Supplementary Submission No 269a

INQUIRY INTO FEASIBILITY OF UNDERGROUNDING THE TRANSMISSION INFRASTRUCTURE FOR RENEWABLE ENERGY PROJECTS

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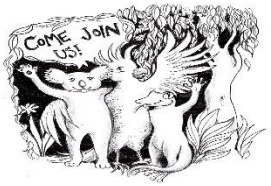
The Future is the Natural World



"Biodiversity loss is the most significant environmental problem facing Australia"
Professor David Lindenmayer. (2007) *"On Borrowed Time"*

Inquiry: feasibility of undergrounding transmission infrastructure for renewable energy projects

Dear Committee,

This submission is part of a project which incorporates measures to save nationally listed communities of species in rare Urban Forest for the future – in the Age of Environmental Breakdown.

This research would therefore like to thank the Chair and the Committee for the opportunity to speak on behalf of rarest native wildlife struggling to find remaining habitat, in the city of Sydney (or any urban area in Australia). Treasury must leverage Transition to the Economics of Biodiversity (Account FOR Nature), but not through the current planning and development system which, in the case study, is privatizing critical habitat for loss to the private sector. This is happening in the development, sport and recreational 'economy'. Testing the undergrounding of transmission infrastructure as a prototype, should regard an area of critical habitat and corridor ecology as critical biological infrastructure (CBI). This will update the entire system - by providing new zones for Protection, new concepts such as *advanced landscape conservation* (ALC), *avoid baseline shift* (ABS) and *acquisition before impact* (ABI), in order to update controls for biodiversity conservation via accounting system & pilot study. It must be a public enterprise since it presents paradigm change. This for the Economics of Biodiversity.

Case Study of near-to-station rare urban biodiversity (fauna & flora) from within rarest near-to-station remnants of Blue Gum High Forest (BGHF) and Sydney Turpentine Ironbark Forest (STIF). Appreciating the almost impossible task of undergrounding transmission infrastructure in vast areas of an urban landscape, this research (originating in 20 + years of resident bush care), supplies context briefly, stating multiple new threats to wildlife. Lands for undergrounding transmission infrastructure, in areas of rare Urban Forest should have Protection Strategies, to deal with biodiversity loss and climate extremes. It is interesting to note, at this point, that the current Urban Forest Strategy does not even reference local critically endangered ecological communities of species. The question is Why?

Currently conservation is inappropriately sought within outdated planning process (DECC 2008), this research proposed a pilot Transition Town study (2018), to engage ecologically sustainable survival economics (ESSE), (a) to allow Accounting FOR Nature (not offsetting), (b) to overcome flaws in current powerful planning & development systems, and (c) to achieve Eco-literacy, mental health, and national reconstruction of last native Urban Forest.

Distant decisions – Local Damage. If planning is done under external development pressure, by planning systems also external, then unsympathetic decisions are imposed which are unaware of changed local conditions. Residents and wildlife suffer immediate & cumulative negative impacts (usually irreversible), such as the laying of "synthetic grass" next to critically endangered ecological communities. Apart from the obvious disadvantages across the LGA of rapid removal of protected trees – residents must then fight against regional sport and recreation impacts. A pilot Transition project to test the feasibility of undergrounding the transmission infrastructure for renewable projects will at the same time bring back volunteers, engage citizen science, identify loss of habitat, restore species numbers & save *critical biological infrastructure* in the form of rare Urban Forest.

Critical biological infrastructure (CBI). Such areas of rare urban biodiversity greatly need undergrounding transmission infrastructure …. To PROTECT last remaining fauna and flora and habitat (CBI) from fires and winds, storms blowing away nests, and soil moisture loss. To prevent rare hollows and food-source being lost, a Protection Strategy is needed more than targets for tree planting. Fauna management plans and rewilding are needed for critically endangered ecological communities. Incredibly, in the case study (a) the Urban Forest Strategy cleanses the document of critically endangered ecological communities, and (b) E- for Environment zones have been changed to E-for Employment zones by planning and development systems. Zones to Use land are now 20+. State government laws changed by previous government to "facilitate" the Economy have allowed non-locals and unqualified planning and development systems to determine loss of rare urban bushland. [1]

Nature needs areas for her to restore herself - for the future. Ecological integrity is crucial to protect, restore and fund for food source and habitat to maintain diversity, but no signage, updated to local conditions, and loss of a table for discussion, has disengaged long-term volunteers. Without necessary local insight, no new planning controls and no adoption of fundamental new concepts and new zones (E5 2012), deep ecological flaws are visible. For eg. lack of inclusion of biodiversity and climate crises in "*A new approach to re-zoning*" (DPE, 2022). Locally the Urban Forest Strategy in this area does not list the most threatened and endangered species and communities. Under such pressures, in areas of rarest remaining BGHF and STIF, with old gardens and Eco-literacy disappearing, verges, streets, sports fields, bowling clubs, golf courses, natural areas and Parks are crucial for survival of all species.

1. The planning and development department are powerful because they are the sole department able to contact the State Government Planning sections responsible for rezoning; thus they are the only people able to gazette LEPs, do Amendments (with no oversight), do spot re-zoning for developers or listen to locals requests for correction and protection. PROTECTION is limited to just 3 E-for Environment zones (now changed to E-for Employment zones?) and more than 20 zones to USE land..
2. Suppression of sensitivity by planning has erased the detail of critically endangered ecological communities of species – white out to allow re-zoning of development in last ESAs such as the "critical habitat and corridor ecology" to take effect.
3. Treatment of Parks, Reserves and Sportsgrounds as discrete entities steamrolled and zoned RE1 has been a trojan horse for disposal in future, with little regard for local residents and security of Public ownership of undergrounded transmission infrastructure – this will cause problems like foreign ownership of poles and wires.
4. Simplify, certainty & speed are catch calls of the planning and development system & dumbing down of complex Ecology is a requirement of current P&D to ensure #1
5. Thus survival of ALL species AND addition of more urban wildlife, has been achieved at great cost – cost to Nature and Cost in dollars to consultant reports.
6. It needs federal government to be engaged to protect MNES for the NRS.
7. In the Age of Environmental Breakdown, It takes more than "targets" to plant trees to achieve a Protection Strategy ….. the Transition Town to protect fauna and flora by undergrounding renewable transmission must be a serious exercise- not a game to deny and delay protection but speed and satisfy development, sport and recreation.
8. It needs previously denied empathy and engagement of local citizens and residents by intelligent signage, to educate and protect, restore and add to rare Urban Forest.
9. Briefing to make ESAs comply with the cost of considering matters of undergrounding electric wires to protect BGHF and STIF from storms and fires.
10. Aims of urban Transition are to multiply benefits of undergrounding transmission infrastructure – to protect, restore and fund conservation of rarest matters of national environmental significance (MNES) free of ecological illiteracy of P & D systems.

[1] https://www.smh.com.au/environment/conservation/secret-plan-to-develop-bushland-20080728-gdso01.html

Ecological considerations are overridden by too powerful Planning & Development systems.

Transition must be an audit of what remains, before loss is irreversible in the food chain (eg. Insects, small hollow dwellers, tree canopy, mid and ground cover – for the powerful owl, its food, small birds and ground dwellers like dunnarts and water dragons). Ecology department in the Transition Town (TTT) fully equipped with required qualifications, must attempt re-wildling, restoration and repair – alongside & together with undergrounding cables, etc.

Secret plans to develop bushland cause injury and must be negated by Transition:

- Creeks contaminated/poisoned by synthetic grass, birds killed by eating corkfill,
- Humans injured by heat and forest fires should be banned in sensitive bushlands.
- Mis information Planning website calls bushland "Public Bushland" making environment compliant to society and economy.
- Procurement of synthetic grass for landscapes of critically endangered ecological communities (CEECs) of species – should be banned out of respect for last endangered CEECs.
- Footprints for individual development in the ESA Transition Town should be strictly controlled to not clear at least one third of the block.
- Transition must avoid loss of remnant intact bushland corridors (streets, parks, and connecting reserves, etc).

Eco-Literacy & Echo the principle of 30%by 2030. Does the planning and development system know about this? In the ESA TTT old gardens to be amalgamated into lots for massive developments, and established food and habitat trees removed by Council officers show little or no regard to allowing them to stand for food-source and habitat. Street trees are weakened by footpaths, verge trees with hollows are lost, but all trees must be protected for future critical habitat & corridor ecology (see pages ……..). Lost gardens mean verges become critical for remaining trees, and small bird habitat. Conflicted use in urban areas: verges are overused by agencies for water, etc. and subject to cycle and footpath use.[2]

The Economics of Biodiversity In NSW, complexity increases when planning & development systems fail to ensure / or just don't know about protection for Environmental Breakdown. As a result, systemic flaws (such as too few environment zones, lost sound scapes and wind barriers, cumulative development, recreation and sport impacts, complying developments, etc.etc.), do not **expedite** understanding of protected tree removal. Local conditions such as windbreak loss, new low to ground windspeeds, loss of old gardens, ground, shrub, midstory and canopy cover loss, drying or concreting of creeks, riparian areas: All impacts become irreversible as soils and seedbank are converted at high speed to concrete. This leads to soil moisture level reduction and nesting decline (alongside and near rarest remnants).

Vetting is essential Local Strategic Planning Statement (LSPS) prioritizes housing not protection of ratepayers and wildlife, by instigating tree removal in development anticipation. It is no wonder the department buried a report stating the sensitivity of the LGA (in 2016). It was not unearthed until the General Manager gave it to a local environmental group. (It can be found on pages …….

[2] ***https://www.caselaw.nsw.gov.au/decision/549f8fe33004262463aea54e*** *"Where species or communities have been listed as critically endangered, the preservation and protection of a few neighbouring isolated trees can contribute to the long-term viability of a greater community and should be preserved. No community can re-generate if the seedbanks or sources of those seedbanks have been removed…. Where a community once existed there remains a distinct possibility that viable seed banks may be retained in the surrounding soils….. With respect to the connectivity and fragmentation of endangered and critically endangered species, a few remaining trees may well provide a critical link to maintaining and contributing to the long term viability of refugia ……"*

Cumulative removal of fauna and flora communities. The Transition Town in critical habitat is an opportunity to test the undergrounding of transmission infrastructure for cities to retain rare Urban Forest. The research shows natural and built significance, lost to multiple re-zonings for development. This means loss of local soils, seedbank and mature trees (with hollows, roost, food source and shelter). This, despite calls for recovery plans, objections to impacts of sport and recreation, court cases, protests and submissions to protect intergenerational inheritance for the future of all species.

Rezoning for development erases the sensitivity of an area of sensitivity, by not protecting it. Current flaws, laws, loopholes, and lack of wildlife perspective, means unforeseen, irreversible loss of ecological integrity. Native forest clearing in urban areas begins with rezoning for development – a higher order trigger than the current Key Threatening Process (KTP) clearing native vegetation.

Native forest loss in urban areas begins with rezoning for development – a higher order trigger than the current Key Threatening Process (KTP) which is clearing native vegetation. Rezoning for development by erasing the sensitivity of an area of sensitivity, or incorrectly protecting it, means the last habitats of vanishing wildlife, will not be saved for the future.

Protect Restore and Fund Critical Biological Infrastructure (CBI) loss. In such last BGHF &STIF reserves for repair and rewilding, restoration and revaluation:

In a situation, where planning and development systems include systemic flaws such as:

- too few environment zones,
- forced introduction of multiple impacts by development, recreation and sport,
- no local understanding of multiple protected tree removal, windbreak loss, new windspeeds, loss of old gardens and ground, shrub, midstory and canopy cover, consequences loss and removal of creeks, riparian areas.
- leading to complex degradation of soil moisture level reduction and nesting space decline adding to insect extinction (base of food chain) and
- No calculation or consideration of irreversible loss such as of soils and seedbank converted at high speed to concrete, bitumen and synthetic grass….

Then a Pilot Project to test the undergrounding of transmission infrastructure in the proposed The Transition Town would be a well-supported citizen science engagement project.

Ten years of extinction debt lost to denial, delay and destruction of the same ESA – means an Audit of threatened species in the proposed Transition Town will save critical habitats and corridor ecology.

Recommendations will be sent to the Committee, the NSW Auditor General Office, the Biodiversity Conservation Act Review, the NSW Premier and Federal Government.

With good wishes,

Janet Harwood

IPBES Stakeholder https://www.ipbes.net/news/Media-Release-Global-Assessment

14th July 2023. (as per phone request to add pages below17th July 2023)

Urgency - Two sides of the same coin.

Protection is the new Business: Biodiversity crisis is other side of Climate crisis.

We have everything we need to fix the climate crisis, but we need to do it now,

writes **Nick O'Malley**.

(This article was published on 21st March 2023 ... but was placed on page 10.)

'Everything, everywhere, all at once' needed to fight climate change
Humanity has a last-ditch chance to make meaningful cuts to greenhouse gas emissions

and secure a future for life on Earth, according to the definitive report on climate change. The latest assessment from the United Nations' Intergovernmental Panel on Climate Change says the climate crisis is rapidly altering Earth's atmosphere, oceans, land

and ice, causing deadly heatwaves, droughts, floods and rising sea levels – a child born today is likely to experience three to four times as many extreme climate events as their grandparents.
This synthesis report, the closing chapter of the IPCC's sixth cycle of assessment, is the most comprehensive analysis of climate change across the globe and the definitive stocktake of the committee's work over the past seven years. The report, which has 93 expert authors and draws on the work of thousands of scientists over half a decade of study and analysis, warns that our actions this decade will be crucial.
The world has already warmed by 1.1 degrees and is likely to surpass the Paris

Agreement's target of 1.5 degrees by 2040, the report states, but it can still be reversed if immediate action is taken. The authors note there are still feasible and effective ways

to reduce emissions and adapt to climate change with the use of solar and

wind energy, electrification and urban greening. They argue new oil and gas field exploration must end, and new coal-fired power stations should not be built. These actions could slow global warming within two decades and improve atmospheric pollution within a few years.

