Pittwater Native Vegetation Management Plan

December 2012

PITTWATER COUNCIL

Bangalay (Ecological and Bushfire)

Eastcoast Flora Survey

Signed:

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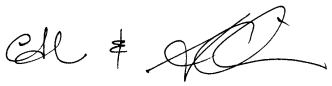

October, 2011

Bangalay Botanical Surveys/ Bangalay (Ecological and Bushfire)

Signed:
Stephen Bell

September, 2011

Eastcoast Flora Survey

Acknowledgements: The vegetation community profiles referred to in this document have been developed for the Pittwater Local Government Area based on that completed by DECCW for the Sydney Metropolitan Catchment Management Authority. As far as possible they follow the same formatting and community nomenclature as that project, so that both projects can interrelate with ease. Many thanks to Daniel Connolly (DECCW), for his preparedness to link the two projects in this way, and also for discussions and information about the vegetation of the Sydney region.

Pittwater Council is thanked for their support of this project, and in particular Pittwater Council staff members Mark Beharrell, Kim Macqueen, Matt Hansen, Karin Nippard and Lavinia Schofield. The following land owners and land managers are thanked for permission to access their lands: National Parks and Wildlife Service, Pittwater Council and Katandra Sanctuary.

Citation

The reports should be cited as follows:

Bangalay (Ecological and Bushfire) and Eastcoast Flora Survey. 2011. '*Pittwater Native Vegetation Classification, pre-1750 Vegetation Mapping and Vegetation Profiles*'. Report prepared for Pittwater Council.

Bangalay (Ecological and Bushfire) and Eastcoast Flora Survey. 2011. '*Pittwater Native Vegetation Management Plan*'. Report prepared for Pittwater Council.

Bangalay (Ecological and Bushfire) and Eastcoast Flora Survey. 2011. '*Pittwater pre-1750 Native Vegetation Mapping*'. GIS prepared for Pittwater Council.

Amendments				
Version	**Amendments**	**Signed**	**Date**	**Approved**
v. 1.1 Final Draft Report		SC, SB and CD	5th October, 2011	
v.1.2 Final Draft Report		Kim Macqueen	16th January, 2011	
V.1.3 Final Draft Report		Matt Hansen	30th April, 2012	
Final Version		Matt Hansen	30th October, 2012	

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Executive Summary

In response to the Strategic Plan 2020 'Our Sustainable Future', Pittwater Council commissioned a native vegetation mapping and management plan for the Pittwater Local Government Area (LGA). The purpose of the Mapping and Plan is to assist council to improve the viability of native vegetation in Pittwater and to effectively manage habitat and linkages within the LGA.

The plan applies to the entire Pittwater Local Government Area, including both public and private land, excluding National Parks and other lands which are managed by the Office of Environment and Heritage (formerly the Department of Environment, Climate Change and Water, DECCW).

The scope of the study encompasses the following components:

(i) ***'Pittwater Native Vegetation Management Plan'*** which is referred to hereafter as the Vegetation Management Plan or the 'Plan' which outlines an effective means of managing native vegetation within Pittwater Local Government Area (LGA).

(ii) ***'Pittwater Native Vegetation Classification', and pre-1750 Vegetation Mapping and Profiles'*** has been undertaken to assist council to manage the viability of native flora in Pittwater and to manage habitat and vegetation types within the LGA. The pre-1750 vegetation mapping examines the loss of habitats in the intervening period, and the associated mapping for specific issues including development assessment is provided in the accompanying GIS layers.

(iii) ***'Vegetation Profiles'*** which can form the basis of a guide to the supplementary habitat / planting within the defined mapping units to encourage appropriate plant selection, for landscaping and restoration and recreation activities.

The Pittwater Native Vegetation Management Plan is consistent with the principles and stated obligations relating to sustainability under the NSW *Local Government Act 1993*. The aim of this plan is to provide a procedural and working management plan which reflects the overall purpose and intent of the Pittwater Sustainability Policy (Pittwater Council, Policy No. 164) and the Pittwater Council 2020 Strategic Plan by:

- assisting decision making in relation to long and short-term environmental management;
- promoting and encouraging environmental awareness and responsibility in the community;
- improving the sustainability of the environment on a local and regional scale; and
- aiding in the process of continuous improvement of environmental performance associated with the management of vegetation within the LGA.

The plan also satisfies the requirements of SREP 20 in that it addresses a range of specific planning policies and recommended strategies. It also meets the objectives of the Sydney Metropolitan and Hawkesbury-Nepean Catchment Action Plans.

This Vegetation Management Plan incorporates the goals and objectives of Pittwater Council's 2020 Strategic Plan, in particular its Biodiversity Strategy objectives, including:

(i) Valuing and Caring for our Natural Environment
- to protect, enhance, conserve and restore bushland and creek ecosystems;
- to maintain abundance of diversity of Pittwater's native plant and animal species.

(ii) Biodiversity Strategy
- to manage catchments, habitats, corridors and ecosystems effectively;
- to halt the loss of biodiversity and advance its recovery;
- to lead by example in managing natural and built assets;
- to protect threatened species by reducing the rate of loss of those species.

(iii) Vegetation Strategy
- to sustainably manage urban forest and native bushland;
- to promote use of native vegetation species; and
- to recognise bushland, landscape and vegetation in land use allocation and development controls.

This Plan and associated mapping also aims to:

1. Provide a basis for ongoing management and monitoring of the Pittwater Local Government Area environment relevant to:
- the presence, condition and resilience of endangered (*Threatened Species Conservation Act 1995*) or threatened ecological communities (*Environment Protection and Biodiversity Conservation Act* 1999);
- existing and potential threats to any ecological communities, species or endangered population or habitats present;
- identifying and addressing threatening processes and abatement measures; and
- outlining means by which environmental change can be measured over time.

2. Set out strategic measures and actions for native vegetation management, including:
- the protection of natural features and conservation of native vegetation by establishing measurable goals and the means by which those goals can be achieved;
- the maintenance of natural processes;
- educate residents regarding the likely effects of either exclusion or excessive use of planned or unplanned fire within the LGA;
- to aid in bushfire management, manage fire regimes and hazard reduction to avoid the extinction of indigenous species, populations and communities known, or with potential, to occur within the area;
- to delineate management actions to be implemented over a specified cycle in order to mitigate identified or perceived threats; and
- to outline an appropriate monitoring strategy.

This study has determined that at the LGA scale, and time of writing, the Pittwater LGA encompasses 10,900ha of land. Of this, 43% (approx. 4693ha) occurs within Ku-ring-gai Chase National Park, and 15% (approx. 1650ha) occurs in water bodies (principally Pittwater Estuary).

Of the remaining land in the LGA (i.e. 4557ha), 83% of the original pre-1750 vegetation has been cleared or significantly disturbed (i.e. 3,624ha), with 17% of the pre-1750 vegetation extent remaining (i.e. 933ha), of which 430ha is within Council reserves and in good condition.

Of the extent remaining, a total of 36 native vegetation communities have been identified, 10 of which are listed Endangered Ecological Communities (EECs) in NSW.

NOTE: This report and associated documents should **not** be used either partially or wholly as a replacement for ecological impact statements (flora and fauna assessments) as required under Council's Development Control Plan policy for the purpose of development assessment and/or evaluation under Part 4 or Part 5 of the *Environmental Planning & Assessment Act 1979*.

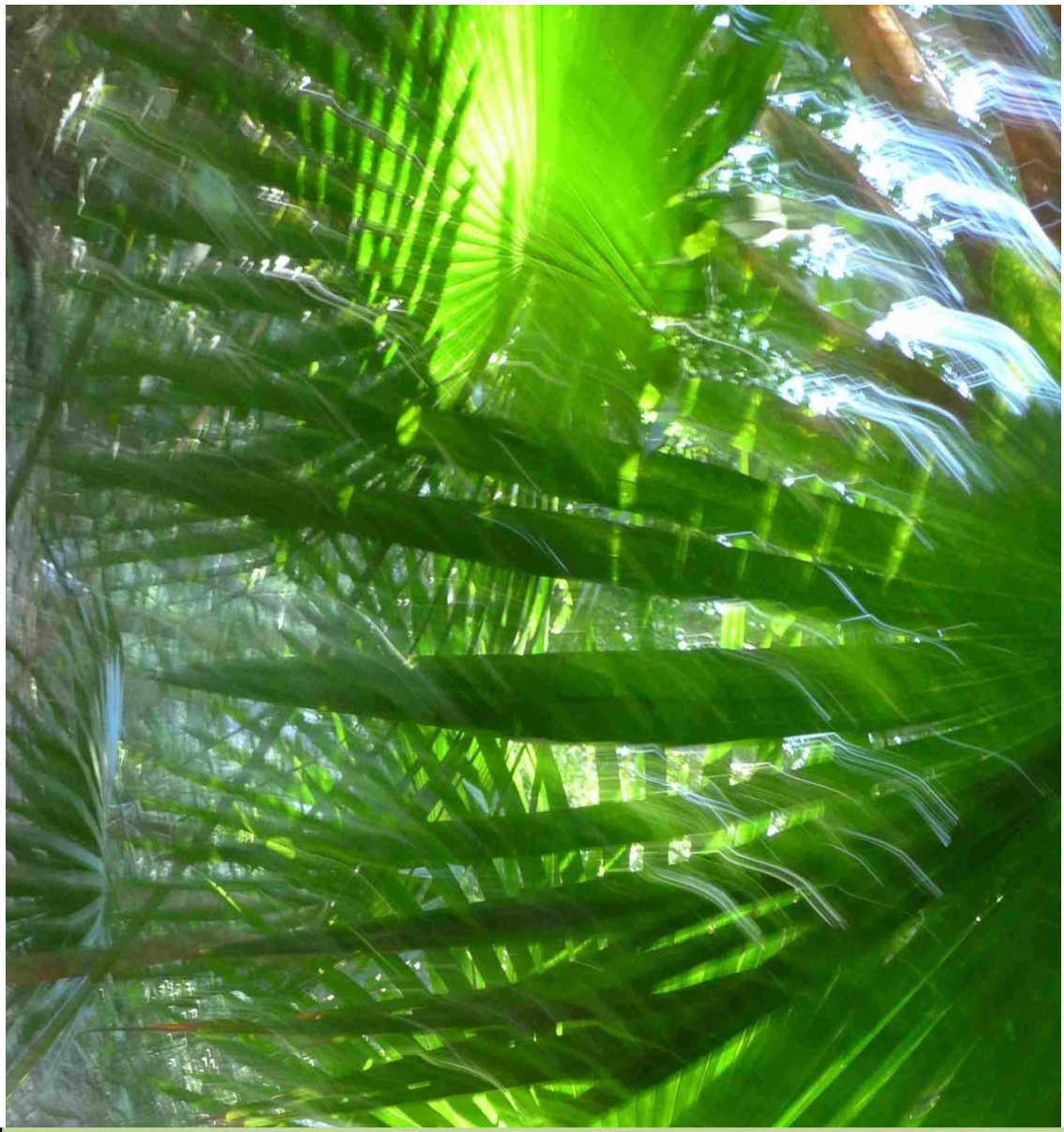
The Summary Tables below outline Management Issues, Key Threatening Processes and their priority.

Summary Table - Management Issues and Priority for Mitigation

Management Issue	Priority Rank	Priority Status (2012-2017)
Fire regimes		
Inappropriate fire regimes - fire exclusion	High	Ongoing
Inappropriate fire regimes – frequent burning	High	Ongoing
Inadvertently increasing fire risk	High	Ongoing
Rate of vegetation loss within Pittwater LGA	High	Ongoing
Hydrological regimes		
Weed incursion associated with stormwater and erosion	Medium-high	Ongoing
Pollution controls associated with construction	Medium-high	Ongoing
Urban Interface Management		
Management of the urban interface	Medium-high	Ongoing
Edge effects and barriers	Medium	Ongoing
Horticultural introduction of opportunistic weed species	Medium	Ongoing
Inappropriate plant species selection for regeneration and landscaping	Medium-high	Ongoing
Management of Public Access		
Vegetation damage due to inappropriate pedestrian access	Medium-high	Ongoing
Vegetation Management		
Low recruitment of upper canopy species	Medium-high	Ongoing
Genetic changes to plant species on a local and regional scale	Medium-high	Ongoing
Reserve shape and area: high edge-to-area ratios	Medium	Ongoing
Intensive management of vegetation types which would otherwise be subject to natural changes in species composition	Medium	Ongoing
Inadvertent encroachment of weed species by means of routine management and disposal of garden wastes in bushland	Medium	Ongoing
Coastal Zone Management		
Foredune trampling	High	Ongoing
Loss of vegetation, erosion of coastal clifflines and foreshores (e.g. due to climate change and increased wave action through boat activities etc)	High	Ongoing
Biodiversity loss		
Biodiversity loss	High	Ongoing
Corridors and loss of connectivity	Medium-high	Ongoing
Presence of Flying Foxes	Medium-high	Ongoing
Koala Habitat	Medium	Ongoing
Adequate Development Controls		
Improving Development Controls	High	Ongoing

Summary Table - Mitigation of Key Threatening Processes of relevance to the Pittwater LGA

Threatening Process	Priority Rank	Priority Status
Anthropogenic Climate Change		
Anthropogenic climate change and loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	High	Ongoing
Habitat Alteration		
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	High	Ongoing
Loss of hollow-bearing trees (proposed key threatening process declaration)	Medium-high	Ongoing
Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands	Medium-high	Ongoing
Clearing of native vegetation and land clearance	High	Ongoing
Removal of dead wood and dead trees	Medium-high	Requires investigation
Pathogenic		
Infection of/dieback in native plants by *Phytophthora cinnamomi*	Medium-high	Ongoing
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	Medium-high	Ongoing
Habitat Invasion		
Competition and grazing by the feral European rabbit	Medium	Ongoing
Competition from feral honeybees	Medium-high	Ongoing
Introduction of the large earth bumblebee, *Bombus terrestris*	Medium	Ongoing
Importation of Red Imported Fire Ants into NSW	Medium	Ongoing
Invasion of the Yellow Crazy Ant (*Anoplolepis gracilipes* (Fr. Smith)) into NSW	Medium	Ongoing
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	Medium	Ongoing
Invasion and establishment of exotic vines and scramblers	Medium-high	Ongoing
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.	High	Ongoing
Invasion of native plant communities by *Lantana camara*	Medium-high	Ongoing
Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*	Medium	Ongoing
Invasion of native plant communities by bitou bush and boneseed	Medium-high	Ongoing
Invasion of native plant communities by exotic perennial grasses (Including Gamba Grass)	Medium-high	Ongoing
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	Medium	Ongoing
Aquatic and Marine		
Degradation of native riparian vegetation along New South Wales water courses	Medium-high	Ongoing



Pittwater Native Vegetation Management Plan

Part 1 Introduction

1.0 INTRODUCTION

1.1 Background

In response to the Strategic Plan 2020 Our Sustainable Future, Pittwater Council has commissioned this plan for the management of native vegetation within the Pittwater Local Government Area (LGA) as shown in Figures 1 and 2 below. This Mapping and Plan is to assist council to improve the viability of locally native flora in Pittwater and to effectively manage habitat and vegetation types within the LGA. The plan applies to the entire Pittwater Local Government Area, including both public and private land (excluding National Parks, which are managed by the Office of Environment and Heritage, formerly the Department of Environment, Climate Change and Water (DECCW)).

The Plan and associated mapping addresses the key direction 'Valuing and Caring for our Natural Environment' within Pittwater Council's 2020 Strategic Plan - Our Sustainable Future. The broad goals of this key direction are:

- to protect, enhance, conserve and restore remnant bushland and ecosystems;
- to maintain an urban forest; and
- to maintain abundance and diversity of Pittwater's native plant and animal species.

Further, the plan addresses the following strategies under this key direction and the associated objectives:

(1) Biodiversity Strategy
- to manage catchments, habitats, corridors and ecosystems effectively;
- to halt the loss of biodiversity and advance its recovery;
- to lead by example in managing natural and built assets; and
- to protect threatened species.

(2) Vegetation Strategy
- to sustainably manage urban forest and native bushland;
- to promote use of native vegetation species; and
- to recognise bushland, landscape and vegetation in land use allocation and development controls.

1.2 Objectives of this Plan

The *Pittwater Native Vegetation Management Plan* is consistent with the principles and stated obligations relating to sustainability under the NSW *Local Government Act 1993* (SECT 8 – The Councils' Charter); the aim of this plan is to provide a procedural and working management plan which reflects the overall purpose and intent of the Pittwater Local Government's Sustainability Policy (Pittwater Council Policy No. 164) and the Strategic Plan 2020 by:

- assisting decision making in relation to long and short-term environmental management;

- promoting and encouraging environmental awareness and responsibility in the community;
- improving the sustainability of the environment on a local and regional scale; and
- aiding in the process of continuous improvement of environmental performance associated with the management of vegetation within the LGA;

The plan is also consistent with the requirements of Regional Environmental Plan No. 20 (SREP 20, 1997) which aims to integrate planning with catchment management to protect the Hawkesbury–Nepean river system by considering impacts associated with land-use (water quality and quantity, environmentally sensitive areas, riverine scenic quality, agriculture and urban and rural residential development) in a regional context. The plan also satisfies the requirements of SREP 20 in that it addresses a range of specific planning policies and recommended strategies (Total Catchment Management Policy). The Plan is also consistent with the Sydney Metropolitan and Hawkesbury-Nepean Catchment Action Plans.

This Plan provides a basis for ongoing management and monitoring of Pittwater Local Government Area relevant to:

- the presence, extent, condition and resilience of threatened or Endangered Ecological Communities (EECs), threatened species or endangered populations (as listed under the Schedules of the *Threatened Species Conservation Act 1995* and/or the *Environment Protection and Biodiversity Conservation Act 1999* (Cwth.));
- existing and potential threats to any ecological communities, species or endangered population or habitats present;
- identifying and addressing threatening processes and abatement measures, and
- outlining means by which environmental change can be measured over time.

This Plan sets out strategic measures and actions for native vegetation management, including:

- the protection of natural features and conservation of native vegetation by establishing measurable goals and the means by which those goals can be achieved;
- the maintenance of natural processes;
- educate residents regarding the likely effects of either exclusion or excessive use of planned or unplanned fire within the LGA;
- to aid in bushfire management, manage fire regimes and hazard reduction to avoid the extinction of indigenous species, populations and communities known, or with the potential, to occur within the area;
- to delineate management actions to be implemented over a specified cycle in order to mitigate identified or perceived threats; and
- to outline an appropriate monitoring strategy.

NOTE: this report should **not** be used as a replacement for ecological impact statements (or flora and fauna assessments) as required in Pittwater Council's Development Control Plan for the purpose of development assessment and/or evaluation under Part 4 or Part 5 of the *Environmental Planning & Assessment Act 1979*.

Although the accompanying classification of vegetation within Pittwater Local Government Area excludes National Parks and other land managed by OEH, the Pittwater Native Vegetation Management Plan includes reference to vegetation within National Parks, allowing future management of vegetation to be considered across the entire LGA. The *Plan* and accompanying classification aims to improve the management of vegetation communities and threatened plant species on both private and public lands within the Pittwater LGA.

Recommendations are provided to manage vegetation communities and species across the LGA particularly in relation to:

- the provision of baseline data for planning documents including Council's Local Environment Plan and Development Control Plan (DCP); Wildlife Corridor Strategy; and Public Area Plans of Management;
- the implementation of priority action statements (PAS) for threatened plant species and endangered ecological communities (Appendix 12);
- the provision of performance indicators in order to monitor the effectiveness of the plan;
- aid in the assessment of development applications and post development compliance (*e.g.* recommendations for landscaping and retaining bushland and managing bushfire requirements *e.g.* Asset Protection Zones (APZs));
- managing the balance between bushfire threat and maintenance of biodiversity with input to existing prescriptions relating to fire intensity and fire intervals for specific vegetation communities;
- climate change;
- tree planting to sustain Pittwater's tree canopy (including species and locations);
- review to accuracy pre-1750 mapping of vegetation;
- identifying vegetation communities and habitat types at risk and what actions should be taken to reduce that risk; and
- providing descriptions of the vegetation categories that are locally relevant and correspond with the Biodiversity Banking Scheme – "BioBanking" vegetation categories and Scientific Committee Determinations.

2.0 ENVIRONMENTAL SETTING

2.1 Site Location and Character

Pittwater Local Government Area (LGA) is located approximately 30km north of the Sydney CBD, and is bounded by Broken Bay to the north, the Tasman Sea to the east, Narrabeen Lagoon to the south, Deep Creek to the south west and Pittwater to the west (excepting several small villages on the western shore of Pittwater, including Great Mackerel Breach, Lovett and Elvina Bays).

The total land area of Pittwater LGA is approximately 125km^2 (Pittwater Council website, 2011) of which approximately 43% is National Park. The remainder is a mix of semi-rural and urban areas and water bodies, particularly the Pittwater estuary (refer to Table 1). Bushland reserves comprise 430 hectares extending over 20 suburbs and offshore localities. The local population is approximately 58,818 (Pittwater Council website, 2011) resulting in a population density of approximately 6.5 persons/hectare.

Pittwater LGA occurs within the Central Coast botanical division of New South Wales; 80% of the LGA occurs within the Pittwater sub-region of the Hawkesbury-Nepean Catchment Management Authority Region, and the balance in the Sydney Metropolitan Catchment Management Authority Region.

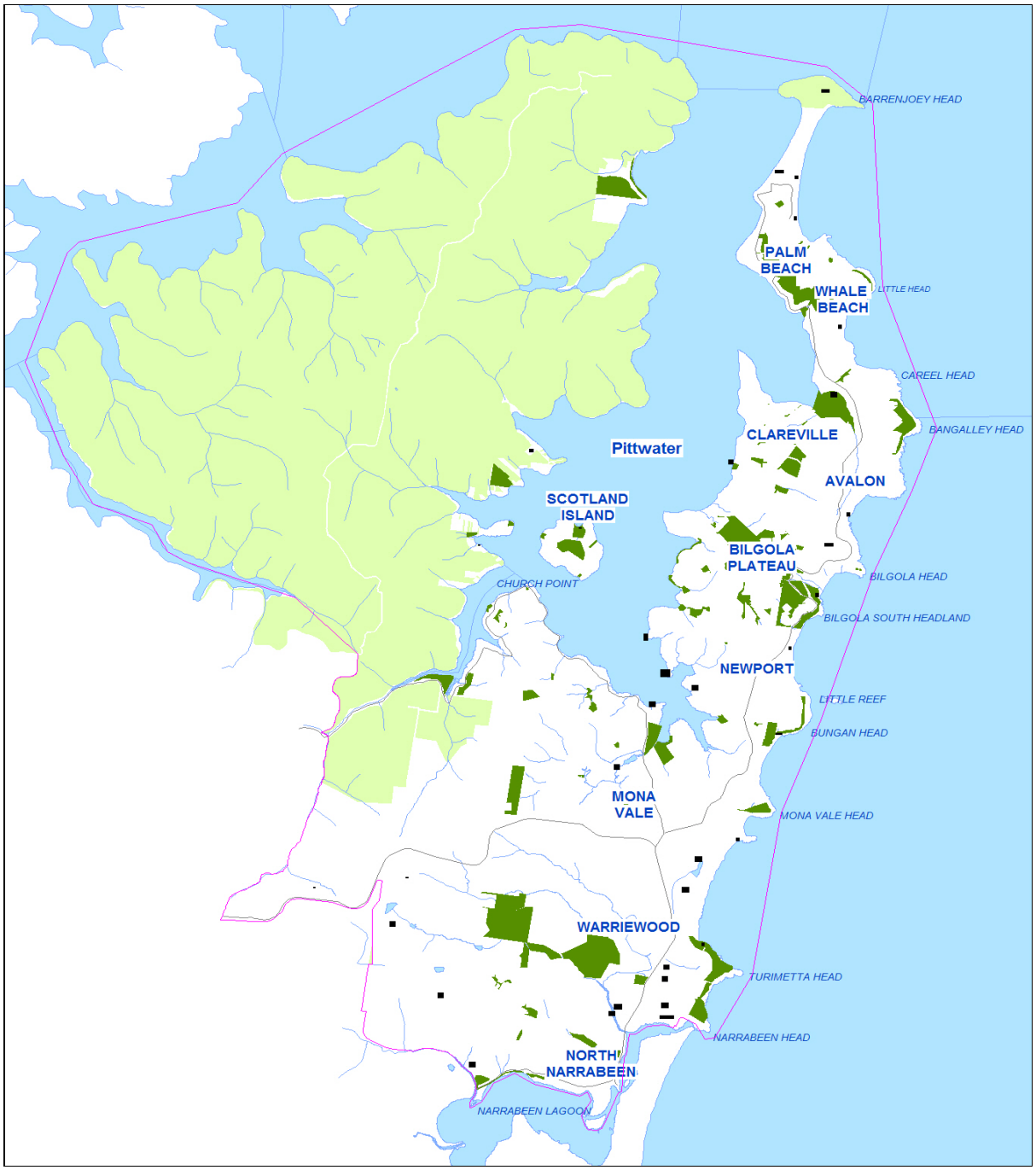
Pittwater Council is a member of the cooperative group 'Shore Regional Organisation of Councils' (SHOROC) representing councils on Sydney's Northern Beaches (Manly, Mosman, Pittwater and Warringah).

Figure 1 Location of Pittwater LGA relative to other SHOROC councils on Sydney's Northern Beaches (Manly, Mosman, Pittwater and Warringah). (Source: Department of Lands).

Table 1 Pittwater LGA

	Percent (%)	Hectares
National Park	43	4693
Water bodies	15	1650
Semi-Rural / Urban	42	4557
Total	100	10,900

Figure 2 Pittwater Local Government Area (Source: Pittwater Council).



Key:

National Park | Bushland Reserves | Urban / Semi-rural

2.2 Geomorphology, Geology and Soil Landscapes

Pittwater LGA forms part of the Sydney Basin, a large geological basin system covering 36 000km^2 of land (Geoscience Australia, 2011) which extends from Batemans Bay in the south to the Hunter River in the north, and from the coast west to Muswellbrook, Rylstone, Lithgow, and the Southern Highlands (DECC, 2008). The Sydney Basin comprises horizontal beds of sandstones and shales laid down between the Permian and Triassic ages. During the formation of the Great Dividing Range, these were subject to uplifting and folding; subsequent erosion has given rise to the typically dissected topography of the elevated, sandstone-derived landscapes in the west, north and south of the Sydney Basin. In its extreme west and north, north-west, and west Pittwater Local Government is bounded by the Hawkesbury–Nepean River system: this river system features extensive Tertiary (66–1.6Mya) and Quaternary (<1.6Mya) alluvial soils (Bannerman & Hazelton, 1990). The geology of Pittwater LGA is predominantly Triassic Hawkesbury Sandstone with thin ridge caps of Ashfield Shale (Liverpool Sub-group), chert, sandstone, quartzose sandstone, shale and claystone of the Narrabeen Group in exposed valleys and coastal sites. Alluvium, gravel, sand, silt and clay of the Quaternary coastal sands occur in low-lying parts of the coastal plain (NSW Dept. Mines, undated document).

The geological and soil landscapes of the area have been described by numerous authors, including: Chapman & Murphy, 1989 (shown in Appendix 1, along with the soil landscape classes (Sydney Metropolitan Catchment Management Authority, 2006); Benson & Howell; 1994, NSW Department of Mines (shown in Appendix 2) and Department of Environment and Climate Change (DECC, 2008). Soil landscapes spanning the LGA comprise a range of colluvial, residual, erosional, fluvial, aeolian, marine, estuarine, swamp and disturbed landscapes. Soils derived from Triassic Hawkesbury Sandstone (Hawkesbury, Gymea, Somersby, Oxford Falls and Lambert) occur at a relative relief of between 20-200m; soil landscapes derived from Narrabeen Shale occur at a relative relief of between 60-120m; and aeolian sands (Tuggerah and Newport), marine sediments (Narrabeen and Woy Woy occur at a relative relief of less than 20m).

