Flying-fox Monitoring

WC2NH

July 2013

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UPR	*Description*	*Date Issued*	*Issued By*
2182-1008	First issue	05/08/2013	RVI
2182-1013	Second issue	13/08/2013	RVI

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1 Introduction

1.1 Introduction

Sinclair Knight Merz (SKM) and NSW Roads and Maritime Services (RMS) are working to resolve the Grey-headed Flying-fox (*Pteropus poliocephalus*) camp conflict on the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project. GeoLINK was engaged to undertake flying-fox monitoring at the subject roost, which is located in a patch of Swamp Sclerophyll Forest vegetation north of Bald Hill Road, Macksville. Specifically GeoLINK was engaged to:

- Map the vegetation types within the subject Swamp Sclerophyll Forest, to gain clarity on the distribution of the Melaleuca and Casuarina dominated vegetation types;
- Undertake preliminary field surveys and desktop assessment to identify other potentially occurring threatened species within the subject Swamp Sclerophyll Forest;
- Survey the open water to identify its depth and distribution within the subject Swamp Sclerophyll Forest; and
- Survey the presence and extent of the flying fox camp in late July 2013.

The monitoring was undertaken 23 - 25 July 2013.

2

Vegetation Mapping

2.1 Methodology

A field survey to map the vegetation types within the subject Swamp Sclerophyll Forest, with an emphasis on defining the boundary between the Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Swamp Oak (*Casuarina glauca*) dominated vegetation types, was undertaken on 24 July 2013. The methodology included:

- Initial aerial photograph interpretation and review of existing vegetation mapping (SKM 2010 and Ecological 2005); and
- Ground-truthing, using GPS, to map vegetation boundaries. Other relevant features of each vegetation type were also noted, including dominant species, vegetation structure (cover and height of each strata layer), condition and presences of standing water.

2.2 Results

The subject Swamp Sclerophyll Forest occupies an area of 23.4 ha and was found to support three vegetation types, as detailed in Appendix A and mapped in Illustration 2.1.

Broad-leaved Paperbark swamp forest occurs across the majority of the subject Swamp Sclerophyll Forest system (18 ha). Swamp Oak swamp forest (3.8 ha) and Swamp Mahogany/ Broad-leaved Paperbark swamp forest (approximately 1.6 ha) were restricted to the edges.

The subject Swamp Sclerophyll Forest conforms to the *Threatened Species Conservation Act 1995* (TSC Act) listed Endangered Ecological Community (EEC) *Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.*

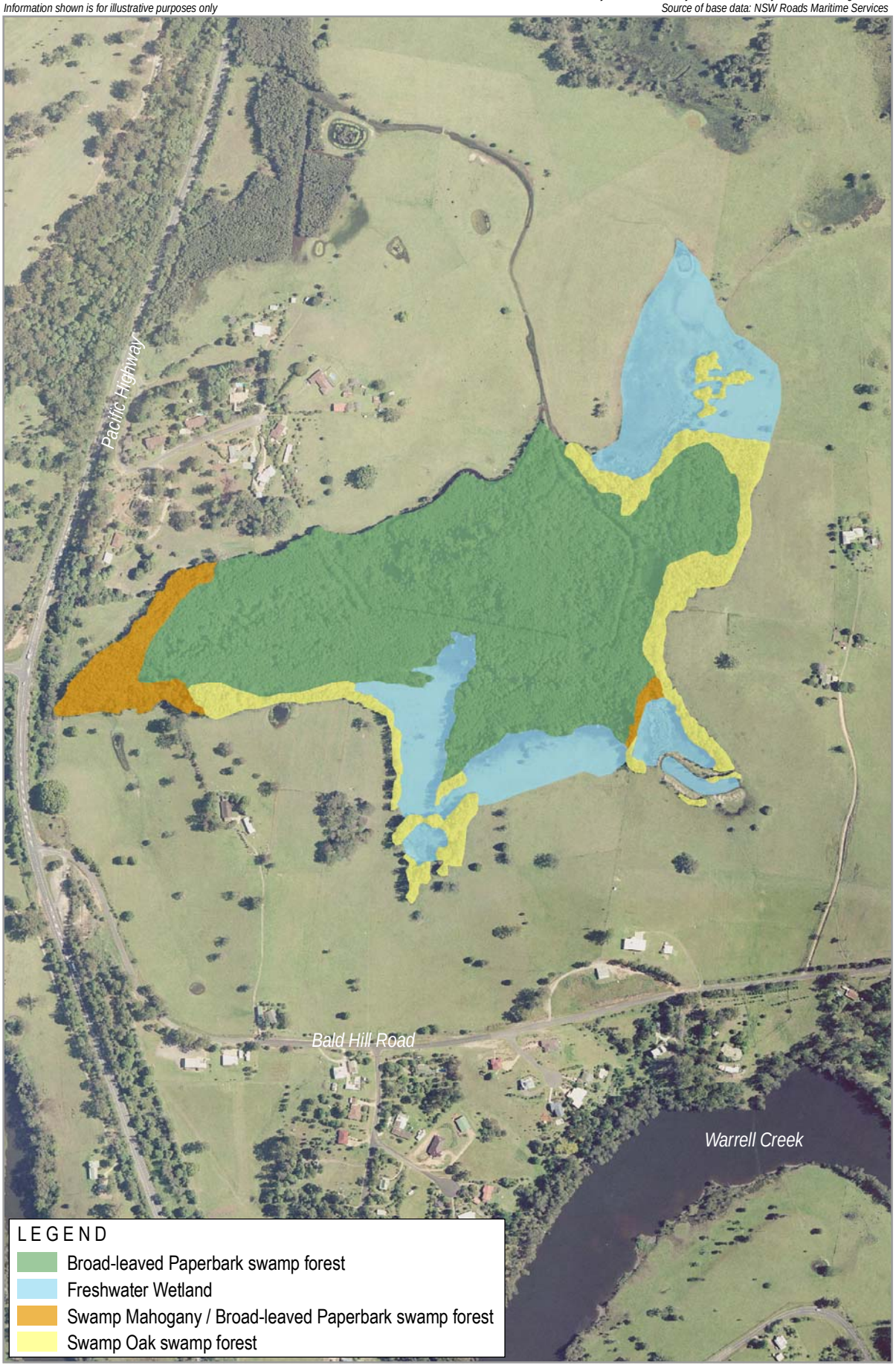
Vegetation condition is predominantly good, though localised areas around the edges are in low or moderate condition due to edge effects, historic clearing and/ or livestock disturbances. Stands of mostly treeless Freshwater Wetland vegetation communities occur to the north-east and south-east. These areas constitute the TSC Act listed EEC *Freshwater wetlands on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions*.

The majority of the subject Swamp Sclerophyll Forest supports surface water, predominantly between 0.4 and 0.8 m deep. Only the periphery of the subject Swamp sclerophyll Forest (typically 5 to 20 m wide), where it did not directly adjoin Freshwater Wetlands, was not inundated at the time of the survey.

Substantial *Salvina molesta* infestation covers approximately 40% of the water in the subject Swamp Sclerophyll Forest. This species is listed as a noxious species and weed of national significance. Care should be taken by all personal visiting the site to avoid spread of this highly invasive species.

Information shown is for illustrative purposes only

Drawn by: DSA Checked by: RVI Reviewed by: GJM Date: August 2013
Source of base data: NSW Roads Maritime Services



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North

Vegetation Map

GeoLINK environmental management and design

WC2NH Flying-fox Monitoring July 2013
2182-1009

Illustration 2.1

3 Preliminary Threatened Species Assessment

3.1 Methodology

A preliminary threatened species assessment was undertaken to identify potentially occurring threatened species (additional to the Grey-headed Flying-fox *Pteropus poliocephalus*) within the subject Swamp Sclerophyll Forest. This included:

- Database searches (*Environmental Protection and Biodiversity Conservation Act 1999* [EPBC Act] Protected Matters Search Tool and Office of Environment and Heritage [OEH] BioNet – July 2013) and literature review of relevant Nambucca Heads to Urunga Pacific Highway Upgrade (NH2U) Project Approval documentation to identify threatened species recorded within a 10 km radius of the site; and
- Habitat evaluation and opportunistic searches for threatened species during other survey activities (i.e. vegetation mapping, flying-fox searches and water depth surveys) on 24 and 25 July 2013 (total 28 person hours).

The literature review search included the following documents:

- Ecos Environmental (2013). Warrell Creek to Urunga upgrade: Threatened Plant Species Management Plan. Report to Roads and Maritime Services;
- SKM (2010). Environmental Assessment – Upgrading the Pacific Highway Warrell Creek to Urunga. Report to Roads and Maritime Services; and
- Project GIS mapping (provided by RMS).

Marine species were excluded from the assessment due to the absence of marine environments on and adjacent to the subject Swamp Sclerophyll Forest.

3.2 Results

The results of the preliminary threatened species assessment are provided in Appendix B. Fifty threatened fauna and 18 threatened flora were identified from the literature review as threatened species or species habitat (from the EPBC Act search only), known to occur within a 10 km radius of the site (excluding marine species).

No additional threatened species were recorded during the survey. Two threatened species have previously been recorded within the subject Swamp Sclerophyll Forest, including:

- *Maundia triglochinoides* (TSC Act listed Vulnerable species): previously recorded in the Freshwater Wetlands to the south of the subject Swamp Sclerophyll Forest. It is referred as 'mt82' in Ecos Environmental (2013), *Warrell Creek to Urunga upgrade: Threatened Plant Species Management Plan*. The site inspection was undertaken outside this species flowering period (i.e. period of best detectability November and January) and with the presence of other ribbon weed species (e.g. *Triglochin spp.*) it was difficult to detect. Targeted surveys during November and January would be required to adequately survey the distribution of this species within the subject Swamp Sclerophyll Forest and associated Freshwater Wetland.
- Little Bent-wing Bat (*Miniopterus australis* – TSC Act listed Vulnerable species) was previously recorded during the Project EA assessment (SKM 2010). The subject Swamp Sclerophyll Forest does not constitute significant habitat for this species.

The habitat within the subject Swamp Sclerophyll Forest provides potential habitat (at least in broad habitat terms) for the following additional locally recorded threatened species:

- Green and Golden Bell Frog (*Litoria aurea*);
- Regent Honeyeater (*Anthochaera phrygia*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Black-necked Stork (*Ephippiorhynchus asiaticus*);
- Little Lorikeet (*Glossopsitta pusilla*);
- Brolga (*Grus rubicunda*);
- Little Eagle (*Hieraaetus morphnoides*);
- Black Bittern (*Ixobrychus flavicollis*);
- Swift Parrot (*Lathamus discolor*);
- Square-tailed Kite (*Lophoictinia isura*);
- Powerful Owl (*Ninox strenua*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Large-footed Myotis (*Myotis macropus*);
- Squirrel Glider (*Petaurus norfolcensis*);
- Brush-tailed Phascogale (*Phascogale tapoatafa*);
- Koala (*Phascolarctos cinereus*);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*);
- Greater Broad-nosed Bat (*Scoteanax rueppellii*);
- Eastern Blossom-bat (*Syconycteris australis*); and
- Spider Orchid (*Dendrobium melaleucaphilum*).

These species would require further consideration with regards to any Project alignment changes (including updates to their impact assessments where required). Of the additional relevant threatened species, the Koala, Spider Orchid and *Maundia triglochinoides* pose the main potential constraint with regards to changes to the highway alignment within the subject Swamp Sclerophyll Forest. Targeted surveys would be required to determine whether these species pose actual constraints.

4

Water Depth Survey

4.1 Methodology

The water depth survey was undertaken by traversing the extent of standing water and undertaking two transects (one north-south and one east-west) across the standing water within the subject Swamp Sclerophyll Forest and measuring water depths (to the closest 0.05 m) at roughly 15 to 20 m intervals. A survey staff was used to provide approximate water depths and a GPS was used to record water depth measurement locations.

The survey was undertaken on 24 and 25 July 2013.

4.2 Results

The results of the water depth transect survey are shown in Appendix C and Illustration 4.1 (GPS data has also been provided). The majority of the subject Swamp Sclerophyll Forest supports surface water predominantly between 0.4 and 0.8 m (average 0.65 m) deep. Only the periphery of the subject Swamp sclerophyll Forest (typically 5 to 20 m wide), where it did not directly adjoin Freshwater Wetlands, was not inundated at the time of the survey.

Attempts to map the extent of standing water via traversing with a hand held GPS were withdrawn as it was not possible to accurately represent the extent of water in relation to the Swamp Sclerophyll Forest boundary or vegetation type boundaries due to the GPS having a typical standard error of 5 m.

Information shown is for illustrative purposes only

Drawn by: DSA Checked by: RVI Reviewed by: GJM Date: August 2013
Source of base data: NSW Roads Maritime Services

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North

Water Depth Survey

GeoLINK environmental management and design

WC2NH Flying-fox Monitoring July 2013
2182-1014

Illustration 4.1

5

Flying-fox Survey

5.1 Methodology and Results

Meander surveys were undertaken across the site on the 24 and 25 July 2013, searching for flying-foxes. No flying-foxes were recorded.

Evidence of recent flying-fox roosting was detected, including damaged tree canopy limbs and a 'musty' smell, typical of flying-foxes.

A flying-out inspection was also undertaken on the 24 July 2013, commencing one hour before dark until dark, in case a small population was present and was not detected during traverse surveys. This also failed to record any flying-foxes.

Three other known local roosts were inspected on the 25 July 2013, including Bowraville, Gordon Park (Nambucca Heads) and Wilson Road (Macksville). Only the Gordon Park site was occupied. No data regarding flying-fox numbers or species were recorded.