"It triggers many alarm bells that we cannot afford to ignore," warns Australian National University Professor Mark Howden, one of the report's authors, while fellow author and ANU Professor Frank Jotzo sounds a note of cautious optimism: "The good news is we know what needs to be done, and we have the technology."

However, UN secretary-general Antonio Guterres says it will take a "quantum leap in climate action" to reverse the damage already done. "Our world needs climate action on all fronts," he said. "Everything, everywhere, all at once."

Read Miki Perkins and Nick O'Malley's report

Who is calculating this loss to the future city?

Rare Urban Forest needs statutory Protection and Recognition

Awareness of extreme sensitivity ie. Matters of National Environmental Significance (MNES) appear to have been suppressed by planning & development system to allow re-zoning for development, recreation, sport etc. to go through.

1.3 Ecological Values of Ku-ring-gai

Overview

The Ku-ring-gai Council area, though relatively small is an area of biological diversity as it contains a variety of plant associations and habitat types that support over 800 plant species, at least 170 fungi and over 690 fauna species including invertebrates and fish. Ku-ring-gai's significant biodiversity stems from its diverse habitats and geological landscapes ranging from estuarine mangrove mudflats to steep sided sandstone gullies and ridges swathed in heath, open forest and riparian scrub to shale capped ridge tops with tall open forest. The area gets one of the highest levels of rainfall in Sydney averaging around 1400mm per annum (Wilks, 2010), which helps support tall open forest dominated by blue gums, blackbutts, turpentines and ironbarks on the richer clay soils. Today Council reserves and the tree lined suburbs provide important bio-linkages or corridors between three national parks and smaller reserves within and around the lower north shore.

Ku-ring-gai LGA covers 84 km^2 with about 1,100 ha of Council bushland reserves many of which are contiguous with about 1,800 ha of National Parks including Ku-ring-gai Chase, Garigal, Lane Cove and Dalrymple-Hay Nature Reserve.

Habitats and diversity

The relatively high species diversity in the LGA is likely due to the diverse range of habitats, microhabitats and ecotones.

Table 2: Summary of biodiversity in Ku-ring-gai

Species and ecosystem diversity	Numbers of species or associations
Flora species	843
Fauna species	693 (including invertebrates)
Mammals	47
Reptiles	45
Amphibians	26
Birds	218
Fish	28
Invertebrates	329**
Fungi species	171
Vegetation associations	26
Threatened Species	
Flora species	15
Fauna species	28
Mammals	8
Reptiles	1
Amphibians	3
Birds	15
Fish	1
Invertebrates	1 - not confirmed
Threatened Ecological Communities	
Threatened Ecological Communities (NSW TSC Act / FM Act)	7 (2 of these also listed under EPBC Act)

** Mostly aquatic macro-invertebrates identified to family or morpho-species only. With approximately 195 identified to species or genus level.

Source: *Biodiversity Strategy* (KC 2006) (Refer to strategy for full species list).

Ecological communities and plant associations

A summary of vegetation communities (including Key Vegetation Communities) within the Local government area as mapped with *Mapping and assessment of key vegetation communities across the Ku-ring-gai local government area KC 2012a and 2012b),* is provided within in Table 3 below (See Section 3.1 for further information).

Table 3: Vegetation Communities within Ku-ring-gai LGA

Vegetation Community	Legal status ▲		Key & non-key vegetation
	TSC Act & FM Act	*EPBC Act*	
Blue Gum High Forest (BGHF)	CEEC	CEEC	Key vegetation community
Sydney Turpentine-Ironbark Forest (STIF)	EEC	CEEC	
Duffys Forest (DF)	EEC	-	
Coastal Shale Sandstone Forest (CSSF)	Legal status to be determined through consultation with OEH, upon completion of the Sydney Metropolitan CMA mapping (DECCW 2009a)		Key vegetation community identified and added during the course of the vegetation mapping project in response to increased knowledge gained. Considered regionally significant. Recognised through field work and consultation with OEH (as part of their Sydney metropolitan vegetation mapping, DECCW 2009a).
Sydney Sandstone Gully Forest (SSGF)	-	-	These non-key communities have defined using broad community descriptions.
Sydney Sandstone Ridgetop Woodland (SSRW)	-	-	
Gully Rainforest (GF)	-	-	This non-key community was defined using broad community descriptions.
Estuarine Fringe Forest - Swamp Oak Floodplain Forest	EEC	-	Key communities. Fine scale mapping of these communities has been undertaken by Allen *et al* (2007), Kelleway *et al* (2007), West and Williams (2008) and incorporated within DECCW (2009a). No field assessment was undertaken for these communities within Council's vegetation mapping project.
Estuarine Saltmarsh	EEC	-	
Seagrass	P, EP	-	

Vegetation Community	Legal status ▲		Key & non-key vegetation
	TSC Act & FM Act	*EPBC Act*	
Estuarine Mangrove	P	-	Non-key communities. Fine scale mapping of these communities has been undertaken by Allen *et al* (2007) and incorporated within DECCW (2009a). No field assessment was undertaken for these communities within Council's vegetation mapping project.
Coastal Flats Swamp Mahogany Forest	EEC Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions	-	Key community No field assessment was undertaken for these communities within Council's vegetation mapping project. These communities were beyond the sandstone boundaries of Council's field validation process and are incorporated within DECCW (2009a).
Coastal Upland Swamp	EEC	-	Key community Field assessment for this community was undertaken as part of ongoing vegetation mapping refinement and bushland management

▲ *FM Act 1994*: P – Protected, EP – Endangered Population
TSC Act 1995 and *EPBC Act 1999*: CEEC - Critically Endangered Ecological Community
EEC - Endangered Ecological Community

- ***Source:*** *Ku-ring-gai Council 2013a and 2013b* (further consultation of as part of finalisation for the SM CMA mapping (DECCW,2009a) is yet to be undertaken, this may inform future vegetation community classifications).

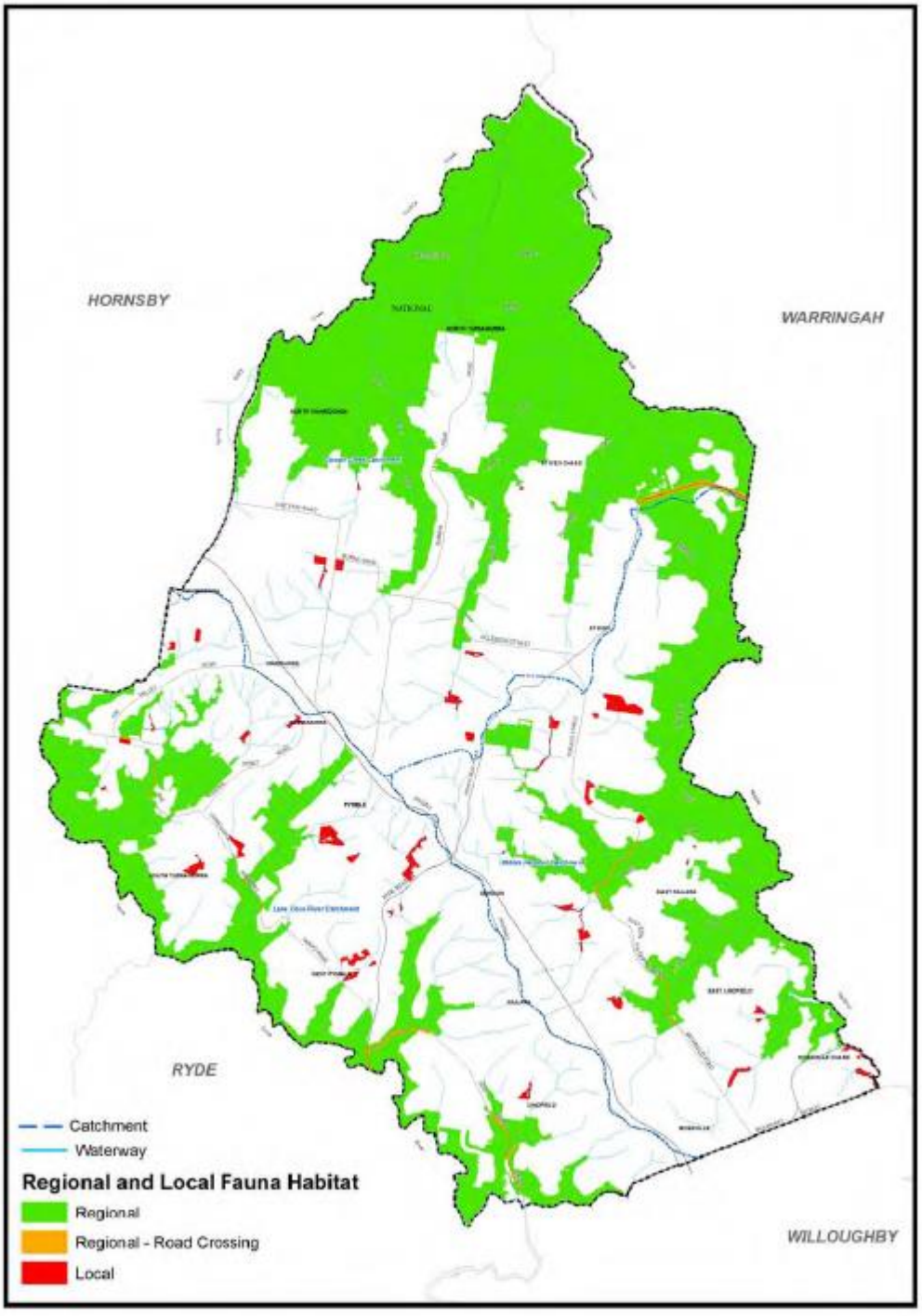
Habitats

Ku-ring-gai contains both terrestrial and aquatic habitats (see Table 4).These broad habitat types can merge into others forming ecotones between terrestrial and aquatic, urban and natural and between types within each group such as forest to woodland. Within terrestrial vegetation Ku-ring-gai contains various structural types of plant associations. Based on the Specht (1981) classification system there are structural types ranging from closed forest and tall open forest to low open woodland and low heath land.

Table 4: Examples of broad habitat categories within Ku-ring-gai

Terrestrial habitats	Intermediate habitats	Aquatic Habitats
Forest	Riparian zones	Streams (freshwater)
Woodland	Mangroves	Streams tidal (brackish)
Heath	Wetlands / soaks	Estuarine (marine)
Caves, rock faces and soil	Intertidal zones	
Urban / artificial	Drains, culverts and channels	Dams, ponds, marinas

Figure 3: Ku-ring-gai Regional and Local Fauna Habitat



3.3 Regional and Local Fauna Habitat

3.3.1 Background

Healthy native fauna are required for functioning ecosystems, providing vital ecosystem services influencing biodiversity, including pollination and nutrient cycling (HNCMA, 2008). As previously described in Section 1.4.1, habitat loss, predation and competition by introduced species are leading to declining population and distribution of threatened and non-threatened fauna (HNCMA, 2008). Adequate conservation of ecosystem services and biodiversity over long time-frames requires protection of ecological processes as well as high quality habitats.

The NSW Department of Environment and Climate Change considers that 'areas supporting high vertebrate fauna species diversity are also likely to be complex, diverse, functioning environments that have, at least in part, escaped the myriad of threatening processes acting on natural ecosystems' (DECC 2008c). Vertebrate fauna species are particularly sensitive to habitat disturbance and local extinction is often the result.

Large connected areas of bushland (core areas) are required to support threatened and non-threatened fauna populations (including national, state and regionally significant species). For the purposes of this study regionally important areas are considered to be Regional Fauna Habitats (See Figure 3). These include both native and non native vegetation with structure. The presence of weeds and non natives still provide an ecological service through the creation of habitat, food resources, soil stability and connectivity.

Fauna habitat is also provided by core isolated remnants located more centrally in the LGA, for example areas adjoining Wombin Reserve. Within this study these areas of local significance are included within either Ku-ring-gai Natural Areas or private / public lands not reserved for conservation (See Figure 3).

By recognising and seeking to protect areas of Regional and Local Fauna Habitat, Ku-ring-gai Council intends to support the role of native fauna in the ecosystem, facilitating their continued survival, as well as preserving their social and cultural importance for the community.

Ecological principles underlying the identification of land as regional and local fauna habitats include the recognition of habitats:

- with the highest relative biodiversity values;
- that are likely to support the highest population densities of fauna;
- that strengthen population viability through important landscape or habitat connectivity features (as supported through biodiversity corridors, Section 4.2);
- with consideration of the effect of reserve size on fauna conservation and biodiversity;
- occurring along environmental gradients (for instance rainfall, temperature, altitude and soil type);
- located across land tenures. Although fauna habitat is primarily located within formal reserves, other private and public lands may have an equally important role in sustaining the regional viability of biodiversity by enhancing habitat characteristics and total size.

  Regional and local fauna habitat within Ku-ring-gai and the broader Sydney Metropolitan Catchment Management Area (DECC 2008c), includes formal reserves and lands owned by local Councils, the Crown, OEH, as well as other public authorities and private landholders.

