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Local Environmental Study

At

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

PART 3 - KEY HABITATS AND CORRIDORS ASSESSMENT

FEBRUARY 2011

EXECUTIVE SUMMARY

The key habitats derived from this study and wildlife corridors map prepared by the NSW State Government agencies was investigated as a further part of the proposal. Management recommendations pertaining to land usage within and external to the site have been made. The main recommendations relate to habitat protection for threatened species and part of this can be achieved by manoevering the corridor to capture cave dwelling bat species roosting habitat on Alum Mountain. Future planning for the site will need to include conservation of part of all habitats that were identified during this study.

CONTENTS

TABLES

FIGURES

1.0 INTRODUCTION

Clarke, Dowdle & Associates have together with *Robert Payne-Ecological Surveys & Management* prepared an ecological 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 fauna and surveys have been completed by *HWR Ecological, Clarke Dowdle & Associates* and *Robert Payne – Ecological Surveys and Management* the details of which are found in accompanying but separate reports. This assessment of the key habitats and wildlife corridor forms the final component of the Local Environmental Study. The function of this report is to evaluate the key habitats and wildlife corridors, SEPP 14 Coastal Wetland and SEPP 26 Littoral Rainforest areas in light of the findings of the flora and fauna study.

1.1 Aims and Objectives

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

- Review the NSW DECCW key habitat and corridors mapping as it applies to the subject site and adjoining lands for a surrounding distance of one kilometer.
- Investigate the location of any SEPP 14 Coastal Wetlands within a one kilometer range of the subject land.
- Investigate the location of any SEPP 26 Littoral Rainforests within a one kilometer range of the subject land.
- Provide an assessment of the key habitat findings from the flora and fauna study.

2.0 BACKGROUND TO WILDLIFE CORRIDORS

Corridor habitats are used to retain filter strips of vegetation and such vegetation strips play an important role as habitat as well as the facilitation of movement and dispersal of biota. From a theoretical point of view corridor habitats will conserve certain forest types of vegetation, act as fauna refuges, link adjoining reserves and provide shelter and nesting sites for animals. The long-term value of these corridors has not been demonstrated (Lindenmayer & Nix, 1993), but it is common in planning practice for these standards to be applied. In the past, the standard practice for corridors was to plan them for a required width or minimum width (McFarlane, M.A. & Seebeck, J.H. 1991), but Recher (1996), more recently, argued that the boundaries should not be based on set widths but on ecological boundaries instead.

For ecological reasons, vegetated corridors which comprise a mosaic of different habitats are more than likely to have the necessary vital food, shelter and nesting resources for fauna. Seasonal resource requirements are essential for the survival of fauna and may only be found between a range of habitats at different altitudes and geographic variations. Therefore, those corridors which link patches of vegetation over the entire ecological gradient from ridge to gully will conserve more species and especially those species that have large home ranges and seasonal resource requirements (Lindenmayer et al 1994).

The quality of the vegetation within the corridor remnant is also an important factor when considering these planning issues. Some species of fauna will reluctantly utilise corridors of

low vegetation quality. Although this reluctance may be related to behavioural activity, the low quality vegetation may have been subjected to fire or have been invaded by weeds which would not support the necessary resources to sustain their movement and presence (Merriam, 1991). However, corridors are used for movement and the quality will be important in terms of these factors and therefore corridor size will play a major influence. Narrow corridors are prone to edge effects and become colonised by edge species, which prey upon or dislodge forest species, thus reducing the diversity of the corridor (Simberloff & Cox, 1987).

Corridors can also act as breeding areas especially if they support the necessary resources such as breeding hollows. In Western Australia for example it was found that trees with hollows between vegetated woodland remnants were essential to the breeding sucess of Carnaby's Cockatoo and the remnants were essential to their survival (Saunders, 1990). Without connecting corridors between vegetation patches, the patches become isolated and gene flow is restricted. Random breeding therefore declines and interbreeding can result threatening the future survival of any population.

Fruit and seed are dispersed by fauna and at dispersal sites the chances of survival and conservation are greater because diaspores are less likely to be predated and less competition for resources ocurrs (Osunkoya et. al, 1993). Furthermore, in many instances a fauna species may be a specialist pollinator or a vectar for a particular flora species. In well vegetated corridors that contain a diverse array of resources the survival chances of fauna are enhanced through pollination and dispersal. Where high quality habitats are involved, diaspores can be prone to predation pressure because predators generally avoid habitats with sparse vegetation cover and low resource availability (Price & Jenkins, 1986). If the distance between resources is too far and vegetated corridors are not available between patches, it is unlikely seed will be dispersed. Whilst resources need to be large enough to satisfy critical food requirements, corridors are even more important for some of the migratory species because the distance between their required food trees occurs over a wider geographical range with various influences of altitude, soil and climate. For example, rainfall pigeons rely on rainforest fruit and because rainforest trees fruit in a sporadic and sometimes unpredictable nature, it can cause food shortages and therefore longer distances need to be travelled. If vegetated corridors are lacking the rainforest pigeons can become physiologically stressed (Crome 1995).