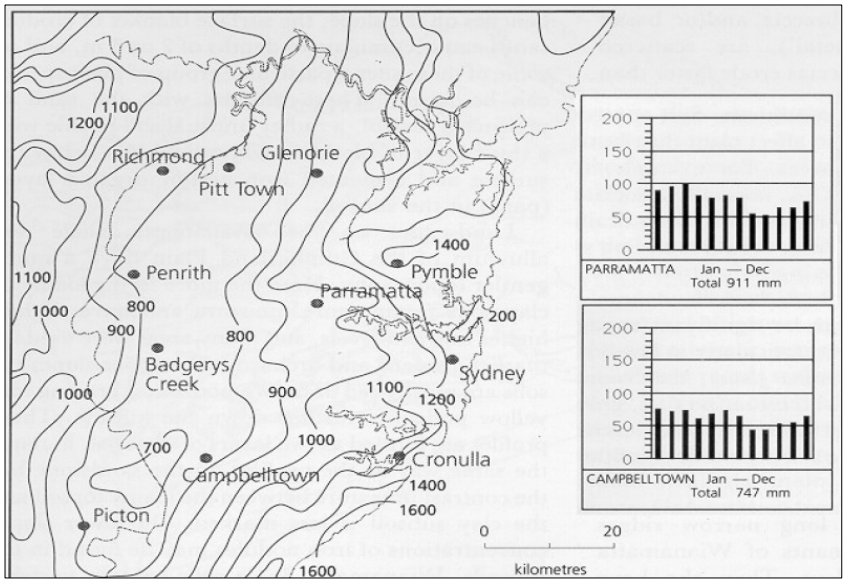
2.3 Hydrology

At a local scale, gullies, creeks and minor drainage lines in the western portion of Pittwater LGA flow either east to Pittwater (Salvation Creek), or westwards to the Cowan Creek (Refuge Gully, Coal and Candle Creek and Yeoman's Creek), which forms one of the easternmost tributaries of the Hawkesbury-Nepean River. The eastern portion of the LGA is bounded by Pittwater to the west and the Tasman Sea to the east; along the eastern seaboard, the Pittwater Peninsula drains directly into the Tasman Sea via Bilgola Creek and a number of unnamed creeks and minor drainage lines. Along the western aspect of Pittwater Peninsula, the terrain drains directly into the Pittwater Estuary via Careel Creek and a number of unnamed creeks and minor drainage lines. Further south, Narrabeen Creek forms a tributary of Mullet Creek shortly before it drains into Narrabeen Lagoon and to the south-west; Wirreanda Creek and McCarrs Creek drain northwards into Pittwater Estuary directly south of Church Point.

2.4 Climate

The climate in Sydney is considered temperate, featuring warm summers and cool winters (Bureau of Meteorology website, 2011). Distance from the coast and topography are major factors influencing weather patterns in the Sydney area: the eastern parts of Sydney, including the entire Pittwater LGA are moderated by their proximity to the Pacific Ocean. In the City of Sydney (Observatory Hill) January is the warmest month (mean maximum 25.9°C) and July the coolest (mean minimum temperature 8.0°C). The majority of Pittwater LGA occurs within the 1,100 to 1,300 isohyets range (see Figure 3 below). Rainfall occurs throughout the year, although is generally higher in summer and autumn, largely due to onshore winds. Mean annual rainfall is 1212.6mm (Bureau of Meteorology) at Observatory Hill.

Figure 3 Mean rainfall isohyets (from Benson & Howell, 1990)



3.0 LITERATURE REVIEW

3.1 General

A literature review of documents pertaining to the LGA includes previous flora and fauna surveys in the area, documents published by local or other governmental bodies, previous broad-scale vegetation mapping, and documentation of other relevant environmental factors.

3.1.1 Pittwater Council State of the Environment Report (SoE)

In accordance with its responsibilities under the *Local Government Act* 1993, Pittwater Council has until 2008-09 prepared an annual State of the Environment Report for the Pittwater Local Government Area (under the cooperative group 'Shore Regional Organisation of Councils' (SHOROC) representing the four councils on Sydney's Northern Beaches (Manly, Mosman, Pittwater and Warringah). These reports provide details on the condition of, and pressures upon, the natural environment, and outlines possible response procedures to perceived pressures on terrestrial and aquatic ecosystems.

3.1.2 Pittwater Council Local Planning Strategy

The recently adopted Pittwater Local Planning Strategy serves as an important tool for achieving the vision "To be a vibrant sustainable community of connected villages inspired by bush, beach and water" which has been identified in the Pittwater 2020 Strategic Plan – Our Sustainable Future. The objectives of the Pittwater Local Planning Strategy include the presentation of rationale for future land use planning decisions, and a foundation for the Pittwater Local Environmental Plan (LEP) and Development Control Plan (DCP).

Chapter 10.0 of the Pittwater Local Planning Strategy considers issues associated with the environment, heritage and resources as they relate to land use planning in Pittwater. This section includes the proposal of the following actions, among others, for implementation:

- Identify and map vegetation, habitat and wildlife corridors;
- Implement any relevant planning actions from the Estuary Management Plan adopted in December 2010, Native Fauna Management Plan adopted May 2011, and Native Vegetation Management Plan (this document);
- Development on sensitive land shall continue to be controlled via appropriate zoning and DCP controls;
- Provide improved protection for significant bushland.

In particular, the Pittwater Local Planning Strategy recommends that the biodiversity base layer within the Capability Mapping (as outlined in chapter 5.0 of the strategy) be considered in future land use planning decisions in Pittwater, and that consideration be given to adopting appropriate clauses within a Standard Instrument LEP for Pittwater, relevant to preserving biodiversity, threatened species, wildlife corridors, habitat, bushland and trees.

Environmental controls are a crucial component within the Pittwater Local Planning Strategy and determination of future land use planning. Due to the large amount of land within the Pittwater LGA (outside of national park land) being privately owned, there is an emphasis on environmental management and minimising development impact via the LEP and DCP. The Vegetation Management Plan therefore needs to provide effective management actions and controls which can be incorporated within the LEP and DCP.

3.2 Hawkesbury-Nepean Catchment Management Authority (HNCMA)

In line with its responsibilities under the *Catchment Management Authorities Act* 2003, the Hawkesbury Nepean Catchment Management Authority (HNCMA) has prepared a Catchment Action Plan (CAP). The current HNCMA CAP (March, 2008) sets the direction for the activities and investment of the Hawkesbury Nepean CMA over the next ten years.

The current CAP sets clear targets and a timetable for the CMA to:

- improve river health;
- protect biodiversity; and
- encourage best practice soil and land management.

The CAP is a non-regulatory statutory plan created under the *Catchment Management Authorities Act* 2003 (*i.e.* its contents are not legally binding or enforceable).

Of importance to Pittwater is the CAP's *Biodiversity management target MT B2-1 Remnant buffers* (HNCMA CAP, p.94) which states:
"*By 2016, the condition of native vegetation has been improved by active/passive regeneration of buffers of at least 20m around high priority, existing remnants resulting in an increase of 360 ha under active/passive regeneration.*" The stated *Priorities* include:

- *"At least 50% of investment to vegetation protection is directed towards establishing protective buffers around high priority remnants, Mitchell landscapes that are more than 70% cleared (Appendix 7 and Map 13(of the CAP)) (with even higher priority put on restoring EECs);*
- *Priority fauna habitats: grassy woodlands, upland swamps, alluvial forests and woodlands, coastal wetlands, and saltmarsh; and*
- *Regional biodiversity corridors".*

3.3 Sydney Metropolitan Catchment Management Authority (SMCMA)

The Catchment Action Plan of the SMCMA project (DECCW 2009) was developed to enable the "*strategic improvement of the natural resource values of the Sydney region*". The CAP aims to "*focus investment by government, industry and community in sustainable management of the natural resources that underpin the highly valued landscape of the Sydney Metropolitan Catchment (SMC) region. The CAP sets priorities and connects the natural resource management (NRM) actions of stakeholders*"

Part of the Pittwater LGA is included within the scope of the SMCMA project (the Narrabeen Lake sub-catchment and the suburbs of Warriewood, Elanora Heights and North Narrabeen, and some southern parts of Ingleside). In addition, the aims, targets and strategies stated in the SMCMA project are relevant to the entire Pittwater LGA.

The SMCMA CAP targets for 2016 include:

- catchment targets – "the trend in the condition of key natural resources which needs to be achieved for progress towards sustainability"; and
- management targets – "the most important changes that need to happen for the catchment targets to be achieved", where the CAP identifies actions for each target.

Catchment targets include:

- biodiversity – maintain or improve extent and condition of native vegetation, increase connectivity, better conservation of threatened terrestrial and aquatic taxa and reduced impact of invasive species;
- land – reduce edge effects of urban expansion, increase the amount of land "managed within its capability", identify and incorporate indigenous cultural knowledge into land use planning.

3.4 Sydney Metropolitan Strategy

The *Sydney Metropolitan Strategy* is the NSW Government's principal strategic planning framework for the greater Sydney region up to the year 2031. Within the overall Strategy are a number of regional and sub-regional plans and strategies, most of which have been released as either in draft format or as documents for public comment. Of relevance is the *Draft North-east Sub-regional Strategy* (NESS) released in 2007.

The Draft NESS emphasises *inter alia* development, improved accessibility and services, employment opportunities, public transport and agricultural production in its *2031 Vision for the North East*, yet does not include improvements to environmental indicators. Its *Key Directions* statements include "*Promote the environmental and scenic qualities of the region*", with Key Actions:

- the NSW Department of Planning in consultation with local councils will develop an approach to managing conservation areas and balancing growth targets of the Strategy;
- Councils to identify significant rural and resource lands in Principal LEPs and incorporate measures to protect them from incompatible and inappropriate uses;
- Regionally significant open space including Ku–ring–gai Chase National Park, Garigal National Park and Sydney Harbour National Park, as well as foreshore reserves, to be conserved and managed to ensure continued contribution to the recreational and scenic amenity of the subregion; and
- Council to ensure development pressures of visitor activities are managed to minimise loss of natural resources, potential for land use conflict and impact on the environment.

In its summary of the various LGAs in the sub-region, the Draft NESS (2007) states that the Pittwater LGA "*...the north east subregion has large areas of bushland which are highly valued by residents and contribute to biodiversity protection, air quality and water quality...*" (Draft NESS, 2007). The document does not address the fact that much of this bushland (protected within conservation reserves or not) occurs on Hawkesbury Sandstone landscapes, while vegetation on the Narrabeen Shale (*e.g. Pittwater Spotted Gum Forest*) within the LGA occurs as small, isolated fragments largely on private land.

3.5 Australian Heritage Database (Commonwealth)

The Australian Heritage Database is a repository of all places, sites and items of world, national, Commonwealth and National Estate heritage significance. Of these categories, the *Register of the National Estate* lists natural, Indigenous and historic heritage places throughout Australia: a new national heritage scheme replaced previous lists in 2004, with the new *Register of the National Estate* coming under the auspices of the *Environment Protection and Biodiversity Conservation Act 1999.* Three relevant natural sites are listed on the *Register of the National Estate* for the Pittwater Local Government Area. These have been summarised below and listings have been provided in Appendix 3:

Angophora Reserve / Hudson Park NSW (Site 2949)
Statement of Significance: The area has high value as probably the largest area of remnant vegetation on the Palm Beach Peninsula, as such it provides an important refuge and protected movement corridor for fauna particularly Sydney's diminishing koala population. The area conserves remnants of Corymbia maculata (Spotted Gum) communities which were once widespread in the area. It now provides one of the few intact examples of this community with original understorey species present. It is also valued by the local community as an area of natural bushland in the Sydney Metropolitan Area. Approximately 18.5ha, in Avalon and Bilgola, comprising Hudson Park and Angophora Reserve.

Ku-ring-gai Chase National Park (1980 boundary) (Site 2608)
Statement of Significance: Ku-ring-gai Chase National Park, established in 1844, has long been an important natural recreation area close to Sydney. The Park has a very diverse flora (over 900 species) and rich fauna. Ku-ring-gai has a number of trails to give visitors a good insight into the diversity of the area.

NSW Long Reef Barrenjoey Coastal Rocks NSW (Site 2946)
Statement of Significance: The superb cliff exposures of early Triassic sediments of the Narrabeen group in this section '...display the most environmentally complex sequence of rocks found anywhere in the Sydney basin' (Packham, 1976). The area includes the type localities of several of the palaeosol associations recognised by Retallack (1977A, 1977B), as well as the type localities for a number of fossil plant taxa and vegetation associations. The section is frequently studied by students on geological excursions.

3.6 Previous Regional Biodiversity Surveys and Vegetation Mapping

A considerable body of literature currently exists on the natural vegetation of the northern Sydney area, including Pittwater LGA. Many of these studies examine restricted areas of the City, or concentrate on particular taxonomic groups or vegetation types. Studies considered for review included published papers, unpublished reports on specific areas or threatened species and published and unpublished maps of vegetation distribution. The entire literature search is provided in the accompanying document entitled '*Pittwater Native Vegetation Classification, pre-1750 Vegetation Mapping and Vegetation Profiles*'.

3.7 Biota

3.7.1 Threatened Species, Populations and Ecological Communities

A list of threatened flora species and populations known to occur in Pittwater LGA was drawn from the Office of Environment and Heritage (OEH) *Atlas of NSW Wildlife* and Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) databases. The search included all records of threatened taxa and Endangered Ecological Communities considered within Pittwater LGA (for the full list, see Tables 19 and 20, Appendix 4).

3.7.2 Cryptic or deciduous plant species

The majority of the threatened flora species likely to occur in the area (based on database searches) are readily identifiable during spring searches when not flowering; however, some deciduous or cryptic species would be conducive to detection and identification for a limited part of the year (during flowering). Also, a number of species are only able to be identified during their flowering period *e.g. Epacris purpurascens*. (See Table 21 Appendix 5).

3.8 Recovery Plans and Priority Action Statements

In accordance with its responsibilities under the *Threatened Species Conservation Act 1995* (TSC Act), the OEH have issued a number of Priority Action Statements for some of the species outlined in Appendices 6 and 7. These statements set out the recovery and threat abatement strategies to be adopted for promoting the recovery of each threatened species, population and ecological community and for managing each Key Threatening Process and Threat Abatement Strategy. Each statement also establishes performance indicators and timetables to facilitate reporting on achievements (*i.e.* their effectiveness) in implementing recovery and threat abatement strategies. In addition, the OEH and DEWHA have issued Recovery Plans for a number of the threatened species outlined in Appendix 6. The availability of Recovery Plans and Priority Action Statements is summarised in Appendix 7 for Endangered Ecological Communities and outlined in detail in Appendix 12 for flora species.

3.9 Critical Habitat

Critical Habitat, as defined in the TSC Act 1995 (s. 37), is considered to be "*the whole or any part or parts of the area or areas of land comprising the habitat of an endangered species ... that is critical to the survival of the species*". To date, no declaration of Critical Habitat has been made for those Threatened Species, Threatened Populations and Endangered Ecological Communities within Pittwater LGA listed on the *TSC Act 1995* or the Register of Critical Habitat under the auspices of the *EP&BC Act 1999*.

3.10 Disturbance and Resilience of Ecological Communities

One of the key factors in assessing the value of remnant urban bushland is the 'resilience' of the patch or remnant to disturbance. McDonald (1996) postulates that "*…Arguably, the ecosystem property of most interest to restoration is that of "resilience" - that is, the capacity of a community or species to "bounce back" after disturbance...*" and "*… This is because it is likely that the ecological limits and disturbance adaptations of individual species which largely govern resilience after natural disturbance will largely govern recovery after anthropogenic disturbance or other anthropogenic impacts…*"

A number of factors relevant to the potential for native vegetation to be restored within the Pittwater LGA were noted and assessed. A condition code has been applied to each patch in accordance with the categories defined in Table 6 and Appendix 8. These categories have also been adapted to a proforma for the ongoing mapping of vegetation on road reserves (See Appendix 9), although the latter has not been delineated in the accompanying GIS. In summary, the categories used to delineate condition focus on the distribution of age classes in each stratum, the extent of apparent disturbances, connectivity and habitat provision, weed incursion and prevalence of dieback associated with surrounding natural areas.

3.11 Fauna and Fauna Habitats

In response to the Strategic Plan 2020 - Our Sustainable Future, Pittwater Council has adopted the Pittwater Native Fauna Plan of Management (2011) to assist council in improving the viability of locally native fauna in Pittwater and manage habitat and vegetation types within the LGA. Pittwater Council is currently updating the Wildlife Corridors Strategy as recommended in the Native Fauna Plan of Management for the Pittwater Local Government Area (LGA).

4.0 VEGETATION MAPPING

Field investigations were conducted throughout the LGA on the 9th, 14th, 17th and 25th September; 1st, 12th, 13th, 14th and 22nd October; 11th, 12th, 17th 18th and 23rd November and 4th, 15th, 21st and 23rd, December, 2009 and the 1st January, 2010. Surveys involved the application of general traverses throughout the site, according to the methods described in York *et al.* (1991) and Department of Environment and Conservation guidelines (2004). Targeted searches for threatened species (*i.e.* listed as threatened under the *TSC Act* 1995 and/ or the *EPBC Act* 1999) were not required as part of the scope for this project. Details relating to vegetation condition, management issues and the extent to which threatening processes operate within the study area were recorded along with rapid data collection for the purpose of vegetation classification and mapping.

The methods used to derive the vegetation communities described in this report are detailed in the accompanying classification report entitled '*Pittwater Vegetation Classification, pre-1750 Vegetation Mapping and Vegetation Profiles*'. In summary, the method follows that completed for the Metro project, and meets or exceeds the Department of Environment, Climate Change and Water Native Vegetation Interim Type Standard (OEH website, January 2010) in providing quantifiable processes for surveying and mapping native vegetation by means of a randomised representative sampling regime, undertaken with appropriate replication.

Plot locations were selected randomly within stratified units on a proportional stratified sampling basis. Based on the area of each stratified vegetation unit, 100 plots were undertaken across vegetation units shown in Table 2 below, using the standard DECC (2004) methods, by means of a plot proforma.

4.1 Summary of Results

4.1.1 Pittwater Native Vegetation Classification and Vegetation Profiles

Vegetation community profiles have been developed for the Pittwater LGA following the format of the NSW Department of Environment, Climate Change & Water (DECCW) for the Sydney Metropolitan Catchment Management Authority (SMCMA) Area.

Thirty-five vegetation communities were defined for the Pittwater LGA (excluding those within Ku-ring-gai Chase National Park). On the whole, these vegetation communities show strong similarity with vegetation defined elsewhere in the Sydney metropolitan area (DECCW 2010). These vegetation units are detailed in the accompanying document entitled '*Pittwater Vegetation Classification, pre-1750 Mapping and Vegetation Profiles*'. The current extent of the defined vegetation communities in Pittwater LGA is under review.

4.1.2 Pre-1750 Mapping

Upon completion of the extant vegetation mapping, RDP data, contour, landscape, drainage and aspect GIS layers were used to predict the likely identity of cleared and disturbed areas of the LGA. Knowledge of the landscapes within the Pittwater LGA largely guided the pre-1750 mapping process. In some areas, historical black and white aerial photographs from the 1950's and 1960's were available for use, however these were not comprehensive for the LGA and most of the disturbed lands had already been cleared by this time. Pre-1750 mapping for the Pittwater LGA are shown in Figure 4.

Both the newly created classifications and pre-1750 GIS layers for the Pittwater LGA allowed for the reduction in geographic extent associated with each vegetation type to be measured. It is anticipated that this measure can be used to guide management of remnant vegetation within the LGA.

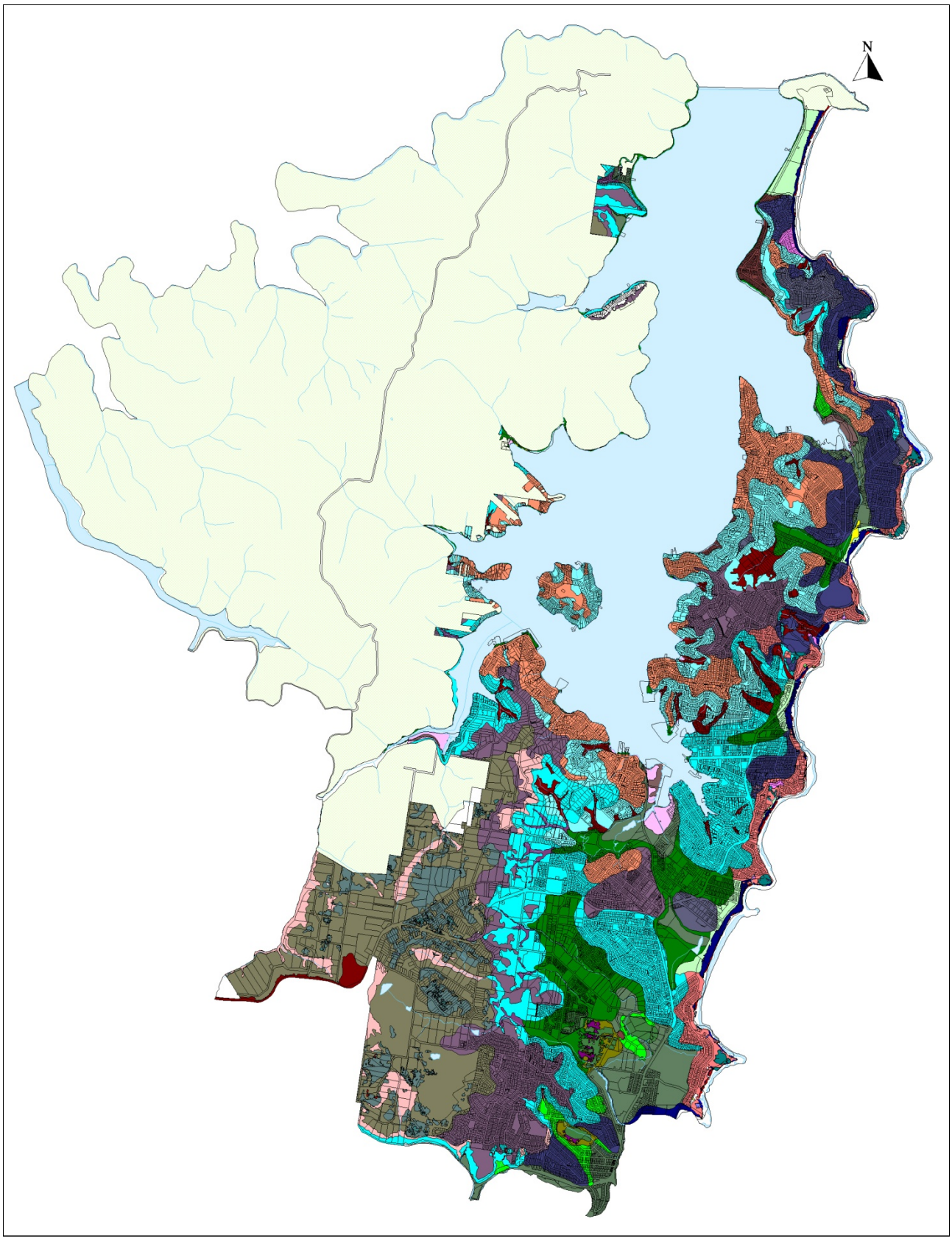
4.1.3 Results

This study has determined that at the LGA scale, and time of writing, the Pittwater LGA encompasses 10900ha of land. Of this, 43% (approx. 4693ha) occurs within Ku-ring-gai Chase National Park, and 15% (approx. 1650ha) occurs in water bodies (principally Pittwater Estuary).

Of the remaining land in the LGA (i.e. 4557ha), 83% of the original pre-1750 vegetation has been cleared or significantly disturbed (i.e. 3,624ha), with 17% of the pre-1750 vegetation extent remaining (i.e. 933ha), of which 430ha is within Council reserves in good condition.

Of the extent remaining, a total of 36 native vegetation communities have been identified, 10 of which are listed Endangered Ecological Communities (EECs) in NSW.

Figure 4 Pittwater Local Government Area – Pre-1750 Vegetation Mapping



Note – Sample only

Table 2 Area of stratified vegetation zones and reciprocal plot requirements.

			Equivalence		Conservation Status						
Unit	**Name**	**Keith Class**	**SMCMA Equivalence**	**EEC Equivalence**	**NSW Status[1]**	**National[2]**	**No plots**	**Extant (ha)**	**Comment on Standard Requirements**	**p1750 (ha)**	**% loss**
Dry Sclerophyll Forests											
S_DSF06	Coastal Sandstone Foreshores Forest	Sydney Coastal Dry Sclerophyll Forests	Coastal Sandstone Foreshores Forest	-	-	-	2	22.28	few publically accessible locations	294.2	92.43
S_DSF08	Coastal Sandstone Riparian Forest	Sydney Coastal Dry Sclerophyll Forests	Coastal Sandstone Riparian Forest	-	-	-	0	n/a	-	n/a	n/a
S_DSF09	Coastal Sandstone Sheltered Peppermint-Apple Forest	Sydney Coastal Dry Sclerophyll Forests	Coastal Sandstone Sheltered Peppermint-Apple Forest	-	-	-	7	57.9	Meets standard	111	47.84
S_DSF11a	Hornsby Sandstone Exposed Bloodwood Woodland - typical	Sydney Coastal Dry Sclerophyll Forests	Hornsby Sandstone Exposed Bloodwood Woodland	-	-	-	20	92.77	Meets standard	489.9	81.06
S_DSF11b	Hornsby Sandstone Exposed Bloodwood Woodland - coast	Sydney Coastal Dry Sclerophyll Forests	Hornsby Sandstone Exposed Bloodwood Woodland	-	-	-	6	10.75	Meets standard	67.19	84
S_DSF12a	Hornsby Sandstone Heath-Woodland (woodland form)	Sydney Coastal Dry Sclerophyll Forests	Hornsby Sandstone Heath-Woodland	-	-	-	10	165.3	Meets standard	589.3	71.95
S_DSF12b	Hornsby Sandstone Heath-Woodland (heath form)	Sydney Coastal Dry Sclerophyll Forests	Hornsby Sandstone Heath-Woodland	-	-	-	2	79.18	low priority for sampling as an easily defined unit	151.7	47.8

[1] Listed under Schedule 1 (Endangered) and Schedule 2 (Vulnerable) of the *TSC Act* 1995.

[2] Listed Endangered or Vulnerable or Endangered on the *EPBC Act* 1999.

