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THREATENED SPECIES ASSESSMENT

Local Environmental Study

At

PACIFIC HIGHWAY, BULADELAH, NSW (LOT 3 IN DP 1120817 AND LOT 100 IN DP 1139447)

PART 2 – FAUNA COMPONENT

MAY 2011

EXECUTIVE SUMMARY

Fauna surveys on the subject site were conducted over a four-year period by *HWR Ecological* together with *Clarke Dowdle & Associates* and *Robert Payne-Ecological Surveys & Management*. The results from these surveys were collated and used in the production of this fauna report, towards a Local Environmental Study. Several surveys were carried out in different seasons to target particular threatened species. This included three winter and spring summer surveys although no autumn survey was involved.

From the fauna surveys conducted thirteen 'threatened' fauna species were recorded onsite, being the Common Bent-wing Bat, the Little Bent-wing Bat, possibly the Large-eared Pied Bat, the Yellow-bellied Sheath-tailed Bat, the Eastern Cave Bat, the Large-footed Myotis and the Eastern Free-tail Bat. The Parma Wallaby, the Glossy Black Cockatoo, the Varied Sittella, the Squirrel Glider, the Grey-headed Flying Fox and the Powerful Owl were also seen either on one or several occasions. The subject site is highly significant for Squirrel Glider habitat based on winter flowering resources and the numbers captured over a relatively small area. A number cave dwelling species that could possibly roost on Alum Mountain were also detected. Alum Mountain has caves which are potential roosting sites for the cave dwelling bats.

Threatened species foraging habitat for the Parma Wallaby and the Large-footed Myotis appears to include the yabbie ponds and the surrounding grassland in association with the lower slopes whilst roosting and feeding habitat for the Glossy Black Cockatoo appears to be the mid slopes where there is a large population of *Allocasuarina littoralis.*

Surveys for the Squirrel Glider revealed they were only captured in pipe traps and the capture rates reveal a density of one Squirrel Glider/7.8ha or 0.1 animals/ha. This figure falls within the density range identified in Smith (2002). A squirrel Glider habitat assessment based on randomly selected quadrats revealed that the data collected for critical winter flowering resources was adequate to determine habitat quality but tree hollow counts were not. Based on the former Red Mahogany/Paperbark Swamp Sclerophyll Forest, Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland and Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland all support adequate winter food resources but the other communities do not. Tree hollow data in the assessment needs to be revised because it did not provide adequate results, when matched against the trapping data, which indicates that the majority of Squirrel Gliders were captured in the coastal plain vegetation in Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest. This vegetation type returns a low number of tree hollows when quadrats are randomly selected.

The koala assessment, under SEPP 44, revealed that Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland, Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest & Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest all constitute potential koala habitat but no core koala habitat was revealed. Under the NSW Koala Recovery Plan, using two revised methods, Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland vegetation qualifies as primary koala habitat whilst Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest and Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest vegetation qualify as secondary koala habitat class A and secondary habitat class B respectively. Using the Callaghan method Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland Sclerophyll Forest, Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest and Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest vegetation all qualify as secondary habitat class A.

At a finer scale, higher densities of preferred foraging tree species occur on the mid to upper slopes and the tree species in question are Sydney Blue Gum *Eucalyptus saligna,* Tallowwood *E. microcorys,* Grey Gum *E. punctata* and Brushbox *Lophostemon confertus* although only isolated trees of Sydney Blue Gum and Brushbox are present. The area of Swamp Mahogany in the Group 2 Sub-community 2; Upland Open Scrub with Emergents of Swamp Mahogany in Areas of Permanent High Water Tables vegetation community also provides preferred forage trees for the Koala. With the exception of this Swamp Mahogany forest, the remainder of higher quality foraging habitat for the Koala occurs outside of the footprint of the proposed Master Plan for the subject site.

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1.0 INTRODUCTION

Clarke, Dowdle & Associates have together with *Robert Payne-Ecological Surveys & Management* and *HWR Ecological* prepared a fauna survey as part of a Local Environmental Study (LES) on a large parcel of land at Bulahdelah, owned by *Brewery Australia Developments Pty. Ltd*. The assessment has been undertaken to ensure the LES is consistent with the requirements of the *Environmental Planning and Assessment Act 1979*, the *Threatened Species Conservation Act 1995 and* the *Environmental Protection and Biodiversity Conservation Act 1997.*

Initially a fauna survey was completed by HWR Ecological but no detailed report was prepared. Due to unforeseen circumstances only field notes and maps survive covering the results of this fieldwork. Following discussions with *Great Lakes Shire Council* and a proposal prepared by HWR Ecological (2006) several fauna issues remained to be completed over the subject site and the adjoining land. This report forms part of a Local Environmental Study detailing the fauna attributes of the area as a result of further survey between 2008 and 2010.

1.1 Aims and Objectives

The aims and objectives of this survey and report are to address the following outstanding issues:

- Identify, document and consider available ecological information pertaining to the site and its locality;
- Survey and describe the faunal habitats and faunal species diversity within the site;
- determine and describe all features of biological significance within the site;
- Contribute ecological knowledge to determine an appropriate strategic land use planning of the land within the site.

2.0 LOCATION

The site is located approximately 1km north-east of Bulahdelah, NSW along the Pacific Highway (Figure 1). The location of the subject land is the Pacific Highway Bulahdelah. On the Bulahdelah 1:25 000 topographic mapsheet (9333-3-S) the MGA grid co-ordinates are $_{4}$ 26 770E, $_{64}$ 14 770N. The site is also located in the Parish of Bulahdelah, the County of Gloucester in the Shire of Great Lakes. Cadastrally, the site is known as Lot 3 in DP 1120817 and Lot 100 in DP 113447 (Figures 1 & 2).

Figure 1- Aerial photograph showing location of the study area in relation to the township of Bulahdelah.

Figure 2- The Subject Site, showing cadastral boundaries, located east of the Pacific Highway

3.0 WILDLIFE ATLAS DATABASES

Wildlife atlas records were initially retrieved from the NSW and commonwealth databases in 2007 for a 10km range from the property and the results are presented in Table 1 (see Payne, 2007). The database was again updated in 2010 and the table amended. Those threatened species, highlighted in light brown, are likely to occur in the subject area and would be used to undertake targeted surveys for threatened fauna species that may be expected to occur over the property.

Table 1 – Threatened species that have been recorded within a 10km range of the property (updated for 2011); Source NSW wildlife atlas and commonwealth Dept of Arts, Heritage & Environment databases.

Latin Name	Common Name	TSC Status	EPBC Status
FAUNA			
Litoria aurea	Green & Golden Bell Frog	Endangered	Vulnerable
Hoplocephalus stephensii	Stephens banded Snake	Vulnerable	
Anseranas semipalmata	Magpie Goose	Vulnerable	
Ephippiorhynchus asiaticus	Black-necked Stork	Endangered	
Circus assimilis	Spotted Harrier	Vulnerable	
Calyptorhynchus lathami	Glossy Black-Cockatoo	Vulnerable	
Ninox strenua	Powerful Owl	Vulnerable	
Ninox connivens	Barking Owl	Vulnerable	
Tyto novaehollandiae	Masked Owl	Vulnerable	
Tyto capensis	Grass Owl	Vulnerable	
Daphoenositta chrysoptera	Varied Sittella	Vulnerable	
Petroica boodang	Scarlet Robin	Vulnerable	
Stagonopleura guttata	Diamond Firetail	Vulnerable	
Dasyurus maculatus	Spotted-tailed Quoll	Vulnerable	Endangered
Phascolarctos cinereus	Koala	Vulnerable	
Petaurus australis	Yellow-bellied Glider	Vulnerable	
Petaurus norfolcensis	Squirrel Glider	Vulnerable	
Macropus parma	Parma Wallaby	Vulnerable	
Pteropus poliocephalus	Grey-headed Flying-fox	Vulnerable	Vulnerable
Miniopterus australis	Little Bentwing-bat	Vulnerable	
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	Vulnerable	
ADDITIONAL EPBC		**STATUS**	
Haliaetus leucogaster	White-bellied Sea Eagle	Migratory terrestrial, Listed marine EPBC	
Hirundapus caudacutus	White-throated	Migratory terrestrial, Listed	

	Needletail	marine EPBC
Merops ornatus	Rainbow Bee-eater	Migratory terrestrial, Listed marine EPBC
Monarcha melanopsis	Black-faced Monarch	Migratory terrestrial, Listed marine EPBC
Monarcha trivirgatus	Spectacled Monarch	Migratory terrestrial, Listed marine EPBC
Myiagra cyanoleuca	Satin Flycatcher	Migratory terrestrial, Listed marine EPBC
Rhipidura rufifrons	Rufous Faintail	Migratory terrestrial, Listed marine EPBC
Ardea alba	Great Egret	Migratory wetland, listed marine EPBC
Ardea ibis	Cattle Egret	Migratory wetland, listed marine EPBC
Gallinago hardwickii	Latham's Snipe	Migratory wetland, listed marine, EPBC
Rostratula benghalensis	Painted Snipe	Migratory wetland, listed marine EPBC
Apus pacificus	Fork-tailed Swift	Migratory terrestrial, listed marine, listed EPBC

Notes for Table 1:

- TSC- *Threatened Species and Conservation Act, 1995*
- EPBC- *Environment Protection and Biodiversity Conservation Act 1999*

Table 2 – Threatened species records (from Table 1) and their general locations/habitats within a 10km range of the property (and elsewhere within the LGA)

Species	**Distance from subject site**	**Remarks as to Habitat**
Green & Golden Bell Frog	Within 5 km	Bulahdelah Plain
Stephens Banded Snake	Within 4km	Coolongolook Range
Magpie Goose	Within 2km	Bulahdelah township
Black-necked Stork	Between 3-4 km	Crawford River, Myall River, Bulahdelah township & Bulahdelah Plain
Spotted Harrier	Within 5km	Coolongolook Range
Glossy Black-cockatoo	Between 1-4 km	Alum Mountain, Boolambayte Creek & Bulahdelah State Forest
Powerful Owl	No previous records	Alum Mountain (record from this survey)
Grass Owl	Within 3km	Crawford River
Masked Owl	Between 1- 5km	Crawford River, golf course, Priestlys Creek, Traynor Creek & Boolambayte Creek

(Cont.)

Species	Distance from subject site	Remarks as to Habitat
Varied Sittella	Within 1km	Golf course
Spotted-tailed Quoll	Between 4-6km	Bulahdelah SF & Priestlys Creek
Koala	Between 1-4km	Boolambayte, Bulahdelah north, Alum Mountain, Bulahdelah township, Traynor Creek, Priestlys Creek & Coolongolook Range
Yellow-bellied Glider	1-5km	Coolongolook Range, Boolambayte Creek, Priestly Creek & Alum Mountain
Squirrel Glider	2km	Bulahdelah township
Parma Wallaby	No previous records	Alum Mountain (records from this survey)
Grey-headed Flying Fox	Within 3km	Coolongolook Range & Bulahdelah township
Little Bent-wing Bat	Between 1-3 km	Alum Mountain, Crawford River & Myall River.
Eastern Bent-wing Bat	Between 1-3 km	Alum Mountain, Crawford River & Myall River.
ADDITIONAL SPECIES FOUND ELSEWHERE IN THE GREAT LAKES LGA		
Species	**Habitat**	**Relevance to this proposal**
Amphibians		
Wallum Froglet	Low lying acid sandy swamps	No
Green-thighed Frog	Various including rainforest, open forest, open shrubland with heath or grass, wet/heathland usually sandy substrate	possibly
Stuttering Frog	Tall moist forests and rainforest with intermittent streams and rock shelves	Alum Mountain
Giant Barred Frog	Tall moist forests and rainforest with permanent rocky streams	No
Birds		
Emu	Open woodlands and coastal heaths on coast	No
Speckled Warbler	Dry woodlands with rocky understorey	Alum Mountain
Little Eagle	Open areas, plains, foothills, open forests, woodlands and farmlands	Yes
Square -tailed Kite	Forests, heathlands and woodlands	Yes
Osprey	Estuaries and ocean shores	No

(Cont.)

Species	Habitat	Relevance to this proposal
Spotted Harrier	Grassy woodlands and more open areas	No
Blue-billed Duck	Freshwater swamps	No
Black Bittern	Various wetland and riparian	Frys Creek
Rufous Scrub-bird	Rainforest	No
Wompoo Fruit-dove	Riparian and rainforest habitats	Frys Creek
Rose-crowned Fruit-dove	Riparian and rainforest habitats	Frys Creek
Superb Fruit-dove	Riparian, rainforest & mangrove habitats	Frys Creek
Turquoise Parrot	Grassy woodlands, forested hills and heaths	Unlikely
Little Lorikeet	Forests and woodlands	Yes
Swift Parrot	Flowering and lerp infested forests and woodlands in winter	Upland Hanging Swamp
Bush-stone Curlew	Open grassy and grassy woodland habitats with grass 10cm high.	No
Regent Honeyeater	Flowering forests and woodlands in winter	Upland Hanging Swamp
White-fronted Chat	Damp habitats especially heath	Parts of coastal plain
Black-chinned Honeyeater	Dry eucalypt forests and woodlands	Alum Mountain
Olive Whistler	Moist habitats including riparian and paperbark swamps	Frys Creek
Grey-crowned Babbler	Dry woodlands and farms	No
Hooded Robin	Dry forests and woodlands	Yes
Flame Robin	Forests and woodlands in summer	Yes
Barking Owl	Open forests and woodlands	Yes
Masked Owl		
Sooty Owl		
Mammals		
Eastern Chestnut Mouse	Moist heathlands	No
Eastern Pigmy Possum	Winter flowering Banksias in coastal heath; Swamp Mahogany	Coastal plain; upland hanging swamp
Brush-tailed Phascogale	Flowering and dead eucalypts with large hollows in open forests with sparse ground cover	Maybe Alum Mountain
Common Planigale	Various	Yes
Red-legged Pademelon	Rainforest and moist forest	No
Long-nosed Potoroo	Coastal heath and forests with thick ground cover; sandy soils	No

(Cont.)

Species	Habitat	Relevance to this proposal
Brush-tailed Rock Wallaby	Rocky areas with numerous ledges and caves	Alum Mountain
Common Blossom-bat	Heathland and Melaleuca swamps with Banksia and Callistemon	Frys Creek
Microbats		
Yellow-bellied Sheath-tailed Bat	Various; feeds and forages well above tree canopy,; nests in hollows	Yes
Eastern Freetail-bat	Various forests and woodlands; open area specialist; sometimes over water.	Yes
Southern Myotis	Open water specialist; Riparian areas; roosts in mangroves, hollows and artificial structures	Yes
Eastern False Pipistrelle	Forests, woodlands and water	Yes
Greater Broad-nosed Bat	Various; nests in hollows	Yes
Golden-tipped Bat	Moist closed forest	No
Eastern-cave Bat	Drier forests; roosts in caves	Yes

** The above table was compiled at various times and at the time wildlife atlas records were obtained for a scale at the LGA level NSW DECCW could not supply co-ordinates due to maintenance procedures.*

4.0 PREVIOUS LOCAL STUDIES

4.1 Terrestrial fauna

Previous fauna studies of the local area are also relevant to what threatened species have been actually recorded in the immediate area. These species can also help to evaluate the potential conservation significance of a subject site. Thus, the Environmental Impact Statement for the Pacific Highway upgrade at Bulahdelah is relevant to this proposal (Parsons Brinckerhoff, 2004). The route of the Pacific Highway upgrade follows the existing route of the current highway but lies immediately to the east. On the southern approach to Alum Mountain, the route crosses the Myall River and follows the base of Alum Mountain and continues beside the golf course. In the vicinity of Alum Mountain the route lies within 200 metres of the subject property.

A total of 184 animal species were recorded in their study area during the six day survey period as well as during additional surveys, targeted surveys and other opportunistic surveys (Parsons Brinckerhoff, 2004). This figure included 32 mammal species, 125 bird species, 15 reptile species and 12 frog species. Nine of the 184 animal species were exotic introduced species. The fauna recorded included three species, which are of state significance (listed on the TSC Act, 1995). Such species were the Koala *Phascolarctos cinereus*, Eastern Free-tail Bat *Mormopterus norfolkensis* and the Masked Owl *Tyto novaehollandiae*.

An additional 16 species of state significance have been recorded within 10 kilometers of the study area as shown by the NSW wildlife atlas database from other surveys and

observations (Table 1). In summary, these fauna species include the Green and Golden Bell Frog *Litoria aurea*, Stephens Banded Snake *Hoplocephalus stephensii,* Magpie Goose *Anseranas semipalmata,* the Black-necked Stork *Xenorhynchus asiaticus,* the Spotted Harrier *Circus assimilis,* the Glossy Black Cockatoo *Calyptorhynchus lathami,* the Masked Owl *Tyto novaehollandiae,* the Grass Owl *Tyto longimembris*, the Varied Sittella *Daphoenositta chrysoptera,* the Scarlet Robin *Petroica boodang,* the Diamond Firetail *Stagonopleura guttata,* Spotted-tailed Quoll *Dasyurus maculates,* Koala *Phascolarctos cinereus,* Yellow-bellied Glider *Petaurus australis*, the Squirrel Glider *Petaurus norfolkensis*, the Grey-headed Flying Fox *Pteropus poliocephalus, the* Little Bent-wing Bat *Miniopterus australis* and the Eastern Bent-wing Bat *Miniopterus schreibersii oceanensis*. Both the Powerful Owl *Ninox strenua* and Parma Wallaby *Macropus parma* have not been previously recorded previously within a 10km range of the property.

