated at 10,000-20,000 individuals).

2.3.2 Phenology of Trees in Region

June flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Swamp Mahogany (*Eucalyptus robusta*) (however, flowering of this species appears to have finished at the site, which has likely led to a reduction in incidental foraging at the site by transitory flying-foxes), 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). 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 indicate that strong flowering of Swamp Mahogany is no longer occurring.

2.4 Conclusion

The results of the June 2014 flying-fox monitoring indicate that the absence of flying-foxes at the site continues, as was first recorded in early-mid April 2014. This comes after a variable period of flying-fox presence and absence at the site in December 2013 and January 2014, including an absence in early January 2014, and a peak in numbers during March 2014 (numbers >40,000). Flying-foxes were also absent from both the Bowraville camp and the Bellingen Island camp. However, GHFF are still camped in a separate nearby camp behind Wheatley Street in Bellingen. In contrast, the numbers of flying-foxes at Gordon Park remain relatively high (estimated at 10,000-20,000).

At occupied camps, monitoring indicated that GHFF dominates the species composition, with Black Flying-fox present in low numbers at the Gordon Park and Wheatley Street (Bellingen) camp. Although no detailed demographic data was collected due to an absence of flying-foxes at the site and the Bellingen Island comparison site, general observations at Gordon Park indicate that both male and female GHFF are present. No dependent young were observed.

Observations from the current monitoring event indicate that overall numbers of flying-foxes at (most) regional camps have decreased since the peak in February 2014, with flying-foxes now absent at the site, Bellingin Island (however, if Wheatley Street is considered part of the Bellingin Island camp, still number in the thousands) and Bowraville. In contrast, numbers at Gordon Park have remained relatively high. This is likely to reflect the current local foraging resource availability.



Dr Tom Pollard
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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22 July 2014
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Attention: Rachel Vazey

Dear Rachel,

July 2014 fortnightly Flying-fox monitoring report

This short report details the findings of the July 2014 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.

A traverse of the site was undertaken on 17 July 2014. No roosting flying-foxes were located, as was the case in all previous monitoring events undertaken since late April 2014. The last time that flying-foxes were recorded roosting at the site was in early April 2014, when an estimated 25,000 individuals were present.

An exit count was conducted at two vantage points north and south of the site on the evening of 17 June 2014. No flying-foxes were observed flying from the site in the exit count.

Other regional flying-fox sites were visited in the previous week on 12 July. General observations made at these camps are as follows:

Bellingen Island:

No flying-foxes were recorded (population peaked in February 2014 and has declined since). However, GHFF estimated to number in the low thousands are roosting nearby, north of the showground in Camphor Laurel vegetation behind Wheatley Street, as has been the case since the population peak in summer. The number of flying-foxes at the Wheatley Street site has decreased over the last couple of months along with a corresponding reduction in the roost area. Only GHFF were observed to be present.

Gordon Park (Nambucca Heads):

GHFF (>90%) and Black Flying-fox (<10%) are present. Roost area and population similar to that recorded during the last monthly monitoring event (estimated at 10,000 – 20,000 individuals).

Bowraville:

No flying-foxes were observed to be roosting at Bowraville. As for the site, the last time that flying-foxes were recorded roosting at Bowraville was in early April 2014.

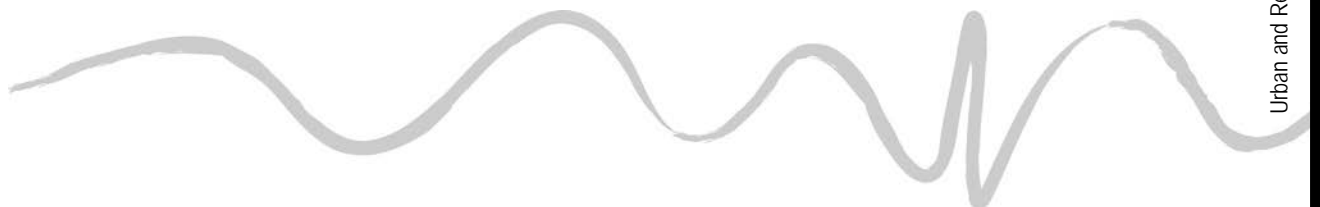
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Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW in July includes Swamp Mahogany (*Eucalyptus robusta*), Coastal Blackbutt (*E. pilularis*) (coastal lowlands), Forest Red Gum (*E. tereticornis*) (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). Observations when travelling between regional flying-fox camps indicate that no significant heavy flowering of any of these key species is occurring within the locality at present. Flowering of Swamp Mahogany appears to have finished at the site, which has likely led to a reduction in incidental foraging at the site by transitory flying-foxes. A non-key diet species for GHFF observed to be flowering in the region and supplying a nectar resource for GHFF is Coast Banksia (*Banksia integrifolia*). Flying-fox were regularly observed to be foraging in Coast Banksia at Nambucca Heads over the last two weeks.

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

Yours sincerely
GeoLINK



Dr Tom Pollard
Ecologist

Flying-fox Monitoring

Warrell Creek to Nambucca Heads

Pacific Highway Upgrade

July 2014

Prepared for: Jacobs
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Introduction

1.1 Introduction

Jacobs and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at a camp near Macksville, located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road (henceforth referred to as 'the site'). To date, monthly monitoring at the site has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly at the site since occupation commenced in December 2011 (Eby 2012).

This report details the July 2014 seasonal monitoring results. The monitoring was undertaken on 30-31 July 2014.

Flying-fox Survey

2.1 Methodology

Fieldwork for the July seasonal survey was undertaken by GeoLINK ecologists Dr Tom Pollard and Frank Makin (GeoLINK subcontractor). 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.

A dusk exit count survey was undertaken at the site on the evening of 30 July 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. No additional observers were required, as recent observations indicate that the site is currently unoccupied. Additional observers (up to 5 individuals during the seasonal peak in numbers during summer) have been used previously to effectively undertake the exit count.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive); and
- on a ridge south of the camp (41 Bald Hill Road).

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

On 31 July a survey of the site was undertaken on foot to locate and map any roosting flying-foxes. When flying-fox are present at the site, data on species composition, demographics, reproductive status and behaviour are also collected.

The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp.

Comparative data on species composition, demographics, reproductive status and behaviour is also collected at a control site located at Bellingen Island (when flying-foxes are present) (approximately 31 km north north-west of the Macksville camp). Due to the Bellingen Island camp remaining unoccupied recently, comparative data was instead collected at the nearby overflow camp at Wheatley Street. Observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to (refer to **Illustration 2.1**) for location of these regional camps).

2.2 Results

2.2.1 Population Estimate – Exit Count

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

No exit count was conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: 10,000-20,000 individuals (population has remained relatively steady over several months);
- Bowraville: no individuals recorded (population peaked in February and has declined since); and
- Bellingen Island: no individuals recorded (population peaked in February and has declined since. However, GHFF estimated to number approximately 1,000 are roosting nearby, north of the showground in Camphor Laurel vegetation behind Wheatley Street).

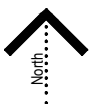
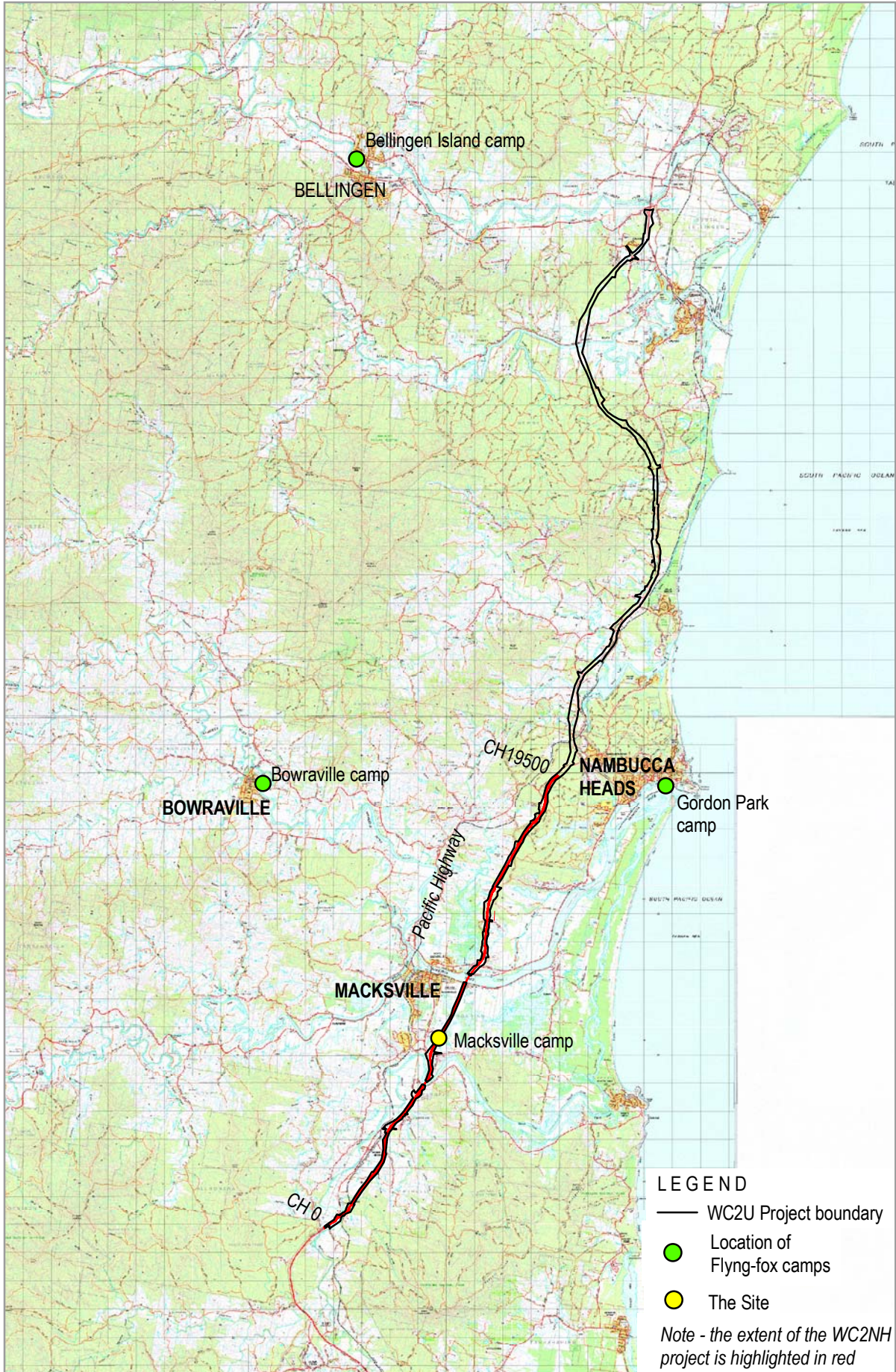
2.2.2 Roost Footprint

No flying-foxes were observed to be roosting at the site in the camp traverse. No flying-foxes have been recorded at the site since mid-late April 2014.

Likewise, no roosting flying-foxes were recorded at either Bellingen Island or Bowraville in the current monitoring event. Flying-fox have not been observed to be roosting at Bowraville since mid-late April 2014 and numbers have been low (<1000) at Bellingen Island since mid-May 2014. As mentioned previously, despite an absence from Bellingen Island, GHFF estimated to number approximately 1,000 are roosting nearby north of the showground in Camphor Laurel regrowth behind Wheatley Street.

The flying-fox roost footprint at Gordon Park (Nambucca Heads) remains relatively extensive, as has been observed during the last few months, reflecting the observation that this camp is currently supporting the largest number of flying-foxes in the region.

Information shown is for illustrative purposes only



0 4 km



Location of Regional Flying-fox camps

2.2.3 Detailed Data

2.2.3.1 Species Composition

No flying-foxes were recorded at the site. Therefore, no detailed species composition data was collected for the current monitoring event. Likewise, no flying-foxes of any species were recorded at Bowraville or at Bellingen Island.

Observations of the Wheatley Street camp in Bellingen indicated that both GHFF and Black Flying-fox were present, as was also the case in the Gordon Park camp.

At the Wheatley Street roost Black Flying-fox were estimated to make up approximately 5% of all individuals present. It was estimated that GHFF accounted for approximately 90% of all individuals present at the Gordon Park camp, with Black Flying-fox accounting for approximately 10%. As has been previously recorded, Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned above, no flying-foxes were present at the site. Consequently no detailed demographic composition data at the site was collected for the current monitoring event.

As no flying-foxes currently occupy the Bellingen Island camp, in order to obtain some relevant regional demographic data, the camp at Wheatley Street was investigated. Data of habitat characteristics and demographic composition at this camp is provided in **Table 2.1**.

The structure of the vegetation at the Wheatley Street camp consists of an even canopy of Camphor Laurel (*Cinnamomum camphora*) approximately 10-15 m in height over an open understorey.

Table 2.1 displays the results of the demographic data collected at the Wheatley Street camp. As only a relatively small number of flying-foxes were roosting at Wheatley Street, all of which were grouped tightly together into a small number of Camphor Laurel trees, only four demographic count points were able to be completed. Females were more numerous than males in all of the demographic counts.

General observations of the flying-foxes present at the regional Gordon Park camp indicated that both female and male GHFF are present. No dependent young were observed.

Table 2.1 Demographic Data for Wheatley Street (Bellingham)

<i>Tree Code</i>	<i>Tree Species</i>	<i>Easting, Northing (zone 56)</i>	<i>Sex Ratio (female:male)</i>	<i>Presence of Dependant Young (yes/no)</i>	<i>% females with Dependant Young</i>	<i>Notes</i>
WS1	Camphor Laurel	490841, 6631546	2:1	no	n/a	All trees closely clumped and therefore easting and northing given as same value for each count
WS2	Camphor Laurel	490841, 6631546	10:3	no	n/a	
WS3	Camphor Laurel	490841, 6631546	5:2	no	n/a	
WS4	Camphor Laurel	490841, 6631546	10:7	no	n/a	

2.2.3.3 Water level at the site

Water level at the representative measurement location at the site was approximately 24 cm in depth as is shown in **Figure 2.1**. After a brief increase in water levels in April, the general declining trend in water levels has continued, reflecting ongoing relatively dry conditions experienced in the region during May and July.