S_DSF14	Sydney Ironstone Bloodwood - Silver-top Ash Forest	Sydney Coastal Dry Sclerophyll Forests	Sydney Ironstone Bloodwood - Silver-top Ash Forest	Duffys Forest Ecological Community in the Sydney Basin Bioregion	Endangered	-	2	12.48	few publically accessible areas	23.39	46.64
S_DSF21	Coastal Sand Bangalay Forest	South Coast Sands Dry Sclerophyll Forests	Coastal Sand Bangalay Forest	Bangalay Sand forest of the Sydney Basin and South East Corner Bioregions	Endangered	-	0	0	represented by canopy trees over exotic groundlayer	26.97	100
S_DSF25	Coastal Dry Spotted Gum Forest	Sydney Coastal Dry Sclerophyll Forests	n/a	Pittwater Spotted Gum Forest in the Sydney Basin Bioregion	Endangered	-	19	42.58	Meets standard	363.4	88.28
Forested Wetlands											
S_FoW01	Coastal Alluvial Bangalay Forest	Coastal Swamp Forests	Coastal Alluvial Bangalay Forest	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	-	1	4.58	mostly weed infested, and effectively meets low condition standard	60.79	92.47
S_FoW02	Coastal Flats Swamp Mahogany Forest	Coastal Swamp Forests	Coastal Flats Swamp Mahogany Forest	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	-	5	13.96	Meets standard	310.4	95.5
S_FoW03	Coastal Freshwater Swamp Forest	Coastal Swamp Forests	Coastal Freshwater Swamp Forest	Sydney Freshwater Wetlands in the Sydney Basin Bioregion	Endangered	-	2	9.92	mostly weed infested, and meets low condition standard	21.99	54.88
S_FoW08	Estuarine Swamp Oak Forest	Coastal Floodplain Wetlands	Estuarine Swamp Oak Forest	Swamp Oak Floodplain Forest of the New South Wales	Endangered	-	3	32.82	low priority for sampling as an easily defined unit	241.4	86.4

				North Coast, Sydney Basin and South East Corner Bioregions							
S_FoWxxa	Coastal Headland Swamp Oak – Gahnia Soak (form a)	Coastal Swamp Forests	n/a	-	Pending site-by-site assessment	-	2	1.69	Meets standard	2.65	36.08
S_FoWxxb	Coastal Headland Swamp Oak – Gahnia Soak (form b)	Coastal Swamp Forests	n/a	-	Pending site-by-site assessment	-	2	0.15	Meets standard	0.18	17.51
Freshwater Wetlands											
S_FrW01	Coastal Upland Damp Heath Swamp	Coastal Heath Swamps	Coastal Upland Damp Heath Swamp	-	-	-	1	0.08	Meets standard	0.08	0
S_FrW03	Coastal Freshwater Reedland	Coastal Freshwater Lagoons	Coastal Freshwater Reedland	Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Endangered	-	2	5.85	low priority as an easily definable unit	6.02	2.92
S_FrW04	Coastal Sand Swamp Paperbark Scrub	Coastal Freshwater Lagoons	Coastal Sand Swamp Paperbark Scrub	Sydney Freshwater Wetlands in the Sydney Basin Bioregion	Endangered	-	1	9.7	low priority as an easily definable unit	10.98	11.67
S_FrW06	Estuarine Reedland	Coastal Freshwater Lagoons	Estuarine Reedland	Potentially Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	-	-	1	1.06	Meets standard	1.06	0
Grasslands											
S_GL01	Beach Spinifex Grassland	Maritime Grasslands	Beach Spinifex Grassland	-	-	-	3	5.59	Meets standard	5.85	4.48

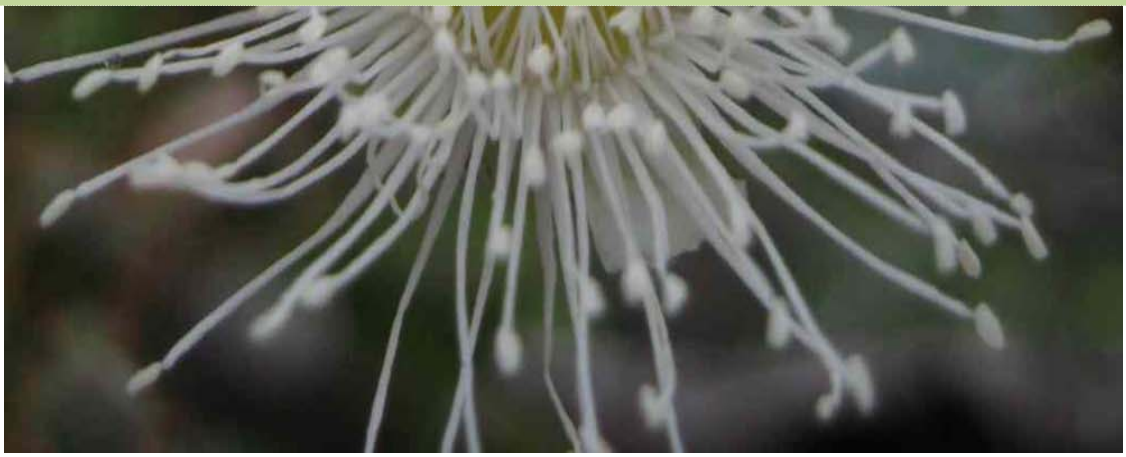
S_GL02a	Coastal Headland Grassland (typical)	Maritime Grasslands	Coastal Headland Grassland	Themeda Grassland on Seacliffs & Headlands EEC	Endangered	-	5	1.09	Meets standard	1.63	33.31
S_GL02b	Coastal Headland Grassland (Lomandra Sedgeland)	Maritime Grasslands	Coastal Headland Grassland	Themeda Grassland on Seacliffs & Headlands EEC	Endangered	-	2	0.09	Meets standard	0.17	47.83
Heathlands											
S_HL01a	Coastal Headland Clay Heath – A.distyla	Coastal Headland Heaths	Coastal Headland Clay Heath	-	-	-	4	10.66	Meets standard	13.39	20.39
S_HL01b	Coastal Headland Clay Heath – non A.distyla	Coastal Headland Heaths	Coastal Headland Clay Heath	-	-	-	4	19.53	Meets standard	115.3	83.06
S_HL02	Coastal Tea-tree – Banksia Scrub	Coastal Headland Heaths	Coastal Tea-tree – Banksia Scrub	-	-	-	1	10.09	largely weed infested and prob includes plantings anyway	39.83	74.67
S_HL05	Coastal Foredune Wattle Scrub	Sydney Coastal Heaths	Coastal Foredune Wattle Scrub	-	-	-	5	16.55	Meets standard	44.07	62.45
S_HL07	Coastal Headland Cliffline Scrub	Coastal Headland Heaths	Coastal Headland Cliffline Scrub	-	-	-	0	6.45	too dangerous for sampling	0	n/a
S_HL08	Coastal Sandstone Heath-Mallee	Sydney Coastal Heaths	Coastal Sandstone Heath-Mallee	Coastal Upland Swamp in the Sydney Basin bioregion (preliminary determination) may be present.	Pending outcome of preliminary determination	-	5	0.05	Meets standard	0.05	0
S_HL09	Coastal Sandstone Plateau Rock Plate Heath	Sydney Coastal Heaths	Coastal Sandstone Plateau Rock Plate Heath	-	-	-	3	7.58	Meets standard	8.04	5.71
S_HLxx	Coastal Cliffline Weedy Scrub	Sydney Coastal Heaths	n/a	-	-	-	0	6.45	too dangerous for survey and dominated by weeds	6.45	0

Rainforests											
S_RF02	Coastal Sandstone Gallery Rainforest	Northern Warm Temperate Rainforests	Coastal Sandstone Gallery Rainforest	-	-	-	4	10.52	Meets standard	20.33	48.25
S_RF06	Coastal Dune Littoral Rainforest	Littoral Rainforests	Coastal Dune Littoral Rainforest	Site-by-site assessment required - Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions +/or Littoral Rainforest and Coastal Vine Thickets of Eastern Australia may be present.	Endangered	Critically Endangered	1	0.22	Meets standard	0.22	0
S_RF07	Coastal Escarpment Littoral Rainforest	Littoral Rainforests	Coastal Escarpment Littoral Rainforest	Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Endangered	-	10	30.43	Meets standard	87.16	65.09
S_RF08	Coastal Headland Littoral Thicket	Littoral Rainforests	Coastal Headland Littoral Thicket	Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	Endangered	-	2	0.95	Meets standard	7.56	87.45
S_RF10	Sandstone Cliffsoak	Not described	Sandstone Cliffsoak	Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions	-	-	0	n/a	-	n/a	n/a
Saline Wetlands											
S_SW01a	Estuarine Mangrove Forest	Mangrove Swamps	Estuarine Mangrove Forest	Coastal Saltmarsh may be present - site-by-site assessment required	Endangered. Pending site-by-site assessment	-	2	15.76	low priority for sampling as an easily defined unit	30.62	48.53

S_SW01b	Estuarine Mangrove Forest - Saltmarsh Complex	Mangrove Swamps / Saltmarshes	Estuarine Mangrove Forest / Estuarine Saltmarsh	Coastal Saltmarsh may be present - site-by-site assessment required	Endangered. Pending site-by-site assessment	-	*	2.92	included in S_SW01a	3	2.9
S_SW02	Estuarine Saltmarsh	Saltmarshes	Estuarine Saltmarsh	Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South east Corner Bioregions	Endangered	-	*	0.41	included in S_SW01a	6.5	93.74
S_SW03a	Seagrass Meadows - Zostera	Seagrass Meadows	Seagrass Meadows	n/a	-	-	0	52.88	outside of brief	52.88	0
S_SW03b	Seagrass Meadows - Posidonia	Seagrass Meadows	Seagrass Meadows	n/a	-	-	0	46.05	outside of brief	46.05	0
S_SW03c	Seagrass Meadows - Halophila	Seagrass Meadows	Seagrass Meadows	n/a	-	-	0	0.07	outside of brief	0.07	0
S_SW03d	Seagrass Meadows - Zostera/ Halophila	Seagrass Meadows	Seagrass Meadows	n/a	-	-	0	8.07	outside of brief	8.07	0
S_SW03e	Seagrass Meadows - Posidonia/ Zostera	Seagrass Meadows	Seagrass Meadows	n/a	-	-	0	78.68	outside of brief	78.68	0
Wet Sclerophyll Forests											
S_WSF02	Coastal Enriched Sandstone Moist Forest	North Coast Wet Sclerophyll Forests	Coastal Enriched Sandstone Moist Forest	n/a	-	-	3	163.1	few publically accessible locations outside of KCNP	699	76.67
S_WSF11	Coastal Moist Spotted Gum Forest	Northern Hinterland Wet Sclerophyll Forests	n/a	Pittwater Spotted Gum Forest in the Sydney Basin Bioregion	Endangered	-	11	69.43	Meets standard	385.4	81.98

Pittwater Native Vegetation Management Plan

Part 2: Vegetation Management



5.0 MANAGEMENT ISSUES AND ACTIONS

5.1 Development on Private Land – Process and Issues

All development on private land in Pittwater is required to address Council's relevant planning instruments and/or within the development application and assessment process. This includes controls to project significant vegetation. Currently Section B4 of the Development Control Plan (DCP) contains controls relating to the natural environment. These are based on habitat condition, wildlife corridors, Endangered Ecological Communities, and various freshwater and marine habitats. Additionally, development must be in accordance with State and Federal Government legislation, Council's controls are map-based and each land parcel within the LGA generates one or more B4 control.

These development controls are designed to ensure development has no significant impact on vegetation communities and wildlife habitat and offsets any unavoidable loss. Much of the private land in Pittwater LGA contains natural vegetation and habitat features. Planning controls are the primary mechanism for ensuring development does not impact adversely on the natural environment of the Pittwater LGA. As the controls are regularly reviewed and updated, issues and actions from this Vegetation Management Plan, as well as the updated vegetation mapping will be incorporated into the relevant planning controls.

Development Application lodgement and assessment is currently conducted within the planning software MasterPlan. Applicants are informed within the Enquirer section of MasterPlan as to what information is required to be submitted, based on the DCP controls associated with the property. If a property has an associated Habitat Category 1 or 2 control, or an Endangered Ecological Community control, a more detailed environmental assessment is required, as part of the application lodgement. This can include ecological impact assessments, flora and fauna assessments, arborist reports, aquatic ecology reports and environmental sustainability plans. This Vegetation Management Plan and mapping will provide a more accurate and updated guide as to the level of assessment required for development applications.

For development on; unzoned lands, land with a Plan of Management (development without consent) and land to which State Environmental Planning Policy (Infrastructure) (SEPP Infrastructure (2007)) applies, a Part Five assessment is required under the EP&A Act 1979 to provide an equivalent assessment to those undertaken on private property. Where there are threatened species, wildlife corridors or endangered ecological communities present or likely, a Review of Environmental Factors (REF) is required to minimise impacts on these natural resources.

The majority of landscapes on private and public land in the Pittwater LGA have been modified over time and now consist of suburban gardens and parkland with pockets of remnant vegetation. Due to pressures from urbanisation including increased development, population growth and need for open space for recreation and amenity, the majority of vegetated areas consist of planted shrubs and lawns.
The tree canopy varies across each suburb and is generally a mixture of remnant indigenous trees, as well as planted native and exotic specimens. In suburbs such as Bayview, Church

Point, Scotland Island, and parts of Newport, Avalon and Palm Beach the canopy is still predominantly indigenous and characteristic of Pittwater Spotted Gum Forest, however the understorey is mostly modified. The controls and conditions associated with the Pittwater 21 DCP aim to protect and restore native habitat such as the Pittwater Spotted Gum Forest Endangered Ecological Community. Residents are somewhat reluctant to convert existing gardens and lawns back into natural bushland, so the challenge is to find a balance between the needs of the landowners and restoring vegetation communities.

The replacing of canopy trees is critical to maintaining the viability of habitat and ecology on private land within the Pittwater LGA. This is particularly important in the Pittwater Spotted Gum Forest areas where at present the majority of tree specimens are in the mature to over-mature age class with few young specimens coming through to replace them. Within the development application process when issuing consents, Council has a general policy of a 3:1 tree replacement ratio for every native tree required to be removed, as well as all new trees planted must be locally native species. This is enforced when approving landscape plans, and the imposing of such conditions on development consents. An ongoing issue however is the decrease in area available to support large trees and the safety concerns related to trees in urban areas as the population grows and built-upon areas increase – this has resulted in the size of canopy trees being reduced and only species which grow to a lesser mature size can be supported on some residential allotments.

Access to private lands was limited throughout the mapping project, and as a consequence identification of native vegetation and attribution of vegetation units on private lands may not always be correct. As a consequence, reliance should not be placed on the mapping associated with this project to determine the review of Category 1, 2 and 3 Land Control Maps in Pittwater's Development Control Plan.

Additionally, some EEC determinations such as Pittwater Spotted Gum Forest (PSGF) are only present as scattered trees and although the condition assessment is low the area is still an EEC under the determination.

5.2 Management Issues

A range of processes that are known to contribute to (or be implicated in) the degradation and loss of remnant vegetation were observed in Pittwater LGA, some of which are associated with development:

- habitat fragmentation including edge effects;
- loss of corridors and connectivity;
- loss of habitat and resources including hollow-bearing trees;
- loss of ground habitats (logs, bushrock);
- exposure to various types and intensities of disturbances;
- reduced soil water infiltration rates;
- increased soil surface erosion;
- nutrient enrichment;

- soil disturbance;
- deterioration of soil structure;
- altered hydrological regimes;
- altered fire regimes;
- weed invasion;
- threats from feral fauna (pests predation, displacement); and
- rubbish dumping.

Native plant species displacement by exotic shrubs, grasses and herbs often indicate past disturbance. However, the extent to which these threats operate along the coastal plain is largely unquantified. With the exception of a number of threatening processes which are operating across the LGA, weed incursion or alteration to one or more strata may be one of the few indicators of the extent to which threatening processes have operated. Table 3 shows a range of management issues which were observed during field work and Table 4 shows threatening processes. These have been separated on the basis that a range of management issues can be readily linked to the implementation of management strategies but have not been listed as threatening processes. Further discussion on threatening processes and management issues are provided below.

Table 3 Management Issues

Management Issue	Description
Fire Regimes	
Inappropriate fire regimes - fire exclusion / frequent burning	Fire has been excluded from a number of patches in urban areas due to their proximity to the urban interface. The increase in mesic cover depletes the regeneration of sclerophyllous species thus altering the natural dynamics of the vegetation communities concerned. Although 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' is listed as a KTP, the exclusion (or too low a frequency) is not. Fire events have also occurred too frequently in some parts of the LGA. Too frequent fires can cause the loss of species, habitats and assemblages at local and landscape scales, and can irrevocably alter the composition and function of communities. Too frequent fires can also result in the introduction or increase of exotic species. Burning is likely to be a significant factor in species loss and overall bushland condition where patches on private or public land are burnt too frequently, particularly in areas adjacent to APZs or SFAZs.
Inadvertently increasing fire risk	Associated with 'risks to life and property' and the management of forested landscapes (including those in urban or near-urban areas) is the recent research undertaken by Lindenmeyer *et al.* (2011) following the 2009 wildfires in Victoria and NSW. The research, involving detailed on-site measurements, outlines the concept of the "landscape trap" which assumes stands of younger forest burn at higher severity than stands of mature forest. Lindenmeyer *et al.* describe the process whereby 'entire landscapes are shifted into, and then maintained (trapped) in, a highly compromised structural and functional state as the result of multiple temporal and spatial feedbacks between human and natural disturbance regimes'. In describing how landscape traps are formed, Lindenmeyer *et al.* identify a positive feedback loop between 'reduced forest stand age and fire' by means of a range of processes, including structural changes associated with both logging and altered fire regimes. This research adds weight to the notion that forested landscapes which have been disturbed (by logging or by altering natural fire regimes) are often more prone to increased fire intensity during uncontrolled fire events.
Rate of Vegetation Loss	
Rate of vegetation loss within Pittwater LGA	Nationally, 30% of pre-European vegetation remains intact in Australia, with another 12% remaining as scattered trees with some native understorey. Regionally, the Sydney Basin is one of only seven Interim Biogeographic Regions of Australia (IBRA) where up to half of all major vegetation groups have less than 30% of their original extent remaining (Australian State of the Environment Report, 2006). At the LGA scale, and time of writing, the Pittwater LGA encompasses approximately 10,900ha of land. Of the remaining 4557ha of land managed by Council, 83% (approx. 3,624ha) of the pre-1750 vegetation has been cleared or significantly disturbed, with 17% (approx. 933ha) of the pre-1750 vegetation extent remaining, of which 430ha is in Council reserves.
Hydrological Regimes	
Weed incursion associated with stormwater and erosion	Storm water discharge and urban run-off associated with discharge of contaminated water from various sources and non-reticulated sewage systems can both supply additional nutrients, pollutants and weed propagules.

	Weed incursion (See Appendix 10 for all Noxious Weeds listed for the LGA as well as environmental weeds) can be accelerated by increased nutrient loads (pollutants) and increased moisture associated with stormwater outlets. Stormwater outlets can contribute to degradation of bank and bed stability along riverbanks and foreshore areas. Incursion by freshwater can also change the composition of saltmarsh by encouraging colonisation by species which proliferate in brackish conditions (*e.g. Phragmites australis*).
Pollution controls associated with construction	The release of polluted water associated with various activities including; construction sites, site de-watering and septic systems can supply extreme nutrients and other pollutants as well as weed propagules. Increased nutrients in the soil can contribute to dieback.
Urban Interface Management	
Management of the urban interface	Activities associated with the urban interface and areas of open space (e.g. sports-grounds, parks, showgrounds etc.) require specific management to curtail their effects on adjacent bushland. Potential impacts include; • an increase in weed incursion, as well as encroachment of native horticultural plant species into native vegetation cover; • littering and dumping; • altered frequency of fire regimes and intensity of fire; • impacts from feral or domestic animals; • edge effects associated with altered microclimate and hydrological conditions; • alterations to hydrological conditions due to the use of impervious surfaces along with the reduction in tree cover; and • removal of important habitat components (such as decaying woody material).
Edge effects and barriers	Continued clearing and fragmentation of native vegetation results in remnants which are often linear and narrow; such remnants are especially prone to "edge effects". All remnant patches are subject to various deleterious effects along boundaries, including altered hydrological and edaphic factors, increased wind-shear, increased light levels, loss of habitat features (critical to many species), soil compaction, increased runoff and establishment of weeds or other 'pest' species. Roads, fire trails and tracks within bushland also provide further opportunities for weed and pest invasion.
Horticultural introduction of opportunistic weed species	Horticultural introductions of species known as garden escapees have the potential to become naturalised posing a threat to bushland reserves.
Inappropriate plant species selection for regeneration and landscaping	Inappropriate species selection or use of inappropriate stock can pose a significant threat to local species genetic diversity and to the viability of bushland in many reserves.
Management of Public Access	
Vegetation damage due to inappropriate pedestrian access	Unhindered pedestrian access resulting in vegetation trampling and terrain damage, thus increasing vulnerability to erosion and compaction of soils and introduction of weed propagules. This is particularly problematic where the substrates are prone to erosion such as headlands and more elevated, steeper slopes. Damage to foreshore vegetation due to inappropriate access has also been observed along the Pittwater Estuary, this increases the vulnerability of foredune and estuarine ecosystems to changing tidal flux.

Vegetation Management	
Low recruitment of upper canopy species	Intensive management regimes (e.g. use of fertilisers, irrigation etc) in residential gardens contributes to lower levels of recruitment in species characteristic of native vegetation communities, particularly Endangered Ecological Communities. The abundance of exotic species and lack of or too frequent fires can also lead to reduce recruitment of upper canopy species.
Genetic changes to plant species on a local and regional scale	The introduction of plant material which has the capacity to alter local genetic stock. For example, Lemon-scented Gum (*Corymbia citriodora),* a species from Northern NSW is widely planted in the Pittwater LGA. This species has the capacity to impact on the genetic make-up of Spotted Gums *(Corymbia maculata).* Similarly, the use of non-local stock for replanting schemes in or near bushland areas can alter local genetic diversity (*e.g. Westringia fruticosa*).
Reserve shape and area: high edge-to-area ratios	As mentioned above, continued clearing and fragmentation of native vegetation results in remnants which are often linear and narrow; such remnants are especially prone to "edge effects". The longer the boundary edge in relation to its area, the higher the level of ecological stress and the lower the viability of the remnant. The high edge-to-area ratio effect is exacerbated in Sydney because continued land clearing and fragmentation has resulted in many corridors being isolated from others, and thus many links have been severed. Existing remnants are often fragmented internally where infrastructure corridors occur, i.e. roads, fire trails and maintenance tracks which also provide opportunities for weed invasion and pest animal access. Many patches of native vegetation in Pittwater LGA are long and narrow making them vulnerable to edge effects including elevated soil nutrient levels, weed infestation and altered hydrological regimes. The cumulative effects of these impacts also have implications for bushfire management and containment.
Intensive management of vegetation types which would otherwise be subject to natural changes in species composition	As an example, narrow pockets of Themeda grassland occur sporadically along previously disturbed coastal tracks. In the absence of intensive management, these areas may revert to coastal heath/scrub. Conversely, inappropriate management regimes (especially fire regimes) may encourage invasion by shrubs into viable patches of Themeda grassland. Although the ideal scenario would allow for the ongoing management of larger examples of Themeda Grassland, consideration may need to be given to the long-term viability associated with some of the thin, narrow pockets.
Inadvertent encroachment of weed species by means of routine management and disposal of garden wastes in bushland	Garden escapees (species grown in gardens which establish themselves in adjacent bushland) and the dumping of garden waste contribute to the spread of weeds along disturbed bushland margins. Dumping of garden waste can lead to increased nutrients and changes in soil moisture. Roadsides and powerline easements where vegetation maintenance has been undertaken on a regular basis also allow for the perpetuation and spread of weed species.
Coastal Zone Management	
Foredune trampling	Vegetation trampling through untrammelled vehicle or pedestrian access resulting in the loss of vegetation and increased vulnerability of foredunes to changing tidal flux, wind and wave erosion.
Loss of vegetation, erosion of coastal clifflines and foreshores (e.g. due to climate change and increased wave action through boat activities etc)	The CSIRO Climate Change Vulnerability assessment defines a range of vulnerabilities for the Pittwater LGA. The potential for storm-surge, sea-level rise, and flooding suggest that there is potential for the acceleration of normal coastal processes such as erosion of exposed clifflines and foreshores under climate change scenarios. Foreshore erosion and loss of foreshore vegetation can be also be accelerated by increased wave action from boating activities.

Biodiversity loss	
Biodiversity loss	Amendments to the *Threatened Species Conservation Act 1995* were made to incorporate Biodiversity Certification Assessment Methodology. This allows planning authorities a streamlined biodiversity assessment at the strategic planning stage, along with options for offsetting impacts on biodiversity. To counter the loss or fragmentation of populations of cryptic and/or deciduous species, biocertification and any impact assessment undertaken through the statutory planning controls needs to consider the potential loss of species (including threatened species) and their habitats that are not amenable to study due to specific seasonal survey requirements at the time of biocertification or development application lodgement.
Corridors and loss of connectivity	Fauna movement across the landscape is often reliant on tree canopy as a minimum structural requirement, with increased ecological function being associated with more structurally diverse corridors. Currently the Pittwater Development Control Plan (DCP) contains a Wildlife Corridor Control which requires review to allow, where practical, connections between bushland reserves for highly mobile species including bird, bat and invertebrate species, as well as some terrestrial fauna species. Observations made during field work suggest that there a low levels of recruitment of native upper canopy species in many areas. These areas include: • remnant native vegetation on private property; • remnant native vegetation in reserves mostly or entirely bounded by residential or urban development; and • remnant native vegetation on steep slopes throughout the Pittwater peninsula, especially those patches featuring predominantly mesic species in the mid-canopy, understorey and groundcover strata. For example, Pittwater Spotted Gum EEC often occurs on steep slopes where patches are long and narrow, these patches often consist of scattered mature remnant Spotted Gum trees above dense mesic lower strata.

Adequate Development Controls	
Adequate Development Controls	Inappropriate development can have a significant impact on natural vegetation both directly and indirectly. Controls exist within Pittwater Council's planning instruments to minimise the impact of development on the natural environment including vegetation, bushland, threatened species, Endangered Ecological Communities and wildlife corridors. The controls are designed to ensure development is appropriate and a suite of conditions exist and are imposed onto development consents which aim to protect vegetation, mitigate impact and offset any unavoidable loss of natural resources.
Valuing Natural Assets	
Valuing Natural Capital	Responding to a global issue, the Lawton Review (Lawton *et al.* 2010) concluded that the highly fragmented landscapes in England are no longer able to respond effectively to new pressures such as climate and/or population change. The British government has released a White Paper on valuing Natural Assets and its implications, "The Natural Choice: securing the value of nature", which encourages the consideration of natural capital in economic evaluation. Although Lawton *et al.* (2010) is outlining measures which are applicable to British landscapes, the measures are applicable globally. Lawton *et al.* recommends that valuing natural assets can be underpinned by three objectives:

	(1) To restore species and habitats appropriate to [England's] physical and geographical context to levels that are sustainable in a changing climate, and enhanced in comparison with those in 2000. (2) To restore and secure the long-term sustainability of the ecological and physical processes that underpin the way ecosystems work, thereby enhancing the capacity of our natural environment to provide ecosystem services such as clean water, climate regulation and crop pollination, as well as providing habitats for wildlife. (3) To provide accessible natural environments rich in wildlife for people to enjoy and experience

5.3 Key Threatening Processes (KTPs)

The NSW Scientific Committee has listed a number of Key Threatening Processes under the *Threatened Species Conservation Act 1995* (TSC Act 1995). One of the objectives of the TSC Act (1995) is the integration of the conservation of threatened species into control processes under the *Environmental Planning and Assessment Act 1979* (EP&A Act 1979). Schedule 3 of the TSC Act (1995) is intended to provide a list of the Key Threatening Processes which are regarded as relevant to the Act and its implementation. The TSC Act (1995) defines a '*threatening process*' as "*a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities*". The relevance to the Pittwater LGA of Key Threatening Processes listed under the TSC Act (1995) (Schedule 3), Schedule 6 of the *Fisheries Management Act* 1994 (FM Act 1994) and the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) are outlined in Appendix 11 (for all KTPs) . Summarised in Table 4 are those KTPs deemed relevant (those which have been observed, or are likely to be occurring in Pittwater) and fall within the scope of this plan, along with an indication of how the prescribed management actions can be implemented to counter or eradicate those processes. Key Threatening Process impacting on native fauna (not flora) have been addressed in Pittwater's Native Fauna Management Plan (2011).