4.2 Terrestrial Invertebrates

Thirteen terrestrial invertebrate fauna species were also recorded in the study area (Parsons Brinckerhoff, 2004). None of these species are considered to be of conservation significance.

4.3 Fish

Eight fish species were recorded from the study area in Frys Creek. Although it was not recorded, the Catfish was expected to occur. A further thirteen species have been previously recorded in the Myall-Crawford Catchment (*NSW Fisheries,* in *PPK Environment and Infrastructure 2000; Harris and Gehrke, 1997),* however, these species prefer more estuarine, shallow and/or upstream habitats. All of these species recorded are native with the exception of the Eastern Gambusia, a declared noxious pest. None of the species known to occur are listed as protected or threatened under the Fisheries Management Act, 1994.

Two professional fishermen operate in the upper Myall River targeting Eels and Freshwater Mullet. They report seasonally good catches for both species. During very dry weather, the upper reaches of the river become fairly saline and attract several estuarine species as far as Bulahdelah. However, commercial species normally found in the river include Freshwater Mullet, Eels, Australian Bass and the occasional Sea Mullet.

4.4 Aquatic Invertebrates

Forty-two macro-invertebrate families were recorded in the study area (Parsons Brinckerhoff, 2004). Thirty-seven families were recorded in Frys Creek, 27 families in the Myall River and 14 families were recorded in the northern wetland.

The results indicate a depauperate macro-invertebrate fauna within the sediments of the upper Myall River. Low numbers of individuals from only a few species were present. The most abundant species, the Tubifex Worm, is considered to be highly tolerant to pollution and stress. Deeper waters were characterized by very poor conditions for aquatic life with no food source available for fish. All the invertebrates collected from the Myall River were freshwater organisms, with the exception of a single brackish-water polychaete, *Notomastus esturarius.*

The most abundant macro-invertebrate taxa recorded in the open waters of the Myall River, Frys Creek and the northern and southern wetlands were generally tolerant of pollution and

stress. Based on SIGNAL indices, the Myall River crossing is considered to be severely polluted and stressed whereas Frys Creek varies from being mildly to moderately polluted, depending on the location of the sample site in relation to the sewerage treatment plant. The northern wetland is moderately polluted. No sampling for macro-invertebrates was undertaken for the southern wetland.

5.0 HABITAT CHARACTERISTICS OF THE SITE

The vegetation communities that have been described in the flora component of the study (Part 1) will form the basis (but not totally so) for the classification of the study area into faunal habitats, according to the guidelines prepared by Great Lakes Council. While the vegetation mapping reflects changes in the floristic composition of an area, habitat identification is based upon structural components of the vegetation, age class of the vegetation (for example old growth, regrowth), specific habitat components (for example freestanding water, caves) and plant species composition. Therefore, some habitats can be smaller than the vegetation unit, while others can incorporate a number of units.

To determine the characteristics for the habitat assessment, each vegetation unit was sampled for mean tree diameter at breast height, dead trees, fallen timber, rock outcrops, caves, wet areas, fruit and nectar plants, fauna refuges and hollows per hectare. All these characteristics were documented (Table 3). Twenty nine quadrats, each 400m^2, were surveyed throughout the property to determine the characteristics (Table 3 and Appendix 14). No surveys were undertaken on the summit of Alum Mountain due to access difficulties but it should be noted that floristically, Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest vegetation, merges with part of the vegetation on the summit of this mountain. For the purposes of this survey this habitat has been described from the earlier surveys when access and weather conditions were more appropriate.

The following information describes the fauna habitat features within the mapped vegetation communities.

5.1 Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest (Group 5 vegetation)

This habitat has a partially closed canopy with a varying diversity of species. There are few structural layers, with the shrub and sedge layers usually dense. Fruit and nectar producing trees, such as *Acmena smithii*, *Melaleuca sieberi* and *Callistemon salignus* provide good habitat for nectivorous and fructivorous bird species and a foraging resource for arboreal mammals. The sedge layer provides shelter for terrestrial fauna such as *Rattus fuscipes* (see Press, 1986) and the creek environment for other small mammals after fire (see Friend, 1979; Fox & McKay, 1981). Suitable microclimatic conditions occur in this habitat to enable foliage-roosting bats to refuge. High moisture levels would also enable amphibians to flourish. Few tree hollows are normally found in this habitat type but ground logs with hollows are present which provide faunal refuges for ground mammals. However, in the old growth sections emergent eucalypts provide a high number of hollows for hollow dependant fauna including birds, mammals and microbats. The winter flowering nectar producing tree species *E. microcorys* and *E. robusta* are present in this habitat. The mean diameter at breast height (dbh) for standing trees is 0.353m.

5.2 Red Mahogany/Paperbark Swamp Sclerophyll Forest (Group 2/1 vegetation)

This habitat is characterised by an open tall tree canopy and a dense sub-canopy dominated by *Melaleuca spp*. which would harbour bark insects. This area does not provide a significant winter flowering food source due to the paucity of *Eucalyptus robusta* but the *Melaleucas* would supply nectar in other times of the year for nectivorous birds and mammals. The area also provides potential foraging resource for koalas with the presence of the supplementary species *Eucalyptus resinifera subsp. hemilampra.* Dense ground cover, pock-marked undulations, litter, plus available water during rain and dense sedgelands would provide reasonable habitat for amphibians, some reptiles and ground mammals. There appeared to be a large number of hollows within the overmature trees present which provide suitable habitat for foraging and nesting opportunities for many arboreal mammal, birds, reptile and bat species. Ground logs were found to contain reptile eggs (Photos 1, 2, 3 & 4). Mean DBH was measured and calculated to be 0.418m.

Photo 1 – *Melaleuca* forest with emergent of *E. resinifera subsp. hemilampra* showing the dense sedge cover over the pock marked undulations. Melaleucas can be dense with the papery bark harbouring insects.

Photo 2 – *Melaleuca* forest with emergents showing the hollow fallen dead trees. This log revealed evidence of reptile eggs.

Photo 3 – Large over mature trees are common in the *Melaleuca* forest with emergent habitat and these trees support many hollows.

Photo 4 – These large over mature trees readily fall in the *Melaleuca* forest and then provide habitat for small mammals, amphibians and reptiles.

5.3 Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland (Group 2/2 vegetation)

This habitat is characterised by a very open tree canopy and a dense to moderately dense understorey, which would harbour small mammals (see Press, 1985) even after fire. The winter flowering tree species *Eucalyptus robusta* is present in this habitat along with other winter flowering species, *Banksia robur* and *Callistemon pachyphyllus*. All three species could be an important food source for nectivorous birds and mammals. Swamp Mahogany is the main late autumn-winter food source for species such as the Regent Honeyeater, the Swift Parrot, Squirrel Glider, Yellow-bellied Glider, the Grey-headed Flying Fox and honeyeaters at a time when other available food resources are lean. Dense ground cover and litter, plus available water, provides good habitat for amphibians. Arboreal mammals such as the Squirrel Glider would utilise the winter flowering species in this habitat. No significant hollows are present in this habitat type and the habitat area is only small but it does adjoin other suitable habitat for such species. Mean DBH is 0.357m.

5.4 Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland (Group 3 vegetation)

This community has an open, mature canopy with a low-moderate number of trees containing hollows due to past logging practices. These hollows are suitable for sheltering and nesting of arboreal mammals, birds and bats, including threatened species. One supplementary koala food tree species occurs within this community, but the canopy diversity is moderate. The ground cover and shrub layer are usually dense with shrubs and sedges and is floristically diverse. Fallen timber provides habitat for small terrestrial mammals and reptiles. The area would be utilised by insectivorous bats, while the soaks and sedges in this area would provide habitat for amphibians and small mammals such as *Antechinus stuartii* (see Stratham & Harden, 1982). The area contains a moderate forest

oak small tree layer which is important foraging resources for the threatened Glossy Black Cockatoo occurring in the area and throughout the site generally. Both the winter flowering *E. microcorys* and *E. fergusonii subsp. fergusonii* occurs in this habitat. Habitat for small mammals including the Eastern Pigmy Possum *Cercatetus nanus* is present with the large population of nectar producing shrubs *(Banksia spp.)* and ground logs with hollows (see Payne, 2009; 2010). Mean tree DBH is 0.454m.

5.5 Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest (Group 4 vegetation)

This community has an open tall, mature canopy with a low number of trees containing hollows due to past logging practices. It appears logging has been more intense in this area as opposed to the lower slopes. One primary and one supplementary koala food tree species dominate this community, while canopy diversity is moderate. The ground cover and shrub layer are usually dense and floristically diverse with fallen timber providing habitat for small terrestrial mammals and reptiles. The area would be utilised by insectivorous bats, while sheltered aspects of this area would provide habitat for amphibians. This habitat supports significant stands of She Oak which is an important foraging resource for the threatened Glossy Black Cockatoo occurring on the site. Rocky debris and rocky outcrops are present providing refuges for reptiles.

On the upper parts of Alum Mountain are significant areas of cliffs, caves, intercises and crevices which are habitat for small insectivorous bats and reptiles. The open sunny rocky scree areas are also habitat for reptiles. Understorey vegetation is poorly represented at this location. The winter flowering *E. microcorys* is dominant in this habitat (Photo 5). Mean DBH is 0.411m.

Photo 5 – Woodland Tall Forest can be seen from the centre of the photo to Alum Mountain in the background. On Alum Mountain this vegetation changes to woodland with no understorey. Caves, cracks, crevices and rocky debris dominate the latter habitat. A cleared area can be seen in the foreground.

5.6 Stunted forest on Alum Mountain volcanic (Group 1 vegetation)

At the northern end of Alum Mountain is a low stunted Brush Box Forest growing in the rocky substrate. A few cracks and crevices are present as potential reptile habitat but the area is subject to cooler temperatures and high desiccating winds. Falcons such as the Peregrine Falcon *Falco peregrinus* are seen hunting from these mountain tops.

5.7 Cleared areas

This is a structurally simplistic community, usually comprising only a herb/grass layer with regenerating shrubs. This habitat provides a foraging resource for macropods and seed-eating birds. Some reptiles and amphibians may occur in the area. However, the habitat values for the majority of native fauna are limited. This is the only modified habitat on the property (Figure 3 & Photo 5). One area near the yabbie ponds is very moist grassland dominated by tussock grasses, developed as a result previous clearing and often the Parma Wallaby *Macropus parma* was seen in this area. Dense forest lies behind this area with Alum Mountain above (see Read & Fox, 1991).

Table 3 – Summary of Habitat Assessment

Attribute	Group 2/1	Group 2/2	Group 3	Group 4	Group 5
No. of quadrats	6	1	10	8	3
Mean tree (dbh)mm	418	357	454	411	353
Dead trees	0.33	1	0.30	0.375	0.333
Fallen Timber (% of quadrat)	7.16	1	6	6.875	22.67
Rock outcrops	Nil	Nil	Nil	Rocky debris ground cover-increases with altitude	Nil
Caves	Nil	Nil	Nil	Nil but are found on Alum Mountain	Nil
Wet areas	Some areas have pock-marked undulations which are subject to inundation	High watertables and saturated soils	Some seasonal soaks	Nil	Frys Creek has permanent water
Fruit/ nectar plants	Many *Melaleuca spp.*	Winter flowering nectar species	Winter flowering nectar species. *Xanthorrhoea* spp. sporadic	Winter flowering *Acacia spp.* & *Allocasuarina* spp. Occasional *Xanthorrhoea* spp.	Fleshy-fruited rainforest species. *Melaleuca* & *Callistemon* nectar species.

(Cont.)

Attribute	Group 2/1	Group 2/2	Group 3	Group 4	Group 5
Fauna refuges	Dense sedge & grass cover; hollow logs & trees with hollows	Dense sedge cover and water pools	Some sedge cover; hollow logs & trees with hollows.	Rocky debris provides habitat for reptiles	Dense sedge cover; permanent water in creek for amphibians
Hollows (per ha.)	75	25	58	0	5
Trees with hollows (per ha.)	25	25	20	0	5

5.8 Summary

The table shows that the riparian tall forest on alluvium along Frys Creek, the Melaleuca forest with emergents in areas of impeded drainage and upland open scrub with emergents of Swamp Mahogany would have the main potential for amphibians. The fact that the latter habitat has *E. robusta* and *B. robur* as winter flowering plants would indicate some habitat for the Squirrel Glider, Eastern Pigmy Possum and Grey headed Flying Fox. The *Red Mahogany/Paperbark Swamp Sclerophyll Forest* (group 2/1 vegetation) has potential for amphibians with the presence of pock-marked undulations as does the *Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland* (group 2/2 vegetation). Both the Squirrel Glider and Eastern Pigmy Possum are likely to be present in this Melaleuca forest and the *Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland* (Group 3 vegetation) because of the Banksia and Melaleuca food resource plants and the plants required for nesting material. Large trees with hollows are present in this latter habitat and may be suitable for the large owls and/or Glossy Black Cockatoos (Figure 5).

Regarding the habitats on Alum Mountain the presence of caves, intercises, cliffs, rocky debris and cracks would indicate that some focus should be placed on microbats and reptiles that inhabit the area during the surveys. The woodland/forest on Alum Mountain volcanics over lower coastal slopes and plain has substantial areas of Banksia understorey.

There are three main winter flowering trees present on the property. *E. robusta* was recorded in 2010 flowering between April and June, *E. fergusonii subsp. fergusonii* in June and July and *E. microcorys* beginning in July. It is well known that *E. robusta* and *E. microcorys* produce copious quantities of nectar whilst nothing appears in the literature about the nectar quality of *E. fergusonii subsp. fergusonii*. The species of Banksia occur on the property, which are all winter producing nectar plants are *B. robur, B. spinulosa* and *B. oblongifolia* (Table 4).

6.0 TREE HOLLOW ASSESSMENT

6.1 Initial assessment

A summary of the habitat assessment is given in Table 3, which were determined using format sheets for each 400m^2 quadrat combined with a separate point quarter survey and analysis for diameters at breast height, tree hollow density and trees with hollows (Appendix 15). The point-quarter method is a scientific based method used to gather data on relative tree density and frequency and relative dominance (Krebs, 1999). This data was gathered through the existing habitats/vegetation communities and involved random selection of quadrats and taking parameter measurements from all trees in the quadrats at the random selected point along a transect. Hollows were rated and estimated as being small (<50mm dia), medium (50mm-200mm dia.) or large (>200mm).

Overall there are a very large number of trees with hollows throughout the property and it would not be possible to co-ordinate all of these trees. Instead the main overmature tree species were recorded that are suitable for owl roosts and these are shown on Figure 5 with more details in Appendix 15. These results were originally determined by HWR. As part of the Squirrel Glider habitat assessment the number of trees with hollows and hollows per hectare were calculated from the data sheets and are shown in Table 3, with the locations shown on Figure 3. The *Red Mahogany/Paperbark Swamp Sclerophyll Forest* vegetation (Melaleuca forest with emergents in areas of impeded drainage) and Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland vegetation (Woodland/forest on Alum Mountain volcanics over lower coastal slopes and plains) support the greatest number of tree hollows on the property. The assessment for tree hollows was based upon an estimate involving three categories; small between 0-15mm diameter, medium 16-30mm diameter and large >30mm diameter. From six quadrats *Red Mahogany/Paperbark Swamp Sclerophyll Forest* vegetation supported five large, 11 medium and two small hollows. Group 2/2 (Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland) supported only one large hollow from one quadrat whilst Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland vegetation supported three large, 18 medium and three small hollows from ten quadrats. The *Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest* did not support any tree hollows from eight quadrats and group 5, *Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest*, supported 1 large hollow from three quadrats.

Most of the hollows could support the Squirrel Glider, but the larger ones, could support breeding owls and the Glossy Black Cockatoo if they are suitable. Rainbow Lorikeets were also observed nesting in the smaller hollows.

Table 3a – Summary of hollows recorded

Vegetation Group	Small hollows	Medium size hollows	Large hollows	No. of quadrats
2/1	2	11	5	6
2/2	-	1	-	3
3	3	18	3	10
5	-	-	1	1

A separate owl tree hollow assessment is given in Appendix 16 for the property and part of the adjacent state forest area. Seventeen trees were identified in the initial stages of the project by HWR and a further seven trees identified north of Frys Creek during the later

stages by Robert Payne and Kristan Dowdle, mainly north of Frys Creek. These trees are shown on Figure 5.

6.2 Detailed assessment

Forest Fauna Surveys (2011) improved on the tree hollow assessment through a specialized survey. Habitat trees were located by walking the entire subject site and plotting their location with a hand held GPS (Garmin 60CSx). Where a habitat tree was located, the following data was recorded:

- Tree ID,
- Tree species,
- Location recorded as easting and northing in MGA (GDA94) projection,
- Diameter at breast height (dbh) (cm),
- Height of tree (metres),
- % dead,
- Number of major and minor limb spouts or hollows, number of trunk hollows or spouts, and
- Assessment of likely fauna species to utilise hollows.

The assessment of likely fauna to utilise hollows was based on a size class of each hollow, where the following rating applied:

(1) Hollows with small openings <20mm or small fissures on dead branches, main trunk or split bark were classed as potential hollows for microchiropteran bats and small reptiles,
(2) Hollows with small openings >20mm <50 mm were classed as potential hollows for gliders and small birds (i.e. treecreepers),
(3) Hollows with medium sized openings >50mm <200mm were classed as potential hollows for possums and larger birds (i.e. Eastern Rosella)
(4) Hollows with large openings >200mm diameter were classed as potential hollows for large birds (large forest owls, cockatoos, ducks) and reptiles such as Lace Monitor and Diamond Python.