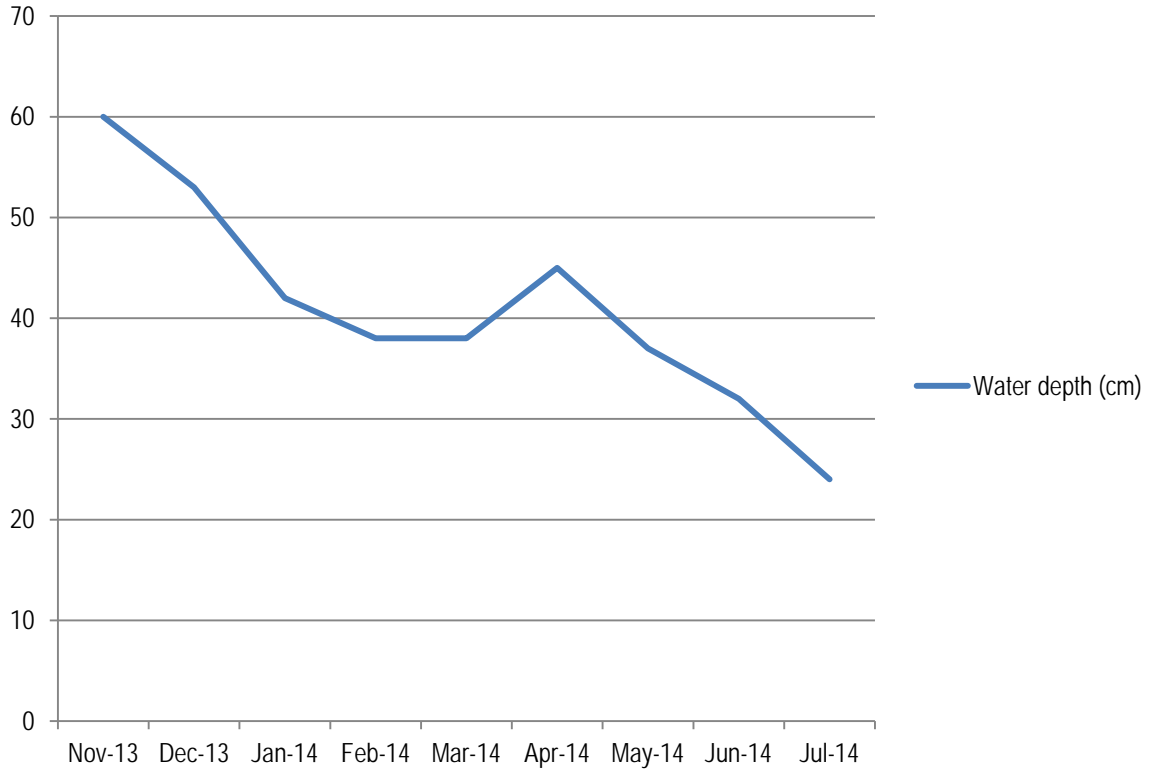


Figure 2.1 Water Level Measurements at The Site

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. Previous monitoring of the site during July 2013 also indicated an absence of flying-foxes at the site (GeoLINK 2013). No flying-foxes have been recorded at the site since early-mid April 2014, following a sustained period of occupation since late January 2014, including relatively large numbers (>40,000) recorded in early March.

The low number or absence of flying-foxes at the Bowraville and Bellingen Island camps has continued since April. However, as mentioned previously, a small number (estimated to be approximately 1,000) GHFF are currently camped nearby at Wheatley Street in Bellingen. In previous years, the Wheatley Street roost has typically been occupied by flying-fox as an 'overflow' roost when flying-fox occupying Bellingen Island are in large numbers (V. Jones pers. comm.). Due to the proximity of Wheatley Street to Bellingen Island (< 1 km), the Wheatley Street roost could be considered to be part of the broader Bellingen Island camp. For this reason demographic data was collected from the Wheatley Street Camp until the Bellingen Island camp is reoccupied.

In contrast the occupation of the Gordon Park camp has remained stable since summer, with numbers remaining relatively high (estimated at 10,000-20,000 individuals).

2.3.2 Species Composition, Demographic Data and Behaviour

At the camps that were occupied by flying-fox both GHFF and Black Flying-fox were recorded in the current monitoring event. GHFF dominated the species composition at occupied camps, and Black Flying-fox accounted for less than 10% of all individuals present.

Detailed demographic data recorded at the Wheatley Street camp in Bellingen indicated that both females and male GHFF are present and that females outnumber males. No dependent young were present and mating behaviour was not evident.

2.3.3 Phenology of Trees in 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). 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 did not record strong flowering in any of these key diet species.

2.4 Conclusion

The results of the July 2014 flying-fox monitoring indicate that the absence of flying-foxes at the site continues, as was first recorded in early-mid April 2014. This comes after a variable period of flying-fox presence and absence at the site in December 2013 and January 2014, including an absence in early January 2014, and a peak in numbers during March 2014 (numbers >40,000). Flying-foxes were also absent from both the Bowraville camp and the Bellingen Island camp. However, GHFF in relatively low numbers are still camped in a separate nearby camp behind Wheatley Street in Bellingen. In contrast, the numbers of flying-foxes at Gordon Park remain relatively high (estimated at 10,000-20,000).

At occupied camps, monitoring indicated that GHFF dominates the species composition, with Black Flying-fox present in low numbers at the Gordon Park and Wheatley Street (Bellingen) camp. Although no detailed demographic data was collected at the site or Bellingen Island due to an absence of flying-foxes,

demographic data was collected at Wheatley Street. This demographic data indicated that both females and male GHFF are present and that females outnumber males. No dependent young were observed.

Observations from the current monitoring event indicate that overall numbers of flying-foxes at (most) regional camps have decreased since the peak in February 2014, with flying-foxes now absent at the site, Bellingham Island (however, if Wheatley Street is considered part of the Bellingham Island camp, the Bellingham population persists in low numbers) and Bowraville. In contrast, numbers at Gordon Park have remained relatively high. This is likely to reflect the current local foraging resource availability.



Dr Tom Pollard
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.

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GeoLINK (2013). *Flying-fox Monitoring, July 2013. WC2NH*. Unpublished report to Jacobs and NSW Roads and Maritime Services. GeoLINK, Lennox Head.

21 August 2014
Ref No: 2182-1106

The Manager
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DANGAR NSW 2309

Attention: Rachel Vazey

Dear Rachel,

August 2014 fortnightly Flying-fox monitoring report

This short report details the findings of the August 2014 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.

A traverse of the site was undertaken on 14 August 2014. No roosting flying-foxes were located, as has been the case in all previous monitoring events undertaken since late April 2014. The last time that flying-foxes were recorded roosting at the site was in early April 2014, when an estimated 25,000 individuals were present.

An exit count was conducted at two vantage points north and south of the site on the evening of 14 August 2014. No flying-foxes were observed flying from the site in the exit count.

Other regional flying-fox sites were visited on the 15 August 2014. General observations made at these camps are as follows:

Bellingen Island:

A relatively small number of flying-foxes (<1000) were recorded at Bellingen island. This follows a short absence (or occupation in very low numbers) of flying-foxes at Bellingen Island over the last few months. No GHFF were recorded in the Camphor Laurel vegetation behind Wheatley Street, where they have previously been roosting since January 2014. There has been a general trend of decreasing numbers of flying-foxes roosting behind Wheatley Street over the last couple of months.

Gordon Park (Nambucca Heads):

GHFF (>90%) and Black Flying-fox (<10%) are present. Roost area and population similar to that recorded during the last monthly monitoring event (estimated at 10,000-15,000 individuals).

Bowraville:

No flying-foxes were observed to be roosting at Bowraville. As for the site, the last time that flying-foxes were recorded roosting at Bowraville was in early April 2014.

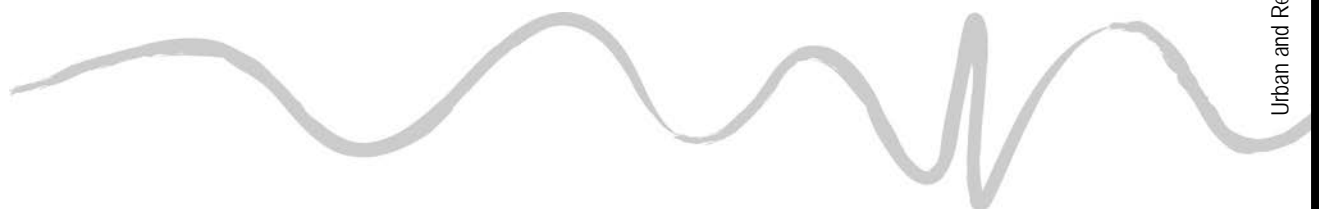
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Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW in August includes Coastal Blackbutt (*Eucalyptus pilularis*) (coastal lowlands), Forest Red Gum (*E. tereticornis*) (coastal lowlands and further inland at low elevation) and Grey Ironbark (*E. siderophloia*) (coastal lowlands). 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 indicate that no significant heavy flowering of any of these key species is occurring within the locality at present. Another non-key diet species for GHFF observed to be currently flowering in the region and supplying a nectar resource for GHFF is Coast Banksia (*Banksia integrifolia*).

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

Yours sincerely
GeoLINK



Dr Tom Pollard
Ecologist

Flying-fox Monitoring
Warrell Creek to Nambucca Heads
Pacific Highway Upgrade
August 2014

Prepared for: Jacobs
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Introduction

1.1 Introduction

Jacobs and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at a camp near Macksville, located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road (henceforth referred to as 'the site'). To date, monthly monitoring at the site has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly at the site since occupation commenced in December 2011 (Eby 2012).

This report details the August 2014 seasonal monitoring results. Due to unseasonably wet conditions at the end of August, the monitoring was undertaken at the next available opportunity on 2-3 September 2014.

Flying-fox Survey

2.1 Methodology

Fieldwork for the August 2014 monthly survey was undertaken by GeoLINK ecologists Dr Tom Pollard and Jessica O'Leary. 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 2 September a survey of the site was undertaken on foot to locate and map any roosting flying-foxes. When flying-fox are present at the site, data on species composition, demographics, reproductive status and behaviour are also collected.

The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp.

A dusk exit count survey was undertaken at the site on the evening of 2 September 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. No additional observers were required, as recent observations indicate that the site is currently unoccupied. Additional observers (up to 5 individuals during the seasonal peak in numbers during summer) have been used previously to effectively undertake the exit count.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive); and
- on a ridge south of the camp (41 Bald Hill Road).

The survey extended over approximately 45 minutes from sunset until dark (approximately 5:30 pm to 6:15 pm).

Comparative data on species composition, demographics, reproductive status and behaviour is also collected at a control site located at Bellingen Island (when flying-foxes are present) (approximately 31 km north north-west of the Macksville camp). Observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to (refer to *Illustration 2.1*) for location of these regional camps).

2.2 Results

2.2.1 Population Estimate – Exit Count

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

No exit count was conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: approximately 10,000 (population appears to have decreased somewhat since the last monthly monitoring event);
- Bowraville: no individuals recorded (population peaked in February and has declined since); and
- Bellingin Island: estimated to number 3000-5000 (flying-fox occupation of Bellingin Island camp has been sporadic since late autumn, with periods of absence). The results of the current monitoring event indicate that the number of flying-foxes at Bellingin Island is at the highest level for several months. No flying-foxes were recorded in the Camphor Laurel vegetation behind Wheatley Street, where they have previously been roosting since January 2014.

2.2.2 Roost Footprint

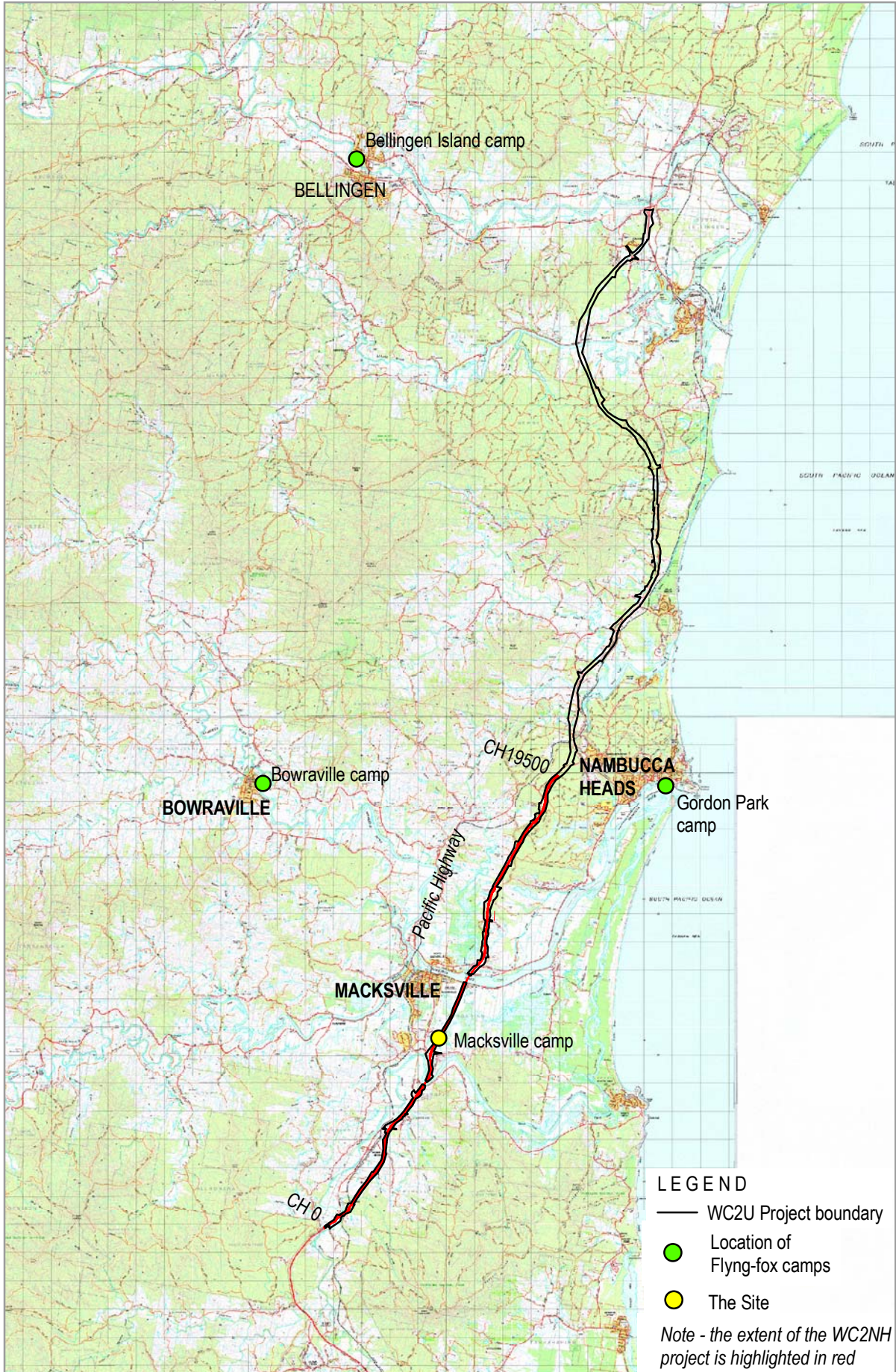
No flying-foxes were observed to be roosting at the site in the camp traverse. No flying-foxes have been recorded at the site since mid-late April 2014.