Table 4 Management Issues – Legislated Key Threatening Processes (KTPs) relevant to the Pittwater LGA

Key Threatening Process	Status		Notes
	NSW Status	National Status	
Anthropogenic Climate Change			
Anthropogenic climate change - Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases	Listed on the *TSC* Act 1995	Listed on the *EPBC* Act 1999	Changes to the interactions between native and exotic species, and to species composition under climate change is largely unknown. Under a climate change scenario, an improvement in connectivity (latitudinally and longitudinally) throughout the LGA may assist flora and fauna species to adapt. Larger pockets of vegetation are likely to adapt more readily compared with isolated, narrow and /or small stands. Reducing weed invasion and other pressures will also assist adaptation responses.
Habitat Alteration			
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition	Listed on the *TSC* Act 1995	-	Plants and animals have a range of mechanisms to survive individual fires. The long-term survival of plants and animals over repeated fires is dependent upon the ability of species to maintain life cycle processes and the maintenance of vegetation structure over time as habitat for animal species. Where fires occur at close intervals (high frequency fire) both these key features can be disrupted. If high frequency fire is sustained it will consequently lead to a loss of plant species, a reduction in vegetation structure and a corresponding loss of animal species. Too frequent burning on public or private land is likely to be a significant factor in species loss and overall bushland condition particularly in areas adjacent to dedicated or nominated APZs or SFAZs.
Loss of hollow-bearing trees	Listed as a KTP on the *TSC* Act 1995	-	The presence, abundance and size of hollows are positively correlated with tree trunk diameter, which is an index of tree age. Hollows with large internal dimensions are the rarest and occur predominantly in large old trees, which are rarely less than 220 years old. The distribution of hollow-bearing trees depends on tree species composition, site conditions, competition, tree health and past management activities. Hollows occur at varying densities; undisturbed woodlands typically contain 7–17 hollow-bearing trees per hectare and undisturbed temperate forests 13–27 per hectare. On a landscape basis, dead trees often account for 20–50% of the total number of hollow-bearing trees.
Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands	Listed as a KTP on the *TSC* Act 1995	-	Alteration to natural flow regimes refers to reducing or increasing flow rates, altering seasonality of flows, changing the frequency, duration, magnitude, timing, predictability and variability of flow events, altering surface and subsurface water levels and changing the rate of rise or fall of water levels. The degree to which these processes operate within the LGA is largely

			unknown.
Bushrock removal	Listed as a KTP on the *TSC* Act 1995	-	Bushrock Removal is the removal of natural surface deposits of rock from rock outcrops or from areas of native vegetation. Rocks may be loose rocks on rock surfaces or on the soil surface, or may have been removed from rock outcrops by excavation or blasting. Bushrock serves many purposes in the natural environment. It provides habitat for many plants and animals, some of which are threatened. Many animals use rocks and rock environments for shelter, to hide from predators, find food, avoid extreme weather conditions and escape bushfires. Bushrock is also known to provide egg-laying sites for reptiles. (Final Determination).
Clearing of native vegetation / Land clearance	Listed as a KTP on the *TSC* Act 1995	Listed on the *EPBC* Act 1999	At the LGA scale and the time of writing, the Pittwater LGA encompasses 10,900ha. Of the 4557ha of land managed by Council, 3,624ha of the pre-1750 vegetation has been cleared or significantly disturbed, with 933ha (20.5%) of the pre-1750 vegetation extent remaining.
Removal of dead wood and dead trees	Listed on the *TSC* Act 1995	-	Dead wood and dead trees provide essential habitat for a wide variety of native animals and are important to the functioning of many ecosystems. The removal of dead wood can have a range of environmental consequences, including the loss of habitat (as they often contain hollows used for shelter by animals) and the disruption of ecosystem process and soil erosion. Removal of dead old trees (either standing or on the ground) results in the loss of important habitat such as hollows and decaying wood for a wide variety of vertebrates, invertebrates and microbial species and may adversely affect threatened species known to occur in the area.
Pathogenic			
Infection of native plants by *Phytophthora cinnamomi*	Listed on the *TSC* Act 1995	Listed on the *EPBC* Act 1999	*Phytophthora cinnamomi* is a soil borne pathogen belonging to the water mould group (Oomycetes). It spreads in plant roots in warm, moist conditions through movement of spores which may swim to new hosts or be dispersed over large distances in flowing water such as storm runoff. The pathogen appears to be widespread in coastal forests, and is known to infect a large range of species that display a range of symptoms; some are killed, some are damaged but endure, and some show no apparent symptoms. In some circumstances, *P. cinnamomi* may contribute to plant death where there are other stresses present (*e.g.* waterlogging, drought, and/or wildfire).
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	Listed on the *TSC* Act 1995	-	The NSW Department of Primary Industry (formerly the Department of Industry & Investment) website describes Myrtle Rust as "*a newly described fungus that is closely related to the Eucalyptus/Guava rusts. These rusts are serious pathogens which affect plants belonging to the family Myrtaceae including Australian*

			natives like bottle brush (Callistemon spp.), tea tree (Melaleuca spp.) and eucalypts (Eucalyptus spp.)... Infection on highly susceptible plants may result in plant death". It is considered that this fungus may pose a serious threat to the integrity and function of native vegetation, and is considered to be widely distributed in almost the entire NSW coastal zone (including the Pittwater LGA). Currently, 36 species of Myrtaceae are known to be susceptible, and this figure is expected to rise. The Myrtle Rust National Management Group admits that it is not feasible to eradicate the disease.
Habitat Invasion			
Competition and grazing by the feral European rabbit	Listed as a KTP on the *TSC* Act 1995	Listed on the *EPBC* Act 1999	Grazing and burrowing by rabbits can cause massive erosion problems, reduce recruitment and survival of native plants, and alter entire landscapes. Rabbits also threaten the survival of a number of native animal species by altering habitat, reducing native food sources, displacing small animals from burrows and attracting introduced predators such as foxes. In addition, rabbits may have significant impacts on Aboriginal and historic cultural heritage. For example, overgrazing by rabbits has exacerbated soil erosion in Mungo and Kinchega national parks, exposing culturally significant sites such as Aboriginal burial grounds. (Final Determination)
Competition from feral honeybees	Listed as a KTP on the *TSC* Act 1995	-	Feral honeybees are introduced bees, *Apis mellifera*, which originally escaped from hives and have subsequently established in the wild usually centred on tree hollows. Feral honeybees are thought to occur patchily throughout most of the State with the exception of alpine areas (Paton, 1996). Honeybees impact on biodiversity in two broad ways: via competition for tree hollows and floral resources such as pollen and nectar. The loss of tree hollows due to occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. This is of particular concern for species which are threatened. Hollows are an extremely important resource for many Australian animals, particularly birds and mammals. (Final Determination)
Introduction of the large earth bumblebee, *Bombus terrestris*	Listed on the *TSC* Act 1995	-	Bumblebees, *Bombus terrestris*, are a relatively large, primitively eusocial bee native to Europe. Bumblebees were first recorded in Tasmania in 1992 and have since spread over a large area of the state in both urban and native bush areas (Hingston *et al.* 2001). They have become established throughout Tasmania in a wide range of habitats, from sea level to 1250 m altitude within all the major native vegetation types (Hingston and McQuillan 1998). Their wide adaptability demonstrates the potential of the species to naturalise in NSW. At present this species is not known to occur in NSW, but could establish through accidental introduction from colonies in Tasmania or New Zealand, or deliberate introduction as a pollinating agent. (Final Determination)

Importation of Red Imported Fire Ants into NSW	Listed on the *TSC* Act 1995	Listed on the *EPBC* Act 1999	The Red Imported Fire Ant, *Solenopsis invicta*, is a small colonial ant that is a native of southern Brazil. They damage plants by eating fruit and seeds and tunnelling into stems and girdling seedlings. They also prey heavily on ground invertebrates and attack any slow moving vertebrates such as bird nestlings. Fire ants are listed among the worlds 100 worst invaders by the Invasive Species Specialist Group of the IUCN (ISSG 2994). Climatic modelling of the potential habitat for fire ants across Australia shows that they could occupy most of the coastal belt and the more mesic inland areas (Sutherst 2001). This includes the eastern half of NSW except for alpine areas. Workers forage during the warmer months of the year when temperatures are between 22°C and 36°C. The NSW Department of Primary Industries has declared the Red Imported Fire Ant a notifiable pest under the Plant Diseases Act 1924. This means there is a legal obligation to report suspected red fire ant infestations to the Department as soon as possible. (Final Determination)
Invasion of the Yellow Crazy Ant (*Anoplolepis gracilipes* (Fr. Smith)) into NSW	Listed on the *TSC* Act 1995	Listed on the *EPBC* Act 1999	Crazy ants, *Anoplolepis gracilipes*, are notable for their frenetic activity when disturbed. Crazy ants have spread across 2500 km2 in the Northern Territory (Young *et al.* 2001). Crazy ants have been intercepted in Australian ports at least 161 times since 1988 (Pest and Diseases Information Database, DAFF). Approximately 40% of interceptions have been in NSW ports. The Yellow Crazy Ant is a scavenging predator with a broad diet. It preys on a variety of litter and canopy fauna, from small isopods, myriapods, earthworms, molluscs, arachnids, and insects to large land crabs, birds, mammals, and reptiles. In addition to these protein-rich foods, Yellow Crazy Ants obtain carbohydrates and amino acids from plant nectaries and honeydew excreted by aphids and scale insects, (Homoptera), which are tended on stems and leaves of a wide variety of tree and shrub species. The Yellow Crazy Ant is known to kill invertebrates, reptiles, hatchling birds and small mammals. Secondary effects are caused by the outbreaks of sap-sucking scale insects tended by the Yellow Crazy Ant. This reduces seed production and increased mortality in some canopy tree species.
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	Listed on the *TSC* Act 1995	-	The severity of dieback associated with over-abundant psyllids and bell miners varies across the forested areas of NSW, although its extent has not been fully investigated. The forest types most susceptible are those dominated by Sydney Blue Gum (*E. saligna*), Narrow-leaved White Mahogany (*E. acmenoides*), Grey Gum (*E. punctata*) and Grey Ironbark (*E. paniculata*). Another forest tree species present which are known to be susceptible to attack include the Spotted Gum *Corymbia maculata* usually after a substantial decline in the most susceptible species.

Invasion and establishment of exotic vines and scramblers	Listed on the *TSC* Act 1995	-	The majority of these exotic vines and scramblers are garden escapees associated with the horticultural industry. Many are recognised as significant environmental weeds in particular regions.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.	-	Listed on the *EPBC* Act 1999	Escaped garden plants, including aquatic species, have significant adverse effects on biodiversity by forming dense thickets, suppressing native vegetation and seedlings through shading, nutrient competition, smothering and allelopathy (*i.e.* the chemical suppression of germination and/or growth of other plant species). A number of these species are known to readily invade disturbed sites and communities including edges and canopy breaks in dense forest communities.
Invasion of native plant communities by *Lantana camara*	Listed on the *TSC* Act 1995	-	Lantana has significant adverse effects on biodiversity by forming dense thickets, suppressing native vegetation and seedlings through shading, nutrient competition, smothering and allelopathy (*i.e.* the chemical suppression of germination and/or growth of other plant species). Lantana readily invades disturbed sites and communities, including edges and canopy breaks in dense forest communities. In open forests and woodlands lantana often becomes a dominant understorey species, and in warmer, moister areas lantana often becomes dominant in regenerating pastures.
Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*	Listed as a KTP on the *TSC* Act 1995	-	*Olea europaea* L. subsp. *cuspidata* is a major woody weed in woodland remnants which tends to favour heavier soils. Seedlings recruit under canopy eucalypts, dead trees, and power lines (resulting from bird dispersal) and dense stands shade out and out-compete native species for moisture. Major seedling recruitment occurs during wet periods (Royal Botanic Gardens profile).
Invasion of native plant communities by *Chrysanthemoides monilifera* (bitou bush and boneseed)	Listed on the *TSC* Act 1995	-	*Chrysanthemoides monilifera* invades and displaces native plant communities. Boneseed (subspecies *monilifera*) is the less important of the two weeds in New South Wales but has the potential to be a serious threat to inland areas in the future if left uncontrolled. Bitou bush was first recorded in New South Wales in 1908 near Newcastle, and between 1946 and 1968 was planted for dune stabilisation at a number of locations along the New South Wales coastline. It has spread rapidly from these plantings and is now found along 80% of the coastline covering more than 900 km.
Invasion of native plant communities by exotic perennial grasses	Listed on the *TSC* Act 1995	-	Exotic perennial grasses are those that are not native to NSW and have a life-span of more than one growing season. More than a hundred species of exotic perennial grasses occur in New South Wales. Of concern are a relatively small number of exotic perennial grasses with the capability of threatening native plant communities. These include *Hyparrhenia hirta* (Coolatai grass), *Cortaderia* spp. (pampas grasses), *Sporobolus fertilis* (giant Parramatta grass), *Nassella neesiana* (Chilean needlegrass), *Nassella*

			trichotoma (serrated tussock) and *Eragrostis curvula* (African lovegrass) (Final Determination).
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	Listed as a KTP on the *TSC* Act 1995	-	Scotch Broom, *Cytisus scoparius*, is a leguminous shrub native to Europe and was first introduced to Australia in the early 1800s. By 1901 it had spread significantly and was declared a noxious weed in NSW. *C. scoparius* is estimated to infest more than 200,000 ha in south-eastern Australia and has become an environmental weed in higher rainfall areas. It grows most successfully in cool temperate areas on moist, fertile soils. It is continuing to spread through both expansion of existing infestations and colonization into new areas. In some locations it has formed near monocultures. (Final Determination).
Aquatic and Marine			
Degradation of native riparian vegetation along New South Wales water courses	Listed on the FM Act 1994	-	Riparian vegetation refers to the vegetation fringing water courses and can be defined as any vegetation on land which adjoins, directly influences, or is influenced by a body of water. Riparian habitats thus include land immediately alongside large and small creeks and rivers, including the river bank, gullies, lakes, wetlands etc. Degradation of riparian vegetation includes the removal or modification of native species and a major cause of degradation is the introduction of, or invasion by, non-native species. Degradation of riparian vegetation has a major influence on stream ecosystems by; increasing sediment and nutrients (via runoff) and increasing light penetration of the water body. Impacts include; smothering of benthic communities, increases in harmful algal growth, reduces organic carbon (via leaves, twigs, and branches), reduced large woody debris, destabilises river banks and reduces overhanging riparian vegetation resulting in a loss of shade and shelter for fish. (Final Determination)

Refer to the New South Wales Scientific Committee Final Determinations for references included in tables above.

6.0 RESTORATION

6.1 Restoration Objectives - Maintaining Biodiversity

The objectives of this Plan reinforce and are in line with the aims, goals and targets set in Pittwater Council's *2020 Strategic Plan* – Our Sustainable Future (Key Direction 2 – Valuing and Caring for our Natural Environment) and its commitments in the 2010 *SHOROC State of the Environment Report 2009/2010.* Table 5 (below) outlines some initiatives and actions relevant to biodiversity management.

Table 5 Key Biodiversity Objectives.

Goal	2020 Target	Selected Relevant Initiatives and Actions
To protect, enhance, conserve and restore remnant bushland and creek line ecosystems	80% of bushland is in a self-sustaining state	Continue and increase targeted noxious weed removal campaigns; Develop and promote Voluntary Conservation Agreements and other agreements; and Develop and implement a program with community and business to maximize tree retention.
To maintain urban forest	Establish current baseline tree canopy data (% coverage) and ensure no net loss	Determine criteria for appropriate landscape; Review biodiversity outcomes very 5 years including impacts of climate change; Increase education to residents on the benefits of canopy retention Review and update the Wildlife Corridor Plan to improve connectivity and regenerate strategic corridors, including road reserves.
To maintain abundance and diversity of Pittwater's native plant and animal species	No increase in the number of listed threatened or endangered species	Develop an education, awareness and information program for the community to recognise the value of vegetation and appropriate plants; and Review and update the Wildlife Corridor Plan to improve connectivity and regenerate strategic corridors, including road reserves.

With respect to disturbances, it has often been assumed that a reservation/protection strategy that looks after rare and threatened elements of biological diversity will also protect the areas of highest ecological integrity and *vice versa* (Kirkpatrick J. & Gilfedder L., 1995). Conversely, Kirkpatrick and Gilfedder (1995) used native and exotic species richness and cover as indicators of bushland integrity and observed that the disturbances that favour threatened species do not necessarily favour more widespread or common native species. Consequently, although the objectives of management prescriptions (including the use of fire) includes advice relating to specific threatened species which are responding to specific disturbance regimes, management prescriptions in this document take into account appropriate management for the community as a whole (or, in the case of small patches or reserves, the entire patch).

Where possible, the works outlined in the schedules in Section 10 - Plan Implementation aim to avoid the use of potentially high-risk strategies due to the sensitive nature of the environments present. The use of appropriate management prescriptions, along with appropriate follow-up strategies, aims to ensure effective management while reducing potential risks associated with

certain management actions as far as possible. Given continuing pressure on native vegetation communities from development and increasing resource use, it may not be possible to ameliorate some of the threatening processes operating within the LGA (e.g. altered fire frequency or changes to nutrient or moisture status). Where possible, recruitment opportunities which aim to improve the trajectory of restored vegetation should focus on the amelioration of threatening processes along with assisted regeneration, rather than the importation of additional genetic material (via seed or established seedlings), except where there is evidence that these come from the same original provenance and there is a particular case to reintroduce them (i.e. needed for ecological processes).

6.2 Condition of Remnants

The three condition codes utilised are shown in Table 6 below. Condition was mapped over the entire study area using aerial photograph interpretation and field observations. Areas mapped in the accompanying GIS as Condition Class 1 (High Condition – Intact Bushland) are generally situated furthest from the urban and suburban interface. Areas mapped Condition Code 2 (Moderate Condition- Intact Bushland) or Condition Code 3 (Altered Bushland - High Disturbance) show areas where there is scope for improvement in the overall condition by means of a range of management strategies. Condition Classes 2 and 3 generally reflect areas situated closer to the urban and suburban interface and those with modified landscapes; these are all sites subject to increased nutrient loads, altered hydrology and fire regimes, dieback of canopy trees, lack of canopy species recruitment and often dense weed infestation, refer to Figure 6 – Vegetation Condition Mapping.

6.3 Conservation

Areas identified in the mapping as requiring conservation need to be incorporated into Council land-use planning and relevant development controls created to afford protection.

Figure 5 Pittwater Local Government Area excluding Ku-ring-gai Chase National Park – Vegetation Condition Mapping (sample only)

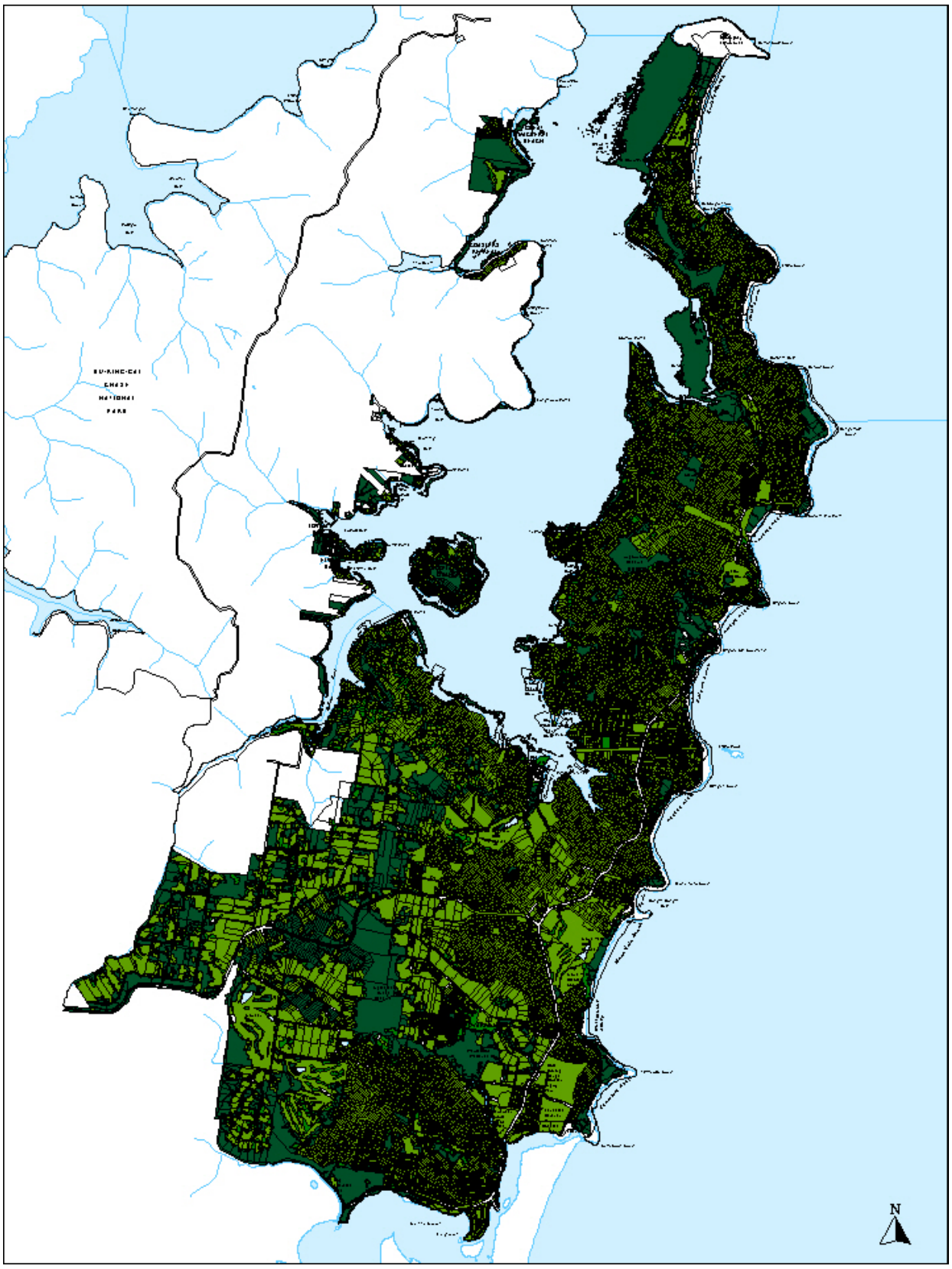


Table 6 Condition Categories and Pittwater Local Government DCP Equivalents.

Condition Code	Brief Definition	Typical Connectivity[3]	Typical Resilience[4]	Typical Condition and Disturbance Level[5]	Pittwater DCP Classes	Indicative matrix (surrounding areas)	Equivalent BioBanking class
Core Bush-land							
1	High Condition Intact Bushland (Low Disturbance (or Disturbance Absent))	High	High resilience – sufficient native biota remaining *in-situ* to enable good recovery to pre-disturbance state. Low to moderate levels of management intervention required to facilitate restoration. Natural regeneration and assisted restoration treatments only.	Species of all age classes in all strata well represented. No apparent disturbance or if present much **localised**. **Good connectivity and habitat provision** (*i.e.* fallen timber *etc.*). Very high resilience to natural disturbances. Very **minor to no weed** incursion. In wooded vegetation types: • **all tree age classes present;** • **tree dieback infrequent;** In estuarine vegetation types: • **age classes may be difficult to discern;** • **dieback infrequent;** No weeds **or if present:** very few scattered annual +/- perennial groundcover; **or** one or two discrete patches; **or** limited to edges (*ie.* Weed Classes A or B). May contain threatened species, populations or elements of Endangered Ecological Communities (EEC's) as list under the Threatened Species Conservation Act 1995 which are subject to separate controls in the DCP.	**Category 1** Areas with high quality intact bushland with good connectivity of predominately native vegetation. Native vegetation in this category includes rainforest, forest, woodland, scrub, heath, mangroves, saltmarsh and wetland vegetation. Depending on vegetation type, all structural layers including canopy, sub-canopy, understorey and groundcovers are generally present but some local disturbances may occur. Disturbances such as weed incursion, if present, is limited to very few scattered perennial/annual ground cover species; one or two discrete patches; or limited to edges.	Near natural - vegetation in excellent condition. Undeveloped matrix (surrounding area) *i.e.* little difference between matrix and patch.	Moderate to good condition.

[3] Connectivity: the degree to which an area (or areas) of native vegetation is linked with other areas of vegetation (DEC, 2009).

[4] Resilience: capacity of vegetation community or patch to recover once disrupted.

[5] References to trees, upper canopy *etc.* do not apply to naturally treeless vegetation types (*e.g.* wetlands, native grasslands, heaths & scrubs, saltmarsh, herbfields)

Condition Code	Brief Definition	Typical Connectivity[3]	Typical Resilience[4]	Typical Condition and Disturbance Level[5]	Pittwater DCP Classes	Indicative matrix (surrounding areas)	Equivalent BioBanking class
Fragmented Bushland							
2	Moderate Condition Intact Bushland- (Moderate Disturbance)	Moderate	Moderate resilience – *in-situ* native biota likely to be somewhat depleted. Moderate levels of management intervention required to facilitate restoration. Primarily assisted restoration required.	Species of all age classes in all strata represented. **Moderate** levels of **localised disturbance** apparent (*i.e.* although **not grazed or slashed, some negative influence** from adjacent areas may affect integrity). **Good connectivity and habitat provision.** Exotic species **present but restricted** in extent to edges and/or disturbed or modified areas. In wooded vegetation types: • **one or more tree age classes absent or not well represented;** • Tree **dieback limited to infrequent occurrences of mature individuals** (greater levels than in surrounding natural areas) **but recruitment present.** Worst cases in this category may include +areas which fall short of the above definition in that localised disturbance may require some addition effort in order to facilitate restoration or restoration is currently underway. May contain threatened species, populations or elements of Endangered Ecological Communities (EEC's) as list under the Threatened Species Conservation Act 1995 which are subject to separate controls in the DCP.	**Category 2** Areas of fragmented bushland in moderate condition and occurring outside of core bushland areas. This includes developed areas interspersed with small patches of remnant bushland with good connectivity of predominately native vegetation. Native vegetation in this category includes rainforest, forest, woodland, scrub, heath, mangroves, saltmarsh and wetland vegetation. Depending on vegetation type, all structural layers including canopy, sub-canopy, understorey and groundcovers are generally present but vegetation in this category is likely to be affected by moderate localised disturbance such as partial clearing and weed incursions (with weeds often limited to disturbed areas and remnant edges). Fragmented bushland may include large numbers of native trees and shrubs retained in gardens and parks.	Some disturbance: all habitat components still present, but still retains high integrity. Vegetation present has good resilience and removing the causes of the degradation could show immediate beneficial effects.	Moderate to good condition

Condition Code	Brief Definition	Typical Connectivity[3]	Typical Resilience[4]	Typical Condition and Disturbance Level[5]	Pittwater DCP Classes	Indicative matrix (surrounding areas)	Equivalent BioBanking class
Cleared Land with potential for Restoration							
3	(i) Altered Bushland (High Disturbance); (ii) Cleared Bushland (Very High Disturbance)	Low	(i) Low resilience - *in-situ* native biota likely to be significantly depleted. High levels of management intervention required to facilitate restoration. Primarily assisted restoration treatments. (ii) Very low resilience - *in-situ* native biota replaced by exotics. Primarily assisted restoration with some rehabilitation and/or re-vegetation treatments.	(i) Native ground stratum species **not well represented, apparent disturbances high** (*e.g.* grazed, slashed, or physically disturbed with negative influence from adjacent areas affecting integrity evident). Introduced species **common in one or more strata**, exotic vine thickets occasionally smothering canopy. (*i.e.* Weed Classes C, D or E). **Moderate habitat provision** and level of resilience. **Fragmented connectivity** and influenced negatively by activities in adjacent areas. In wooded vegetation types: • **greatly reduced tree cover or understorey species** only with some overstorey and/or poor understorey & ground stratum integrity (*e.g.* grazed, slashed or physical disturbed). • **Tree dieback apparent** with **no recruitment**. • Groundcover almost entirely weeds and/or woody weeds very common in all strata +/- nutrient input. May contain threatened species, populations or elements of Endangered Ecological Communities (EEC's) as list under the Threatened Species Conservation Act 1995 which are subject to separate controls in the DCP. Worst cases in this category may include areas which fall short of the above definition in that: • native ground stratum species **poorly represented or absent**. • Apparent **disturbance very high** (*e.g* grazed, slashed, compacted area or **terrain physically disturbed** [*i.e.* modified]) and / or adverse influences from adjacent areas	**Category 3** Areas of highly disturbed or cleared bushland with poor connectivity which has been negatively impacted by activities in adjacent areas (e.g. land clearing). These areas are located outside areas identified as wildlife corridors. These areas can be modified landscapes with predominately planted native and exotic vegetation such as those typical of suburban gardens, although they still have potential for habitat recreation or enhancement through appropriate landscaping. Depending on vegetation type, vegetation in this category is likely to have a reduced canopy and sub-strata (including groundcover). Weed incursion is likely to be moderate to very high with widespread perennial/annual weeds dominating the understory and groundcover structural layers. Exotic vine	(i) Degraded as a consequence of continued disturbance and degradation which has affected the long-term sustainability of the community or patch. Upper and under-storey species partly lost but regeneration apparent; ground cover often dominated by weeds and introduced grasses. The removal of degrading influences is important, but some treatment to promote regeneration may also be needed. (ii) Highly degraded because of continued disturbance and degradation affecting the long-term sustainability of the community or patch. Low resilience: understorey species lost, and low or no regeneration apparent. One or more strata almost	(i) **Low condition if:** canopy cover <25% **and** <50% ground cover indigenous **or** >90% ground cover cleared (wooded communities); ground cover <50% indigenous **or** >90% cleared (grasslands, wetlands, herbfields) **<u>Moderate-good condition</u>** (ii) This condition class may be consistent with 'Low Condition' vegetation in BioBanking) depending on floristics and structure. *i.e.* Low condition - canopy

Condition Code	Brief Definition	Typical Connectivity[3]	Typical Resilience[4]	Typical Condition and Disturbance Level[5]	Pittwater DCP Classes	Indicative matrix (surrounding areas)	Equivalent BioBanking class
				affecting integrity evident.	thickets smothering remnant native canopy species may also be present.	entirely dominated by weeds.	cover <25% **and** <50% ground cover indigenous **or** >90% ground cover cleared (wooded communities); ground cover <50% indigenous **or** >90% cleared then low condition (grasslands, wetlands, herbfields)

Weed encroachment

The level of weed encroachment in vegetation remnants was categorized into weed classes: these weed classes contributed to the ranking of the overall condition code for each patch and thus to delineation of the appropriate management actions. The weed classification considered factors such as weed type, incidence and intensity of weed cover, according to the criteria set out below.