Given that the habitat trees were located by walking the entire subject site and plotting their location with a hand held GPS (Garmin 60CSx) the apparent accuracy would be limited. The accuracy of the GPS is ± 5 -10 metres; however it must be acknowledged that the error will be significantly greater whilst recording beneath tree canopy cover.

Additionally, the assessment of potential fauna species that may utilise each tree hollow is based on a visual assessment conducted at ground level. There was no scope in this study to conduct internal inspections of each tree hollow to determine adequacy for fauna species. Hence, the count is likely to over-estimate the number of actual hollows utilised by tree hollow dependent fauna.

Figure 3 – Vegetation map showing the areas that were cleared in 2008 north of the existing dwelling.

Figure 4 – Location of large trees with hollows and suitable as owl roost trees.

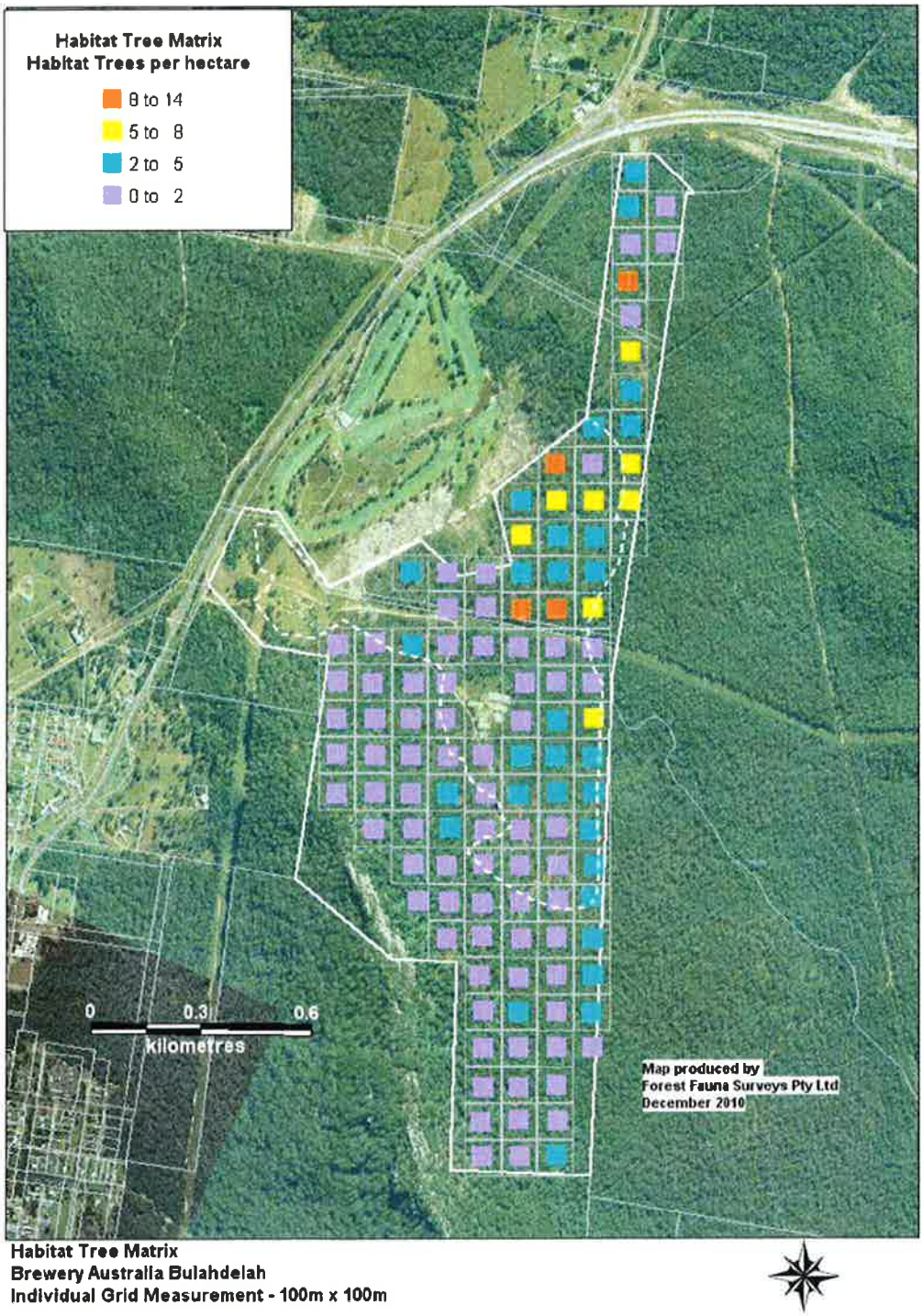

Figure 5- Habitat Tree Abundance based on Habitat Assessment Counts, Bulahdelah

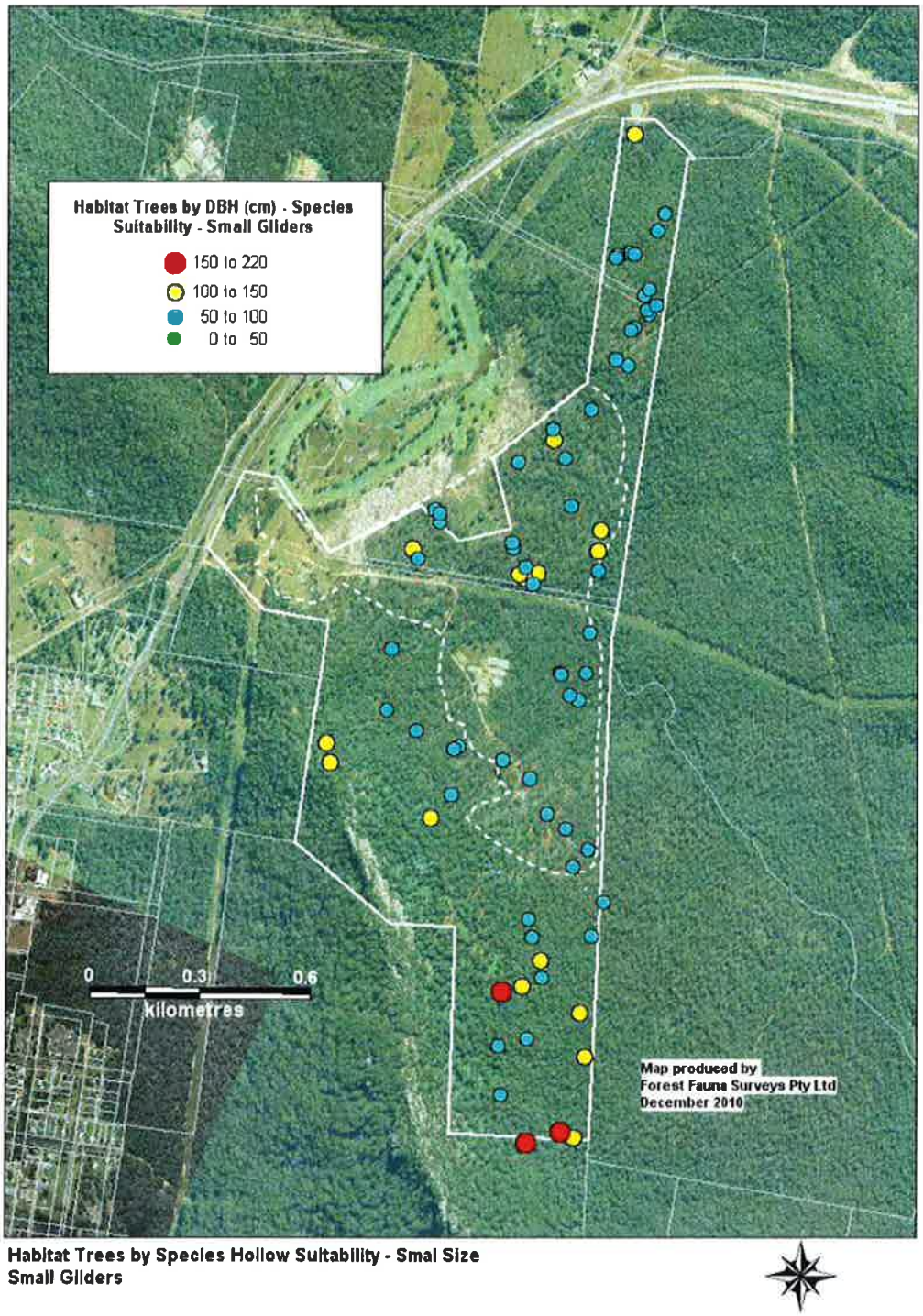

Figure 6- Distribution of Habitat Trees by Small Hollows (Gliders), Bulahdelah

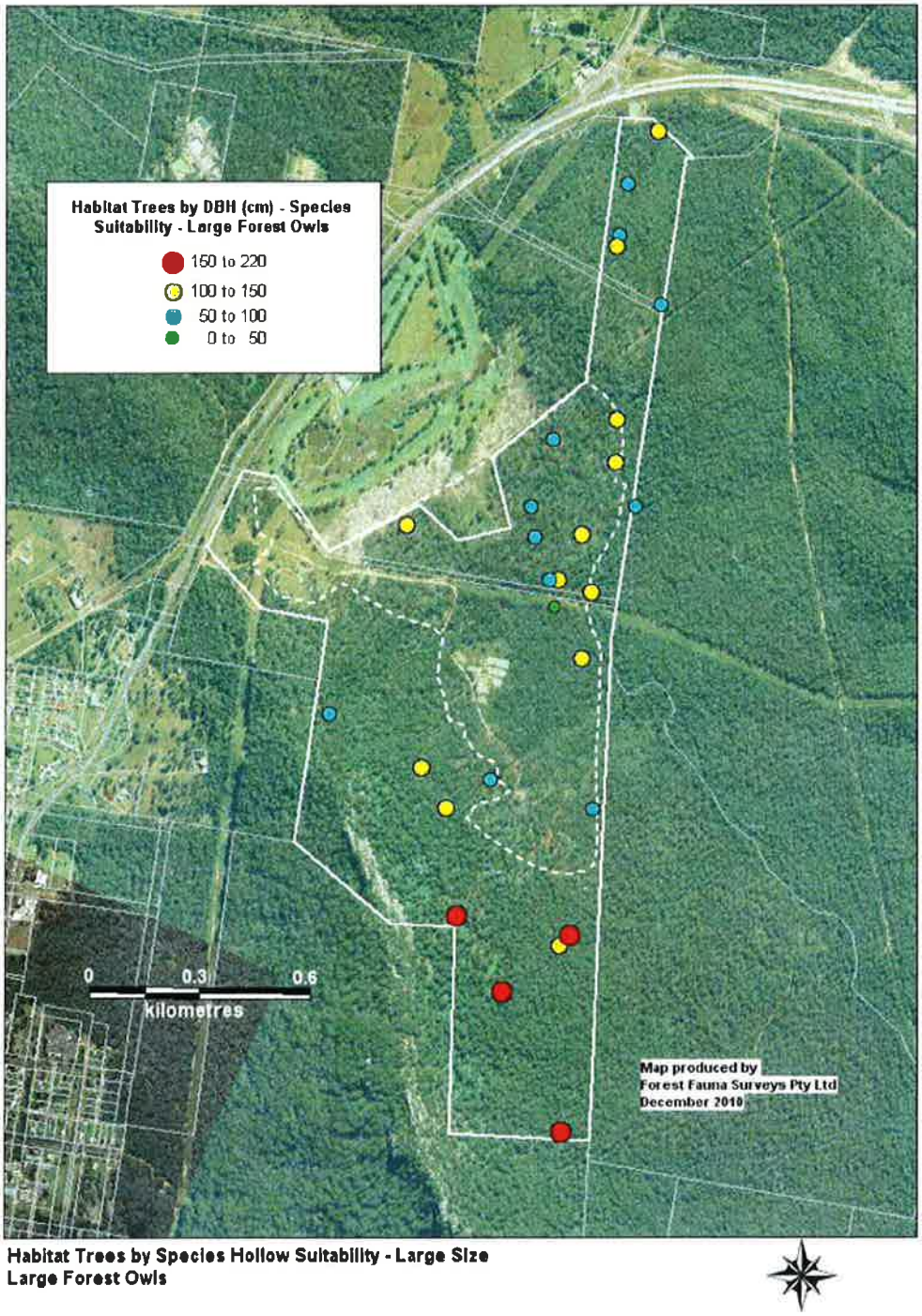

Figure 7- Distribution of Habitat Trees by Very Large Hollows (Large Forest Owls), Bulahdelah

Overall the subject site contains a low abundance of habitat trees. The highest number of assessment plots scores a habitat tree abundance of less than 5 per hectare. Smith and Murray (2003) found that abundance and diversity of possums and gliders was strongly correlated with abundance of natural tree hollows.

The distribution of habitat trees across the subject site, based on counts at each habitat assessment point, is presented above in Figure 5. The map detail shows that the higher densities of habitat trees are situated in the lower elevated parts of the subject site, particularly the low lying forest in close proximity to Fry's Creek. In contrast, the upper slope of Alum Mountain has been extensively logged and supports only a low distribution of habitat trees.

The abundance of habitat trees was also recorded by actual counts over an area of 143 hectares. A total of 192 habitat trees were recorded resulting in an average abundance of 1.34 habitat trees per hectare, which is considered very low. This confirms the previous assessment of low abundance of habitat trees recorded by the point habitat assessment counts mentioned above.

The basis of individually locating each habitat tree is to assess its physical characteristics for particular fauna groups. Habitat tree quality is expressed by a number of figures indicating the following:

- Size of habitat tree expressed as dbh (diameter at breast height) in centimetres;
- Number of total hollows;
- Number of habitat trees with hollows and fissures containing small openings suitable for microbats;
- Number of habitat trees with hollows containing small openings suitable for small gliders;
- Number of habitat trees with hollows containing medium sized openings suitable for possums and larger birds (i.e. cockatoo's), and
- Number of habitat trees with hollows containing large to very large openings suitable for birds such as large forest owls.

Based on dbh size classes, a summary of the number of habitat trees in each size class is summarised below in Table 4.

Table 4 – Habitat tree size class expressed as dbh for the total site area

	Habitat tree size class				
Size (cm)	**0-50**	**50-100**	**100-150**	**>150**	**TOTAL**
No.	4	137	45	6	192
Proportion (%)	7.1	71.3	23.4	3.2	

The distribution of potential habitat trees for possums, glider and microchiropteran bats occur widely across the subject site, but in contrast, the distribution of potential hollows for large forest owls is more restricted, with a small cluster (5 trees) north of Fry's Creek (see Figure 4), a group of 13 potential trees in the central portion (see Figure 7) and a group of 10 trees in the southern portion of the subject site (see Figure 7). None of the potential habitat trees exhibited recent evidence of use by large forest owls, such as whitewash and

regurgitation pellets, in proximity to the trees. No calls of large forest owls were heard on the subject site during the nocturnal searches for this survey of the subject site. However, a Powerful Owl was heard during a previous survey in 2009 and a dead individual was located in proximity to Fry's Creek (Clarke Dowdle & Associates, 2010b).

6.3 Specialised tree hollow assessment for micropteran bats

The majority of Australian vespertilionid bats are naturally tree roosting species, although manmade structures such as buildings and bridges are also commonly used. Three threatened tree roosting species have been recorded within or near to subject land (Yellow-bellied sheathtail bat, East-coast freetail bat and Greater broad-nosed bat). The Large-footed myotis has been possibly recorded foraging over the yabbie dams as well as other parts of the property and is known to roost in tree hollows as well as caves tunnels, bridges and culverts.

Ecotone Ecological Consultants (2011) improved the habitat assessment for micropteran bats. In order to identify areas of roosting habitat, the distinct patches of forest on the subject land were traversed on foot, predominantly using existing vehicle tracks. The abundance of hollow bearing trees, suitable for microbats, was estimated for each patch so that a crude quality ranking could be applied. A quantitative assessment of the number of hollows was not carried out given the large size of the study area and poor access to parts of the property, however, estimates of the number of hollows per hectare at sites across the property for the squirrel glider study (Forest Fauna Surveys 2010) have been used to assist in the assessment.

A convenient transect line following a communication easement was traversed, starting from the main forestry road to the east of the property (Sams Road) and finishing at the transmission line easement (Figure 8). This allowed a comparison in the quality of habitat between the adjoining State Forest and the subject land. The State Forest to the east of the forestry track had been recently been heavily logged with only scattered young trees remaining. The existing forest to the west of the forestry track consists mainly of small stems (<40cm DBH) and few hollow bearing trees were observed. The number of hollow bearing trees increased on the lower slopes and into the subject land where the forest was more open. Large, mature hollow bearing trees were noted to be common along the edge of the riparian habitat of Fry's Creek (see Figures 4 & 7).

Based on the assessment, the best potential roost habitat occurs in the east of the property, north of the transmission line. Although fewer hollow bearing trees occur within the forested upper slopes of Alum Mountain, this area is considered to be good roosting and foraging habitat for microbats as a result of the taller trees and open canopy.