Cameron (1997) developed the concept of the Inter-regional Open Space System (IROSS) which incorporated wildlife corridors for the Lower Hunter-Central Coast Region. It was concluded that the southern and coastal precincts were particularly important to *"develop and maintain linkages and provide a buffer between development of the Central Coast and the Lower Hunter".* As a result of the outcome of this regional study, Wyong Shire Council then implemented the Wyong Conservation Strategy and from the results of a major modelling study a large number of corridors were proposed (Smith, Watson & Murray, 2002) which incorporated a number of smaller corridors outlined previously (eg see Payne, 2001), which were recognised also, for their role in streambank stabilisation and ecological viability. Although the smaller linkages had been implemented through previous planning strategies, one of the main objectives of the newly developed inter-regional corridor was to ensure links were maintained between adjoining local government areas.

These initial riparian and terrestrial corridors were developed according to the principles outlined by Recher (1996) which stated that a variety of habitats, encompassing the whole suite of faunal resources, should be captured. Smith, Watson & Murray (2002) refined this strategy and used the target species approach outlined by Kavanagh (1991) to capture such

necessary resources in vegetation communities. In addition to this, the authors defined corridor targets, incorporated fragment size and the risk of clearing, prioritised remnants and prepared management strategies. In doing so a number of key habitats were recommended for inclusion in the corridor system.

Apart from the corridor assessment, a verification of the validity of resource use, expected to be used by fauna and captured in the conservation strategy, was undertaken. Instead of using the Powerful Owl or the Yellow-bellied Glider as the target species, the Grey-headed Flying Fox was used instead because it also lies near the top of the food chain but in addition, it utilises a wide range of resources. It was recognised, however, this species does not utilise corridors but the strategy would provide for the inclusion of a sufficient variety of habitats to satisfy the regional fauna over the various seasons. More emphasis was placed on the seasonal use of resources.

Payne (2002) investigated the validity of the corridor links and based on previous overseas and Australian studies (e.g. Goosem, 1997; Hunt, et al 1997) regarding roads as barriers to movement, concluded that these links would only be achieved efficiently if the corridors were properly designed and that wide roads were sufficiently addressed. Whilst roadsides and their vegetation can be used by fauna for breeding and seasonal movements, the installation of underpasses (including exclusion fencing) has shown to be effective in reducing mortality. Species such as the Eastern Pigmy Possum, the Common Wombat and the Tiger Quoll have been shown to use underpasses. Goosem et al (2001), furthermore, showed that in Queensland the larger and more open the underpass the more it will be used by larger mammals, but open forest and grassland species require underpasses which have shorter lengths and clearer lines of sight with vegetation remnants at either end. Food plants grown at either end of the underpass was also another strategy recommended in the study to encourage fauna to utilise any underpass structure.

At a wider scale the planning for wildlife corridors can be a complicated and long process (see Cameron, 2010; Scotts, 2003). The Border Ranges Integrated Biodiversity Planning and Implementation Program was one such study that developed planning for wildlife corridors at a very broad scale and although this process utilised specialised techniques and specialised information, it would be similar to the planning process that developed the corridors in the study area.

This study initially used priority groups of lifeforms (flora and fauna) to prioritise areas for wildlife corridor consideration. Flora was subdivided into "trait-based groups" to define risk based assessment categories to inform management priorities and actions for all species. Information that was used to develop these groups was based upon life history (seed size, fruit type, dispersal node, leaf size and persistence), broad vegetation type and landscape unit. Fauna was subdivided into biogeographical biota groups (eg Torresian, Bassian and Tumbunan) whilst non-terrestrial species were grouped into basic assemblages according to the landscape units.

Threats to diversity were then assessed using the conservation action planning process Geographic Information System (GIS) tool (Nature Conservancy, 2007). Sources of the threats to biodiversity were then considered and these threats were developed from the key threatening processes listed on the EPBC Act, 1999, TSC Act, 1995 and the FM Act, 1994. Modelling and forcasting programs were implemented to identify priority areas for implementation of recovery actions within the corridor area. The results produced a spatial representation of various levels of biodiversity priority and significance across the study area. These values were designated as conservation priorities or repair priorities.

Corridors identified were classified into four categories: - Reserve buffers and linkages, protect and enhance, stepping stone consolidation and valley floor linkages all of which are identified at a broad landscape scale. Community consultation furthermore, identified further areas of interest and climate change linkages (those which may become subject to more frequent fire) were included.

3.0 METHODS

When appraising wildlife corridors (Kavanagh 1991), the target species approach is considered appropriate for wildlife management. This approach is based upon the fact that each species will have its own unique habitat attributes and the focus is upon the attributes of indicator or keystone species (Soule & Simberloff 1986). Kavanagh (1991) states the characteristics of a target species is that they are sensitive to management practices under consideration, can be common and widespread, are easily surveyed, have preferred habitats which are easily mapped and have functionally important roles through their influence on the structure of communities. Examples of such species are the Yellow-bellied Glider and the Powerful Owl.

3.1 Corridors Mapping

The regional corridors mapping was obtained from NSW DECCW (Coffs Harbour Office) under license in ESRI and DXF format for the Bulahdelah study area. This information was first overlaid onto the Bulahdelah 1:25 000 mapsheet, using the GIS program "ARCVIEW" to determine if the corridor would impact upon the subject property. Following this, the mapping was overlaid on top of the aerial photography for a one kilometre radius from the property to determine the extent of any movement corridors. This task was undertaken using the program AUTOCAD.