Weed Classes

Weed Class and Level of weed encroachment	Criteria
Class A Good condition vegetation (e.g. Condition Code 1 or 2)	No weeds **or if present:** very few scattered annual +/- perennial groundcover; **or** one or two discrete patches; **or** limited to edges.
Class B Low to Moderate weed encroachment	Few perennial/annual groundcover throughout; **or** some denser/larger discrete patches present but generally limited to two strata (*e.g.* groundcover **+/-** few sporadic woody weeds); **and** weed cover along edges as in Weed Class 'A'.
Class C Moderate weed encroachment	Groundcover weeds widespread, mixed with native groundcover; occasional woody perennials in 2 or more strata; **or** woody perennials very common in **one** stratum.
Class D High weed encroachment	Groundcover weeds widespread and common, few natives; woody perennials common in **more than** two strata +/- nutrient input.
Class E Very high weed encroachment	Groundcover almost entirely weeds and/or woody weeds very common in all strata +/- nutrient input.

Implications and Requirements for Development

Development applications are required under the provisions of the Environmental Planning and Assessment Act 1979 to assess the potential impact on adjacent vegetation. Applicants are required to address relevant biodiversity controls within the Pittwater 21 Development Control Plan (DCP) and this may involve engaging ecological consultants to undertake flora assessments which outline the existing structure, species and condition of the vegetation in the vicinity of the proposed works and determine the level of impact the works may have and how this could be mitigated.

The Condition Categories described in Table 6 above and the associated mapping directly inform controls in the DCP currently known as B4.1 Flora and Fauna Conservation Category 1 Land (Category 1 in Table 6), B4.3 Flora and Fauna Habitat Enhancement Category 2 Land (Category 2 in Table 6) and B4.5 Landscape and Flora and Fauna Enhancement Category 3 Land (Category 3 in Table 6). The names and numbers of these controls are subject to change with future DCP reviews.

Applicants will be required to submit a detailed flora impact assessment if the subject property is mapped as Category 1 and has the associated DCP control. This will be coupled with a fauna assessment and is to be undertaken by a qualified ecological consultant. The report may be known as a "Flora and Fauna Assessment", "Ecological Impact Assessment", "Biodiversity Impact Assessment" or similar. If the subject property is mapped as Category 1, landscaping is generally inappropriate and the vegetation is to be managed in a natural state, and a Bushland Management Plan or Ecological Sustainability Plan will also be required to be submitted. This will demonstrate how the natural features of the site will be protected, enhanced and managed into the future, and is to be undertaken by a qualified ecological consultant.

For properties mapped as Category 2, a flora assessment may be required as determined by Council during the assessment process, depending on the existing nature of the vegetation. As Category 2 vegetation can include remnant canopy trees with little remnant understorey, an arboricultural assessment will be required to assess potential impacts to existing canopy trees, as undertaken by a qualified arborist. This may also apply to properties mapped as Category 3 which generally do not require detailed flora assessments.

6.3.1 Regeneration, Restoration or Re-vegetation

1. *Bush regeneration* is the recovery of an ecosystem after disturbance by utilising a site's natural processes (Buchanan R.A., 2009). This technique omits active intervention and focuses on maintenance of sites where abatement of a threatening process(es) is in an advanced stage. It focuses largely on weed removal to ensure that natural processes are retained and is commonly used in good condition sites. As threat abatement in one form or another (*e.g.* control of pests, regulation of appropriate fire regimes) is required in most parts of the remnants, this technique is one of the stated objectives associated with *Assisted natural restoration* described below.

2. *Assisted natural restoration* techniques are used in areas with moderate to high levels of resilience (*i.e.* for example above 25% below benchmark to benchmark) and is achieved by integrating a range of techniques into the restoration process including abatement of threatening processes such as correction to natural flows, the appropriate control and removal of competing species, and delineating appropriate use of ecologically sensitive fire regimes. *Assisted natural restoration* is undertaken by allowing the site or patch to naturally regenerate using the moderate to high resilience present in order to reverse degrading processes, repair ecosystem structure and to reinstate ecosystem process and function. Once abatement reaches a level where natural processes are reinstated, management regimes need to shift to technique 1 (*i.e. Bush regeneration).*

3. *Bushland revegetation* techniques are used in areas with lower resilience and/or soil profile disturbance (*i.e.* for example less than 25% below benchmark) and involve human intervention such as planting, direct seeding and brush-matting. This technique would be appropriate in circumstances where historic clearing has been undertaken (*i.e. in* a paddock situated near remnant vegetation to strengthen a weak corridor link). *Bushland revegetation* incorporates much greater levels of intervention that continue to the point where natural processes are observed to predominate. At this point, management regimes need to shift to the *Assisted natural restoration* technique.

Whichever techniques are utilised, the important underlying common factor is for the rate of change to be concomitant with that of natural processes particularly in ecologically sensitive sites and in situations where introduced plant species are providing proxy native habitats and food resources.

Restoration should also be undertaken in accordance with the following:

- any recovery plans for any threatened taxa, including any draft recovery plans (as shown, but not limited to the list provided in Appendix 6);
- any Priority Action Statements for threatened species, populations and Endangered Ecological Communities (as shown in, but not limited to, the lists provided in summary at Appendix 7 and in full at Appendix 12);
- ecological advice provided in scientific determinations and species and community profiles; and
- relevant current scientific literature.

6.3.2 Vegetation Management

Assessment or implementation of measures on private lands can be undertaken by:

- providing incentives for non-mandatory participation in restoration programmes;
- providing incentives for land-holders as part of a local government focused programme for pooling carbon dioxide sequestration and associated credits;
- through the statutory planning process; or
- through penalties associated with provisions of the *Noxious Weeds Act 1993*;

The selection of management options to be adopted should be guided by the condition and associated resilience of each patch as well as the need to implement abatement strategies. Similar landforms are subject to distinct groups of threatening process and weed distribution is closely linked to soil landscape and disturbance factors. Consequently, the entire LGA has been divided into broad vegetation types (which reflect condition and vegetation cover), to which broad management objectives and management strategies are applied. Prescriptions for management have been allocated for each broad vegetation type. Equivalence between broad vegetation type and Endangered Ecological Communities are shown in Table 2.

In circumstances where there is a need to implement strategies which reinforce natural processes (Condition Codes 1-2), ***Assisted natural restoration*** techniques are recommended as the preferred management prescription. NB condition codes 2 and 3 show scope for improvement in future management of the remnants. ***Assisted natural restoration*** is applicable to vegetation which is structurally intact, or where there may be some structural deficiency but the patch is floristically typical of the community. It is aimed at encouraging natural regeneration through weed removal, control or eradication of threatening processes and the reinstatement of processes associated with natural regeneration. Where low levels of resilience occur (Condition Code 2 and 3) and natural processes are poor or absent, ***Bushland Revegetation*** techniques are recommended as the preferred management prescription.

Replanting is not considered appropriate for units which have been ascribed a condition score of 1-2 **(*i.e.* Assisted natural restoration)**, but is permitted and / or recommended in areas ascribed a condition score of 2-3 **(*i.e.* Bushland Re-vegetation)**. This may be undertaken in the form of planting, direct seeding and brush-matting. For example, where cleared and disturbed sites abut areas with a condition score of 1-2, supplementary planting may comprise the inclusion of upper canopy species with plant stock derived from locally provenanced seed. The introduction of shrub and groundcover is not recommended in these areas due to the diversity often present in the groundcover or in immediately adjacent areas.

6.4 Patch Size, Shape and Connectivity

The fragmentation of temperate eucalypt woodlands has resulted in those ecosystems being more susceptible to weed invasion because of their high levels of exposure to invasive propagules (Yates C.J. & Hobbs R.J., 1997), (Adair R.J., 1995); as a consequence of their greater edge-to-area ratios (Panetta F.D. & Hopkins A.J.M., 1991), and, because those stands are subject to a number of exogenous disturbances that favour the growth of exotic species (Humphries S.E. *et al.*, 1994). Weed seed dispersed into the centre of remnants as large as

1030ha has been observed to show minimal weed establishment where vegetation canopies were intact and that the greatest invasion occurred where the canopy was disturbed (Hobbs R.J. & Atkins L., 1998). Consistent with this, surveys in Western Sydney (Tozer M., 2003) found that '*…the number of weeds recorded in a survey site was correlated with the perimeter to area ratio for the remnant in which it was located … There was also a weak inverse correlation between the number of exotic species recorded and the distance at which the survey site was located from the edge of the.* Similar positive relationships have been reported between exotic plant cover and exogenous disturbances (McIntyre S., & Lavorel S., 1994), (Prober S.M., 1996).

6.5 Wildlife Corridors

Remnant native vegetation is a critical element in movement corridors for fauna, particularly for those species which require certain attributes or cannot traverse wide gaps between remnants and where the difference in quality between the patch and the matrix is significant. On habitat connectivity Lindemayer and Fischer (2006) observed "*...the landscape connectivity provided by corridors has the potential to enhance both the habitat connectivity of some species and the ecological connectivity of some key ecosystem processes.*" Corridors "*... are believed to:*
(i) *Facilitate the movement of animals;*
(ii) *Provide habitat for resident populations;*
(iii) *Enhance dispersal success;*
(iv) *Prevent and reverse local extinctions by recolonisation of empty patches;*
(v) *Promote exchange of genes between sub-populations, increasing the effective population size and reducing genetic drift and inbreeding depression;* and
(vi) *Maintain the inherent species richness at the patch and landscape scale.*"

Corridor linkages within Pittwater LGA will be revised as detailed in council's Native Fauna Plan of Management (2011) as part of the revised Wildlife Corridor Strategy.

6.5.1 Corridor Management

The reinforcement of any corridors linking sensitive lands could be undertaken by means of a number of options, including BioBanking or programs which focus on the mitigation for key threatening processes. In the event that BioBanking was utilised for any vegetated lands within the LGA, it would be anticipated that the width of a number of priority corridors could be widened at least one increment in the BioBanking connectivity measure (*e.g.* from <500m to >500m) to improve the movement of wildlife between patches, and also as a means for dispersing pollen, seed and other genetic material. In circumstances where the soil seed store is depleted in some areas, surrounding areas may be sufficiently species-rich to assume that transfer of propagules will not be inhibited, although such sites will require dedicated and continuing effort to restrict the spread of weed species.

Corridor management in sensitive environments should accord with the following:

- ridgeline and riparian vegetation corridors of natural high conservation value, along with natural features to be retained in their natural state to preserve habitat and high visual quality locations;
- where possible, disturbed areas which connect areas of high conservation value or which are visually prominent should be rehabilitated and managed accordingly;
- increased reliance on utilising natural features rather than civil works;
- disturbed soil to be protected from erosion or the effects of increased salinity;
- reduce the risk of fire originating in nearby development; and
- habitat trees which would generally be deemed unsafe in suburban locations need to be retained as habitat resources.

6.6 Edges and Buffer strips

Native re-vegetation or natural buffer strips can be used as required to protect intact native vegetation from the effects of nutrient inputs, wind damage and weed invasion (DECC, 2005). For example, strategically-placed buffer strips would create a more gentle transition from remnants to the adjacent matrix, and thus protect margins of native vegetation by reducing the edge effects. An example of the use of such buffer strips would include hind-dunes where the buffer strip would afford protection to residential properties situated leeward. As a general rule, the wider the strip (recommended minimum width 25-50m), the less susceptible to 'edge' effects the buffer strip (and thus the remnant) will be (DECC, 2005). Ideally, any fencing installed along the suburban interface should be fauna-friendly although this may not be practicable in some circumstances.

Where corridors are reinforced using buffer strips re-vegetation may include, but should not be limited to, upper canopy species, using tube-stock derived from locally-provenanced seed. The aim should be to reproduce an ecosystem that is structurally and functionally similar to existing remnant vegetation. Alterations to the edge of the remnants, including reinforcement of corridors and provision of native buffer strips, should be done in a manner mindful of the preferred shape and arrangement for bushland remnants and the underlying ecological principles (see Appendix 14). Actions to restore bushland should be wholly consistent with the objectives of any relevant Recovery Plans (including Draft documents) and the Priority Action Statements provided in Appendices 6 and 12 and should adhere to the plan implementation scheduled in Section 10 – Plan Implementation. All structures of re-vegetation should use locally-provenance seed.

6.7 Fauna and Fauna Habitats

The condition of native vegetation remnants has a profound effect on fauna habitats, and thus fauna species diversity and the health of fauna populations. While fauna species are not the major focus of this report, several attributes of the vegetation remnants within the Pittwater LGA may act as indicators of the probable value of these remnants to native fauna, including:

- Large, mature trees with trunk and limb hollows – these are used by a wide range of species such as bats, birds, arboreal mammals (gliders, possums) and reptiles. Gibbons

and Lindenmayer (2002) estimated that almost 2/3rd of all know microchiropteran bat species and almost 1/3rd of all terrestrial mammals use tree hollows, while hollow use by birds is ~50% higher in Australia than anywhere else in the world.

- Wetlands and wetland vegetation are important for invertebrates, amphibians, fish, reptiles and a range of bird species. The Final Determination for the Freshwater Wetlands EEC notes that this community "*...has a distinctive fauna that includes frogs, fish, freshwater tortoises, waterbirds and a diversity of micro- and macro-invertebrates. The frog families represented are Myobatrachidae (southern frogs) and Hylidae (tree frogs), including the threatened Green and Golden Bell Frog (*Litoria aurea*). Waterbirds include Black Swan (*Cygnus atratus*), Pacific Black Duck (*Anas superciliosa*), Australian Grey Teal (*Anas gracilis*), Pacific Heron (*Ardea pacifica*), White-faced Heron (*Ardea novaehollandiae*), Great Egret (*Ardea alba*), Intermediate Egret (Ardea intermedia), Little Egret (*Ardea garzetta*), Straw-necked Ibis (*Threskiornis spinicollis*), Sacred Ibis (*Threskiornis aethiopica*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Royal Spoonbill (*Platalea regia*), Yellow-billed Spoonbill (*Platalea flavipes*), Japanese Snipe (*Gallinago hardwickii*), Black-winged Stilt (*Himantopus himantopus*), Dusky Moorhen (*Gallinula tenebrosa*), Comb-crested jacana (*Jacana gallinacea*) and Purple swamphen (*Porphyrio porphyrio*)."
- In wooded communities, the dense shrub cover provided is an essential habitat element for smaller forest birds, providing shelter from predators, foraging resources and nesting materials;
- Depth and extent of leaf litter is critical for invertebrates and reptiles, as well as other species that depend on those species (*e.g.* insectivorous birds, mammals and reptiles);
- Dense groundcover flora provides shelter and foraging habitat for ground-dwelling mammal and reptile fauna;
- Large hollow ground logs are a critical habitat resource for ground-dwelling fauna, particularly reptiles although a number of dumped car bodies also provide surrogate habitat in the absence of alternatives. These are also critical resources for a range of invertebrate fauna (beetles, ants, termites, spiders) which are in turn predated upon by reptiles, frogs and mammalian fauna including microchiropteran bat species, gliders and echidnas;
- Certain tree species are important for some threatened fauna species (*e.g.* ironbark species for the Regent Honeyeater and Swift Parrot) and members of the Proteaceae family (*e.g. Banksia spp*. for the Eastern Pygmy-possum);
- Higher plant species diversity (within a vegetation community) generally leads to higher fauna species diversity (DECC, 2005). Regenerating vegetation low in plant species diversity and structure may lack foraging resources (pollen, nectar, flowers and fruits) or structural elements critical to a range of fauna species (dense shrub strata important for shelter for smaller woodland birds or hollow-bearing trees);
- Many of these habitat attributes are also important for invertebrate species that are consumed by vertebrate fauna, and which have vital roles in processes such as pollination, litter decomposition, nutrient cycling and seed dispersal;

- Native vegetation remnants are a critical attribute in movement corridors for fauna especially less mobile or sedentary species.

6.8 Weed Management

6.8.1 Sclerophyllous Vegetation Communities

The invasion of temperate eucalypt woodlands by exotic plant species is a major threat to the conservation of plant species diversity and the ecological integrity of remnant vegetation patches, and their control is one of the most important issues for any restoration works (Yates C.J. and Hobbs R.J., 1997). In areas surrounding remnant patches (especially smaller linear ones on sloping sites), it is likely to be more beneficial to temporarily retain annual weed species where they play a role in preventing erosion and actively utilising excess nutrients. This may assist in restricting the growth of perennial weed species, as is likely to be the case in most small or linear remnants in urban locations. Weed removal methods should accord with Buchanan (2009) in accordance with the specified strategies outlined above (*i.e.* Condition Codes 1-2 Assisted Natural Restoration and Condition Codes 2 and 3 Bushland Re-vegetation).

Fire is also an important disturbance process in breaking dormancy. This can assist in restoration as well as the control of weeds (Watson P. & Morris C.E., 2006) by accelerating germination and depleting the weed seed bank of those weed species that respond to fire. Planned fire events should include both pre-fire and post-fire targeted weed removal to ensure that germinating weeds do not reach reproductive maturity. Specific prescriptions for weed treatments are provided in Appendix 13 and outlined in the schedules of Section 10 (Plan Implementation).

Prescribed fires will be effective in the removal of above-ground parts of weed species with modified root systems or stems (including rhizomes, stolons, bulbs, corms or tubers) but complete eradication of such species will require hand removal techniques. Willis *et al*, (2003) considers autumn to be the best time for such fires, after the plant's annual shoot cohort has emerged (Willis A.J., 2000), (Yates E., 1997) because seasonal shoot emergence initially depletes the below-ground carbohydrate reserve accumulated during the previous year. However, burning will only serve to delay growth, not eradicate the plant.

6.8.2 Rainforest Vegetation Communities

Unlike sclerophyllous communities, planned fire as a means of weed removal cannot be used in rainforests or other communities with a significant mesophytic element. Physical removal may be most practical for isolated individuals or small patches of troublesome species, and in a few cases hand removal can work for more widespread species (such as rolling up mats of Wandering Jew). However, hand removal of dense or large areas of infestation of species such as Lantana can be costly and time-consuming and in such cases, chemical control may be most practical. Ultimately, best results for weed control (particularly in sensitive communities such as rainforests) are achieved by Integrated Weed Management (IWC), a combination of physical, chemical, biological and cultural controls married to planned follow-up works.

6.8.3 Approach to Weed Control

Regardless of the type of native vegetation community some basic principles should be observed in regards to removing weed infestation. These include:

- remove or ameliorate the sources of disturbance / deleterious effects as far as possible before attempting rehabilitation or restoration. This may involve re-routing stormwater drains, removing or ameliorating sources of nutrient input, constructing silt / erosion traps, fencing off areas to prevent rubbish dumping or simply installing educational signs;
- Identify and control existing weeds, as far as possible, using a combination of the most appropriate and effective methods whilst in particular targeting the more invasive species e.g. vines;
- encourage native germination of soil seed bank – plants derived from local genetic pools are usually better suited to site conditions than *ex situ* stock;
- follow-up weed control;
- reduction of remaining weed propagules by timed weed removal and by continuing soil disturbance to encourage weed seed germination;
- removal of quick succession weeds and reducing weed species with bird-attracting fruits;
- encourage native seed dispersal;
- supplement natural regeneration with additional planting – this is recommended only where the patch being resourced has lost key species or functions, and / or where conditions have changed radically such that the most viable option is to create a new, stable "natural" community i.e. soil profile has been disturbed; and
- undertake long-term monitoring and (adaptive) maintenance.

(Buchanan R., 1995)

The following general points regarding weed removal also need to be considered (adapted from Department Infrastructure, Planning and Natural Resources, 2003) and are applicable to a range of habitats:

- weeds provide potential habitat for fauna. Assess for fauna usage should be undertaken prior to removal. Weed cover should be removed slowly as other native resources become available as habitat;
- adoption of a staged or mosaic pattern of weed removal on degraded sites, involving areas no larger than 20m x 20m, or no more than one third of the total area at any one time;
- removing areas of dense weed infestations only outside peak bird breeding times, and when these are not providing a major food source;
- fallen timber, bark, dead brush and natural debris must be retained and should not be disturbed during bush regeneration activities;
- protection of mature trees by removal of weedy vines smothering the canopy and weed competition from around their bases. In the absence of mature indigenous trees, selectively retain mature exotic trees until mature sized indigenous canopy trees become established;

- all use of herbicides, fungicides and / or pesticides must comply with directions given on labels on the product;
- consideration of the potential impacts of herbicides on amphibian species when used in or near water bodies. Ideally herbicide use should be limited to woody weeds which are too deep-rooted to be pulled. Care should be taken to use herbicide at the correct time of year;
- herbicide application must follow the methods set out in Pittwater Council's Pesticide Use Notification Plan as per the *Pesticides Regulation 1995*; and
- seed collection (of upper canopy species only) will be undertaken at the remnants and the resultant tube-stock used only in areas subject to re-vegetation (excluded from regeneration areas). Ideally areas which are to be regenerated should be included in hazard reduction activities.

Planting schemes in areas immediately adjacent to reserves should avoid using species identified in Appendix 10, as well the following groups of plants:

- plants which have the potential to become environmental weeds or otherwise problem plants (*i.e.* are highly opportunistic and / or have been detected in remnants). These species include those identified in Appendix 10 as 'Native, originating horticulturally or otherwise'). Examples are Queensland Silver Wattle *Acacia podalyriifolia,* Silky Oak *Grevillea robusta,* Bracelet Honeymyrtle *Melaleuca armillaris* and Cadaghi *Corymbia torelliana;*
- plants which may compromise the genetic integrity of species which occur in the region, including Lemon-scented Gum *Corymbia citriodora* and Cootamundra Wattle *Acacia baileyana*; and
- species which are endemic to other parts of Australia which are either listed as threatened (preliminary or final) or on the brink of regional rarity. Examples include *Eucalyptus scoparia* and *Eucalyptus nicholii.*

7.0 MONITORING

7.1 Monitoring of Restoration

The collection of baseline data (plot data – floristics and structure, photographic records and notes on disturbance type(s) and intensity) allows for ongoing monitoring to identify changes in floristics and structure and hence the effectiveness of management regimes. The programme should incorporate periodic data collection in the form of (i) plot data and (ii) assessments of condition, as follows:

Monitoring Structure
Any monitoring programme needs to encompass documentation of ecological changes and testing of any assumptions in strategies adopted (*i.e.* that the prescribed management actions will improve ecological processes and functions operating at the site). Monitoring of native vegetation should be incorporated into Pittwater's Rapid Assessment Tool currently being developed.

► **Objectives:**

- to measure the adequacy of restoration and rehabilitation, the presence of weeds and species composition changes by defined and repeatable methodology;
- to protect remnant native vegetation of high conservation value;
- to maintain and improve biodiversity levels throughout the LGA;
- to maintain and / or reinstate natural / environmental flows to wetlands and other water bodies;
- to revegetate to improve corridor functioning with adequate width and habitat characteristics;
- to reduce the impact of threatening processes including control of pest animals and plants;
- to provide for appropriate use of fire in the management of vegetation. Due to the fragmented nature of the reserves, it is recommended that mosaic burning patterns be used strictly to ensure that resources are not entirely exhausted for fauna species in the absence of appropriate corridor linkages; and
- to protect remnant native vegetation of high conservation value.

► **Targets:**

- maintain or improve the viability of the current extent of native vegetation within the LGA;
- restoration as per the goals and targets set out in Pittwater Council's *2020 Strategic Plan* ("Key Direction 2 – Valuing and Caring for our Natural Environment") and in relation to commitments in the 2010 *SHOROC State of the Environment Report*

2009/2010 and with regard to specific prescriptions outlined in this document under bushfire management and works administration;

- improve biodiversity;
- manage and abate threatening processes to mitigate habitat loss by identifying those that are operating and their extent; and
- optimise management practices to reduce deleterious effects of inappropriate management regimes (*e.g.* fire exclusion or excessive use of planned fire);

► **Indicators:**

The "indicators" used should be clearly stated, measureable, easy to collect (proforma), display (records and GIS), show trends over time and allow assessment of cumulative changes. Biodiversity is likely to be the most useful indicator of environmental change due to its sensitivity to cumulative change. Consequently, no net loss in indigenous diversity should be aimed for over the entire LGA (Wilkins S. *et al.*, 2003).

Improvement (increase) in native species composition at monitoring sites in the short term (<15 years, including any measurable change(s) during the reporting periods adopted) and improvement in structural aspects of monitoring sites in the long term (>15 years) including increase in canopy cover and diversity of age classes and restoration of missing or impoverished strata.

► **Indicator Linkages**

- Indicators need to be linked directly to objectives or targets.

►**Suggested Indicators**

► **Management, restoration and rehabilitation**

- changes in native species composition;
- changes in threatening processes, type and intensity;
- biodiversity - species composition;
- weed species present as a proportion of the total number of plant species;
- prevalence of signs and / or scats of pest species.

Suggested indicator species may be selected from the Vegetation Profiles

► **Prioritisation:**

Works should follow the general approach described by Buchanan (2009), which involves commencement in the least affected area and working toward the most affected areas, at least as far as funding priorities allow. Work should commence in areas with a Condition Code of 1 and improvement (progressively towards Condition Code 2) should be monitored as recommended. Prioritisation of tasks should be in accordance with the following:

1 commence addressing threatening processes, including key threatening processes - *e.g.* examine causes of tree dieback where instances occur; consolidate landscape links by increasing/improving corridors; install fauna-friendly fencing where appropriate and

gradually replace existing fencing; commence the implementation of bushfire management; maintenance/reinstatement of environmental flows *etc*.;

2 commence weed and pest species management in areas delineated by Condition Code 2, then 3 and so on;

3 remove any rubbish or debris but retain that which has habitat value until alternative habitat features such as fallen timber become available.

► **Considerations:**

- season of survey – cryptic and deciduous species may not be detectable through much of the year;
- prevailing conditions may hamper plant identification (see Benson and Howell, 2002);
- qualifications / experience of personnel;
- data records should be in a form compatible with GIS and other databases;
- slow rate of change.

► **Evaluation:**

- implementation of restoration and re-vegetation objectives should be evaluated every five years to allow for adaptive components to be built in over time.

Management and Reporting Framework

a. Annual Reporting

- document the degree to which the performance measures (see 6.2.2.3) for each management action have been achieved. For example, by contractor recording details of the implementation of management actions (i.e. what, where, when, how and by whom) in project log books.
- evaluate and internally report on the effectiveness of individual management actions and/or techniques in addressing threats and/or improving vegetation condition;
- document and justify any alterations to the proposed management actions or implementation techniques made as part of an adaptive management process and assess whether impact assessment requires re-evaluation.

b. Five Yearly Reporting

- document changes in overall site condition and evaluate effectiveness of the management plan. For example, by a contractor monitoring and comparing changes in vegetation structure and floristics at five year intervals in permanent plots established during initial survey(s) to contrast changes with baseline data.
- the plan should be re-evaluated 3 years after commencement and at 5 year intervals thereafter.

7.2 Experimental Factorial Design

The benefit of incorporating an experimental design into the management of reserves within the LGA is that it will constitute a substantial source of information for the development of innovative approaches to future adaptation of management actions.

7.2.1 Research Priorities

Research priorities should inform future decisions regarding the adaptive use of management actions and provide feedback into the monitoring programme outlined above. Research priorities should be selected on the basis of the best value outcomes given available funding (unknown at this stage). Any adaptive management system should aim to:

- ascertain effects of varying fire regimes on biodiversity and threatened species;
- examine management regimes which maintain distinctive biodiversity elements such as threatened species;
- develop expertise in managing Endangered Ecological Communities (NSW Threatened Species Conservation Act, 1995) and Threatened Ecological Communities (Commonwealth Environmental Protection & Biodiversity Conservation Act, 1999);
- develop specific conservation measures for threatened flora and fauna known in an area;
- assess vulnerabilities to climate change and levels of resilience of Endangered Ecological Communities from the area;
- develop adaptive responses and appropriate recovery actions in relation to local conditions;
- monitor the effectiveness of management actions and the need to adapt them if necessary; and
- manage changes to hydrology that could result in changes to the water table and / or salinity.

Pittwater Native Vegetation Management Plan

Part 3: Bushfire Management

8.0 BUSHFIRE RISK and HISTORY

8.1 Objectives of Bushfire Management

The primary responsibility of all authorities with regard to bushfire management is to minimise the threat from bushfire on life, property and the environment.