6.4 Specialised cave assessment for micropeteran bats

The northern section of Alum Mountain, particularly within the subject property was assessed by two observers on the 15 October 2010 for potential bat roosts. Accessible caves and fissures were searched for the evidence of bat use, mainly by direct observation of individuals or by the presence of guano. Some large caves on the eastern side of the mountain could not be accessed as specialist climbing equipment and expertise would be required. Although several potential roost sites were observed, evidence of bat use was only observed within two shallow dome shaped caves. Small piles of guano were noted in a cave near the base of the eastern side of the mountain (WGS 426876E 6414303N +/- 11m) and two eastern horseshoe bats and guano were observed in a small cave on top of the

mountain approximately 350m south of the above GPS location. Both of these caves and other served caves and fissures could also be potentially used by the threatened Eastern cave bat and Large-eared pied bat however it is unlikely that they would used by the bent-winged bats. The large caves not accessed appear to be too open to provide roost sites however if deeper and darker tunnels and side caves are present then potential roost sites could occur. The known bat roost at the southern end of Alum Mountain could not be inspected as the access road has been closed for the construction of the Bulahdelah By-pass and an alternative route could not be found.

Based on previous observations and this assessment, the Eastern horseshoe bat appears to permanently roost and breed at several locations at Alum Mountain and the Eastern and Little bentwing bats are known to at least periodically use the old mine workings at the southern end of the mountain. Although no records could be found of the Eastern cave bat and the Large-eared bat actually roosting on the mountain, potential roost sites for these species occur. Although the Large footed myotis is known to roost in caves, tunnels, culverts and bridges, it is considered unlikely to roost in the elevated dry tunnels of Alum Mountain as known roost sites are generally situated over or near to permanent water.

All of the habitats surrounding the mountain provide potential foraging habitat for cave roosting bat species. Even the open grazing land would be used at least the Eastern bent-wing bat whereas the other species would be more likely to forage within or along the edge of the open forests and woodland. The old yabbie ponds provide a focal point for bat activity in that they provide access to water as well as flying insects. The Large-footed myotis would be particularly attracted to the open water areas as they are known to forage on both aquatic and flying insects as well as small fish, which are scooped from the water surface by large curved claws on the hind feet.

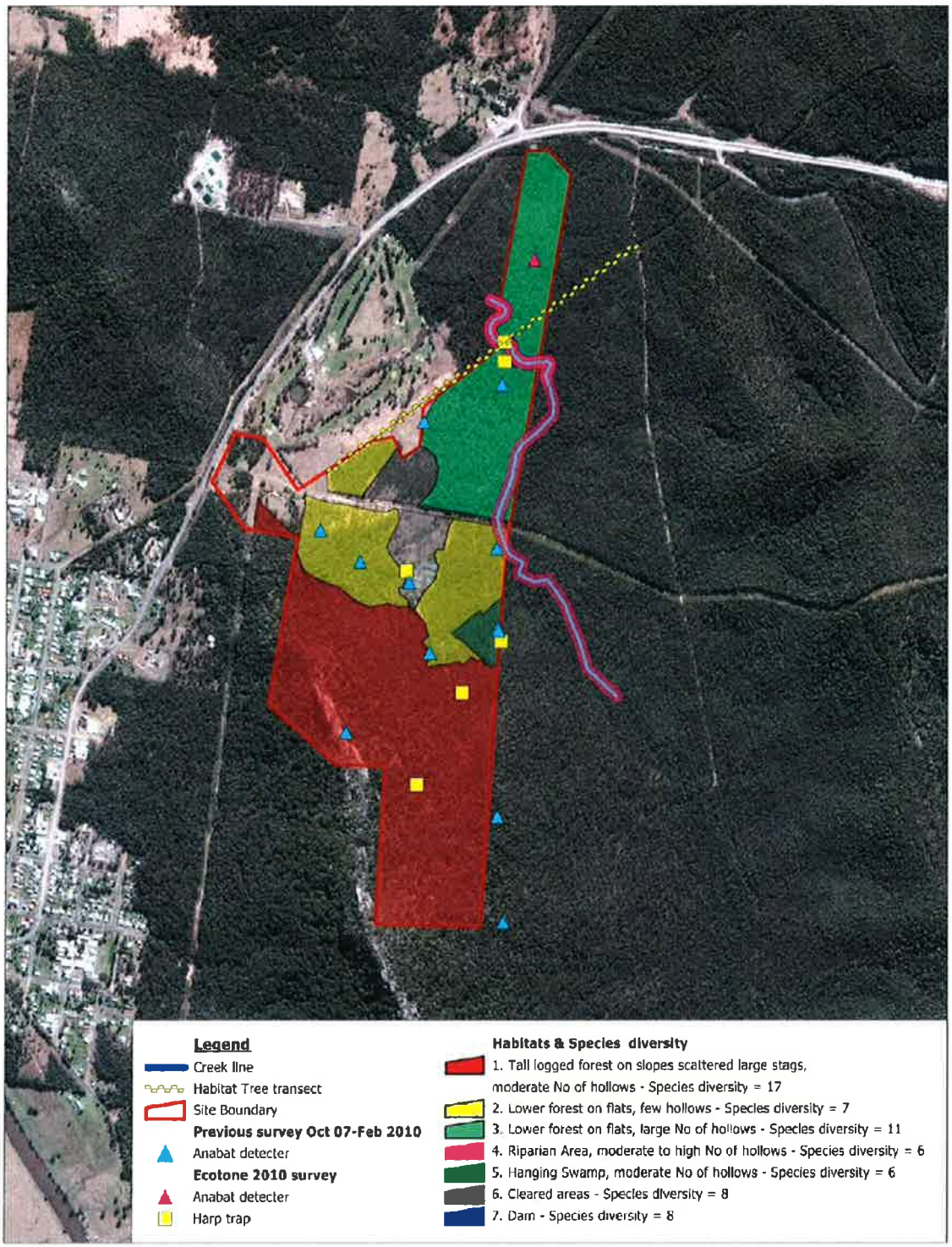

Figure 8 – Survey site locations, species diversity, tree hollow abundance by habitat types (Source: Ecotone Ecological Consultants)

7.0 SQUIRREL GLIDER HABITAT ASSESSMENT

7.1 Initial assessment

Normal procedure for the LES requires a radio tracking study for Squirrel Gliders but as a result of discussions between the client and Great Lakes Council and a further meeting held at Council it was decided that a Squirrel Glider habitat assessment should be undertaken instead but as a trial procedure. This initial procedure utilized the method from the Squirrel Glider Study of Wyong Shire Council (Smith, 2002), which outlines the known resources utilized by Squirrel Gliders, remnant patch size, shape and the density and diameter at breast height of trees with hollows. Forest Fauna Surveys (2011) also state that a winter source of exudate (nectar, sap or gum) appears to be critical for persistence of squirrel glider populations and in fact winter flowering *Banksia sp.* are known to be a particularly important foraging resource for gliders and other nectarivores because they generally flower reliably ever year and provide a source of both energy and protein when other food resources (insects, gums and saps) are less abundant. This study also notes that Sharpe and Goldingay (1998) reported that foraging on *Banksia* spp accounted for 45% of all feeding observations of the squirrel glider at Bungawalbin Nature Reserve on the NSW north coast and significant correlations were also found between the abundance of *B. spinulosa* and number of squirrel gliders on the central coast of NSW (Smith and Murray, 2003). Other foraging resources include the gum from bipinnate *Acacia sp.* and sap from trees such as Red Bloodwood *Corymbia gummifera*. The occurrence of squirrel gliders in Sydney Peppermint *Eucalyptus piperita* forests (0.30animals/hectare) in the Wyong and Lake Macquarie regions was due to the presence of *Acacia irrorata ssp irrorata* in the dense understorey. Smith and Murray (2003) found no correlation however between squirrel glider density and the abundance of known eucalypt sap feed trees. Pink bloodwoods *Corymbia intermedia* were incised for sap in autumn and winter by squirrel gliders at Bungawalbin (Sharpe and Goldingay1998) and Red Bloodwood *Corymbia gummifera* is known to be scarred by squirrel gliders in the lower Hunter region. Smith and Murray (2003) also identified that forest types with an understorey containing *Banksia sp.*, bipinnate *Acacia sp.*, *Xanthorrhoea sp.* and trees including Swamp Mahogany and Red Bloodwood, scored the highest habitat quality for the Squirrel Glider on the Central Coast of NSW.

Details and procedures from this study and data gathered from surveys from this current project, particularly winter flowering resources (Table 5), were combined to produce a survey proforma to assess each vegetation unit for the presence of resources utilized by Squirrel Gliders. The assessment sheets are presented in Appendix 15. This information could be combined with any further Squirrel Glider trapping results.

Table 5 – Table showing Squirrel Glider resources over winter (adapted from Smith, 2002)

NECTAR AND GUM PRODUCING SPECIES	J	F	M	A	M	J	J	A	S	O	N	D
Eucalyptus robusta												
Eucalyptus fergusonii subsp. fergusonii?												
Banksia spinulosa												
Banksia oblongifolia												
Banksia robur												
Callistemon pachyphyllus												
Callistemon salignus												
Acacia spp. (sap producing)												
Melaleuca linariifolia												
Melaleuca nodosa												
Melaleuca sieberi												

From the 28 quadrats undertaken for the assessment the results are summarized in Table 6 and shown on Figure 9. The results so far obtained show vegetation groups 2/1(Red Mahogany/Paperbark Swamp Sclerophyll Forest), 2/2 (Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland) and 3 (Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland) are more ideal for Squirrel Gliders than vegetation groups 4 (Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest) and 5 (Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest). Group 1 (Brushbox Stunted Forest Woodland) was not assessed due to its unsuitability for Squirrel Gliders.

At a finer scale the main keystone or critical food resources are found in Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland and Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland vegetation and this is one of the most important factors. Tree hollows, also a main characteristic, are also found in Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland and whilst hollows are not abundant in Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland vegetation although this vegetation adjoins Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland vegetation (Figure 4), where these resources are held.

Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland and Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest are larger in patch size but Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest vegetation does not support many hollows. Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland has abundant tree hollows. Tree hollow density is presented in Table 3.

If these details are correlated with Squirrel Glider captures by HWR, then 69% of animals were found in Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland and 23% found in Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest where suitable tree hollows were recorded in very low numbers. Furthermore, the critical winter food resources were found in the former vegetation community whilst these

resources are very poorly represented in the latter vegetation community. Therefore, further survey needs to be undertaken to gain a better understanding of their critical resources in Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest and the spatial distribution of tree hollows in Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland and Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest.

Figure 9 – Survey site locations used to record details of Koala and Squirrel Glider habitat assessment by Robert Payne and Clarke Dowdle.

Table 6 – Table showing Squirrel Glider Habitat Assessment

Plants per ha	**Group 2/1**	**Group 2/2**	**Group 3**	**Group 4**	**Group 5**	**Remarks**
Quadrats	6	1	10	8	3	
Angophora costata	37	Nil	100	15	Nil	sap, nectar & pollen
Eucalyptus robusta	8	175	Nil	Nil	16	sap, nectar & pollen
Eucalyptus fergusonii subsp. fergusonii	Nil	Nil	Low	Low	Nil	sap, nectar & pollen
Corymbia gummifera	Nil	Nil	2	Nil	Nil	sap, nectar & pollen
Melaleuca nodosa	≥300	Nil	≥62	Nil	≥166	nectar & insect bark food
Melaleuca sieberi	≥125	≥125	≥25	Nil	≥166	nectar & insect bark food
Acacia spp. (sap producing)	≥83	Nil	≥88	≥15	Nil	seeds & gum
Banksia spinulosa	≥21	Nil	≥75	Nil	Nil	nectar & pollen
Banksia oblongifolia	Nil	Nil	≥38	Nil	Nil	nectar & pollen
Banksia robur	Nil	≥375	Nil	Nil	Nil	nectar & pollen
Callistemon pachyphyllus	Nil	≥375	Nil	Nil	Nil	nectar & pollen
Callistemon salignus	Nil	Nil	Nil	Nil	≥250	nectar & pollen
Xanthorrhoea spp.	Nil	Nil	≥112	≥31	Nil	nectar & potential gum
Habitat attributes						
Remnant patch size	8.554	2.224	94.20	65.13	2.339	
Shape of patch	round	round	oval	oval	linear	
Trees with hollows/ha	25	25	20	Nil	8	
Overall quality for Squirrel Gliders	high	high	medium	low	low	

Notes for Table 6:

- Species which flower in winter.

The random quadrat method so far determined for the Squirrel Glider habitat assessment maybe applicable for winter flowering resources but it would not be applicable with respect to tree hollows. Whilst the numbers of trees with hollows/hectare have been determined adequately, Smith (2002) additionally states suitable hollows for Squirrel Gliders range between 4-15cm diameter. Further analysis of the data shows a very low count for these

sized hollows in all vegetation communities so the methodology for trees hollow counts should be revised. It is suggested that tree hollow counts be determined from parallel transects, spaced 20m apart, in each vegetation community.

7.2 Further habitat assessment

Further field assessment, as mentioned above, was undertaken by Forest Fauna Surveys (2011). This work involved recording the presence and densities of known foraging resources essential to the Squirrel Glider. A habitat matrix was then generated. Given the similar floristic composition that has been recorded on the Bulahdelah site, with that of the Central Coast of NSW, the vegetation may enable a direct comparison of habitat quality. Despite the absence of adequate Squirrel Glider trapping data in this study to assist in identification of preferred vegetation types on the subject site, the habitat assessment matrix was conducted specifically to determine distribution and abundance of preferred foraging resources for the Squirrel Glider. The habitat assessment determined presence and abundance of key food plants such as *Banksia sp.* in the understorey and occurrence of winter flowering eucalypt trees (such as Swamp Mahogany *Eucalyptus robusta*).

The findings of Forest Fauna Surveys (2011) within the subject site showed that the occurrence of bipinnate *Acacia sp.* and Red Bloodwood was very low, with only a small number of the habitat assessment plots scoring presence (refer to Figure 9 below). Only one *Corymbia gummifera* Red Bloodwood was found within the subject site containing sap incisions by small gliders. This tree was found in proximity to the yabbie dams in the central section of the subject site. Hairpin Banksia *Banksia spinulosa* and *Banksia oblongifolia* were restricted to dense concentrations on the low lying parts of the subject site within Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland (see also Figure 4 regarding vegetation communities). High quality habitat was also found to occur in Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest. These findings equate to the initial random quadrat surveys (see Section 7.1).

Overlaying the previous subject site Squirrel Glider records (trapped in 2006 by HWR) with the habitat matrix for the species, there is a strong correlation between the distribution of foraging resources and Squirrel Glider occurrence. There is also a high correlation between the distribution of habitat trees suitable for gliders and higher quality habitat and the previous presence of Squirrel Gliders. Based on the habitat matrix for the Squirrel Glider, the highest quality habitat is restricted to the central low lying portion of the subject site in Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland. In contrast, the slopes and summit of Alum Mountain provide marginal habitat for the Squirrel Glider, due to absence of suitable foraging resources.

8.0 KOALA HABITAT ASSESSMENT

8.1 Initial assessment

Potential koala habitat is defined as "areas of native vegetation where the trees of types listed in Schedule 2 of the SEPP 44 Policy and constitute at least 15% of the total number of trees in the upper or lower strata of the tree component". Schedule 2 of SEPP 44 lists eucalypt species which are primary koala food trees for the state of NSW. The relevant tree species that are found on the study site are:

- *Eucalyptus robusta* Swamp Mahogany
- *Eucalyptus microcorys* Tallowwood
- *Lophostemon confertus* Brush Box (does not constitute a dominant; see flora report)

Searches for scats and a SEPP 44 assessment were conducted by HWR on the 27 June 2006. Details of the location of each of these surveys can be seen in Figure 9. Further searches and an assessment were conducted by Kristan Dowdle and Robert Payne. This involved searches for scats within each of the botanical vegetation quadrats (n = 25 x

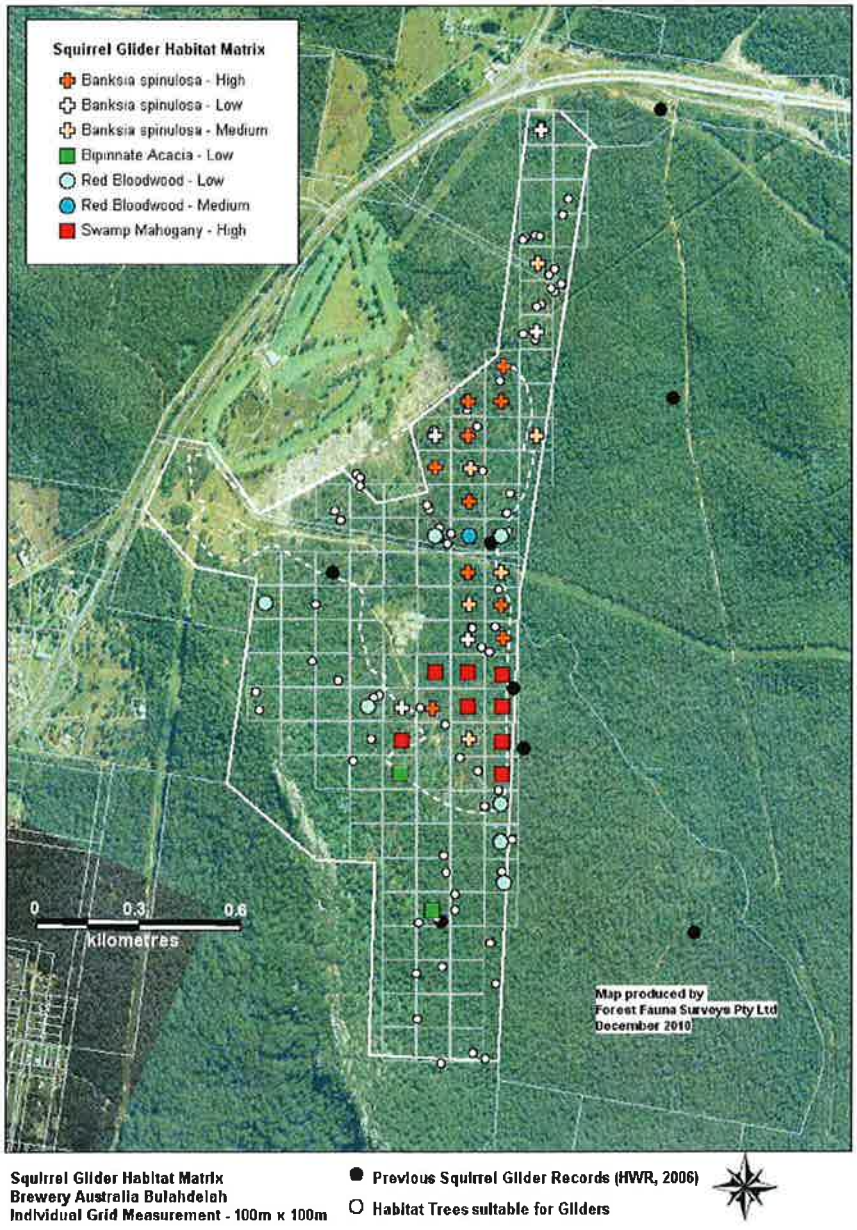

Figure 10 – Squirrel Glider Habitat matrix. Highest quality habitat occurs in Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland and Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest (see also Figure 3 for the location of vegetation types)

400m^2) initially, further searches as part of other surveys and a specific koala habitat assessment, involving further scat searches (n = 26 x 400m^2). The surveys involved the

spot assessment technique (Phillips and Callaghan, 2000) and recording DBH measurements and tree species counts in 26 quadrats of 400m^2 each over the site where primary koala tree species according to the SEPP 44 Policy and primary and secondary tree species according to the NSW Koala Recovery Plan were present (Figure 9). From these measurements stand importance values (SIV) based on relative density were calculated for each vegetation group to determine if potential koala habitat, under SEPP 44 is present.