In carrying out the assessment for the wildlife corridors the methodology used in two prevous assessments were relied upon (see Section 3.0). Initially, the inter-regional corridor modelling study and final assessment for the Wyong Local Government Area (Smith, Watson & Murray, 2002) was used to determine major constraints that might be encountered with this proposal and furthermore the corridor and habitats contained therein were evaluated using the target species approach of Kavanagh (1991). The two target species that were chosen were the Powerful Owl because it lies at the top of the food chain and the Grey-headed Flying Fox which utilises a wide range of resources. A further assessment was provided using part of the methodology of Cameron (2001) whereby each habitat is assessed for key threatening processes against the main attributes.

To determine the adequacy that flora species are well represented in the wildlife corridor the method of Kooyman & Rossetto (2007), and Verheyen et al (2003) was refined and utilised for this project. This method uses trait based functional plant groups as a basis for multi species recovery planning. Whilst it is recognised that multi-variate methods were used initially to develop these groups and applied to rainforest vegetation in other studies (see Cameron 2001), the method would be suitable for vegetation incorporating multi-species within vegetation communities. Focusing upon and prioritising species on the basis of rarity is considered to be unsuitable because these species in small populations are not necessarily the most threatened (Kooyman & Rossetto 2007) and in this particular case threatened plant species do not occur. This method utilises species groups to establish priority management actions based on plant groups that reflect biological and ecological aspects of species life histories on an altitudinal gradient.

3.2 SEPP 14 AND SEPP 26 Mapping

SEPP14 Coastal Wetland and SEPP26 Littoral Rainforest mapping was checked first through the CANRI (community access to natural resource information) website to establish if any such mapping exists in the study area. This website provides statewide mapping for planning purposes which is not otherwise available through the websites of government agencies.
ARCVIEW was then used to view the mapping and establish the locations of SEPP14 and SEPP26 areas.

Table 1 – Corridor linkage evaluation (refer to Figure 2)

Vegetation community within linkage	Corridor design	Condition	General tree height (m)	Main barriers to species dispersal	Gaps (metres)
1 *Stunted forest on Alum Mountain Volcanics*	not within corridor proposal	excellent	5-6	nil	nil
2/1 *Melaleuca forest with emergents in areas of impeded drainage*	wholly within corridor proposal	excellent	18-20	nil	nil
2/2 *Upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables*	Almost wholly within corridor proposal	excellent	12-15	nil	narrow access track (5m)
3 *Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains*	Almost wholly within corridor proposal	moderate	15-25	Transmission easement, cleared areas & tracks	Transmission easement (20m), cleared areas (100m) & tracks (5m)
4 *Woodland/tall forest on upper slopes of Alum Mountain Volcanics*	Small section within corridor proposal	moderate	15-25	Several tracks	Several tracks (5m)
5 *Riparian tall forest on alluvium along Frys Creek*	wholly within corridor proposal	excellent	25-35	Two creek crossings	Creek crossings (3m)

4.0 RESULTS

4.1 Corridors Mapping

Figure 1 reveals the extent of the corridors from the NSW DECCW mapping for the one kilometre range around the property. Three corridors are present, known as Bulahdelah State Forest, Bulahdelah ÍÍ and Bulahdelah. The corridor link Bulahdelah ÍÍ bisects the subject property at the northern end and it joins the Bulahdelah State Forest and Bulahdelah corridors at the southeastern and northwestern ends respectively. The Bulahdelah State Forest corridor encompasses the large public land area of Bulahdelah State Forest, located to the east of the subject site.

Table 1 is the corridor linkage evaluation and it can be seen that vegetation group 3 (*Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains*) has characteristics that will create minor barriers to dispersal. Vegetation group 4 (*Woodland/tall forest on upper slopes of Alum Mountain Volcanics*) is only partly contained within the corridor. The wetland and riparian vegetation units *Melaleuca forest with emergents in areas of impeded drainage*, *Upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables* and the *Riparian tall forest on alluvium along Frys Creek* are captured by the corridor proposal. The *Brushbox Stunted Forest on Alum Mountain Volcanics*, located on the Alum Mountain summit, is not captured by the corridor proposal.

4.2 SEPP 14 and SEPP 26 Mapping

Mapping reveals that no SEPP 14 wetlands occur within a one kilometre range of the subject site. The nearest SEPP 14 wetland lies to the south of Bulahdelah known as the Bulahdelah Plain.

No SEPP 26 mapping exists for the study area. The nearest SEPP 26 sites are many kilometres away at Booti Booti and between Danger Point and Blueys Head along the coast and lakes.

Table 2 – Refined trait-based flora categories as applied to Alum Mountain.

1	Comprises fleshy fruited species that are dispersed by specialist bird species. Mostly medium sized trees which develop a closed canopy and they have the capacity to resprout. They are mature shade tolerant rainforest subcanopy species.	Mainly found along Frys Creek, in northern draining gullies and on the northern face of Alum Mountain. Will only be partly protected under the corridor proposal but subject to damage by the feral goat population on Alum Mountain.
2	Comprises habitats with understorey sedges, reeds and herbs which develop small seeds and is foraging habitat for small mammals and seed-eating birds.	Mainly found north of Frys Creek in the Red Mahogany/Paperbark Swamp Sclerophyll Forest and the Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest and Woodland.Will be fully protected under the corridor proposal.
3	Habitats with specialist plant species such as ferns, epiphytic orchids and other habitat specialists such as grasses and shrubs adapted to desiccating conditions. Mainly rocky outcrop species.	Only found on Alum Mountain. Not protected under the corridor proposal. Subject to damage by the feral goat population.
4	Habitats mainly adapted to fire and comprising those species which can regenerate from fire; epicormic buds & shoots, re-seeders & re-sprouters.	Mainly found in the Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland and will be partly protected under the corridor proposal.
5	Habitats that support winter flowering nectar producing species sought after by honeyeaters, flying foxes & gliders. Honeydew and Acacia sap is included in this category.	Parly found in the Red Mahogany/Sydney Peppermint/Red Bloodwood Dry Sclerophyll Forest and Woodland where E. fergusonii subsp. fergusonii occurs and in the Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest which will be only partly protected. The Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest will be fully protected. Includes *Xanthorrhoea spp.*

