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Abbreviations

API	Aerial Photographic Interpretation
CAMBA	China Australia Migratory Bird Agreement
CBMP	Cessnock Biodiversity Management Plan
EEC	Endangered Ecological Community
GBMWA	Greater Blue Mountains World Heritage Area
GHM	Greater Hunter Native Vegetation Mapping
HPCAs	High Priority Conservational Areas
LHCCREMS	Lower Hunter and Central Coast Regional Environmental Management Strategy
JAMBA	Japan Australia Migratory Bird Agreement
KTP	Key Threatening Processes
LGA	Local Government Area
LHRCP	Lower Hunter Regional Conservational Plan
LHRS	Lower Hunter Regional Strategy
MNES	Matters of National Environmental Significance
OEH	The Office of Environment and Heritage
PCT	Plant Community Type
RCP	Regional Conservational Plan
ROKAMBA	Republic of Korea Australia Migratory Bird Agreement
RDP	Rapid Data Point survey
SEWPaC	The Commonwealth Department of Sustainability, Environment, Water, Population and Communities

Executive summary

As part of the Australian Government's sustainable population strategy, the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) is undertaking Sustainable Regional Development programs in high growth areas, including the Lower Hunter. The Lower Hunter region covers 429,741 ha and encompasses five Local Government Areas (LGAs) (Cessnock, Newcastle, Port Stephens, Lake Macquarie and Maitland), and is located within the broader Hunter Valley region, approximately 120 km north-west of Sydney, NSW. This is one of Australia's largest urban areas and a major centre of economic activity with high levels of growth and development expected in the region in the coming decades. The Sustainable Regional Development program aims to provide a comprehensive approach to planning and development in the region which in turn will ensure the region develops in a strong and sustainable way. Specifically, the program aims to protect Matters of National of Environmental Significance whilst helping to streamline environmental approvals and thus provide greater certainty for businesses, and state and local governments in development and investment in this high growth region.

Two key knowledge gaps for the Lower Hunter region were identified by local, state and commonwealth governments, namely data gaps in vegetation mapping of the Cessnock Local Government Area (LGA) and a consolidated single vegetation mapping product for the region. This mapping is needed to support the regional sustainability planning program in the Lower Hunter region and has been used in the mapping of Threatened Ecological Communities in the Lower Hunter region (Parsons Brinckerhoff 2013a) and priority conservation areas within the Greater Blue Mountains World Heritage Area of the Cessnock LGA (Parsons Brinckerhoff 2013b). This report aims to describe the distribution of native vegetation within the Lower Hunter region. The project refined vegetation mapping within identified areas of Cessnock LGA and provides a compilation of existing mapping projects in the region into a single mapping product where vegetation communities are aligned to Plant Community Types. This will aid in filling of knowledge gaps identified within the Cessnock LGA and the consolidation of vegetation information across the region.

The project also aimed to provide a suitable resource to support regional sustainability planning, particularly in regards to the preparation of a revised Lower Hunter Regional Strategy and Lower Hunter Regional Conservational Plan by the NSW Government (and the Strategic Assessment under the EPBC Act). The project also involved identifying Key Threatening Processes that are likely to impact biodiversity (such as land clearance, mining and introduced species) and provides mapping of vegetation communities present within the region to assist in identification of Commonwealth *Environment, Biodiversity and Conservation Act 1999* (EPBC Act) listed or nominated Endangered Ecological Communities and High Priority Conservation Areas.

Refinement of vegetation mapping within Cessnock LGA

One of the key data gaps identified through the Sustainable Regional Development Program is the need for revised vegetation mapping in Cessnock LGA. The Cessnock LGA is located within the broader Hunter Valley region, approximately 120 km north-west of Sydney, NSW and covers approximately 196,473 ha. Four main investigation areas within the Cessnock LGA were chosen for field investigations to refine existing mapping. These investigation areas were identified through literature review and consultation with the stakeholders and corresponded to those areas containing broad-scale vegetation mapping (Greater Hunter Native Vegetation Mapping and/or Lower Hunter and Central Coast Regional Environmental Management Strategy mapping only), limited vegetation survey field data and potential for future threats to conservation management in the form of development pressures and threatening processes.

The vegetation was initially assessed on the basis of a 'desk-top' review of existing vegetation data that was verified and refined in a field survey. The 'desk-top' study involved the review of aerial photography and existing vegetation mapping to create a Geodatabase which was taken into the field and verified using Rapid Data Points (RDPs). RDPs involved the collection of data to determine the dominant vegetation surrounding

each point, including vegetation structure, dominant species in canopy, shrub and ground layer, field-observed vegetation unit, GPS location and photographic record of vegetation community, groundcover and canopy cover. This data was used to verify and refine existing mapping. The raw data was aligned to existing vegetation community profiles within existing mapping projects of the study area.

A total of 239 RDP surveys were completed and the majority of vegetation within the key focus investigation areas was remapped, covering a total of 30,054 ha and equivalent to 15% of the entire LGA.

Vegetation mapping and assessment across the Lower Hunter region

Existing vegetation mapping projects within the region were reviewed and prioritised according to their resolution, detail and accuracy based on a desk-top review and stakeholder consultation. This prioritisation was used to determine priority of mapping when merging the mapping data layers into a single mapping product across the region. The compiled mapping was standardised by correlating each vegetation map unit to the draft Plant Community Type (PCT) being developed by the Office of Environment and Heritage. A total of 102 PCTs were mapped across the region.

High Priority Conservation Areas (HPCAs) within the region were identified based on the refined mapping of the Cessnock LGA, literature review and consultation with key stakeholders. The HPCAs identified within the Cessnock LGA predominantly consisted of remnant vegetation that had a large patch size, were connected to existing reserves, and occurred within wildlife corridors, contained habitat suitable for threatened biodiversity and/or Matters of National Environmental Significance. The vegetation identified within areas of high conservation value should be considered first when determining areas to concentrate conservation effort.

1. Introduction

1.1 Background

The Lower Hunter region, encompassing five local government areas (Newcastle, Lake Macquarie, Port Stephens, Maitland and Cessnock) is one of Australia's largest urban areas and a major centre of economic activity. Continued population growth and urban and industrial development in the region is expected and the NSW Government's 25 year land use strategy for the region includes:

- new urban areas for a projected population growth of 160,000 people
- new commercial and industrial land to cater for up to 66,000 new jobs
- creation, management and conservation of green corridors with high environmental value
- protection of high quality agricultural land, and natural resources such as water aquifers and extractive materials (Planning 2006).

As part of the Australian Government's sustainable population strategy the Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) is undertaking Sustainable Regional Development programs in high growth areas, including the Lower Hunter.

The Sustainable Regional Development program aims to provide a comprehensive approach to planning and development in the region which in turn will ensure the region develops in a strong and sustainable way. Specifically, the program aims to protect Matters of National Environmental Significance (MNES) whilst helping to streamline environmental approvals and thus provide greater certainty for businesses, and state and local governments in development and investment in this high growth region.

As part of the Sustainable Regional Development program for the Lower Hunter region, two key knowledge gaps were identified by local, state and commonwealth governments, namely data gaps in the vegetation mapping of the Cessnock Local Government Area (LGA) and a consolidated single mapping product for the region. This mapping is needed to support the regional sustainability planning program in the Lower Hunter region, in particular the ability to identify MNES.

1.2 Project aims

The purpose of this mapping project is to provide a suitable resource to support regional sustainability planning, particularly the preparation of a revised Lower Hunter Regional Strategy (LHRS) and Lower Hunter Regional Conservational Plan (LHRCP) by the NSW Government (and Strategic Assessment under EPBC Act). There are two main components to this project:

- to improve the accuracy of existing vegetation mapping products and to map the data gaps that have been identified in the Cessnock
- to review and compile existing mapping of the Lower Hunter region and provide a single consolidated vegetation mapping product for the region (Figure 1.1).

Refinement of vegetation mapping within Cessnock LGA is needed as this area is relatively depauperate of field validated vegetation mapping despite containing significant areas of high conservation value including the Greater Blue Mountains World Heritage Area (GBMWH). The refined mapping is required to support current and future conservation planning initiatives within the LGA, as well as the management and protection of conservation values contained within the GBMWH.

Specifically, the project aimed to:

- review and assess existing vegetation mapping products that currently describe the floristic composition, structure and distribution of vegetation communities within the region
- undertake Rapid Data Points (RDP) surveys to refine vegetation mapping within Cessnock LGA
- compile existing mapping of the Lower Hunter region, including the refined Cessnock LGA mapping
- provide a single consolidated vegetation mapping product for the region standardised to Plant Community Types (as defined by Office of Environment and Heritage (OEH))
- identify key threatening processes that have the potential to impact on vegetation, and threatened flora and fauna species (e.g. fire, weeds, mining and changes in hydrology)
- identify high priority conservation areas within the region.