David Andrighetto
Ecologist

Appendix A

Swamp Sclerophyll Forest Vegetation Types

Table A1 Swamp Sclerophyll Forest Vegetation Types

Vegetation Type	*Location*	*Area (ha)*	*Canopy*		*Mid-Storey*		*Groundcover*		*Condition*	*Approx Area Inundated*	*Comment*
			Dominant Species	*Structure*	*Dominant Species*	*Structure*	*Dominant Species*	*Structure*			
Broad-leaved Melaleuca Swamp Forest	Occupies the central portion of Swamp Sclerophyll Forest	18	Broad-leaved Paperbark. Other species such as Swamp Oak, Swamp Mahogany (*Eucalyptus robusta*) and Prickly-leaved Paperbark (*Melaleuca styphelioides*) comprise <5% of the canopy.	Cover: 10-75 % (typically 40-70%). Height: 8-15 m (typically 12 m). DBH Range: 0.08-0.6 m (typically 0.1-0.3 m).	As per canopy.	Cover: 0-5%. Height: 2-7 m.	*Gahnia clarkei*, *Triglochin procera*, *Blechnum indicum*. *Salvina molesta*, *Philydrum lanuginosum*, *Eleocharis sphacelata.*	Cover: 0-100% (highly variable with location) Height: 0.1-2 m.	Good	Over 90 %	Swamp Oak is common in narrow bands (<5 m wide) along drains and fence lines within the Broad-leaved Melaleuca swamp forest, however occurrences are not significant enough to constitute a separate vegetation unit or influence flying-fox distribution.
Swamp Mahogany / Broad-leaved Paperbark Swamp Forest	Occupies the western edge and a small area in the south-east of the subject Swamp Sclerophyll Forest	1.6	Swamp Mahogany occurs in an emergent layer in the west and within the canopy layer with Broad-leaved Paperbark in the south-east. Other species such as Swamp Oak and Red Mahogany (*Eucalyptus resinifera*) comprise approximately 5% of the canopy.	Cover: Emergent – 15%. Canopy – 50-75%. Height: Emergent – 15-20 m. Canopy – 10-15 m. DBH Range: 0.2-0.7 m (typically 0.2-0.5 m).	Canopy saplings, Prickly-leaved Paperbark, *Callistemon salignus*,	Cover: 10-25%. Height: 2-8 m.	*Gahnia clarkei*, Broad-leaved Paspalum (*Paspalum wettsteinii*), *Blechnum indicum*, *Carex appressa, Salvina molesta*, Lantana (*Lantana camara*), Narrow-leaved Palm Lily (*Cordyline stricta*).	Cover: 50-90 % Height: 0.4-2 m.	Moderate to good (some edge effects and localised weed invasion).	40%	-

Vegetation Type	*Location*	*Area (ha)*	*Canopy*		*Mid-Storey*		*Groundcover*		*Condition*	*Approx Area Inundated*	*Comment*
			Dominant Species	*Structure*	*Dominant Species*	*Structure*	*Dominant Species*	*Structure*			
Swamp Oak Swamp Forest	Occupies the southern and eastern fringes of the subject Swamp Sclerophyll Forest, as well as around the Freshwater Wetlands.	3.8	Swamp Oak. Other species such as Swamp Mahogany and Broad-leaved Melaleuca comprise between approximately 5-40% of the canopy.	Cover: 30-70%. Height: 15-25 m (variable). DBH Range: 0.2-0.5 m.	Canopy saplings, Prickly-leaved Paperbark, *Callistemon salignus*, Swamp Box (*Lophostemon sauveolens*), Creek Sandpaper Fig (*Ficus coronata*).	Cover: 10-25%. Height: 5-15 m.	*Gahnia clarkei*, *Oplismenus imbecillis* Broad-leaved Paspalum, Lantana, *Salvina molesta*, Narrow-leaved Palm Lilly.	Cover: 50-90 % Height: 0.4-2 m.	Moderate to good in areas associated with the core Swamp Sclerophyll Forest. Low in the outer margins of the Freshwater Wetland.	30%	Interface with pastoral land is subject to edge effects. Stands in the far south and south-east associated with the Freshwater Wetland comprise regrowth.

Appendix B

Threatened Species Potential Occurrence Assessment

Table B1 Threatened Species Potential Occurrence Assessment

Scientific Name	*Common Name*	*TSC Act*	*EPBC Act*	*Habitat Requirement (Source: OEH and/ or EPBC website profile 2013)*	*Suitability of Subject Swamp Sclerophyll Forest*	*Potential Occurrence*
ANIMALIA						
Amphibian						
Litoria aurea	Green and Golden Bell Frog	E	V	Amongst vegetation in and around permanent swamps, lagoons, farm dams and on flood-prone river flats, particularly where there are bullrushes or spikerushes.	Moderate in broad habitat terms.	Possible
Litoria booroolongensis	Booroolong Frog	E	-	Permanent streams with some fringing vegetation cover such as ferns, sedges or grasses.	No suitable habitat.	Unlikely
Litoria brevipalmata	Green-thighed Frog	V	-	Rainforest, moist to dry eucalpyt forest and heath, typically where surface water gathers after rain.	No suitable habitat.	Unlikely
Mixophyes balbus	Stuttering Frog	V	V	Cool rainforest, moist eucalypt forest and occasionally along creeks in dry eucalypt forest.	No suitable habitat.	Unlikely
Mixophyes iteratus	Giant Barred Frog	E	E	Deep, damp leaf litter in rainforests, moist eucalypt forest and near dry eucalypt forest.	No suitable habitat.	Unlikely
Aves						
Anthochaera phrygia (formerly Xanthomyza phrygia)	Regent Honeyeater	CE	E	Dry open forest and woodland with an abundance of nectar-producing eucalypts, particularly box-ironbark woodland, swamp mahogany forests, and riverine sheoak woodlands.	Moderate as a fraction of species non-breeding foraging range.	Possible as rare vagrant.
Botaurus poiciloptilus	Australasian Bittern	E	E	Permanent freshwater wetlands with tall dense vegetation, particularly bullrushes and spikerushes.	Moderate in broad habitat terms, particularly in association with adjacent Freshwater Wetland.	Low – no records within the locality (BioNet 2013).
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	Sheoaks in coastal forests and woodlands, timbered watercourses, and moist and dry eucalypt forests of the coast and the Great Divide up to 1,000 m.	Low	Low
Coracina lineata	Barred Cuckoo-shrike	V	-	Rainforest, eucalypt woodlands, swamp woodlands and timber along watercourses.	Low – occurrence of rainforest fruit resources is negligible.	Low
Daphoenositta chrysoptera	Varied Sittella	V	-	Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	Moderate	Possible
Dasyornis brachypterus	Eastern Bristlebird	E	E	High elevation open forest, woodland with dense tussock or sedge understorey adjacent to rainforest or wet eucalypt forest.	Low	Low

Scientific Name	*Common Name*	*TSC Act*	*EPBC Act*	*Habitat Requirement (Source: OEH and/ or EPBC website profile 2013)*	*Suitability of Subject Swamp Sclerophyll Forest*	*Potential Occurrence*
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	Swamps, mangroves, mudflats, dry floodplains.	Moderate – primarily within adjacent Freshwater Wetland. No nests detected.	Possible
Erythrotriorchis radiatus	Red Goshawk	CE	V	Along or near watercourses, swamp forest and woodlands on the coastal plain.	Moderate in broad habitat terms.	Low – no records within the locality (BioNet 2013).
Esacus neglectus	Beach Stone-curlew	CE	-	Tidal flats at the mouth of estuaries or on open beaches.	No suitable habitat.	Unlikely
Glossopsitta pusilla	Little Lorikeet	V	-	Distributed in forests and woodlands from the coast to the western slopes of the Great Dividing Range, extending westwards to the vicinity of Albury, Parkes, Dubbo and Narrabri.	Moderate – primarily as foraging habitat. No significant potential tree hollows for nesting detected.	Possible
Grus rubicunda	Brolga	V	-	Shallow swamps, floodplains, grasslands and pastoral lands, usually in pairs or parties.	Moderate – primarily within adjacent Freshwater Wetland. No nests detected.	Possible
Haematopus fuliginosus	Sooty Oystercatcher	V	-	Intertidal rocky and coral reefs, mostly ocean shores.	No suitable habitat.	Unlikely
Hieraaetus morphnoides	Little Eagle	V	-	Open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used.	Moderate – mainly as foraging habitat. No nests recorded.	Possible
Ixobrychus flavicollis	Black Bittern	V	-	Dense vegetation fringing and in streams, swamps, tidal creeks and mudflats, particularly amongst swamp sheoaks and mangroves.	Moderate	Possible
Lathamus discolor	Swift Parrot	E	E	Forests, woodlands, plantations, and banksias.	Moderate as a fraction of species non-breeding foraging range.	Possible as rare vagrant.
Lophoictinia isura	Square-tailed Kite	V	-	Dry woodland and open forest, particularly along major rivers and belts of trees in urban or semi-urban areas. Home range can extend over at least 100 km^2.	Moderate – mainly as foraging habitat. No nests recorded.	Possible
Ninox strenua	Powerful Owl	V	-	Woodland and open forest to tall moist forest and rainforest, common along drainage lines.	Moderate – mainly as foraging habitat. No nests habitat present.	Possible

Scientific Name	*Common Name*	*TSC Act*	*EPBC Act*	*Habitat Requirement (Source: OEH and/ or EPBC website profile 2013)*	*Suitability of Subject Swamp Sclerophyll Forest*	*Potential Occurrence*
Pandion cristatus (formerly Pandion haliaetus)	Eastern Osprey	V	-	Forage for fish in fresh, brackish or saline waters of rivers, lakes, estuaries with suitable nesting sites nearby.	Low	Low
Ptilinopus magnificus	Wompoo Fruit-dove	V	-	Rainforests, low-elevation moist eucalypt forest, and Brush Box forests.	Low – occurrence of rainforest fruit resources is negligible.	Low
Rostratula benghalensis australis	Australian Painted Snipe	E	V	Well-vegetated shallows and margins of wetlands, dams, sewage ponds, wet pastures, marshy areas, irrigation systems, lignum, tea-tree scrub, and open timber.	Moderate in broad habitat terms (mainly in adjacent Freshwater Wetland)	Low – no records within the locality (BioNet 2013).
Tyto novaehollandiae	Masked Owl	V	-	Dry eucalypt forest and woodlands.	Low	Low
Tyto tenebricosa	Sooty Owl	V	-	Dry, subtropical and warm temperate rainforests and wet eucalypt forests. Nest in large tree hollows.	Low	Low
Insects						
Ocybadistes knightorum	Black Grass-dart Butterfly	E	-	Confined to coastal stands of Swamp Oak and Paperbark where Floyd's Grass grows edging the upper tidal areas of mangroves.	No suitable habitat.	Unlikely
Phyllodes imperialis (southern subspecies)	Pink Underwing Moth	E	E	Found in undisturbed subtropical rainforest below 600 m. Breeding habitat is restricted to areas where the caterpillar's food plant, a native rainforest vine, *Carronia multisepalea*, grows in a collapsed shrub-like form.	No suitable habitat.	Unlikely
Mammals						
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Near cave entrances and crevices in cliffs.	Low	Low
Dasyurus maculatus maculatus	Spotted-tailed Quoll	V	E	Dry and moist eucalypt forests and rainforests, fallen hollow logs, large rocky outcrops.	Low	Low
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	Moist and dry eucalypt forest and rainforest, particularly at high elevations.	Low	Low
Miniopterus australis	Little Bentwing-bat	V	-	Moist eucalypt forest, rainforest and dense coastal scrub.	High – previously recorded (SKM 2010). No breeding habitat present.	Known
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	Forest or woodland, roost in caves, old mines and stormwater channels.	Moderate as foraging habitat. No breeding habitat present.	Possible

Scientific Name	*Common Name*	*TSC Act*	*EPBC Act*	*Habitat Requirement (Source: OEH and/ or EPBC website profile 2013)*	*Suitability of Subject Swamp Sclerophyll Forest*	*Potential Occurrence*
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Roosts in tree hollows.	Moderate as foraging habitat. No potential breeding roosting habitat (tree hollows) detected.	Possible
Myotis macropus	Large-footed Myotis	V	-	Bodies of water, rainforest streams, large lakes, reservoirs.	Moderate as foraging habitat. No potential breeding roosting habitat (tree hollows) detected.	Possible
Petaurus australis	Yellow-bellied Glider	V	-	Tall mature eucalypt forest generally in areas with high rainfall and nutrient rich soils. Dens in tree hollows of large trees, often in family groups. Forest type preferences vary with latitude and elevation; mixed coastal forests to dry escarpment forests in the north; moist coastal gullies and creek flats to tall montane forests in the south.	Low	Unlikely
Petaurus norfolcensis	Squirrel Glider	V	-	Blackbutt, bloodwood and ironbark eucalypt forest with heath understorey in coastal areas, and box-ironbark woodlands and River Red Gum forest inland.	Low – moderate: Habitat is floristically suitable however no potential denning habitat (tree hollows) present and connectivity to potential den trees is poor.	Low to marginally possible.
Petrogale penicillata	Brush-tailed Rock Wallaby	V	V	North-facing cliffs and dry eucalypt forest and woodland, inhabiting rock crevices, caves, overhangs during the day, and foraging in grassy areas nearby at night.	No suitable habitat.	Unlikely
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	Drier forests and woodlands with hollow-bearing trees and sparse ground cover.	Low – moderate: known in Bald Hill Road area and in swamp sclerophyll forest habitats (personal observation), however no potential denning habitat (tree hollows) present and connectivity to potential den trees is poor.	Low to marginally possible.
Phascolarctos cinereus	Koala	V	V	Appropriate food trees in forests and woodlands, and treed urban areas.	Moderate – predominantly in the Swamp Mahogany – Broad-leaved Paperbark swamp forest.	Possible.