  Publicly owned Regional and Local Fauna Habitat is not necessarily designated for conservation purposes. Land in Ku-ring-gai owned by public agencies such as the Roads and Traffic Authority and the Department of Planning is considered to be Regional Fauna Habitat if it contains native vegetation communities with structural complexity and meets the criteria listed above.

3.3.2 Context of Regional Fauna Habitat in Ku-ring-gai

The Ku-ring-gai LGA is bordered by bushland in formal reserves (including National Parks and Council Natural Areas) in the northern, eastern and south-western directions (See Figure 2 and Figure 2). This bushland is continuous with adjoining bushland owned by OEH, Hornsby, Willoughby and Ryde Councils. Strips of remnant vegetation extend from these Formal Reserves into urbanised areas of the LGA (See Figure 3). The National Parks, Natural Areas and connected remnants provide the core habitat for Ku-ring-gai's fauna.

Three key areas of regional fauna habitat have been identified:

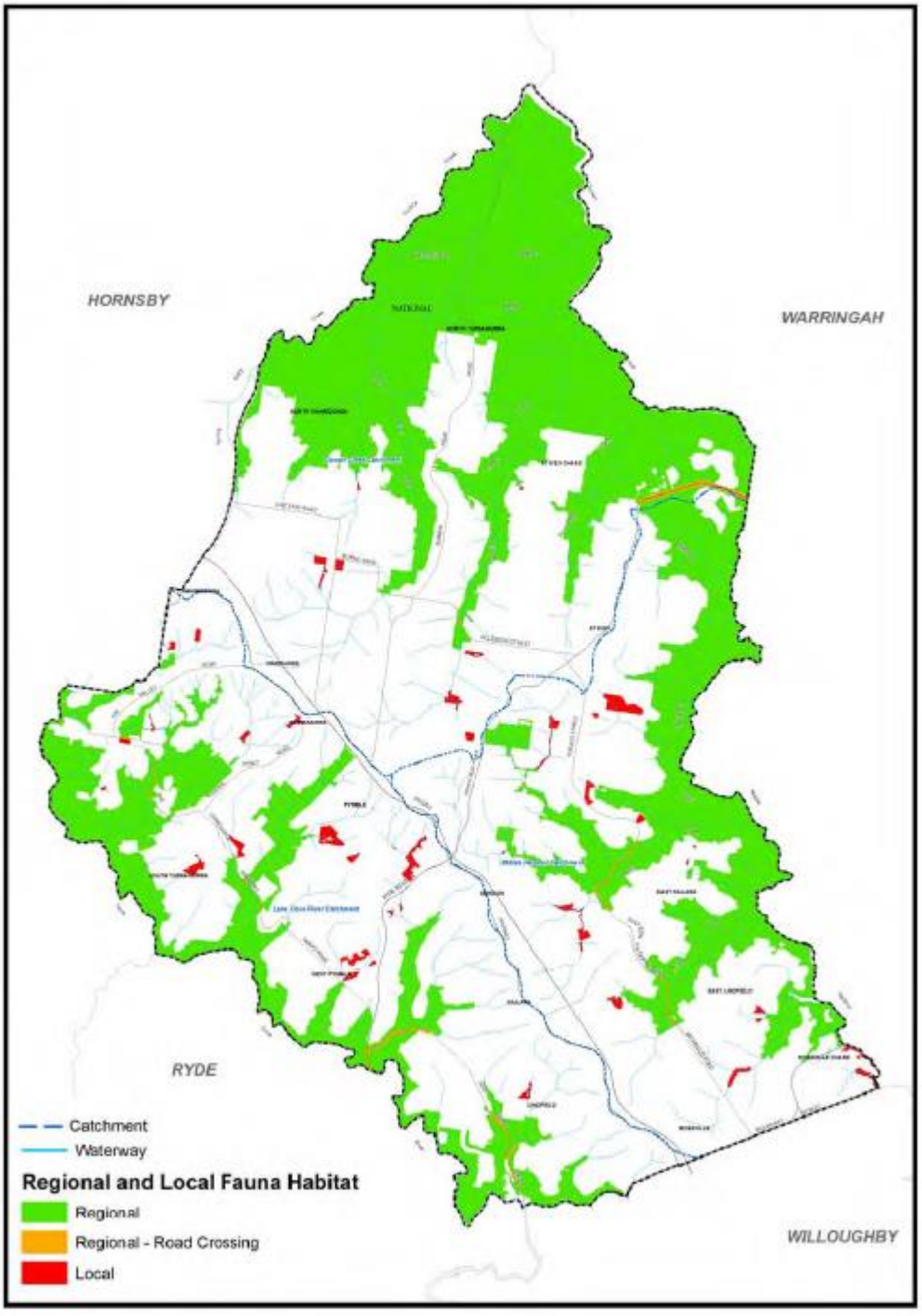
1. Regional Fauna Habitat within the Cowan Creek catchment is located at the north of the LGA and adjoins Ku-ring-gai Chase National Park. There are 23 threatened fauna species found in this area including the Red-crowned toadlet, powerful owl, grey-headed flying fox, glossy black cockatoo (*Calyptorhynchus lathami*) and the Southern brown bandicoot (*Isoodon obesulus*)(BIObase, October 2010). Fauna studies commissioned by Ku-ring-gai Council between 2001 and 2005 have found that this area has the highest native species diversity recorded out of the three catchments (Smith and Smith, 2005).

2. Habitat within the Middle Harbour Valley (including sections of Garigal National Park and areas beyond the Middle Harbour Catchment within Ku-ring-gai LGA), is categorised by DECC (2008c) as having 'Highest Fauna Values'. This habitat is comprised of sections of Garigal National Park as well as connected lands that have good vegetation structure, for example Dalrymple Hay Nature Reserve. DECC (2008c) recognise that Middle Harbour supports moderate amounts of priority fauna habitat (covering 5-50% of Middle Harbour Valley). Three endangered and 14 vulnerable species have been recorded in Middle Harbour Valley, including the Rosenberg's goanna (*Varanus rosenbergi*) and the Grey-headed flying fox colony (located at Ku-ring-gai Flying Fox Forest Reserve, Gordon) (DECC, 2008c). DECC advocated protecting colony sites as these are vital to the conservation of flying foxes (DECC, 2007a).

3. The Lane Cove Valley is considered to have very high fauna values' (DECC, 2008c). This regional fauna habitat is made up of parts of the Lane Cove National Park and connected lands that have good vegetation structure including Sheldon Forest and Troon Creek Natural Areas. It also includes areas beyond the Lane Cove River Catchment in Ku-ring-gai LGA. DECC (2008c) recognise that Lane Cove valley supports moderate amounts of priority fauna habitat (covering 5-50% of Lane Cove valley). The Lane Cove valley regional Fauna Habitat is know to provided habitat for 231 vertebrate fauna species (DECC, 2008c). Of these one endangered and nine vulnerable species and part of one endangered population are found in this area, including the threatened Powerful owl, Barking owl (*Ninox connivens*), Red-crowned Toadlet and Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)(DECC, 2008c).

For further information on fauna within these catchments refer to Appendix A.

Figure 3: Ku-ring-gai Regional and Local Fauna Habitat



2.5.3 Factors considered in Identifying Regional and Local Fauna Habitat

Habitat diversity

Regional and local fauna habitats identified within the LGA are designed to cross a number of environmental gradients including rainfall, temperature, altitude and soil type. This contributes to diversity in vegetation communities which range from mangroves and salt marsh to sandstone and clay influenced environments (see Section 1.3). Each of these communities provides a range of habitat types influencing flora and fauna assemblages. Many species require specific habitat requirements and their persistence is dependant on habitat characteristics being maintained. For example:

- The vulnerable Red-crowned Toadlet inhabits ridgetops in open woodland and heath communities typical of Hawkesbury sandstone geology (characterised by of sandstone ridge and hillside habitats), usually at altitudes less than 200m (DECCW 2001, Smith and Smith 2001). Other habitat attributes required for this vulnerable species include proximity to an ephemeral watersource, typically at the headwaters, and sandstone outcrops (Thumm, 1997).
- The Powerful owl is predominantly recorded in forested gullies with large watercourses (Kavanagh, 2004). Hollow bearing trees are required by Powerful owls for nesting and roosting and are also used by arboreal marsupials which are the owl's main prey (DEC, 2006). A tall, dense shrub layer is preferred at Powerful owl roosting sites as it provides protection for fledglings (DEC, 2006). The species is known to inhabit suburban riparian areas, especially where they adjoin National Parks or reserves with extensive bushland (Kavanagh, 2004, Supported through BIObase records as searched in October 2010).

Regional and local fauna habitat should also link areas of similar habitat to allow fauna to migrate to areas of acceptable habitat when required, for example in times of bushfire (HNCMA, 2008).

Habitat size, fragmentation and effects

In addition to habitat diversity, the size and shape of fauna habitat is also important (See Figure 4 for Ku-ring-gai Formal Reserve patch size analysis). Drinnan (2005) identifies remnant size as being the most significant predictor of species richness. His studies suggest that thresholds exist for remnant size, for example under 4ha the diversity of frogs and birds in a reserve severely declines and at less than 2ha plant and fungal species diversity rapidly declines (Drinnan, 2005). The same study investigated the size of bushland reserves in southern Sydney and found that forest birds only became dominant over urban birds once reserve size exceeded 50ha Drinnan (2005). Suggesting that connecting habitat areas that exceed 40ha (and in many cases 100ha) ensures that regional fauna habitat accommodates shy species that prefer forest habitats free from edge effects as well as urban adapted species (Drinnan, 2005).

The purpose of Local Fauna Habitat areas are to provide stepping stones connections between larger protected areas (including regional fauna habitats and Ku-ring-gai Natural Areas). This connection may be direct or through Biodiversity Corridors (see Section 4.1). Local Fauna Habitats also contribute to the total habitat area available to fauna species.

Many local fauna habitat areas are comprised of native vegetation communities with structural complexity, including threatened ecological communities.

The *Australian Biodiversity Conservation Strategy (2010-2030)* (NRMMC, 2010) acknowledges that fragmentation, associated habitat loss and population isolation, impede the ability of plants and animals to tolerate external pressures. In urban environment such as Ku-ring-gai there has been extensive habitat removal and fragmentation, reducing habitat size and heavily impacting biodiversity. For example, Blue Gum High Forest remnants are highly fragmented, with less than 5% of the original area remaining (NSW Scientific Committee, 2008; Smith and Smith, 2001). Ku-ring-gai fauna surveys in Blue Gum High Forest demonstrate that fauna in these remnants is

depauperate and there are much lower proportions of species which are intolerant to urban environments compared to less fragmented habitats (Smith and Smith, 2001; Smith and Smith, 2005). Even species commonly found in other bushland in Ku-ring-gai were not recorded in these disconnected sites - most of the species recorded in Blue Gum High Forest are those typically found in urban habitats (Smith and Smith, 2001).

Habitat removal and fragmentation in Ku-ring-gai results in reduced habitat size and heavily impacts biodiversity. Ku-ring-gai contains fauna with a range of responses to habitat fragmentation (as broadly defined by Drinnan 2005):

- 'Urban' adapted species, such as the Eastern Water Skink and the Grey-headed Flying Fox, and birds (See Appendix A for urban bird list), are those which will use habitat in urban environments;
- 'Edge' species which will inhabit the bushland/urban interface, such as the Sugar glider (*Petaurus breviceps*) and Satin bowerbird (*Ptilonorhynchus violaceus);*
- 'Forest interior' species which are shy and unlikely to travel through, or inhabit, disturbed areas. This last group, which includes the Southern brown bandicoot and Heath monitor (*Varanus rosenbergi*), are most affected by habitat fragmentation.

In determining Regional Fauna Habitat, provision of habitat for forest interior species is particularly important. Drinnan (2005) reports that once reserve size exceeds 50ha, species less tolerant of fragmentation increase in number. The regional fauna habitat mapping provides for forest interior species, especially in the large bushland reserves adjoining the Ku-ring-gai Chase, Garigal and Lane Cove River National Parks, for example connectivity between Lovers Jump Creek Reserve and Ku-ring-gai Chase National Park is maintained. Urban and edge fauna may be more abundant in the narrower sections of Regional Fauna Habitat such as that between Ku-ring-gai Flying Fox Reserve and Richmond Park.

While some species are recorded as inhabiting, foraging and reproducing in urban and edge environments, evidence exists that these may not be optimal habitats. Hoye and Spence (2004) recognise that even though the Large Bent-wing Bat (*Miniopterus schreibersii*) roosts in urban environments in Ku-ring-gai (including caves and stormwater channels, disused buildings etc), the urban populations suffer more injury and signs of stress compared to roosts unaffected by urban environments (Hoye and Spence, 2004). It is important to ensure that remaining vegetation is protected so that high value habitat does not diminish.

Through appropriate planning and management of urban areas, habitat quality and viability may be improved. One example of this is the potential for improved habitat through the provision of a connected area of non illuminated habitat (as provided by Riparian Lands and some Biodiversity Corridors). Leaving unlit paths for nocturnal bats to commute and roost within can protect them from isolation, reducing foraging pressures and increasing both animal and population fitness (Jones 2000, Stone et al 2009, Boldogh et al 2007). This is particularly important for slower-flying bat species[2] that (unlike faster flying species) do not utilise artificial light areas for foraging, due to a reduced ability to avoid predators (Longcore & Rich 2004). Pressure upon these species is further increased by competitive pressures from faster flying species that do use these resources (Blake et al 1994, cited in Longcore & Rich 2004).