Of the vegetation communities identified upon the site Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland, Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest & Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest vegetation all qualify as potential koala habitat under the SEPP 44 policy (Appendix 13). From the NSW Recovery Plan (NSW DECC, 2008) and using the method of Phillips (2000), Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland vegetation qualifies as primary koala habitat whilst *Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest* and *Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest* vegetation qualify as secondary koala habitat class A and secondary habitat class B respectively. Using the Callaghan method Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland vegetation also qualifies as primary habitat whilst *Red Mahogany/Paperbark Swamp Sclerophyll Forest*, *Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest* and *Smooth-barked Apple/Turpentine/Sydney Peppermint Riparian Tall Forest* vegetation all qualify as secondary habitat class A.

Core koala habitat was assessed through a combination of examination of historical records, targeted scat and scratch mark searches and spotlighting. Historical records of koalas exist to the north and west of the site, with only one record within or in close proximity to the site. Some scratch marks on gums were recorded which could have been koala; however, the only scats found beneath some trees were Common Brush-tailed Possum. No koala scats were found throughout the study area; spotlighting also failed to detect the presence of koalas. Discussions with the previous land owner did not identify the Koala as being present in the area, nor was the koala's presence found within the study conducted for the Bulahdelah Road bypass (Parsons Brinkerhoff, 2004).

Forest Fauna Surveys (2011) also found no evidence of Koalas during a subsequent site visit and during two previous surveys of the subject site. However, similar results were obtained from the previous surveys that suitable foraging habitat exists within the subject site to suggest its likely presence. Furthermore, several residents on the western side of Alum Mountain have occasionally heard male Koala's calling. Scats of Koala were found beneath Tallowwood trees near the new sewer treatment works near the subject site in 2008 (M. Murray, personal records), and there are several records of the species in close proximity to the subject site (DECCW Atlas records, November 2010). Habitat for Koala on the subject site was identified by presence of preferred food trees (*Eucalyptus robusta, E. saligna, E. microcorys, E. punctata* and *Lophostemon confertus* (Figure 9). However, the habitat characteristics given by (Forest Fauna Surveys, 2011) will need to be revised given that Koalas have been found to utilize other key eucalypt and other species. Such species relating to the subject site are *Eucalyptus resinifera, E. propinqua, Callistemon salignus* and *Melaleuca quinquenervia* (Callaghan et. al., 2011 and the Callaghan assessment table in Appendix 13).

Figure 11- Locations of owl survey stations, nocturnal transects and koala transects and quadrats carried out by the various surveys.

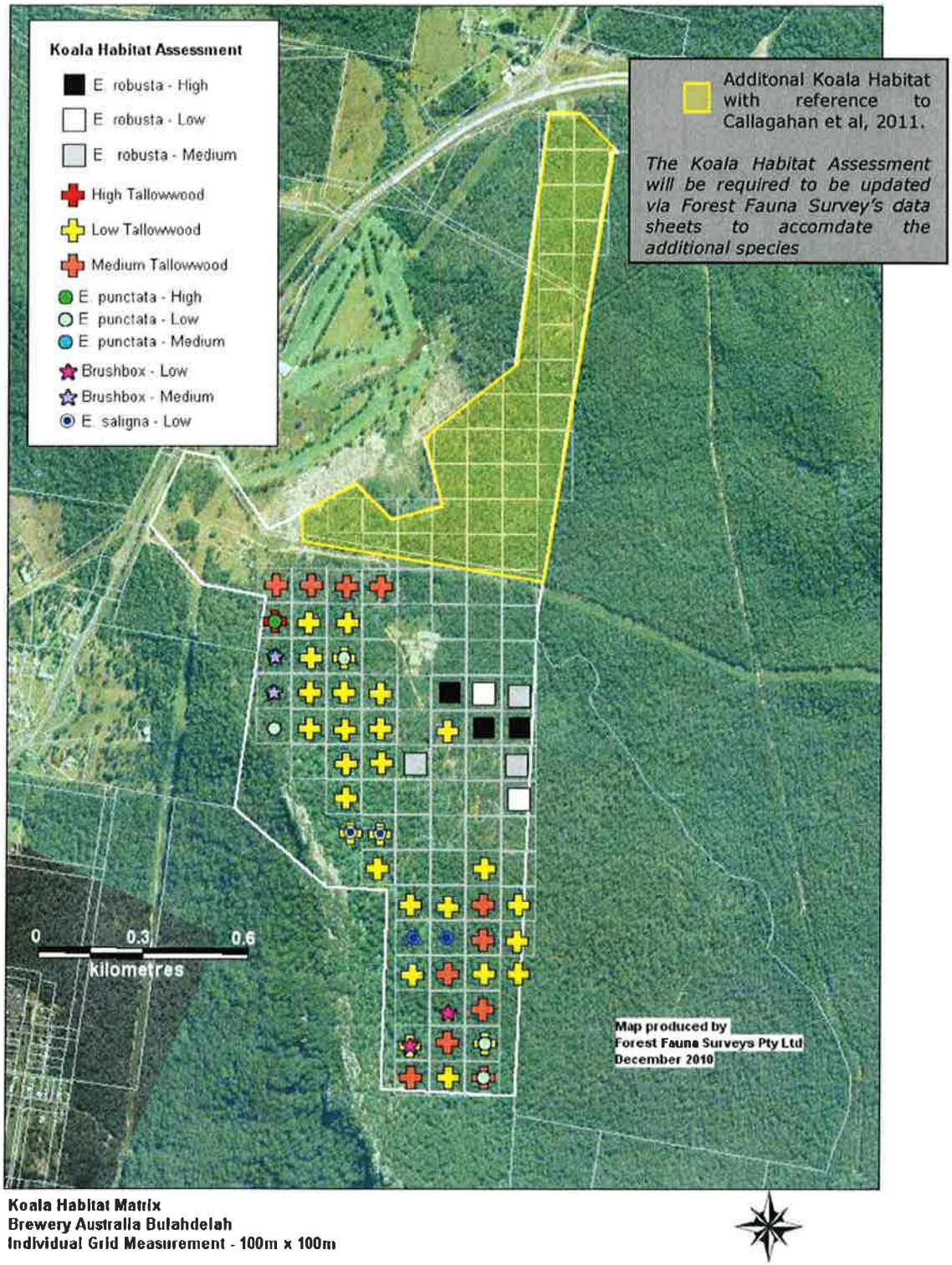

Figure 12-Koala habitat matrix for the subject site (Forest Fauna Surveys).

9.0 FAUNA SURVEY

The initial fauna survey information has been interpreted from the field notes of HWR Ecological dated June-July 2006 and whilst it has been undertaken to the best of our ability it may not be accurate. It is assumed that the survey at this time was undertaken according to the flora and fauna survey guidelines prepared by Murray, Bell & Hoye (2002) for the Central Coast-Lower Hunter Region. Following these earlier surveys additional fauna survey work was conducted by Robert Payne and Kristan Dowdle from 2006 to 2010, all of which is outlined in the following methodology and carried out according to the guidelines of Murray, Bell & Hoye (2002) in the early stages and NSW DEC (2004) in the latter stages. More recently, further specialist survey work was undertaken by Forest Fauna Surveys for Squirrel Gliders and by Ecotone Ecological Surveys for harp trapping.

9.1 Small mammal and arboreal mammal trapping

In total fifteen stations were established throughout the subject land by HWR Ecological as set out in Table 7. At that time the land north of Frys Creek had not been purchased by the proponent.

Table 7 – Small mammal and arboreal trapping details (HWR Ecological)

Station	Easting	Northing	Elliott A/B Terrestrial Trap nights	Vegetation Group	Elliott B Arboreal Trap nights	Pipe Arboreal Trap nights
1	427274	6414014	28 A	**3**	7	21
2	427516	641523	28 A	**4**	7	21
3	428018	6413987	28 A	**3**	7	21
4	427416	6415128	28 A	**3**	7	21
5	428160	6414768	28 A	**4**	7	21
6	426951	6415040	28 A	**4**	7	21
7	427593	6415561	28 A	**3**	7	21
8	427917	6416406	-	**4**	4	12
9	427690	6415878	-	**4**	4	12
10	428021	6415548	-	**4**	4	12
11	427351	6415040	-	**4**	4	12
12	427998	6414948	-	**4**	4	12
13	427484	6414701	-	**2/2**	4	12
14	427599	6416034	20 A	**2/1**	-	-
15	427474	6414617	20 A	**2/2**	-	-
Total Trap nights			**236**		**73**	**219**

Trapping was variable throughout the site with only seven stations (1-7, 14 & 15) used for ground mammal trapping. All stations, except for stations 14 and 15, were used for arboreal trapping, but the number of traps varied between stations 1-7 and 8-13. Trapping was undertaken between 21 June 2006 and 1 July 2006 with traps being closed on 24-28 June 2006 to allow mammals time to recover (see Figure 14).

In total 196 trapnights were achieved by HWR Ecological for small ground mammals with Elliott A traps and 40 trapnights for medium to large terrestrial ground mammals. Seventy three trapnights were achieved for arboreal mammals using Elliott B traps and 219 trapnights for arboreal mammals using pipe traps.

Forest Fauna Surveys (2011) repeated arboreal trapping for possums and gliders in 2010 using Elliott type B (15 x 16 x 45 cm) folding aluminium traps mounted on platforms attached to the tree trunk. Four survey sites were established within the subject site. Trapping site selection was based on a number of parameters:

- Each grid being located in major vegetation types mapped by Clarke Dowdle & Associates (2010a; Figure 4),
- Each grid was spatially separated from each other to ensure no re-captures from adjoining grids,
- Each grid was in close proximity to previous captures recorded in 2006 by HWR Ecological,
- Each grid was within habitat with suitable foraging resources for the species.

At each site, Elliott type B traps were mounted on trees at a height of 4.0 metres. Traps were established in a trapping grid configuration of 2 lines of 5 traps, with each trap spaced approximately 50 metres apart. The effective trap area of this grid configuration (i.e. 4.0 hectares), with a boundary strip of 45 metres wide is 2.0 hectares. Each trap grid was active for two consecutive nights in the first two sampling periods, and three consecutive nights in the third period, resulting in 280 arboreal trap nights for this study. Each trap was baited with a mixture of peanut butter, rolled oats and honey and the trunk of the tree adjacent to the trap sprayed with a mixture of water and honey to act as an attractant. The date of each trapping period is presented below in Table 8, and location of each trapping grid is presented in Figure 13.

Table 8 – Arboreal trapping details by Forest Fauna Surveys (2011)

Date	Trapgrid	Easting	Northing	Trapnights
2-4 Nov 2010 2 nights Abandoned following heavy rainfall on day2	1	427610	6415960	20
	2	427430	6415590	20
	3	427300	6414620	20
	4	427241	6414430	20
TOTAL SURVEY EFFORT=trapnights				**80**
15-17 Nov 2010 2 nights Abandoned following heavy rainfall on days 1 & 2	1	427610	6415960	20
	2	427430	6415590	20
	3	427300	6414620	20
	4	427241	6414430	20
TOTAL SURVEY EFFORT=trapnights				**80**
24-27 Nov 2010 3 nights	1	427610	6415960	30
	2	427430	6415590	30
	3	427300	6414620	30
	4	427241	6414430	30
TOTAL SURVEY EFFORT=trapnights				**120**
OVERALL SURVEY EFFORT = arboreal trapnights				**280**

Figure 13 – Location of Squirrel Glider trapping grids and spotlight transects (Forest Fauna Surveys).

Spotlight searches for the Squirrel Glider were undertaken by foot by Forest Fauna Surveys across the subject site for approximately 60 minutes on each of five separate evenings. Transects were located in proximity to each trapping grid with searches were conducted with a 55 watt spotlight, coupled with periods of quiet listening in darkness to detect any animal movements or vocalisations. Particular attention was paid to trees in flower as these provide a source of blossom and nectar for arboreal mammals such as gliders and bats such as the Grey-headed Flying-fox.

Spotlight searches were conducted on the evenings of Monday 6, Thursday 9, Monday 13, Tuesday 14 and Wednesday 15 September 2004. A total of 8.0 hours of spotlight searches was undertaken during the survey period. Two nights of spotlight searches were cancelled due to storms and rainfall (Tuesday 7 and Wednesday 8 September 2004).

Stag watching involves direct counts of active nocturnal animals emerging at dusk. The technique involves observers stationed beneath hollow bearing dead or living trees in a defined area and recording the identity and number of emergent animals following dusk for a period of about 40 minutes until complete darkness. This technique is useful as it provides an accurate measure of absolute abundance providing all individuals emerge following dusk, and all individuals in a population or group den in tree hollows (Smith *et al.,* 1989).

A peer review of the draft report asked whether the playback of pre-recorded calls of the Squirrel Glider was employed as a survey component for this study. This survey technique was not undertaken during this study because based on 20 years experience in conducting large scale surveys for the Squirrel Glider, Forest Fauna Surveys (2011) has only heard the Squirrel Glider vocalise on one occasion. This occurred in 1995 in response to repeated attacks by a Masked Owl near Charlestown in Newcastle. The only other instance of vocalisation by the species is when gliders are physically removed from traps. However, this threat vocalisation has only been heard on one instance in 1995. In contrast to the lack of Squirrel Glider vocalisation behaviour in the lower Hunter Valley and Central Coast, the Squirrel Glider is known to vocalise extensively in bushland remnants in Brisbane (David Sharpe, Southern Cross University, personnel communications).

The closely related Sugar Glider *Petaurus breviceps*, which also occurs on the subject site and will often vocalize as a form of communication between individual gliders. Their persistent "yapping" is often heard during nocturnal spotlight searches. No Sugar Gliders were heard during spotlight investigations for this study, but an individual was heard in November 2010 by Ray Williams, Robert Payne and Kristan Dowdle (Ecotone Ecological Consultants, 2011) during subject site investigations for microchiropteran bats. The Sugar Glider was also trapped on the subject site during the survey in 2006 by HWR Ecological.

9.2 Medium to larger ground mammal trapping

Twenty trap nights were achieved to target Bandicoots for each of the vegetation groups 2/1 and 2/2 with a maximum of two nights trapping after Bandicoot diggings were noted in these vegetation types for the first time. This trapping effort was undertaken by Robert Payne and Kristan Dowdle. Ten Elliott B traps were set out along one line through the two vegetation units and baited with a mixture of peanut butter, honey, rolled oats and sardines. The two lines of traps were set out by Robert Payne and Kristan Dowdle through the "hanging swamp" and "Swamp Sclerophyll Forest" communities from 16th to 18th February 2010 (see Figure 14 and Table 9).

9.3 Larger cage trapping

Wire cage traps were used by HWR Ecological to determine whether larger ground mammals were present. For the period (21-23 June & 28 June-1 July 2006) one wire cage trap was set out at stations 2, 4, 6 and 9 although at station 9 the trap was retained only between 28 June- 1 July 2006 (Figure 14). This provided 24 trapnights for cage trapping.