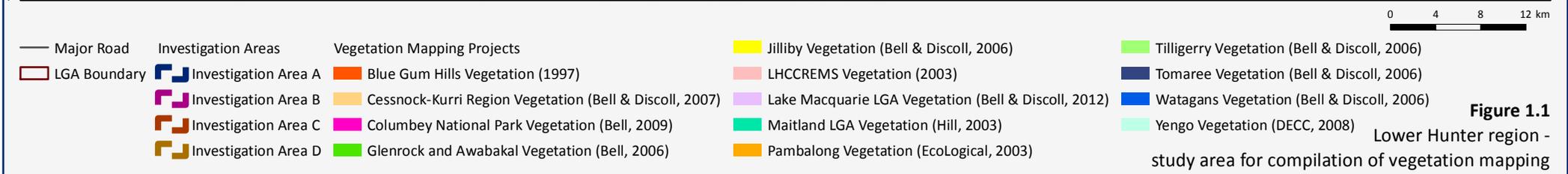
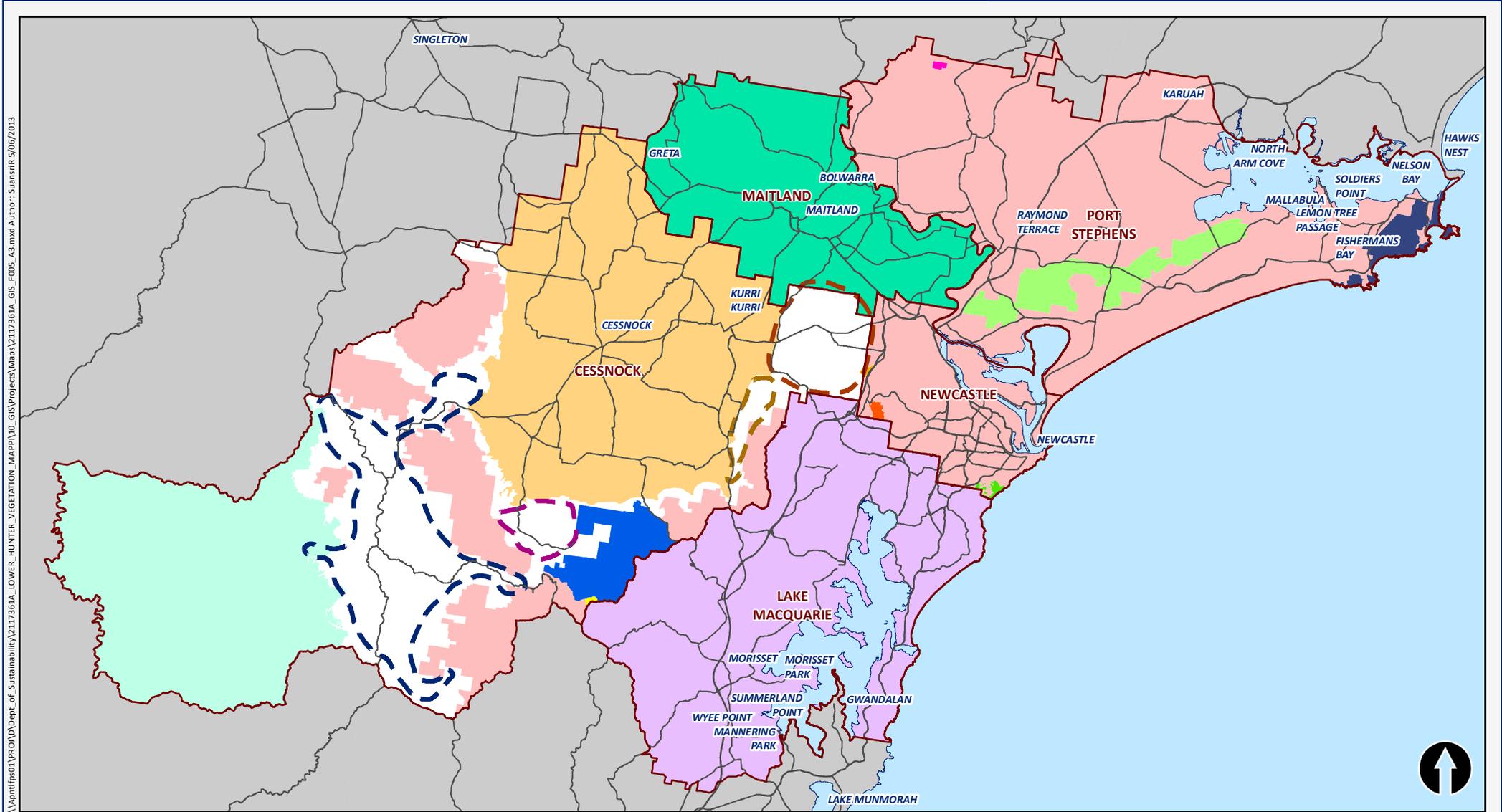


Figure 1.1
Lower Hunter region -
study area for compilation of vegetation mapping

2. Methods

The Lower Hunter vegetation mapping project included gathering data from external sources, 'desk-top' review of existing mapping data as well as field inspections and surveys (i.e. floristic plots/RDPs) of the Lower Hunter region to assess and verify data to refine existing vegetation mapping. This section outlines the specific methods used to survey and map the vegetation within the Lower Hunter region.

2.1 Personnel

The contributors to the preparation of this paper, their qualifications and roles are listed in Table 2.1.

Table 2.1 Study team

Name	Qualifications	Position and role
Alex Cockerill	BSc (Hons)	Project Director – report review, consultation, field survey
Selga Harrington	BSc (Hons)	Project Manager – report preparation
Allan Richardson	BEnvSc (Hons)	Botanist – field surveys, vegetation mapping
Paul Rossington	BSc, Dip WldMgt	Botanist – field surveys
Tanya Bangel	BSc (Hons)	Botanist – field surveys, report preparation
Sam Wilkins	Dip GIS	GIS team lead
Rob Suansri	BSc	GIS specialist
Emily Mitchell	BDevStud, Cert IV SIS	GIS specialist

All work was carried out under the appropriate licences, including scientific licences as required under Clause 22 of the *National Parks and Wildlife Regulations 2002*, Section 132C of the *National Parks and Wildlife Act 1974* (License Number: SL100630).

2.2 Desk-top review of existing data

A desk-top review was undertaken of the relevant vegetation mapping data (Section 3.1), acquired from federal, state and local government. The desk-top review of vegetation mapping data considered, currency resolution and scale of mapping for each of the vegetation mapping projects outlined in Table 2.2. Based on this review, the priority of vegetation mapping projects was determined for the merging of the mapping data layers into a single mapping product across the region.

Table 2.2 Existing vegetation mapping data reviewed

Mapping project	Reference
Vegetation Survey, Classification and Mapping Lower Hunter and Central Coast Region (LHCCREMS)	Lower Hunter and Central Coast Regional Environmental Management Strategy (2003)
Greater Hunter Native Vegetation Mapping (GHM)	Sivertsen <i>et al.</i> (2011)
Vegetation of the Cessnock-Kurri region, Cessnock LGA, New South Wales: Survey, Classification and Mapping	Bell S and Driscoll C (2007)
State Forests Mapping of NSW State Forest	NSW State Forests (undated)

Mapping project	Reference
The Native Vegetation of Yengo and Parr Reserves and Surrounds	Department of Environment & Climate Change (2008)
Vegetation of the Tomago and Tomaree Sandbeds, Port Stephens, New South Wales. Management of Groundwater Dependent Ecosystems.	Bell S and Driscoll C (2006b)
The Natural Vegetation of the Maitland LGA	Hill L (2003)
Vegetation Mapping of the Lake Macquarie LGA: Stages 1-3	Bell S and Driscoll C (2012)
Vegetation of Werakata, National Park, Hunter Valley, New South Wales	Bell S (2004)
Glenrock State Conservation Area and Awabakal Nature Reserve Vegetation Survey	Bell S (2006)
Vegetation mapping of Watagans National Park and Jilliby State Conservation Area	Bell S and Driscoll C (2006a)
Wollemi National Park Vegetation Survey (1998)	Bell S (1998)
Blue Gum Hills Vegetation	('Blue Gum Hills Vegetation' 1997)
Vegetation and floristics of Columbey National Park, lower Hunter Valley, New South Wales	Bell S (2009)
Yengo National Park and Parr State Conservation Area Vegetation Survey for use in fire management	Bell S <i>et al.</i> (1993)

2.3 Mapping refinement within Cessnock LGA

The refinement of existing vegetation mapping within the Cessnock LGA involved a number of steps that included an initial review of existing mapping projects, Aerial Photographic Interpretation (API), ground-truthing to verify existing mapped vegetation through Rapid Data Point Surveys (RDPs) and a final refinement of existing mapped vegetation polygons.