8.2 Risks to Life and Property

Principal among the objectives of bushfire management is the requirement that Council protects life and property by protecting community assets from the adverse effects of bushfires, as well as protection of the health and safety of fire-fighters. Broad approaches include:

- to reduce bushfire hazards by the provision of Asset Protection Zones and by means of reducing ignition potential;
- to protect and preserve scenic and natural features and biodiversity (including flora, fauna and habitats) by protecting environmental, ecological and heritage assets from the adverse effects of bushfires;
- to protect recreational opportunities and facilities;
- to maintain natural processes as far as is possible;
- to preserve areas of actual or potential heritage value.

Note that there are more than 6700 properties on land mapped as "bush fire prone" within the Pittwater LGA.

8.3 Risks to Cultural and Natural Heritage

Pittwater LGA contains known habitat for a number of threatened species, and much of the area is occupied by vegetation communities that are listed as Endangered/Threatened Ecological Communities on the schedules of the *Threatened Species Conservation Act* 1995 and/or *Environmental protection and Biodiversity Conservation Act* 1999. Consequently, management prescriptions involve specific challenges, particularly in relation to bushfire management and decisions in relation to the use of fire. Excessive use, or exclusion, of fire has the potential to create long-lasting detrimental effects on the natural environments present.

The accompanying vegetation classification is consistent with the vegetation classification (Keith, 2004) listed in Planning for Bush Fire Protection (New South Wales Rural Fire Service, 2006), in that it outlines the broad formation that each map unit relates to.

8.3.1 Risk to Natural Heritage

The life histories of most indigenous plant species are closely tied to specific fire regimes. Shifts in those regimes will favour some species but may have a deleterious effect on others.

Diversity is known to be maximised in the presence of intermediate levels of disturbance (Roxburgh *et al.*, 2003), (Connell J.H., 1978); consequently, the main threats to biodiversity occur as a result of either maximising or minimising, either alone or in combination, the frequency, magnitude (intensity) and interval between fires. Furthermore, loss of floristic diversity contributes significantly to loss of faunal diversity. Changes in the structure and floristics of any area may result in altered mammalian herbivory. One potential consequence of decreased mammalian (indigenous) herbivory is that larger fuel loads may result, with subsequent implications for the magnitude of unplanned fires, or increasing the potential for the escape of prescribed fires.

Threats to biodiversity are likely to occur as a consequence of inappropriate fire regimes (*i.e.* an inappropriate combination of fire frequency, fire intensity, interval between fires and burning in inappropriate seasons, *etc.*) compared with a single fire event. Wild-fire and prescribed burning may have a significant impact, in circumstances where the prescribed thresholds have already been breached. A further consequence of burning too large an area at one time is that increased herbivory in unburned adjacent patches may contribute to the local extinction of some plant species. For these reasons, patches burned in a mosaic configuration should be small in comparison to the overall area prescribed.

Fire events may also influence colonisation of ecosystems by introduced species. Where fires are followed by rain events, the lack of ground and shrub strata cover may also contribute to erosion. Prevailing fire regimes (*i.e.* increasing or decreasing, either alone or in combination, the frequency, magnitude (intensity) and interval between fires) can alter ecosystem processes in a number of ways. Fire is an important selective agent in community composition. It constitutes an important form of dormancy-breaking disturbance essential in forest ecology and can also be a useful tool for the purposes of restoration.

In ascribing appropriate fire regimes a number of factors require consideration. Where fire regimes are inappropriately ascribed, characteristic grassy understorey species are replaced in unburned eucalypt woodlands by woody species. In a study of unburnt remnant of vegetation in Victoria (Withers J. and Ashton D.H., 1977) it is suggested that:

> '*Evidence from regeneration patterns and local history indicates that eucalypts are dying out and are being replaced by Casuarina species, together with some Acacia pycnantha and Banksia marginata. It is suggested that such scrub may be the terminal stage of a long post-fire secondary succession since regeneration of eucalypts under existing conditions is negligible*'.

Bushfire is a critical process in the development of hollows in most *Eucalypt* species (Williams J.E. & Brooker M.I.H., 1997), (Inions G.B. *et al.*, 1989), (Gibbons P. & Lindenmayer D., 2002) Hollow development in most *Eucalypt* species is a slow process (Gibbons P. & Lindenmayer D., 2002) and replacement rates for hollows lost where mature trees are removed are consequently low (Harper M. J., 2005). Where no hollows are available, arboreal fauna must seek suitable alternatives, or leave the area altogether. Excessive use of fire can influence vegetation structure, floristics and fauna assemblages by changing species composition often

favouring more fire-tolerant species at the expense of fire-sensitive ones or by favouring species with short seed-set times over those with longer seed-set periods.

Structural and/or floristic changes can result from repeated frequent burns, burns at too-long an interval, fires that are excessively intense or too many cool burns. These include the promotion of new weed regimes and the attrition of mature and hollow-bearing trees. Extinctions may be more likely when fire regimes of relatively fixed intensity, frequency and extent prevail. Despite the high survival rate of vertebrate fauna species *during* fire, early post-fire losses are high and populations may decline during weeks following a fire. This decline in vertebrate fauna numbers has been attributed to both a shortage of food and an increase in predation (Aust. Academy of Science, 1981). Whelan (1995) concludes that "*…adaptation of animals to fire* per se *is very difficult to examine… it would be reasonable to expect any response of animals to fire to operate through the vegetation response, because the vegetation is such an important part of an animal's habitat.*"

Whelan (1995) also describes the problem with prescribed fire for fuel reduction in relation to local extinction of plant species: "*Although fires kill established plants, these species respond to fire by germination from a stored seedbank (stored either in the soil or in woody fruits in the canopy). Populations of these species will be at risk if a second fire occurs before the post-fire flush of seedlings has had an opportunity to develop a seed bank of its own…*". Although Whelan identifies studies which indicate that the extinction of obligate seeders in south-east Australian Woodlands does occur, he notes that "*…Moreover, several factors may provide some resilience for populations of obligate seeders, in the face of frequent fires: firstly, spatial heterogeneity in fuels produced by topographic discontinuities will provide refugia unlikely to be burned in consecutive fires; and secondly, high fire frequency is likely to produce fires that are of low intensity and patchy, because fuel loads do not have sufficient time to build up and become continuous*".

Fire is considered to be a natural component of the ecology of much of the vegetation in the Sydney Basin; however, inappropriate use (excessive) of fire has been identified as a threatening process (NSW Scientific Committee, 2000). However, exclusion of fire is also likely to result in the loss of plant species in the community and depletion of soil seed reserves of woodland remnants.

8.4 Bushfire History

Bushfire history for the LGA is incomplete, in that accurate locations and extent of fire spread during fire-events and associated fire paths have not always been consistently recorded, or even recorded at all. However, a tabulated summary of wild (unplanned) fires and hazard reduction burns within the LGA is given in Table 7 (below) compiled from NSW Rural Fire Service and Pittwater Council sources.

As can be gleaned from the summarised information presented, fire has been excluded from many areas of native vegetation in the LGA for long periods of time, particularly in coastal areas, the Pittwater peninsula and all highly developed areas. Conversely, other areas are likely to have been burned too frequently: the sandstone plateau and associated slopes in the

Ingleside – Warriewood – McCarrs Creek areas are worst affected, with native vegetation in some sections of Ingleside having been burnt every other year in the past.

Table 7 Bushfire History

Fire Year	Type	Area burnt (ha)	Sample locations
2009-10	Hazard Reduction (HR)	8	Mona Vale, Ingleside (Glen Rd, Tumburra St / Harvey Rd, Mirbelia Rd)
2009	Unplanned	~15	Great Mackerel Beach Res (and adj. KCNP)
2008-09	HR	3	McKay Res (Cynthia St), Ingleside (Bloodwood Rd, Wirreanda Rd)
2007	HR / unplanned	6.5 + 300	Ingleside (Bloodwood Rd-Emmaus Rd, Manor Rd-King Rd)
2006	HR	26	Bilgola Hts (Minkara Rd, Minkara Rd-Walter Rd, Cabbage Tree Rd), Ingleside (Cicada Glen Rd, Lane Cove Rd, Wattle Rd, adj. Ingleside Park, Ingleside Rd-Powder Works Rd), Elanora Hts (Iluka Ave-Elanora Rd), Elanora Rd (nr. Dewrang Res)
2005	HR	455	Mackerel Res (and adj. KCNP), Lovett Res (and adj. KCNP), Ingleside (Cabbage Tree Rd-Cicada Glen Rd and adj. KCNP, Cicada Glen Rd, Bungendore Rd, McCowen Rd-Bloodwood Rd), Ingleside Park, Dendrobium Cres, Bungoona Ave, Amaroo Ave.
2004	HR / unplanned	137 + 674	HR - McCarrs Creek, Attunga Res, Plateau Park, McKay Res, Lovett & Elvina Bay (KCNP areas), Heydon Res. Unplanned – KCNP (McCarrs Ck/ Elvina)
2003	HR / unplanned	100 + 0.25	HR - Ingleside (Bloodwood Rd/ Cowen Rd; Lane Cove Rd/ Boronia Rd/ Ingleside Rd; Garigal NP adj. Monash Country Club; Powderworks Rd; Ingleside Park), Deep Ck Res, Elvina Park, Elvina & Lovett Bay Res, Pathilda Res (Scotland Is.), Stapleton Park. Unplanned – KCNP (West Head Rd).
2002	HR / unplanned	24 + 2	HR - Ingleside (Chiltern/ Bloodwood Rds), McKay Res. Unplanned – Ingleside (Emmaus Rd)
2001	HR / unplanned	95.4 + 1.5	HR - KCNP (McCarrs' Ck area), Ingleside (Bungendore & McCowen Rds an adj KCNP). Unplanned – Ingleside (Powder Works Rd/ Mona Vale Rd and adj. Garigal NP)
2000	HR	9	Newport Hts Res, Ingleside (Glen Rd; Walter Rd)
1999	HR / unplanned	4 + 1.3	HR - Ingleside (Wirreanda Rd; Tumburra Rd; Minkara Rd), Leumeah Res, McKay Res. Unplanned – KCNP (Lovett Bay)
1998	HR	1.5	Elizabeth Pk Scotland Is, Ingleside (Laurel Rd)
1997	HR	6.2	Ingleside (Harvey Rd), Angophora Res.
1996	HR / unplanned	15 + 3.2	HR - Dewrang Res (Elanora), Angophora Res, Lovett Bay, Scotland Is., Plateau Pk. Unplanned – Barrenjoey Head (KCNP)
1995	HR	6.6	Scotland Is., Ingleside (Chiltern Rd), Bangalley Res., Coasters Retreat
1994	Unplanned	5367	Extensive parts of western side of LGA e.g. McCarrs Ck, Ingleside, Warriewood Escarpment, Heydon Res/ Ingleside Pk., Elanora/ Deep Ck/ Billarong Res, Elvina/ Lovett/ Morning Bay, Mackerel and Gt. Mackerel Res (and adj. KCNP)
1993	-	No data available	

Fire Year	Type	Area burnt (ha)	Sample locations
1992	Unplanned	47.5	Ingleside (McCowen Rd, Chiltern Rd, Emmaus Rd, Tumburra Rd, Wirreanda Rd, Mona Vale Rd), Monash Country Club (Caladenia Close)
1991	Unplanned	321.5	Ingleside (McCarrs Ck/ Emmaus Rd/ Chiltern Rd; Mona Vale Rd/ Lane Cove Rd/ Ingleside Rd)), McCarrs Ck (Gilwinga Dr), Minkara Res, Heydon Res/ Epworth Pk, Gt. Mackerel Beach (KCNP), West Head Rd (KCNP)
1990	Unplanned	41	Heydon Res, Ingleside Pk, Ingleside (Powder Works Rd/ Manor Rd/ Lane Cove Rd/ Ingleside Rd; Ingleside Rd/ Laurel Rd; Cicada Glen Rd/ Cabbage Tree Rd)
1989	Unplanned	23	Ingleside (Cicada Glen Rd/ Cabbage Tree Rd; Powder Works Rd/ Manor Rd/ Waratah Rd), Monash Country Club (and adj. Garigal NP)
1988	Unplanned	0 within LGA	-
1987	-	No data available	
1986	-	No data available	
1985	-	No data available	
1984	-	No data available	
1983	-	No data available	
1982	-	No data available	
1981	-	No data available	
1980	-	No data available	
1979	Unplanned	608	Elanora Res, Deep Ck Res, Monash Country Club/ Caladenia Cl-Dendrobium Cr-Koorangi Ave., Ingleside (Mona Vale Rd/ Powder Works Rd/ Manor Rd/ Lane Cove Rd, Ingleside Pk., Wirreanda Rd; McCowen Rd/ Bloodwood Rd/ Cicada Glen Rd), McCarrs Ck-Ingleside (Cicada Glen Rd/ Cabbage Tree Rd/ Walter Rd/ Minkara Rd/ Gilwinga Dr/ Barcoola Pl/ McCarrs Ck Rd)

NOTE: *This does not give the complete number of wild-fires that have occurred in the past.*

9.0 BUSHFIRE MANAGEMENT

Bushfire hazards within Pittwater LGA are managed by the Warringah Pittwater Bushfire Risk Management Committee via the Warringah-Pittwater Bush Fire Management Plan which is revised on an annual basis. For further details on this plan, please see Pittwater Council website: http://www.pittwater.nsw.gov.au/environment/natural_hazards/bushfires.

9.1 Fire Regimes

Fire shadows and refuges are an important part of fire ecology (Bradstock R.. *et al.*, 1995) and should be considered as part of any prescribed burn in light of the fact that "*High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition*" has been listed as a *Key Threatening Process* on Schedule 3 of the TSC Act, 1995. High frequency fire is defined as "*... two or more successive fires close enough together in time to interfere with or limit the ability of plants or animals to recruit new individuals into a population, or for plants to build up a seedbank sufficient in size to maintain the population through the next fire. Sustained high frequency fire will consequently lead to a loss of plant species, a reduction in vegetation structure and a corresponding loss of animal species.*" (NSW Scientific Committee, 2000).

With respect to historic fire regimes, Williams *et al.,* state:

> '*Historically, fire patterns have been a fine mosaic of numerous small interlocking burnt patches with the occasional large fire scar. This pattern is believed to have been practised by Aboriginal communities for tens of thousands of years, and biological communities adapted to this regime. Fire patterns after European settlement have generally changed to a simpler, coarser pattern of large fire scars and large tracts of long-unburned vegetation. This pattern is widely considered to cause much larger fires and fire scars on the landscape…'.*

With regard to fire regimes and the seasonal timing of fires, OEH note:

> '*The early European settlers found that from 1788 to 1845 the pattern of fire around Sydney was markedly seasonal with 87 per cent of fires occurring from August to January, i.e. in spring and early summer. Although incomplete, written records of fires in the Sydney area in this period provide some indication of pre-settlement fire regimes and possible Aboriginal land management practices. In the earliest years, local Aborigines were described as frequently 'setting fire to the country' (Phillip 1791; Hunter 1793; Tench 1789) particularly in the summer, or when it was dry or windy (Hunter 1793). Writers commented on the Aboriginal practice of burning the previous season's grasses to encourage new growth (Atkinson 1826 and Bennett 1834, as cited in McLoughlin 1998). In contrast with this earlier 'natural' or historical fire season, current prescribed burning practices follow a distinctly different seasonal pattern. More than 60 per cent of prescribed burning for asset protection in Sydney between 1980 and 1995 was conducted in autumn and winter (McLoughlin 1998)'.*

As knowledge about the effects of fire regimes on indigenous biota is patchy at best, prescriptions for hazard reduction burns should, where practicable, be carried out over a range of seasons, with a range of inter-fire periods of varying intensities, at least until further researched information is made available which sets out optimum fire intervals. This principle is particularly important where fire has either been excluded for long periods (much of the Pittwater Peninsula) or where it has occurred on a very frequent basis (e.g. Ingleside).

Refugia (*i.e.* a mosaic of unburned patches) are critical for the survival of:

- a wide range of invertebrates during the fire;
- a range of ground-dwelling fauna, such as reptiles, amphibians and some mammals, both during the fire, and for post-fire recolonisation;
- a range of arboreal invertebrates, mammals and bird species. Note that in intense fires, temperatures can be hotter in the shrub and tree canopy layers than at ground level;
- sources of seed or propagules for post-fire recolonisation by plant species; and
- ensuring some food and shelter resources are available in adjacent areas until the burnt area has re-established itself.

Specific strategies for environmental management (*i.e.* fire thresholds) are defined in accordance with the *Bush Fire Environmental Assessment Code* for NSW (2006) as well as the Guidelines for ecologically sustainable fire management (New South Wales National Parks and Wildlife Service. 2003e). The development of these lists is reliant on both further research and feedback mechanisms, which enable improved knowledge in relation to the tolerances of threatened species (*i.e.* accurate and comprehensive record keeping which delineates areas burnt, fire paths, frequency, approximate intensities). Prescribed burning activities need to consider bushfire management practices in relation to the sustainability of remaining unburnt vegetation for wildlife, and the effects of fire, particularly given that high frequency, low-intensity fires can effectively simplify forest ecosystems (Cahill *et al.*, 2008). The same authors (Cahill *et al.,* 2008) note during their study of a high intensity fire at Gembrook that: 'Significant soil properties can also be altered, including dispersion characteristics which could lead to an increase in the erosion hazard. Of much greater concern are the consequences of long term reduction in soil organic matter levels; the loss of substantial amounts of nutrients in smoke; the short circuiting of biogeochemical pathways; the possibility of wetter soils as a consequence of a reduction in understorey vegetation; the effect that wetter soils may have on the spread of *Phytophthora cinnamomi;* and the effect that such a dramatic change to the fire regime will have on the carbon cycle and hence on other nutrient cycles'.

Although Garvey *et al.* (2010) demonstrated that wallabies can avoid fire fronts and that this avoidance behaviour may be more successful during cooler fires, prescriptions involving the use of frequent low-intensity burns are thought to favour feral mammalian species by enabling ease of access and better visibility in the reduced understorey. Anecdotal evidence also suggests that the use of frequent low intensity burns may be operational in the distribution and abundance of the introduced fungal pathogen Phytophthora (*Phytophthora cinnamomi)*, known to be a serious threat to Australian plant communities and listed as a Key Threatening Process under the Schedules of the TSC Act 1995. Phytophthora, *Phytophthora cinnamomi,* activity might be greater in some circumstances following a bushfire because there are fewer plants to use the available water and sites are more prone to waterlogging.

There are a range of threatened species known from the local area (within 10km) for which the condition is 'no fire'. The accompanying notes to the code specifies that for those species, the fire interval "*…may be based on the species' known habitat (e.g. forest species) and its inability to cope with fire. Alternatively the species may be able to cope with some fire but only a small number of individuals remain in existence. In these cases any loss of individuals is likely to be particularly significant and a more detailed assessment of the significance of the expected impacts will be required. An example of a condition for fire is 'no fire more than once every 7 years'. This means that fire can only be used to reduce hazards at the site if there has been no fire (wildfire or prescribed burn) at the particular site within the previous seven years…*". Monitoring of threatened species and their response to prescribed burns is also an important factor in ensuring their long term survival.

The accompanying notes to the code specify the following consideration for fauna habitats:

> "*…Some animal species are so wide ranging that no practical conditions can be developed for hazard reduction e.g. tree roosting micro-bats. Other species, such as some owls, are wide ranging but are likely to be disturbed by burning at particular times of the year and specific locations, such as around active nest sites. For other species, which are not so wide ranging, such as critical weight range mammals, the specific habitat components are less clear, although factors such as sufficient ground and shrub cover are known to be important. Those species which have relatively small ranges with specific habitat requirements are better dealt with by the Code. For example, many frog species have a close relationship with vegetation surrounding waterbodies, and thus this habitat can be identified and protected. Therefore the List does not address all threatened animal species and those that are addressed have differing requirements over differing distances. In all cases it is important to consider the concept of mosaics. In essence, long unburnt (and uncleared) areas of each threatened animal habitat should be maintained in those areas not critical for the protection of life and property. In addition, a range of vegetation age classes would be managed in proximity to these unburnt areas. The important point is that adequate dispersal corridors exist between various age classes of suitable habitat, and that mosaics are of suitable size to support the species…*"

For the management of Endangered Ecological Communities (EECs), the code specifies that "*…Slashing, trittering and bulldozing are all methods that can destroy or significantly damage EECs. The potential for significant loss is particularly high due to the small areas of each EEC that remains in the landscape…"* The accompanying notes to the code also notes that:

"…The reason for having a minimum fire interval is that there is a probability of decline in the species composition of an EEC when the intervals between successive fires are less than the specified desirable minimum. In addition, there is also a probability of a decline when the intervals between successive fires are less than the specified desirable minimum and such intervals prevail across more than 50% of the EEC. The 50% rule is based on distribution of the EEC within the landscape, i.e. the connectivity of occurrences of an EEC. For practical purposes (and therefore for the purpose of the Code) the 50% rule is applied on a LGA basis. This approach also allows for different age classes of the EEC both within and between LGAs"

Therefore, conditions for EECs are as follows:

- *No part of an EEC is to be subjected to successive fires more frequently than the minimum fire interval, and*
- *At least 50% of the EEC within each LGA must exist in a state that has been burnt less frequently than the minimum fire interval.*

This can be achieved by strategic rotational burning of portions of the EEC within each LGA. Ideally, old growth patches of each EEC should be maintained in those areas not critical for the protection of life and property. For example, if an EEC was 50 hectares in extent and required a minimum fire interval of 7 years, then 25 hectares must always have a fire interval of greater than 7 years. If a wildfire occurs before the minimum frequency is reached then no prescribed burning can be undertaken under the Code until such time as the minimum fire frequency is again achieved for at least 50% of the EEC. Furthermore, each portion of the EEC is not to be subjected to fire more often than once every seven years. If hazard reduction burns within EECs are likely to exceed these requirement, for example, if an EEC is only known from one location and is particularly small, then a more detailed assessment of the expected impacts will be required through the existing planning mechanisms (such as licensing under the TSC Act)…".

Fire should not be prescribed at intervals less than the prescribed threshold for the vegetation type which occurs at the remnant (refer to Appendix X of the *Bushfire Environmental Assessment Code for NSW* (RFS, 2006)) and the thresholds should be read as minimum values rather than optimal frequencies.

9.2 Protection of Aboriginal Cultural Heritage and European Cultural Heritage

Threats associated with bushfire can cause direct or indirect damage to historic sites. The New South Wales Rural Fire Service guidelines for fire/fuel management of sites containing Aboriginal Heritage require that person/s undertaking the works recognise that all aspects of all Aboriginal sites must be treated with respect, and keep in mind that things of significance are not always apparent when one is not familiar with different belief systems (NSW Rural Fire Service, 2006). An assessment should be undertaken prior to any prescribed burn to ascertain whether any Aboriginal site(s) of significance are present and burn plans adjusted accordingly.

9.3 Protection of Biodiversity

The NSW Biodiversity Strategy (1999) promotes a collaborative approach to biodiversity conservation: its principle goal is to protect biological diversity and maintain ecological processes and systems; it identifies inappropriate fire regimes as a significant threat to biological diversity in Australia. Within this document, Biodiversity Strategy Objective 3.4 (Improve bushfire management regimes) requires "… actions to manage bush and other fires provide for the protection of the environment and are undertaken with regard to the principles of ecologically sustainable development".

Table 8 below identifies thresholds for each Broad Vegetation Type. Fire intervals and intensity must be maintained within the biodiversity thresholds. These thresholds are not optimum fire intervals, but minimum measures, below which a loss of biodiversity can be expected. Where high fire frequencies are a consequence of unplanned fire (*i.e.* arson or inadvertently as a consequence of planned fire) and the biodiversity thresholds are likely to have been exceeded, the prescribed use of fire will be revised. The following strategies are required for the protection of diversity:

- pre-fire fauna and flora assessments especially relating to threatened species, populations or communities;
- environmental assessment should incorporate any additional information relating to biodiversity and fire thresholds as it becomes available;
- adherence to all aspects of the *Threatened Species Hazard Reduction Lists* for flora, fauna and Endangered ecological communities associated with the *NSW Bush Fire Environmental Assessment Code (2006)*;
- suppression activities will be used that avoid damage to environmental heritage at any known locations;
- a range of fire intervals, intensities and burnt areas should be attained as an optimum, within the criteria specified for each bushfire management zone and management for broad vegetation types;
- all post-fire reports are to consider the effects of fire on biodiversity and where necessary recommend ameliorative action;
- development of mosaic patterns of burning; and
- development of specific bushfire management plans for large reserves.

9.4 Vegetation Assemblages (Endangered Ecological Communities (NSW) and Threatened Ecological Communities (Commonwealth))

The New South Wales Rural Fire Service guidelines for fire/fuel management specify that mechanical forms of hazard reduction in a range of EECs must not include slashing, trittering or tree removal. The 'Rules and Notes' specify that '*…In addition to the specified minimum fire intervals, at least 50% of the endangered ecological community within each local government area must exist in a state that has been burnt less frequently than the minimum fire interval…*'. Although the code deals with planned fuel management, these specifications must take into account wildfire and unplanned events such as arson in order to ensure that fuel reduction

burns do not exceed minimum fire interval requirements. Thresholds for endangered ecological communities are provided in Table 8 in accordance with the *NSW Bush Fire Environment Code for NSW (2006)* and Guidelines for Ecological Sustainable Fire Management (NSW National Parks & Wildlife Service, 2003e).

It is also important to note that thresholds provided in the Guidelines for Ecological Sustainable Fire Management (NSW National Parks & Wildlife Service, 2003) are based on vegetation formations and are not as locally oriented as those specified in the current document. With regard to bushfire management, the following should also be noted:

- Clarke and French (2005) concluded that a heterogeneous fire regime was needed within fragments or within near fragments (rather than across distant fragments) to maintain the species richness of perennial grasses;
- A variable fire regime within the specified intervals is required to avoid species loss and decline in ecological health and function, and this requires varying fire frequency, intensity, season and pattern of burn. Threats to EECs are likely to occur as a consequence of exceeding fire threshold intervals in Table 8. These thresholds should be used as a guide until further research is made available and the 'minimum' intervals should not be breached under any circumstances.

Table 8 Thresholds and intervals for the EECs and other vegetation units.