It is also important that the value of smaller habitat patches be recognised. Although large reserves provide the necessary backbone of successful conservation, small patches form part of the greater habitat mosaic and add important complementary value to large patches. Dispersal through the landscape is facilitated by small patches which act as stepping stones for mobile species. Species differ in their response to habitat fragmentation and not all species are reliant

[2] Within Ku-ring-gai this includes species such as the Lesser Long-eared Bat (*Nyctophilus geoffroyi*), Eastern Horseshoe Bat *(Rhinolophus megaphyllus)*.

on large patches. Small, isolated patches may be particularly important for native invertebrates. Mobile organisms may actively choose to occupy small patches rather than large ones, particularly when small patches of remnant vegetation provide important resources that may be rare or absent from larger patches. For example, parrots may nest in patches as small as single trees providing that a suitable hollow is available.

Protection across tenure

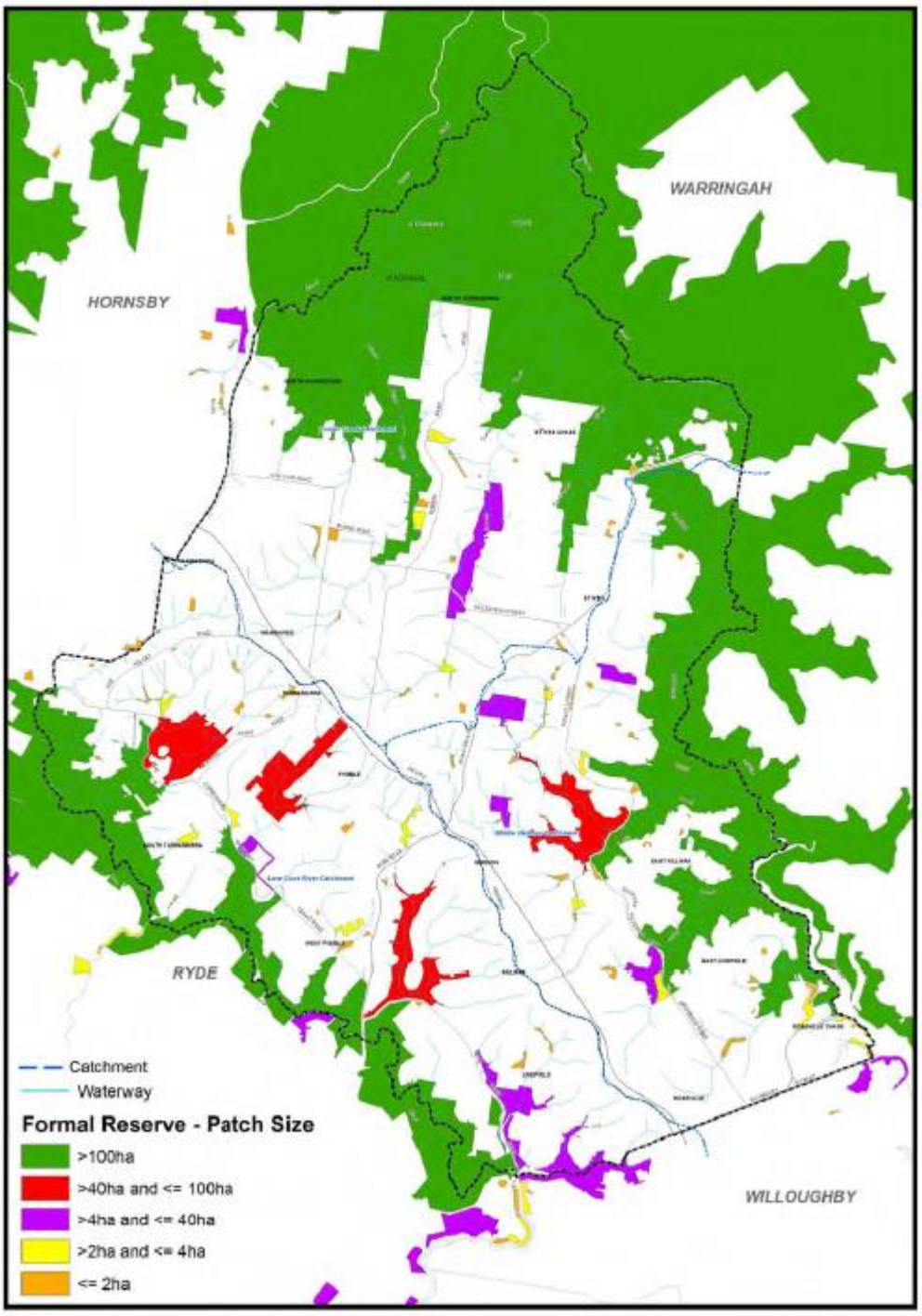
Private land that abuts bushland can also provide habitat for native fauna, even for 'forest interior' species (Catterall, 2004). Small bodied native birds, such as the Golden whistler (*Pachycephala pectoralis*) and Grey fantail (*Rhipidura fuliginosa)*, have been recorded in private gardens in properties adjacent to reserves in Ku-ring-gai. Maintaining the structural complexity (i.e. varying levels of vegetation height) of gardens adjoining bushland is fundamental to these species continuing to use it as habitat.

Removing fauna habitat on private lands may reduce the cumulative area available to these species and can also increase the perimeter to area ratio of fauna habitat (Catterall, 2004). Species with large home ranges or those particularly vulnerable to edge effects may be negatively impacted. For example, Kavanagh (2004) identified the "northern leafy suburbs of Sydney' as providing habitat for the Powerful owl, which has a large home range of up to 300-1500ha (DEC, 2006). Property in close proximity to bushland was found to be particularly important in this study. Fauna surveys in Ku-ring-gai support the importance of private land for fauna with records the Long-nosed bandicoot (*Perameles nasuta*) foraging in private gardens (Smith and Smith, 2005).

While Ku-ring-gai Council acknowledges the importance of fauna habitat on private property, requirements for bushfire management through the creation of Asset Protection Zones (APZ) must also be considered. Where bushfire prone land is mapped to include areas close to private dwellings, regional and local fauna habitat mapping has been modified to facilitate the creation of an APZ between residential structures and areas to be protected as fauna habitat. It should be noted that detailed assessment of residential requirements against *Planning for Bushfire Protection* (RFS, 2006a) was not undertaken and it is acknowledged that the creation of fire mitigation measures within regional and local fauna habitat areas may still be required.

OEH and Council managed land outside the Ku-ring-gai LGA, but contiguous with Ku-ring-gai bushland, was also used to inform Regional Fauna Habitat. Where bushland is contiguous across the LGA boundary, the entire area was considered important for fauna habitat since the statutory boundaries are of no relevance to fauna migration.

Figure 4: Patch size of Formal Reserves within and surrounding Ku-ring-gai



- Are comprised primarily of native vegetation communities, with vegetation structure (canopy, shrub and understorey) as determined through API and / or vegetation mapping condition information (DECCW 2009, KC 2009).
- Where the vegetation is known to support threatened species and/or populations; or was assessed as providing important habitat for threatened and non-threatened fauna species. This was primarily determined through and analysis of patch size and connectivity of formal reserves (Figure 4) and remnant vegetation; as well as results from flora and fauna analysis (see Section 3.2).
- Consideration of CMA regional habitat mapping (as addressed within Section 3.2.1, and below). Areas considered too isolated as mapped at 1: 2,000 were mapped as local rather than regional habitat (eg. lands to the south of Roseville Bridge).

3.4 Biodiversity corridor mapping

3.4.1 Background

Areas providing regional connectivity are considered to be incorporated within Regional Fauna Habitat mapping (See Sections 3.2.1 & 3.3; Figure 2 and Figure 3).

A review of Regional and Local Fauna Mapping, fauna analysis, vegetation mapping and Formal Reserves within Ku-ring-gai has identified the following biodiversity connectivity shortcomings (see information with Section 3 for further details):

- Middle Harbour valley is considered to be poorly connected to surrounding bushland (DECC, 2008c). This is due to sites being linked through narrow habitat connections of modified vegetation. It is also as a result of road barriers preventing easy connection. DECC (2008c) advocate a continuous link between Middle Harbour and Cowan Creek Regional Fauna Habitat in St Ives.

- Within the LGA connections between Middle Harbour and Cowan Creek Regional Fauna Habitat is provided by Regional Fauna Habitat 'road crossings' over Mona Vale Road. These are areas that form connections between Regional Fauna Habitat over regional, main and some collector roads. Required management techniques for these areas are specific to each corridor as briefly addressed within Appendix C.

- The Lane Cove Valley bushland is not connected to adjacent protected areas or reserves (DECC 2008c). DECC (2008c) supports connecting the Lane Cove Valley with bushland in the Berowra Valley in the Hornsby LGA; however this is outside the scope of this report. The connectivity of Lane Cove Valley bushland within the Ku-ring-gai LGA is compromised by main roads, specifically Ryde Road and The Comenarra Parkway, intersecting the natural areas. Connections between habitat within Lane Cove Valley National Park and Ku-ring-gai Natural Areas and Regional Fauna Habitat is provided by Regional Fauna Habitat 'road crossings', for example across where the Comenarra Parkway divides Lower Dam Creek Reserve and Comenarra Reserve at West Pymble.

- That there is no continuous, good condition vegetation / habitat crossing the urban area of Ku-ring-gai in either a north-south or east-west direction (as supported by Cunningham, 2002). The importance of re-establishing this link was recognised by Conacher Travers (2000), by their recommendation for a broad biolinkage through the urban areas of Ku-ring-gai.

Threatened and Pest Animals of Greater Southern Sydney report (DECC, 2007b) identifies that vegetated fauna corridors are influential in the survival of many fauna species in the Greater Southern Sydney Region. Several of these species are also found in the Ku-ring-gai LGA, for example Rosenberg's goanna and the Southern brown bandicoot DECC, 2007b).

Adam (2004) argues that maximum connectivity of urban bushland in Sydney is fundamental for the survival of urban bushland. Connectivity is also important to maintain diversity and functionality in urban bushland and avoid becoming what Adam terms 'living museums' (2004).

In response to the issues raised above Biodiversity Corridors within the LGA, have been identified through desktop assessment (using field validated vegetation and riparian mapping). These biodiversity corridors link remnants, regenerated or planted vegetation between Regional and local fauna habitat, Ku-ring-gai Natural Areas and remnant patches. These areas are not necessarily comprised of continuous vegetation nor do they necessarily form a direct physical connection between fauna habitat, due to the existence of roads and other urban infrastructure.

Biodiversity Corridors facilitate wildlife (vertebrate and invertebrate) migration between areas of habitat and are particularly important in urban areas, such as Ku-ring-gai, where urban development obstructs migration between formal reserves and local habitat.

Biodiversity Corridors also support the continued survival of flora populations in the landscape primarily by promoting pollination and seed dispersal. *Western Sydney Urban Bushland Biodiversity Survey* (James, 1997) recognises that road reserves, creek corridors and larger patches of habitat on both public and private property play an important role in maintaining biodiversity outside reserves.

Biodiversity Corridors define areas that will be managed for biodiversity connectivity (for example through weed removal and bush regeneration, or appropriate native landscape planting). A brief outline of biodiversity management objectives, advantages and disadvantages, as well as potential management strategies for Biodiversity Corridors within Ku-ring-gai is provided in Appendix C.

It is recognised that flora and fauna will utilise a range of resources both within and outside identified biodiversity corridors, and these areas form one part of a broader approach to biodiversity management within the more urbanised areas of the LGA. This is supported through:

- Council Biodiversity Strategy (KC 2006) and Tree Management Policy (KC 1999)
- Wildthings, Council's care programs (streetcare, parkcare, bushcare) (http://www.kmc.nsw.gov.au/www/html/280-bushcare.asp?intSiteID=1)
- Tree Preservation Order
- *Threatened Species Conservation Act 1995*, *Environmental Protection and Biodiversity Conservation Act 1999*
- Ku-ring-gai Council's Development Control Plans

Ecological principles underlying biodiversity corridors and supporting regional connectivity include:

- Avoiding local extinction
    - Biodiversity Corridors are valuable for protecting isolated flora and fauna populations in Ku-ring-gai and may assist in avoiding local extinction. Fahrig (2003) identified a decline in species richness, population abundance and distribution as being some of the effects of habitat loss and fragmentation on biodiversity.

- Reproduction and genetic mixing
    - Low genetic variation has been identified as one of the effects of habitat fragmentation on fauna (Aares and Ims, 1999: Fahrig, 2003). Facilitating fauna movement between habitats particularly benefits the genetic diversity of isolated, extinction-prone flora (Tewkesbury *et al.*, 2002) and fauna (Aares and Ims, 1999) populations.
    - Biodiversity Corridors provide fauna with an opportunity to connect with breeding partners and offer a greater selection of breeding partners (Aares and Imes, 1997).

  - Biodiversity Corridors enhance native vegetation reproduction and genetic diversity (Tewkesbury *et al.*, 2002). This is particularly important for endangered ecological communities.