Scientific Name	*Common Name*	*TSC Act*	*EPBC Act*	*Habitat Requirement (Source: OEH and/ or EPBC website profile 2013)*	*Suitability of Subject Swamp Sclerophyll Forest*	*Potential Occurrence*
Phoniscus papuensis (formerly Kerivoula papuensis)	Golden-tipped Bat	V	-	Rainforest and adjacent sclerophyll forest. Roost in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests.	Low	Low
Potorous tridactylus tridactylus	Long-nosed Potoroo	V	V	Cool temperate rainforest, moist and dry forests, and wet heathland, inhabiting dense layers of grass, ferns, vines and shrubs.	Low	Low
Pseudomys novaehollandiae	New Holland Mouse	-	V	Occurs in open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes.	Low	Low
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps as well as urban gardens and cultivated fruit crops.	High	Known.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	Forages in a variety of habitats, roosts in tree hollows and buildings.	Moderate as foraging habitat. No potential breeding roosting habitat (tree hollows) detected.	Possible
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	Woodland through to moist and dry eucalypt forest and rainforest, though it is most commonly found in tall wet forest.	Moderate as foraging habitat. No potential breeding roosting habitat (tree hollows) detected.	Possible
Syconycteris australis	Eastern Blossom-bat	V	-	Littoral rainforest and feed on flowers in adjacent heathland and paperbark swamps.	Moderate as foraging habitat.	Possible
Vespadelus troughtoni	Eastern Cave Bat	V	-	Cave roosting species found in dry open forest and woodland near cliffs and rocky overhangs.	Low	Low
Reptiles						
Emydura macquarii signata	Bellinger River Emydura	-	V	Long, deep pools in broad reaches of the upper Bellinger River.	No suitable habitat.	Unlikely
PLANTAE						
Acronychia littoralis	Scented Acronychia	E	E	Littoral rainforest on sand.	No suitable habitat.	Unlikely
Alexfloydia repens	Floyd's Grass	E	-	Understorey of Swamp Oak (*Casuarina glauca)* forest and along the uppermost fringe of mangroves.	No suitable habitat.	Unlikely
Allocasuarina defungens	Dwarf Heath Casuarina	E	E	Tall heath on sand, also on clay and sandstone.	No suitable habitat.	Unlikely

Scientific Name	*Common Name*	*TSC Act*	*EPBC Act*	*Habitat Requirement (Source: OEH and/ or EPBC website profile 2013)*	*Suitability of Subject Swamp Sclerophyll Forest*	*Potential Occurrence*
Arthraxon hispidus	Hairy-joint Grass	V	V	Moist shady places in or on the edges of rainforest and wet eucalypt forest, often near creeks or swamps.	Low	Low
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Does not have well defined habitat and is known from a range of communities, including swamp-heath and woodland.	Low	Low
Cynanchum elegans	White-flowered Wax Plant	E	E	Dry, littoral or subtropical rainforest, and occasionally in scrub or woodland.	Low	Low
Dendrobium melaleucaphilum	Spider Orchid	E	-	Grows frequently on *Melaleuca stypheliodes*, less commonly on rainforest trees or on rocks in coastal districts. Occurs in coastal districts and nearby ranges, extending from Queensland to lower Blue Mountains.	Moderate	Possible
Euphrasia arguta	-	PCE	CE	Known from three sites in/near Nundle State Forest in eucalypt forest with a mixed grass and shrub understorey. Habitat includes open forest country around Bathurst in subhumid places, grassy country near Bathurst and in meadows near rivers.	No suitable habitat.	Unlikely
Marsdenia longiloba	Clear Milkvine	E	V	Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops.	Low	Low
Maundia triglochinoides	-	V	-	Swamps or shallow fresh water on clay.	High	Known
Melaleuca groveana	Grove's Paperbark	V	-	Heath and shrubland, often in exposed sites, rocky outcrops and cliffs at high elevations, also in dry woodlands.	Low	Low
Niemeyera whitei (formerly Amorphospermum whitei)	Rusty Plum	V	-	Rainforest and adjoining moist eucalypt forest.	Low	Low
Parsonsia dorrigoensis	Milky Silkpod	V	E	Subtropical and warm temperate rainforest, on rainforest margins, and in moist eucalypt forest up to 800 m, on brown clay soils.	Low	Low

Scientific Name	*Common Name*	*TSC Act*	*EPBC Act*	*Habitat Requirement (Source: OEH and/ or EPBC website profile 2013)*	*Suitability of Subject Swamp Sclerophyll Forest*	*Potential Occurrence*
Phaius australis	Southern Swamp Orchid	E	E	Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest mostly in coastal areas.	Moderate in broad habitat terms	Low – typically associated with sandy soils and no records within the locality (BioNet 2013).
Streblus pendulinus	Siah's Backbone	-	E	Found in warmer rainforests, chiefly along watercourses at altitudinal range is from near sea level to 800 m above sea level. Grows in well-developed rainforest, gallery forest and drier, more seasonal rainforest. On Norfolk Island, the species is found in a variety of forest types, though it is rare.	Low	Low
Taeniophyllum muelleri	Minute Orchid	-	V	Grows on outer branches and branchlets of rainforest trees; coast and coastal ranges, from sea level to 250 m alt., north from the Bellinger River.	Low	Low
Thesium australe	Austral Toadflax	V	V	Grassland or grassy eucalypt woodland where *Themeda australis* is predominant, on grassy headlands.	Low	Low
Tinospora smilacina	Tinospora Vine	E	-	Dry rainforest and along the boundaries of dry rainforest and dry eucalypt forest.	Low	Low
Tylophora woollsii	Cryptic Forest Twiner	E	E	Moist eucalypt forest, moist sites in dry eucalypt forest and rainforest margins.	Low	Low

Appendix C

Water Depth Survey Transect Results

Table C1 Water Depth Survey Results

Reference No.	*Transect*	*Latitude*	*longitude*	*Easting*	*Northing*	*Water Depth (mm)*
365	East-west	-30.7274	152.9208	492412.9	6600607	0
366	East-west	-30.7274	152.9209	492426.1	6600600	300
367	East-west	-30.7275	152.9211	492444.6	6600596	400
368	East-west	-30.7275	152.9213	492461	6600597	450
369	East-west	-30.7275	152.9215	492482.3	6600595	350
370	East-west	-30.7274	152.9216	492498.9	6600605	450
371	East-west	-30.7275	152.9219	492519.7	6600597	500
372	East-west	-30.7275	152.922	492535.5	6600598	650
379	East-west	-30.7274	152.9223	492560.3	6600607	800
378	East-west	-30.7274	152.9225	492578.6	6600607	900
377	East-west	-30.7274	152.9227	492601.2	6600600	600
376	East-west	-30.7274	152.9228	492612.3	6600603	800
374	East-west	-30.7274	152.9229	492623.2	6600602	900
373	East-west	-30.7274	152.9233	492653.8	6600602	1250
364	East-west	-30.7275	152.9235	492676.8	6600594	800
380	East-west	-30.7274	152.9238	492703.6	6600602	850
381	East-west	-30.7275	152.9239	492719.1	6600599	650
382	East-west	-30.7275	152.9241	492738.2	6600599	700
383	East-west	-30.7275	152.9244	492760.8	6600598	800
384	East-west	-30.7275	152.9246	492780.6	6600599	600
385	East-west	-30.7275	152.9248	492801.3	6600597	700
386	East-west	-30.7275	152.925	492819.5	6600595	700
387	East-west	-30.7274	152.9252	492839	6600603	750
388	East-west	-30.7275	152.9254	492858.1	6600597	650
389	East-west	-30.7275	152.9256	492879	6600597	650
390	East-west	-30.7275	152.9258	492898.2	6600597	750
391	East-west	-30.7275	152.9261	492921.8	6600600	850
392	East-west	-30.7275	152.9263	492942.3	6600591	1050
393	East-west	-30.7275	152.9265	492963.5	6600592	1000
394	East-west	-30.7275	152.9267	492978.1	6600594	800
395	East-west	-30.7274	152.9269	492998.9	6600601	650
396	East-west	-30.7275	152.927	493008.3	6600595	1300 drain
397	East-west	-30.7275	152.9271	493018.5	6600595	650
398	East-west	-30.7276	152.9273	493040.3	6600585	300
399	East-west	-30.7276	152.9275	493058.3	6600583	0
409	North-south	-30.726	152.9248	492803.4	6600764	0
408	North-south	-30.726	152.9248	492802.7	6600758	600
407	North-south	-30.7262	152.9249	492806.6	6600739	650
406	North-south	-30.7264	152.9248	492799.8	6600719	750
405	North-south	-30.7265	152.9247	492793.7	6600703	950
404	North-south	-30.7267	152.9247	492792.7	6600680	1100
403	North-south	-30.7269	152.9248	492802.3	6600658	850
402	North-south	-30.7271	152.9248	492803.5	6600640	850
401	North-south	-30.7273	152.9248	492797.9	6600619	800

Reference No.	*Transect*	*Latitude*	*longitude*	*Easting*	*Northing*	*Water Depth (mm)*
400	North-south	-30.7275	152.9248	492804.4	6600598	500
363	North-south	-30.7278	152.9248	492801.3	6600560	750 drain
362	North-south	-30.728	152.9248	492801.3	6600542	650
361	North-south	-30.7282	152.9248	492800.4	6600517	550
360	North-south	-30.7284	152.9248	492800.7	6600496	450
359	North-south	-30.7285	152.9248	492802.7	6600481	500
358	North-south	-30.7287	152.9248	492801.6	6600462	700
357	North-south	-30.7289	152.9248	492800.7	6600439	550
356	North-south	-30.7291	152.9248	492798.2	6600419	600
355	North-south	-30.7293	152.9248	492800.8	6600399	650
354	North-south	-30.7294	152.9248	492796.5	6600380	650
353	North-south	-30.7296	152.9248	492799.4	6600360	400
352	North-south	-30.7298	152.9248	492799.7	6600343	350
351	North-south	-30.7299	152.9248	492797	6600324	100
350	North-south	-30.7301	152.9248	492796.7	6600310	0

Flying-fox Monitoring

WC2NH

August 2013

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2182-1019	First issue	02/09/2013	RVI
2182-1024	Final	02/09/2013	RVI

1 Introduction

1.1 Introduction

Sinclair Knight Merz (SKM) and NSW Roads and Maritime Services (RMS) are working to resolve the Grey-headed Flying-fox (*Pteropus poliocephalus*) camp conflict on 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.

This report details the August monitoring results. The monitoring was undertaken on 26 - 27 August 2013.

2

Flying-fox Survey

2.1 Methodology

All fieldwork for the August survey was undertaken by Dr Tom Pollard (GeoLINK) and Dr Peggy Eby (flying-fox expert).

On the evening of 26 August, a dusk fly-out survey was undertaken at the site. One person was located at the northern ridge (off Wedgewood Drive) and the other person was located on the southern ridge (off Bald Hill Road). The survey extended over approximately 1 hour from sunset until dark.

On 27 August, a day-time meander survey of the site was undertaken on foot with waders to search for roosting flying-foxes. This survey was focused on the area in which a roost has previously been recorded by SKM & Dr Eby.

In addition to the survey work at the site, three local flying-fox roosts were inspected over 26 – 27 August at Bellingen (Bellingen Island), Bowraville, and at the proposed control site at Nambucca Heads (Gordon Park). During these inspections Dr Eby provided one-on-one training to GeoLINK on methods for assessing flying-fox demographics, reproductive status and fly-out counts, which will be used in subsequent surveying at the Macksville roost.

2.2 Results

No flying-foxes were recorded exiting the site during the dusk fly-out survey.

No roosting flying-foxes were recorded at the site during the meander survey. In combination with the negative result of the dusk fly-out survey, this result indicates, with a high degree of certainty, that the site was not being utilised as a roost by flying-fox at the time of survey.

Of the additionally inspected local flying-fox roosts, only Bellingen and Nambucca Heads are currently occupied. Grey-headed Flying-fox was present at both roosts, with Black Flying-fox being also present at Nambucca Heads. The proportion of these species in the overall roost at Nambucca Heads was estimated to be 70% Grey-headed Flying-fox and 30% Black Flying-fox. No young were recorded at either roost.

As no data on demographics or reproductive status was collected at the site (Macksville roost) during this month's survey, no specific comparative data was collected at the proposed Nambucca Heads control site.

Dr Tom Pollard
Ecologist

Flying-fox Monitoring

WC2NH

September 2013

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2182-1028	First issue	27/09/2013	RVI
2182-1031	Final (following client review)	04/10/2013	RVI

1 Introduction

1.1 Introduction

Sinclair Knight Merz (SKM) and NSW Roads and Maritime Services (RMS) are working to resolve the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp conflict on 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.

This report details the September monitoring results. The monitoring was undertaken on 23 - 24 September 2013.

2 Flying-fox Survey

2.1 Methodology

All fieldwork for the September survey was undertaken by GeoLINK ecologists Tom Pollard and David Andrighetto. The fieldwork followed the methodology developed by Dr Peggy Eby for this roost (Eby 2013). Please refer to that document for full details of the methodology. A summary of the main procedures used from the September monitoring is provided below.

On the evening of 23 September 2013, a dusk exit count survey was undertaken at the site to provide an estimate of the population size. One person was located at the northern ridge (off Wedgewood Drive) and the other person was located on the southern ridge (off Bald Hill Road). The survey extended over approximately one hour from sunset until dark (approximately 5.45 pm to 6.45 pm).

On 24 September, a survey of the site was undertaken on foot with waders to locate and map roosting flying-foxes. Ten randomly located trees were selected in the roost and data collected on species composition, demographics, reproductive status and behaviour. For comparison, data was also collected at the Nambucca Heads roost at Gordon Park.