Likewise, no roosting flying-foxes were recorded at Bowraville in the current monitoring event. Flying-fox have not been observed to be roosting at Bowraville since mid-late April 2014.

Flying-foxes are currently occupying a small roost footprint in the SE corner of the rainforest vegetation at Bellingin Island.

The flying-fox roost footprint at Gordon Park (Nambucca Heads) remains relatively extensive, but is smaller than that recorded in the last monitoring event (particularly in the north-western part near Wellington Drive and Fraser Street).

Information shown is for illustrative purposes only



0 4 km



2.2.3 Detailed Data

2.2.3.1 Species Composition

No flying-foxes were recorded at the site. Therefore, no detailed species composition data was collected at the site for the current monitoring event. Likewise, no flying-foxes of any species were recorded at Bowraville.

Observations at Bellingen Island indicated that both GHFF and Black Flying-fox were present, as was also the case in the Gordon Park camp. Black Flying-fox were estimated to make up approximately 10% of all individuals present at both Bellingen Island and Gordon Park. As has been previously recorded, Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned above, no flying-foxes were present at the site. Consequently no detailed demographic composition data at the site was collected for the current monitoring event.

Comparison data was collected at the Bellingen Island camp. The structure of the vegetation at the Bellingen Island camp consists of a canopy of emergent rainforest species (with some large native figs of substantial diameter and up to 40 m in height) over a relatively open understorey. Most of the flying-foxes were roosting in either Creek Sandpaper Fig (*Ficus coronata*) or Giant Stinging Tree (*Dendrocnide excelsa*).

Data of habitat characteristics and demographic composition at the Bellingen Island camp is provided in Table 2.1. Females were more numerous than males in all of the demographic counts and no young were recorded.

General observations of the flying-foxes present at the regional Gordon Park camp indicated that both female and male GHFF were present. No dependent young were observed.

Table 2.1 Demographic Data of GHFF at Bellingham Island

<i>Tree Code</i>	<i>Tree Species</i>	<i>Easting, Northing (zone 56)</i>	<i>Sex Ratio (female:male)</i>	<i>Presence of Dependant Young (yes/no)</i>	<i>% females with Dependent Young</i>	<i>Notes</i>
BI1	Creek Sandpaper Fig	490107, 6631497	10:4	no	n/a	
BI2	Creek Sandpaper Fig	490086, 6631508	10:3	no	n/a	
BI3	Unknown sp.	490073, 6631511	10:1	no	n/a	
BI4	Creek Sandpaper Fig	490103, 6631515	10:7	no	n/a	
BI5	Creek Sandpaper Fig	490089, 6631521	10:4	no	n/a	
BI6	Creek Sandpaper Fig & Giant Stinging Tree	490076, 6631529	10:4	no	n/a	Count extended across 2 trees
BI7	Unknown sp.	490067, 6631533	10:7	no	n/a	
BI8	Creek Sandpaper Fig	490060, 6631540	10:4	no	n/a	
BI9	Creek Sandpaper Fig	490073, 6631547	10:8	no	n/a	
BI10	Giant Stinging Tree	490091, 6631553	10:5	no	n/a	

2.2.3.3 *Water level at the site*

Water level at the representative measurement location at the site was approximately 24 cm in depth as is shown in Figure 2.1. Following above-average rainfall in late August, the declining trend in water levels at the site has reversed.

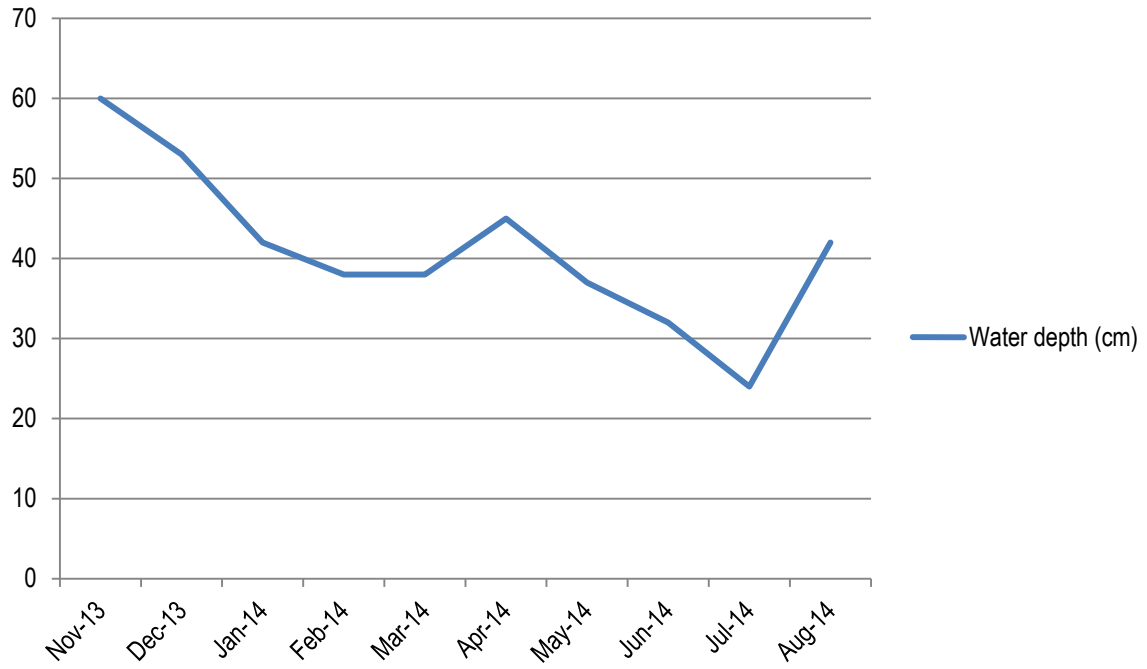


Figure 2.1 Water Level Measurements at The Site

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. Previous monitoring of the site during August 2013 also indicated an absence of flying-foxes at the site (GeoLINK 2013), as was likely the case in 2012 (Eby 2012). No flying-foxes have been recorded at the site since early-mid April 2014, following a sustained period of occupation since late January 2014, including relatively large numbers (>40,000) recorded in early March.

Flying-fox numbers at Bellingen Island are still relatively low (numbering a few thousand), and there has been an increase in numbers since the previous monitoring event in mid-August when it was estimated that approximately 1000 flying-foxes were roosting at the camp. The 'overflow' roost at Wheatley Street in Bellingen remains unoccupied, as was recorded in the mid-August 2014 monitoring event.

Flying-fox numbers at Gordon Park are still relatively high (approximately 10,000) despite having decreased somewhat since the last monthly monitoring event. The consistent occupation of Gordon Park by substantial numbers of GHFF is likely to reflect a local availability of suitable foraging resources.

2.3.2 Species Composition and Demographic Data

At the camps that were occupied by flying-fox both GHFF and Black Flying-fox were recorded in the current monitoring event. GHFF dominated the species composition and Black Flying-fox accounted for approximately 10% of all individuals present. Comparison with data collected in monitoring during August 2013 (GeoLINK 2013) indicates that the proportion of Black Flying-fox was higher at that time, representing up to 30% of individuals recorded at occupied regional camps.

No comparison demographic data was collected at either the site or regional camps in August 2013.

2.3.3 Phenology of Trees in Region

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 Forest Red Gum is now occurring.

2.4 Conclusion

The results of the August 2014 monthly flying-fox monitoring indicate that the absence of flying-foxes at the site continues, as was first recorded in early-mid April 2014. Flying-foxes also continue to be absent at the Bowraville camp. The Bellingen Island camp currently supports a low number of flying-foxes, and this follows from a variable period of occupation, including periods of absence over the winter and early spring period. In contrast, the numbers of flying-foxes at Gordon Park remain relatively high, despite showing a small decrease since the last monitoring event.

At occupied camps, monitoring indicated that GHFF dominates the species composition, with Black Flying-fox making up a comparatively low proportion of individuals at both the Gordon Park and Bellingen Island camps. Demographic data collected at Bellingen Island indicated that both females and male GHFF are present and that females outnumber males. No dependent young were observed.

Observations from the current monitoring event indicate that overall numbers of flying-foxes at (most) regional camps visited are still relatively low following a summer peak in numbers. Flying-foxes have returned to Bellingham Island in relatively low number after a recent absence.



Dr Tom Pollard
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.

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GeoLINK (2013). *Flying-fox Monitoring, August 2013. WC2NH*. Unpublished report to Jacobs and NSW Roads and Maritime Services. GeoLINK, Lennox Head.

19 September 2014
Ref No: 2182-1108

The Manager
Jacobs
PO Box 2147
DANGAR NSW 2309

Attention: Rachel Vazey

Dear Rachel,

September 2014 fortnightly Flying-fox monitoring report

This short report details the findings of the September 2014 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.

A traverse of the site was undertaken on 16 September 2014. No roosting flying-foxes were located, as has been the case in all previous monitoring events undertaken since late April 2014. The last time that flying-foxes were recorded roosting at the site was in early April 2014, when an estimated 25,000 individuals were present.

An exit count was conducted at two vantage points north and south of the site on the evening of 16 September 2014. No flying-foxes were observed flying from the site in the exit count.

Other regional flying-fox sites were visited on the 15, 16 & 17 of September 2014. General observations made at these camps are as follows:

Bellingen Island:

GHFF (>90%) and Black Flying-fox (<10%) were present. A relatively small number of flying-foxes (numbering between 3000- 5000 individuals) were recorded at Bellingen Island. This number is similar to that recorded in the previous monthly monitoring event in August 2014. Flying-foxes continue to be absent from the Camphor Laurel vegetation behind Wheatley Street.

Gordon Park (Nambucca Heads):

GHFF (>90%) and Black Flying-fox (<10%) were present. Roost area and population is similar to that recorded during the last monthly monitoring event (estimated at 10,000-15,000 individuals).

Bowraville:

No flying-foxes were observed to be roosting at Bowraville. As for the site, the last time that flying-foxes were recorded roosting at Bowraville was in early April 2014.

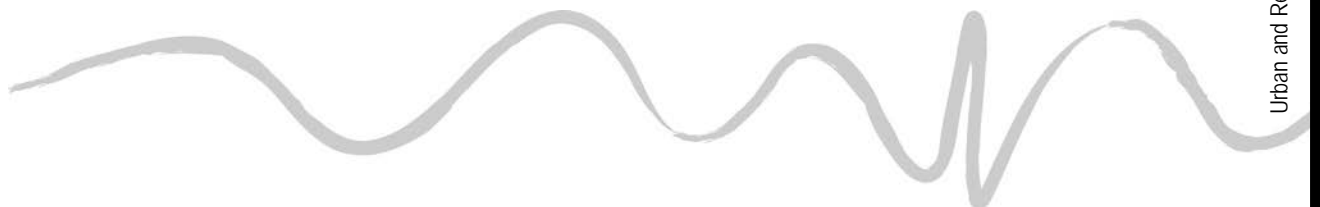
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Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW in September includes Coastal Blackbutt (*Eucalyptus pilularis*) (coastal lowlands), Forest Red Gum (*E. tereticornis*) (coastal lowlands and further inland at low elevation) and Grey Ironbark (*E. siderophloia*) (coastal lowlands). 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 indicate minor flowering of Grey Ironbark (*E. siderophloia*) and Forest Red Gum (*E. tereticornis*) is currently occurring in the region.

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

Yours sincerely
GeoLINK



Jessica O'Leary
Ecologist

Flying-fox Monitoring

Warrell Creek to Nambucca Heads

Pacific Highway Upgrade

September 2014

Prepared for: Jacobs
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Introduction

1.1 Introduction

Jacobs and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at a camp near Macksville, located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road (henceforth referred to as 'the site'). To date, monthly monitoring at the site has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly at the site since occupation commenced in December 2011 (Eby 2012).

This report details the September 2014 monthly monitoring results.

Flying-fox Survey

2.1 Methodology

Fieldwork for the September 2014 monthly survey was undertaken by GeoLINK ecologists Dr Tom Pollard and Jessica O'Leary. 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.