- Pollination and seed dispersal
  - Vegetation that relies on animals for seed dispersal or pollination is able to colonise new habitat (Tewkesbury *et al.*, 2002). This results in increased flora diversity and increased foraging prospects for fauna in the newly colonised patch. Grey-headed Flying-foxes disperse pollen and seeds over a wide range during foraging, often up to 60-100 km per night (DECC, 2007a; Royal Botanical Gardens and Domains Trust, 2010). In this way they contribute to the movement of plant genetic material and thus influence evolutionary processes of forest ecosystems (DECC, 2007a).
  - A study undertaken in South Carolina found that habitat patches connected by corridors contained a higher proportion of flowers which produced fruit than isolated patches (Tewkesbury *et al.*, 2002). This was attributed to pollen movement by invertebrates in this study. The same study by Tewkesbury *et al.* (2002) also found that seeds are more likely to be found in connected than unconnected habitat patches. This was attributed to a preference for birds to use the corridor to travel between patches.

- Response to change
  - Habitat disturbance, or a change in habitat condition, has the potential to result in local extinction if fauna populations have no migration pathway. Bushfire, drought, food scarcity and increased predation can all potentially result in a decline in fauna numbers. Biodiversity Corridors provide an opportunity to temporarily seek refuge in a more favourable habitat (HNCMA, 2008). Smith and Smith (2005) acknowledge that National Parks experience more frequent fires than the adjacent bushland in Ku-ring-gai. Corridors provide the ability for fauna to migrate to unburnt areas during these times.
  - Biodiversity Corridors also facilitate the re-colonisation of sites following a disturbance (HNCMA, 2008). There is greater potential for successional flora and fauna species to enter the disturbed site while it is directly connected to undisturbed habitat.
  - Flora and fauna that have particular habitat, foraging or prey requirements can use the corridors for seasonal migration (HNCMA, 2008) or in response to changing climate factors.

- Regeneration
  - Connectivity between fragmented habitats can also allow for some restoration of naturally occurring landscape variations, patchiness and diversity, which has been lost from smaller isolated fragments (James, 1997).

- Increasing habitat
  - Corridors facilitate increased biodiversity by enabling flora and fauna migration to new habitat that may have been previously unavailable. Linking natural areas may also result in locally extinct species being reintroduced (Tewksbury *et al.*, 2002).
  - Habitat opportunities may also provide fauna with protection from predators in the corridor.
  - Biodiversity Corridors offer a larger total habitat to wildlife species. This provides greater habitat diversity and foraging area. It also assists in preventing over-crowding of existing habitats (Jordan, 2000). More extensive habitat areas also benefits species with large home ranges.

- Corridors may provide additional habitat for flora and fauna species, termed diffusion dispersal (Krebs, 2001 as cited in Horn, 2003) or may provide a migration pathway as animals disperse in search of food, habitat or a mate, termed jump dispersal (Krebs, 2001).

Biodiversity Corridors are considered to be particularly important for species (HNCMA, 2008):

- with large home ranges
- which are sensitive to habitat fragmentation
- which are nomadic or migratory
- which are not able to disperse easily.

3.4.2 Factors considered in identifying Biodiversity Corridors

A landscape approach has been used to identify Biodiversity Corridors within the LGA. In mapping Biodiversity Corridors the following design principles were considered:

Condition

The highest value Biodiversity Corridors are those in good condition which provide connectivity between high value habitats.

A wide corridor of continuous vegetation with native species in all structural layers and providing diverse habitats is likely to supply a migration pathway to a greater number of species (HNCMA, 2008). However even patches of disturbed vegetation provide an important ecological function. Connecting good condition habitat through corridors of partially disturbed communities, for example where the upper stratum is retained but the lower strata are weed infested, can also assist the viability of the ecological community.

The highly urbanised nature of Ku-ring-gai means that garden and street trees are also vital attributes for allowing connectivity and often form integral parts of urban corridors, providing both an ecological and community character function. There is evidence of both bird and bat species that will not travel through open space but will use urban trees. Large-bodied native birds, such as the Grey Butcherbird and Noisy Friarbird, are prevalent in vegetated suburban environments but are less frequently found in suburbs lacking vegetation (Catterall, 2004). These large native birds, which Catterall (2004) terms 'Aussi Icon' species, can be important for public appreciation of wildlife and community support for habitat protection measures. Basham (2005), reports that only the most common bat species forage in the open with the rarer species preferring canopy or shrub cover. Catterall (2004) also emphasises the importance of urban vegetation for small-sized native birds. Small native birds can use gardens with complex strata as habitat, especially those that adjoin bushland. Catterall (2004) further highlights the importance of vegetation in urban areas, especially when compared to unvegetated urban areas. Even though small-bodied native birds will not typically inhabit urban areas, large-bodied native birds are often found here with appropriate vegetation. The designation of biodiversity corridors will encourage increasing vegetation complexity and connectivity to support these species.

Fauna, flora and vegetation community distribution

The flora and fauna assessment (Section 3.2) and Regional Fauna Habitat (Section 3.3) was used to assist in the identification of biodiversity corridors.

A review of threatened ecological community distribution was undertaken to facilitate linking of key remnants. In accordance with NSW recovery strategies for *Acacia bynoeana, Melaleuca deanei, Tetratheca glandulosa,* a review of species location and population connectivity was undertaken in order to ensure that vegetation linkages between sites were retain or re-established. It was determined that connectivity and protection of these species was addressed within the Ku-ring-gai Regional Fauna Habitat.

Fauna assessment surveys in 2001 identified that the Cowan Creek and Middle Harbour catchments support a greater number of native fauna species than the Lane Cove River catchment (Smith and Smith , 2001). This is supported by further fauna surveys in 2003-2005 (Smith and Smith, 2005; Smith and Smith, 2004; Smith and Smith, 2003). In particular the Bush rat, Long-nosed Bandicoot and Swamp wallaby *(Wallabia bicolour)* were absent from Hawkesbury Sandstone vegetation in Lane Cove River catchment but recorded in similar vegetation in the other two catchments during these surveys (Smith and Smith, 2001). In fact the species that show the strongest patterns of differentiation between the three catchments are those that spend all or most of their time on the ground (Smith and Smith, 2005).This may reflect the lack of migration pathways available to terrestrial fauna in Ku-ring-gai. The Brushtail possum (*Trichosurus vulpecular*) and Sugar glider were also recorded only in the eastern bushland of the LGA. This provides evidence of the need for Biodiversity Corridors for arboreal fauna.

Throughout the LGA vegetation remnants on Hawkesbury Sandstone support more, native species of a greater diversity than those on Ashfield Shale. This disparity is likely due to the highly fragmented nature of Blue Gum High Forest on Ashfield Shale. Higher fauna diversity is recorded in sandstone vegetation in gullies when compared to sandstone vegetation on ridges and hillsides. In the Lane Cove River catchment the number of native fauna species was much higher in Hawkesbury Sandstone vegetation near watercourses than either sandstone vegetation on ridges and hillsides away from watercourses or isolated plots of BGHF on shale.
There are fauna in Ku-ring-gai that use all of these habitats and it is essential to maintain linkages between them.

Fauna assessment also demonstrates lower abundance of fauna in the Lane Cove Valley which are sensitive to disturbance. This is thought to be due to the lack of connectivity of bushland in the south to Lane Cove National Park. The eastern bushland, where species sensitive to disturbance were recorded, does not display this trend. This reflects the importance of maintaining habitat connectivity in the LGA, through the re-establishment of corridors where necessary.

Urban trees and exotic vegetation provide further significant habitat and migratory pathways for fauna in Ku-ring-gai. Fauna assessment in 2002 (Connell Wagner, 2002) identified Sugar glider bite marks on street trees at several locations in St. Ives. In the Cowan Creek catchment the Long-nosed bandicoot has been observed foraging in lawns and gardens adjacent to bushland (Connell Wagner, 2002). Several species, including some threatened species, will utilise vegetation remnants in urban areas to travel between larger bushland habitat.

Following drought and fire the ratio of urban birds to bush birds increases (Smith and Smith, 2001). This may reflect the lack of refuge habitats available to forest interior species, whereas urban adapted species can find habitat in the urban environment. The Biodiversity Corridor network aims to increase habitat opportunities and access for species which cannot survive in the urban environment.

Corridor design

a) Biodiversity Corridors should link core areas of habitat to support local and regional biodiversity (Section 3.4.1 for ecological principles of biodiversity corridors). These core areas include regional and local fauna habitat (Section 3.3), DECCW protected areas and Ku-ring-gai Natural Areas.

   The area of core habitat to which a corridor joins, is a primary consideration of corridor importance (Drinnan, 2005; Lindenmeyer, 1993).

   A review of Formal Reserve patch size within and adjacent to Ku-ring-gai was undertaken to assist in identification of core areas to be connected (See Figure 4 and glossary for patch size definition). This included mapping areas into 5 classes based on patch size (ha):

- > 100ha
- > 40ha to ≤ 100ha
- > 4ha to ≤ 40ha
- >2ha to ≤ 4ha
- ≤ 2ha

b) Biodiversity Corridors should link key vegetation communities and incorporate existing remnant vegetation.

Corridor pathways were designed to include areas containing Threatened Ecological Communities and/or good condition remnant vegetation to support the recovery of these communities.

c) Shorter Biodiversity Corridors minimise the exposure of flora and fauna to edge effects (Wilson and Lindenmeyer, 1995 as cited in Macdonald, 2003).

Where possible, biodiversity corridors have been designed to connect core habitat through the shortest possible distance. However, they have also been designed to incorporate remnant native vegetation within the urban environment; recognising its role for foraging and habitat stepping stones, facilitating fauna and flora movements. Due to the urban nature of the environment, this does not always result in the shortest distance between the linked habitats.

d) Minimise barriers

Road crossings have been minimised where possible, however, crossing of main, regional and local roads is required in order to link regional and local fauna habitat and address identified connectivity requirement of the LGA. For example, there are two corridors that cross Campbell Drive, Wahroonga. One links regional fauna habitat in Lower Campbell Reserve to the Middle Campbell Reserve Natural Area. The other links Middle Campbell Reserve to regional fauna habitat in South Campbell Reserve. These areas have been identified within biodiversity corridor mapping in order to recognise constraints and to facilitate future management (See Appendix C).

e) Include a diversity of habitats and topographies

Where possible corridors connected and incorporated a diverse range of vegetation communities and habitat types in order to provide opportunity for a greater range of species to access the corridor. For example, corridors connecting gullies to ridges have been found to support greater species diversity and abundance than corridors over a single topographic position (Lindenmayer *et al.*, 1993).

f) Areas identified for corridors should be practical and long term

Where design principles (stated in this section) allow, biodiversity corridors sought to align with riparian mapping (See Section 2.2). These areas will be required to be managed to protect the watercourses and the adjoining lands. Development is already required to be setback from watercourses, providing practical opportunities to restore well connected areas.

It is understood that duplication of the north shore rail line is planned. This would prevent opportunities over the long term to retain or re-establish suitable vegetation and habitat along these areas and therefore biodiversity corridors along these areas have not been identified. It should be noted that mapped threatened ecological communities will be incorporated into other Conservation Significance Assessment Categories (see Section 3.5).

g) 'Loop' design, where habitats are linked in a circular pattern and multiple corridors that link each habitat, are more robust than 'necklace' pattern corridors (Jordan, 2000) or corridors that end in 'dead-ends' (Tewkesbury *et al*, 2002).

Loop corridors were created, where possible, to form multiple connections between habitats. For example Regional Fauna Habitat to the west of Campbell Drive, Wahroonga is linked to Lower Campbell Reserve and adjoining bushland across Lucinda Avenue South in the north and Campbell Drive in the south. The connectivity of habitat is more robust with multiple linkages since if one corridor becomes degraded the others maintain the connection (Jordan, 2000).

Necklace corridor design has been adopted where an isolated Natural Area has been linked to Regional Fauna Habitat. Dead end corridors have only been incorporated where they correspond with a riparian corridor that contains threatened ecological communities and provides a closer link between north and south Regional Fauna Habitat across the LGA.

Corridor width

Though there is evidence that narrow corridors (<40 meters) of remnant vegetation are still beneficial for fauna dispersal (Bennett, 1990), it is generally agreed that wider corridors provide better protection from predators, more foraging opportunities, reduce edge effects and increase the likelihood of fauna migration (Lindenmeyer, 1994; Drinnan, 2005; Tischendorf and Wissel, 1997; Horn, 2003). A study of bird species diversity in road reserves in Western Australia (Arnold and Weeldenberg, 1990) found that the number of bird species significantly increased as road reserve width increased. Wider corridors also facilitate the migration of forest interior species as well as urban and edge species, especially where the corridor is in good condition (Drinnan, 2005).