2.3.1 Aerial Photographic Interpretation

The vegetation community boundaries within Cessnock LGA were assessed using API prior to ground-truthing. The area was evaluated using ADS40 50 cm pixel resolution aerial imagery (LPI, October 2011). This aerial imagery was used to help redefine and then review compiled vegetation communities at a minimum scale of 1:25 000. This rationale for vegetation boundary realignment and assessment is consistent with other vegetation mapping projects done in the area, such as the Vegetation of the Cessnock-Kurri region, Cessnock LGA, New South Wales: Survey, Classification and Mapping (Bell S and Driscoll C, 2007) report.

Existing broad scale vegetation data was overlaid aerial photography to assist in the stratification of vegetation units. This base map was used to direct the field surveys, specifically in deciding where to undertake detailed surveys and focus survey effort. Analysis of aerial-photographs, existing broad scale mapping and field survey ground-truthing, land use disturbance and identified floristic variations (such as dominant species, vegetation structure, canopy cover and soil type) that were used to distinguish the boundaries of differing vegetation communities throughout the Cessnock LGA.

2.3.2 Field surveys

Site inspections were undertaken by four ecologists between 15 January and 17 February 2013 to conduct site specific investigations and refine vegetation mapping. The inspection and field surveys sought primarily

to provide ground-truthing of information provided by the desk-top review, particularly in relation to the following:

- verify accuracy of existing vegetation mapping
- refine existing vegetation mapping.

Four main investigation areas within the Cessnock LGA were focused upon. These investigation areas were developed through the literature review and consultation with the stakeholders and correspond to those areas containing relatively poor resolution broad-scale vegetation mapping (GHM and/or LHCCREMS mapping only), limited vegetation survey field data and potential for future threats to conservation management in the form of development pressures and threatened processes. Focusing on these areas will fill the gaps in knowledge and allow the biodiversity issues across the entire Cessnock LGA to be considered when identifying where best to focus conservation and recovery efforts. The four main investigation areas are illustrated in Figure 2.1.

2.3.3 Rapid Data Point survey

Field surveys of vegetation communities were based on Rapid Data Point (RDP) roadside surveys. RDP surveys are a quick short record of floristic information collected at specific points in the field. An example data sheet is provided in Appendix A. This is a variation on The Office of Environment and Heritage's (OEH) Native Vegetation Interim Type Standard (Sivertsen 2009) and has been used effectively on a number of vegetation mapping projects including the Hunter, Central and Lower North Coast Region of NSW (Hunter Central Coast Regional Environmental Management Strategy 2006), Vegetation Mapping of Lake Macquarie LGA (Bell S & Driscoll C 2012) and Cessnock-Kurri region (Bell S & Driscoll C 2007). This method provides an efficient alternative to traditional quadrat surveys and modelling methods, while still producing a vegetation map based on real on-ground data.

The RDP survey locations were focused in areas earmarked for development and with relatively low density of field survey sites in previous investigations, such as the GHM (Sivertsen *et al.* 2011) or LHCCREMS (Lower Hunter and Central Coast Regional Environmental Management Strategy 2003) mapping projects.

The objective of these RDP surveys is to summarise the dominant vegetation surrounding each point. They are not standardised plots (e.g. 20 m x 20 m) but are variable in size. This methodology allowed for a quick confirmation of vegetation community polygons and vegetation community boundaries as identified from existing vegetation mapping and aerial photographic interpretation.

Information collected at the RPDs included the following:

- canopy layer dominant species
- shrub layer dominant species
- ground layer dominant species
- draft (field-observed) vegetation unit
- GPS co-ordinate (GDA94)
- photographic record of vegetation community, groundcover and canopy cover.

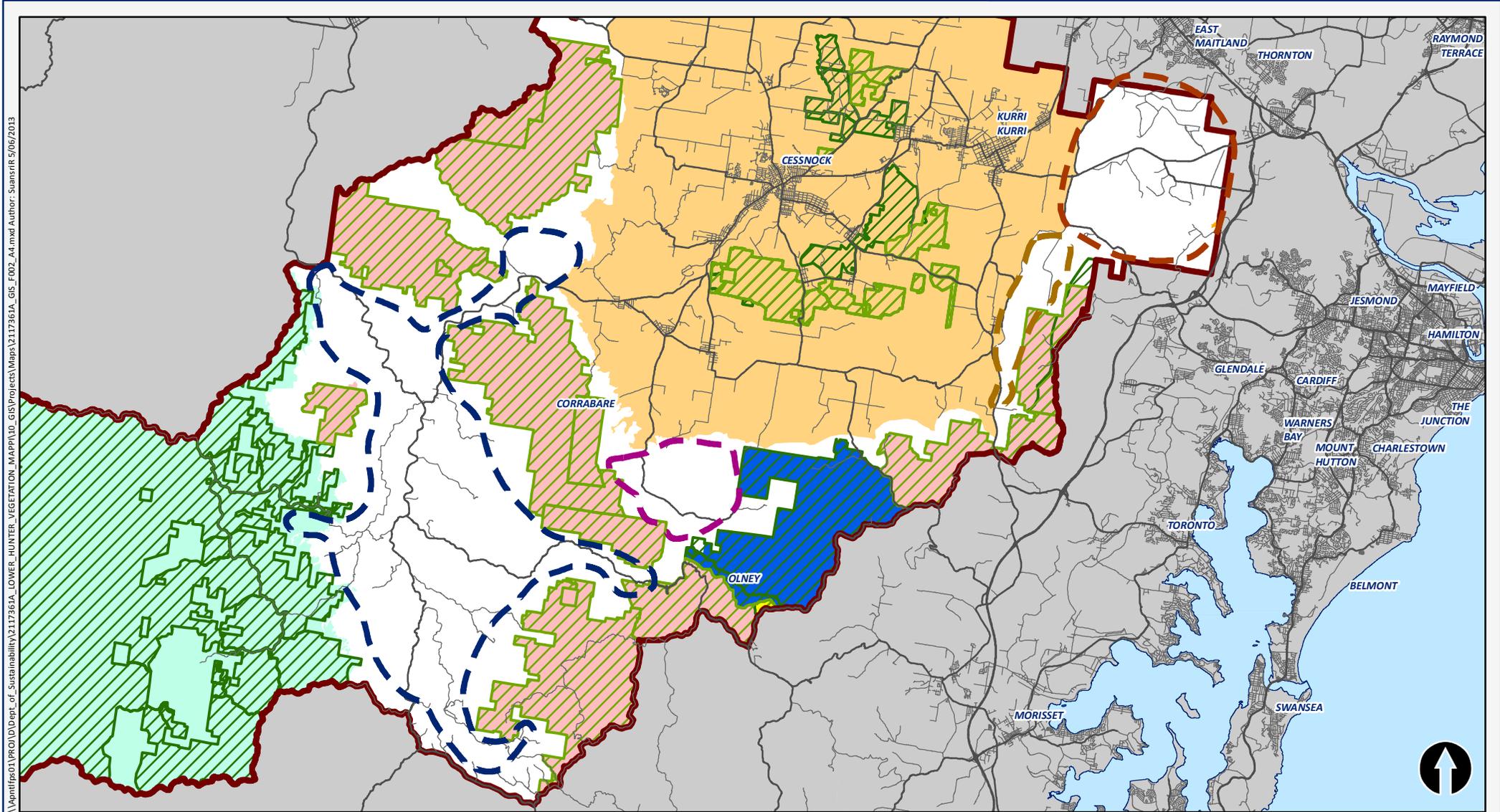


Figure 2.1
Investigation areas in Cessnock LGA for focus during field surveys

The survey effort is outlined in Table 2.3 and illustrated in Figure 2.1.

Table 2.3 Survey effort

Focus area	Area of vegetation (ha)	Date of survey	Survey effort (person hours)	RDP survey sites
A	19,920	15 January to 6 February 2013	60	153
B	2,383	12 February 2013	8	3
C	6301	17 to 23 January 2013	40	70
D	1450	16 to 23 January 2013	20	13
Total	30,054	15 January to 12 February	128	239

2.3.4 Vegetation communities within Cessnock LGA

The vegetation communities identified by the field survey were delineated by floristic composition, structure and soils and aligned to community profiles in existing vegetation mapping projects where possible.

The field survey aimed to align the refined vegetation mapping to vegetation communities identified by the GHM mapping project. Through the course of the field surveys 27% of the RDPs sampled reflected vegetation communities represented by the GHM vegetation mapping. The remaining data from the RDPs was aligned to alternative existing mapping with sufficient detail and resolution within, or bordering, the areas of interest. These included the Yengo National Park ([Department of Environment & Climate Change 2008](#)), Cessnock-Kurri region ([Department of Industry and Investment 2010](#)), and LHCCREMS ([Lower Hunter and Central Coast Regional Environmental Management Strategy 2003](#)) mapping products.