Table 9 – Survey details for medium to larger mammals

Date	Stations	Easting	Northing	Cage Traps (trapnights)	Elliott B Traps (trapnights)
June 2006	2	427516	641523	7	
	4	427416	6415128	7	
	6	426951	6415040	7	
	9	427690	6415878	3	
February 2010	13	427472	6414623		20
	14	427599	6416034		20

9.4 Micropeteran (Insectivorous) Bats

The survey for Micropeteran bats by HWR Ecological targeted six habitats on site in 2006 using Anabat detectors. Fourteen extra sites were targeted by Robert Payne and Kristan Dowdle between 2007 and 2010. As a result of the reconnaissance survey, there was a high focus placed on microbats due to the presence of caves on Alum Mountain and the substantial hollows present in the Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland vegetation (group 3). These habitats are set out in Table 10 and shown on Figure 14. Anabat II Detectors coupled to zero crossings audio interface modules were used, which is designed to detect echolocation calls of small bat species. The calls are transferred onto a card, which is then downloaded onto a computer for analysis. In each case the detectors were set out all night (sunset to sunrise) to capture the full complement of calls from the various microbat species.

Given the uncertainty of the presence of some of the threatened species identified by ultrasonic call analysis only, particularly the eastern cave bat, large-footed myotis and large-eared pied bat, a specialist bat trapping survey was carried out by Ecotone Ecological Consultants and aided by Robert Payne and Kristan Dowdle. Four harp traps were set for two nights and two extra traps for one night over the period 19-21 October 2010. The location of the traps is shown in Figure 8 & Figure 14. The traps were checked once during each evening and a hand held bat detector was in operation during the checking process of bats captured. One bat detector was set overnight in melaleuca forest at the northern end of the property as this area had not been previously surveyed.

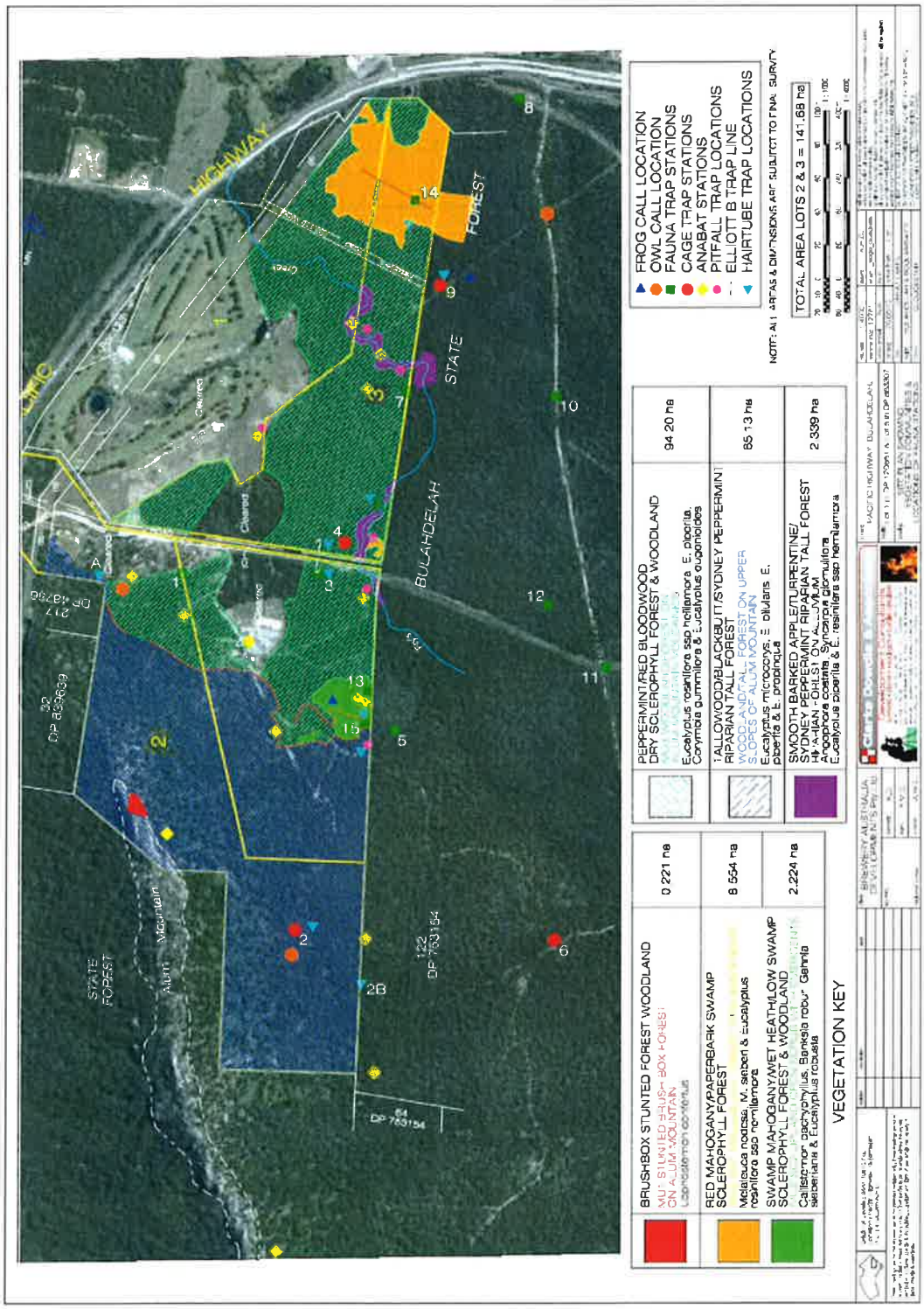

Figure 14 - Locations of small, large mammal terrestrial and arboreal stations and microbat stations.

In addition to the actual equipment surveys a habitat assessment was undertaken by Ecotone Ecological Consultants (2011). The northern section of Alum Mountain, particularly within the subject property, was assessed by two observers on the 15 October 2010 for potential bat roosts. Accessible caves and fissures were searched for the evidence of bat use, mainly by direct observation of individuals or by the presence of guano. Some large caves on the eastern side of the mountain (Photo 5) could not be accessed as specialist climbing equipment and expertise would be required.

In order to identify areas of roosting habitat, the distinct patches of forest on the subject land were traversed on foot, predominantly using existing vehicle tracks. The abundance of hollow bearing trees was estimated for each patch so that a crude quality ranking could be applied (Figure 8). A quantitative assessment of the number of hollows was not carried out given the large size of the study area and poor access to parts of the property however estimates of the number of hollows per hectare at sites across the property for the squirrel glider study (Forest Fauna Surveys 2010) have been used to assist in the assessment (Figure 15).

A convenient transect line following a communication easement was also traversed, starting from the main forestry road to the east of the property and finishing at the transmission line easement (Figure 8). This allowed a comparison in the quality of habitat between the adjoining State Forest and the subject land.

9.5 Nocturnal spotlighting surveys

Nocturnal surveys, using spotlighting techniques, were carried out by HWR Ecological each night from 19-21 June 2006 and from 27-29 June 2006. The surveys were confined to the power line easement, above the golf course, in the central cleared area and east of the mountain. A total of 15 person hours were undertaken.

Further nocturnal surveys were undertaken by Robert Payne and Kristan Dowdle on 12 July, 6 August, 30 August and 30 October 2007, 1-4 of December 2008, 16-18 of February 2010 and 14-16 July 2010. These surveys involved walking the access tracks throughout the entire site for at least one hour at each time (Figure 11). On the 30 October 2007 Robert Payne camped on the mountain all night to obtain additional information on nocturnal animals from calls. A number of additional species were identified. A 100 watt spotlight connected to a dry cell battery was used for spotlighting animals and a pair of binoculars was used to identify animals in trees where necessary. At least 48 person hours was involved to carry out these surveys.

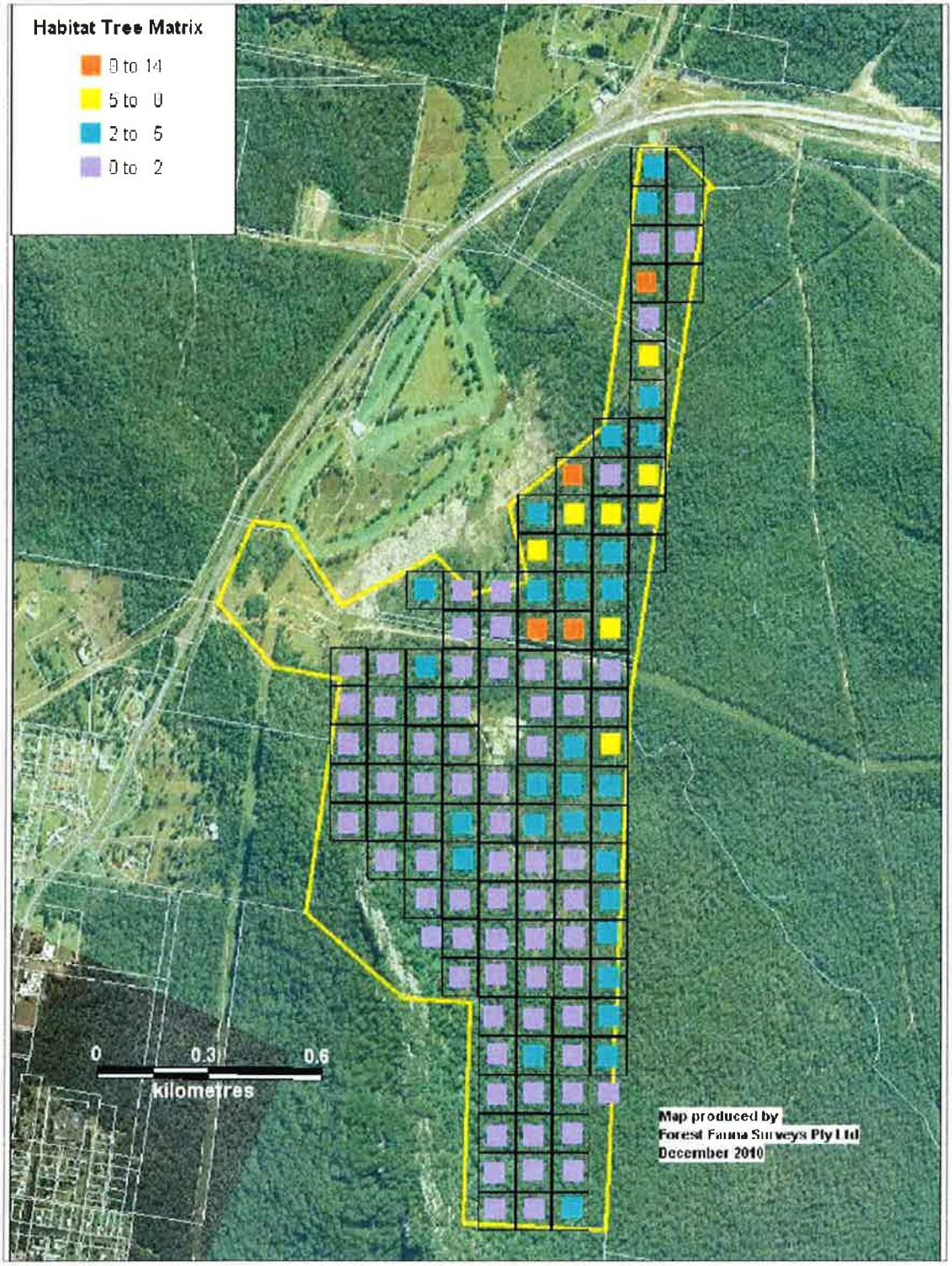

Figure 15- Tree hollow density matrix for the subject site.

9.6 Large owl, Bush-stone Curlew and other nocturnal mammal surveys

Large owl surveys were undertaken using the call playback method. This involves initial quiet listening and spotlighting and then playing back calls of the Barking Owl, Powerful Owl, Masked Owl, Sooty Owl and Grass Owl through a CD Rom and loudhailer system, connected either to a vehicle or dry cell battery. Normally the call is played and ten minutes is spent on quiet listening. The procedure is repeated for each owl species and at the end of the call procedure a further period of 30 minutes is spent on quiet listening.

Call playback was also conducted for the Squirrel Glider, Koala and the Yellow-bellied Glider.

For the Bush Stone-Curlew the short call is played through the CD Rom and loudhailer with thirty minute listening afterwards. This call procedure was repeated twice and was only undertaken above the golf course, being the only suitable habitat (see Figure 14).

Quiet listening was employed for other animal sounds such as the Grey-headed Flying Fox, the Australian Owlet Nightjar and the White-throated Nightjar.

Owl spotlight surveys were conducted from 19-22 and 27-30 June 2006 totalling 20.5 person hours by HWR Ecological. Robert Payne and Kristan Dowdle undertook further owl surveys, and other mammal surveys (Squirrel Glider, Yellow-bellied Glider and Koala) on 12 July 2007 from the lower slopes, 6 August 2007, 30 August 2007, 30 October 2007, 1-4 of December 2008, 16-18 of February 2010 and 14-16 July 2010 from various stations throughout the site (Figure 14), which involved a further 20 person hours. Specifically the latter survey was designed to target the Grass Owl and Masked Owl on the coastal plains and the Bush-stone Curlew surrounding the golf course.

Spotlight searches were also made for the presence of active macropods, particularly the Parma Wallaby in vegetation and along major and minor tracks within the subject site. Searches were also made whilst stationed in close proximity to the habitat trees (Forest Fauna Surveys, 2011).

An additional method of sampling for terrestrial mammal species, including the Parma Wallaby, included the use of remote infra-red motion cameras. Two cameras (HCO ScoutGuard SG550 and a Bushnell Trophy Camera) were installed at two locations and left in position for a period of 30 consecutive days (4 November to 10 December 2010). The selection of camera sites was based on evidence of previous records of the Parma Wallaby (Camera 1 near Yabbie Dams in central part of site) and suitable habitat for the species (Camera 2). The site selected for Camera 2 was a small clearing approximately half way up the eastern side of Alum Mountain, with tall clumps of native grasses in the clearing, and bordered by tall forest with dense ground layer vegetation comprising ferns and native grasses (see Figure 13). These cameras operate by detection of animal movement (motion) or infra-red (heat), effectively sampling both night and day at each site. Attractant baits (canned sardines and peanut butter / rolled oats balls) were set in the field of view of each camera to detect fauna species, particularly larger predators (Forest Fauna Surveys, 2011).

In view of the fact that the Parma Wallabies were seen at the one location feeding at dusk and at night Robert Payne documented and surveyed the habitat characteristics on the 13th April 2011.

9.7 Amphibians, Reptiles and the Eastern Pigmy Possum

The amphibian and reptile survey was undertaken by HWR Ecological as part of their nocturnal survey and a total of two person hours were spent searching for amphibians on the 21,22, 27 & 29 June 2006. Searches were made in appropriate habitats such as wet areas and alongside Frys Creek but the finer details are unknown.

Further nocturnal and daytime amphibian surveys were undertaken by Robert Payne and Kristan Dowdle on 12 July, 6 August, 30 August, 30 October 2007, 1-4 of December 2008, 16-18 of February 2010, 14-16 July 2010 and again on 28 July 2010 in all stratification units. These surveys involved walking the access tracks and Frys Creek throughout the entire site listening for calls of and identifying any amphibian or reptile species found and installing pitfall traps (see below). On the 30 October Robert Payne stayed on the mountain to obtain additional information on amphibians and reptiles. In February 2010 and July 14-16 & 28 2010 several hours in total were spent in the *Red Mahogany/Paperbark Swamp Sclerophyll Forest* (Group 2/1 vegetation) and the hanging swamp (Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland vegetation) during the middle of the day listening for calls of the Wallum Froglet *Crinia tinnula.* This was deemed a targeted survey. The conditions were both sunny in February and raining in July and the pock-marked undulations were filled with water. The Wallum Froglet can be detected in spring-summer as well as winter in sunny conditions or after heavy rain. An attempt was also made to determine the species presence using the revised technique of playback calls using a small speaker (NSW DECCW, 2009) at night, but surveying in the wet weather caused the equipment to malfunction. At least 20 person manhours were involved in this survey task as part of the nocturnal surveys (see Table 10).

Table 10 – Summary table for amphibian surveys

Date	Location	Persons
21,22, 27 & 29 June 2006	Frys Creek & wet areas	HWR Ecological
12 July, 6 August, 30 August, 30 October 2007	Traverses through all habitats	R.Payne & K. Dowdle
1-4 of December 2008	Traverses through all habitats	R.Payne & K. Dowdle
16-18 of February 2010	Traverses through all habitats	R.Payne & K. Dowdle
14-16 July 2010	Targeted survey for Wallum Froglet	R.Payne & K. Dowdle
28 July 2010	Targeted surveys for Wallum Froglet	R.Payne & K. Dowdle
February 2010	Targeted surveys for Wallum Froglet	R.Payne & K. Dowdle
July 14-16 & 28 2010	Targeted surveys for Wallum Froglet	R.Payne & K. Dowdle

Searches were also made throughout the site for reptiles. This involved traverses through all habitats on the same days, lifting debris including old fallen logs, rocks and other features in various areas within the site, specifically within each of the vegetation quadrats and generally throughout the site. Further searches were made on the summit of Alum Mountain searching amongst the rocky debris. A total of at least 20 person hours was involved as part of the botanical surveys and during general search and traverse procedures.

In addition to the above surveys four star-shaped pitfall traps were also installed in the Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland (Group 3 vegetation) to capture any small reptilian and amphibian species or the Eastern Pigmy

Possum. The location and details of the pitfall traps are detailed in Table 11 and Figure 14 and this survey involved 16 trapnights.