2.2 Results

2.2.1 Population Estimate – Exit Count

The Macksville flying-fox camp was occupied at the time of the survey. Residents on Wedgewood Drive reported that the flying-foxes had returned to the camp approximately 10 days prior to the survey (pers. comm. Mr Hunt). Results of the fly-out count indicated that in excess of 10,000 flying-foxes were occupying the camp. Flight-paths of the flying-foxes exiting the camp were to the north and west (predominantly), with a smaller stream of flying-foxes flying to the south (refer to Illustration 2.1).

2.2.2 Camp Footprint

At the time of survey the camp occupied an area within the Swamp Sclerophyll Forest of approximately 0.89 ha, approximately 100 m south from the northern edge. The roost footprint and location of demographic count points is displayed in Illustration 2.1.

The flying-foxes were roosting in a dense stand of Broad-leaved Paperbark (*Melaleuca quinquenervia*). These trees averaged approximately 7 m in height with a diameter at breast height (DBH) less than 20 cm (refer to Plate 2.1).

Plate 2.1 GHFF roosting in Broad-leaved Paperbark at Macksville

Information shown is for illustrative purposes only

Drawn by: TJP Checked by: DSA Reviewed by: MVE Date: September 2013
Source of base data: NSW Roads and Maritime Services

0 150

North

Roost Footprint and Demographic Count Points

2.2.3 Detailed Data

2.2.3.1 Species Composition

Both the Macksville and Nambucca Heads camps supported both GHFF and Black Flying-fox (*Pteropus alecto*). Approximately 95% of the flying-fox present in the Macksville camp were GHFF, while the proportion was slightly less at the Nambucca Heads camp at approximately 85%. The majority of Black Flying-foxes were located towards the north-eastern portion of the Macksville camp, while they were spread more evenly throughout the Nambucca Heads roost. The Black Flying-fox were typically observed roosting higher up in the tree canopy than the GHFF.

2.2.3.2 Habitat Characteristics and Demographic Composition

Data of the GHFF camp habitat characteristics and demographic composition at the Macksville and Nambucca Heads camps are provided in Table 2.1 and Table 2.2. Roost trees at the Macksville camp are nearly 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 Nambucca Heads camp consists of a canopy of emergent rainforest species over a relatively open understorey. Roost trees are generally 15 - 25 m high, and less than 50 cm DBH. The camp is located in the canopy of rainforest vegetation in Gordon Park with the core area occurring on the gently sloping lower slopes with a protected southerly aspect. The more elevated and exposed sections of the park, including the area north and east of Wellington Parade, were not occupied at the time of the survey.

At both the Macksville and Nambucca Heads camps some females were conspicuously pregnant. No dependant young were observed. At the Macksville camp female individuals of GHFF generally outnumbered males by at least 3:1 in any given tree. However, some 'bachelor' trees were also present that only supported males. The ratio of females to males was less at the Nambucca Heads camp, averaging approximately 1.5-2:1.

Table 2.1 Habitat Characteristics and Demographic Data – Macksville Camp

Tree Code	*GPS Co-ordinates (easting, northing)*	*Tree Species*	*Diameter at Breast Height (DBH) (cm)*	*Height (m)*	*Water Depth (cm)*	*Sex Ratio (female:male)*	*Presence of Dependant Young (yes/no)*
M1	0492902, 6600729	*Melaleuca quinquenervia*	12	7	80	10:3	no
M2	0492949, 6600726	*Melaleuca quinquenervia*	10	7	60	10:3	no
M3	0492947, 6600726	*Melaleuca quinquenervia*	15	7	50	0:10 (bachelor tree)	no
M4	0492870, 6600646	*Melaleuca quinquenervia*	10	8	45	10:5	no
M5	0492941, 6600647	*Melaleuca quinquenervia*	10	6	55	10:2	no
M6	0492946, 6600723	*Melaleuca quinquenervia*	12	6	70	10:1	no
M7	0492953, 6600708	*Melaleuca quinquenervia* x 3 (canopies together)	8-12	6-8	60	10:9	no
M8	0492942, 6600684	*Melaleuca quinquenervia* x 2 (canopies together)	8-10	7-8	40	10:4	no

Tree Code	*GPS Co-ordinates (easting, northing)*	*Tree Species*	*Diameter at Breast Height (DBH) (cm)*	*Height (m)*	*Water Depth (cm)*	*Sex Ratio (female:male)*	*Presence of Dependant Young (yes/no)*
M9	0492930, 6600690	*Melaleuca quinquenervia* x 2 (canopies together)	10	10	50	10:3	no
M10	0492925, 6600679	*Melaleuca quinquenervia* x 2 (canopies together)	12	7	50	10:4	no

Table 2.2 Demographic Data – Nambucca Heads Camp Control Site

Tree Code	*GPS Co-ordinates (easting, northing)*	*Tree Species*	*Diameter at Breast Height (DBH) (cm)*	*Height (m)*	*Water Depth (cm)*	*Sex Ratio (female:male)*	*Presence of Dependant Young (yes/no)*
NH1	0500429, 6606888	*Eleaocarpus grandis*	40	20	n/a	10:3	no
NH2	0500421, 6609876	*Casuarina glauca* (two trunks)	50	15-20	n/a	10:5	no
NH3	0500439, 6609864	*Eleaocarpus grandis*	25	25	n/a	10:8	no
NH4	0500426, 6609896	*Eleaocarpus grandis*	60	20	n/a	10:5	no
NH5	0500434, 6609916	*Eleaocarpus grandis*	30	20	n/a	10:7	no
NH6	0500442, 6609926	*Flindersia australis*	30	15	n/a	3:10 (predominantly bachelor tree)	no
NH7	0500456, 6609949	*Lophostemon confertus*	80	20	n/a	3:10 (predominantly bachelor tree)	no
NH8	0500437, 6609949	*Unknown sp.*	20	7	n/a	10:4	no
NH9	0500410, 6609948	*Lophostemon confertus*	30	20	n/a	10:4	no
NH10	0500413, 6609922	*Melia azederach*	40	15	n/a	10:5	no

2.3 Discussion

2.3.1 Population Estimate

No comparable population estimates are available for September 2012, as no monitoring was undertaken. However, in January 2013 the flying-fox population estimate for the Macksville camp was estimated by to be > 10 000 individuals, and quite likely > 20 000 individuals (Eby 2012). For the current September 2013 monitoring event the population estimate of > 10 000 individuals, as determined from the exit count, can be made with a moderate degree of confidence. However, it was a challenge for two observers to count three streams of exiting flying-foxes. It has been suggested by Eby that it may be useful to have additional observers (minimum of four) present during the seasonal exit counts to increase reliability of the count.

2.3.2 Camp Footprint

The footprint of the camp in September 2013 corresponds very closely with the camp footprint mapped by SKM in early 2013, with the camp occupying the core area of the subject Swamp Sclerophyll Forest. These 2013 camp footprints occupy a significantly smaller area of Swamp Sclerophyll Forest than the indicative area identified in Eby (2012).

2.3.3 Demographic Composition

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 September survey in which the female to male ratio at the Macksville camp was found to be higher than that at the Nambucca Heads camp, where a significantly smaller number of individuals were present.

The September survey was undertaken during the later stages of pregnancy for GHFF and prior to the main birthing period of October-early November (Eby 2012). The presence of conspicuously pregnant females at the Macksville camp indicates that birthing will occur soon.

As relatively large numbers of GHFF are currently occupying the Macksville camp immediately prior to the birthing period of October/ early November, there is a high likelihood that the roost will be used for birthing in 2013. This is supported by seasonal increases in foraging resources locally (Eby and Law 2008). The Macksville camp has previously supported dependent young, as evidenced by the sound of flightless young calling in the camp at night during January and February 2012 (Eby 2012). Young are not fully independent until approximately March. Subsequent monitoring will confirm whether the camp is used as a maternity camp over the 2013-2014 GHFF breeding season.

2.3.4 Phenology of Trees in Region

Although the movement patterns of the GHFF are complex and difficult to assign to a single factor, the onset of flowering of Grey Ironbark (*Eucalyptus siderophloia*) and Forest Red Gum (*Eucalyptus tereticornis*) in September on the coastal lowlands of the upper North Coast may be a contributing factor to the return of the GHFF to the Macksville camp. These trees are recognised as highly productive species in this region and can be considered key diet species (Eby 2012; Eby and Law 2008).

2.3.5 Practicalities of Demographic Surveys

A number of characteristics of the Nambucca Heads camp affect the ability to accurately determine the sex of animals. The animals are generally roosting higher (15-20 m) compared with the Macksville camp (animals are roosting at around 4-8 m at Macksville, but height difference is linked to the height of trees at the respective camps, rather than animals roosting lower in trees).

The Nambucca camp is also located within an urban area above a wooden walkway through the park.

These factors decrease the propensity for flying-foxes at Nambucca to be alarmed when approaching on foot, resulting in the opening of wings which facilitates the sexing of animals.

A noise stimulus in the form of breaking of a branch or a soft clap was sometimes required to elicit an alarm response and wing opening at the Nambucca Heads camp. This noise stimulus was intentionally limited as two lost flying-fox foetuses were located beneath the roost during the survey (refer to Plate 2.2). Despite mass abortions of flying-fox foetuses previously being recorded at some roosts during periods of food shortage and inclement weather, isolated incidences of abortion can be expected, as young females (two year olds) often do not carry to term (Eby and Lunney 2002). However, it has also been recognised that additional noise stress, such as that undertaken to achieve relocation, has the potential to increase this risk of abortion (Australian Research Centre for Urban Ecology 2009).

For the current survey, as a precaution, it was considered prudent that additional unnecessary stress from noise should be limited to reduce the risk of further abortion of foetuses occurring.

Consequently, counts were undertaken of those individuals that were able to be sexed within a reasonable time period with as little noise stimulus as possible. The result was that in two predominantly bachelor-dominated trees, the count did not reach the 10 females stipulated by the methodology (Eby 2013). Despite this, it is possible to extrapolate the male/ female ratio for these two trees from the data collected as was done in this data analysis.

Plate 2.2 Aborted foetus beneath the flying-fox camp at Nambucca Heads

2.4 Conclusion

The September 2013 flying-fox monitoring revealed that the Macksville camp has recently been re-occupied by large (> 10 000) numbers of flying-foxes since around the 14 September 2013 and comprising predominantly of the GHFF. The roost is located within Swamp Sclerophyll Forest, and in particular occupies a dense, relatively low and even-aged, immature stand of Broad-leaved Paperbark trees.

As relatively large numbers of GHFF are currently occupying the Macksville camp immediately prior to the birthing period of October/ early November, there is a high likelihood that the roost will be used for birthing in 2013.

Next month will be the first seasonal (spring) monitoring event. More detailed data will be collected at these seasonal monitoring events, with additional survey effort put towards determining population numbers and establishing whether the camp is supporting dependent young.

Dr Tom Pollard
Ecologist

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Flying-fox Monitoring

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

October 2013

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UPR	*Description*	*Date Issued*	*Issued By*
2182-1049	First issue	31/10/2013	Tom Pollard
2182-1057	Second issue	08/11/2013	Tom Pollard
2182-1060	Third issue	11/11/2013	Tom Pollard

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1 Introduction

1.1 Introduction

Sinclair Knight Merz (SKM) and NSW Roads and Maritime Services (RMS) are working to resolve the Grey-headed Flying-fox (*Pteropus poliocephalus*) (GHFF) camp conflict on 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 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 October 2013 monitoring results. The monitoring was undertaken on 28 - 29 October 2013.

2 Flying-fox Survey

2.1 Methodology

All fieldwork for the October survey was undertaken by GeoLINK ecologists Dr Tom Pollard and David Andrighetto and flying-fox expert Dr Peggy Eby. The fieldwork followed the methodology developed by Dr Eby for this roost (Eby 2013). Please refer to that document for full details of the methodology. A summary of the main procedures used from the October monitoring is provided below.

On the evening of 28 October 2013, a dusk exit count survey was undertaken at the site to provide an estimate of the number of flying-foxes currently roosting at the camp. Personnel were strategically located where there were clear views in the directions that flight-paths that were observed in the previous month's exit count (to the north, west and south). One person was located in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive) and the other two investigators were located on ridges south of the swamp sclerophyll forest (off Bald Hill Road). The survey extended over approximately one hour from sunset until dark (approximately 7:00 pm to 8:00 pm).

The October survey was planned to include two dusk exit counts at the site. However, based on the small numbers of flying-foxes observed in the first night's exit count and the lack of any roosting individuals located on the following day, it was decided that a second exit count would not provide additional useful information, and therefore was not necessary.

On 29 October, 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 the Gordon Park camp at Nambucca Heads (approximately 12 km north-east of the Macksville camp) as well as observational comments from regional flying-fox camps at Bellingen Island (approximately 31 km north north-west of the Macksville camp) and Bowraville (approximately 11 km NW of the Macksville camp) (refer to Illustration 2.2 for location of these regional camps).

2.2 Results

2.2.1 Population Estimate – Exit Count

Only 40 flying-foxes were recorded during the exit count at the site on 28 October. Due to small numbers no distinct flight-paths were observed. However, the majority of flying-foxes were observed heading in a southerly to westerly direction.

An exit count was not conducted at the Gordon Park control site, however it was estimated during the demographic survey that the camp was supporting between 10 – 20,000 GHFF individuals. Bellingen Island also supported GHFF numbering in the tens of thousands. Observations at the Bowraville camp indicated that the camp was supporting several thousand GHFF at the time of survey.

2.2.2 Camp Footprint

A traverse of the camp footprint that was mapped during the September 2013 survey (which largely corresponded with the April 2013 footprint mapped by SKM) was undertaken on the 29 October (refer to Illustration 2.1 and Plate 2.1). No roosting flying-fox were recorded, however recent damage by roosting to tree branches and droppings was observed. Flying-fox vocalisations were not heard at any point during the survey. Furthermore, a noise stimulus in the form of a clap did not elicit any vocalisation or wing-flapping that would indicate that flying-fox were present in the Swamp Sclerophyll Forest. The small number of flying-foxes recorded during the exit count on the previous night appeared to have moved on.