Code	Community	1. Threshold (NSW Rural Fire Service, 2006)	2. Lower Interval (years) (NSW NPWS, 2003e)	2. Upper Interval (years) (NSW NPWS, 2003e)	Combined Interval (NSW Rural Fire Service, 2006), (NSW NPWS, 2003e)
Rainforests					
S_RF02	Coastal Sandstone Gallery Rainforest	-	Should be avoided	Should be avoided	None
S_RF06	Coastal Dune Littoral Rainforest	-	Should be avoided	Should be avoided	None
S_RF07	Coastal Escarpment Littoral Rainforest	-	Should be avoided	Should be avoided	None
S_RF08	Coastal Headland Littoral Thicket	-	Should be avoided	Should be avoided	None
S_RF10	Sandstone Cliffsoak	-	Should be avoided	Should be avoided	None
Wet Sclerophyll Forests					
S_WSF02	Coastal Enriched Sandstone Moist Forest	-	25	60	25-60
S_WSF11	Coastal Moist Spotted Gum Forest	-	25	60	25-60
Grasslands					
S_GL01	Beach Spinifex Grassland	-	2	10	2-10
S_GL02	a) Coastal Headland Grassland (typical)	-	2	10	2-10
	b) Coastal Headland Grassland (Lomandra Sedgeland)	-	2	10	2-10
Dry Sclerophyll Forests					
S_DSF06	Coastal Sandstone Foreshores Forest	-	7	35 (20)	7-35 (20)
S_DSF08	Coastal Sandstone Riparian Forest	-	7	35 (20)	7-35 (20)
S_DSF09	Coastal Sandstone Sheltered Peppermint-Apple Forest	-	7	30 (25)	7-30 (25)
S_DSF11	a) Hornsby Sandstone Exposed Bloodwood Woodland - typical		7	30 (25)	7-30 (25)
	b) Hornsby Sandstone Exposed Bloodwood Woodland - coast	-	7	30 (25)	7-30 (25)
S_DSF12	Hornsby Sandstone Heath-Woodland	-	7	30 (25)	7-30 (25)
S_DSF14	Sydney Ironstone Bloodwood - Silver-top Ash Forest	-	7	30 (25)	7-30 (25)
S_DSF21	Coastal Sand Bangalay Forest	-	7	30 (25)	7-30 (25)
S_DSF25	Coastal Dry Spotted Gum Forest	-	5	50 (25)	5-50 (25)
Heathlands					
S_HL01	a) Coastal Headland Clay Heath – A.distyla	-	7	30 (20)	7-30 (20)
	b) Coastal Headland Clay Heath – non A.distyla	-	7	30 (20)	7-30 (20)
S_HL02	Coastal Tea-tree – Banksia Scrub	-	7	30 (20)	7-30 (20)

Code	Community	1. Threshold (NSW Rural Fire Service, 2006)	2. Lower Interval (years) (NSW NPWS, 2003e)	2. Upper Interval (years) (NSW NPWS, 2003e)	Combined Interval (NSW Rural Fire Service, 2006), (NSW NPWS, 2003e)
S_HL05	Coastal Foredune Wattle Scrub	-	7	30 (20)	7-30 (20)
S_HL07	Coastal Headland Cliffline Scrub	-	7	30 (20)	7-30 (20)
S_HL08	Coastal Sandstone Heath-Mallee	-	7	30 (20)	7-30 (20)
S_HL09	Coastal Sandstone Plateau Rock Plate Heath	-	7	30 (20)	7-30 (20)
[KCNP]	[Undefined KCNP heathlands]	-	7	30 (20)	7-30 (20)
Freshwater Wetlands					
S_FrW01	Coastal Upland Damp Heath Swamp	-	6	35 (30)	6-35 (30)
S_FrW03	Coastal Freshwater Reedland	-	6	35 (30)	6-35 (30)
S_FrW04	Coastal Sand Swamp Paperbark Scrub	-	6	35 (30)	6-35 (30)
S_FrW06	Estuarine Reedland	-	6	35 (30)	6-35 (30)
Forested Wetlands					
S_FoW01	Coastal Alluvial Bangalay Forest	-	7	35 (20)	7-35 (20)
S_FoW02	Coastal Flats Swamp Mahogany Forest	-	7	35 (20)	7-35 (20)
S_FoW03	Coastal Freshwater Swamp Forest	-	7	35 (20)	7-35 (20)
S_FoW08	Estuarine Swamp Oak Forest	-	7	35 (20)	7-35 (20)
S_FoWxx	Coastal Headland Swamp Oak – Gahnia Soak	-	7	35 (20)	7-35 (20)
Saline Wetlands					
S_SW01	Estuarine Mangrove Forest	-	Should be avoided	Should be avoided	None
S_SW02	Estuarine Saltmarsh	-	Should be avoided	Should be avoided	None
S_SW03	Seagrass Meadows	-	Should be avoided	Should be avoided	None

NOTE 1: *Intervals and combined intervals are tentative due to insufficient data. Specific interval derived from 'grassland' due to lack of more appropriate data*
NOTE 2: *Thresholds in Column 1, the Lower Interval in Column 2 and the Upper Interval in Column 3 are not optimum fire intervals, but minimum / maximum measures, below / above which a loss of biodiversity can be expected.*

Vegetation Types should be treated at a range of intervals to ensure that biodiversity is maximised across the LGA. This effectively serves to increase the 'patch effect' across broad vegetation types and ensures that no individual EEC or vegetation community is entirely burned in a given hazard reduction season. It should be noted that this information is incomplete until further research is made available.

It is important to emphasise (and as shown in Table 8 above) that many patches of native vegetation (particularly those in small reserves) along the Pittwater peninsula are unlikely to have seen fire for some time and may consequently be already outside the preferred fire interval. Additionally (see Table 8), NSW RFS and Council records indicate that fire frequency in many patches on the sandstone plateau in the Ingleside area is likely to have already exceeded recommended frequencies, and it is possible that species diversity loss is already occurring.

9.5 Threatened Species

Threats to threatened plant species and component species of endangered populations are likely to occur due to maximising or minimising, either alone or in combination, the frequency, magnitude (intensity) and interval between fire regimes. Table 9 shows the fire frequency thresholds for endangered flora species recorded at the remnants or known to occur within a 10km radius of the site. It should be noted that this information is incomplete until further research is made available.

Fires are recurrent disturbances which shape the floristic and structural components of a landscape. At a landscape scale, effect of fire frequency, intensity, season and type have important consequences (Gill A.M. & Bradstock R.A., 2003; Lindenmeyer *et al.* 2011). These factors impact on the capacity of particular plant species to regenerate. The fruits of serotinous species (*e.g. Banksia* spp., *Leptospermum* spp. and *Hakea* spp.) remain un-opened for several years and only open following fire. Therefore, in sclerophyllous vegetation communities, soil seed stores may contain the seed of a number of obligate-seeding species which emerge after fire. By comparison, resprouting plants exhibit variation in fire resistance with stage of life history; for example, fire-tender seedlings, fire-tolerant juveniles and adults which have fire-resistant stems (Bradstock R.A., 1990). Research suggests that geographic location may also be an important factor in fire response (Keeley J.E., 1986).

In addition to the general principles discussed above, the following should also be noted: fire frequency has been identified as a Key Threatening Process (NSW Scientific Committee, 2000), because high fire frequencies have the potential to disrupt important life cycle processes in plant and animal populations resulting in the eventual loss of biodiversity. The exclusion of fire for prolonged periods of time may also contribute to the loss of biodiversity for a species which require fire for their perpetuation (NSW Scientific Committee, 2000).

Thresholds for threatened flora species which are known to occur in Pittwater LGA are provided below in Table 9 (NSW Rural Fire Service, 2006), although threshold listings are unavailable for a number of species. While threatened species are an important consideration for any land management activity, consideration also needs to be extended to a range of other species present at the site, to ensure that future biodiversity loss is reduced and in order to

arrest the rate of threatened species being listed. The lowest threshold ascribed to a threatened species at the site is 'no fire' for fire intolerant species such as *Arachnorchis tessellata*, followed by 5 years for *Chamaesyce psammogeton*, with the highest at 10 years (*e.g. Melaleuca deanei*). This means that although little is known about the upper threshold, any bushfire which occurs in less than the designated threshold is likely to have a deleterious effect on those species. Where fire regime requirements for the species listed below are known and differ from the regime to be applied to the surrounding vegetation, site-specific bushfire management strategies will need to be utilised in order to improve the long-term viability of the local population.

Table 9 Thresholds and intervals for threatened flora species known from and recorded at the site (NSW Rural Fire Service, 2006):

NOTE: *A variable fire regime within the below thresholds is required to avoid species decline, this requires varying fire frequency, intensity, season and pattern of burn.*

Scientific Name	**1. Threshold**	**2. Notes on mechanical treatment (NSW Rural Fire Service, 2006)**	**3. Sensitivity (NSW NPWS, 2002) frequent/infrequent (Noble &Slater, 1980)**		**4. Recommended minimum interval (NSW NPWS, 2002)**
Apatophyllum constablei	No fire more than once every 7 years.	No slashing, trittering or tree removal.	1	4	No intervals provided.
Arachnorchis tessellata (syn. *Caladenia tessellata*)	No fire.	No slashing, trittering or tree removal.	3	3	No intervals provided.
Callistemon linearifolius	No fire more than once every 7 years.	No slashing, trittering or tree removal.	-	-	No intervals provided.
Chamaesyce psammogeton	No fire more than once every 5 years.	No slashing, trittering or tree removal.	-	-	No intervals provided.
Cryptostylis hunteriana	No fire more than once every 10 years.	No slashing in autumn and no fire more frequently than every 10 years.	3	3	No intervals provided.
Diuris bracteata	-	-	-	-	No intervals provided.
Epacris purpurascens var. *purpurascens*	No fire more than once every 7 years.	No slashing, trittering or tree removal.	1	4	No intervals provided.
Eucalyptus camfieldii	No fire more than once every 7 years.	No slashing, trittering or tree removal.	4	4	No intervals provided.
Genoplesium baueri	-	-	-	-	No intervals provided.
Grevillea caleyi	No fire more than once every 10 years.	No slashing, trittering or tree removal.	1	1	8-12

Haloragodendron lucasii	No fire more than once every 7 years.	No slashing, trittering or tree removal.	-	-	No intervals provided.
Kunzea rupestris	No fire more than once every 10 years.	No slashing, trittering or tree removal.	3	3	No intervals provided.
Melaleuca biconvexa	No fire more than once every 10 years.	No slashing, trittering or tree removal.	4	4	No intervals provided.
Melaleuca deanei	No fire more than once every 8 years.	No slashing, trittering or tree removal.	2	1	8
Microtis angusii	No fire.	No slashing, trittering or tree removal.	-	-	No intervals provided.
Persoonia hirsuta subsp. *hirsuta/evoluta*	No fire more than once every 10 years.	No slashing, trittering or tree removal.	1	4	>7
Persoonia laxa	-	-	-	-	No intervals provided.
Pimelea curviflora var. *curviflora*	No fire more than once every 7 years.	No slashing, trittering or tree removal.	4	4	No intervals provided.
Syzygium paniculatum	No fire.	No slashing, trittering or tree removal.	1	1	No intervals provided.
Tetratheca glandulosa	No fire more than once every 7 years.	Slashing only to 100cm, and no trittering or tree removal.	4	4	6-8

Note: *Intervals in Column 4 are not optimum fire intervals, but minimum measures, below which a loss of biodiversity can be expected.*

9.6 Fauna Species

Bushfire (whether planned or unplanned) can cause significant mortality of fauna at a local scale, particularly among sedentary species: this becomes more significant where threatened taxa are at risk of severe impact from catastrophic events. Many (if not most) fauna species are susceptible to changes at a landscape level, particularly species which occur in isolated patches of vegetation, or where minimal continuity exists with adjacent habitat. Once isolated, habitat provides limited opportunity for the movement of animals, which can be particularly problematic during wildfire events or where hazard reduction burns are prescribed for large parts of small reserves. Although the impacts associated with bushfire are known to contribute to the direct cause of decline of fauna populations as a consequence of heat and ember attack, greater impacts are caused by changes to habitat and the availability of foraging, shelter and breeding sites. It is necessary to maintain a diversity of vegetation cover and structure in order to conserve viable local fauna populations. It is therefore important that that any individual fire, or combination of fires within a short period of time, should not completely burn the local extent of any vegetation community (*i.e.* any broad scale fire events are to be avoided).

Unburned areas and refugia are necessary for a wide range of fauna species and invertebrates, both as shelter sites while the fire front passes, and as a habitat and resource base while the burned areas are undergoing regeneration. Bushfire management for native vegetation in reserves must achieve a balance between reduction of fuel loads and ensuring long-term viability of a diverse range of fauna habitats. Consequently, fire thresholds and intervals for threatened fauna species known from and recorded within the LGA should also be considered (NSW Rural Fire Service, 2006).

Pittwater Native Vegetation Management Plan

Part 4: Plan Implementation – Fire and Ecological Management

10.0 PLAN IMPLEMENTATION

10.1 Operations Works Schedule

The operational works schedule in Table 10 (Plan Implementation) sets out a fifteen year schedule for operational works to be undertaken. The program will commence in 2012 and be reviewed in 2017 and at 5 year intervals thereafter. As conditions are likely to change over the planning period, and as new knowledge on vegetation and bushfire management becomes available, amendments to prescribed strategies need to be built in to the works program. Ability to implement the plan will be influenced by seasonal conditions, as well as resources and wildfire events.

Mitigation of threatening processes, including Key Threatening Processes listed under the TSC Act (1995) (Schedule 3), Schedule 6 of the *Fisheries Management Act* 1994 (FM Act 1994) and the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999), has been outlined below in Table 11 for those processes which have been observed, or are likely to be operating, within the LGA (and fall within the scope of this plan). The optimisation of management strategies will also be required to minimise the effect of deleterious processes. The implementation of measures to mitigate the effect of threatening processes should also be undertaken in conjunction with relevant threat abatement plans.

Table 10 Plan Implementation - Management Actions

Management Issue	Description	Mitigation	Priority Rank	Priority Status
Fire regimes				
Inappropriate fire regimes - fire exclusion	Fire has been excluded from a number of patches in urban areas due to their proximity to the urban interface. The increase in mesic cover depletes the regeneration of sclerophyllous species, thus altering the natural dynamics of the vegetation communities concerned.	Undertake ecological burning fire regimes where fire has been excluded in order to maintain biodiversity. This may include pile burns as well as broad acre burns, refer to table 9. Ensure that no Vegetation Map Unit is subject to >50% Hazard Reduction or unplanned fire. Mechanical management of fuel (other than use of hand tools), such as slashing, trittering or tree removal are not permitted as outlined in the NSW Bush Fire Environmental Assessment Code 2006. Fire prescriptions need to be applied in a mosaic to ensure that faunal refuges are allowed for.	High	Ongoing (2012 – 2017)
Inappropriate fire regimes – frequent burning	Too frequent fires can cause the loss of species, habitats and assemblages at local and landscape scales, and can irrevocably alter the composition and function of communities and result in the introduction of exotic species.	Review and reinstate natural fire regimes where patches or areas have been burnt too often or too frequently. Review fire intervals and ensure they are in line with prescriptions for ecological communities present, particularly where patches or areas have been burnt too frequently. Fire prescriptions need to be applied in a mosaic pattern to ensure that faunal refuges are allowed for. Suppress fires unless consistent with prescriptions. Manage vegetation in accordance with the precautionary principle and use suppression methods which have least ecological and environmental impact. Instigate patch burns and avoid the risk of any	High	Ongoing (2012 – 2017)

		large area i.e. >50% of the Vegetation Map Unit burning during a single planned or unplanned event. Monitor threatened species and EECs in consultation with the Threatened Species Unit of the Office of Environment and Heritage (OEH).		
Inadvertently increasing fire risk	Associated with 'risks to life and property' and the management of forested landscapes (including those in urban or near-urban areas) is important recent research undertaken by Lindenmeyer *et al.* (2011) following the 2009 wildfires in Victoria and NSW. This research adds weight to the notion that forested landscapes which have been disturbed (by logging or by altering natural fire regimes) are often more prone to increased fire intensity during uncontrolled fire events.	Consider risks associated with the formation of landscape traps (see Lindenmeyer et al., 2011) as a consequence of excessive use of fire and logging when examining feasibility of forestry on small holdings and private plantation forestry activities.	High	Ongoing (2012 – 2017)
Hydrological regimes				
Weed incursion associated with stormwater and erosion	Storm water discharge and urban run-off associated with illegal discharge of contaminated water from various sources and non-reticulated sewage systems can both supply additional nutrients, pollutants and weed propagules. Weed incursion is often accelerated by increased nutrient loads (pollutants) associated with stormwater outlets. Stormwater outlets can also contribute to degradation of bank and bed stability along riverbanks and foreshore areas.	Accelerated erosion associated with land use activities needs to be monitored and abated to reduce the potential for surface erosion on coastal scarps as well as tracks and trails. Changes should be made slowly. Care should be taken to ensure that exotic food resources are not removed wholesale, particularly when their availability is sparse e.g. in late autumn, winter and early spring months. Primary treatment should focus on expanding the edges (by incorporating upper canopy species) of the more resilient patches with frequent follow-up treatment to ensure recovery of pockets. Small patches of more disturbed patches may be rehabilitated very slowly, working in a mosaic of 20x20m areas to ensure that habitat features are not impacted upon. Propagules will need to be removed. Where	Medium-high	Ongoing (2012 – 2017)

		plants are fee of propagules, they may be utilised as mulch and spread thinly over the ground. Soil disturbance should be avoided wherever possible, but where unavoidable, propagule-free weed material may be used to counter disturbance. Ensure utilities manage vegetation according to best-practice standards.		
Pollution controls associated with construction	The release of polluted water associated with various activities including construction sites, industrial areas, site dewatering or septic systems can supply extreme nutrients and other pollutants as well as weed propagules. Increased nutrients in the soil can contribute to dieback.	Monitoring and compliance with set standards. Apply appropriate controls in Pittwater DCP and assessment(s).	Medium-high	Ongoing (2012 – 2017)
Urban Interface Management				
Management of the urban interface	Activities associated with the urban interface and areas of open space (e.g. sports-grounds and parks) require specific management to curtail their effects on adjacent bushland. Potential impacts include; increase in weed incursion, littering and dumping, altered frequency of fire regimes, impacts from feral or domestic animals etc.	Reduce the frequency and intensity of impacts, including impacts associated with fertiliser run-off. Consider full life-cycle assessment.	Medium-high	Ongoing (2012 – 2017)
Edge effects and barriers	Continued clearing and fragmentation of native vegetation results in remnants which are often linear and narrow; such remnants are especially prone to "edge effects". All remnant patches are subject to various deleterious effects along boundaries, including altered hydrological and edaphic factors, increased wind-shear, increased light levels, and loss of habitat features critical to many species, soil compaction, increased runoff and establishment of weeds or other 'pest' species.	Where weed plumes exist, propagules should be removed and disposed of responsibly prior to mechanical vegetation management (e.g. APZ management) to reduce the potential rate of spread. Suitable endemic plant species for residential sites adjacent to bushland remnants are to be used.	Medium	Ongoing (2012 – 2017)
Horticultural introduction of opportunistic weed species	Horticultural introductions of species known as garden escapees have the potential to become naturalised posing a threat to bushland reserves.	Education of residents on impacts of noxious and environmental weed species. Encourage appropriate plant selection through statutory provisions.	Medium	Ongoing (2012 – 2017)

Inappropriate plant species selection for regeneration and landscaping	Inappropriate species selection or use of non-local stock can pose a significant threat to local species genetic diversity and to the viability of bushland in many reserves.	Select plant species from local plant species lists and source seed locally. Continue bush regeneration and weed removal. Reduce potential for further incursions by providing advice on appropriate endemic plant species selection for land owners adjacent or near bushland reserves. Monitor plant nurseries to remove potentially invasive vines and climbers from their stock. Encourage appropriate plant selection through statutory provisions.	Medium-high	Ongoing (2012 – 2017)
Management of Public Access				
Vegetation damage due to inappropriate pedestrian access	Unrestricted pedestrian access resulting in vegetation trampling and terrain damage, increasing vulnerability to erosion and compaction of soils and introduction of weed propagules. This is particularly problematic where the substrates are prone to erosion such as headlands and more elevated, steeper slopes.	Reduce inappropriate access and formalise pedestrian access via selected routes. Accelerated erosion associated with land- use activities needs to be monitored and abated (particularly along main access tracks) to reduce the potential for surface erosion, particularly where main access tracks occurs in close proximity to cliffs and steep slopes. Include management actions in reserve Plans of Management to control inappropriate access.	Medium-high	Ongoing (2012 – 2017)
Vegetation Management				
Low recruitment of upper canopy species	Intensive management regimes (e.g. use of fertilisers, irrigation etc) in residential gardens contributes to lower levels of recruitment in species characteristic of native vegetation communities, particularly Endangered Ecological Communities. The abundance of exotic species and lack of or too frequent fires can also lead to reduce recruitment of upper canopy species.	Improve connectivity; provide incentives for landholders to plant upper and mid-canopy species.	Medium-high	Ongoing (2012 – 2017)

Genetic changes to plant species on a local and regional scale	The introduction of plant material which has the capacity to alter local genetic stock. For example, Lemon-scented Gum *Corymbia citriodora,* a species from Northern NSW is widely planted in the LGA. This species has the capacity to impact on the genetic make-up of Spotted Gum (*Corymbia maculata).* Similarly, the use of non-local stock for replanting schemes in or near bushland areas can alter local genetic diversity (*e.g. Westringia fruticosa*).	Improve connectivity through use of plants propagated from local stock.	Medium-high	Ongoing (2012 – 2017)
Reserve shape and area: high edge-to-area ratios	Many patches of native vegetation in Pittwater LGA are long and narrow (i.e. have a high edge-to-area ration) making them more vulnerable to edge effects including elevated soil nutrient levels, weed infestation and altered hydrological regimes. The cumulative effects of these impacts also have implications for bushfire management and containment.	Improve structural form of reserves on adjacent areas. Provide incentives to landholders to plant upper canopy species to maintain biodiversity. Bolster connectivity in adjacent areas throughout private lands via development controls to ensure that basic structural form of corridors are maintained.	Medium	Ongoing (2012 – 2017)
Intensive management of vegetation types which would otherwise be subject to natural changes in species composition	As an example, narrow pockets of *Themeda australis* dominated grassland occur sporadically along previously disturbed coastal tracks. In the absence of intensive management, these areas may revert to coastal heath/scrub. Conversely, inappropriate management regimes (especially fire regimes) may encourage invasion by shrub taxa into viable patches of Themeda grassland.	Consideration may need to be given to the long-term viability associated with some of the thin, narrow pockets of specific ecological communities.	Medium	Ongoing (2012 – 2017)

Inadvertent encroachment of weed species by means of routine management and disposal of garden wastes in bushland	Garden escapees (species grown in gardens which establish themselves in adjacent bushland) and the dumping of garden waste contribute to the spread of weeds along disturbed bushland margins. Dumping of garden waste can lead to increased nutrients and changes in soil moisture. Roadsides and powerline easements where vegetation maintenance has been undertaken on a regular basis also allow for the perpetuation and spread of weed species.	Where weed plumes exist, propagules (reproductive parts) should be removed and disposed responsibly prior to mechanical vegetation management (e.g. APZ management) to reduce the potential rate of spread. Suitable species for residential sites adjacent to bushland remnants. Ensure utilities and parks and gardens departments manage vegetation within their easements according to best-practice standards. Public education about the effects of dumping garden wastes along margins of vegetation. Council to provide lists of suitable species for residential sites adjacent to bushland remnants, and list species not considered suitable (i.e. those known to spread into bushland). Monitor plant nurseries to ensure that inappropriate plant species are phased out (e.g. *Acacia saligna*). Dumped miscellaneous debris is likely to provide important shelter for wildlife and should largely be retained until staged removal is possible when natural components become available.	Medium	Ongoing (2012 – 2017)
Coastal Zone Management				
Foredune trampling	Vegetation trampling through untrammelled vehicle or pedestrian access resulting in the loss of vegetation and increased vulnerability of foredunes to changing tidal flux, wind and wave erosion. This is particularly problematic where pedestrian access is not restricted by fencing/signage.	Installation of fencing to direct pedestrian access via selected routes (fencing is to be fauna-friendly to allow fauna movement). Installation of educational signs to highlight effects of trampling, illegal access etc.	High	Ongoing (2012 – 2017)

Loss of vegetation, erosion of coastal clifflines and foreshores (e.g. due to climate change and increased wave action through boat activities etc)	Under climate change scenarios, the potential for storm-surge, sea-level rise and flooding suggest that there is potential for the acceleration of normal coastal processes such as erosion of exposed clifflines and foreshores. Foreshore erosion and loss of foreshore vegetation can be also be accelerated by increased wave action from boating activities.	Given the vulnerabilities, vegetation retention and management may require the preparation of a coastal management plan to aid the retention and ongoing management of remaining cliff-line, dune and foreshore vegetation. Local education about the implications of removing foreshore vegetation. Bolster foreshore plantings.	High	Ongoing (2012 – 2017)
Biodiversity loss				
Biodiversity loss	NSW Biodiversity Certification Assessment Methodology allows planning authorities a streamlined biodiversity assessment at the strategic planning stage, along with options for offsetting impacts on biodiversity. To counter the loss or fragmentation of populations of cryptic and/or deciduous species, biocertification and any impact assessment undertaken through the statutory planning controls needs to consider the potential loss of species (including threatened species) and their habitats that are not amenable to study due to specific seasonal survey requirements at the time of biocertification or development application lodgement (See Appendix 5 for cryptic and/or deciduous species).	Biocertification needs to consider the potential loss of (threatened) species and their habitats of species are not amenable to study due to specific seasonal survey requirements. Similarly, flora and fauna assessments associated with development applications need to specify seasonal survey effort.	High	Ongoing (2012 – 2017)

Corridors and loss of connectivity	Corridors which provide connectivity between bushland reserves benefit highly mobile fauna including bird, bat and invertebrate species, as well as some terrestrial fauna species. Movement across the landscape is often reliant on tree canopy as a minimum structural requirement, with increased ecological function being associated with more structurally diverse corridors. Little recruitment of upper canopy species was observed during the current study.	Review the Wildlife Corridor Control in Pittwater's DCP. Tree and vegetation retention within the built environment needs to encompass a range of age classes. Importantly, mature hollow-bearing trees need to form a component of suburban tree canopy. Installation of fauna friendly fencing to restrict access as required or to direct pedestrian access via selected routes.	Medium-high	Ongoing (2012 – 2017)
Presence of Flying Foxes	As the total area of suitable roosting and foraging habitat declines, Grey-headed Flying-foxes are likely to increasingly rely on those resources available to them in residential areas. Removal of further resources at specific sites will force GHFF to move to other sites within the Pittwater LGA.	Local education about the implications of removing habitat. Bolster habitat and food resources (i.e. upper canopy) in public lands away from residential dwellings (including planting of a wider range of species indigenous to the site/ LGA than is currently the case).	Medium-high	Ongoing (2012 – 2017)
Koala Habitat	Current research indicates that concentrations of carbon-based plant defences (plant toxins) are increasing, whilst nutrient content in leaves is likely to decline in native plant foliage. A range of fauna species, including Koalas, will need to be more selective about which leaves they choose, from which trees; resulting in fauna species having to cover greater distances in search of food, this increases their vulnerability to predation, or being hit by cars.	Bolster corridor connectivity. Avoid isolating individual trees by encouraging regrowth of clumps of trees which provide 'stepping-stone' elements to adjacent corridor and potential linkages.	Medium	Ongoing (2012 – 2017)

Adequate Development Controls				
Improving Development Controls	Inappropriate development can have a significant impact on natural vegetation, both directly and indirectly. Controls exist within Pittwater's Development Control Plan to minimise the impact of development on the natural environment including vegetation, bushland, threatened species, endangered ecological communities and wildlife corridors.	Ensure controls are designed to encourage development that is appropriate and include a suite of conditions that are imposed onto development consents which aim to protect vegetation, mitigate impacts and offset any unavoidable loss of natural resources.	High	Ongoing (2012 – 2017)

Table 11 Mitigation of Threatening Processes and Key Threatening Processes of relevance to the Pittwater LGA.