A dusk exit count survey was undertaken at the site on the evening of 29 September 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. No additional observers were required, as recent observations indicate that the site is currently unoccupied. Additional observers (up to 5 individuals during the seasonal peak in numbers during summer) have been used previously to effectively undertake the exit count.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive); and
- on a ridge south of the camp (41 Bald Hill Road).

The survey extended over approximately 45 minutes from sunset until dark (approximately 5:30 pm to 6:15 pm).

On 30 September a survey of the site was undertaken on foot to locate and map any roosting flying-foxes. When flying-fox are present at the site, data on species composition, demographics, reproductive status and behaviour are also collected.

The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp.

Comparative data on species composition, demographics, reproductive status and behaviour is also collected at a control site located at Bellingen Island (when flying-foxes are present) (approximately 31 km north north-west of the Macksville camp). Observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to (refer to **Illustration 2.1**) for location of these regional camps).

2.2 Results

2.2.1 Population Estimate – Exit Count

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

No exit count was conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: approximately 10,000 (population appears to have reduced somewhat from the last monthly monitoring event);
- Bowraville: no individuals recorded (population peaked in February and has declined since); and
- Bellingin Island: estimated to number approximately 5000 (flying-fox occupation of Bellingin Island camp has been sporadic since late autumn, with periods of absence). The results of the current monitoring event indicate that the number of flying-foxes at Bellingin Island is at the highest level for several months. No flying-foxes were recorded in the Camphor Laurel vegetation behind Wheatley Street, where they have previously been roosting since January 2014.

2.2.2 Roost Footprint

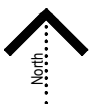
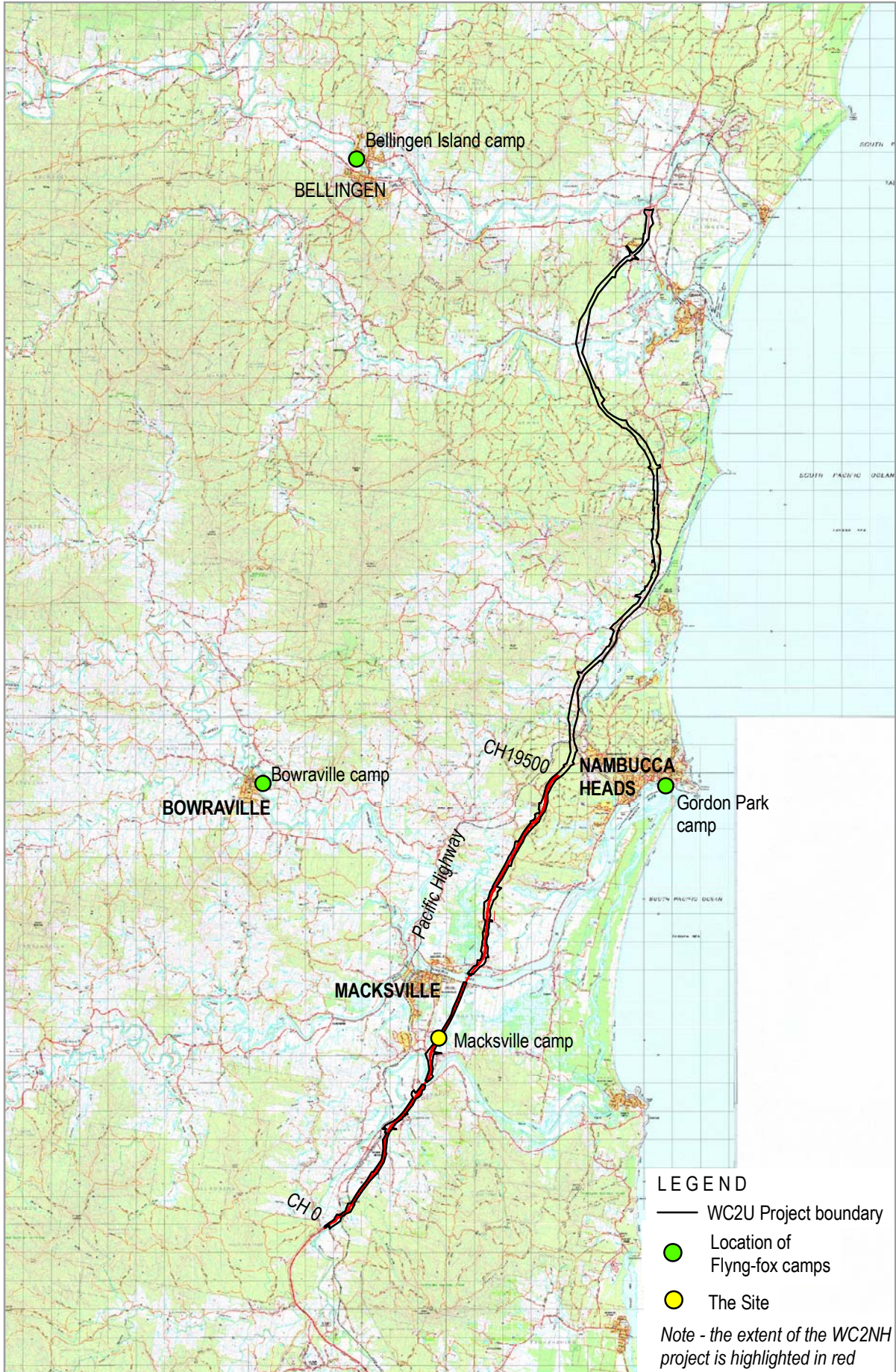
No flying-foxes were observed to be roosting at the site in the camp traverse. No flying-foxes have been recorded at the site since mid-late April 2014.

Likewise, no roosting flying-foxes were recorded at Bowraville in the current monitoring event. Flying-fox have not been observed to be roosting at Bowraville since mid-late April 2014.

Flying-foxes are currently occupying a relatively small roost footprint a Bellingin Island, and are concentrated within the southern section of the rainforest vegetation.

The flying-fox roost footprint at Gordon Park (Nambucca Heads) remains relatively extensive, but, as was recorded in the last monthly monitoring event in August, has reduced somewhat in the north-western section near Wellington Drive and Fraser Street.

Information shown is for illustrative purposes only



0 4 km



Location of Regional Flying-fox camps

2.2.3 Detailed Data

2.2.3.1 Species Composition

No flying-foxes were recorded at the site. Therefore, no detailed species composition data was collected at the site for the current monitoring event. Likewise, no flying-foxes of any species were recorded at Bowraville.

Observations at Bellingen Island indicated that both GHFF and Black Flying-fox were present, as was also the case in the Gordon Park camp. Black Flying-fox were estimated to make up approximately 5-10% of all individuals present at Bellingen Island and around 10% of all individuals at Gordon Park. As has been previously recorded, Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned above, no flying-foxes were present at the site. Consequently no detailed demographic composition data at the site was collected for the current monitoring event.

Comparison data was collected at the Bellingen Island camp. The structure of the vegetation at the Bellingen Island camp consists of a canopy of emergent rainforest species (with some large native figs of substantial diameter and up to 40 m in height) over a relatively open understorey. Most of the flying-foxes were roosting in either Creek Sandpaper Fig (*Ficus coronata*) or Giant Stinging Tree (*Dendrocnide excelsa*).

Data of habitat characteristics and demographic composition at the Bellingen Island camp is provided in Table 2.1. Females were more numerous than males in 9 out of 10 of the demographic counts and no dependent young were recorded. However, some females appeared to be conspicuously pregnant.

General observations of the flying-foxes present at the regional Gordon Park camp indicated that both female and male GHFF were present. No dependent young were observed.

Table 2.1 Demographic Data of GHFF at Bellinghen Island

<i>Tree Code</i>	<i>Tree Species</i>	<i>Height (m);DBH (cm)</i>	<i>Easting, Northing (zone 56)</i>	<i>Sex Ratio (female:male)</i>	<i>Presence of Dependant Young (yes/no)</i>	<i>% females with Dependent Young</i>
BI1	Creek Sandpaper Fig	7; 30	490087, 6631506	10:1	no	n/a
BI2	Red Cedar	10; 30	490101, 6631530	10:8	no	n/a
BI3	Creek Sandpaper Fig	8; 30	490073, 6631511	10:5	no	n/a
BI4	Giant Stinging Tree	10; 30	490098, 6631512	10:4	no	n/a
BI5	Creek Sandpaper Fig	8; 20	490093, 6631539	10:1	no	n/a
BI6	Giant Stinging Tree	10; 8	490106, 6631510	10:4	no	n/a
BI7	Creek Sandpaper Fig	8; 30	490109, 6631501	10:7	no	n/a
BI8	Creek Sandpaper Fig	8; 20, 15, 5 (multi-stemmed)	490103, 6631494	10:2	no	n/a
BI9	Creek Sandpaper Fig	10; 30, 10, 20 (multi-stemmed)	490082, 6631541	10:11	no	n/a
BI10	Creek Sandpaper Fig	8; 30	490076, 6631548	10:2	no	n/a

2.2.3.3 *Water level at the site*

Water level at the representative measurement location at the site was approximately 50 cm in depth as is shown in Figure 2.1. Following above-average rainfall in late August, the declining trend in water levels at the site has reversed.

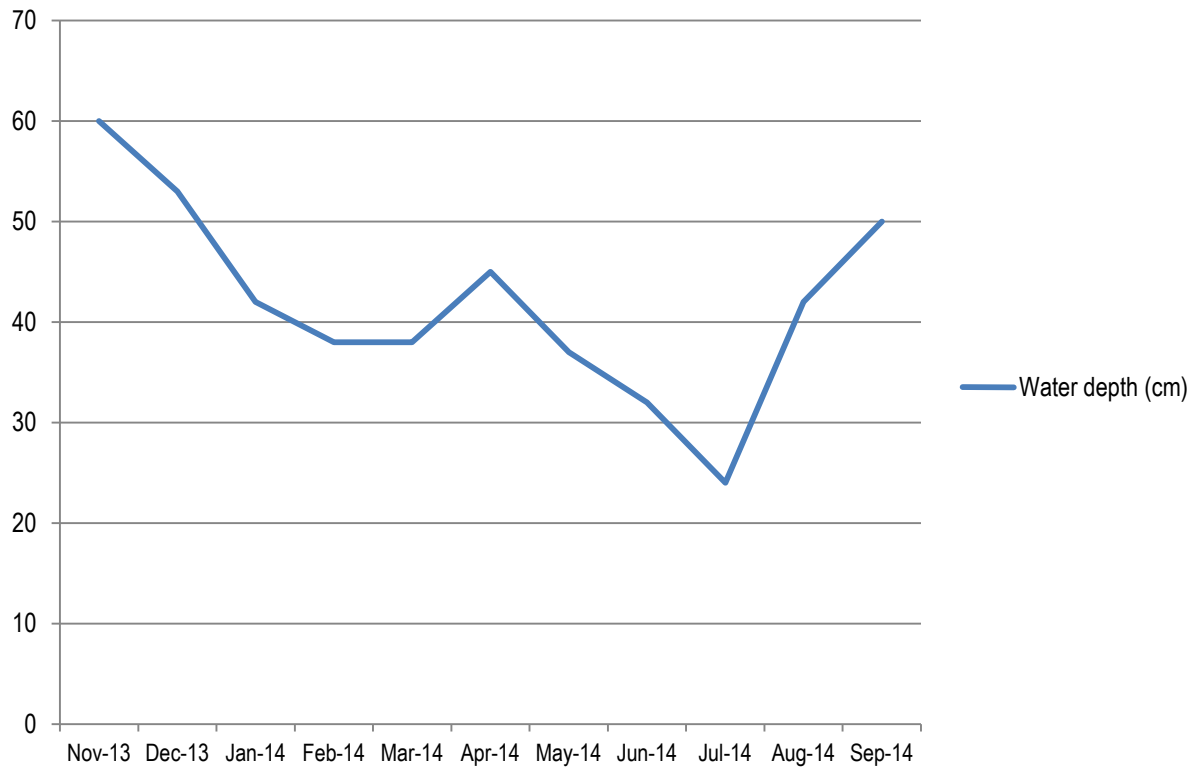


Figure 2.1 Water Level Measurements at The Site

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. No flying-foxes have been recorded at the site since early-mid April 2014, following a sustained period of occupation since late January 2014, including relatively large numbers (>40,000) recorded in early March. Previous monitoring of the site at the same time in September 2013 indicated at least 10,000 flying-foxes were roosted at the site (GeoLINK 2013).

Flying-fox numbers at Bellingen Island are still relatively low (numbering approximately 5,000 individuals). The number of flying foxes present at the Bellingen camp is similar to that recorded in the last monitoring event in mid-September. The 'overflow' roost at Wheatley Street in Bellingen continues to be unoccupied.

Flying-fox numbers at Gordon Park are still relatively high (approximately 10,000), however, this appears to be slightly less than the 10,000-15,000 that were recorded in the last monitoring event a fortnight previous. The consistent occupation of Gordon Park by substantial numbers of GHFF is likely to reflect a local availability of suitable foraging resources.

2.3.2 Species Composition and Demographic Data

At occupied camps (Bellingen Island and Gordon Park), GHFF dominated the species composition and Black Flying-fox accounted for approximately 5-10% of all individuals present. Comparison with data collected in monitoring during September 2013 (GeoLINK 2013) indicates that the proportion of Black Flying-fox was similar, representing between 5-15% of individuals recorded.

2.3.3 Phenology of Trees in Region

September flowering of a number of highly productive nectar source trees in the upper North Coast region of NSW includes Blackbutt (*Eucalyptus pilularis*) (coastal lowlands), Forest Red Gum (*Eucalyptus tereticornis*) (coastal lowlands and inland at 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 Forest Red Gum and moderate flowering of Grey Ironbark is now occurring.