Prior to the survey discussions with residents on Wedgewood Drive indicated that flying-fox numbers appeared low recently at the site and that odour had ceased to be a significant issue (pers. comm. Mr Wilkes and Mr Ainsworth).

When undertaking nearby ecological survey work approximately two weeks prior to the October survey on Thursday 17 October, GeoLINK ecologists reported hearing vocalisations of flying-fox that were roosting at the site (David Andrighetto, pers. obs.).

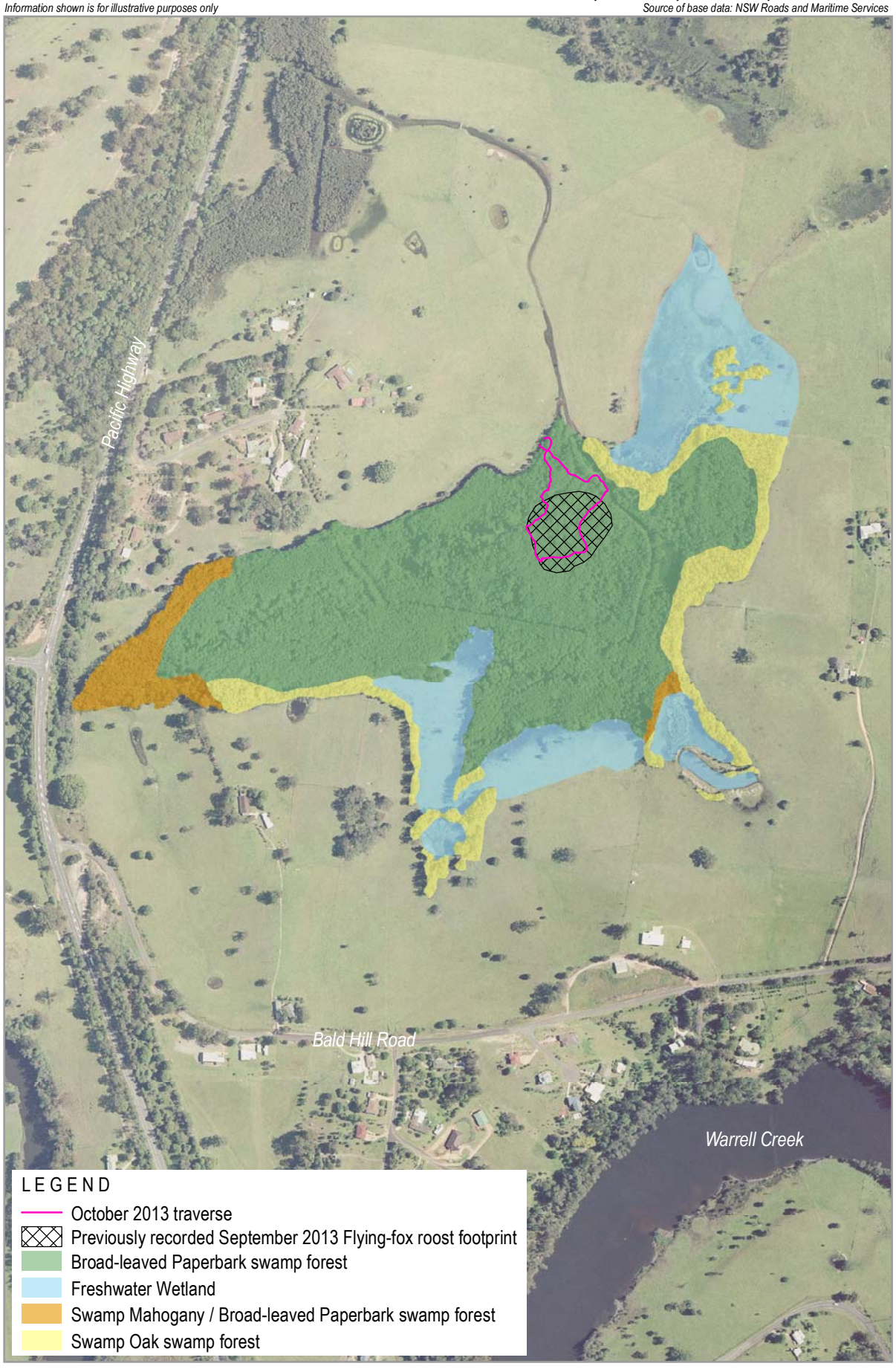
No water measurements were made at the Macksville camp in October 2013 as the levels have previously been measured along with detailed data at each demographic count tree. As no flying-fox were present no demographic count trees were investigated. However, despite that, the following estimations relating to water level at the Macksville camp can be made:

- Comparison of photos taken in the swamp in September and October showing the exposed roots growing from the base of Broad-leaved Paperbark trees indicate that a decrease in water levels of approximately 10-20 cm has occurred between September and October 2013; and
- Although variable depending on exact location, the average water level in October beneath the flying-fox camp is estimated to be approximately 60 cm depth and the maximum water level in the drainage channels is in excess of 100 cm.

Plate 2.1 Traversing through the Dense Broad-leaved Paperbark Swamp at the Site

Information shown is for illustrative purposes only

Drawn by: TJP Checked by: DGH Reviewed by: DSA Date: October 2013
Source of base data: NSW Roads and Maritime Services



North

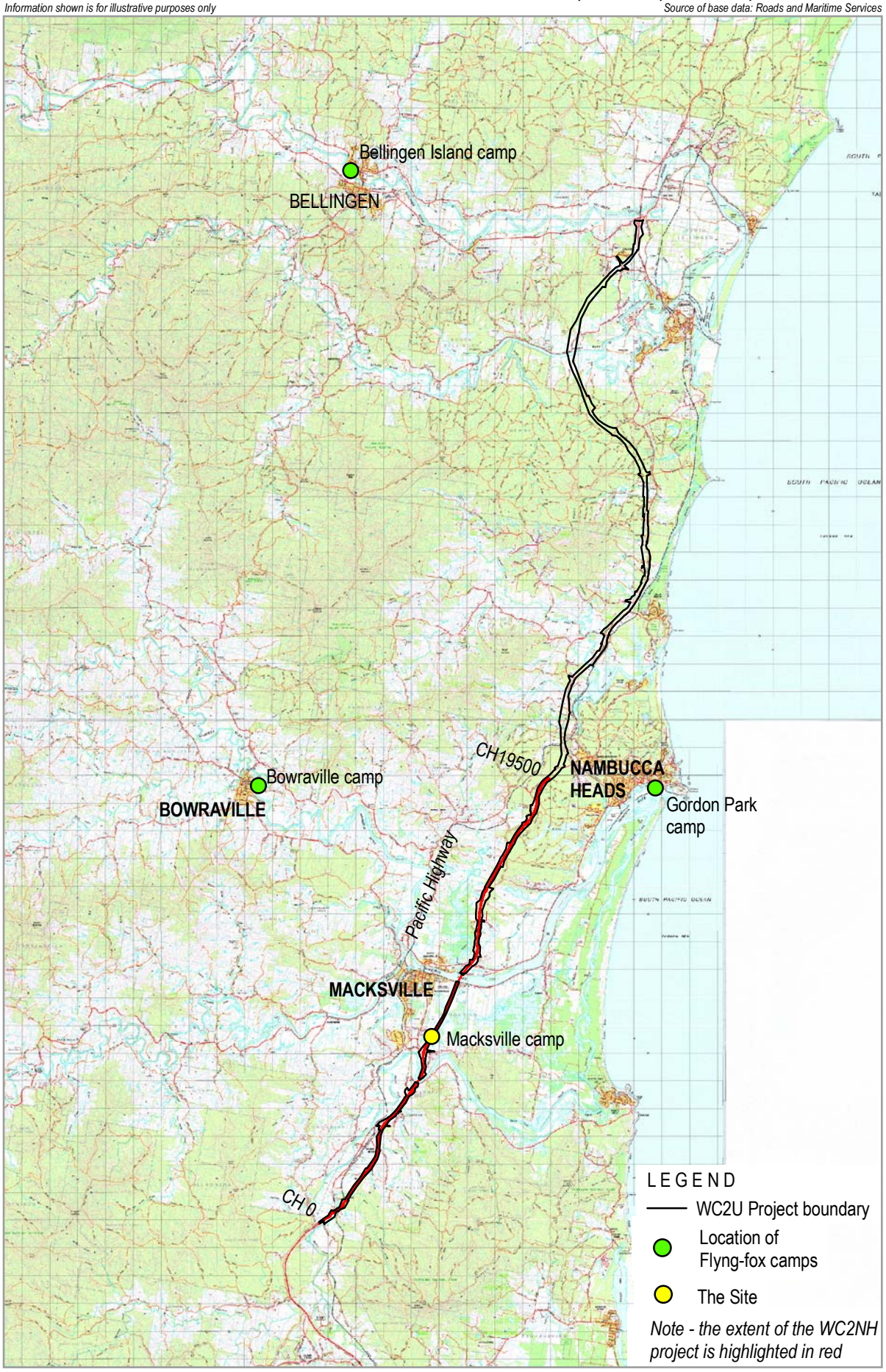
0 150

October 2013 Survey Traverse

Drawn by: TJP Checked by: MVE Reviewed by: DSA Date: November 2013

Information shown is for illustrative purposes only

Source of base data: Roads and Maritime Services



North

0 4 km

Location of Regional Flying-fox camps

2.2.3 Detailed Data

As no flying-fox were observed roosting at the site, it was not possible to collect detailed data. Therefore, detailed data is only reported from the Gordon Park camp. Where applicable, comment is also made relating to flying-fox at Bellingen Island and Bowraville camps.

2.2.3.1 Species Composition

The Gordon Park camp supported both GHFF and Black Flying-fox (*Pteropus alecto*). It was estimated that approximately 85% of the flying-fox present in the Nambucca camp were GHFF. The Black Flying-foxes were located in small groups that were integrated throughout the roosting GHFFs (rather than roosting in clearly defined separate areas).

2.2.3.2 Habitat Characteristics and Demographic Composition

Data of the GHFF camp habitat characteristics and demographic composition at the Gordon Park camp is provided in Table 2.1. The structure of the vegetation at the Gordon Park camp consists of a canopy of emergent rainforest species over a relatively open understorey. Roost trees are generally 15 – 25 m high, and less than 50 cm DBH. The camp is located in the canopy of rainforest vegetation in Gordon Park with the core area occurring on the gently sloping lower slopes with a protected southerly aspect. The more elevated and exposed sections of the park, including the area north and east of Wellington Parade, were not occupied at the time of the survey.

The ratio of females to males varied considerably between trees ranging from approximately 1.5:1 to 3:1. A small number of trees were also recorded that predominantly supported males ('bachelor' trees - e.g. NH3). The percentage of GHFF females with dependent young was at least 50% in all roosting trees that were investigated.

Table 2.1 Habitat Characteristics and Demographic Data – Gordon Park Camp

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*
NH1	0500404, 6609895	*Syzygium smithii*	20	15	10:3	yes	70
NH2	0500407, 6609901	Unidentified rainforest species	30	20	10:4	yes	60
NH3	0500393, 6609893	*Eleaocarpus grandis*	30	20	10:>20 (predominantly male grouping)	yes	50
NH4	0500412, 6609901	Unidentified rainforest species	20	15	10:6	yes	70
NH5	0500413, 6609893	Unidentified rainforest species	20	15	10:6	yes	60
NH6	0500418, 6609897	*Casuarina glauca*	25	20	10:4	yes	60
NH7	0500443, 6609920	*Callistemon saligna*	15	10	10:7	yes	70
NH8	0500449, 6609920	*Melia azederach*	15	10	10:5	yes	60
NH9	0500454, 6609901	*Ficus macrophylla*	30	20	10:5 (possibly greater proportion of males)	yes	70

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*
NH10	0500454, 6609911	*Acacia melanoxylon*	15	12	10:6	yes	80

Female GHFF with dependent young were also present at the Bellingen Island and Bowraville camps.

2.2.3.3 Presence of dead young flying-fox

A single dead young bat was opportunistically observed at the Gordon Park camp and at the Bellingen Island camp. No aborted foetuses were observed.

2.3 Discussion

2.3.1 Population Estimate

It is not unexpected for camps with highly consistent patterns of occupation to contain no animals for short periods nor is it uncommon for the number of animals in such a camp to fluctuate over short time-scales (P. Eby pers. comm.). For example, monthly population estimates of GHFF in the Gordon camp, Sydney (classified as a continuously occupied camp), recorded between 1995 and 2012 (Ku-ring-gai Bat Conservation Society), showed that population size can vary considerably month to month, from <50 to >10,000 animals between months. These fluctuations are believed to reflect both the quantity and quality of food in the local area and the quantity of highly preferred food sources at a regional scale (P. Eby pers. comm.). Periods of zero population have also been recorded at various other sites with long histories of consistent use such as Harriet Island, Bundaberg (mean population size 44,000); Currumbin Creek, Gold Coast (mean population size 6,700); and Regents Park, Logan (mean population size 8,000) (Queensland EPA).

Partially eaten segments of citrus were observed floating on the water beneath the previously occupied roost area at Macksville. This observation may indicate that there is currently a local shortage of suitable food for flying-foxes within the vicinity of the camp as citrus are not a preferred food source (P. Eby pers. comm.). This may be a contributing factor explaining why few, then no flying-foxes were roosting at the site at the time of the October survey.

No population estimate of GHFF is available for the site in October last year. However, radio-tracking undertaken by John Martin at the Royal Botanic Garden and Domain Trust (RBGDT), Sydney indicates that both adult male and female GHFF individuals were present at the site in October 2012. Radio-tracked individuals were also recorded at the site in each subsequent month through to May 2013 (data courtesy of John Martin, RBGDT, unpublished).