Table 3 – Plant flowering and fruiting periods for Grey-headed Flying Fox with comments on protection under the proposed wildlife corridor

Plant species	J	F	M	A	M	J	J	A	S	O	N	D	Remarks
Acmena smithii													Frys Creek/protected
Angophora costata													Coastal plain/partly protected
Banksia oblongifolia													Coastal plain/protected
Banksia spinulosa													Coastal plain/protected
Callistemon salignus													Frys Creek/protected
Cissus antarctica													Alum Mountain/drainage lines/not protected
Corymbia gummiera													Coastal plain/Frys Creek/protected
Elaeocarpus reticulatus													Drainage lines/protected
Eucalyptus carnea													Alum Mountain/not protected
Eucalyptus pilularis													Slopes/partly protected
Eucalyptus propinqua													Slopes/partly protected
Eucalyptus resinifera													Coastal plain/protected
Eucalyptus robusta													Red Mahogany/Paperbark Swamp Sclerophyll Forest and the Swamp Mahogany Wet Heath Low Swamp Sclerophyll Forest/protected
Eucalyptus saligna													Beneath Alum Mountain/not protected
Ficus coronata													Drainage lines/Frys Creek/partly protected
Ficus rubiginosa													Alum Mountain/not protected
Lophostemon confertus													Alum Mountain/not protected
Morinda jasminiodes													Frys Creek/drainage lines/partly protected
Pittosporum undulatum													Frys Creek/drainage lines/partly protected
Syncarpia glomulifera													Frys Creek/protected
Xanthorrhoea spp.													Tallowwood/Blackbutt/Sydney Peppermint Riparian Tall Forest/not protected

Flowering	
Fruiting	

Table 4- Habitat requirements for the Powerful Owl using the target species approach as to the suitability of the corridor.

Criteria	Remarks
Broad forest Types	
Tall moist productive forest	Some aspects of this nature are present on the upper slopes below Alum Mountain
Wet sclerophyll Forest	Some aspects of this nature are present on the upper slopes below Alum Mountain and in parts of the northern draining gullies
Dry sclerophyll Forest	Present on coastal plain north and south of Frys Creek and lower slopes
Rainforest	Not present
Mid to late successional stage forest	Mid-successional stage forest present on coastal plain mainly north of Frys Creek
Mixed aged forest Multi-aged forest	Some mixed aged/multi-aged forest present on upper slopes and north of Frys Creek.
Terrain	
Undulating gentle terrain near the coast	This type of terrain is present
Habitat	
Dense mid canopy trees or tall shrubs in sheltered gullies	Not present
Heads of minor drainage lines	Present but not suitable
Food resources	
High density of arboreal animals	Not present. Density is low.
Common Ringtail Possum	Present
Greater Glider	Not present
Sugar Glider	Present
Common Brush-tailed Possum	Present
Grey-headed Flying Fox	Present
Diurnal birds	Present

Tree hollows	
Entrances greater than 6m above ground and commonly more than 20m	Present
Tree dbh >80cm	Numerous present especially north of Frys Creek
Hollows > 45cm diameter & >100cm deep present	Very few
Surrounded by canopy trees & sub-canopy mid storey trees/tall shrubs	Present
Are suitable trees with hollows > 10 per two ha. (to support prey species)	Well below the number required for Powerful Owl habitat. Mainly found north of Frys Creek

Table 5 – Key Threatening Processes to assess threats to biodiversity of corridor

Key Threatening Process	**Act**
Anthropogenic climate change	TSC Act
Loss of hollow bearing trees	TSC Act
Removal of dead wood and dead trees	TSC Act
Invasion and establishment of exotic vines and scramblers	TSC Act
Invasion of native plant communities by Bitou Bush and Boneseed *Chrysanthemoides monilifera*	TSC Act
Invasion of native plant communities by exotic perennial grasses	TSC Act
Invasion, establishment and spread of Lantana*, Lantana camara*	TSC Act
High Frequency Fire resulting in description to life cycles of plants and animals	TSC Act
Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus*	TSC Act
Competition and habitat degradation by feral Goats, *Capra hircus*	EPBC Act & TSC Act
Competition from the feral Honeybee, *Apis mellifera*	TSC Act
Predation by the Plague Minnow, *Gambusia holbrooki*	TSC Act
Predation by the European Red Fox, *Vulpes vulpes*	TSC Act
Predation and hybridisation by the Feral Dog, *Canis lupus familiaris*	TSC Act
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	EPBC Act & TSC Act
Degradation of native riparian vegetation along watercourses	FM Act

5.0 RESOURCE ANALYSIS FOR THE WILDLIFE CORRIDOR

Figure 2 shows the corridor link, known as Bulahdelah ÍÍ and proposed by the State Government, to impact upon the property. This corridor captures the two sensitive vegetation habitats Group 2/1 (*Melaleuca forest with emergents in areas of impeded drainage*) and Group 2/2 (*Upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables)* and a substantial proportion of Group 3 vegetation (*Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains*), where the Squirrel Glider population occurs. It also captures the Group 5 riparian vegetation (*Riparian tall forest on alluvium along Frys Creek)*.