Threatening Process	Description/Relevance	Mitigation	Priority Rank	Priority Status
Anthropogenic Climate Change				
Anthropogenic climate change and loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	**Changes to the interactions between native and exotic species, to species composition and to fire regimes under climate change are largely unknown and beyond the scope of this management plan.**	Monitor long-term changes in vegetation associated with climate change. An improvement in connectivity (latitudinally and longitudinally) throughout the LGA could assist flora and fauna species to adapt. Larger pockets of vegetation are likely to adapt more readily compared with isolated, narrow and/or small stands. Reducing weed invasion and other pressures will also assist adaptation responses. Increase recruitment of canopy and sub-canopy species along the urban interface to allow for latitudinal and longitudinal shifts in species distribution and range.	High	Ongoing
Habitat Alteration				
High frequency fire resulting in the disruption of life cycle	Plants and animals have a range of mechanisms to survive individual fires. The long-term survival of plants and animals over repeated fires is dependent upon the ability of species to maintain life cycle processes; and the maintenance of	To slow or eliminate species loss and alterations to life cycle processes, adopt planned hazard reduction and ecological burns, as set out in this Plan which accord with the NSW Rural Fire Service Environmental Code	High	Ongoing

Threatening Process	Description/Relevance	Mitigation	Priority Rank	Priority Status
processes in plants and animals and loss of vegetation structure and composition	vegetation structure over time as habitat. Where fires occur at close intervals (high frequency fire) both these key features can be disrupted. If high frequency fire is sustained a loss of plant species will occur, along with a reduction in vegetation structure and a corresponding loss of animal species. Too frequent burning on public or private land is likely to be a significant factor in species loss and overall bushland condition particularly in areas adjacent to dedicated or nominated APZs or SFAZs.	and the Guidelines for ecologically sustainable fire management 6;7. Ensure full flora and fauna pre and post-fire monitoring and assessments are undertaken.		
Loss of hollow-bearing trees (proposed key threatening process declaration)	The presence, abundance and size of hollows are positively correlated with tree trunk diameter, which is an index of tree age. Hollows with large internal dimensions are the rarest and occur predominantly in large old trees, which are rarely less than 220 years old. The distribution of hollow-bearing trees depends on tree species composition, site conditions, competition, tree health and past management activities. Hollows occur at varying densities; undisturbed woodlands typically contain 7–17 hollow-bearing trees per hectare and undisturbed temperate forests 13–27 per hectare. On a landscape basis, dead trees often account for 20–50% of the total number of hollow-bearing bearing trees.	Retain large hollow-bearing trees and dead trees ("stags") in reserves wherever possible. Identify and conduct regular inspections and risk assessments where large hollow-bearing trees are retained. Design and deliver education programmes to inform the public and residents of the reasons for retaining these features and their ecological value. Create opportunity for installation of nest boxes where appropriate.	Medium-high	Ongoing
Alteration to the natural flow regimes of rivers, streams,	Alteration to natural flow regimes refers to reducing or increasing flow rates, altering seasonality of flows, changing the frequency, duration, magnitude, timing, predictability and variability of flow events, altering surface	Accord with current best practice in managing natural flow regimes of rivers, streams, floodplains & wetlands.	Medium-high	Ongoing

Threatening Process	Description/Relevance	Mitigation	Priority Rank	Priority Status
floodplains & wetlands	and subsurface water levels and changing the rate of rise or fall of water levels. The degree to which these processes operate within the LGA is largely unknown.			
Clearing of native vegetation and land clearance	At the LGA scale, and the time of writing, Pittwater LGA encompasses 10,900ha. Of the 4557ha of land managed by Council, 3,624ha of the pre-1750 vegetation has been cleared or significantly disturbed, with 933ha (20.5%) of the pre-1750 vegetation extent remaining.	Reduce the rate of vegetation loss by planting locally indigenous species and encouraging the community to do the same on private land.	High	Ongoing
Removal of dead wood and dead trees	Dead wood and dead trees provide essential habitat for a wide variety of native animals and are important to the functioning of many ecosystems. The removal of dead wood can have a range of environmental consequences, including the loss of habitat (as they often contain hollows used for shelter by animals) and the disruption of ecosystem process and soil erosion. Removal of dead old trees (either standing or on the ground) results in the loss of important habitat such as hollows and decaying wood for a wide variety of vertebrates, invertebrates and microbial species and may adversely affect threatened species known to occur in the area.	Retain dead wood and dead trees ("stags") in reserves wherever possible (bearing in mind responsibilities for attenuating bushfire fuel loads). Identify and conduct regular inspections and risk assessments where large dead trees are retained. Educate members of the public and relevant agencies about the importance of dead wood for the purpose of habitat.	Medium-high	Requires investigation
Pathogenic				
Infection of/dieback in native plants by *Phytophthora cinnamomi*	*Phytophthora cinnamomi* is a soil borne pathogen belonging to the water mould group (Oomycetes). It spreads in plant roots in warm, moist conditions through movement of spores which may swim to new hosts or be dispersed over large distances in flowing water, such as storm runoff. The pathogen appears to be widespread in coastal forests, and is known to infect a large range of species that display a range of symptoms; some are killed, some are damaged but endure, and some show no apparent symptoms. In some circumstances, *P. cinnamomi*	Rationalise access to bushland via trails. Design and deliver education programmes to inform the public and relevant agencies about the issue and follow any hygiene protocols available. Provide appropriate access to bushland via trails. Develop protocols for contractors, staff and volunteers when working in bushland reserves.	Medium-high	Ongoing

Threatening Process	Description/Relevance	Mitigation	Priority Rank	Priority Status
	may contribute to plant death where there are other stresses present (*e.g.* waterlogging, drought, and/or wildfire).			
Introduction and Establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	The NSW Department of Primary Industry (formerly the Department of Industry & Investment) website describes Myrtle Rust as "*a newly described fungus that is closely related to the Eucalyptus/Guava rusts. These rusts are serious pathogens which affect plants belonging to the family Myrtaceae including Australian natives like bottle brush (Callistemon spp.), tea tree (Melaleuca spp.) and eucalypts (Eucalyptus spp.)... Infection on highly susceptible plants may result in plant death*". It is considered that this fungus may pose a serious threat to the integrity and function of native vegetation, and is considered to be widely distributed in almost the entire NSW coastal zone (including the Pittwater LGA). Currently, 36 species of Myrtaceae are known to be susceptible, and this figure is expected to rise. The Myrtle Rust National Management Group admits that it is not feasible to eradicate the disease.	Devise and deliver an education program for staff (particularly field staff, contractors and bushcare volunteers) and the general community to inform them of the risks, methods of transmission and means to ameliorate the pathogen's spread, and advise them of reporting requirements where outbreaks are detected. See DPI (formerly Department of Industry & Investment) website for further information on spread and mitigation of Myrtle Rust in bushland	Medium-high	Ongoing
Habitat Invasion				
Competition and grazing by the feral European rabbit	Grazing and burrowing by rabbits can cause massive erosion problems, reduce recruitment and survival of native plants, and alter entire landscapes. Rabbits also threaten the survival of a number of native animal species by altering habitat, reducing native food sources, displacing small animals from burrows and attracting introduced predators such as foxes. In addition, rabbits may have significant impacts on Aboriginal and historic cultural heritage. For example, overgrazing by rabbits has exacerbated soil erosion in Mungo and Kinchega national parks, exposing culturally significant sites such as Aboriginal burial grounds. (Final Determination)	Engage in community education and continue feral animal controls.	Medium	Ongoing

Threatening Process	Description/Relevance	Mitigation	Priority Rank	Priority Status
Competition from feral honeybees	Feral honeybees are introduced bees, *Apis mellifera*, which originally escaped from hives and have subsequently established in the wild usually centred on tree hollows. Feral honeybees are thought to occur patchily throughout most of the State with the exception of alpine areas (Paton, 1996). Honeybees impact on biodiversity in two broad ways: via competition for tree hollows and floral resources, such as pollen and nectar. The loss of tree hollows due to occupation by feral honeybees reduces the number of hollows available for native animals to breed and shelter. This is of particular concern for species which are threatened. Hollows are an extremely important resource for many Australian animals, particularly birds and mammals. (Final Determination)	Engage in community education and implement feral animal controls.	Medium-high	Ongoing
Introduction of the large earth bumblebee, *Bombus terrestris*	Bumblebees, *Bombus terrestris*, are a relatively large, primitively eusocial bee native to Europe. Bumblebees were first recorded in Tasmania in 1992 and have since spread over a large area of the state in both urban and native bush areas (Hingston et al. 2001). They have become established throughout Tasmania in a wide range of habitats, from sea level to 1250 m altitude, within all the major native vegetation types (Hingston and McQuillan 1998). Their wide adaptability demonstrates the potential of the species to naturalise in NSW. At present this species is not known to occur in NSW, but could establish through accidental introduction from colonies in Tasmania or New Zealand, or deliberate introduction as a pollinating agent. (Final Determination)	Train staff, contractors and volunteers in the identification of this species. Engage in community education about this issue and implement feral animal controls as appropriate.	Medium	Ongoing

Threatening Process	Description/Relevance	Mitigation	Priority Rank	Priority Status
Importation of Red Imported Fire Ants into NSW	The Red Imported Fire Ant, *Solenopsis invicta*, is a small colonial ant that is a native of southern Brazil. They damage plants by eating fruit and seeds and tunnel into stems and girdle seedlings. They also prey heavily on ground invertebrates and attack any slow moving vertebrates such as bird nestlings. Fire ants are listed among the worlds 100 worst invaders by the Invasive Species Specialist Group of the IUCN (ISSG 2994). Climatic modelling of the potential habitat for fire ants across Australia shows that they could occupy most of the coastal belt and the more mesic inland areas (Sutherst 2001). This includes the eastern half of NSW except for alpine areas. Workers forage during the warmer months of the year when temperatures are between 22°C and 36°C. The NSW Department of Primary Industry has declared the Red Imported Fire Ant a notifiable pest under the Plant Diseases Act 1924. This means there is a legal obligation to report suspected red fire ant infestations to	Train staff, contractors and volunteers in the identification of this species. Engage in community education about this issue and implement feral animal controls as appropriate.	Medium	Ongoing

Threatening Process	Description/Relevance	Mitigation	Priority Rank	Priority Status
	the Department as soon as possible. (Final Determination)			
Invasion of the Yellow Crazy Ant (*Anoplolepis gracilipes* (Fr. Smith)) into NSW	The Yellow Crazy Ant poses a significant threat to biodiversity as the ants have the potential to displace native fauna (Gerlach 2004, O'Dowd ***et al.*** 2003, Lester and Tavite 2004). The Yellow Crazy Ant is known to kill invertebrates, reptiles, hatchling birds and small mammals. Fauna are at risk either directly through predation or indirectly through habitat alteration or resource depletion, particularly in rainforest ecosystems (DEH 2004). Secondary effects caused by the outbreaks of sap-sucking scale insects that were tended by the Yellow Crazy Ant. This reduced seed production and increased mortality in some canopy tree species (DEH 2004). (Final Determination)	Train staff, contractors and volunteers in the identification of this species. Engage in community education about this issue and implement feral animal controls as appropriate.	Medium	Ongoing
Forest Eucalypt dieback associated with over-abundant psyllids and bell miners	The severity of dieback associated with over-abundant psyllids and bell miners varies across the forested areas of NSW, although its extent has not been fully investigated. The forest types most susceptible in the LGA are those dominated by Sydney Blue Gum (*E. saligna*), Narrow-leaved White Mahogany (*E. acmenoides*), Grey Gum (*E. punctata*) and Grey Ironbark (*E. paniculata*). Another forest tree species present which are known to be susceptible to attack include the Spotted Gum (*Corymbia maculata)* which may be affected, usually after a substantial decline in the most susceptible species.	Consider scientific literature and knowledge gaps in implementing policy. Continue to monitor large scale dieback in canopy species. Identify sites where this issue may occur. Train staff, contractors and volunteers on how to identify this issue in the field.	Medium	Ongoing
Invasion and establishment of exotic vines and scramblers	The majority of these exotic vines and scramblers are garden escapees associated with the horticultural industry. Many are currently recognised as significant environmental weeds in particular regions.	Continuing bush regeneration and weed removal. Reduce potential for further incursions by providing advice on appropriate plant species selection for land owners adjacent or near bushland reserves, also lobby plant nurseries to remove potentially invasive vines and climbers from their stock.	Medium-high	Ongoing

Threatening Process	Description/Relevance	Mitigation	Priority Rank	Priority Status
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.	Escaped garden plants, including aquatic species, have significant adverse effects on biodiversity by forming dense thickets, suppressing native vegetation and seedlings through shading, nutrient competition, smothering and allelopathy (*i.e.* the chemical suppression of germination and/or growth of other plant species). A number of these species are known to readily invade disturbed sites and communities, including edges and canopy breaks in dense forest communities.	Continuing bush regeneration and weed removal. Reduce potential for further incursions by providing advice on appropriate plant species selection for land owners adjacent or near bushland reserves. Monitor plant nurseries to remove potentially invasive vines and climbers from their stock. Encourage appropriate plant selection through statutory provisions.	High	Ongoing
Invasion of native plant communities by *Lantana camara*	Lantana has significant adverse effects on biodiversity by forming dense thickets, suppressing native vegetation and seedlings through shading, nutrient competition, smothering and allelopathy (*i.e.* the chemical suppression of germination and/or growth of other plant species). Lantana readily invades disturbed sites and communities, including edges and canopy breaks in dense forest communities. In open forests and woodlands lantana often becomes a dominant understorey species, and in warmer, moister areas lantana often becomes dominant in regenerating pastures.	Continuation of current removal programmes and bush regeneration. Ensure removal of stands of Lantana is pre-assessed for habitat value. Clear large stands over a period of time outside of breeding season for fauna species, in particular small birds.	Medium-high	Ongoing
Invasion of native plant communities by African Olive *Olea europaea* L. subsp. *cuspidata*	*Olea europaea* L. subsp. *cuspidata* is a major woody weed in woodland remnants which tends to favour heavier soils. Seedlings recruit under canopy eucalypts, dead trees, and power lines (resulting from bird dispersal). Dense stands shade and out-compete native species for moisture. Major seedling recruitment occurs during wet periods (Royal Botanic Gardens profile).	Continuing bush regeneration and weed removal. Reduce potential for further incursions by providing advice on appropriate plant species selection for land owners adjacent or near bushland reserves. Monitor plant nurseries to remove potentially invasive vines and climbers from their stock.	Medium	Ongoing
Invasion of native plant communities by bitou bush and boneseed	*Chrysanthemoides monilifera* invades and displaces native plant communities. Boneseed (subspecies *monilifera*) is the less important of the two weeds in New South Wales but it has the potential to be a serious threat to inland areas in the future if it is left uncontrolled. Bitou bush was first	Continuation of current removal programmes and bush regeneration.	Medium-high	Ongoing

Threatening Process	Description/Relevance	Mitigation	Priority Rank	Priority Status
	recorded in New South Wales in 1908 near Newcastle, and between 1946 and 1968 was planted for dune stabilisation at a number of locations along the New South Wales coastline. It has spread rapidly from these plantings and is now found along 80% of the coastline, covering more than 900 km.			
Invasion of native plant communities by exotic perennial grasses (Including Gamba Grass)	More than a hundred species of exotic perennial grasses occur in New South Wales. Of concern are a relatively small number of these exotic perennial grasses with the capability of threatening native plant communities. Exotic perennial grasses of particular concern in parts of the LGA include African Love Grass, Panic Veldt Grass, Kikuyu and Buffalo.	Continuation of current removal programmes and bush regeneration.	Medium-high	Ongoing
Invasion and establishment of Scotch broom (*Cytisus scoparius*)	Scotch Broom, *Cytisus scoparius*, is a leguminous shrub native to Europe, first introduced to Australia in the early 1800s. Subsequent introductions were made for ornamental purposes and by 1901 it had spread significantly and was declared a noxious weed in NSW. *C. scoparius* is estimated to infest more than 200 000 ha in south-eastern Australia and has become an environmental weed in higher rainfall areas. It grows most successfully in cool temperate areas on moist, fertile soils. It is continuing to spread through both expansion of existing infestations and colonization into new areas. In some locations it has formed near monocultures. (Final Determination).	Maintain weed management programmes	Medium	Ongoing
Aquatic and Marine				
Degradation of native riparian vegetation along New	Riparian vegetation refers to the vegetation fringing water courses including land immediately alongside large and small creeks and rivers, gullies, lakes, wetlands etc. Degradation of riparian vegetation includes the removal or	Continuing bush regeneration and weed removal in riparian areas. Reduce potential for further weed incursions by providing advice on appropriate plant species selection for land owners adjacent or near	Medium-high	Ongoing

Threatening Process	Description/Relevance	Mitigation	Priority Rank	Priority Status
South Wales water courses	modification of native species and a major cause of degradation is the introduction of, or invasion by, non-native species. Degradation of riparian vegetation has a major influence on stream ecosystems by; increasing sediment and nutrients (via runoff) and increasing light penetration of the water body. Impacts include; smothering of benthic communities, increases in harmful algal growth, reduces organic carbon (via leaves, twigs, and branches), reduced large woody debris, destabilises river banks and reduces overhanging riparian vegetation resulting in a loss of shade and shelter for fish.	bushland reserves. Accord with current best practice in managing natural flow regimes of rivers, streams, floodplains & wetlands.		

10.2 Prescribed Burning

As discussed above, proposed fire thresholds and intervals are in accordance with those prescribed the Bush Fire Environment Code (NSW Rural Fire Service, 2006) and Guidelines for Ecological Sustainable Fire Management (NSW NPWS, 2003). It should be borne in mind that thresholds provided by the NSW Biodiversity Strategy (NSW NPWS, 2003e) are based on vegetation formations and on data which has significant gaps, especially for particular regions, for particular sub-formations and for cryptic (flora and fauna) species and particularly poorly known threatened fauna. Effects of the use of these prescriptions should therefore be monitored over time and management regimes altered accordingly. Consequently, the approach taken for the purpose of fire prescriptions is as follows:

- Table 9 provides an interval which is a combination of the entire intervals generated, as well as the intervals of the NSW Biodiversity Strategy (NSW NPWS, 2003e);
- Prescriptions are based on percentiles obtained from these intervals with the exception of a number of map units for which the relevant documents makes no recommendations;
- Monitoring of the effects of fire in these communities is therefore critical. Observations should be noted in relation to threatened species' responses to fire thresholds (particularly where thresholds are breached as a consequence of unplanned fires), EEC responses (post fire regeneration *etc.*) and any damage incurred.

10.3 Review

This plan identifies bushfire management works to be undertaken over the next five years. An adaptive management approach is needed, with particular caution in relation to the availability of new information resulting from ecological research. This plan is to be read in conjunction with the Warringah Pittwater Bush Fire Management Committee Plan of Operations and section 52 of the *Rural Fires Act 1997*.

This Plan will be reviewed after five years: the review should consider new information on best practice management techniques, and should accommodate recommendations made as a result of the interpretation of ecological monitoring data and fire record data.

10.4 Implementation and Evaluation – Performance Indicators

In terms of bushfire management, the effectiveness of this plan is to be measured by performance indicators identified in Section 7.1 (ecological) and Table 12 (bushfire) below.

Table 12 Performance indicators for the evaluation of the overall effectiveness of plan.

Management	Performance Indicators
Asset Protection Zone	No loss of life, property or other assets. No passage of fire from remnants and reserves to adjacent areas and *vice versa*. No increase in ignitions caused by humans over the period. Fires occurring on the remnants are suppressed within appropriate control lines, with minimum environmental damage and cost. No death or injury to persons, or destruction of property, caused by bushfires within the remnants and no incidents of the transfer of fire into remnants from urban interface. Records of maintenance and fire activity are retained on GIS and reported annually.
Strategic Fire Advantage Zone	The provision of access for strategic containment of wildfire and safe access for fire fighters and equipment. Reduction of risk of bushfire attack to property. No passage of fire from buildings and facilities to vegetated portion of remnants and vice versa. The containment of fire and adherence to prescribed fire regime which are consistent with management outcomes. Unplanned fires occurring in the remnants are suppressed within appropriate control lines, with minimum environmental damage and cost. No death or injury to persons, or destruction of property, caused by bushfires within the remnants. Records of maintenance and fire activity are retained on GIS and reported to the local BFMC annually.
Land Management Zone	The management of bushfire events in accordance with the conservation objectives for species, populations, habitats, EECs or cultural heritage (*i.e.* no decline in conservation and cultural values, due to inappropriate fire regimes, suppression operations or other bushfire management work) during the planning period. No fires to exceed prescribed fire intervals or intensities. No damage caused to Aboriginal cultural heritage sites. Requirements of recovery plans and PASs for threatened species are implemented as required. Records of maintenance and fire activity are retained on GIS and reported to the local BFMC annually. Risks associated with the formation of landscape traps (see Lindenmeyer *et al*., 2011) as a consequence of excessive use of fire and logging are not exacerbated from forestry on small holdings and private plantation forestry activities.

11.0 OPERATIONAL OBJECTIVES

11.1 Guidelines

Table 13 lists operational guidelines to be implemented during all bushfire operations, including wildfires and prescribed fires. The guidelines aim to protect life and property as well as the natural and cultural assets of the remnants. Periodic maintenance of tracks ensures that fires occurring within the remnants are suppressed safely within appropriate control lines, thereby minimising environmental damage. Prescribed fire regimes need to be maintained within specified ecological thresholds across no more than 50% of the area of each broad vegetation type during prescribed burn events. Prescribed fire regimes for the management of the EEC will

involve 50% of the EEC having a longer or shorter fire interval than the remaining 50%, in order to minimise risk of environmental degradation of that community. Burning regimes will also be mindful of the potential for Aboriginal relics within the remnants.

All operational guidelines in this plan are to be read in conjunction with the Warringah Pittwater Bush Fire Management Committee Plan of Operations.

Table 13 Operational Guidelines.

Management Unit	Standard Operational Guidelines
Vegetation communities where fire has been more frequent than the minimum fire frequency threshold	Exclude prescribed burns and suppress unplanned burns.
Vegetation communities where fire has been less frequent than the maximum fire frequency threshold	Maintain a mosaic of burnt and unburned patches and control fire within strategic areas. Do not exceed prescriptions for maximum areas to be burnt during single operation. Consultation with neighbors required prior to prescribed burns.
Potential Aboriginal and historic sites	Brief all personnel involved in control line maintenance and fire fighting operations on the location of potential sites and required control line. Protect all sites from damage. Provide detailed Environmental Assessments of sites to appropriate fire control body for the preparation of Burn Plans.
Threatened flora	Brief all personnel involved in control line maintenance and fire fighting operations on the broad location of sites and broadly defined known habitat of threatened species. Protect all sites from damage. Environmental Assessments of sites to appropriate fire control body for the preparation of Burn Plans.
Threatened fauna	Brief all personnel involved in control line maintenance and fire fighting operations on the broad location of sites and broadly defined known habitat for threatened species. Protect all sites from damage. Environmental Assessments of sites to appropriate fire control body for the preparation of Burn Plans.
Heavy machinery	Restrict use to existing roads, tracks or control lines during wet weather. Brief all personnel involved on the broad location of Aboriginal or historic sites, broadly defined known habitat for threatened species and the significance of the EEC.
Fire fighting chemicals	Exclude the use of wetting or foaming agents within 20 metres of a watercourse or dam and limit use of those agents wherever possible. Repeated use in any one broad vegetation type is to be avoided. Guidelines for their safe use should be adhered to.
Use of salt water	Only in the event of fresh water being unavailable during firefighting operations, the use of salt water is considered to be acceptable in exceptional circumstances only, and its use should be limited to small scale applications.
Back-burning	Brief all personnel involved in control line maintenance and fire fighting operations on the location of important sites and broadly defined known habitat for threatened species. Protect all sites from damage.
Smoke management	Prevailing weather conditions should be considered. Best practice guidelines should be adhered to, and consultation with EPA will be necessary.
Use of hoses	Minimise heavy water flows onto bushland areas from fire hoses (use spray) to minimise erosion and disturbance of native seed bank in upper soil profile.

Pittwater Native Vegetation Management Plan

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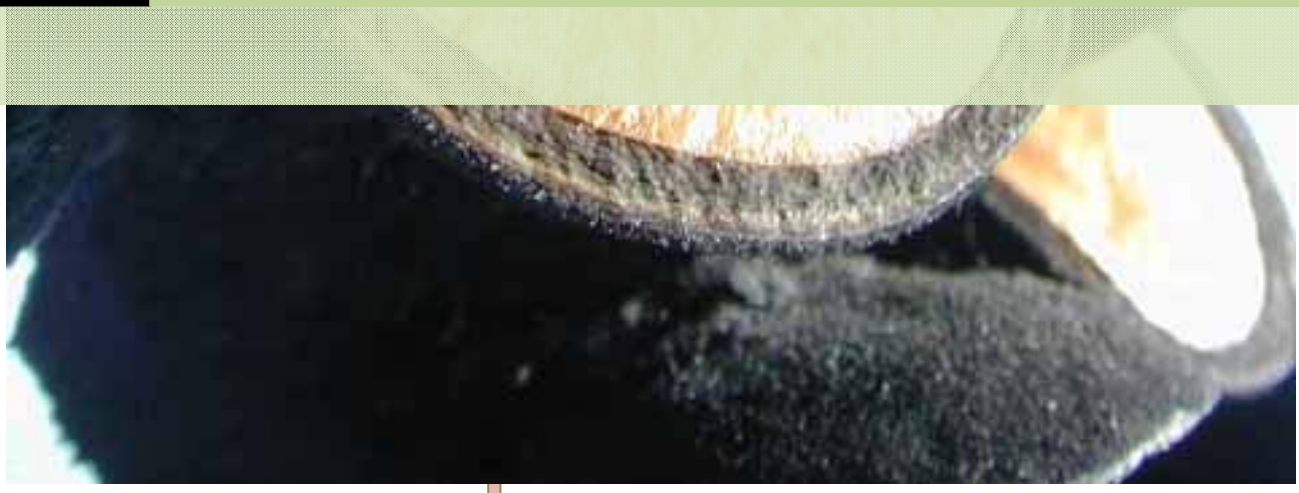

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APPENDIX

Experimental Survey Design

Map Units with a condition code of 1-3 would form the ideal basis of a stratified random sampling study. Study sites would comprise:

(i) control sites – sites where no restoration or re-vegetation is underway within site or adjacent areas;

(ii) treatment sites – sites where (i) restoration; and (ii) bushfire management is actively underway;

(iii) transects (as required for habitat variables).

A premise of such a study would be that temporal changes would be the same in both sets of sites if the treatment did not occur (control and treatment) and that other processes at the two sites did not differ (*i.e.* similar regenerative capacity, access by ground mammals within survey plots *etc.*).

Site Selection

In order to measure the effectiveness of restoration or re-vegetation the survey design needs to adopt three broad principles:

1. The study must comprise a range of habitats;
2. There should be sufficient replication of the nominated treatments within each habitat type (Vegetation Map Unit). Ideally this should be calculated for each study; and
3. Treatments should be applied across the condition categories (i) 1; (ii) 2; and (iii) 3 etc. Changes in response to active management will differ between these discrete units and may be more readily measured over a shorter time period in some units over others.

Plot Locations

The baseline data collected during the vegetation survey is both random and representative and therefore provides an ideal basis for long-term monitoring.

- it is anticipated that data within the same habitat treatment be separated appropriately to assume data independence and avoid pseudo-replication. Baseline plot locations are considered sufficiently independent for this purpose;
- each broad habitat should have been subject to analogous and recent fire regimes or this factor must be dealt with as a separate factor for which variation can be isolated.

Within each broad habitat type the following experimental examples may be used to assess the separate and combined effects of two or more independent variables on a dependent variable:

(i) 2 X 2 factorial design - study the effects of treatment (restoration vs. no restoration) and bushfire management (fire management vs. no fire management) on indigenous species richness (dependent variable)

(ii) 4 X 2 X 2 factorial design - study the effects of the number of years of active treatment (in accordance with management periods 1, 3, 6, >9 etc.), type of treatment (restoration vs. bushfire management) and habitat condition by type (in accordance with management of each Vegetation Map Unit (Condition Category) *e.g.* Map Unit 1 vs. Map Unit 2) on indigenous species richness (dependent variable). Plot requirements should be discerned using power calculations and the main effects (effect of each factor) and interaction should be discerned. Appropriate replication should be an important consideration to avoid pseudo-replication.

Reliable indicators

As discussed above, a range of indicators of ecosystem health are available but those selected should relate directly to the research question. For example, changes in species richness and abundance of introduced plant species provide a reliable basis for measuring threat abatement and overall change. Bird species richness could be used as a suitable indicator of overall ecological value (Barrett G., 2000).

Table 14 Reliable Indicators

Objective and Indicator	Performance measure
Biodiversity conservation	
Presence of threatened species.	No net loss of threatened species from any Vegetation Map Unit (using defined measurement parameters).
Level of diversity.	Evidence of increase in (short term) and stabilising of (long term) species diversity.
Prevalence and diversity of weeds in endangered ecological communities.	Decline in prevalence and diversity of weed species.
Endangered ecological communities distribution	No reduction in area of Endangered Ecological Communities.
Degradation of endangered ecological communities.	Decline in prevalence and diversity of weed species. No measurable adverse change to ecosystem processes such as prevalence of dieback, weed incursion, surface water flows.
Vegetation management	
Degraded sites.	Reduction in area of degraded vegetation. No net loss of threatened species from vegetation type. Reduction in prevalence and diversity of weed species. Reduction over time in area of bush re-vegetation and restoration activities.
Fauna	
Presence of fauna habitat.	Increase in prevalence of direct observations, signs and scats, and use of fauna habitat features. Retention of present abundance and diversity of fauna species (targeted survey to sample area for indicator species).

Pest fauna species	
Presence of pest fauna.	Reduction in prevalence of direct observations signs and scats. Decline of present abundance and diversity of pest fauna species (targeted survey to sample area for specific species such as rabbit burrows, scats).
Bush fires	
Fire regimes.	Appropriate number and intensity of bushfires over time. Compliance with overall aims of plan (*i.e.* no net loss in diversity).
Wetland Biodiversity and stormwater	
Changes in water quality.	Improvement in water quality and wetland biodiversity. Restoration of natural flow regimes in wetlands.
Activities and maintenance	
Maintenance costs	Management becomes more cost effective over time
Monitoring and research	
Indicators	Use of indicators becomes more focused over time
Documentation and research	Documentation, research and mapping of areas contributes to adaptive management.
Cultural and historic sites	
Heritage sites.	Number and condition of heritage sites.