2.4 Conclusion

The results of the September 2014 monthly flying-fox monitoring indicate that the absence of flying-foxes at the site continues, as was first recorded in early-mid April 2014. Flying-foxes also continue to be absent at the Bowraville camp. The Bellingen Island camp currently supports a relatively low number of flying-foxes, and this follows from a variable period of occupation, including periods of absence over the winter and early spring period. In contrast, the numbers of flying-foxes at Gordon Park remain comparatively high.

Observations from the current monitoring event indicate that overall numbers of flying-foxes at (most) regional camps visited are still relatively low following a summer peak in numbers.



Tom Pollard
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.

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GeoLINK (2013). *Flying-fox Monitoring, September 2013. WC2NH*. Unpublished report to Jacobs and NSW Roads and Maritime Services. GeoLINK, Lennox Head.

18 October 2014
Ref No: 2182-1110

The Manager
Jacobs
PO Box 2147
DANGAR NSW 2309

Attention: Rachel Vazey

Dear Rachel,

October 2014 fortnightly Flying-fox monitoring report

This short report details the findings of the October 2014 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.

A traverse of the site was undertaken on 14 October 2014. No roosting flying-foxes were located, as has been the case in all previous monitoring events undertaken since late April 2014. The last time that flying-foxes were recorded roosting at the site was in early April 2014, when an estimated 25,000 individuals were present.

An exit count was conducted at two vantage points north and south of the site on the evening of 14 October 2014. No flying-foxes were observed flying from the site in the exit count.

Other regional flying-fox sites were visited on the 14 October 2014. General observations made at these camps are as follows:

Bellingen Island:

GHFF (>90%) and Black Flying-fox (<10%) were present. A relatively small number of flying-foxes (numbering approximately 5000 individuals) were recorded at Bellingen Island, as was recorded in the previous monthly monitoring event in September 2014.

Observations indicated that a small number of the female GHFF present had dependent young. Flying-foxes continue to be absent from the Camphor Laurel vegetation behind Wheatley Street.

Gordon Park (Nambucca Heads):

GHFF (>90%) and Black Flying-fox (<10%) were present. Roost area and population is similar to that recorded during the last monthly monitoring event (approximately 10,000 individuals). As was the case at Bellingen Island, GHFF with dependent young were also observed.

Bowraville:

No flying-foxes were observed to be roosting at Bowraville. As for the site, the last time that flying-foxes were recorded roosting at Bowraville was in early April 2014.

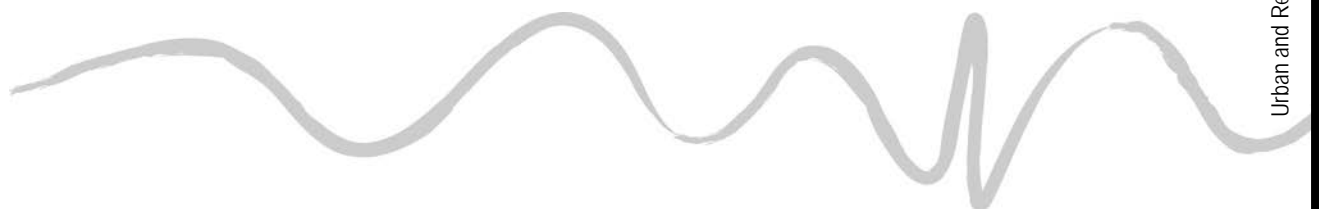
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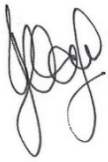
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Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW in October includes Forest Red Gum (*E. tereticornis*) (inland at low altitude and high altitude), Grey Ironbark (*E. siderophloia*) (coastal lowlands and foothills and ranges) 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 flowering of Grey Ironbark (*E. siderophloia*) and Forest Red Gum (*E. tereticornis*) (minor) is currently occurring in the region. Heavy flowering of Silky Oak (*Grevillea robusta*) was also observed (likely planted: outside of natural distribution).

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

Yours sincerely
GeoLINK



Jessica O'Leary
Ecologist

Flying-fox Monitoring

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

October 2014

Prepared for: Jacobs
© GeoLINK, 2014



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Introduction

1.1 Introduction

Jacobs and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at a camp near Macksville, located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road (henceforth referred to as 'the site'). To date, monthly monitoring at the site has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly at the site since occupation commenced in December 2011 (Eby 2012).

This report details the October 2014 monthly monitoring results.

Flying-fox Survey

2.1 Methodology

Fieldwork for the October 2014 monthly survey was undertaken by GeoLINK ecologists Dr Tom Pollard and Jessica O'Leary. 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 29 October a survey of the site was undertaken on foot to locate and map any roosting flying-foxes. When flying-fox are present at the site, data on species composition, demographics, reproductive status and behaviour are also collected.

The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp.

Comparative data on species composition, demographics, reproductive status and behaviour is also collected at a control site located at Bellingen Island (when flying-foxes are present) (approximately 31 km north north-west of the Macksville camp). Observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to (refer to Illustration 2.1) for location of these regional camps).

Following the site traverse, a dusk exit count survey was undertaken at the site on the evening of 29 October 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. No additional observers were required, as recent observations indicate that the site is currently unoccupied. Additional observers (up to 5 individuals during the seasonal peak in numbers during summer) have been used previously to effectively undertake the exit count.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive); and
- on a ridge south of the camp (41 Bald Hill Road).

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

2.2 Results

2.2.1 Population Estimate – Exit Count

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

No exit count was conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: approximately 10,000 - 15,000 (population size is broadly consistent with that recorded in the last monthly monitoring event);
- Bowraville: 1,000 to 5,000 individuals recorded (flying-fox have now returned after being absent from the roost since late April); and
- Bellingen Island: estimated to number approximately 7,500 to 10,000 (an increase in numbers since the last monitoring event. Flying-fox occupation of Bellingen Island camp has been sporadic since late autumn, with periods of absence). The results of the current monitoring event indicate that the number of flying-foxes at Bellingen Island is at the highest level for several months. No flying-foxes were recorded in the Camphor Laurel vegetation behind Wheatley Street, where they have previously been roosting since January 2014.

2.2.2 Roost Footprint

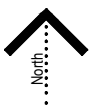
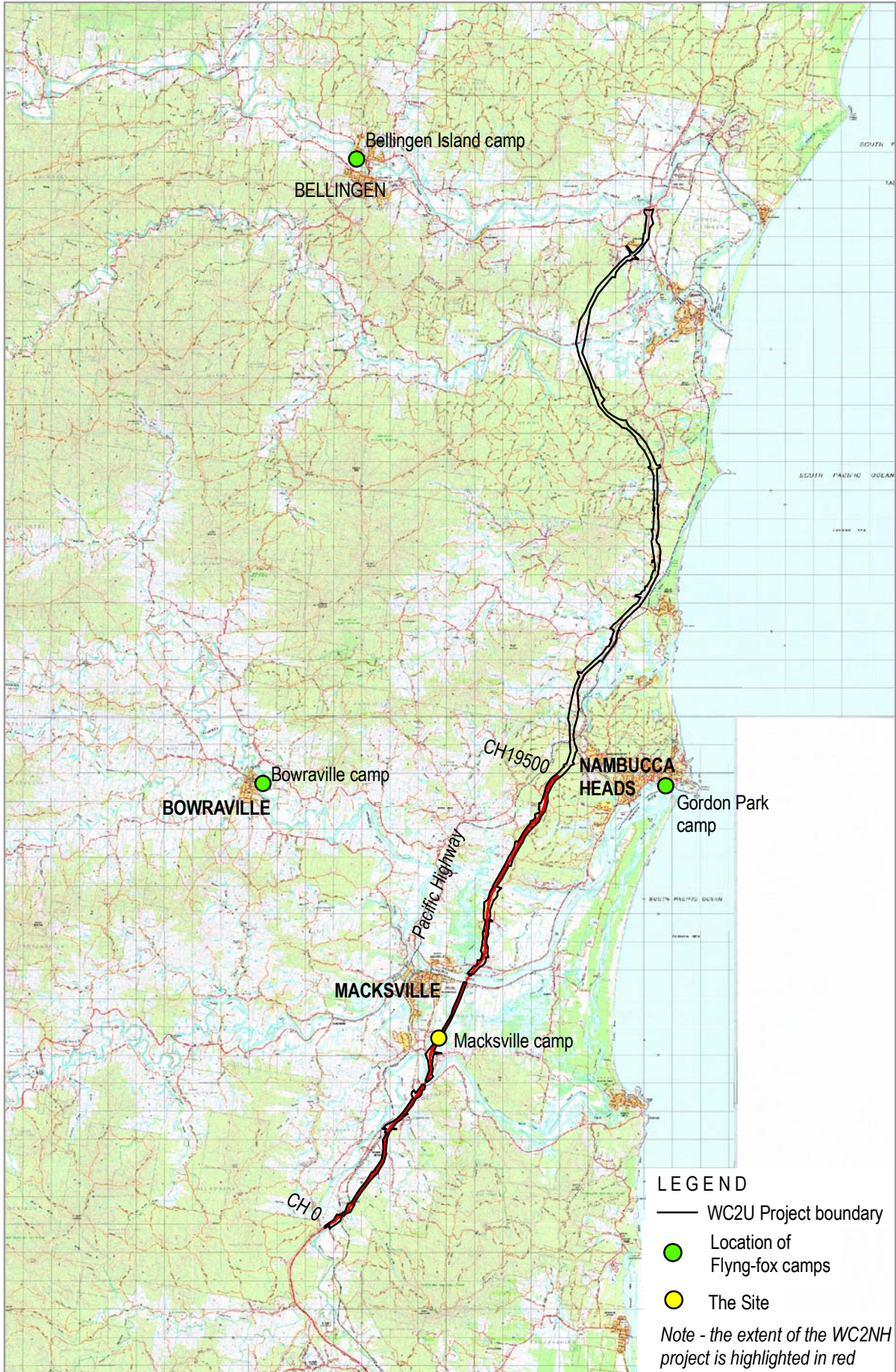
No flying-foxes were observed to be roosting at the site in the camp traverse. No flying-foxes have been recorded at the site since mid-late April 2014.

Flying-foxes have recently returned to the Bowraville camp. The extent of the roost is consistent with the previous area of occupation. The flying-fox are currently roosting in mid-storey vegetation between the loop access road and the Nambucca River.

Although the Bellingen island footprint is still relatively small compared to times of peak use, the October monthly observations indicated a recent increase in the area occupied, encompassing more of the rainforest vegetation in the southern, central and eastern edge of the island.

The flying-fox roost footprint at Gordon Park (Nambucca Heads) remains relatively extensive, and is generally consistent with that recorded in the last monthly monitoring event.

Information shown is for illustrative purposes only



0 4 km



Location of Regional Flying-fox camps

2.2.3 Detailed Data

2.2.3.1 Species Composition

No flying-foxes were recorded at the site. Therefore, no detailed species composition data was collected at the site for the current monitoring event.

GHFF have returned to the Bowraville roost for the first time since mid-late April 2014. No Black Flying-Fox were recorded among the roosting individuals.

Observations at Bellingen Island and Gordon Park indicated that both GHFF and Black Flying-fox were present. Flying-fox were estimated to make up approximately 5-10% of all individuals present at Bellingen Island and around 10% of all individuals at Gordon Park. As has been previously recorded, Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned above, no flying-foxes were present at the site. Consequently no detailed demographic composition data at the site was collected for the current monitoring event.

Comparison data was collected at the Bellingen Island camp. The structure of the vegetation at the Bellingen Island camp consists of a canopy of emergent rainforest species (with some large native figs of substantial diameter and up to 40 m in height) over a relatively open understorey. Most of the flying-foxes were roosting in either Creek Sandpaper Fig (*Ficus coronata*) or Giant Stinging Tree (*Dendrocnide excelsa*).

Data of habitat characteristics and demographic composition at the Bellingen Island camp is provided in Table 2.2. Females were more numerous than males in 9 out of 10 of the demographic counts. One 'bachelor tree' was recorded which predominantly supported males. Females with dependant young were first observed during the last October fortnightly monitoring event in low numbers (~5-10%). The percentage of GHFF females observed with dependent young in the current monitoring event was much higher (40%-90%), with an average of 75% of GHFF females having young.

Table 2.1 Demographic Data of GHFF at Bellinghen Island

<i>Tree Code</i>	<i>Tree Species</i>	<i>Height (m);DBH (cm)</i>	<i>General Location on Island</i>	<i>Sex Ratio (female:male)</i>	<i>Presence of Dependant Young (yes/no)</i>	<i>% females with Dependent Young</i>
BI1	Giant Stinging Tree	10; 40	South-east	10:2	yes	40%
BI2	Creek Sandpaper Fig	7; 30	South-east	10:4	yes	90%
BI3	Giant Stinging Tree	10; 40	South-east	10:3	yes	70%
BI4	Giant Stinging Tree	10; 30	South-east	10:3	yes	80%
BI5	Creek Sandpaper Fig	8; 15	South-east	10:4	yes	90%
BI6	Creek Sandpaper Fig	7; 20	South-east	10:3	yes	90%
BI7	Creek Sandpaper Fig	8; 20	South-central	10:4	yes	70%
BI8	Creek Sandpaper Fig	7; 15	South-central	0:10	no	0%
BI9	Creek Sandpaper Fig/Red Cedar	8; 20/8; 30	Eastern channel	10:5	yes	80%
BI10	Creek Sandpaper Fig/ Creek Sandpaper Fig & Unknown	7; 15 (multi-stemmed),	Eastern channel	10:8	yes	70%

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

Although no detailed data was collected at the Bowraville camp, female GHFF with dependent young were observed within the camp.

2.2.3.3 Water level at the site

Water level at the representative measurement location at the site was approximately 45 cm in depth as is shown in Figure 2.1. Following above-average rainfall in late August and an increase in water levels, more recently the water level has decreased.