Wider corridors have less edge for a given amount of area (Fahrig, 2003). Edge effects include:

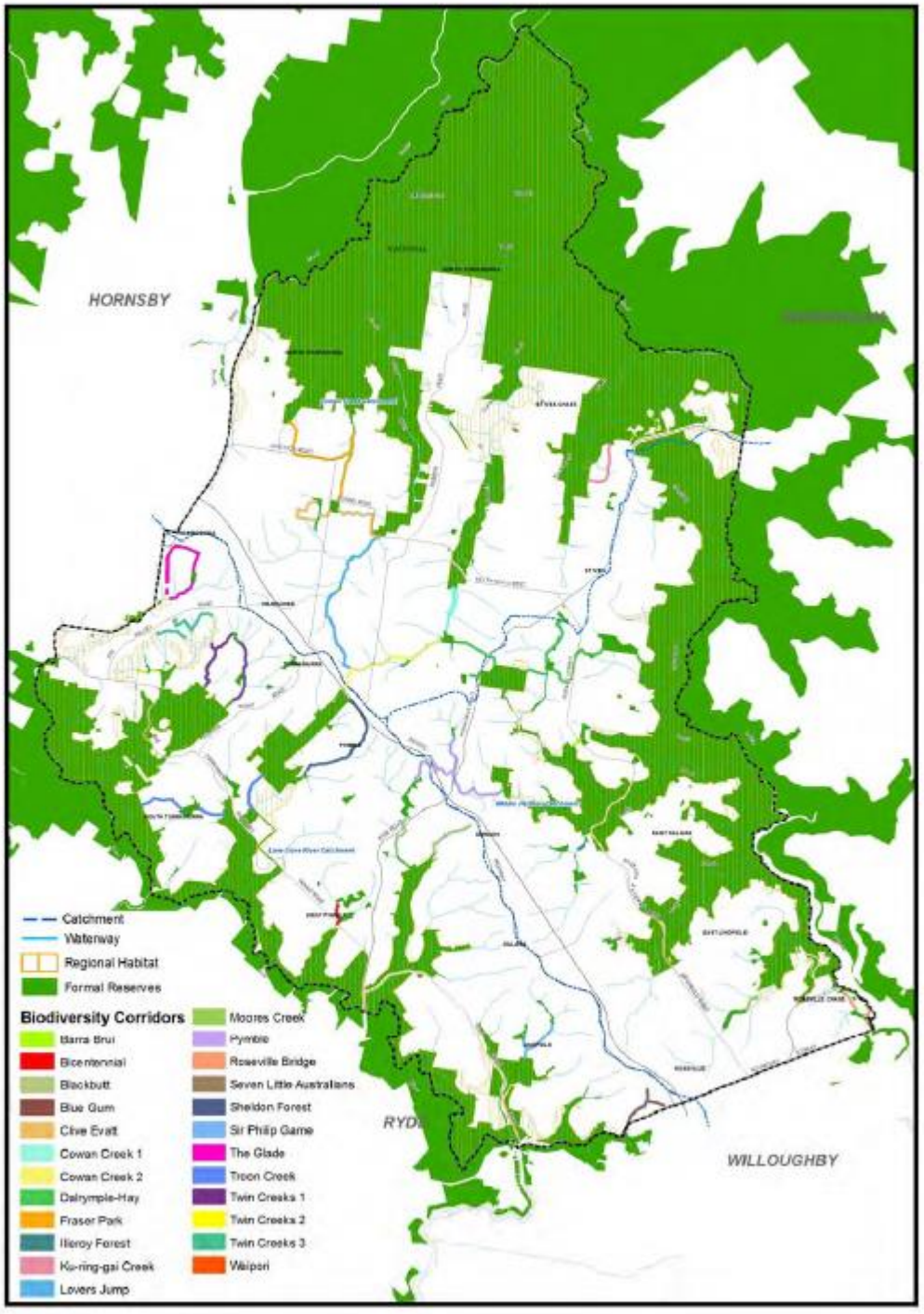
- Changes to the microclimate
- Weed invasion
- Increased predation
- Nutrient enrichment of the soil (Smith and Smith, 1997)

It is advised that corridors be greater that 25 m wide to prevent the increase of edge effects (LCC Biodiversity Strategy, 2003. Queensland Fisheries Service recommend minimum buffer widths for provision of wildlife habitat (15 – 45m), protection of remnant vegetation (5 – 100m) and sediment filter / control and stormwater run-off filter / control (30 – 90m) (Bavins *et al* 2000).

A 40m wide corridor is considered to be adequate for many species to use as a dispersal mechanism between core habitat areas (Horn, 2003). However species that do not tolerate urban or bushland edge environments may not travel through such a narrow corridor. Wider biodiversity corridors may be necessary to facilitate the migration of the shyer forest interior species (Drinnan, 2005). These species are more likely to move through Regional Fauna Habitat.

Given the limitations of the Ku-ring-gai urban environment a 40m wide Biodiversity Corridor has been adopted for all corridors with the exception of corridors that align with Riparian Lands mapping Category 1 'Environmental corridor'. Here a width of 80m was applied, matching riparian mapping Core Riparian Zones (See Section 2.2).

Figure 5: Biodiversity Corridors



3.5 Conservation significance assessment (CSA)

An LGA wide assessment of biodiversity conversation significance was undertaken using baseline data and overlay information outlined within Section 2 and 3.

The Conversation Significance Assessment (CSA) (***also referred to as 'Greenweb'***) identifies five (5) categories and will be used to inform Council's management and its LEPs and DCP (see Section 4.2.1).

An explanation of CSA categories and supporting information is provided below, along with important data preparation and limitation information. Maps showing CSA results are provided within Appendices F and G.

Data preparation

Riparian lands, Regional and Local Fauna Habitat and Biodiversity Corridor mapping
Additional information relating to preparation of data used in this analysis (including riparian lands, regional and local fauna habitat and corridor mapping) is provided in Sections 2 and 3.

Vegetation mapping, connectivity and patch size
Refer to Section 3.1 for additional information relating to preparation of vegetation data used in this analysis.

In addition to recognising protected and core habitat lands, the CSA mapping prioritises the protection of Key Vegetation Communities (KVCs).

Key Vegetation Communities include communities currently listed, or considered likely to be listed, under the *NSW Threatened Species Conservation (TSC) Act 1995, NSW Fisheries Management (FM) Act 1994* and / or the *EPBC Act 1999.*

Vegetation condition is a key factor determining the inclusion of remnant vegetation as a threatened ecological community, under the *TSC Act, FM Act* and *EPBC Act.* In order to accommodate future variations in federal and state scientific committee determinations and their interpretation, KVCs have been based upon vegetation community not condition. As such Key Vegetation Communities (KVC) are vegetation communities that align with Threatened Ecological Communities (listed under the *TSC Act, FM Act* and /or the *EPBC Act*) but may include areas outside the scope of conditions required to meet the determination.

A new vegetation community, Coastal Shale Sandstone Forest has been recognised within Ku-ring-gai's recent vegetation mapping and mapping by DECCW (DECCW 2009). The future legal status of this community is unclear at present and further consultation with OEH as part of the SMCMA mapping project (DECCW 2009) is being undertaken. From a precautionary standpoint, within the LGA this community should be treated as regionally significant and has been included within the CSA as a Key Vegetation Community.

The CSA used condition classes applied to Ku-ring-gai key vegetation community mapping (KC 2011a and 2011b) (See Appendix B and Section 3.1). Condition mapping within alluvial and estuarine areas mapped by DECCW (2009) was not easily translatable to KC vegetation condition classes. However all areas containing these communities are included under Greenweb categories that did not require the consideration of condition)) (See Table 5).

For all areas within Ku-ring-gai key vegetation community mapping (KC 2011a and 2011b), lacking condition class information, a category of low condition (TXU / TXUD) was applied.

An assessment of vegetation connectivity and patch size was undertaken as part of the CSA process to enable protection / consideration of more connected and larger patches of vegetation.

The assessment of connectivity was based upon direct connectivity of vegetation mapping, refined to canopy areas of ≥10m in height (with areas <10m in height included on an opportunistic basis) (See Section 3.1). It is acknowledged that vegetation below these heights may be part of a KVC or provide connectivity to larger remnants.

Key Vegetation Community (KVC) patch size was derived by grouping all directly adjoining areas of KVCs. When reviewing the final CSA mapping it is important to note that part of a patch may be included within an area identified as a higher category.

In order to allow for small scale regeneration and disturbances as well as mapping accuracy, a 2m buffer was applied to vegetation mapping data used within CSA. However, due to the fine scale mapping, the unbuffered vegetation mapping was used to determine patch size and connectivity (eg. vegetation adjoining Regional Fauna Habitat and adjoining vegetation in core riparian zones). For vegetation within Core Riparian Zones and Biodiversity Corridors the 2m buffer applied was restricted to the areas within the CRZ or Biodiversity Corridor.

Ku-ring-gai Natural Areas and Office of Environment and Heritage protected areas

For the purpose of CSA mapping, a review of drainage easements and access handles was undertaken for Ku-ring-gai Natural Areas and Office of Environment and Heritage protected areas (formal reserves). This review sought to exclude formal reserve areas extending into adjacent land uses, and that do not provide ecological functionality; thereby consolidating mapping of core biodiversity lands.

These drainage easements and access handles were included within the CSA mapping only where the land contained vegetation or riparian value, where the access handle or easement is relatively wide.

Limitations of the Conservation Significance Assessment (CSA)

- Limitations of the *Mapping and assessment of key vegetation communities across the Ku-ring-gai local government area* (KC 2012a and 2012b) apply to this Conservation Significance Assessment (See Section 3.1).

- The CSA utilises the identified Core Riparian Zone (CRZ) from riparian mapping as outlined within Section 2. Limitations relating to this mapping apply (See Section 2.2.1.).

- Mapping of Significant trees within KVCs was undertaken with reference to surrounding vegetation. As such where a tree is located within a larger remant KVC patch, the entire patch was mapped. As such mapping of Significant trees within KVCs includes the mapped area in which they are located. Where sufficient information was not available to refine location to a reasonable level the tree was excluded from this mapping.

- The purpose of this CSA is to foster a consistent and strategic approach to biodiversity management. Although there are considerable benefits to natural resource planning at this scale there are also limitations. Investigations at a site scale for DA and activity proposals may identify inaccuracies.

Conservation Significance Assessment methodology

The methodology for the Conversation Significance Assessment (CSA) (Greenweb) is outlined within Table 5, with further descriptions provided below.

The following category descriptions are provided in an alternate table based format within Appendix E. Maps of each category are provided at Appendices F and G.

Table 5: Ku-ring-gai Conservation Significance Assessment methodology

Category	*Description*
Category 1	Office of Environment and Heritage protected areas
	Ku-ring-gai Natural Areas
	Regional Fauna Habitat
Category 2	Key Vegetation Communities (KVCs), adjoining Category 1
	Local Fauna Habitat
	Vegetation within Core Riparian Zones: • Riparian categories 1, 2 and 3 – all vegetation • Riparian category 3a - limited to KVCs and KVCs adjoining vegetation within Core Riparian Zones as mapped above.
	All vegetation within Biodiversity Corridors
Category 3	KVC Patches that are ≥ 0.1ha in size or contain KVC vegetation in good, moderate condition
	Significant trees within KVCs and the mapped area in which they are located
Category 4	Areas of consolidation for Category 1 & Category 2
	Areas lacking vegetation within Biodiversity Corridors
Category 5	KVC Patches that are <0.1ha in size and do not contain KCV vegetation in good, moderate condition

Category 1

OEH protected areas

Formal reserves consisting of Office of Environment and Heritage estate managed for the purpose of biodiversity protection.

Ku-ring-gai Natural Areas

Formal reserves consisting of areas managed by Ku-ring-gai Council as Natural Areas under the *Local Government Act* 1993 for the purpose of biodiversity protection.

Regional Fauna Habitat

Regional Fauna Habitat includes regionally important connected areas of habitat providing resources for threatened and non threatened fauna species and populations (including national, state and regionally significant species).

Areas of Regional Fauna Habitat which cross major, regional and collector roadways have been included within this category, but have been identified in order to assist in the management of key barriers / breaks within the regional fauna habitat (See Figure 3).

See Section 3.3 for further background.

Category 2

Key Vegetation Communities (KVC) adjoining Category 1

These areas provide support for Category 1, through the protection and improvement of vegetation quality and quantity, providing a buffer, reducing the contrast between core lands and the urban environment.

This concept is supported by the recommendations for a 60m retained buffer zone of native vegetation around significant vegetation; in response to identifying impacts from human disturbance up to 60m from road edges within the Blue Mountains (Smith and Smith (1997). Similarly, NSW DECC (2007c) recommends an absolute minimum buffer of 50m to Duffys Forest.

Whilst lands adjoining core areas within Ku-ring-gai consist primarily of developed lands, there is still capacity to retain / enhance some form of vegetation assemblage and structure as a buffer supporting adjoining core areas.

These buffer areas have the ability to provide resources that encourage urban-sensitive species to utilise forest edges and adjoining areas, as well as reducing edge effects to consolidated vegetation. Enabling for example a higher level of bird diversity to be maintained (Hodgson 2005, Hodgson et al 2006). This benefit is enhanced by native vegetation but is also aided by exotic plantings.

Research has identified significant bird diversity and abundance within the LGA (See Appendix A). In addition, the proportion of housing and associated factors including habitat and predation have been recognised as influencing the movement of birds between native vegetation and the urban matrix (Hodgson et al 2006). Medium sized nectarivores have been observed to increase at the edges of high-density housing, encouraged by inappropriate planting (multitudes of large flowering cultivars) (Birds Australia et al 2005), and an increased predation ability (added by a reduction in the complexity of vegetation structure). In turn these birds have been observed to induce an inhibitory response among the small insectivores at the edges of high-density housing reducing bird diversity.

Local Fauna Habitat

Local Fauna Habitat is provided by isolated remnants located more centrally in the LGA. Mapping included areas within both private and public land ownership, including Ku-ring-gai Natural Areas.

See Section 3.3 for further background.

Vegetation within Core Riparian Zones:

- *Riparian categories 1, 2 and 3 – all vegetation*
- *Riparian category 3a - limited to KVCs*

and KVCs adjoining vegetation within Core Riparian Zones as mapped above.

Vegetation within CRZs provide support for riparian lands through the protection and improvement of vegetation quality and quantity.