Those trait-based features of the flora, identified for the project (Table 2), are also mainly captured by the corridor proposal. Table 2 shows the various trait-based flora groups that exist in the study area and for the purposes of providing resources for fauna, most of the different resource types that exist in the study area have been captured. Those habitats that occur from the coastal plain to at least the upper slopes (nearly the whole range of altitudinal habitats) have been incorporated into the corridor. This proposal includes the fire adapted Red Mahogany Forest on the coastal plain (incorporating re-seeders and resprouters), wetlands with sedgelands that provide small seeds and winter flowering resources on upper slopes and lowlands, fleshy-fruited resources and small seeds from sedgelands along Frys Creek and further fire-adapted forests on upper slopes. Ferns, epiphytic orchids and other unusual rocky outcrop plant species are not captured by the proposal.

Applying the target species approach, using the Powerful Owl, the evaluation of the corridor only produces limited results (Table 4). Whilst numerous potential den trees are present throughout the property, roost sites for this target species are virtually absent and the density of arboreal prey fauna species and their hollows appears to be too low. North of Frys Creek the density of trees with hollows appears to be greater and this area would be more applicable. Minor potential for a roost site is present in the north draining gully located above the *upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables.*

Using the Grey-headed Flying Fox as a target species, the corridor is considered to be more suitable. Table 3 shows there is a wide range of food species available to support this mammal species but the abundance of plants is probably not great enough in all seasons to support Grey-headed Flying Foxes all year. For example, Blueberry Ash bears fruit all year but the number of trees on the property is very low. Furthermore, the large Port Jackson Fig which occurs on Alum Mountain potentially could be a main food resource in the fruit-bearing season. However, this large tree is not included within the corridor area. Similarly, the winter flowering Swamp Mahogany is not well represented on the property.

Overall the proposed corridor on the property does not include the wide range of resource needs for both target species but it does include some resources within the boundaries of the property. Further afield all of the necessary resources may be captured and essentially what is omitted are the cave habitats for the microbat species on Alum Mountain. Some adjustment to the corridor location is required.

6.0 KEY HABITAT ANALYSIS

From the results of the flora and fauna survey it is apparent certain elements within each vegetation community are essential to support particular threatened and generalist fauna species or a suite of species. Perhaps the most important keystone species is *Eucalyptus robusta* Swamp Mahogany, which occurs as isolated trees in the *Melaleuca forest with emergents in areas of impeded drainage* and *Riparian tall forest on alluvium along Frys Creek* vegetation communities and as a small area within the *upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables* vegetation community.The latter area is the "hanging swamp" groundwater dependant ecosystem and part of the drainage line upslope from the community.

Swamp Mahogany is the main winter flowering species on the east coast of NSW which produces copious quantities of nectar during a time when other resources are lean. The nectar (and pollen) is attracted to mammals such as the Grey-headed Flying Fox, the Squirrel Glider and the Sugar Glider as well as a whole suite of honeyeater bird species. Swamp Mahogany is perhaps the most important tree species within the study area for this reason. Two other winter flowering eucalypts are present, *Eucalyptus fergusonii subsp. fergusonii* Ferguson's Ironbark and *E. microcorys* Tallowwood with the latter having an extended flowering period through to spring but nectar from the flowers of both species are probably very low and are not sought after by the many animal species (R. Payne & K. Dowdle pers. obs.).

Most of the *Woodland/tall forest on upper slopes of Alum Mountain Volcanics* supports the dominant sub-canopy tree *Allocasuaina littoralis* Black Sheoak and occasionally *A. torulosa* Forest Oak. These two tree species produce seed cones and the seed forms the total component of the diet of the Glossy Black Cockatoo. Specimens of the Black Sheoak tree species are found sporadically throughout the *Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains* and particularly along the floodplain of Frys Creek at the northern end of the property. Large trees with hollows that would be suitable for breeding purposes are also found mainly within the *Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains* and at times in the *Woodland/tall forest on upper slopes of Alum Mountain Volcanics.* In the latter vegetation community such trees were seen out near the south eastern area of the property and in the Bulahdealah State Forest.

A number of sightings of the birds and spent seed cones from the birds were recorded. Mostly these sightings were recorded in the *Woodland/tall forest on upper slopes of Alum Mountain Volcanics* vegetation community and the sightings occurred in many different areas such that it is not possible to identify a specific feeding area. A few sightings of the spent cones were also found in the *Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains* vegetation community along the access track to the *upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables vegetation community.* One site was found along the northern end of Frys Creek in the vicinity of the access track.