The vegetation community profiles, for the vegetation communities mapped within the Cessnock LGA, are not included in this report. The profiles are however, provided in the relevant existing mapping reports outlined in Table 2.2.

2.4 Consolidated vegetation mapping

A desk-top review was undertaken of available vegetation mapping data for the region (see Section 2.2 and 3.1). This review, prioritised the vegetation mapping projects for merging the mapping data layers into a single mapping product across the region (see Section 2.3). This map was based on the preliminary vegetation map produced through data collation and the refined vegetation mapping within Cessnock LGA. The scale of vegetation mapping varies across the region depending on the scale of the source mapping data. The scale is at a minimum of 1:100,000 with refined vegetation mapping provided at a minimum of 1:25,000.

Once compiled, the vegetation communities were aligned to draft Plant Community Types being developed by the OEHL to provide a single standardised list of communities across the region.

2.5 High Priority Conservation Areas

High priority conservation areas within the region were modelled and mapped based on a range of parameters including patch size, threatened biodiversity and connectivity. Weightings were applied to each parameter to ensure the most important parameters were modelled as higher priority in the mapping process (Table 2.4). An Analytical Hierarchy Process was adopted to rank and weight each parameter used in the model. The parameter was assigned individual values (e.g. 1 to 3) where sub criteria needed to be considered or a true-false (0 or 1) classification. Following the ranking process each criteria was assigned a

multiplier value dependant on its relative importance in the model. The aggregate score was the combined sum of the different criteria values. The criteria scores and associated weightings are provided in Table 2.4.

Other areas of high conservation priority were identified in existing conservation plans for the region and through the expert workshop and consultation with key stakeholders (see Section 2.4).

Table 2.4 Parameters and weighting used for High Priority Conservation Areas mapping

Parameter	Description	Weighting	Approach
EPBC-listed or nominated Threatened Ecological Communities	A number of vegetation types are listed or nominated at the Commonwealth level as being threatened. .	1	Vegetation was scored as 10 (Listed), 7 (Nominated) or 5 (Further investigation required). Rationale for not using a 3 to 1 range was to not over-inflate the importance the EPBC listing in relation to the other criteria. Where overlaps occurred higher sensitivity areas took precedence.
Connectivity specifically to nature reserves	Direct connectivity of native vegetation to existing nature reserves is considered to be an important factor in determining lands that may be priority areas.	7	Extent of vegetated area in relation to nature reserves was assessed. Only vegetation patches that were overlapping or adjoining were defined as being connected. These patches were scored as 1 (true) or 0 (false)
Threatened flora habitat value	The occurrence of threatened flora and related habitat is considered of high importance.	7	The NSW Atlas of Wildlife Database records and any SEWPAC ERIN datasets were used to identify patches that are known to contain threatened flora under the TSC and EPBC Acts. This was modelled and scored as patches either containing threatened flora or not containing threatened flora. A recognised limitation of this method is the intensity of surveys being skewed towards populated areas. These patches were scored as 1 (true) or 0 (false)
Threatened fauna habitat value	The occurrence of threatened fauna and related habitat is considered of high importance.	7	The NSW Atlas of Wildlife Database records and any SEWPAC ERIN datasets were used to identify patches that are known to contain threatened fauna under the TSC and EPBC Acts. This would be modelled and scored as patches either containing threatened fauna or not containing threatened fauna. A recognised limitation of this method is the intensity of surveys being skewed towards populated areas. These patches were scored as 1 (true) or 0 (false)
Patch size	Patch size is a consideration when considering integrity of native vegetation within each patch. Generally, the greater the patch size, the greater the integrity or condition. Vegetation integrity reflects general biodiversity values of patches.	5	Patch sizes were categorised as over 500 ha (3), 100–500 ha (2) or <100 ha (1).

Parameter	Description	Weighting	Approach
Habitat Connectivity	Habitat connectivity is considered to be important for native flora and fauna and genetic exchange.	5	<p>The following corridor mapping was used for determining habitat connectivity:</p> <ul style="list-style-type: none"> ■ OEH regional north coast key corridors ■ Lower Hunter Regional Strategy green corridor ■ Cessnock Biodiversity Management plan "Landscape Conservation Corridors". <p>Using spatial analysis the area of habitat corridor for each overlapping TEC area was determined. A coverage percentage was calculated and any TEC area that was covered by a percentage 50% or more was scored as 1 (true). All other areas were scored as 0 (false)</p>

2.6 GIS

2.6.1 Preliminary work

The vegetation mapping process was completed by our GIS team in conjunction with the ecologists and their field findings. All the GIS data is standardised and attributed with metadata to ensure quality and to assist in the vegetation mapping of the Cessnock LGA.

A centralised GIS database (Geodatabase) was developed and used to store all relevant GIS data including vegetation mapping, layers created for the gap analysis, aerial photography and other relevant topographic information

2.6.2 Field work assistance

Data within the geodatabase was loaded onto mobile tablets prior to field work, ensuring that field staff had the most up-to-date information available when assessing survey information. GPS-enabled tablets were used to capture field data with information such as vegetation communities and their associated floristic characteristics and survey locations compiled as spatial data for reference. Following the completion of the field work, data from the tablet was checked for errors and loaded into the central GIS database. This data captured from the field was integrated into a consolidated dataset made up of existing vegetation data, and this data was adjusted to fit in with the pre-existing vegetation extents.

2.6.3 Data compilation

The process of refining the vegetation data from the field was completed by exporting the RDP locations, RDP data and vegetation mark ups from the tablet. This data was then supplied to the ecologists with the existing vegetation datasets to make decision as to how communities should be classified and if any re-digitising of extents were required. This information from the ecologists was then used by the GIS team and integrated with the base vegetation layer, aligned to reflect the current aerial imagery. Topology and data consistency checks were then completed and maintained and a singular vegetation layer was produced as required by the project brief.

The compiled mapping of the Lower Hunter region was standardised by correlating each vegetation map unit to the draft Plant Community Type (PCT) being developed by the OEH.

The completed GIS database is provided with this report.

2.6.4 GIS tasks

The GIS team completed the following:

- overlaid existing broad scale vegetation data over aerial photographs to assist in the stratification of vegetation units
- loaded all the field GPS data collected to guide vegetation community boundaries
- assigned attribute data to existing polygons
- conducted a gap analysis to identify missing data and ensure no polygon overlap occurs
- conducted spatial analysis to calculate areas of vegetation communities
- checked and maintained Geodatabase topology to assure data is consistent and functional
- produced GIS maps.

2.7 Stakeholder consultation

A stakeholder meeting was held on 22 January 2013 between key members of the Parsons Brinckerhoff project team (Alex Cockerill, Selga Harrington, Sam Wilkin and Toby Lambert) and staff from the OEH, HCREMMS, Cessnock City Council and other Lower Hunter council officers (from Lake Macquarie, Maitland, Newcastle and Port Stephens). This stakeholder consultation sought to ensure that the project outputs were appropriate and to gather relevant data and information to refine the survey methodology.

An expert workshop was run on the 22 April by Selga Harrington and Alex Cockerill. Attendees included from SEWPaC Regional Sustainability Planning, SEWPaC Environmental Resources Information Network, SEWPaC Ecological Communities, the NSW Office of Environment and Heritage (OEH), Lake Macquarie City Council, Newcastle City Council, the Hunter Central Coast Regional Environment Management Strategy team (HCCREMS) and Stephen Bell (Eastcoast Flora Survey). Other key stakeholders unable to attend were invited to provide comments and input. Outcomes of the expert workshop included:

- identification of additional areas of high conservation priority
- identification and prioritisation of Key Threatening Processes relevant to the Lower Hunter Region.

Additional stakeholder engagement has occurred between relevant Council, OEH, SEWPaC staff and Stephen Bell throughout the project to ensure that the project outputs are fit for purpose.

2.8 Limitations

2.8.1 Reliance on externally supplied data

In preparing this study, Parsons Brinckerhoff has relied upon data, surveys, analyses, plans and other information provided by the client. Except as otherwise stated in the study, Parsons Brinckerhoff has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this study (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Parsons Brinckerhoff will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Parsons Brinckerhoff.

This study did not include analysis of quadrat data using PATN software to identify similarities between vegetation communities within the study area. The vegetation communities were determined using the data collected from RDPs. This involved using the dominant species of each community and aligning them to existing vegetation community profiles from existing mapping projects (such as Bell, LHCCREMS).