For future exit counts it is recommended that an additional person be stationed east of the site to ensure that flying-fox exiting to the east are more easily counted.

2.3.2 Demographic Composition

Locally, the first young of both GHFF and Black flying-foxes at Bellingen Island were observed on 5 October and were determined to be at least two days old at this time (P. Eby pers. comm., data collected by Tim Pearson, doctoral candidate at Macquarie University). As births typically commence at the same time in neighbouring camps it is reasonable to surmise that females at the site gave birth to young at approximately the same time (i.e. 3 October). Commencement of births on or around 3 October is also consistent with observations this year at several camps in Sydney including Gordon, Centennial Park, Parramatta Park and Kareela (P. Eby pers. comm.).

As roosting flying-foxes were present at the site on 17 October [GeoLINK observations] prior to departing sometime between 17 October and 28 October, it is reasonable to predict that females with young were also present in the site at that time. As females carry their dependent young with them on nightly foraging flights for a period of 4 to 5 weeks following birth, and the roost has shown some recent fluctuations in occupation, it is not possible to determine with certainty whether GHFF gave birth at the site in 2013. The site has previously supported dependent young, as evidenced by the sound of flightless young calling in the camp at night during January and February 2012 (Eby 2012). Young are not fully independent until approximately March.

Subsequent monthly monitoring between now and March 2014 will confirm whether the site is re-occupied by GHFF and used as a maternity camp during the 2013/14 breeding season.

2.3.3 Phenology of Trees in Region

Flowering of the flying-fox food trees Grey Ironbark (*Eucalyptus siderophloia*) and Forest Red Gum (*Eucalyptus tereticornis*) continues throughout October on the coastal lowlands and river valleys of the lower North Coast. These trees are recognised as highly productive species in this region and can be considered key diet species (Eby 2012; Eby and Law 2008). Although the movement patterns of the GHFF are complex and difficult to assign to a single factor, the local and regional availability of these and other food resources may be influencing monthly presence at the site at this time.

2.3.4 Selection of Control Site

As identified in the previous September monitoring report the height of the tree canopy at the Gordon Park control site makes undertaking the demographic survey challenging. For this reason, it is proposed that the Bellingen Island camp be considered as an alternative as the canopy here is considerably lower.

2.3.5 Ongoing Water-level Measurements

As suggested by RMS a more permanent relative water measurement method will be established during the next monitoring event and will consist of either a nail (non-copper) in a tree or a marker on a steel post.

2.4 Conclusion

The October 2013 flying-fox monitoring revealed that only a small number of flying-foxes (approximately 40) were occupying the site on the 28 October, and the site was not occupied on the 29 October. This follows re-occupation of the camp by large (> 10,000) numbers of predominantly GHFF in mid-September 2013, after the camp was unoccupied during the July and August monitoring events. It is not unexpected for camps to experience large fluctuations in flying-fox numbers over short time scales or for camps with highly consistent patterns of occupation to contain no animals for short periods, (including during the breeding period) as the availability of foraging resources changes at a local and regional scale (P. Eby pers. comm.).

Females with dependent young were likely to have been present at the site on 17 October 2013 before flying-foxes departed. Other local camps at Gordon Park, Bellingen Island and Bowraville were supporting females with dependent young at the time of the October 2013 survey.

Future monthly monitoring will provide information on whether the current decrease in occupation at the site is temporary in response to local and regional food quality and availability, and further information regarding the camp's overall usage over the 2013/14 breeding season.

Dr Tom Pollard
Ecologist

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Flying-fox Monitoring

Warrell Creek to Nambucca Heads Pacific Highway Upgrade

November 2013

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UPR	*Description*	*Date Issued*	*Issued By*
2182-1067	First issue	25/11/2013	Tom Pollard
2182-1069	Second issue	04/12/2013	Tom Pollard

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1 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 November 2013 monitoring results. The monitoring was undertaken on 20 November 2013.

2

Flying-fox Survey

2.1 Methodology

All fieldwork for the November survey was undertaken by GeoLINK ecologists Dr Tom Pollard and David Andrighetto. 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 from the November monitoring is provided below.

On 20 November, 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). Previous control site data for the September and October monitoring events was collected at the Gordon Park camp. However, for logistical reasons this has been changed to the Bellingen Island camp. Please refer to Section 2.3.4 for further information.

A permanently flagged marker on a tree was set up at the site to measure the water level at the roost. The water level at this location is representative of the average level across the camp.

On the evening of 20 November 2013, a dusk exit count survey was undertaken at the site to provide an estimate of the number of flying-foxes currently roosting at the camp. Personnel were strategically located where there were clear views to the north, west and south, corresponding to the directions that flight-paths were observed during the exit count in September 2013, when the flying-fox population was at its greatest level since the July 2013 monitoring began.

One person was located in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive) and the other person was located on a ridge south of the swamp sclerophyll forest (off Bald Hill Road). The survey extended over approximately one hour from sunset until dark (approximately 7:30 pm to 8:30 pm).

2.2 Results

2.2.1 Population Estimate – Exit Count

An estimated 1200 flying-foxes were recorded during the exit count at the site on 20 November. The vast majority of flying-foxes (approximately 1100 individuals) were observed heading in a westerly direction. The remaining small number of flying-foxes were observed heading in a 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: 3000-5000 individuals; and
- Bellingen Island: >10,000 individuals.

2.2.2 Camp Footprint

The camp occupied an area within the Swamp Sclerophyll Forest of approximately 0.08 ha, approximately 100 m south from the northern edge. The camp footprint at the site was considerably reduced in comparison with that mapped in September 2013, when it occupied an area of 0.89 ha.

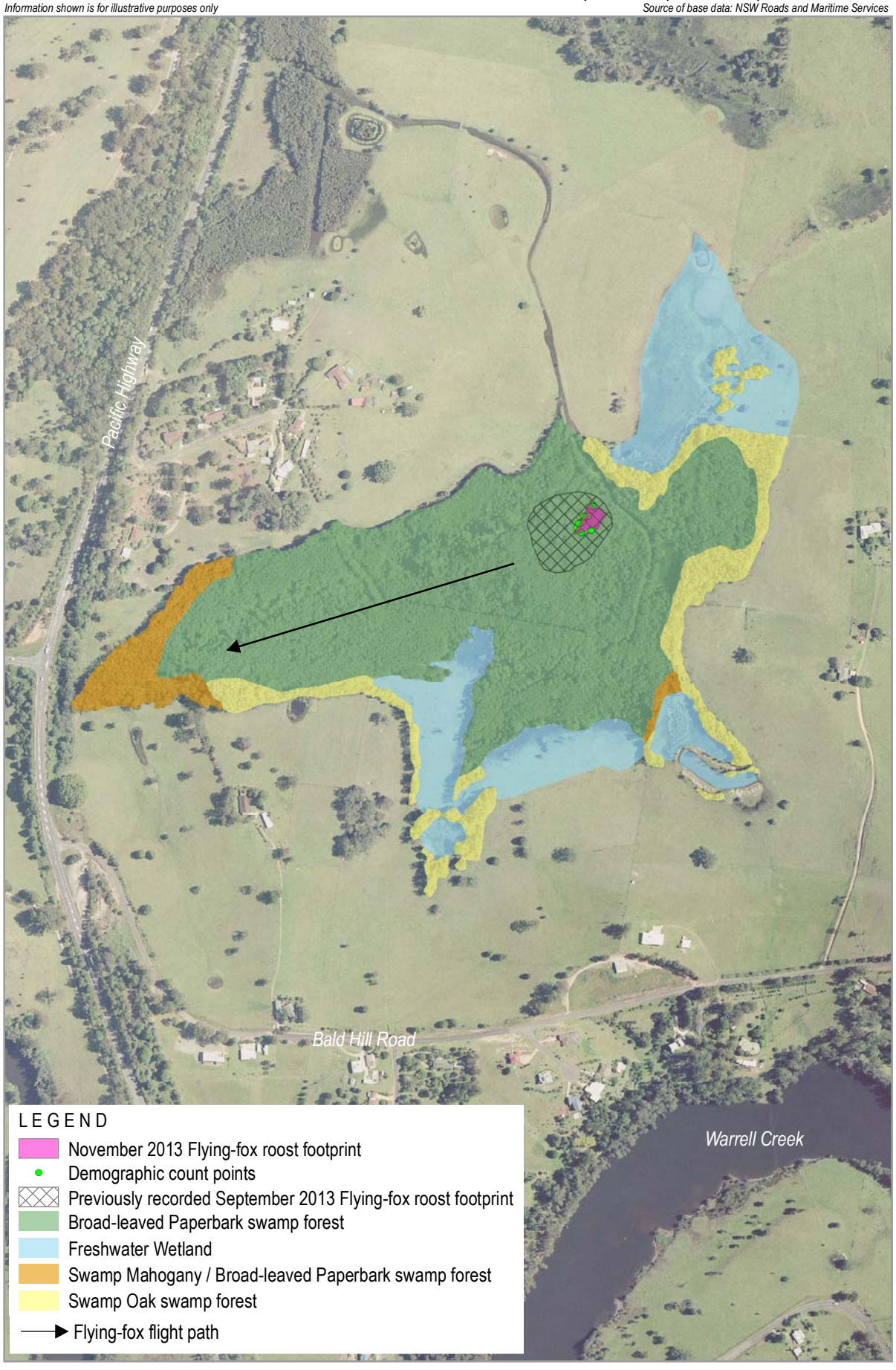
The roost footprint and location of demographic count points is displayed in Illustration 2.1.

As has been previously recorded, the flying-fox are roosting in a dense stand of Broad-leaved Paperbark (*Melaleuca quinquenervia*). These trees averaged approximately 7 m in height with a diameter at breast height (DBH) less than 20 cm.

Drawn by: TJP Checked by: MVE Reviewed by: DSA Date: November 2013

Information shown is for illustrative purposes only

Source of base data: NSW Roads and Maritime Services



North

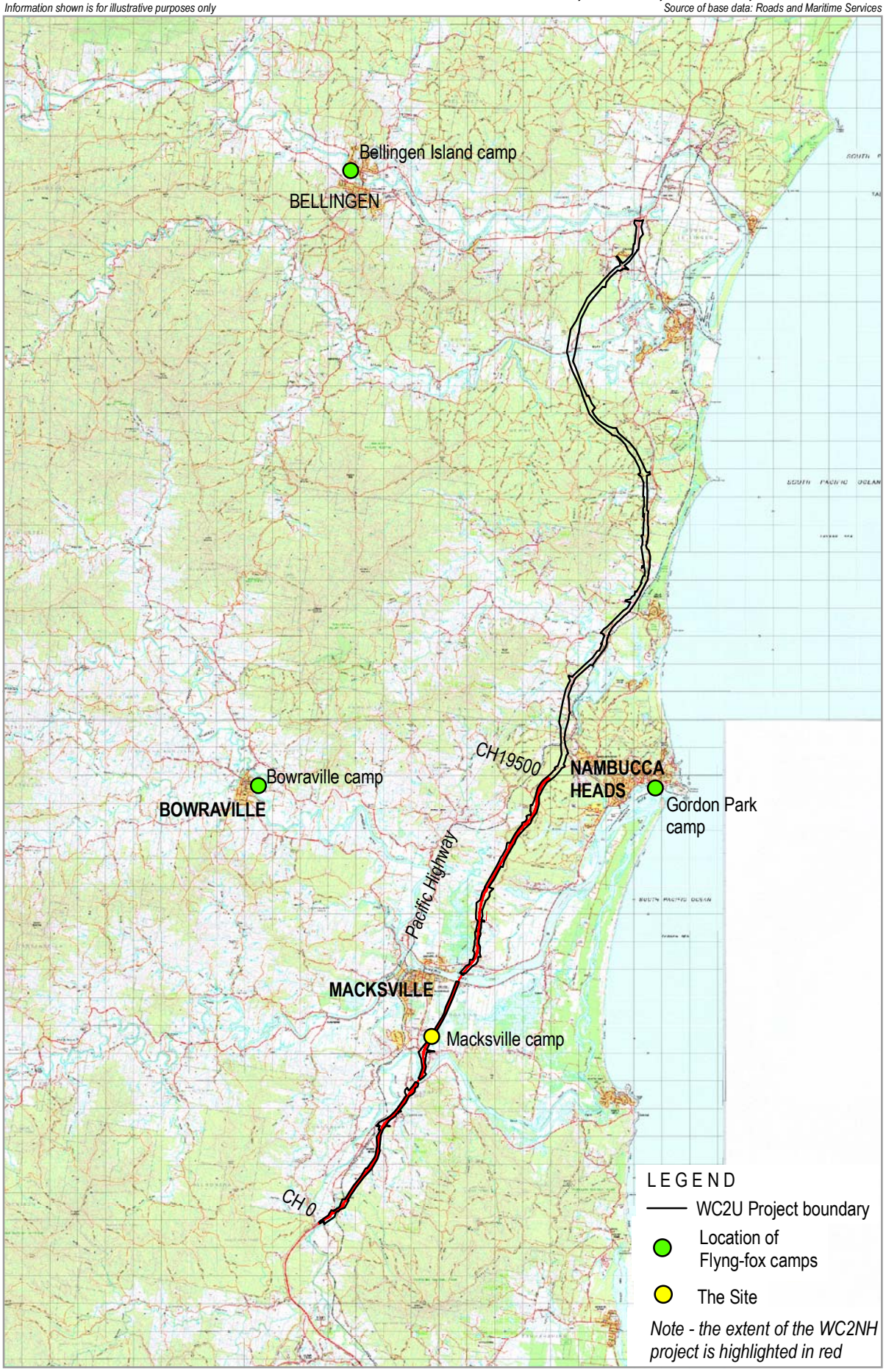
0 150

Roost Footprint and Demographic Count Points

Drawn by: TJP Checked by: MVE Reviewed by: DSA Date: November 2013

Information shown is for illustrative purposes only

Source of base data: Roads and Maritime Services



0 4 km

North

Location of Regional Flying-fox camps

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 the site and at Bellingen Island. It was estimated that approximately 80% of the flying-fox present at the site consisted of GHFF. This was significantly lower than the ratios during September, where the proportion of GHFF at the site was estimated to be approximately 95%. At Bellingen Island GHFF accounted for approximately 95% of the flying-fox present. The Black Flying-fox were interspersed among the GHFF at these camps, but typically occurred in small groupings.