The Parma Wallaby habitat is based upon many sightings of the animals at more-or-less the one particular location just upslope from the yabbie ponds. Beside the old shed is a small area of tussock grassland dominated by *Themeda australis* Kangaroo Grass. The area is rather moist from seepage originating from the hillslope. However, the area is now being colonised by *Acacia spp.* which has regenerated over the past four years. More lately, the Parma Wallabies have been absent from the area and it is not known whether the vegetation regeneration or the presence of the European Fox is responsible for their

conspicuous absence. This area is seen as important feeding habitat for the species due to their common presence at this location. This area is only small and occurs within the *Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains* vegetation community.

A large component of microbat species was recorded over the four year survey. A few species were cave dwelling but most species were forest bats which would utilise small tree hollows for denning. Two to three species will utilise artificial structures for denning. Most species forage along access tracks throughout the vegetation but the Large-footed Myotis specifically forages over water and in this case the yabbie ponds and the farm dam but furthermore, a relatively large number of other microbat species were recorded foraging over the yabbie ponds and the farm dam as well. Those species concerned include four threatened species such as the Little Bent-wing Bat, the Eastern Bent-wing Bat, the Large-eared Pied Bat and the Eastern Freetailed Bat. The Eastern Cave Bat may be included within this category but its presence is not considered definite.

Given the scenario that the microbats were recorded foraging throughout most of the property it is important to highlight some of their preferred habitats. Firstly, it is noted that the two main cave dwelling bats, the Little Bent-wing Bat and Eastern Bent-wing Bat, were present foraging on the property in winter 2006 and winter 2007. However, these two microbat species are present in spring summer of 2008 but only the Little Bent-wing Bat was present in the summer of 2010. This is interpreted in the following manner. During summer a large number of calls were recorded indicating a solid presence by these bent-wing bat species but by autumn/winter only a small colony exists because only a low number of calls were recorded.

The large-eared Pied Bat was present in low numbers in both seasons.

Given the large microbat component on the property a further assessment is presented of habitat. It is assumed the caves on Alum Mountain support the roosting presence of the cave dwelling bats. However, ideal roosting habitat for the hollow dependant bat species is mainly found on the coastal plain in the *Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains* and the *Melaleuca forest with emergents in areas of impeded drainage* vegetation communities. Better habitat is found north of Frys Creek, where a large number of trees with hollows are found. Only a limited number of trees with hollows are found within the *Woodland/tall forest on upper slopes of Alum Mountain Volcanics* vegetation community and isolated hollows are found in the small vegetation community *upland open scrub with emergents of Swamp Mahogany in areas of permanent high water tables.* The reason for former community having a low number of hollows is the previous logging practices that have taken place. Large trees with hollows, however, are still common on the coastal plain. Given the large number of microbats recorded further clarification of habitat will be required by a microbat expert.

Similar tree hollow habitat attributes for microbats also apply to the Squirrel Glider but this species requires winter flowering food resources as well. These resources include nectar and pollen, insects, honeydew exudates, acacia gum from specific *Acacia spp.*and phloem from specific eucalypt trees. Some of these resources are set out in Table 3 but more detail is presented in the fauna report. Those resources that can be identified are mainly found on the coastal plain in in the *Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains,* the *Melaleuca forest with emergents in areas of impeded drainage* and the *upland open scrub with emergents of Swamp Mahogany in areas of permanent high*

water tables vegetation communities. The quality of Squirrel Glider habitat will need to be determined through further investigation of tree hollow density methodology.

The Powerful Owl, whilst it was recorded twice, is not resident on the property. It is expected that the owl is only an occasional visitor during foraging bouts.

Last but not least are the migratory fantails, flycatchers and monarchs which are not listed species at the state level but are to be considered at the commonwealth level. Of those species recorded, the Cicadabird, the Fan-tailed Cuckoo, the Leaden Flycatcher, the Rufous Fantail and the White-bellied Sea Eagle, the letter three are the listed species. The Rufous Flycatcer was seen moving through *Riparian tall forest on alluvium along Frys Creek* vegetation whilst the Leaden Flycatcher was recorded within *Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains* vegetation. The White-bellied Sea Eagle is often heard calling from the vicinity of the northern section of Frys Creek within the same two vegetation communities as the other migrants.

7.0 KEY THREATENING PROCESSES

A number of key threatening processes are relevant to the proposal, which is set out in Table 5. Those considered of most concern are "Invasion, establishment and spread of Lantana*, Lantana camara*", which is present above and below the track on upper slopes in the *Woodland/tall forest on upper slopes of Alum Mountain Volcanics* vegetation. "Competition and habitat degradation by feral Goats, *Capra hircus"* also applies to this vegetation unit on and just below Alum Mountain. "Predation by the European Red Fox, *Vulpes vulpes",* "Predation and hybridisation by the Feral Dog, *Canis lupus familiaris"* is also present on the upper slopes of Alum Mountain. Both dog and fox scats were recorded in this area. "Invasion of native plant communities by exotic perennial grasses" in this case *Andropogon virginicus* Whiskey Grass occurs on the adjoining golf course land and is beginning to invade the recently cleared area of the *Woodland/forest on Alum Mountain Volcanics over lower coastal slopes and plains* vegetation.