The vegetation community profiles, for the vegetation communities mapped within the Cessnock LGA, are not included in this report. The profiles are however, provided in the relevant existing mapping reports outlined in Table 2.2.

The existing mapping projects were reviewed and prioritised according to their resolution, currency, detail and accuracy. As a result of the desk-top review and data not being available for some projects, not all existing vegetation mapping projects available for the Lower Hunter region were used in this study.

This vegetation mapping is based on existing mapping projects and as such is largely limited to woody vegetation. With the exception of saltmarsh vegetation, in general this mapping does not include non-woody vegetation such as natural or derived grasslands.

2.8.2 Additional mapping projects not included in source data

A number of additional mapping projects from the region were identified and provided to Parsons Brinckerhoff at a late stage in the project. It is recommended these additional data sources be included in future revision and their absence is considered a limitation of the project. The mapping projects include (not but limited to):

- Commonwealth lands Department of Defence mapping for Salt Ash Air Weapons Range and Singleton Army Base.
- Vegetation mapping of Lake Macquarie LGA: Stages 5, Eastcoast Flora Survey April 2013.
- Vegetation of the Worimi Conservation Lands Port Stephens, New South Wales: Worimi NP, Worimi SCA & Worimi RP Eastcoast Flora Survey November 2010.
- Vegetation and floristics of Columbey National Park, lower Hunter Valley, New South Wales Update with Duns Creek addition, Eastcoast Flora Survey June 2010.

2.8.3 Field survey limitations

Survey was restricted to publically accessible land, predominantly within the within the focus investigation areas. No private properties were accessed during the survey. Refinement of vegetation mapping was restricted to the vicinity of RDP locations and areas visible from public roads.

A few RDP survey points were undertaken nearby but outside the investigation areas and outside the Cessnock LGA where public access within the study area was limited and the vegetation communities were equivalent.

As a result of limited access, the vegetation communities within these areas were extrapolated using RDP survey data in nearby similar vegetation, assessed from a distance and desk-top review of aerial photography and existing vegetation projects. Based on this information the vegetation polygons were redrawn in the field using GPS-enabled tablets.

2.8.4 GIS limitations

Not all existing vegetation datasets will join precisely with bordering datasets when integrated into a master vegetation layer. This is a result of the methods used to originally capture the existing vegetation. Specifically, differing sources, scales, aerial photography and the individual identification of existing vegetation communities by the original compilers will all contribute to variations in vegetation dataset boundaries. The time required to rectify the joins between datasets is an extensive process. This process is out of the project's scope for a large portion of the data where we have not specified gaps.

Due to the complexity of the attributes stored within each dataset, it would be unwise to retain all stored attribute data for each existing vegetation dataset, as certain information is only relevant to certain features and not for others. In order to give a detailed description of the data common information across the datasets was retained where feasible. However, updating information to certain features (to maintain consistency) is a complex and assumed process that was not scoped at the start of the project.

3. Vegetation mapping

3.1 Review of existing mapping

Existing vegetation mapping projects within the region were reviewed and prioritised according to their resolution and correlation to vegetation recorded within the study area (Table 3.1). The review prioritised the more detailed local government vegetation mapping and mapping of conservation reserves over the broadscale vegetation mapping within the region. In this way, the more detailed information and mapping was captured. The local, detailed vegetation mapping projects focussed either on LGAs or on conservation reserves and as such, there were few overlaps in these projects.

In addition to determining the priority of vegetation mapping projects during the consolidation of mapping, this prioritisation was used to assign existing vegetation community profiles to the vegetation recorded during the field investigation. Based on this prioritisation, vegetation communities identified in the field were firstly aligned to the Cessnock-Kurri region vegetation community profiles (Bell & Driscoll 2007) if possible. However, if the vegetation community did not correlate to the Cessnock-Kurri region vegetation profiles, the community was then aligned to the next highest priority mapping project (as outlined in Table 3.1). The highest priority mapping projects provide localised vegetation mapping with detailed vegetation profiles of vegetation communities that are often locally restricted. As such, following the prioritisation process, the field identified vegetation communities often did not match these profiles well and were better aligned to the more broadscale LHCCREMS mapping.

Table 3.1 Review of existing vegetation mapping in the Lower Hunter region

Priority	Mapping project	Reference	Year produced	Area of region covered (Ha)	Proportion of Lower Hunter region covered (%)	Comments
Local vegetation mapping projects						
1	Vegetation of the Cessnock-Kurri region, Cessnock LGA, New South Wales: Survey, Classification and Mapping	Bell S and Driscoll C (2007)	2007	21,000	4.89%	These mapping projects do not overlap and provide the most detailed and accurate mapping of these areas.
	Vegetation Mapping of the Lake Macquarie LGA: Stages 1-3	Bell S and Driscoll C (2012)	2012	54,838	12.76%	
	The Natural Vegetation of the Maitland LGA (2003)	Hill L (2003)	2003	8,304	1.93%	
Conservation reserves mapping						
2	The Native Vegetation of Yengo and Parr Reserves and Surrounds	Department of Environment & Climate Change (2008)	2008	46,613	10.85%	These vegetation mapping projects provide high resolution, detailed mapping of discrete conservation areas and were used where they did not overlap with mapping listed above.
	Blue gum hills Vegetation	('Blue Gum Hills Vegetation' 1997)	1997	161	0.04%	
	Tomago and Tomaree Sandbeds, Port Stephens – Management of Groundwater – Dependant Ecosystems Parts 1 & 2.	Bell S and Driscoll C (2006b)	2006	6,019	1.40%	
	Vegetation Mapping of Watagans National Park and Jilliby State Conservation Area	Bell S and Driscoll C (2006a)	2006	7,649	1.78%	
	Glenrock SRA and Awabakal NR Vegetation Survey	Bell S (2006)	2006	950	0.22%	

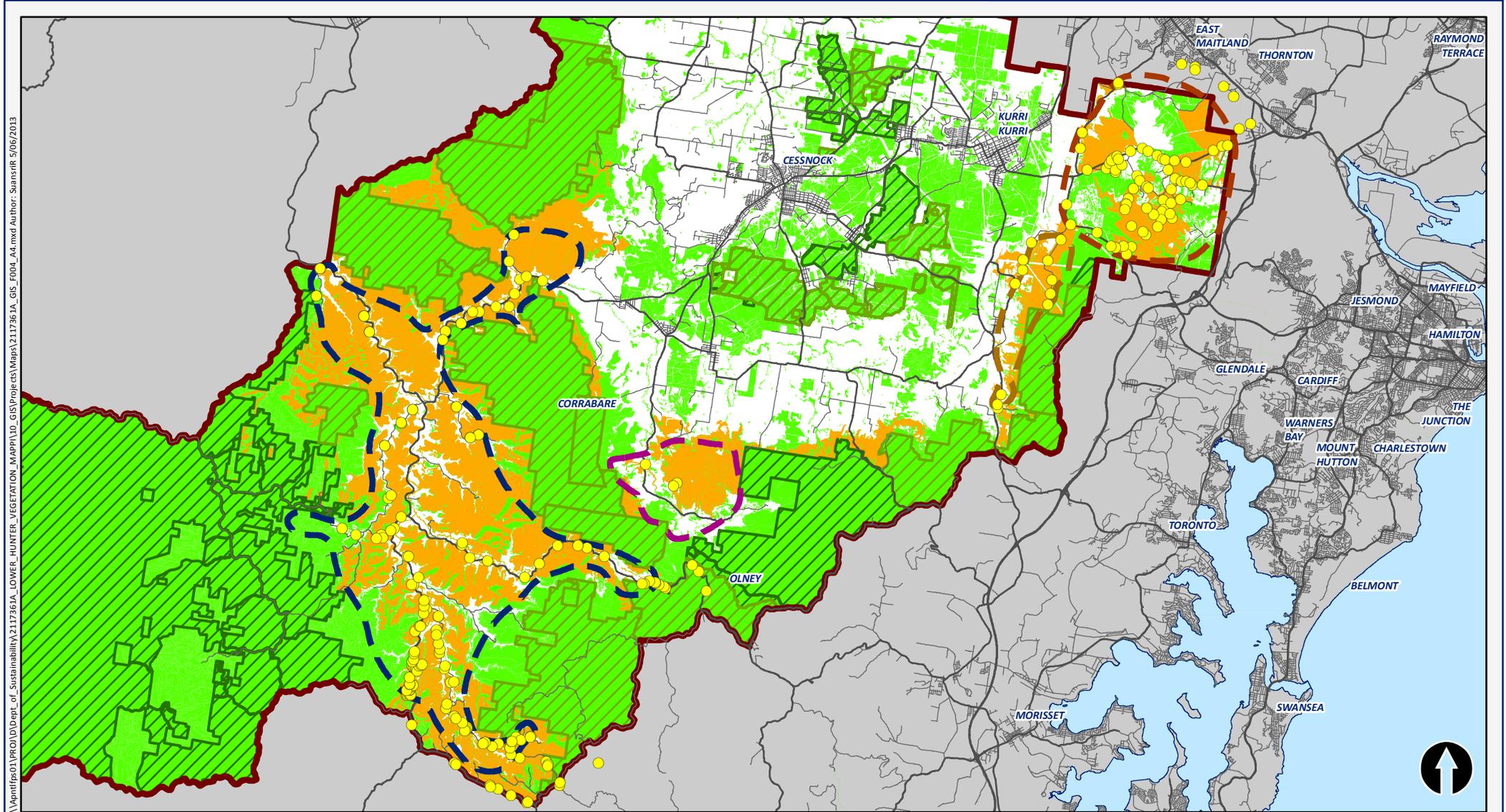
Priority	Mapping project	Reference	Year produced	Area of region covered (Ha)	Proportion of Lower Hunter region covered (%)	Comments
	Vegetation and floristics of Columbey National Park, lower Hunter Valley New South Wales	Bell S (2009)	2009	810	0.02%	
	Pambalong Nature Reserve	(Ecological Australia 2003)	2003	34	<0.01%	
Broadscale vegetation mapping						
3	Vegetation Survey, Classification and Mapping Lower Hunter and Central Coast Region (LHCCREMS)	Lower Hunter and Central Coast Regional Environmental Management Strategy (2003)	2003	264,404	61.53%	The vegetation mapping is broadscale and was used next in the areas outside aforementioned mapping projects.
4	Greater Hunter Native Vegetation Mapping (GHM)	Sivertsen et al. (2011)	2011	429,519	99.95%	Based on field surveys within the Cessnock LGA, this vegetation mapping was found to be less accurate and detailed than the above mapping projects. This vegetation mapping project was used only where the aforementioned projects do not occur.
5	State Forests Mapping of NSW State Forest	NSW State Forests (undated)	undated	58,867	13.70%	The vegetation mapping was the lowest priority as the vegetation mapping was of similar detail to broadscale mapping projects such as LHCCREMS but lacked the detail and refinement in vegetation profiles.