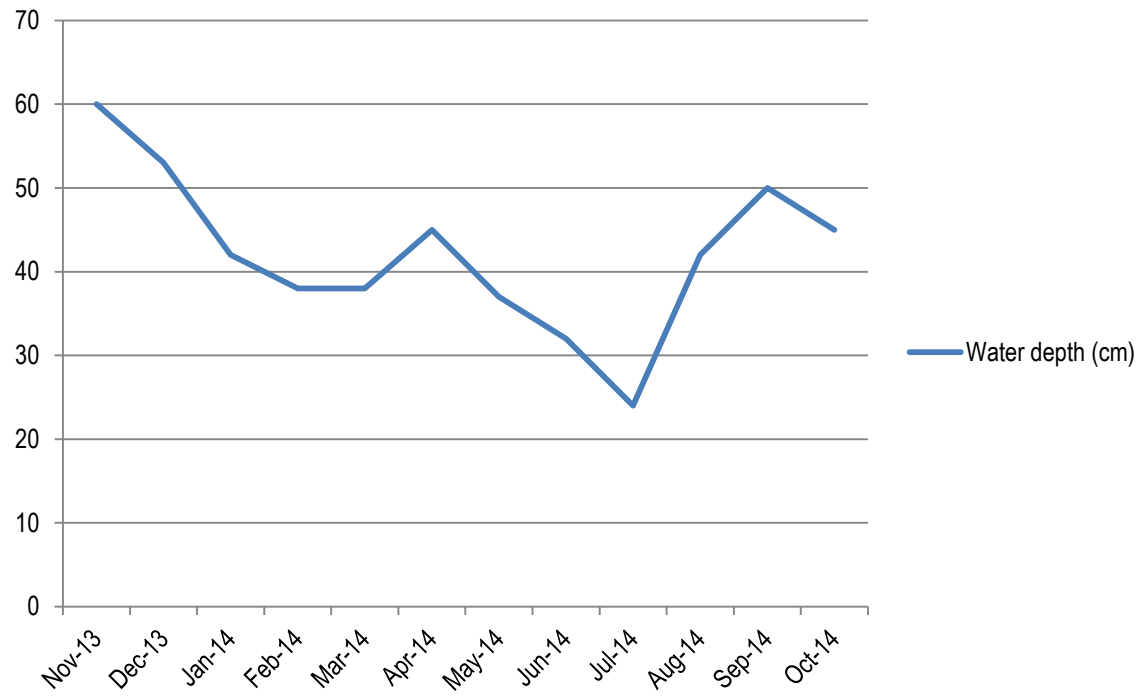


Figure 2.1 Water Level Measurements at The Site

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. No flying-foxes have been recorded at the site since early-mid April 2014, following a sustained period of occupation since late January 2014, including relatively large numbers (>40,000) recorded in early March. Previous monitoring of the site at the same time in October 2013 indicated that only a small number of flying-foxes were roosted at the site (GeoLINK 2013), with only 40 individuals recorded during the exit count.

Flying-fox numbers at Bellingen Island have started to increase recently (numbering approximately 7,500 to 10,000 individuals) since the last monitoring event in mid-October. The 'overflow' roost at Wheatley Street in Bellingen continues to be unoccupied.

Flying-fox numbers at Gordon Park are still relatively high (approximately 10,000-15,000), this count is consistent with the most recent monthly and fortnightly monitoring events and therefore the roost numbers seem to be remaining stable. The consistent occupation of Gordon Park by substantial numbers of GHFF is likely to reflect a local availability of suitable foraging resources.

2.3.2 Species Composition and Demographic Data

At occupied camps (Bellingen Island and Gordon Park), GHFF dominated the species composition and Black Flying-fox accounted for approximately 5-10% of all individuals present. Comparison with data collected in monitoring during October 2013 (GeoLINK 2013) indicates that the proportion of Black Flying-fox was slightly higher at that time, representing between 15% of individuals at Gordon Park.

2.3.3 Phenology of Trees in Region

October flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW in October includes Grey Ironbark (*E. siderophloia*) (coastal lowlands and foothills and ranges) and Silky Oak (*Grevillea robusta*). These 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 only light flowering of Grey Ironbark (*E. siderophloia*) is currently occurring and heavy flowering of Silky Oak (*Grevillea robusta*) was also observed (likely planted: outside of natural distribution).

2.4 Conclusion

The results of the October 2014 monthly flying-fox monitoring indicate that the absence of flying-foxes at the site continues, as was first recorded in early-mid April 2014. A small number of Flying-Foxes have returned to the Bowraville camp. The Bellingen Island camp currently supports a relatively low, yet increasing, number of flying-foxes, and this follows from a variable period of occupation, including periods of absence over the winter and early spring period. In contrast, the numbers of flying-foxes at Gordon Park remain comparatively high.

Observations from the current monitoring event indicate that overall numbers of flying-foxes at (most) regional camps visited are still relatively low following a summer peak in numbers.



Tom Pollard
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.

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GeoLINK (2013). *Flying-fox Monitoring, October 2013. WC2NH*. Unpublished report to Jacobs and NSW Roads and Maritime Services. GeoLINK, Lennox Head.

19 November 2014
Ref No: 2182-1112

The Manager
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PO Box 2147
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Attention: Rachel Vazey

Dear Rachel,

November 2014 fortnightly Flying-fox monitoring report

This short report details the findings of the November 2014 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.

A traverse of the site was undertaken on 12 November 2014. No roosting flying-foxes were located, as has been the case in all previous monitoring events undertaken since late April 2014. The last time that flying-foxes were recorded roosting at the site was in early April 2014, when an estimated 25,000 individuals were present.

An exit count was conducted at two vantage points north and south of the site on the evening of 12 November 2014. No flying-foxes were observed flying from the site in the exit count.

Other regional flying-fox camps were visited on the 12 November 2014. General observations made at these camps are as follows:

Bellingen Island:

GHFF (>90%) and Black Flying-fox (<10%) were present. A relatively small number of flying-foxes (numbering approximately 5,000 individuals) were recorded at Bellingen Island. This represents a minor decrease in numbers since the last monthly monitoring event. Visual observations indicated that a substantial number of the female GHFF present are supporting dependent young. Flying-foxes continue to be absent from the Camphor Laurel vegetation behind Wheatley Street.

Gordon Park (Nambucca Heads):

GHFF (>90%) and Black Flying-fox (<10%) were present. Roost area and population is similar to that recorded during the last monthly monitoring event (approximately 10,000 individuals). As was the case at Bellingen Island, GHFF with dependent young were also observed.

Bowraville:

It was estimated that approximately 5,000 flying-foxes were present at the Bowraville roost. This number has noticeably increased since the previous monitoring event. Females with dependant young were also observed within the Bowraville camp.

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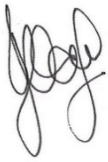
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Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW in November includes Forest Red Gum (*E. tereticornis*) (inland at low altitude and high altitude), Grey Ironbark (*E. siderophloia*) (coastal lowlands and foothills and ranges) 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 light flowering of Grey Ironbark (*E. siderophloia*) is currently occurring in the region.

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

Yours sincerely
GeoLINK



Jessica O'Leary
Ecologist

Flying-fox Monitoring

Warrell Creek to Nambucca Heads

Pacific Highway Upgrade

November 2014

Prepared for: Jacobs
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Introduction

1.1 Introduction

Jacobs and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at a camp near Macksville, located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road (henceforth referred to as 'the site'). To date, monthly monitoring at the site has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly at the site since occupation commenced in December 2011 (Eby 2012).

This report details the November 2014 monthly monitoring results.

Flying-fox Survey

2.1 Methodology

Fieldwork for the November 2014 monthly survey was undertaken by GeoLINK ecologist Jessica O'Leary and ecologist Terry Tweedie (GeoLINK subcontractor). 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.

The timing of this monitoring event was brought forward by one week to coincide with the annual National Flying-Fox census conducted by OEH. On 20 November a survey of the site was undertaken on foot to locate and map any roosting flying-foxes. When flying-fox are present at the site, data on species composition, demographics, reproductive status and behaviour are also collected.

The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp.

Comparative data on species composition, demographics, reproductive status and behaviour was also collected at a control site located at Bellingen Island (when flying-foxes are present) (approximately 31 km north north-west of the Macksville camp). Observational comments from other regional flying-fox camps at Gordon Park camp, Nambucca Heads (approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to (refer to [Illustration 2.1](#)) for location of these regional camps).

Following the site traverse, a dusk exit count survey was undertaken at the site on the evening of 20 November 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. No additional observers were required, as recent observations indicate that the site is currently unoccupied. Additional observers (up to 5 individuals during the seasonal peak in numbers during summer) have been used previously to effectively undertake the exit count.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive); and
- on a ridge south of the camp (41 Bald Hill Road).

The survey extended over approximately 1 hour from sunset until dark (approximately 7:15 pm to 8:15 pm).

2.2 Results

2.2.1 Population Estimate – Exit Count

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

No exit count was conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: approximately 10,000 - 15,000 (population size was broadly consistent with observations in recent months);
- Bowraville: >15,000 individuals recorded (flying-fox numbers have recently increased substantially); and
- Bellingen Island: estimated to number approximately 3,000 – 5,000 (a decrease in numbers since the last monitoring event. Flying-fox occupation of Bellingen Island camp has been sporadic since late autumn, with periods of absence). The results of the current monitoring event indicate that the numbers of flying-foxes at Bellingen Island has decreased since the last monthly monitoring event in October, which recorded the highest number of flying-foxes for several months. No flying-foxes were recorded in the Camphor Laurel vegetation behind Wheatley Street, where they have previously been roosting since January 2014.

2.2.2 Roost Footprint

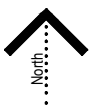
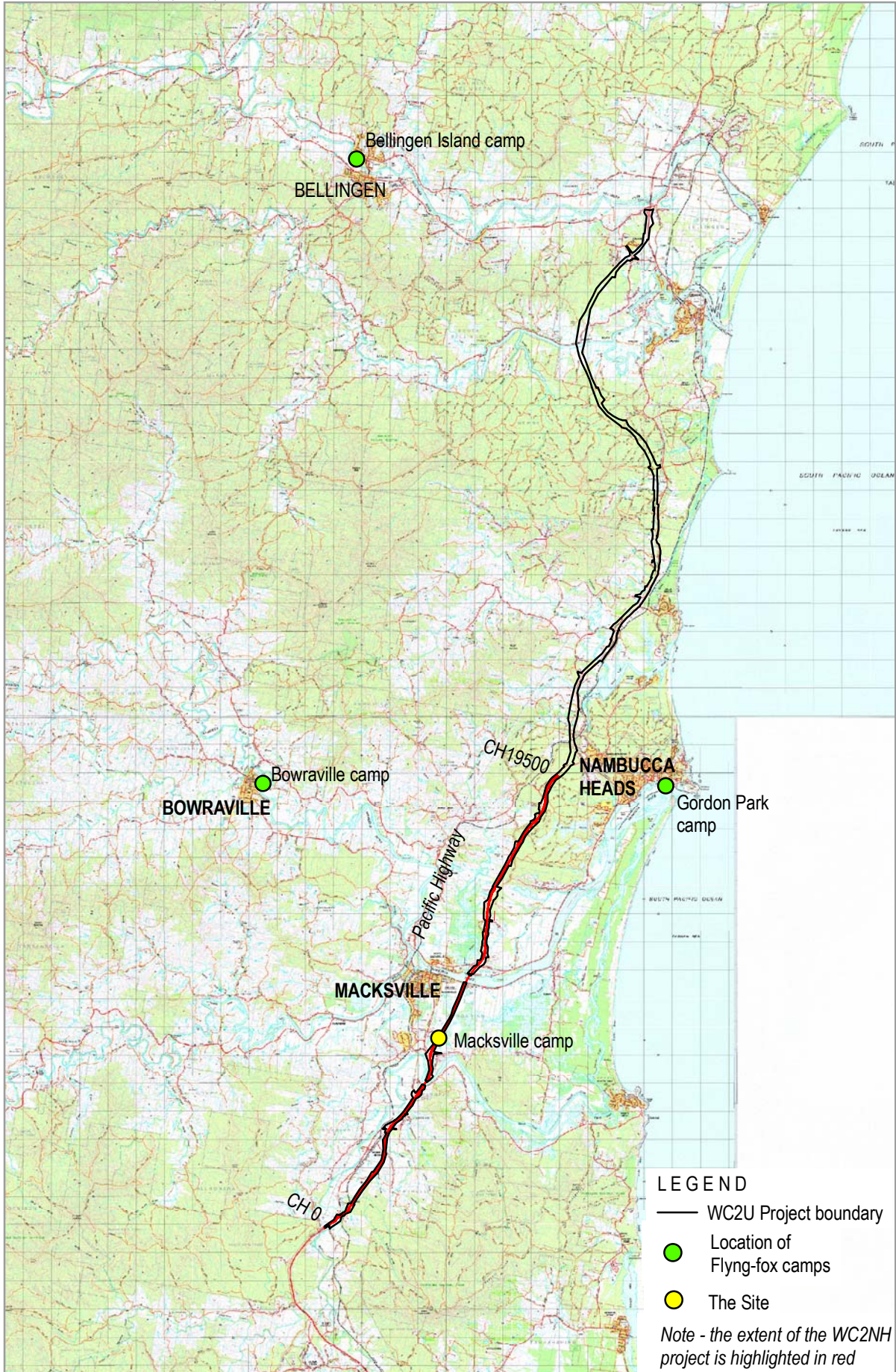
No flying-foxes were observed to be roosting at the site in the camp traverse. No flying-foxes have been recorded at the site since mid-late April 2014.

Flying-foxes have recently returned to the Bowraville camp. The extent of the roost is consistent with the previous area of occupation. The flying-fox are currently roosting in mid-storey vegetation between the loop access road and the Nambucca River.

Although the Bellingen island footprint is still relatively small compared to times of peak use, the November monthly observations indicated a reduced extent of the roost footprint in the central and southern part of the island.

The flying-fox roost footprint at Gordon Park (Nambucca Heads) remains relatively extensive, and is generally consistent with that recorded in the last monthly monitoring event.