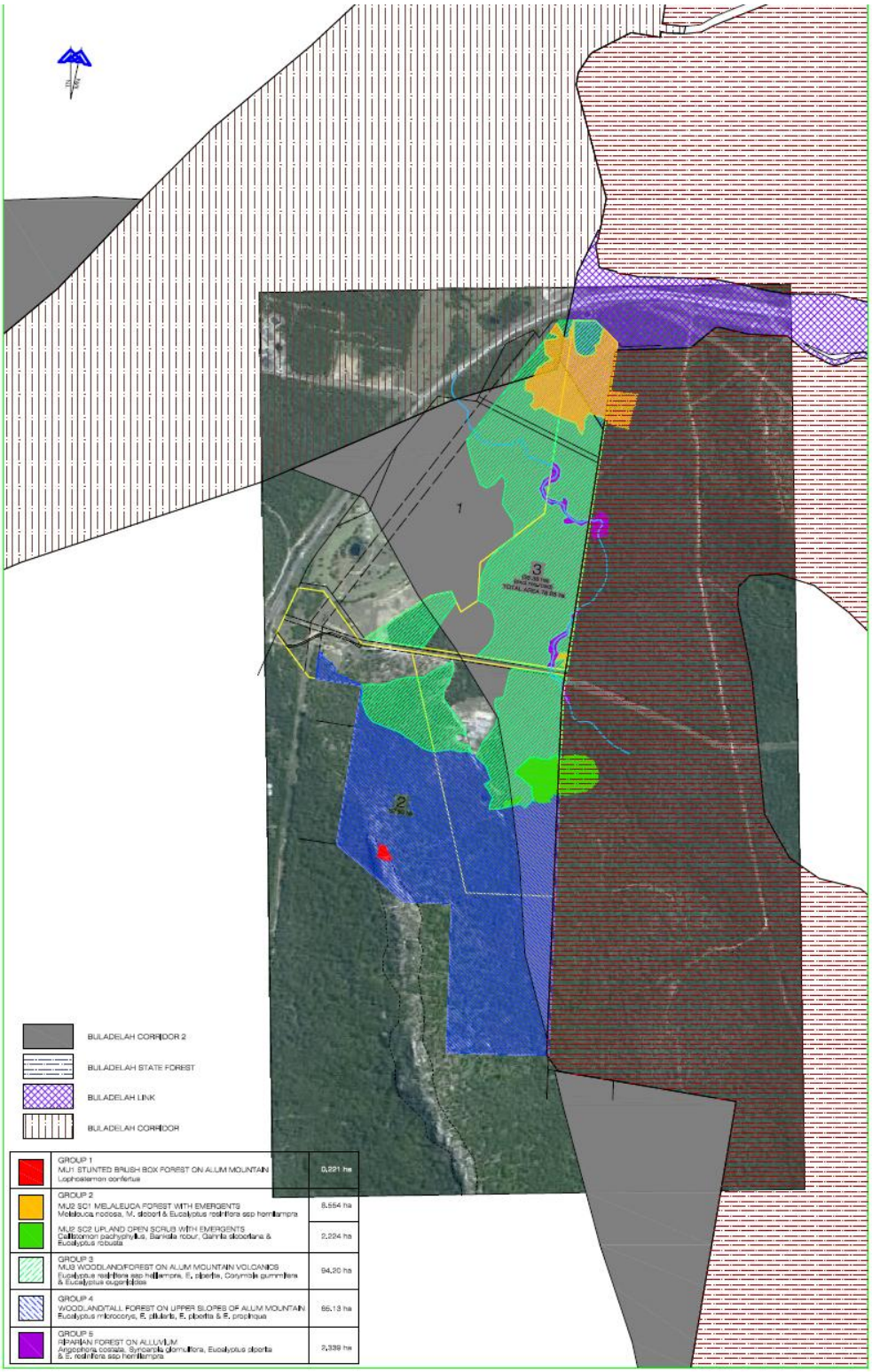

Figure 1-Extract from the key habitat and corridors map overlaid onto the vegetation map. Source NSW DECCW.