Both GHFF and Black Flying-fox were also present at the remaining regional camps. It was estimated that GHFF accounted for approximately 85% of the flying-fox present in the Gordon Park camp and 95% of the flying-fox present in the Bowraville camp. The Black Flying-fox typically occurred in small groupings and were interspersed among the GHFF at these regional camps. However, they appear to show a 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 Bellingen Island control site are provided in Table 2.1 and Table 2.2 respectively.

As has been previously recorded, 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 Bellingen Island camp consists of a canopy of emergent rainforest species (with some large native figs of substantial diameter and up to 30 m in height) over a relatively open understorey. Flying-fox roost trees are generally 5 - 15 m high, and up to 70 cm diameter at breast height (DBH). The camp is relatively extensive at Bellingen Island, occurring in a significant proportion of the available rainforest vegetation.

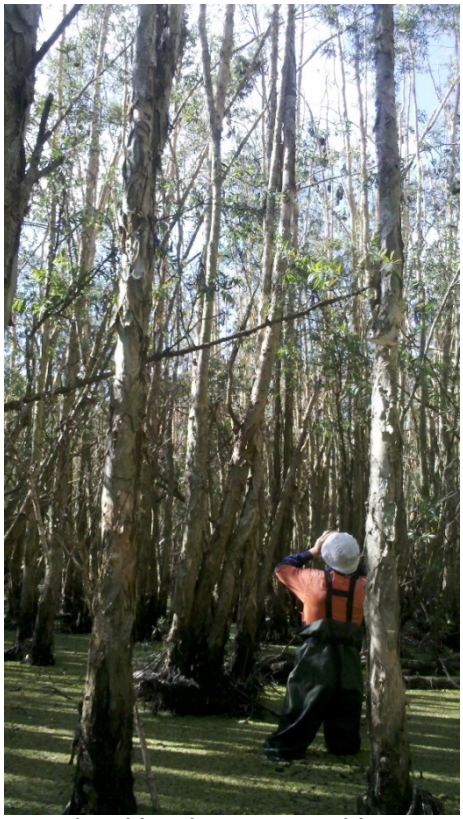


Plate 2.1 Undertaking the Demographic Count at The Site

Table 2.1 displays the results of the demographic data collected at the site. Note that it was only possible to collect detailed demographic data for eight trees (usually demographic data is collected for 10 trees). This was due to the small size of the camp and the flighty nature of the flying-fox present at the site shifting location within the camp.

The ratio of females to males varied considerably between trees ranging from approximately 1:2 to 2:1. A small number of trees were recorded that predominantly supported males ('bachelor' trees - e.g. M2 and M3). The percentage of GHFF females with dependent young was variable, ranged between 20% and 80% for the roosting trees that were investigated.

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	0492949, 6600729	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:5	yes	80
M2	0492943, 6600676	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:18 (predominantly male grouping)	yes	20
M3	0492921, 6600668	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:17 (predominantly male grouping)	yes	20
M4	0492913, 6600683	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:5	yes	40
M5	0492917, 6600691	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:6	yes	30
M6	0492919, 6600694	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:7	yes	40
M7	0492927, 6600705	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:4	yes	40
M8	492926, 6600707	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:9	yes	70
M9	No data collected						
M10	No data collected						

Table 2.2 displays the results of the demographic data collected at the Bellingen Island camp. The ratio of females to males varied considerably between trees ranging from approximately 1:1.5 to 3:1. A small number of trees were recorded that predominantly supported males ('bachelor' trees - e.g. BI8). The percentage of GHFF females with dependent young was variable, ranged between 30% and 80% for the roosting trees that were investigated.

Table 2.2 Demographic Data for Bellingen 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	0489996, 6631657	*Dendrocnide excelsa*	30	8	10:4	yes	80
BI2	0490014, 6631627	*Ficus coronata*	20	5	10:2	yes	30
BI3	0490028, 6631616	*Ficus corontata / Toona australis* (2 trees)	20-30	8	10:2	yes	50
BI4	0490044, 6631624	Unknown sp.	30-40	15	10:5	yes	70
BI5	0490072, 6631587	*Dendrocnide exclesa*	50	8	10:6	yes	40
BI6	0490053, 6631563	*Dendrocnide exclesa*	40	10	10:2	yes	30
BI7	0490048, 6631552	Unknown sp.	40	25	10:6	yes	40
BI8	0490047, 6631544	Unknown sp.	25	13	10:14 (predominantly male grouping)	yes	40
BI9	0490028, 6631526	*Dendrocnide exclesa*	70	15	10:10	yes	80
BI10	0490068, 6631534	*Ficus coronata*	25	8	10:2	yes	50

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

No dead young were observed beneath the camp at the site. However, due to the camp being located above open water covered in a dense cover of the aquatic weed *Salvinia*, any deaths may have been obscured from view.

During data collection at Bellingen Island camp two dead young were observed on the ground beneath the camp. These individuals appeared to be at the same developmental stage as other young currently in the camp, which indicates that these individuals have died recently. In addition to this a single live dependent young that had presumably fallen from its mother was observed on the ground. This individual was transferred to a local WIRES carer at Bellingen.

2.2.3.4 Water level at the site

Water level at the representative measurement location at the site was approximately 60 cm.

2.3 Discussion

2.3.1 Population Estimate

The flying-fox population estimate at the site as recorded in the exit count this month shows that relatively small numbers of flying-fox have returned to the camp after a recent short period of non-occupation last month. This variability between months is not uncommon and is believed to reflect both the quantity and quality of food in the local area and the quantity of highly preferred food sources at a regional scale (P. Eby pers. comm.). Population levels are considerably lower than the levels recorded in September 2013 when >10,000 individuals were observed exiting the camp.

Numbers at the Gordon Park and Bellingen camps appear to have remained relatively stable between October and November. At the Bowraville camp the population estimate this month seems to indicate a minor increase since last month, reflected in an increased camp footprint. 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.

As was seen in October at the site, partially eaten citrus fruit was observed beneath the Bellingen Island camp. This observation may indicate that there is currently a local shortage of suitable food for flying-foxes within the foraging range of the camp as citrus are not a preferred food source (P. Eby pers. comm.).

No population estimate of GHFF is available for the site in November last year. However, satellite-tracking undertaken by John Martin at the Royal Botanic Garden and Domain Trust (RBGDT), Sydney indicates that both adult male and female GHFF individuals were present at the site in November 2012. 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, and varied from approximately 80% of individuals present at the site to >95% of individuals present at Bellingen Island and Bowraville.

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).

For the 2013 breeding season, it was surmised that births of GHFF commenced on or around 3 October 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 of GHFF. The site has previously supported dependent young, as evidenced by the sound of flightless young calling in the camp at night during January and February 2012 (Eby 2012) (young are not fully independent until approximately March). However, no calls of flightless young were heard during the exit count on 20 November. This is not unexpected, as flightless young are typically left at a camp while females forage in late November (Eby 2012) and this may not have occurred yet at the site.

2.3.3 Phenology of Trees in Region

Flowering of Grey Ironbark (*Eucalyptus siderophloia*) and Forest Red Gum (*Eucalyptus tereticornis*) (in the inland coastal lowlands and at high altitude) continues throughout November 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). Although the movement patterns of the GHFF are complex and difficult to assign to a single factor, the local and regional availability of these and other key food resources may be influencing monthly presence at the site at this time. As was observed at the Bowraville camp until it being abandoned in 2011, 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 (*Corymbia intermedia*) or Grey Ironbark (Eby 2012).

2.3.4 Selection of Control Site

As identified in the previous monitoring reports the height of the tree canopy at the Gordon Park control site makes undertaking the demographic survey challenging. As the trees in which flying-fox are roosting at the Bellingen Island camp considerably lower, it was decided (in consultation with Dr Eby) that the Bellingen Island camp is potentially more suitable as a comparison site. It is possible to collect more reliable data at the Bellingen Island camp as the lower height of the roosting flying-foxes makes sampling easier and a noise stimulus is not necessary to encourage the flying-fox to open their wings for accurate sexing. Therefore, control site demographic data for the current monitoring event, and subsequent monitoring events, will be collected at Bellingen Island camp.

2.3.5 Ongoing Water-level Measurements

The establishment of a representative water level measurement location at the site allows for comparisons between months of water level changes beneath the camp. However, the accuracy and usefulness of this data should be acknowledged as detailed below:

- the water level varies considerably over short distances within the swamp sclerophyll vegetation due to wind-thrown Broad-leaved Paperbark resulting in significant holes of greater depth (not uncommon to be up to 1 m depth; and
- the ground substrate is soft in the swamp making it difficult to accurately establish the bottom of the water column.

Despite these inaccuracies in undertaking water level measurements, the location selected is considered to be representative of average water levels elsewhere beneath the camp.

2.4 Conclusion

The results of the November 2013 flying-fox monitoring indicated that flying-foxes have re-established at the site, although in smaller numbers (approximately 1200) than was recorded in September 2013 when >10,000 individuals were present. GHFF dominates the site and other regional camps visited in the monitoring representing over 80% of all individuals. The return of flying-fox to the site after a short absence is likely to be in response to the availability of foraging resources changes at a local and regional scale (P. Eby pers. comm.).

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 November 2013 survey.

Future monthly monitoring will provide information on whether the current occupation of the site by GHFF continues and whether the camp is used as a refuge for flightless young during the upcoming period until full independence in March 2014.

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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5 December 2013
Ref No: 2182-1070

The Manager
Sinclair Knight Merz
PO Box 2147
DANGAR NSW 2309

Attention: Rachel Vazey

Dear Rachel,

December 2013 fortnightly Flying-fox monitoring report

This short report details the findings of the December 2013 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 4 December 2013. 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 two vantage points on either side of the site on the night of the 4 December 2013. The results of this exit count supported the findings of the traverse that the camp was essentially un-occupied. Less than 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.

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

December 2013

Prepared for: Sinclair Knight Merz

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UPR	*Description*	*Date Issued*	*Issued By*
2182-1072	First issue	09/01/2014	Tom Pollard

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1 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 December 2013 monitoring results. The monitoring was undertaken on 18 December 2013.

2

Flying-fox Survey

2.1 Methodology

All fieldwork for the December survey was undertaken by GeoLINK ecologists Dr Tom Pollard and David Andrighetto and GeoLINK environmental scientist Peter Thrift. 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 from the December monitoring is provided below.

On 18 December, 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; Plate 2.1), 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.

On the evening of 18 December 2013, a dusk exit count survey was undertaken at the site to provide an estimate of the number of flying-foxes currently roosting at the camp. Personnel were strategically located where there were clear views to the north, west and south, corresponding to the directions that flight-paths were observed during the exit count in September 2013, when the flying-fox population was at its greatest level since the July 2013 monitoring began.

Observers were located in a paddock to the north of the swamp sclerophyll forest (off Wedgewood Drive), on a ridge south of the swamp sclerophyll forest (off Bald Hill Road), and west of the Pacific Highway at the junction with Upper Warrell Road. The survey extended over approximately one hour from sunset until dark (approximately 7:45 pm to 8:45 pm).

Plate 2.1 Bellingen Island Camp

2.2 Results

2.2.1 Population Estimate – Exit Count

An estimated 2500 flying-foxes were recorded during the exit count at the site on 18 December. The vast majority of flying-foxes (approximately 2000 individuals) were observed heading in a westerly 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: >10,000 individuals.