Information shown is for illustrative purposes only



0 4 km



Location of Regional Flying-fox camps

2.2.3 Detailed Data

2.2.3.1 Species Composition

No flying-foxes were recorded at the site. Therefore, no detailed species composition data was collected at the site for the current monitoring event.

Observations at Bowraville indicated that the roosting individuals only consisted of GHFF, with no Black Flying-Fox recorded.

Observations at Bellingen Island and Gordon Park indicated that both GHFF and Black Flying-fox were present. Flying-fox were estimated to make up approximately 5-10% of all individuals present at Bellingen Island and around 10% of all individuals at Gordon Park. As has been previously recorded, Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned above, no flying-foxes were present at the site. Consequently no detailed demographic composition data at the site was collected for the current monitoring event.

Comparison data was collected at the Bellingen Island camp. The structure of the vegetation at the Bellingen Island camp consists of a canopy of emergent rainforest species (with some large native figs of substantial diameter and up to 40 m in height) over a relatively open understorey. Most of the flying-foxes were roosting in either Creek Sandpaper Fig (*Ficus coronata*) or Giant Stinging Tree (*Dendrocnide excelsa*).

Data of habitat characteristics and demographic composition at the Bellingen Island camp is provided in Table 2.1. Females were more numerous than males in 7 out of 10 of the demographic counts. Three 'bachelor trees' were recorded which predominantly supported males.

The results of the demographic count indicated that 40-80% of all females observed supported dependent young (refer to Table 2.1). This is similar to the percentage of GHFF females observed with dependent young recorded during the October monthly monitoring (ranging between 40% and 90%).

Table 2.1 Demographic Data of GHFF at Bellingen Island

Tree Code	Tree Species	Height (m);DBH (cm)	General Location on Island	Sex Ratio (female:male)	Presence of Dependant Young (yes/no)	% females with Dependent Young	Notes
BI1	Creek Sandpaper Fig & Giant Stinging Tree	8; 35 10; 30	Eastern Channel	3:15	no	0%	'Bachelor tree' supporting majority of males.
BI2	Giant Stinging Tree	10; 40	Eastern Channel	10:5	yes	50%	
BI3	Creek Sandpaper Fig	8; 25	Eastern Channel	10:5	yes	60%	
BI4	Unknown rainforest tree	13; 40	South-central	10:6	yes	80%	
BI5	Unknown rainforest tree	18; 50	South-central	10:2	yes	40%	

Tree Code	Tree Species	Height (m);DBH (cm)	General Location on Island	Sex Ratio (female:male)	Presence of Dependant Young (yes/no)	% females with Dependent Young	Notes
BI6	Giant Stinging Tree	10; 25	South-western	0:10	no	0%	'Bachelor tree' supporting majority of males.
BI7	White Booyong	10; 35	South-central	10:4	yes	40%	
BI8	Creek Sandpaper Fig	12; Multi-stemmed	South-east	0:10	no	0%	'Bachelor tree' supporting majority of males.
BI9	Giant Stinging Tree	10; 30	South-east	10:4	yes	60%	
BI10	Creek Sandpaper Fig across 2 trees	8; 10 8; 15	South-east	10:7	yes	60%	

General observations of the flying-foxes present at Gordon Park and Bowraville indicated that both female and male GHFF were present. Females with dependant young were also observed.

2.2.3.3 Water level at the site

Water level at the representative measurement location at the site was approximately 33 cm in depth as is shown in Figure 2.1. Following above-average rainfall in late August and a brief increase in water levels, more recently the water level has decreased.

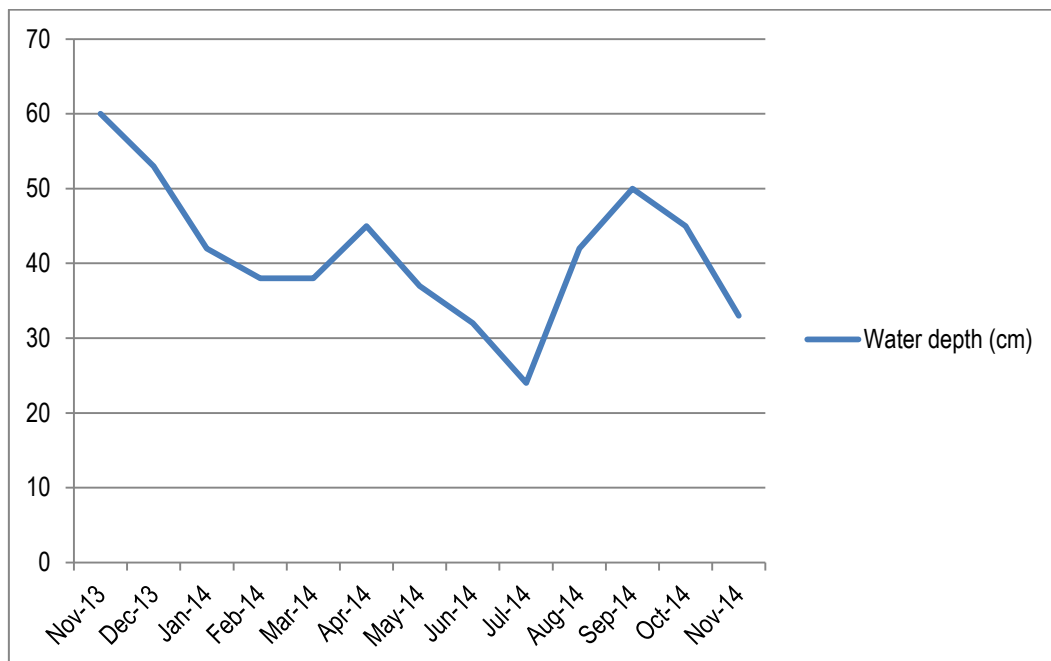


Figure 2.1 Water Level Measurements at The Site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes were observed 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. No flying-foxes have been recorded at the site since early-mid April 2014, following a sustained period of occupation since late January 2014, including relatively large numbers (>40,000) recorded in early March. Previous monitoring of the site at the same time in November 2013 indicated that a relatively small number of flying-foxes were roosting at the site at that time (GeoLINK 2013), with approximately 1,200 individuals recorded during the exit count.

Flying-fox numbers at Bellingen Island have decreased since the last monthly monitoring event from approximately 7,500-10,000 down to 3,000-5,000 individuals. The 'overflow' roost at Wheatley Street in Bellingen continues to be unoccupied.

Flying-fox numbers at Gordon Park are still relatively high (approximately 10,000-15,000 individuals) and appear to be remaining relatively stable. The consistent occupation of Gordon Park by substantial numbers of GHFF is likely to reflect a local availability of suitable foraging resources.

Numbers of flying-fox at the Bowraville camp have increased significantly since the last monitoring event undertaken in mid-November from approximately 5,000 to >15,000.

2.3.2 Species Composition and Demographic Data

GHFF dominated the species composition at all occupied regional flying-fox camps. Black Flying-fox accounted for a small proportion of approximately 5-10% of all individuals present at both Bellingen Island and Gordon Park and only GHFF were recorded at the Bowraville camp. Comparison with data collected in monitoring during November 2013 (GeoLINK 2013) indicates that the proportion of Black Flying-fox was approximately the same in occupied camps at that time.

2.3.3 Phenology of Trees in Region

Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW in November includes Forest Red Gum (*E. tereticornis*) (inland at low altitude and high altitude), Grey Ironbark (*E. siderophloia*) (coastal lowlands and foothills and ranges) 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 moderate flowering of Grey Ironbark (*E. siderophloia*) is currently occurring in the region.

2.4 Conclusion

The results of the November 2014 monthly flying-fox monitoring indicate that the absence of flying-foxes at the site continues, as was first recorded in early-mid April 2014. A significant increase in the number of flying-foxes has occurred at the Bowraville camp recently. The Bellingen Island camp currently supports a relatively low number of flying-foxes, and this follows from a variable period of occupation, including periods of absence over the winter and early spring period. In contrast, the numbers of flying-foxes at Gordon Park remain comparatively high.

Observations from the current monitoring event indicate that overall numbers of flying-foxes at (most) regional camps visited are still relatively low following a summer peak in numbers.



Jessica O'Leary
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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17 December 2014
Ref No: 2182-1114

The Manager
Jacobs
PO Box 2147
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Attention: Rachel Vazey

Dear Rachel,

December 2014 fortnightly Flying-fox monitoring report

This short report details the findings of the December 2014 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.

A traverse of the site was undertaken on 10 December 2014. No roosting flying-foxes were located, as has been the case in all previous monitoring events undertaken since late April 2014. The last time that flying-foxes were recorded roosting at the site was in early April 2014, when an estimated 25,000 individuals were present.

An exit count was conducted at two vantage points north and south of the site on the evening of 10 December 2014. No flying-fox were observed exiting from the site. From the northern vantage point a small number of individuals (<50) were observed to be flying over the site from north to south, and are likely to consist of individuals originating from the Nambucca Heads camp that are flying over the site to forage in areas further south.

Other regional flying-fox camps were visited on the 10 December 2014. General observations made at these camps are as follows:

Bellingen Island:

GHFF (>90%) and Black Flying-fox (<10%) were present. Numbers may have recently increased and were estimated at approximately 7,500-10,000 individuals. This represents an increase in numbers since the last monthly monitoring event at the end of November when numbers were estimated to be approximately 3,000-5,000 individuals. Visual observations indicated that female GHFF were supporting dependent young at the time of the current monitoring event. Flying-foxes continue to be absent from the Camphor Laurel vegetation behind Wheatley Street.

Gordon Park (Nambucca Heads):

GHFF (>90%) and Black Flying-fox (<10%) were present. Roost area and population is similar to that recorded during the last monthly monitoring event (approximately 10,000-15,000 individuals). As was the case at Bellingen Island, GHFF with dependent young were also observed.

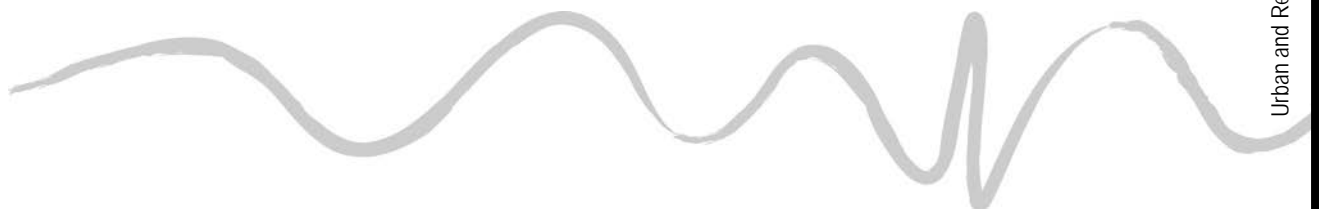
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Bowraville:

It was estimated that approximately 5,000-7,500 flying-foxes were present at the Bowraville roost. Both GHFF and Black Flying-fox were observed, with GHFF making up at least 90% of all individuals present. Flying-fox numbers have been estimated at between 5,000 and 15,000 at Bowraville over the last couple of months. Female GHFF with dependant young were also observed.

Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW in December includes Forest Red Gum (*E. tereticornis*) (high altitude), Grey Ironbark (*E. siderophloia*) (foothills and ranges), Coastal Blackbutt (*E. pilularis*) (foothills and ranges), and a number of *Corymbia* species including Spotted Gum (*Corymbia maculata* and *C. variegata*), Red Bloodwood (*C. gummifera*) and Pink Bloodwood (*C. intermedia*). 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 light flowering of Grey Ironbark (*E. siderophloia*) is continuing in the region in the low hilly country between the coast and the inland river valleys.

If you have any queries regarding this report, please feel free to call on 02 6621 6677.

Yours sincerely

GeoLINK



Tom Pollard
Ecologist

Flying-fox Monitoring

Warrell Creek to Nambucca Heads

Pacific Highway Upgrade

December 2014

Prepared for: Jacobs
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Introduction

1.1 Introduction

Jacobs and NSW Roads and Maritime Services (RMS) are working to resolve issues relating to the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp within the approved alignment of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project.

GeoLINK has been engaged to undertake monthly flying-fox monitoring at a camp near Macksville, located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road (henceforth referred to as 'the site'). To date, monthly monitoring at the site has been undertaken by GeoLINK since July 2013. However, a significant amount of data from previous monitoring has also been collected irregularly at the site since occupation commenced in December 2011 (Eby 2012).

This report details the November 2014 monthly monitoring results.

Flying-fox Survey

2.1 Methodology

Fieldwork for the December 2014 monthly survey was undertaken by GeoLINK ecologist Tom Pollard and ecologist Terry Tweedie (GeoLINK subcontractor). 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 22 December a survey of the site was undertaken on foot to locate and map any roosting flying-foxes. When flying-fox are present at the site, data on species composition, demographics, reproductive status and behaviour are also collected.

The water level at the site was measured at a previously established measurement point. The water level at this location is representative of the average level beneath the camp.

Comparative data on species composition, demographics, reproductive status and behaviour was also collected at a control site located at Bellingen Island (approximately 31 km north north-west of the Macksville camp). Observations were also made of flying-foxes at other regional flying-fox camps at Nambucca Heads (Gordon Park; approximately 12 km north-east of the Macksville camp) and Bowraville (approximately 11 km north-west of the Macksville camp) (refer to **Illustration 2.1** for location of these regional camps).

Following the site traverse, a dusk exit count survey was undertaken at the site on the evening of 20 November 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. No additional observers were required as recent information from nearby landholders indicated that the site is currently unoccupied. Additional observers (up to 5 individuals during the seasonal peak in numbers during summer) have been used previously to effectively undertake the exit count when flying-foxes are present at the site.

Observers were located at the following vantage points:

- in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive); and
- on a ridge south of the camp (41 Bald Hill Road).