Table 11 –Pitfall trap survey details

Date	Location	Trapnights	Persons
1-4 December 2008	4 27 480E, 64 14 995N	3	R. Payne and K. Dowdle
	4 27 498E, 64 15 142N	3	R. Payne and K. Dowdle
	4 27 575E, 64 15 623N	3	R. Payne and K. Dowdle
	4 27 480E, 64 15 743N	3	R. Payne and K. Dowdle
16-17 February 2010	4 27 178E, 64 15 457N	2	R. Payne and K. Dowdle
	427483E, 641 4548N	2	R. Payne and K. Dowdle

The Eastern Pigmy Possum is difficult to trap. There is evidence of captures using small Elliott traps placed on the ground or attached to shrubs in the *Banksia spp.* understorey. Traps are baited with candied honey. However, as the Eastern Pigmy Possum spends a great deal of its time foraging on the ground, pitfall traps can be more successful although research is showing that it takes three years to provide data on Eastern Pigmy Possum populations using permanent nest boxes (Payne, 2009; 2010).

In view of these circumstances pitfall traps were used to target small reptiles, amphibians and the Eastern Pigmy Possum (Figure 14). Four pitfall trap stations were established with two sites in December 2008 and a further two sites in 2010. Pitfall traps and drift fences were installed (Photo 5) and each pitfall trap, 50 cm deep and 150 mm diameter, was inserted into a ground hole made with a soil auger. A floating base plate is inserted into the trap as a safety precaution during rainfall events. If the area becomes inundated and the trap fills with water, the base plate floats to the surface allowing any animal to escape. Traps were checked each morning.

Photo 5. Pitfall trap with three drift fences set out at an angle of 120°. Locating pitfall traps using high-powered GPS.

Pitfall traps can only be used on the coastal plain where the soil is deep and no shallow rock occurs. On the slopes they cannot be used because of rock at shallow depth.

9.8 Birds

Two strategies were adopted for the bird census by Robert Payne and Kristan Dowdle. These strategies were:

- Diurnal 30 minute censuses, which involves recording all bird species from calls and observations throughout a one hectare area one hour after dawn. Additional evening surveys were undertaken around and throughout the same survey quadrat. These surveys were undertaken in all stratification units (vegetation groups).
- Opportunistic detection, which involves recording of other bird species during other random traverses over a wider area of the subject site.

Bird surveys were conducted on 12 July, 6 August, 30 August and 30 October 2007, 1-4 of December 2008 and 16-18 of February 2010 involving 18 person hours.

9.9 Hair Tube Trapping, Scat Collection and Analysis

Ten hair tube stations were chosen throughout the project site to complete part of the mammal survey component and one large hair tube trap (faunatech) was set at each station on 16 July 2010 and were left insitu for 10 days giving a total of 100 trap nights (Figure 14). The traps were collected on the 28 July 2010 and the hair returns were sent away to Dr. B. Triggs for analysis.

Records of animal tracks and scats observed during the survey were also recorded randomly during other traverses but areas for this evidence are very limited given the highly vegetated nature of the site. Sand traps were considered for the track survey but given the vehicular traffic along the tracks the method was not adopted. These records are anecdotal being recorded along with other sections of the survey.

9.10 Climate

Temperature and relative humidity conditions during the surveys undertaken by Robert Payne and Kristan Dowdle were recorded using a "Tiny Tag" data logger. This equipment was housed in a "Stevenson Screen" and attached to a tree near the existing dwelling. The datalogger was set to record temperature and humidity at 15 minute intervals over the entire fauna survey periods in the field at the subject site. Rainfall events and high wind conditions were also recorded. Forest Fauna Surveys (2011) utilized data collected at the Nelson Bay weather station.

9.11 Summary

The fauna survey has been on-going since 2005 and in a disjunct manner caused by circumstances beyond the control of the proponent. In the earlier stages the survey was undertaken using the guidelines of Murray, Bell and Hoye (2002). In the later stages the guidelines of NSW DECC (2004) were used. However, not all components of the survey meet the NSW DECC requirements. This is because the coastal plain area was surveyed as part of the Stage 1, which was finalised well before the more recent guidelines came into force. Only the more elevated sections of the property were surveyed after the NSW DECCW guidelines were issued but there are still some shortcomings in the survey effort. This is not due to the need for survey effort but due to the economic circumstances during the later years.

Table 12- Summary of outstanding survey requirements

FAUNA COMPONENT	COMPLIANCE WITH NWS DECC REQUIREMENTS
Small mammal and arboreal mammal trapping	Now meets requirements
Medium to larger mammal trapping	An additional 80 trapnights in the both stratification units is still required to satisfy the requirements.
Larger mammal cage trapping	The guidelines require 24 trapnights in each stratification unit and at this point in time this survey component does not meet the requirements.
Hair-tube trapping	This survey update will require 50 large and 50 small hair tube traps for the entire site to meet the requirements.
Nocturnal spotlighting surveys	These surveys meet the requirements.
Large Owl, Bush-stone Curlew and other nocturnal mammal surveys	These surveys meet the requirements.
Amphibian and reptile surveys	The surveys meet the requirements.
Birds	The bird surveys meet the requirements
Microbats	The surveys meet the requirements.

10.0 RESULTS

10.1 Small Mammals

The results of the small mammal ground trapping component by HWR Ecological were as follows (Table 13).

Table 13 – Results of Small Mammal Ground Trapping

Species	*Rattus fuscipes*	*Rattus rattus*	*Antechinus stuartii*	*Antechinus flavipes*
Capture Rate (%)	11.73	1.02	6.12	1.53

The overall capture rate was relatively high for small mammals achieving 20.4%. The main species captured was the Common Bush Rat *Rattus fuscipes* but all species captured are common at a local and regional scale. The Black Rat *Rattus rattus* is an introduced species.

10.2 Arboreal Mammals

Table 14 presents the results for arboreal mammals. It is obvious there is a significant population of the Squirrel Glider *Petaurus norfolkensis* throughout the forest on the subject site and in the adjoining state forest based on the number of animals captured. The Squirrel Glider is listed on Schedule 2 of the *Threatened Species Conservation Act, 1995.* It is also very obvious the plastic pipe traps attached to trees are advantageous to trapping the smaller gliders over the stainless steel Elliott B traps. Overall the arboreal trapping was very successful achieving a net capture rate of 19.86%. The net capture rates for pipe and Elliott trapping are 16.43% and 3.42% respectively.

Given that the Squirrel Glider is the mammal of most concern being listed on the *Threatened Species Conservation Act, 1995*, the graph (Figure 16) shows stations 5, 9, 10 and 12 are the only areas that did not return captures. Stations 4 and 6 returned three and four captures (Figure 16) respectively, whilst the remainder of the stations returned two captures. Re-captures are not included in these figures.

The figures indicate that the Squirrel Glider is well and widely distributed throughout the subject site and beyond. It should be noted at this point that stations 8,9,10,11,5 & 6 are within Bulahdelah State Forest.

Table 14 – Results of overall arboreal mammal trapping (number of animals shown in brackets)

Species	***Petaurus norfolkensis***	***Petaurus breviceps***	***Antechinus stuartii***	***Antechinus flavipes***
Pipe Trap Capture Rate (%)	9.13 (20)	3.65 (8)	8.68 (19)	0.46 (1)
Elliott Trap Capture Rate (%)	-	1.36(1)	10.96(8)	1.37 (1)
Overall capture rate (%)	6.84	3.08	9.24	0.68

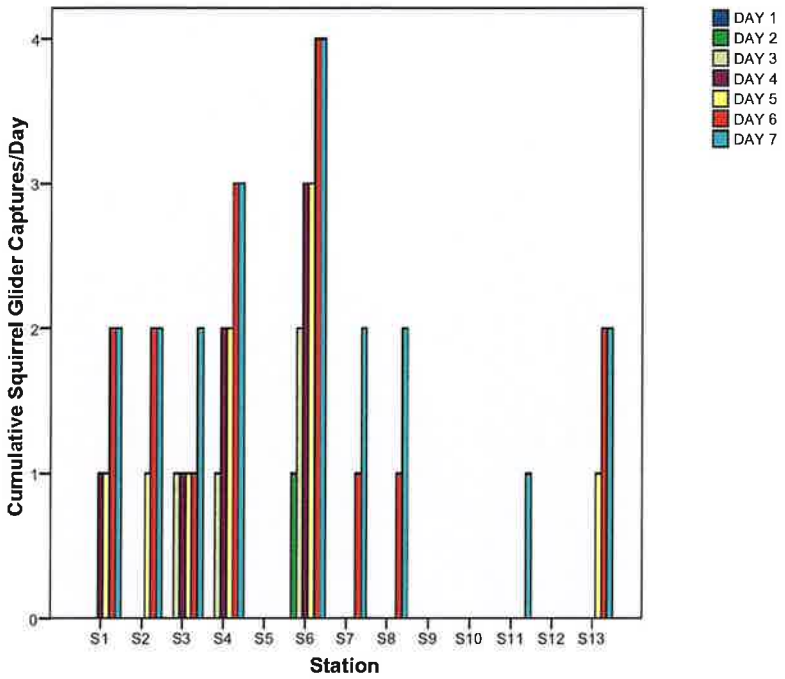

Figure 16 - Graphical representation of cumulative captures of Squirrel Gliders for each survey day. Stations 4 & 6 (Figure 14) have the highest captures.

An analysis of the figures for Squirrel Glider captures in winter reveal that the majority of captures in the known vegetation types are from Group 3 (Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland) with one capture each in Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland vegetation (Hanging Swamp) and *Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest* vegetation (Tall woodland/ forest on upper slopes). These figures only roughly correlate

with the Squirrel Glider habitat assessment which shows Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland to have the highest habitat qualities for the Squirrel Glider whilst Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland vegetation has medium quality habitat. Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest vegetation has the lowest quality habitat for Squirrel Gliders and no comparison can be made with Red Mahogany/Paperbark Swamp Sclerophyll Forest vegetation because no traps were set in this habitat (Table 6 and Figure 14).

The tree trapping survey conducted by Forest Fauna Surveys (2011) in late spring was interrupted by heavy rainfall which may have washed off the honey attractant which is sprayed onto the trees daily. Additionally, it is possible that heavy rainfall disrupts the normal foraging movements of the gliders, which together, limits the potential to capture individuals. As a consequence of the interruptions to the trapping program, the trapping survey was conducted over three consecutive nights rather than the original intent of 5 consecutive nights. Despite the shortened trapping survey period, no gliders were captured during each of the three surveys involving 280 trapnights. In comparison to the previous survey conducted in 2006 by HWR Ecological, at least 20 gliders were captured for a survey of similar survey effort (292 trap nights).

Spotlight searches were also conducted over five evenings when no rainfall was encountered. Each spotlight survey concentrated on the trapping grid area plus adjoining forest area for a total of approximately 8.0 hours in total. No evidence of any arboreal mammal species was detected by spotlight searches, despite targeting suitable forest areas. Weather conditions were good during the spotlight searches and did not appear to influence the ability to detect arboreal possums and gliders. The absence of gliders or possums being detected by spotlight searches was surprising considering the subject site supports areas of high quality habitat, and the fact that at least 20 individuals were captured in 2006. However, the occurrence of possum species such as the Common Brushtail Possum was confirmed by trapping surveys and remote infra-red cameras during this survey.

Similar to the trapping and spotlight searches, no arboreal mammals were observed departing hollows by stag-watch observations.

In the Wyong Shire, Smith and Murray (2003) found that 45% of squirrel gliders were captured on the first night, which was a study directly comparable to this survey in the sense that identical survey personnel and methodology was utilized. If Squirrel Gliders were present on the subject site, it is considered that several individuals should have been captured for the survey effort of 280 trap nights.

The more recent survey was conducted in spring whilst that of HWR was conducted in winter. During winter the nectar food resources for the Squirrel Glider from *Eucalyptus robusta, Banksia spinulosa* and *Banksia oblongifolia* are far more plentiful and the population may roost near these resources. In spring and summer, when these resources are not available the population may move elsewhere where alternative resources are more plentiful (e.g. within the state forest).

The Clarke Dowdle & Associates report (2010b), suggested the subject site supports a highly significant local population of the Squirrel Glider based on numbers of individuals. However, upon review of the original site trapping data, the capture rates indicate the subject site is comparable to sites in Lake Macquarie and Wyong LGAs', and below those recorded at other localities such as Port Macquarie, Brisbane and central Victoria. A comparison of trap success rates between the various study areas is summarised below in Table 15 (Forest Fauna Surveys, 2011).

Table 15- Comparison of Squirrel Glider trap rates between sites

Author	Location	Trap success rate (%)
HWR (2006)	Brewery Australia Land, Bulahdelah	8.4
Quin (1995)	Limeburners Creek, Port Macquarie	16
Smith and Murray (2003)	Lake Macquarie, Wyong LGA's	6.0
Menkhorst *et. al.* (1988)	Victoria	3.3
Sharpe & Goldingay (2010)	Brisbane, Queensland	19.0
Van der Ree (2002)	Euroa, Victoria	26.0

It should also be noted that the HWR survey used a combination of pipe traps and Elliott B traps and returned captures only in the former. Forest Fauna Surveys (2011) also only used Elliott B traps which did not return captures by HWR Ecological.

Forest Fauna Surveys (2011) suggests the likely cause for absence of Squirrel Glider by trapping in the 2010 survey is the recent fire of 2006 and this is generally agreed by all the ecological personnel involved with the project. Overlaying the 2006 Squirrel Glider records on the fire matrix (Figure 17) indicate all records of the species occur in areas that have been subsequently burnt. It is known that the fire occurred following the 2006 trapping survey rather than pre-ceding it. This may have strongly influenced the absence of Squirrel Glider records on the subject site during this survey.

Quin (1995) found that fire caused abandonment of home ranges by Squirrel Gliders at his site at Limeburners Creek near Port Macquarie. However, on the Central Coast and Lake Macquarie fire did not result in abandonment of home ranges, but lower reproductive success was observed (Smith and Murray, 2003). Sharpe and Goldingay (2010) monitored a Squirrel Glider population which exhibited a sharp decline in abundance over a 6 year period. The variation in abundance of this population occurred because the floral resource the Squirrel Glider relies upon undergoes substantial inter-annual variation driven by local climatic factors (Sharpe and Goldingay, 2010). Trees that flowered heavily in the initial years of the Brisbane site did not repeat this flowering intensity in subsequent years.

Despite the absence of Squirrel Glider trapping data in this study to assist in identification of preferred vegetation types on the subject site, the habitat assessment matrix was conducted specifically to determine distribution and abundance of preferred foraging resources for the Squirrel Glider. The habitat assessment determined presence and abundance of key food plants such *Banksia sp.* in the understorey and occurrence of winter flowering eucalypt trees (such as Swamp Mahogany *Eucalyptus robusta*). Smith and Murray (2003) identified that forest types with an understorey containing *Banksia sp.*, bipinnate *Acacia sp., Xanthorrhoea sp.* and trees including Swamp Mahogany and Red Bloodwood, scored the highest habitat quality for the Squirrel Glider on the Central Coast of NSW. Similar floristic composition was recorded on the Bulahdelah subject site to enable direct comparison of habitat quality.

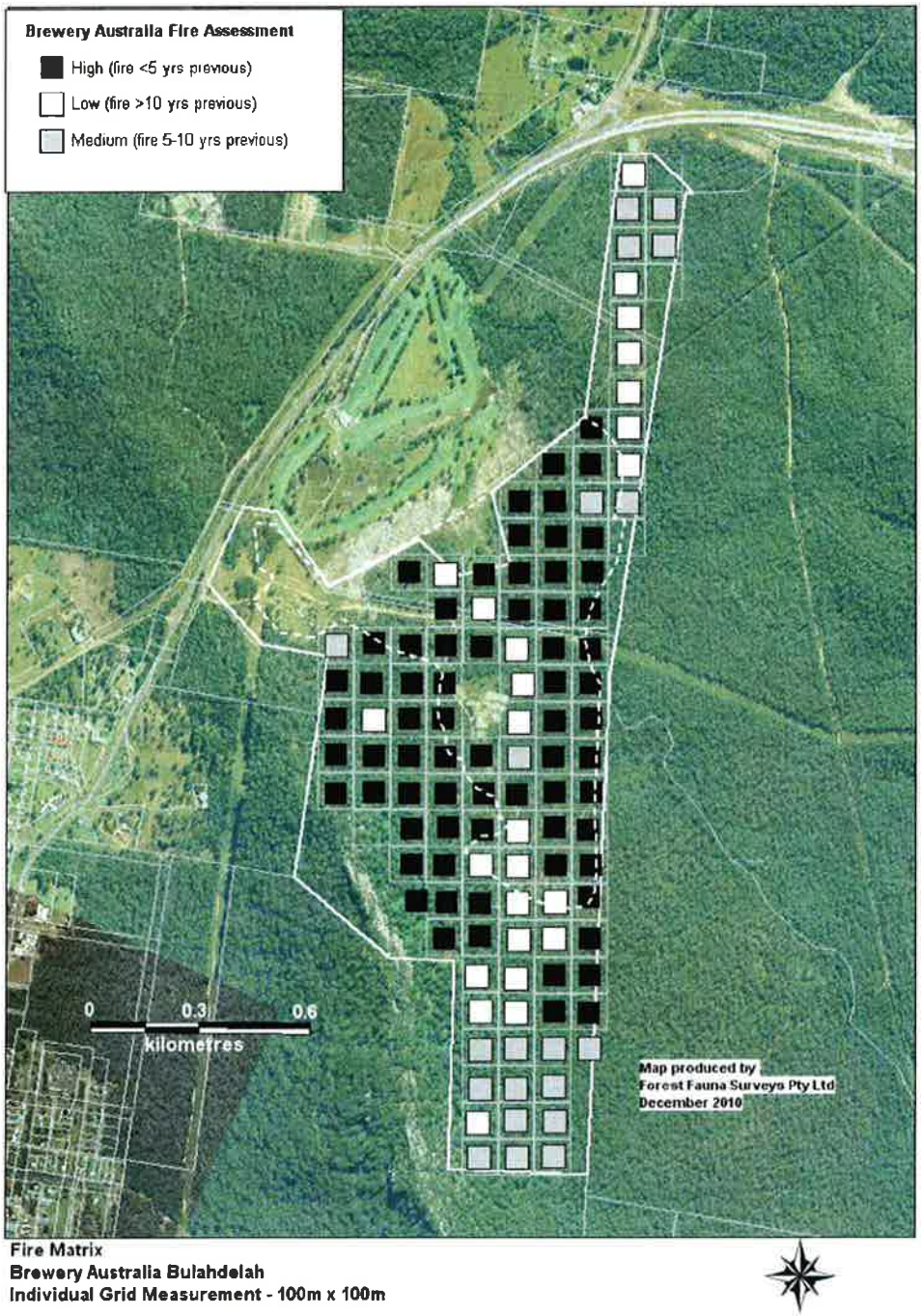

Figure 17. Fire Frequency, Brewery Australia Site, Bulahdelah

10.3 Micropeteran Bats

Micropeteran bats recorded for the subject site between 27 and 30 June 2006, 30 October 2007, 1-4 of December 2008 and 16-18 of February 2010 are given in Table 17. Three species were recorded in winter, which are the Little Bent-wing Bat, *Miniopterus australis*, the Common Bent-wing Bat, *Miniopterus schreibersii oceanensis* and the Chocolate Wattled Bat, *Chalinolobus morio*. Both of the bent-wing bat species are listed on the *Threatened Species Conservation Act, 1995*. Given the times of the recordings it is suggested that the bats would roost close by and that site would be the caves of Alum Mountain.