All vegetation within these Core Riparian Zones (as identified in Section 2) has been targeted, including native and non-native species, with the exception of Riparian category 3a (consisting of piped creeks). For Riparian category 3a the areas identified in Greenweb category 2 is limited to mapped KVCs only, recognising the significance of these areas within any future restored landscape.

KVCs adjacent to CRZ areas described above have also been included within Greenweb category 2. These areas provide an increased buffer to CRZ within areas of ecological importance. Additionally connectivity provided by the CRZ helps to support the KVC area.

Vegetation within riparian areas provides a number of ecological services, including habitat, food resources, bank stability and sediment / nutrient filtration. They also act as microclimates, changing conditions in small remnant areas to support a variety of organisms as well as providing resources to nomadic, migratory and nearby resident species (Price et al 2007). Whilst occupying only a small proportion of the landscape, they support a greater variety and abundance of animal life than surrounding areas (Catterall et al 2007).

Riparian areas are known to be directly associated with many species. Apart from a wide array of invertebrates, in Ku-ring-gai, the Eastern Water Skink (*Eulamprus quoyii)*, the Eastern Water Dragon (*Physignathus lesueurii*) and a number of frog species are entirely dependant on riparian areas for dispersal and survival. A number of microbat species, ground dwelling marsupials and the endangered Powerful Owl (*Ninox strenua*)[3] depend on riparian zones regularly on a daily and seasonal basis.

The potential for moister environments to withstand temperature rises as associated with climate change may also play an important conservation role in the future. These areas provide for the protection of vegetation across the topographical range within the LGA. From 1st order streams, originating at shale bearing ridges though to 3rd order streams within sandstone gullies and estuarine environments.

[3] Ku-ring-gai has the highest recorded distribution throughout the Greater Sydney Region (Kavanagh 2004).

All vegetation within Biodiversity Corridors

This includes all vegetation, including non local / non native species, within Biodiversity Corridors.

See Section 3.4 for further background on biodiversity corridors.

Note that areas of within Biodiversity Corridors lacking vegetation are mapped within Category 4.

Category 3

KVC Patches that are > 0.1ha in size or contain KVC vegetation in good, moderate condition

This includes all vegetation of patch size ≥ 0.1ha in size or vegetation areas of good or moderate condition within the urban matrix.

The patch size of ≥ 0.1ha, is estimated to include an area of approximately 6 large established trees. This patch size aligns to the 0.1ha layout of nested 20 × 50 m and 20 × 20 m plots used for the assessment of vegetation condition, as used within Biobanking (DECC 2008b) and the Biometrics methodology for assessing clearing and ecological thinning proposals on terrestrial biodiversity under the *Native Vegetation Act 2003* (DECCW 2011).

This patch size is considerably larger than the 'standard' plot size (0.04ha) recommended by *Native Vegetation Interim Type Standard* for vegetation mapping and identification (Sivertsen 2009[4]). It is also larger than the minimum area of forest (0.05 hectares with tree crown cover >10%) used for emissions reporting and accounting purposes under the Kyoto Protocol (Cadman, 2008).

Note: A 5ha size threshold is adopted within the Biobanking methodology (DECC 2008a) and the BGHF listing advice under the EPBC Act (DEWHA 2005). A patch size analysis of Key Vegetation Communities ≥ 0.1ha as included within Category 3, identified that all patches ≥ 5ha are already mapped within Category 1 or 2.

These areas assist in the maintenance of TECs across a range of topographies. They also play an important role as biodiversity reservoirs, providing stepping stone links for fauna and seedbank / pollination resources to support the resilience of remnant vegetation patches.

Small patches can be valuable for native inverterbrates and for some birds (Fischer and Lindenmayer, 2002). Urban street trees for example, provide bird habitat for resting, nesting, feeding and hollow use (Young *et al* 2007, Tzilkowski *et al* 1986, Weleh 1994, Cannon 1999, Chamberlain *et al* 2004). They also provide habitat for pollinators, such as bats, that may be less constrained by landscape features (Aldrich & Hamrick 1998, cited in Sork and Smoise 2006).

Areas included within this category (as well as those identified within biodiversity and riparian corridors) provide genetic resources from remnant vegetation to support the ecological functions of both KVCs and non KVCs, and facilitate gene flow (reducing genetic erosion / isolation and the effects of fragmentation).

In urban areas where fragmentation has occurred, the main strategy to fight genetic erosion is the maintenance of a good quality and quantity of gene flow among fragments. "Fragmentation

[4] The *Native Vegetation Interim Type Standard* (Sivertsen 2009) addresses the quality and nature of the scientific processes for native vegetation type activities; and applies to all relevant vegetation activities to which the NSW Government is a signatory or to which the NSW Government makes a financial or in-kind contribution.

does not necessarily equate to genetic isolation", Krauss *et al* states (2007 p396). As long as there is sufficient gene flow between fragments, species should be able to survive and grow at a distant site. In other words, even though habitat may be separated, if the quality and frequency of gene flow can be maintained, genetic erosion should not occur. Sork and Smoise (2006) summarized that two elements measuring the degree of isolation of a fragmented landscape are the quantity of incoming pollen and the diversity of incoming gene sources.

As such the more connectivity and protection of sufficient / relevant remnant areas within the urban area, the higher the resilience the core areas will have.

Significant trees within KVCs and the mapped area in which they are located

This category includes trees within KVCs identified as significant during Ku-ring-gai Key Vegetation Community mapping (KC 2011a and 2011b).

This included the identification of local native trees; identified as significant due to the presence of habitat (e.g. a hollow), provision of food for wildlife, and / or exceptional form or size. This mapping provides an opportunistic selection of significant native trees and is not considered to capture every significant tree within the urban landscape.

Category 4

Areas of consolidation for Category 1 and Category 2

This consists of an 8m buffer applied to areas of Category 1 and 2, in order to highlight areas where improved connectivity/consolidation is sought. This may include both vegetated and non vegetated areas not already included within categories above.

These buffers will help to reduce edge effects on the ecological community (Smith and Smith, 1997; NSWDECC, 2007c). Edge effects include, for instance, the impacts of stormwater runoff, disturbance, dumping, weed encroachment, microclimate variations and nutrient changes. The buffer width is limited to 8m due to the practical constraints of the urban environment of Ku-ring-gai.

Areas lacking vegetation within Biodiversity Corridors

This category addresses areas lacking vegetation within identified Biodiversity Corridors. These areas are identified for enhancement to reconnect patches of remnant vegetation, facilitating the improvement of connectivity between core habitats. These areas may provide additional functions such as protection of water quality.

Considered within the context of surrounding vegetation and habitat, these areas will help to maintain and restore the health, diversity and connectivity of native species population and communities and improve their resilience under future climate change.

Note that vegetation within Biodiversity corridors' is addressed within in Category 2.

Category 5

KVC Patches that are <0.1ha in size and do not contain vegetation in good, moderate condition

Whilst smaller than patches identified within Category 3, these areas also provide habitat stepping stones, assist in the maintenance of TECs across a range of topographies, facilitate genetic flow and provide fauna habitat for more mobile / urbanised species.

4 Recommended land use planning measures

Under the state government's standard LEP instrument, a number of measures can be used to protect riparian lands and biodiversity. It is recommended that a combination of these be used for the relevant LEPs.

The proposed location, type and design of future development under the proposed LEPs need to consider the results of the strategic assessment of riparian lands and biodiversity outlined above. Further detail will need to be provided in the associated DCP/s. However, it is also recognised that a number of other factors must also be integrated with these considerations.

The results of the mapping and assessment process are recommended for incorporation within the Draft LEPs through a number of mechanisms:

- inclusion of environmental zones;
- incorporation of a map overlay, identifying areas of biodiversity significance (the *Biodiversity Map*);
- incorporation of a map overlay, identifying riparian lands (the *Riparian Lands Map*), broken down into the categories described in Section 2.2.1;
- inclusion of local provisions relating to the areas identified in the map overlays;
- inclusion of a local stormwater provision;
- increase in the minimum lot size, and a reduction in the maximum floor space ratio for larger sites in environmental zones;
- inclusion of the tree preservation provision.

More detailed controls would need to be provided in the DCP/s. It is recommended that controls be prepared specific to each category of the Greenweb.

4.1 LEP Zoning

The *Ku-ring-gai Planning Scheme Ordinance (1971)* (KPSO) is a deemed environmental planning instrument, that dates back prior to the EP&A Act. There are no environmental zones within the KPSO. It is recommended that four environmental zones be incorporated within the LEPs:

E1 – National Parks and Nature Reserves:

- This zone is intended to enable management and appropriate use of lands that are identified by OEH as 'protected areas'. These include National Parks and Nature Reserves. It is also intended to apply to sites proposed to be reserved under this Act to protect their environmental significance. The permissible land uses are set through the standard LEP instrument, as those governed by the *NSW National Parks and Wildlife Act 1974*
- This zone will apply to Ku-ring-gai Chase National Park, Lane Cove National Park, Dalrymple Hay and Garigal National Park and to land zoned E1 for the Ku-ring-gai Campus of the University of Technology, Sydney under *SEPP (Major Development) 2005*.

E2 -Environmental Conservation:

- This zone is intended to protect land that has high conservation value. The objectives for this zone are primarily related to the protection and restoration of areas of ecological, scenic, cultural or aesthetic values.
- A number of land uses considered to be inappropriate for this zone have been mandated as prohibited uses in the standard LEP instrument. Dwelling houses can be prohibited by councils within this zone. It is therefore most appropriate for reserves, or as a split zone on larger private sites. While split zoning is generally discouraged, there are instances where it may be justified.[5]
- It is recommended that the following lands be considered for inclusion within this zone:
  - Council owned lands categorised as Natural Areas under the *Local Government Act 1993*
  - Lands zoned for acquisition for conservation under the KPSO, namely lands zoned *County Open Space* and containing bushland that have not yet been acquired by the relevant authority. These sites are generally larger than standard residential sites. It is noted that this will result in split zones for some sites, as occurred in the KPSO, however, as many of the sites zoned in this way under the KPSO have now been acquired, the number of sites affected is far more limited. Where these lands are owned by state agencies the concurrence of the state agencies will be required for any proposed acquisition and consent for the proposed zoning.
  - Lands identified as E2 under *SEPP (Major Development) 2005* for Wahroonga Estate
  - Roads (including unformed roads), through, or in some cases, adjacent to, E2 lands.
  - Lands owned by state agencies or the Crown, that are identified as Regional or Local Fauna Habitat (eg in the abandoned B2 corridor in Wahroonga and Carcoola Rd St Ives). Consent from the state agencies and the Crown will be required.
  - Areas of high conservation value/Regional Fauna Habitat that are currently within split zones – e.g. currently open space and residential.

E3 -Environmental Management:

- According to the NSW Department of Planning (2009) this zone is for land *'where there are special ecological, scientific, cultural or aesthetic attributes or environmental hazards/ processes that require careful consideration/ management and for uses compatible with these values'.*
- The objectives of this zone under the Standard LEP Instrument, relate to the provision of development that will allow the protection, management and restoration of areas with special ecological, scientific, cultural or aesthetic values.

[5] For instance, drainage easements and access handles to formal reserves extending into adjacent land uses that do not provide ecological functionality were split from E2 zones. These drainage easements and access handles are only to be included as E2 only where the land contains vegetation, has riparian value, or where the access handle or easement is relatively wide.

- Mandatory permissible land uses to be included in the zone are restricted to dwelling houses, home occupations roads and environmental protection works. Uses such as seniors housing, service stations and multi-dwelling housing and retail premises are prohibited.
- The *Draft Background Paper on Managing Bushfire Risks Now and into the Future* (Ku-ring-gai Council 2011) recommends the use of this zone in certain extreme risk bushfire prone lands[6]. It is recommended that the zone be extended to protect Regional Fauna Habitat in these areas, forming a transition between high conservation value land, e.g. land zoned E1 or E2 and other land as recommended by the Department of Planning (2009).
- Isolated lots that meet these criteria may not be appropriate for the E3 zoning. The zone would be applied to lots in groups.
- The lands identified as E3 under *SEPP (Major Development) 2005* for the Ku-ring-gai Campus of the University of Technology, Sydney must also be retained as E3 in the PLEP.

E4 – Environmental Living:

- The objectives within the Standard LEP Instrument relate to the provision of low-impact residential development in areas with special ecological, scientific or aesthetic values.
- Mandatory land uses to be included in the zone are restricted to dwelling houses, home occupations, roads and environmental protection works. There are also a few mandatory prohibited uses.
- It is recommended that:
  - Additional permitted uses in the E4 zone include bed and breakfast accommodation, group homes and secondary dwellings. These uses can be compatible with the protection of environmental values, while allowing some additional residential development to occur on these sites.
  - The E4 zone be applied where a combination of ecological values and risks support greater restrictions on land uses and development.
  - Isolated lots that meet these criteria would not be zoned E4. The zone would be applied to lots in groups.
- This zoning would fit well with the urban nature of Ku-ring-gai.
- The *Draft Background Paper on Managing Bushfire Risks Now and into the Future* (Ku-ring-gai Council 2011) also recommends the use of the e4 zone to minimise bushfire risk. [7] Areas visible from Middle Harbour would also be included for the purposes of scenic protection. The E4 zone in these locations will also provide valuable ecological protection to vegetation and habitat within these sites.

[6] The application of the E3 – Environmental Management zone where land is constrained by hazards is recognised by the Department of Planning (2009). The land use table would prohibit uses that would increase the evacuation risk in these areas, (such as secondary dwellings, seniors housing, dual occupancy and bed and breakfast), uses that may result in combustible materials being stored or used on the site, as well as development types that are mostly used by the more vulnerable members of the community.