2.2.2 Roost Footprint

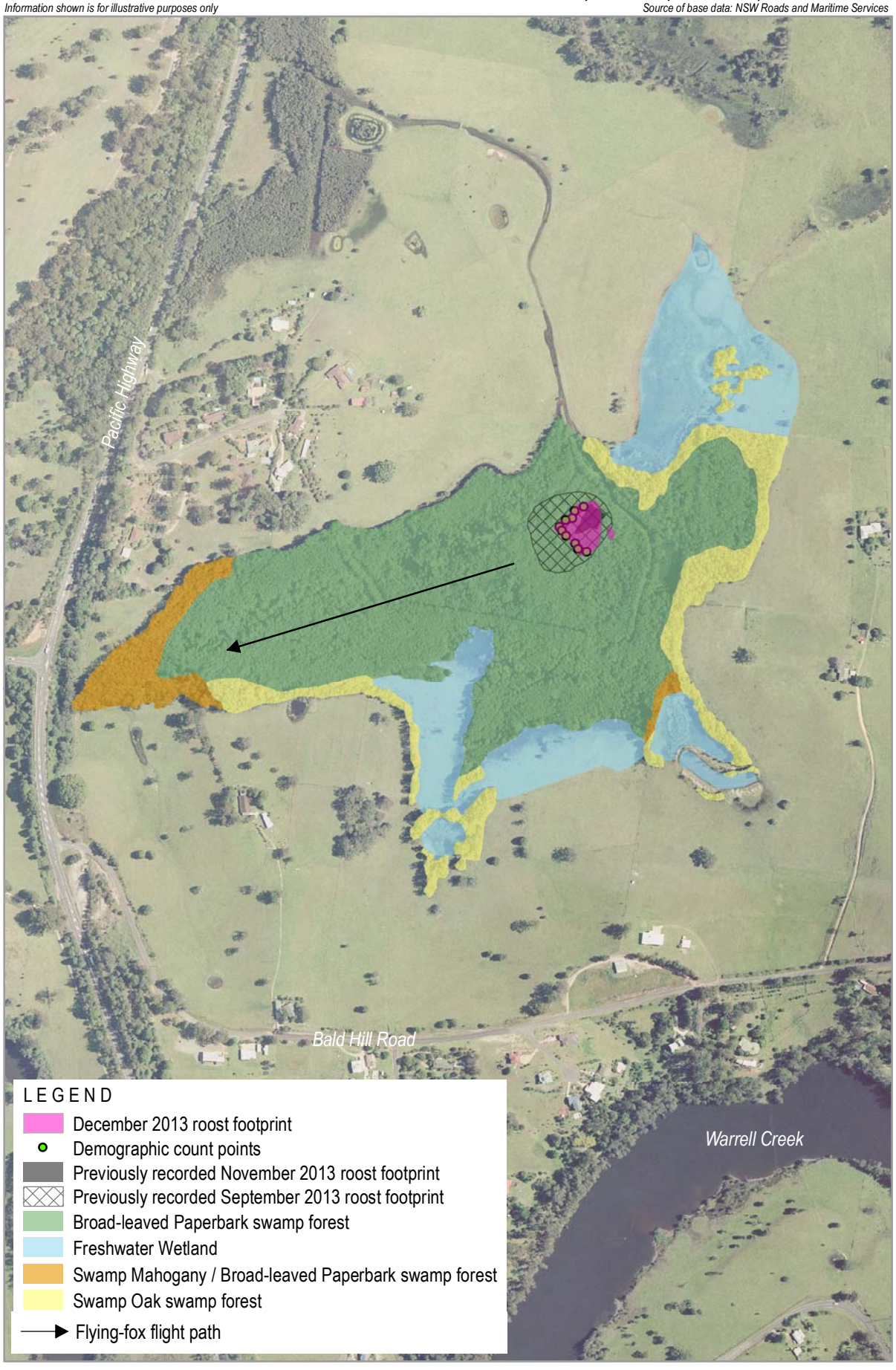
The roost occupied an area within the Swamp Sclerophyll Forest at the site of approximately 0.32 ha and was located within the same general area in which flying-fox have previously been mapped in September and November 2013. The size of the roost has increased since November, when it occupied an approximate area of 0.08 ha. A maximum roost footprint of approximately 0.89 ha was recorded in September 2013.

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 7 m in height with a diameter at breast height (DBH) less than 20 cm.

Information shown is for illustrative purposes only

Drawn by: TJP Checked by: GJM Reviewed by: DSA Date: December 2013
Source of base data: NSW Roads and Maritime Services



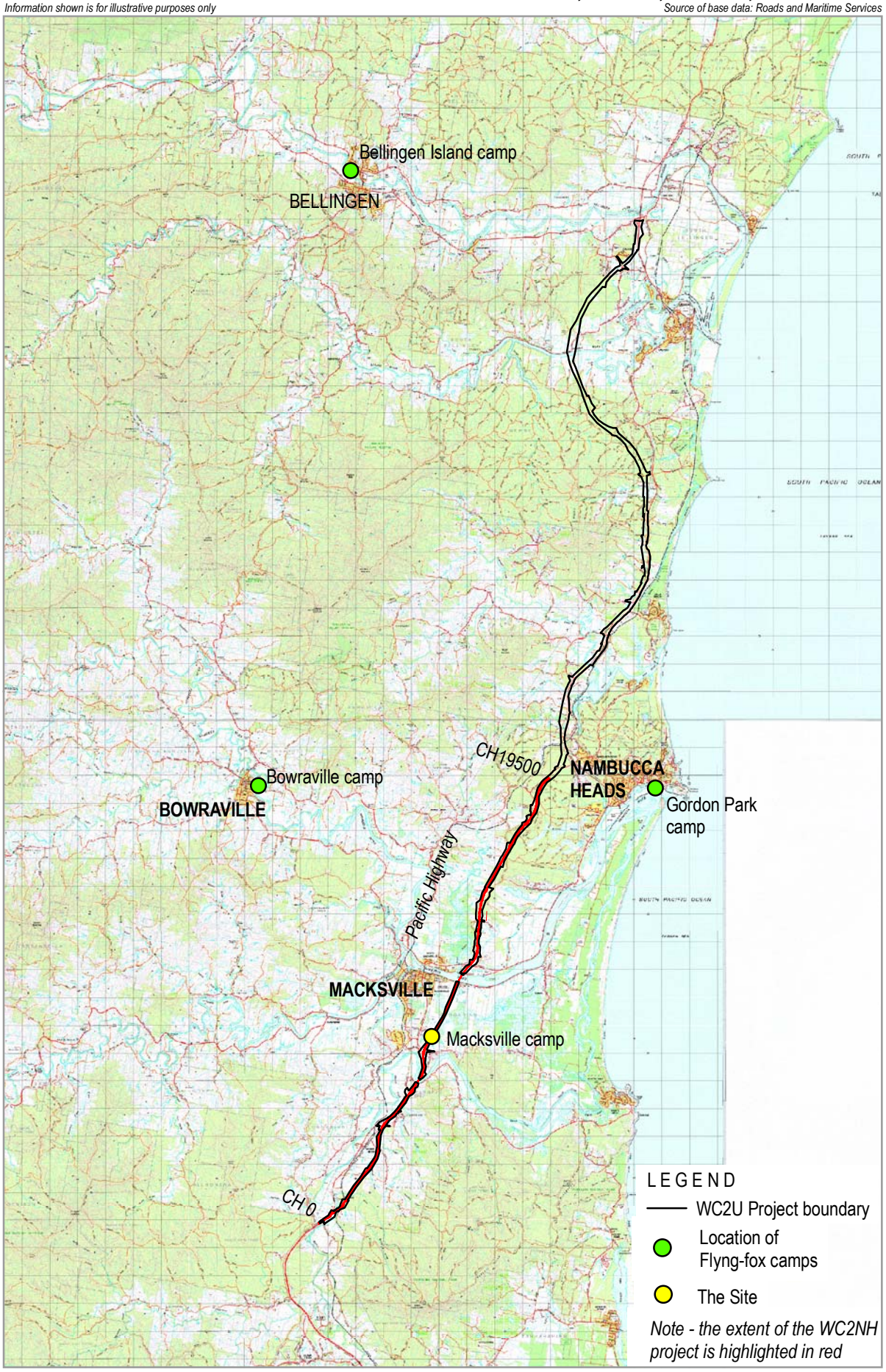
North

0 150

Roost Footprint and Demographic Count Points

Information shown is for illustrative purposes only

Drawn by: TJP Checked by: MVE Reviewed by: DSA Date: November 2013
Source of base data: Roads and Maritime Services



0 4 km

North

Location of Regional Flying-fox camps

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 at Bellingen Island. It was estimated that approximately 90-95% of the flying-fox present at the site consisted of GHFF. This proportion was higher than that recorded in November 2013, when it was estimated that approximately 80% of the flying-fox present at the site were GHFF. At Bellingen Island GHFF accounted for approximately 95% of the flying-fox present, consistent with proportions recorded in previous months. The Black Flying-fox were interspersed among the GHFF at these camps, and typically occurred in small groupings.

Both GHFF and Black Flying-fox were also present at the remaining regional camps. It was estimated that GHFF accounted for approximately 85-90% of the flying-fox present in the Gordon Park camp and 95% of the flying-fox present in the Bowraville camp. These proportions have not changed 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 a 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 Bellingen 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 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. Flying-fox were recorded in roost trees that are generally 5 - 15 m high, and up to 70 cm diameter at breast height (DBH). The roost area is extensive at Bellingen 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. The camp was dominated by male GHFF. All roost trees that were investigated were found to predominantly support males, and a substantial proportion of these trees were exclusive 'bachelor' trees without any females (e.g. M1, M2 and M6). The ratio of females to males in roost trees ranged from approximately 1:2 to 1:15. The percentage of GHFF females with dependent young in demographic counts ranged between 25% and 50%. The maximum percentage of females with dependent young in the November 2013 count was higher than this at 80%.

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	6600728, 492937	*Melaleuca quinquenervia* (multiple)	10-20	6-8	Bachelor tree (no females present)	no	n/a
M2	6600724, 492919	*Melaleuca quinquenervia* (multiple)	10-20	6-8	Bachelor tree (no females present)	no	n/a
M3	6600706, 492904	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:34 (predominantly male grouping)	no	n/a
M4	6600703, 492900	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:50 (predominantly male grouping)	yes	25
M5	6600696, 492886	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:40 (predominantly male grouping)	no	n/a
M6	6600681, 492884	*Melaleuca quinquenervia* (multiple)	10-20	6-8	Bachelor tree (no females present)	no	n/a
M7	6600672, 492891	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:150 (predominantly male grouping)	no	n/a
M8	6600664, 492902	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:>66 (predominantly male grouping)	yes	30
M9	6600662, 492906	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:23 (predominantly male grouping)	no	n/a
M10	6600640, 492923	*Melaleuca quinquenervia* (multiple)	10-20	6-8	10:33 (predominantly male grouping)	yes	50

Table 2.2 displays the results of the demographic data collected at the Bellingen Island camp. Females were generally more numerous than males in demographic counts, however a small number of trees predominantly supporting males (e.g. BI10). The ratio of females to males varied considerably in demographic counts ranging from approximately 1:1 to 5:1. The average ratio was around 2:1. The percentage of GHFF females with dependent young was also variable, ranging between 30% and 90%.

Table 2.2 Demographic Data for Bellingen 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	6631651, 490047	*Melia azederach*	15	8	10:7	yes	40
BI2	6631617, 490042	Unknown sp. (LAURACEAE)	60	15	10:4	yes	80
BI3	0490014, 6631627	*Dendrocnide exclesa*	30	12	10:4	yes	30
BI4	6631578, 490062	*Dendrocnide exclesa*	35	12	10:6	yes	60
BI5	6631575, 490052	*Dendrocnide exclesa*	30	15	10:5	yes	80
BI6	6631553, 490058	*Dendrocnide exclesa*	35	15	10:6	yes	60
BI7	6631539, 490056	*Ficus coronata*	10, 15 (multiple trunks)	8	10:2	yes	70
BI8	6631524, 490066	*Dendrocnide excelsa* & *Ficus coronata* (adjacent canopies)	25	10	10:7	yes	50
BI9	6631528, 490074	*Ficus coronata*	25	9	10:5	yes	50
BI10	6631653, 490018	*Ficus coronata*	10	5	10:12 (predominantly male grouping)	yes	90

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 Bellingen 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 53 cm. This was a slight decrease from the previous measurement of 60 cm recorded in November 2013.

2.3 Discussion

2.3.1 Population Estimate

The flying-fox population estimate at the site of 2500 as recorded in the exit count on 18 December indicates that there has been a minor increase in flying-fox numbers since the previous monthly count in November 2013 when 1200 flying fox were counted. This is also reflected in an increased camp footprint (refer to Illustration 2.1). However, the number of individuals is still relatively low when compared to the peak of >10,000 individuals recorded in September 2013. The number of individuals at the site is also relatively low compared with other regional camps that were visited in December, all of which were estimated to be supporting >10,000 flying-foxes.

Numbers at the Gordon Park and Bellingen camps appear to have remained relatively stable between November and December. The trend of increasing numbers of flying-fox at the Bowraville camp between October and November has continued into December, with a substantial increase in numbers from around 5,000 to >10,000. The camp footprint has also expanded. 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.

No population estimate of GHFF is available for the site in December of the previous year. However, flying-fox were present at the site during November/ early December 2011 when the presence of a flying-fox camp was first noted (Eby 2012). 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 December 2012. 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 varied from approximately 80% of individuals present at the site to >95% of individuals present at Bellingen Island and Bowraville. This is consistent with the results from previous monthly monitoring.

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).

The proportion of female GHFF recorded at the site in December 2013 was considerably lower than that recorded in November 2013. Very small camps (< 500) are often dominated by adult males and sub-adults and the percentage of adult females in the population generally increases in association with population size (Eby 2012). Although there was a minor increase in overall numbers of flying-fox at the site between November and December 2013, there was no corresponding increase in the overall proportion of females occupying the camp. The driving factor/s leading to lower female flying-fox numbers at the site during the current monitoring event remain unclear. Depending on the nature of the flowering of highly productive species (e.g. species of *Corymbia*) within the broad locality over the summer period, the GHFF population at the site is expected to reach a maximum over the next few months. If flowering of these key foraging tree species is strong, the results of the January 2014 monitoring may show an increase in the proportion of females and young occupying the camp as the overall number of individuals at the camp increases

For the 2013 breeding season, it was surmised that births of GHFF commenced on or around 3 October 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). No calls of flightless young were heard during the exit count on 18 December. This may reflect the low number of young that were recorded in the camp during this month's monitoring.

2.3.3 Phenology of Trees in Region

Flowering of *Corymbia* species such as Pink Bloodwood (*C. intermedia*), Red Bloodwood (*C. gummifera*) and Spotted gum (*C. maculata / C. variegata*) as well as Grey Ironbark (*Eucalyptus siderophloia*) (foothills and ranges) occurs in December 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).

2.4 Conclusion

The results of the December 2013 flying-fox monitoring indicated that flying-foxes have increased in numbers at the site between November and December (from approximately 1200 individuals to 2500 individuals. This population size is substantially less than was recorded in September 2013 when >10,000 individuals were present. GHFF dominates the site and other regional camps visited in the monitoring representing over 80% of all individuals.

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.

A lower proportion of female GHFF were recorded occupying the site in December 2013 compared with the November monitoring results. This is despite an increase in the overall population size. Results of the next seasonal monitoring event in January 2014 may clarify whether this is an ongoing trend at the site or represents short-term variability in population characteristics in response to local 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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