3.2 Refined vegetation map for Cessnock LGA

The field survey has refined and remapped approximately 30,054 ha of vegetation within Cessnock LGA, primarily within the focus areas (Figure 3.1). An updated vegetation map for Cessnock LGA was produced using this field-refined vegetation mapping and collation of existing vegetation mapping projects. Based on this consolidated vegetation map, a total of 145 communities were identified within Cessnock LGA (Appendix B). The vegetation community profiles, for the vegetation communities mapped within the Cessnock LGA, are not included in this report. The profiles are however, provided in the relevant existing mapping reports outlined in Appendix B.

3.3 Vegetation map for Lower Hunter region

The prioritisation of vegetation mapping resulted in the consolidation of fourteen separate projects across the Lower Hunter (Figure 3.2). Vegetation communities were aligned to draft Plant Community Types being developed by the OEH to provide a single standardised list of communities across the region. A total of 352 vegetation communities were mapped within the Lower Hunter region, these were then aligned to 102 PCTs (Table 3.2 and Figure 3.3).



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- | | | |
|-------------------------|----------------------|--|
| — Major Road | Investigation Areas | Existing Vegetation Mapping |
| — Minor Road | Investigation Area A | Refined Vegetation Mapping |
| ▬ Cessnock LGA Boundary | Investigation Area B | ● Rapid Data Point (RDP) Survey Location |
| ▨ State Forest | Investigation Area C | |
| ▨ NPWS Estate | Investigation Area D | |

0 4 8 12 km

Figure 3.1
Vegetation mapping
for Cessnock LGA

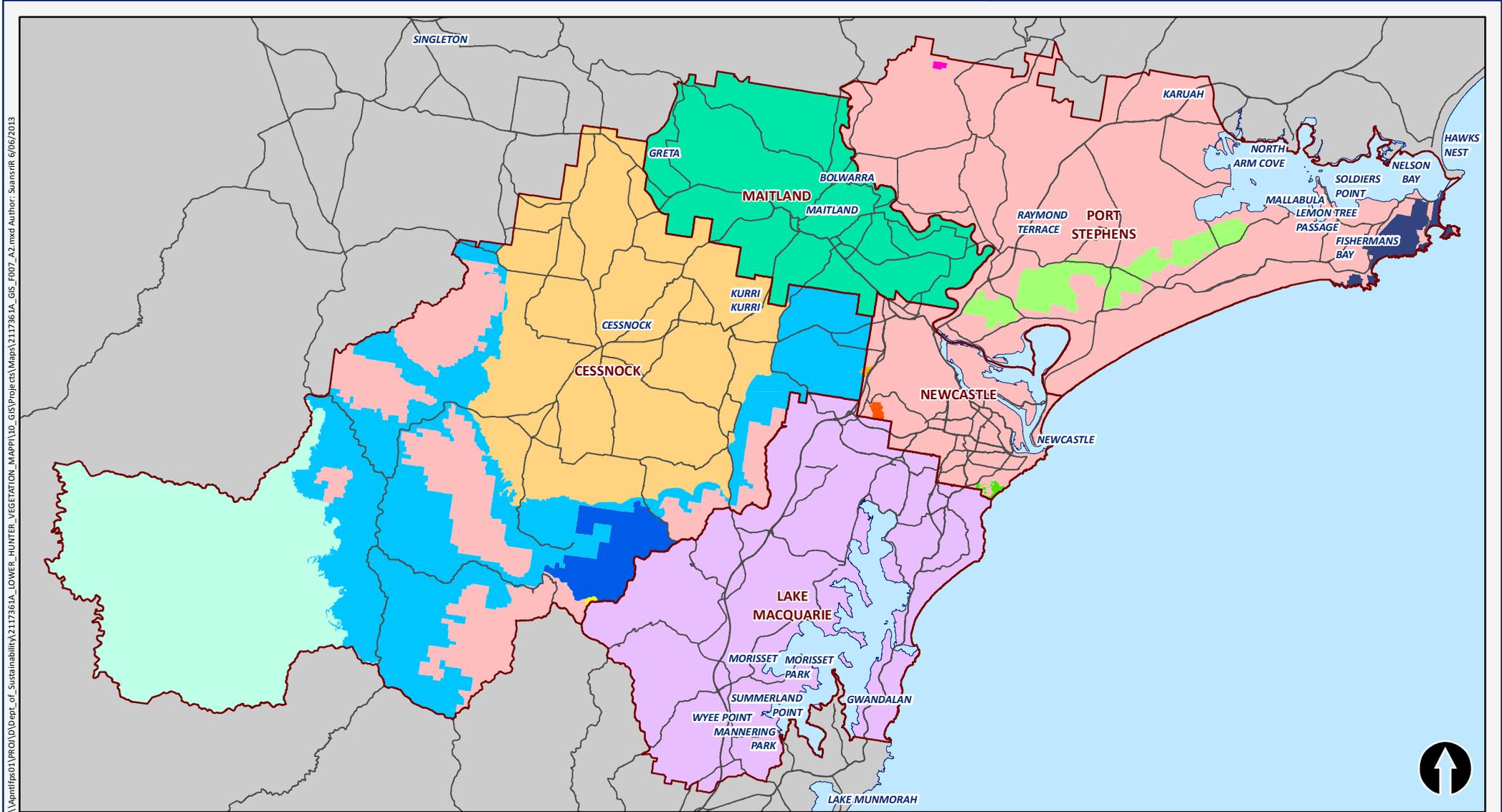
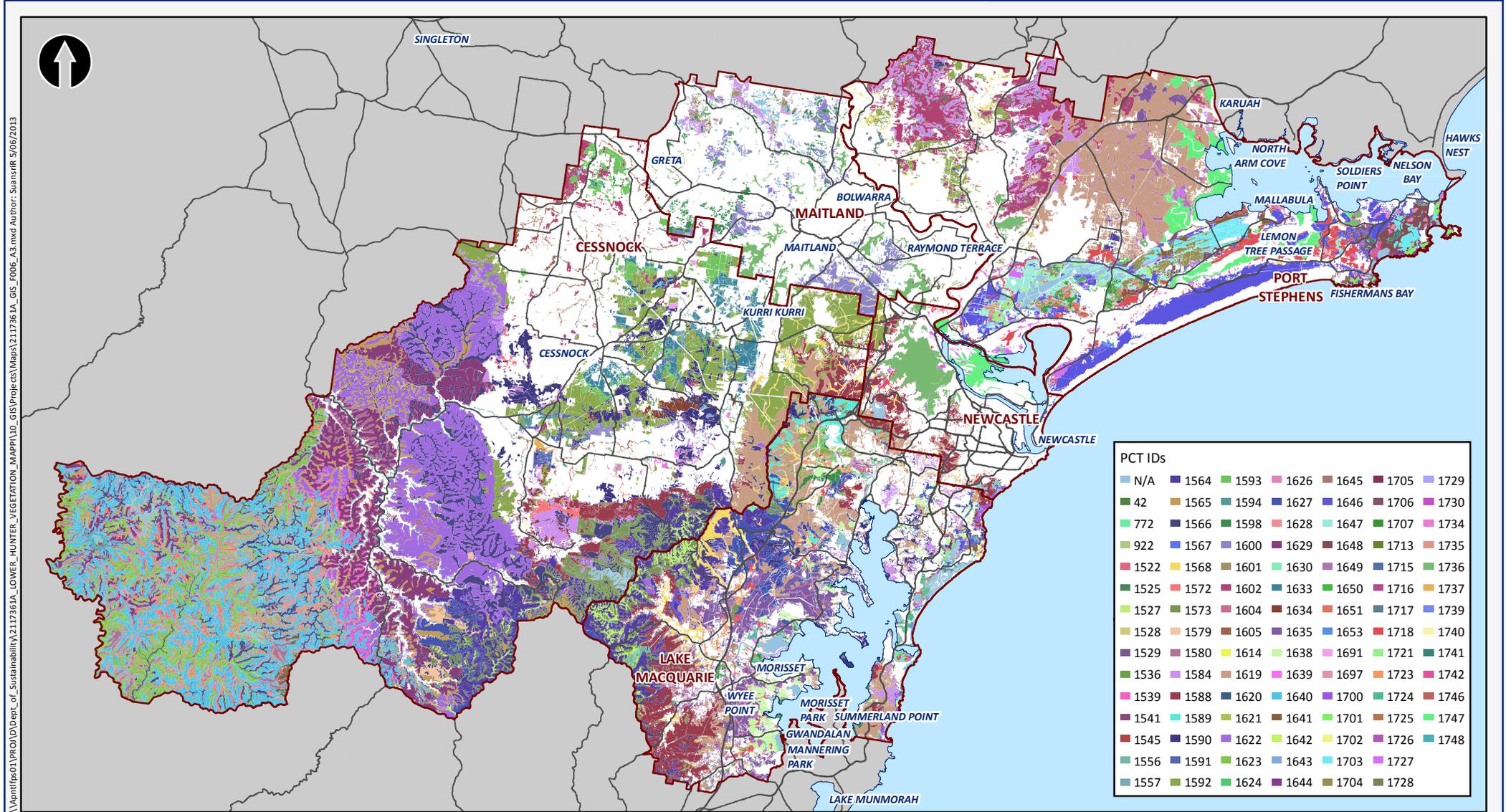