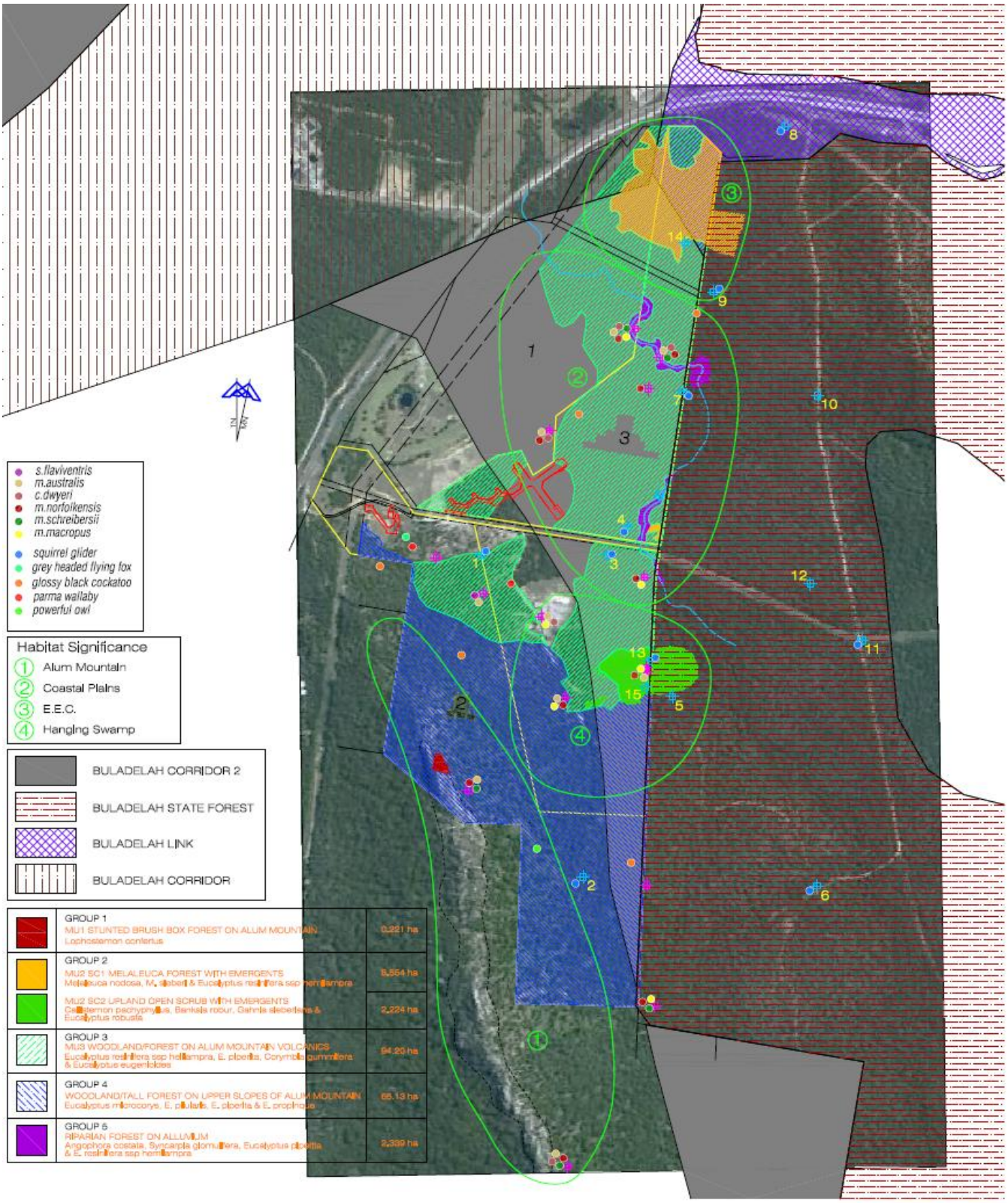

Figure 2- Map showing zones with priority numbers according to flora and fauna attributes.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Following an investigation of the flora and fauna in part of the Alum Mountain sub-catchment, a further investigation was undertaken of the propsed key habitats on the property and corridors proposed by the State Government as it relates to this proposal. The investigation considered all the threatened flora and fauna species found and concluded that future planning for any development must recognize certain findings. For the purposes of identifying areas to allow Great Lakes Council to pursue the LES Proposal zones based on flora and fauna attributes in order of priority, have been identified (Figure 2). These zones are as follows.

Zone 1, whilst it lies outside the study area, has a link to the property because of the presence of habitat for cave dwelling bat species. This zone has been allocated the highest quality habitat. Not only does this area have unusual plant species, but it is likely to be the roost/breeding site of several microbat species, some of which are 'threatened'. Further to this, the many cracks, crevices and intercises would provide refuges for different species of reptiles, which is otherwise not present over other areas of the property.

Zone 3 has been given Priority 2 due to the fact that part of the vegetation qualifies as an 'Endangered Ecological Community' under State Legislation. This habitat, from discussions at the meeting with Great Lakes Council would be utilised for offset purposes. A significant area of large trees with hollows occurs in this zone, which are likely to support microbats and part of the Squirrel Glider population. Part of the area (the "endangered ecological community") is subject to inundation and whilst not totally surveyed as part of this project, may have attributes suitable for other amphibians.

Zone 2, is given Priority 3 because of the presence of a Squirrel Glider population and a type of vegetation that may well turn out to be a restricted type of vegetation at the regional level. This zone also supports the highest density of winter flowering nectar resources which would be used by Honeyeaters and Gliders. Large trees with hollows are also common and this zone is foraging habitat for threatened bat species.

Zone 4 is the area of the hanging swamp which is also dominated by winter flowering resources and which may help to support part of the Squirrel Glider population and the Grey-headed Flying Fox. It supports a specialised vegetation type, but does not qualify as an 'Endangered Ecological Community' under State Legislation. However, it is a fragile habitat and should not be disturbed from future impacts.

Zone 5 is the remaining slopes dominated by the Tallowwood/Blackbutt Small Fruited Grey Gum Forest. These forests do support small populations of the Glossy Black Cockatoo and the Parma Wallaby, as well as the Squirrel Glider, but the habitat is far more widespread in the area, forming much of the vegetation along the range in the State Forest. Even so, the habitat is potential Koala habitat, although there are minimal records for Koalas in this habitat within this zone. The Parma Wallaby is also found within this zone.

The following recommendations are also issued for future management throughout the property;

Foraging habitat for the threatened microbat species and not just their roosting habitat on Alum Mountain must be taken into account for conservation purposes.
Squirrel Glider, Glossy Black Cockatoo habitat, including the yabbie pond and dam foraging areas for the Large-footed Myotis, must be contained in a conservation zone. The Parma Wallaby habitat should be considered within this conservation zone.
Consideration of manoevering the wildlife corridor should be given a priority to capture additional threatened species habitat, particularly the Alum Mountain roosting caves.

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