With respect to the bat call analysis some small bat species have distinctive echolocation calls, which are unlikely to be confused with other species. Other species overlap in call frequency and structure, making identification problematic in some cases. The degree of confidence attributed to call identification will depend on the quality of the call as well as the activity of the bat at the time of recording and its direction of flight. However, echocall location procedures will obtain successful results and will determine more species than harp traps although harp traps will provide more positive identification.

In spring the results show the bent-wing bats have disbanded and a number of other bats are more common, especially the Eastern Cave Bat *Vespadalus troughtoni* and the Eastern Horseshoe Bat *Rhinolophus megaphyllus*. Fifteen microbat species are likely to be present based on calls, although a large number of calls only indicate the probability of a species being present. Overall there is a large diverse range of bat species around Alum Mountain and the spring surveys recorded a further five threatened species. These species are the Yellow-bellied Sheath-tail Bat, *Saccolaimus flaviventris,* possibly the Large-eared Pied Bat *Chalinolobus dwyeri*, the Eastern Cave Bat *Vespadalus troughtoni,* the Large-footed Myotis, *Myotis macropus* and the Eastern Free-tail Bat, *Mormopterus norfolkensis*.

Overall seven species are listed as threatened on the *Threatened Species Conservation Act, 1995*. These species are the Little Bent-wing Bat, *Miniopterus australis*, the Southern Bent-wing Bat, *Miniopterus schreibersii oceanensis*, the Eastern Cave Bat *Vespadalus troughtoni,* the Yellow-bellied Sheath-tail Bat, *Saccolaimus flaviventris,* the Large-eared Pied Bat *Chalinolobus dwyeri*, the Large-footed Myotis, *Myotis macropus* and the Eastern Free-tail Bat, *Mormopterus norfolkensis*. Some of the species recorded are addressed in the commonwealth action plan for bats (Environment Australia, 1999). These species are the Large-eared Pied Bat *Chalinolobus dwyeri*, the Large-footed Myotis, *Myotis macropus* and the Eastern Free-tail Bat, *Mormopterus norfolkensis*.

Ecotone Ecological Consultants (2011) states that of the threatened species identified by call analysis, it should be possible to positively identify the Little bent-wing bat, the East-coast freetail bat, the Large-eared pied bat and the Yellow-bellied sheathtail bat, provided that the calls are of good quality and a long call sequence is obtained. The remaining three species, the Eastern bent-wing bat, the Large-footed myotis and the Eastern cave bat can be easily confused with other species. Non-threatened species that are difficult or impossible to identify are the long-eared bats (virtually impossible to separate to species level) and members of the genus, which demonstrate significant regional changes to the characteristic end frequency value of the call sequence. In addition the characteristic frequency can overlap and the shape of the pulse can change, sometimes making positive identification to the species level impossible. Therefore, the list of species shown in Table 18 may contain some inaccuracies even though it is not impossible for these species to occur.

The most glaring omission from the list is that of the Little forest bat and the Eastern forest bat. Both these species are expected to be common within the subject lands and as their call frequencies can overlap with the Eastern cave bat it is considered to be highly likely that

most (if not all) of the calls attributed to the Eastern cave bat are in fact those of the Little forest bat. Having said this it is not impossible for the Eastern cave bat to occur as suitable roost sites for this species are available on Alum Mountain.

With regards to the long-eared bats, only Gould's long-eared bat is listed in Table 17. As it is currently impossible to differentiate between the lesser long-eared bat and Gould's long-eared bat, the calls should not have been attributed to a species level. In addition it is often difficult to distinguish between long-eared bats and the Large-footed myotis and therefore some calls may have been attributed to the wrong species. As the Large-footed myotis primarily forages over open water and is rarely captured in forested environments away from water it is possible that most calls recorded in forested areas and attributed to this species are actually those of a long-eared bat species.

Although known to occur at Alum Mountain, the Eastern bent-wing bat calls can be confused with the large forest bat, a species which has been recorded in the study locality and could occur within the subject lands. Despite the uncertainty of the identity of some species shown in Table 17 the species diversity recorded for each of the habitat types may still be valid although the species composition is likely to be inaccurate.

Normally, the timing of the survey in late October would be ideal for bat activity, however a cool change over the survey period resulted in very low bat activity. Despite this, four species were caught, enabling the positive identification of species difficult to identify via bat call analysis (Little forest bat *Vespadelus vulturnus*, Gould's long-eared bat *Nyctophilus gouldi*, Lesser long-eared bat *Nyctophilus geoffroyi* and the Chocolate wattled bat *Chalinolobus morio*). A fifth species, Gould's wattled bat *Chalinolobus gouldii* was recorded via the bat detectors.

Table 16 – Harp trap results

Date	**Trap No.**	**Location**	**Species**
19-20th October 2010	1	Yabbie ponds	nil
	2	Hanging Swamp	nil
	3	Tall forest track	*Vespadalus vulturnus; Nyctophilus gouldii*
	4	Tall forest track	*Vespadalus vulturnis; Chalinolobus morio*
20th -21st October 2010	1	Yabbie ponds	*Vespadalus vulturnus*
	2	Hanging Swamp	nil
	3	Tall forest track	*Nyctophilus gouldii;Nyctophilus geoffroyi*
	4	Tall forest track	nil
	5	Frys Creek	nil
	6	Edge riparian area	nil

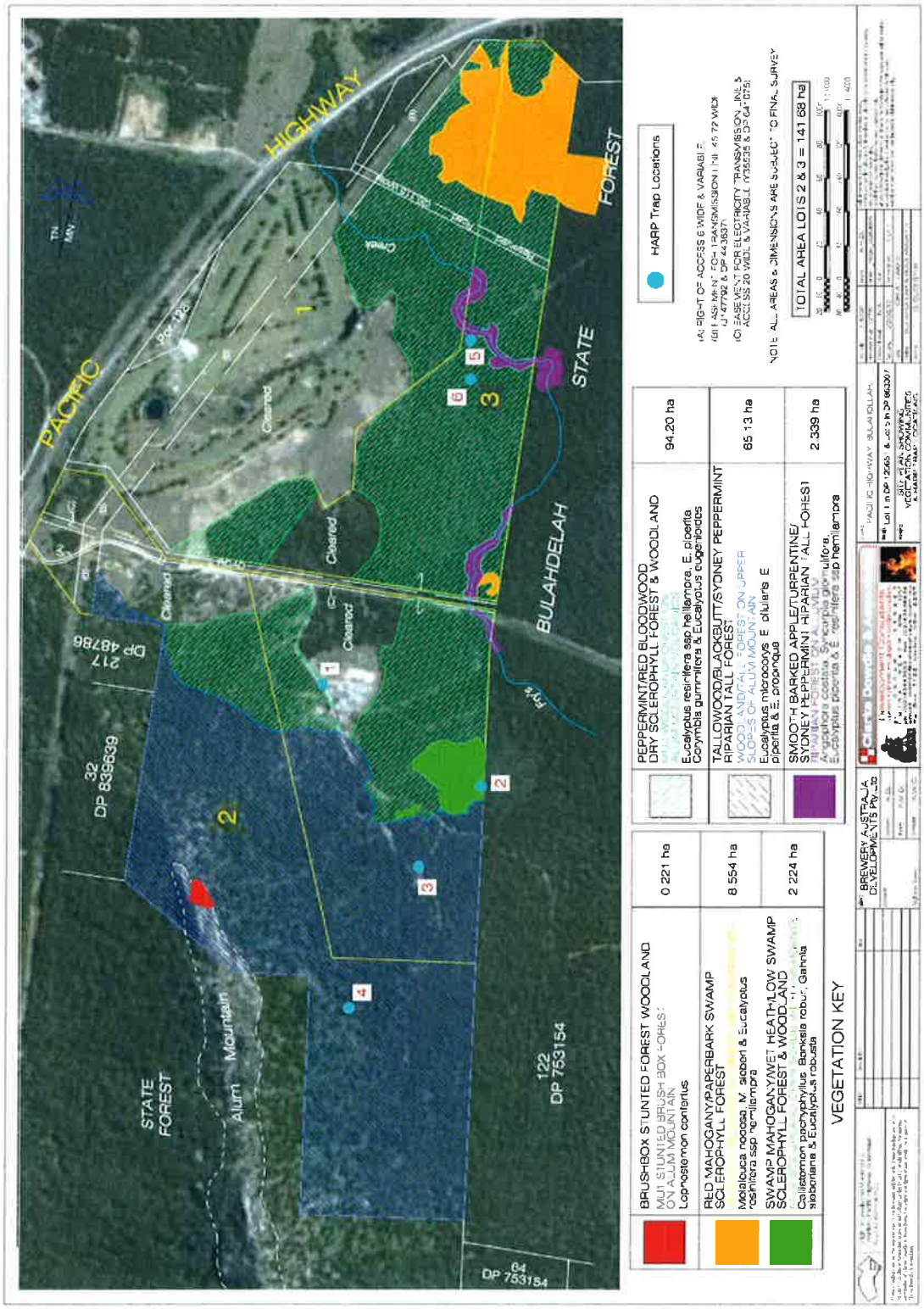

Figure 18- Harp trap sites showing station numbers (refer to Table 14)

The State Forest to the east of the forestry track has recently been heavily logged with only scattered young trees remaining. The existing forest west of the forestry track consists mainly of small stems and few hollow bearing trees were observed. The number of hollow bearing trees increased on the lower slopes and into the subject land where the forest was more open. Large, mature hollow bearing trees were noted to be common along the edge of the riparian habitat of Fry's Creek.

Table 17- Anabat ultrasonic call results

Date, Location & Duration	**File No.**	**Frequency (kHz)**	**Species**	**Reliability**
20-21st October 2010; *Red Mahogany/Paperbark Swamp Sclerophyll Forest* ; 427600E, 6416028N	2142.51	52.8	*Vespadalus vulturnus*	Possible short call
	2152.00	27.8	*Chalinolobus gouldii/Mormopterus sp.*	Either possible
	0240.25	38.9	*Nyctophilus sp.*	Possible poor short call
19th October 2010; Walked transect between harp traps 1-4	1956.27-2105.25	51-54	*Vespadalus vulturnus* or *V. troughtoni* or *V. pumilus*	Probable Possible
	2018.36 & 2018.57	50.3	*Chalinolobus morio*	Definite
20th October 2010;Near harp trap 4-release calls and others flying in clearing at top of hill at dusk	1828.40	28-30	*Chalinolobus gouldii*	Definite
	1828.04	50-52	*Chalinolobus morio*	Definite-release call
	1828.22 1836.44	40	*Nyctophilus gouldii*	Definite-release call
	1829.15-1837.32	51-53	*Vespadalus vulturnis* or *V. troughtoni* or *V. pumilus*	Probable Possible
	1835.58	51-52	*Vespadalus vulturnus*	Definite-release call
	1836.13-2025.42	51-53	*Vespadalus vulturnus*	Probable

Table 18- Specific details of microbats recorded on site

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Miniopterus australis																			
Miniopterus schreibersii																			
Chalinolobus gouldii																			
Chalinolobus morio																			
Chalinolobus dwyeri																			
Vespadalus regulus																			
Vespadalus troughtoni/vulturnus/ pumilus?																			
Mormopterus sp2																			
Mormopterus norfolkensis																			
Myotis Macropus?/ Nyctophilus spp.																			
Nyctophilus spp.(gouldii or geoffroyi																			
Tadarida australis																			
Scotorepens orion																			
Saccolaimus flaviventris																			
Rhinolophus megaphyllus																			

Notes for table 18:

- 1- station 2
- 2- central cleared area
- 3- track
- 4- Powerline easement
- 5- Forest Road
- 6- Alum mountain
- 7- yabbie ponds
- 8-Frys Creek crossing (South)
- 9-Frys Creek crossing (North)
- 10-Frys Creek access track
- 11- lower track
- 12- Dam
- 13- hanging swamp
- 14- access track
- 15- Alum mountain caves
- 16-Access track
- 17- treed paddock
- 18- hanging swamp
- 19- near golf course

KEY

Surveys by HWR

Surveys by Robert Payne and Kristan Dowdle

10.4 Reptiles and Amphibians

The Brown Tree Snake *Boiga irregularis,* the common skinks *Lampropholis delicata, Egernia mcpheei* and the Lace Monitor *Varanus varius* were the only reptile species recorded during the survey. However the previous land owner (Mr Richards) advised that the Diamond Python *Morelia spilota*, the Red-bellied Black Snake *Pseudechis porphyriacus* are present on the property. The Eastern Brown Snake *Pseudonaja textilis* is common on Alum Mountain. In addition, following discussions with the Australian Museum, the common lizard Cryptoblepharus *Virgatus virgatus* and the common skink *E. mcpheei* have been previously recorded on Alum Mountain and therefore the former species is likely to occur within the site. The latter species was recorded on the coastal plain.

Both the Brown Tree Snake *B. irregularis* and Lace Monitor *V. varanus* would be regarded as rare on the property with the common skinks being abundant.

A number of amphibians were also recorded which were the Common Eastern Froglet *Crinia signifera*, Red Backed Broodfrog *Pseudophryne coriacea* and *Uperoleia fusca* in puddles and dams away from the drainage lines. These three species are all relatively common. The slope forest supports the Broad-palmed Frog *Litoria latopalmata*, the Eastern Dwarf Tree Frog *Litoria fallax,* Peron's Tree Frog *Litoria peroni,* the Laughing Tree Frog *Litoria tyleri* and the Jervis Bay Tree Frog, *Litoria jervisiensis.* All of these tree frogs are relatively common on the property. The dams support the Spotted Grass Frog *Limnodynastes tasmaniensis*. The threatened species the Wallum Froglet *Crinia tinnula* was not recorded.

10.5 Birds

Over fifty bird species were recorded from the subject site (Appendix 4). One of the species recorded, the Glossy Black Cockatoo *Calyptorhynchus lathami*, is listed as threatened. These birds frequent the mid slope areas where mature *Allocasuarina littoralis* She Oaks are found. The species was also observed flying to and from the site in a survey conducted in February 2010. Beneath Alum Mountain there were several individuals of the Tawny-crowned Honeyeater *Philidonyris melanops,* and whilst this species is not listed as 'threatened' it is uncommon. A further uncommon bird species the Varied Triller *Lalage leucomela* was recorded along Frys Creek on 12 August 2010.

The area is abundant with the White-throated Nightjar, *Eurostopodus mystica,* which call throughout the night. These birds require ground habitat, where they roost and breed. Of the night owls the only species recorded was the Powerful Owl, *Ninox strenua.* This species was only heard on one occasion 6 August 2007 and a dead specimen was found on the coastal plain beside Frys Creek on 30 August 2007. The species is listed as vulnerable on the *Threatened Species Conservation Act, 1995*. On 3 December 2008, whilst on the summit of Alum Mountain, one Peregrine Falcon *Falco peregrines,* was observed below hunting above the tree canopy.

Varied Sittellas *Daphoenositta chrysoptera*, a vulnerable species listed on the *Threatened Species Conservation Act, 1995* was also recorded as a group on the slopes on 6 August 2007 and again on the Alum Mountain summit in the woodland on 4 December 2008.

In July 2010 the White-bellied Sea-Eagle *Haliaetus leucogaster* was recorded along Frys Creek and on Alum Mountain. The species is listed as migratory terrestrial on the commonwealth *Environment Protection and Biodiversity Act, 1999*. There are also a number of other migratory species present which are:-

- White-bellied Sea Eagle - Marine