Figure 3.2
Vegetation mapping compilation



— LGA Boundary

— Major Road

0 4 8 12 km

Figure 3.3
Vegetation map for Lower Hunter region

Table 3.2 Plant Community Types in Lower Hunter Region

Plant Community Type (PCT)	PCT name	Area (ha)
42	River Red Gum / River Oak riparian woodland wetland in the Hunter Valley	52.61
772	Coast Banksia - Coast Wattle dune scrub of the Sydney Basin Bioregion and South East Corner Bioregion	15.44
922	Melaleuca decora low forest of the central Hunter Valley, Sydney Basin Bioregion	4.17
1522	Lilly Pilly - Sandpaper Fig - Prickly-leaved Tea Tree warm temperate rainforest of the Central Coast and lower Hunter Valley	53.83
1525	Sandpaper Fig - Whalebone Tree warm temperate rainforest	999.57
1527	Bangalow Palm - Coachwood - Sassafras gully warm temperate rainforest of the Central Coast	1253.33
1528	Jackwood - Lilly Pilly - Sassafras riparian warm temperate rainforest of the Central Coast.	7.12
1529	Lilly Pilly - Coachwood gully warm temperate rainforest on sandstone ranges of the Sydney Basin	82.25
1536	Tuckeroo - Lilly Pilly - Coast Banksia littoral rainforest	12.63
1539	Grey Myrtle sheltered gully dry rainforest in gullies of the Sydney Basin	2397.44
1541	Whalebone Tree - Red Kamala dry subtropical rainforest of the lower Hunter River	62.84
1545	Giant Stinging Tree - Sandpaper Fig dry subtropical rainforest at Mt Yengo	35.45
1556	Tallowwood - Smooth-barked Apple - Blackbutt grass tall open forest of the Central and lower North Coast	147.40
1557	Rough-barked Apple - Forest Oak - Grey Gum grassy woodland on sandstone ranges of the Sydney Basin	602.16
1564	Blackbutt - Rough-barked Apple - Turpentine - ferny tall open forest of the Central Coast	7156.86
1565	Turpentine - Rough-barked Apple - Forest Oak moist shrubby tall open forest of the Central Coast	4653.79
1566	White Mahogany - Turpentine moist shrubby tall open forest	14857.67
1567	Tallowwood - Brush Box - Sydney Blue Gum moist shrubby tall open forest on foothills of the lower North Coast	3.11
1568	Blackbutt - Turpentine - Sydney Blue Gum mesic tall open forest on ranges of the Central Coast	2979.05
1572	Grey Myrtle - Mountain Blue Gum - Rough-barked Apple ferny tall open forest in sandstone gullies of the Sydney Basin	3591.32

Plant Community Type (PCT)	PCT name	Area (ha)
1573	Sydney Blue Gum - Lilly Pilly mesic tall open forest of coastal ranges and tablelands escarpment	6771.19
1579	Smooth-barked Apple - Turpentine - Blackbutt open forest on ranges of the Central Coast	893.79
1580	Turpentine - Rough-barked Apple - Mountain Blue Gum shrubby open forest on ranges of the Sydney Basin	4305.22
1584	White Mahogany - Spotted Gum - Grey Myrtle semi-mesic shrubby open forest of the central and lower Hunter Valley	6548.50
1588	Grey Ironbark - Broad-leaved Mahogany - Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast	11277.06
1589	Spotted Gum - Broad-leaved Mahogany - Grey Gum grass - shrub open forest on Coastal Lowlands of the Central Coast	1238.16
1590	Spotted Gum - Broad-leaved Mahogany - Red Ironbark shrubby open forest	5931.67
1591	Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter	787.48
1592	Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	14834.34
1593	Red Ironbark - Spotted Gum - Prickly-leaved Paperbark shrubby open forest of the Lower Hunter	2219.53
1594	Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	911.09
1598	Forest Red Gum grassy open forest on floodplains of the lower Hunter	2073.15
1600	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	3195.51
1601	Spotted Gum - Narrow-leaved Ironbark-Red Ironbark shrub - grass open forest of the central and lower Hunter	804.11
1602	Spotted Gum - Narrow-leaved Ironbark shrub - grass open forest of the central and lower Hunter	7836.65
1604	Narrow-leaved Ironbark - Grey Box - Spotted Gum shrub - grass open forest of the central and lower Hunter	62.66
1605	Narrow-leaved Ironbark - Native Olive shrubby open forest of the central and upper Hunter	823.42
1614	Grey Gum - Grey Myrtle - Narrow-leaved Stringybark - Rusty Fig open forest on ranges of the Upper Hunter	0.24
1619	Smooth-barked Apple - Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands	26079.58
1620	Grey Ironbark - Broad-leaved Mahogany - Smooth-barked Apple coastal headland low open forest of the Central Coast	30.30
1621	Smooth-barked Apple open forest on coastal lowlands of the Central Coast	11.43