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

2.2 Results

2.2.1 Population Estimate – Exit Count

No flying-foxes were observed flying from the site in the exit count. A small number (<50) of flying-foxes were observed from the northern ridge to be flying in from the north across the site. Previous exit counts at the site when flying-fox are not roosting also recorded a small number of flying-foxes flying from north to south across the site, and it has been surmised that these flying-foxes likely originate at other nearby occupied regional camps (e.g. Gordon Park) and are commuting over the site to foraging areas.

No exit count was conducted at any of the other regional camps. However, rough population estimates for these camps based on extrapolation of counts in individual trees and the size of the camps are as follows:

- Gordon Park: approximately 10,000 - 15,000 (population size was broadly consistent with observations in recent months);
- Bowraville: 5,000-7,500 individuals recorded (flying-fox numbers have fluctuated between 5,000 and 15,000 individuals over the last two months); and
- Bellingen Island: estimated to number approximately 5,000-7,500 individuals (a decrease in numbers since the last monitoring event. The number of flying-foxes at Bellingen Island have been at low to moderate levels (<10,000) over the last several months. No flying-foxes were recorded in the Camphor Laurel vegetation behind Wheatley Street, where they have previously been roosting since January 2014.

2.2.2 Roost Footprint

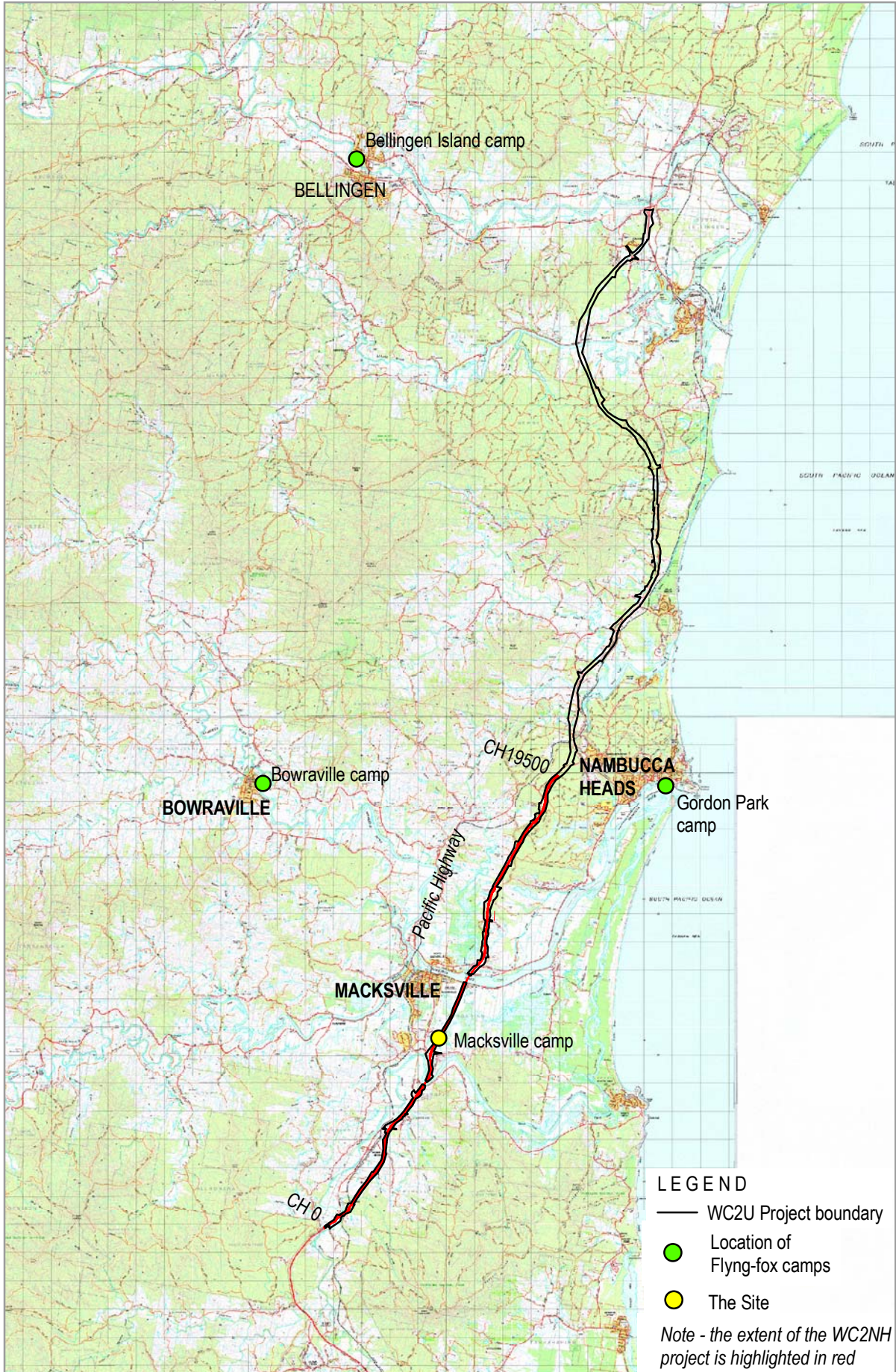
No flying-foxes were observed to be roosting at the site in the camp traverse. No flying-foxes have been recorded at the site since mid-late April 2014.

At the Bowraville camp flying-foxes are currently mostly roosting in mid-storey vegetation between the loop access road and the Nambucca River, with smaller numbers roosting in the canopy of a handful of Camphor Laurel trees on the opposite bank of the Nambucca River. The extent of the roost is generally consistent with that recorded in the December 2014 fortnightly monitoring event.

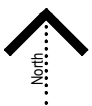
At Bellingen Island the flying-fox roost footprint was found to mainly occupy the southern and eastern sections of the rainforest vegetation. A similar area has been occupied for several months now.

The flying-fox roost footprint at Gordon Park (Nambucca Heads) remains relatively extensive, and this year has generally consistently occupies a similar area without substantial change.

Information shown is for illustrative purposes only



LEGEND
— WC2U Project boundary
● Location of Flying-fox camps
● The Site
Note - the extent of the WC2NH project is highlighted in red



0 4 km



Location of Regional Flying-fox camps

2.2.3 Detailed Data

2.2.3.1 Species Composition

No flying-foxes were recorded at the site. Therefore, no detailed species composition data was collected at the site for the current monitoring event.

Observations at Bellinghen Island, Gordon Park and Bowraville indicated the presence of both GHFF and Black Flying-fox. Flying-fox were estimated to make up <10% of all individuals present at Bellinghen Island Bellinghen Island and Gordon Park and <5% of all individuals at Bowraville. As has been previously recorded, Black Flying-fox are most prominent on the periphery of the Gordon Park camp, particularly along Wellington Drive.

2.2.3.2 Habitat Characteristics and Demographic Composition

As mentioned above, no flying-foxes were present at the site. Consequently no detailed demographic composition data at the site was collected for the current monitoring event.

Comparison data was collected at the Bellinghen Island camp. The structure of the vegetation at the Bellinghen Island camp consists of a canopy of emergent rainforest species (with some large native figs of substantial diameter and up to 40 m in height) over a relatively open understorey. Most of the flying-foxes were roosting in either Creek Sandpaper Fig (*Ficus coronata*) or Giant Stinging Tree (*Dendrocnide excelsa*).

Data of habitat characteristics and demographic composition at the Bellinghen Island camp is provided in **Table 2.1**. Females were more numerous than males in 9 out of 10 of the demographic counts. One 'bachelor tree' were recorded which predominantly supported males.

The results of the demographic count indicated that 30-100% of all females observed supported dependent young (refer to **Table 2.1**), with seven out of ten of the demographic point counts recording at least 70% of females with dependent young. Similar percentages of GHFF females with dependent young at Bellinghen Island were recorded during the October and November monthly monitoring.

Table 2.1 Demographic Data of GHFF at Bellinghen Island

Tree Code	Tree Species	Height (m);DBH (cm)	General Location on Island	Sex Ratio (female:male)	Presence of Dependant Young (yes/no)	% females with Dependent Young	Notes
BI1	Creek Sandpaper Fig	8; 30	South-east	10:5	yes	60%	
BI2	Creek Sandpaper Fig	8; 20	South-east	10:1	yes	80%	
BI3	Giant Stinging Tree	15; 40	South-east	10:3	yes	80%	
BI4	Creek Sandpaper Fig	8; 30	South-east	5:1	yes	90%	
BI5	Giant Stinging Tree	12; 60	South-east	5:1	yes	100%	
BI6	Stag	10; 60	East	0:10	no	0%	'Bachelor tree' supporting majority of males.
BI7	Unknown MYRTACEAE	8; 30	Eastern Channel	5:2	yes	80%	

Tree Code	Tree Species	Height (m);DBH (cm)	General Location on Island	Sex Ratio (female:male)	Presence of Dependant Young (yes/no)	% females with Dependent Young	Notes
BI8	Creek Sandpaper Fig	7; 20	Eastern Channel	10:3	yes	70%	
BI9	Giant Stinging Tree	8; 70	Eastern Channel	5:1	yes	40%	
BI10	Unknown MYRTACEAE	8; 30	Eastern Channel	10:3	yes	30%	

General observations of the flying-foxes present at Gordon Park and Bowraville indicated that both female and male GHFF were present. Females with dependant young were also observed at both of these camps.

2.2.3.3 Water level at the site

Water level at the representative measurement location at the site was approximately 30 cm in depth as is shown in **Figure 2.1**. The declining trend in water levels at the site continues.

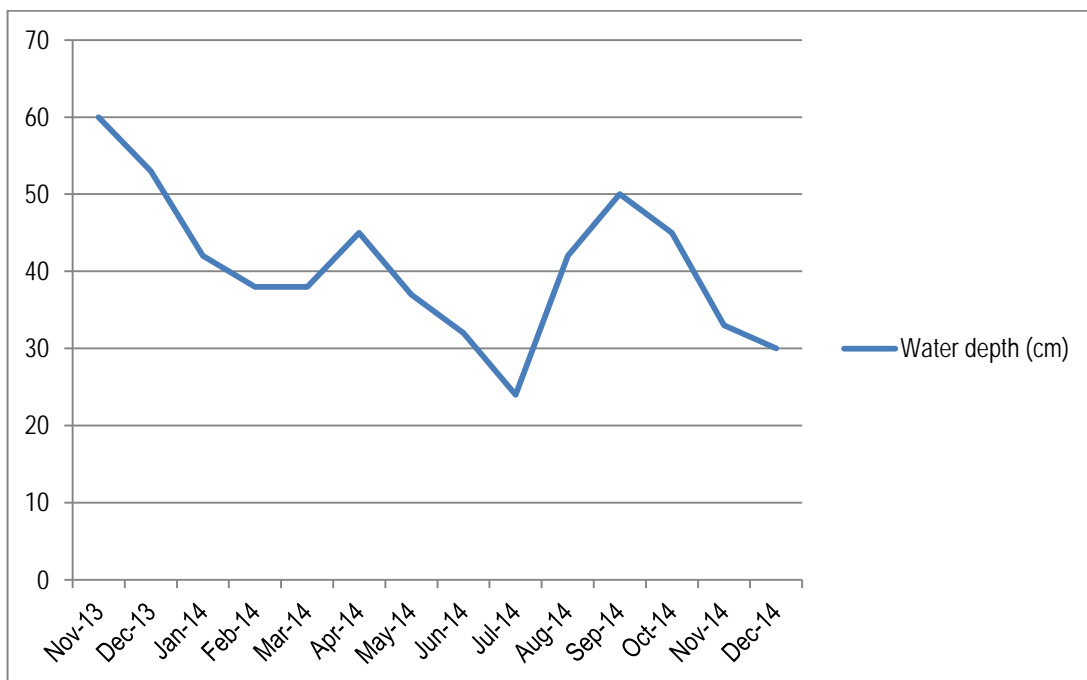


Figure 2.1 Water Level Measurements at The Site

2.3 Discussion

2.3.1 Population Estimates

No flying-foxes have been recorded roosting at the site since early-mid April 2014, following a sustained period of occupation since late January 2014, including relatively large numbers (>40,000) recorded in early March. Previous monitoring of the site at the same time in December 2013 indicated that a relatively small number of flying-foxes were roosting at the site at that time (GeoLINK 2013), with approximately 2,500 individuals recorded during the exit count.

Previous monitoring at all of the visited regional flying-fox camps at the same time in December 2013 indicated occupation levels of >10,000 individuals at each camp (GeoLINK 2013). The only regional camp to have consistently recorded flying-fox numbers in excess of 10,000 individuals in 2014 has been Gordon Park in Nambucca Heads.

2.3.2 Species Composition and Demographic Data

GHFF dominated the species composition at all occupied regional flying-fox camps. Black Flying-fox accounted for a small proportion of approximately 5-10% of all individuals present at all regional flying-fox camps visited. This is consistent with the results from previous monthly monitoring.

2.3.3 Phenology of Trees in Region

Flowering of a number of highly productive nectar source trees for GHFF in the upper North Coast region of NSW in December includes Forest Red Gum (*E. tereticornis*) (high altitude), Grey Ironbark (*E. siderophloia*) (foothills and ranges), Coastal Blackbutt (*E. pilularis*) (foothills and ranges), and a number of *Corymbia* species including Spotted Gum (*Corymbia maculata* and *C. variegata*), Red Bloodwood (*C. gummifera*) and Pink Bloodwood (*C. intermedia*). 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 for the current monitoring indicated that no significant flowering of any of these species is currently occurring in the region.

2.4 Conclusion

The results of the December 2014 monthly flying-fox monitoring indicate that the absence of flying-foxes at the site continues, as was first recorded in early-mid April 2014. Flying-foxes have returned to Bowraville over the last few months and numbers have been moderate to relatively high (5,000-15,000). The Bellingen Island camp currently supports a relatively moderate (5,000-7,500) number of flying-foxes, and this follows a variable period of occupation, including periods of absence over the winter and early spring period. In contrast, the numbers of flying-foxes at Gordon Park have consistently remained comparatively high throughout 2014.



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Ecologist



References

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