[7] The *Draft Background Paper on Managing Bushfire Risks Now and into the Future* (Ku-ring-gai Council 2011) recommends the use of this zone for lands identified as Category 1 or 2 bushfire prone lands in areas of lower risk than those identified for E3 zones.

Selection of E3 or E4:

There will be a number of areas in Ku-ring-gai, particularly residential areas, where a combination of ecological values and risks support an environmentally focussed set of zoning objectives and land uses. In determining whether an E3 or E4 zone should be applied to a particular site, at least the following aspects should be considered in combination:

- the biodiversity significance and extent of the lands within the site identified in the Greenweb map;
- the location and category of riparian land on the site;
- the steepness of the site;
- the bushfire risk;
- the scenic value (from Middle Harbour);
- proximity to and connectivity with formal reserves;
- high potential for site erosion;
- existing lot size/development configuration on the site.

Where a number of these factors combine in such a way as to make it preferable to apply the restrictions of an environmental zone, the most suitable zone would then be considered. Where bushfire evacuation risk plays a major role in the combination of factors, the E3 zone may be the most suitable. Where bushfire risk is not as high, and other factors point towards an environmental zoning, the E4 zone is likely to be applied.

4.2 *Environmental map/ overlays*

The standard LEP template allows for the incorporation of maps or overlays and associated local provisions in the Instrument. The advantage of a map overlay is that it is possible to co-ordinate and implement multiple natural resource management provisions and objectives, while allowing for development permissible within the zoning. The map overlay identifies areas that require consideration of specific objectives and provisions in order to ensure that important attributes within these areas are considered during the development assessment process.

It is recommended that this measure be used to support environmental outcomes in the draft LEPs currently under preparation. Similarly to the KLEP (Local Centres), two maps are proposed:

- *Biodiversity Map* and
- *Riparian Lands Map.*

4.2.1 Natural Resource – Biodiversity

An LEP is a strategic land use planning document. Accordingly, it is not appropriate to include every remnant patch or tree, even if potentially part of a threatened ecological community (TEC) within the LEP maps.

It is recommended that biodiversity *Categories 1 to 4* (within Section 3.5 of this report) be combined as a single overlay for the purposes of the LEPs. Maps may be found in Appendix F.

"Biodiversity loss is the most significant environmental problem facing Australia"
Professor David Lindenmayer. (2007) *"On Borrowed Time"*

Rare Urban Forest needs statutory Protection and Recognition

Awareness appears to have been suppressed by planning & development system.

1. Did the General Manager have to step in, in order to release this 2016 Report to environmental groups in 2020…. because it was concealed by the planning and development system?
2. Is current re-zoning in the Transition Town (TTT) proposed, Eco-literate about Urban Forest?
3. Is current re-zoning aware of future cumulative impacts on Urban Forest?

10/50 code The updated Code of Practice came into effect on Friday 4 September 2015. Whilst the new Code has undergone extensive review in light of 3500 submissions, Council considers that there are outstanding problems associated with the operation of the *Code* that need to be addressed. These include:

1. **10/50 Code has been developed without fire modelling and therefore has no scientific validation - scientific surveys highlight that ember attack is responsible for the majority of house losses during bushfires and the effect of clearing is marginal at best in high intensity fire events.**

2. Embers can originate from any number of sources including existing burning houses, gardens, commercial properties, roadside landscaping as well as from bushland. CSIRO research shows that embers will travel over distances ranging kilometres away. The removal of trees and bushland understoreys will not remove the threat of ember attack. There is evidence to suggest that **trees have an ember-blocking effect**.

3. RFS engagement with homeowners on ember-proofing of houses and property maintenance is fundamental to reducing threat from fire.

4. On-going building and property maintenance measures are supported by fire researchers and Council, but there is no mention of asset maintenance in the *Code*.

5. There must be a commitment by the RFS to undertake a detailed assessment of the effectiveness of 10/50 following any bushfire. If benefits cannot be clearly demonstrated, the Code should be repealed.

6. There is no available evidence in NSW of property damage due to the refusal by the RFS for vegetation clearing approval under the previous Bushfire Risk Assessments processes. As such, Bushfire Risk Assessments and the issuing of Hazard Reduction Certificates by the RFS have proved to be effective and should be reinstated.

7. The *10/50 Code* is a one-size-fits-all methodology that fails to consider the bush fire risk associated with individual locations and is clearly inappropriate for Ku-ring-gai Council. Risk has been replaced with proximity and is not equal for every vegetation community or for properties in suburbia where vegetation is largely disconnected by extensive road networks, hard infrastructure and large recreational spaces.

8. Vegetation assessment should be returned to RFS experts to determine risk and provide proven protection measures. **Self-assessment by inexpert residents invalidates the precautionary principle which underpins state and commonwealth environmental legislation.**

9. **It is irresponsible to engage residents as proxies for skilled RFS assessors who have undergone extensive training and assessment to apply their profession.**

Ecological / environmental consequences from operation of the *Code* as applicable in Ku-ring-gai:

10. Whilst the updated Code now includes vegetation that cannot be cleared including Critically Endangered species, habitats and ecological communities as scheduled in NSW; coastline; wetlands and special environmental SEPPs, it does not go far enough. Nearly 70% of Endangered Ecological Communities (EECs) in Ku-ring-gai occur on private land. Whilst Blue Gum High Forest and Shale Sandstone Transition Forest are now excluded from 10/50 due to their critical status, the following EECs are at risk in the LGA:

Vegetation Type	NSW *TSC Act*	Commonwealth *EPBC Act*
Coastal Flats Swamp Mahogany Forest	EEC	-
Coastal Upland Swamp	EEC	EEC
Duffys Forest	EEC	-
Estuarine Fringe Forest - Swamp Oak Floodplain Forest	EEC	-
Sydney Turpentine-Ironbark Forest	EEC	CEEC

11. Endangered is the step before extinction. There exists the real potential that the *Code* will push these vegetation communities gradually towards extinction. **We must remember this vegetation is endemic and occurs nowhere else in the world.**

12. The following threatened flora and fauna are afforded no protection under the Code:

State and Nationally Threatened Flora

Scientific Name	NSW *TSC Act*	Commonwealth *EPBC Act*
Acacia pubescens	Vulnerable	Vulnerable
Haloragodendron lucasii	Endangered	Endangered
Darwinia biflora	Vulnerable	Vulnerable
Eucalyptus camfieldii	Vulnerable	Vulnerable
Melaleuca deanei	Vulnerable	Vulnerable
Genoplesium baueri	Endangered	Endangered
Grammitis stenophylla	Endangered	-
Tetratheca glandulosa	Vulnerable	-
Epacris purpurascens var. purpurascens	Vulnerable	-

State and Nationally Threatened Fauna

Common name	NSW *TSC Act*	Commonwealth *EPBC Act*
Eastern Bent-wing Bat	Vulnerable	-
Eastern False Pipistrelle	Vulnerable	-
Eastern Freetail-bat	Vulnerable	-
Eastern Pygmy-possum	Vulnerable	-
Greater Broad-nosed Bat	Vulnerable	-
Grey-headed Flying-fox	Vulnerable	Vulnerable
Large Pied Bat	Vulnerable	Vulnerable
Little Bentwing-bat	Vulnerable	-
Southern Brown Bandicoot	Endangered	Endangered
Southern Myotis	Vulnerable	-
Spotted tailed Quoll	Vulnerable	Endangered
Yellow-bellied Sheathtail-bat	Vulnerable	-
Red-crowned Toadlet	Vulnerable	-
Rosenberg's Goanna	Vulnerable	-
Barking Owl	Vulnerable	-
Gang-gang Cockatoo pop. Hornsby and Ku-ring-gai LGA	Endangered (Pop), Vulnerable	-
Glossy Black-Cockatoo	Vulnerable	-
Little Lorikeet	Vulnerable	-
Powerful Owl	Vulnerable	-
Regent Honeyeater	Endangered	CE

State and Nationally Threatened Populations

Scientific Name	Common name	NSW *TSC Act*	Commonwealth *EPBC Act*
Callocephalon fimbriatum	Gang-gang Cockatoo pop. Hornsby and Ku-ring-gai LGA	E (Pop), V	-

Internationally Significant Biodiversity

Species Name	Common Name	International Status*
Apus pacificus	Fork-tailed Swift	C,J,K
Hirundapus caudacutus	White-throated Needletail	C,J,K
Egretta sacra	Eastern Reef Egret	C

Haliaeetus leucogaster	White-bellied Sea-Eagle	C
Calidris acuminata	Sharp-tailed Sandpiper	C,J,K
Calidris ferruginea	Curlew Sandpiper	CE,C,J,K
Limicola falcinellus	Broad-billed Sandpiper	C,J,K

* C =Listed on China Australia Migratory Bird Agreement, CD =Conservation Dependent (Commonwealth EPBC Act 1999),CE =Critically Endangered (Commonwealth EPBC Act 1999) ,E =Endangered (Commonwealth EPBC Act 1999) , J=Listed on Japan Australia Migratory Bird Agreement , K =Listed on Republic of Korea Australia Migratory Bird Agreement, KTP= Key Threatening Process (Commonwealth EPBC Act 1999), V =Vulnerable (Commonwealth EPBC Act 1999), X=Extinct (Commonwealth EPBC Act 1999), XW =Extinct in the Wild (Commonwealth EPBC Act 1999)

13. The Code is contributing to a **key threatening process** (Clearing of Native Vegetation) under OEH legislation has significant ramifications for **inter-generational equity** as well as contravening the international *Convention on Biological Diversity*, which Australia is a party to. It would be a tragic legacy to lose species of local, national and international significance to an unproven policy.

14. The loss of majestic remnant trees that define Ku-ring-gai will negatively impact on birds and mammals and fragment or eliminate important wildlife corridors. Whilst the Code does not condone injury to wildlife, potentially many hollows (which may take more than 80 years to form) will be lost to threatened species such as powerful owls.
15. Most native species are cryptic (shy) and it is likely residents are unaware of their presence. Detection may take the experience of an ecologist, as some fauna may only be identified by certain tree markings, scats or through the use of hidden cameras or trapping devices. **The use of the *Code* condones inadvertent damage to valued habitat and hence poses a real threat to native species.** Even if there was a breach, it would be out of sight and out of mind. The **loss of hollows** and habitat is a **key threatening process** under OEH legislation. Again, the *Code* is expecting residents to act as proxy wildlife experts and determine fauna presence and habitat. This neither realistic nor reasonable.
16. The *Code* conceals the actual clearance area affected. A typical single dwelling in Ku- ring-gai is 20m x 15m on a vegetated block; hence the area impacted by tree removal would be about 1500 sq. metres, while the understorey clearance area could potentially be 1.35 hectares. This is an enormous impact if it were to be fully realised.
17. Edge effects, which are the negative consequences of clearing on the perimeter of bushland, can include an increased exposure of sunlight and wind and an alteration to evaporation rates and water runoff, essentially drying the land and making it more fire prone. These effects can permeate nearly 60 metres into bushland and

    have other inevitable consequences such as erosion, weed invasion, changes to fauna and flora assemblages and increases in predation by foxes and cats as core habitat is opened.

18. Whilst the *Code* protects Aboriginal heritage as mapped, if the land parcel does not contain legal protection, it is up to the resident to determine if a tree is an 'Aboriginal scar tree' using an on-line OEH field manual. Not all scarred trees have been found or recorded and again the *Code* is requiring residents to act as Aboriginal heritage experts. If one tree is accidently removed because of inexpert application of the manual, who is to blame? This heritage is special to every Australian and future generations.

19. **The Code has removed red tape and transferred a number of complicated conditions onto the landowner who is now required to be an 'expert' in environmental land management practices.**

20. There is no evidence that the *Code* is being accessed, read and followed and it is very difficult for Council officers to detect breaches when they are not informed of the clearing to begin with. It is usually up to neighbours to notify Council and this has various enforcement issues due to timing and the willingness of complainants to provide evidence.

21. Since its introduction, observations indicate that the *10/50 Code* is being used to remove trees to improve views, facilitate development, build garden sheds and other non-bushfire related purposes. Some trees are being removed because residents don't like raking up leaves.
22. The *Code* is also being taken advantage of by commercial tree and land clearing contractors and fly-by-night operators for their own commercial gain. There are reports from many areas within Ku-ring-gai of commercial operators letterboxing residents and groups of apparently unqualified tree fellers pushing for business door-to-door. It is surprising there has not been a fatality as yet. Is anyone policing these operators?

23. A significant workload (cost of time and resources) is placed on Council to field queries and ensure that compliance exists with the Code. However, there are no regulatory provisions or formal monitoring as there is no approval process or register. Furthermore, resources for this regulatory role do not exist nor is funding available for additional resources.

24. Treed landscapes that are valued by residents and add economic value to the locale are being degraded. Some streets and even parts of suburbs have had their character already changed. Some of these trees are over 90 years old and will never be enjoyed by the public again and most probably will never be replaced, and all this for unproven protective gain.

25. The *Code* needs to be repealed immediately to stop these actions and before another listed ecological community, population or species is mulched and pushedto extinction for unproven protective gain.
26. Council encourages the return of Bushfire Risk Assessments and the issuing of Hazard Reduction Certificates by the RFS and for tree removal to be regulated byLocal Government with effective monitoring and enforcement provisions.

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Please email for questions.