Plant Community Type (PCT)	PCT name	Area (ha)
1622	Grey Gum - Smooth-barked Apple - Blue-leaved Stringybark shrub - grass open forest on coastal ranges of the Sydney Basin	18599.16
1623	Narrow-leaved Ironbark - Yellow bloodwood - Rough-barked Apple shrubby open forest on sandstone ranges of the Sydney Basin	10172.21
1624	Smooth-barked Apple - Swamp Mahogany - Red Mahogany - Cabbage Palm open forest on lowlands of the Central Coast	140.02
1626	Smooth-barked Apple - Broad-leaved Mahogany - Red Bloodwood heathy low open forest on hills at Nelson Bay	214.17
1627	Smooth-barked Apple - Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast	4911.95
1628	Turpentine - Smooth-barked Apple - Broad-leaved Mahogany shrubby open forest on sandstone ranges of the Central Coast	1691.89
1629	Narrow-leaved Stringybark - Grey Gum shrubby open forest on sandstone ranges of the Sydney Basin	12809.29
1630	Sydney Peppermint - Grey Gum heathy open forest on sandstone ranges of the Sydney Basin	13.49
1633	Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	2763.36
1634	Yellow Bloodwood - Red Bloodwood - Brown Stringybark shrub - grass open forest in the Cessnock-Kurri Kurri area	561.14
1635	Narrow-leaved Apple - Parramatta Red Gum - Persoonia oblongata heathy woodland of the Howes Valley area	5039.44
1638	Smooth-barked Apple - Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast	1852.46
1639	Scribbly Gum - Sydney Peppermint - Smooth-barked Apple heathy woodland on residual sands of the Quorrobolong area	92.34
1640	Yellow Bloodwood - Narrow-leaved Apple heathy woodland on sandstone ranges of the Sydney Basin	18795.24
1641	Dwarf Apple - Scribbly Gum heathy low woodland on sandstone ranges of the Central Coast	953.38
1642	Scribbly Gum - Red Bloodwood - Old Man Banksia heathy woodland of southern Central Coast	201.81
1643	Red Bloodwood - Smooth-barked Apple - Scribbly Gum - Old Man Banksia heathy woodland on sandstone ranges of the Central Coast	63.59
1644	Coast Tea Tree - Old Man Banksia coastal shrubland on foredunes of the Central and lower North Coast	308.31
1645	Old Man Banksia - Rough-barked Apple - Bangalay shrubby open forest on coastal sands of the Central Coast	9.22
1646	Smooth-barked Apple - Blackbutt - Old Man Banksia woodland on coastal sands of the Central and Lower North Coast	7215.85
1647	Red Bloodwood - Smooth-barked Apple heathy woodland on coastal sands of the Central and lower North Coast	1602.38

Plant Community Type (PCT)	PCT name	Area (ha)
1648	Smooth-barked Apple - Blackbutt heathy open forest of the Tomaree Peninsula	905.16
1649	Smooth-barked Apple - Red Mahogany - Swamp Mahogany - Melaleuca sieberi heathy swamp woodland of coastal lowlands	2307.18
1650	Parramatta Red Gum - Rough-barked Apple - Swamp Mahogany - Paperbarks swamp forest on lowlands of the Central Coast	270.97
1651	Parramatta red gum - Fern-leaved banksia - Melaleuca sieberi swamp woodland of the Tomaree Peninsula	230.43
1653	Coast Tea Tree - Coast Banksia - Ficinia nodosa low open shrubland on coastal foredunes	158.58
1691	Narrow-leaved Ironbark - Grey Box grassy woodland of the central and upper Hunter	287.28
1697	Kangaroo Grass - Coastal Rosemary grassland on coastal headlands	31.42
1700	Dwarf Casuarina - Prickly-leaved Paperbark - Hairpin Banksia Coastal Heath of the Central Coast and lower North Coast	297.59
1701	Prickly-leaved Paperbark - Fern-leaved Banksia heath on coastal headlands of Central Coast	268.06
1702	Dwarf Casuarina - Wallum Banksia heath on coastal headlands of Central Coast	169.08
1703	Wallum Banksia-Monotoca scoparia heath on coastal sands of the Central Coast and lower North Coast	1443.00
1704	Fern-leaf Banksia - Prickly-leaved Paperbark-Tantoon - Leptocarpus tenax wet heath on coastal sands of the Central Coast and lower North Coast	796.07
1705	Heath-leaved Banksia-Olive Tea-tree-Wallum Boronia wet heath on coastal sands of lower North Coast	65.14
1706	Leptospermum liversidgei-Callistemon citrinus-Xanthorrhoea fulva wet heath on coastal sands of lower North Coast	534.51
1707	Banksia oblongifolia-Hakea teretifolia-Leptocarpus tenax-Lepyrodia scariosa wet heath on sandstone ranges of the Central Coast	444.64
1713	River Oak - Sandpaper Fig riparian forest of the Upper Hunter and Liverpool Ranges	87.00
1715	Prickly-leaved Paperbark - Flax-leaved Paperbark swamp forest on poorly drained soils of the Central Coast	71.13
1716	Prickly-leaved Paperbark forest on coastal lowlands of the Central Coast and Lower North Coast	90.69
1717	Broad-leaved Paperbark - Swamp Mahogany - Swamp Oak - Saw Sedge swamp forest of the Central Coast and Lower North Coast	253.46
1718	Swamp Mahogany - Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast	3689.09
1721	Swamp Mahogany - Broad-leaved Paperbark - Saw Sedge - Yellow Marsh Flower swamp forest of coastal lowlands	570.68

Plant Community Type (PCT)	PCT name	Area (ha)
1723	Melaleuca biconvexa - Swamp Mahogany - Cabbage Palm swamp forest of the Central Coast	412.99
1724	Broad-leaved Paperbark - Swamp Oak - Saw Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast	336.42
1725	Swamp Mahogany - Broad-leaved Paperbark - Swamp Water Fern - Plume Rush swamp forest on coastal lowlands of the Central Coast and Lower North Coast	12.97
1726	Flax-leaved Paperbark - Tall Sedge shrubland of the Sydney Basin	63.34
1727	Swamp Oak - Sea Rush - Baumea juncea swamp forest on coastal lowlands of the Central Coast and Lower North Coast	1232.60
1728	Swamp Oak - Prickly Paperbark - Tall Sedge swamp forest on coastal lowlands of the Central Coast and Lower North Coast	133.33
1729	Swamp Oak swamp forest on coastal lowlands of the Central Coast and Lower North Coast	18.06
1730	Swamp paperbark - Baumea juncea swamp shrubland on coastal lowlands of the Central Coast and Lower North Coast	3.30
1734	Wallum Bottlebrush - Leptocarpus tenax - Baloskion pallens Wallum sedge heath of the lower North Coast	180.00
1735	Cladium procerum coastal freshwater wetland	18.37
1736	Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter	4564.84
1737	Typha rushland	140.78
1739	Woolly Water lily - Sand Couch coastal freshwater wetland	0.02
1740	Tall Spike Rush freshwater wetland	3.37
1741	Lepironia articulata sedgeland	192.69
1742	Jointed Twig-rush sedgeland	107.83
1746	Saltmarsh Estuarine Complex	83.02
1747	Grey Mangrove low closed forest	5829.43
1748	Grey Box grassy open forest of the Central and Lower Hunter Valley	172.64

4. Conservation values

The biodiversity within the Lower Hunter region has high conservation value as it is both diverse and distinctive. The region contains a diverse range of flora, fauna, ecological communities and ecosystems that are threatened by a range of threats principally land clearance (see Section 5). The assessment of conservation value within the region is based on MNES as described below.

4.1 Matters of National Environmental Significance

The Lower Hunter region contains a range of biodiversity that are recognised as MNES. These are discussed below.

4.1.1 Threatened species and Threatened ecological communities

Two Critically Endangered Ecological Communities listed under the EPBC Act occur within the Lower Hunter region:

- Littoral Rainforest and coastal vine thickets of eastern Australia
- Lowland rainforest of subtropical Australia.

Three ecological communities currently nominated for listing under the EPBC Act also occur within the region:

- Subtropical and temperate coastal saltmarsh
- Hinterland sand flats forests and woodlands of the Sydney Basin Bioregion
- Hunter Valley remnant woodlands and open forests.

Mapping of these communities in the region is provided in EPBC Act ecological communities mapping (Parsons Brinckerhoff 2013a).

The Lower Hunter region is known or predicted to support 158 Threatened species listed under the EPBC Act (Appendix C), including 108 species of plant, six species of frog, 23 species of bird, four species of fish and 17 species of mammal. The records of threatened species and communities, listed under the EPBC Act (Appendix C), indicate that threatened species records are numerous and widespread across the region and as such provide little information to distinguish areas of higher conservation value. However, record clumps were observed surrounding the towns of Kurri Kurri, Cessnock, Kitchener and Pelton as well as within the National Parks and State Forests located within the Cessnock LGA. Although the clumping of records could be a result of survey effort and observations, such as by locals or roadside observations, these areas should be considered when identifying high conservation priority areas.

Critical habitat is the whole or any part or parts of an area or areas of land comprising habitat critical to the survival of an endangered species, population or ecological community. Critical habitats are listed under the *Threatened Species Conservation Act 1995* (TSC Act) and the EPBC Act. Habitat for Gould's Petrel on Cabbage Tree Island, within Port Stephens LGA, has been listed as critical habitat under the TSC Act. Additional areas of critical habitat may be identified in the future for example if areas are found which meet the condition thresholds for critical habitat within an ecological community.

4.1.2 Migratory species

Migratory species are protected under international agreements to which Australia is a signatory, including the Japan Australia Migratory Bird Agreement (JAMBA), the China Australia Migratory Bird Agreement

(CAMBA), the Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention on the Conservation of Migratory Species of Wild Animals. Migratory species are considered to comprise MNES and are protected under the EPBC Act.

There are 64 Migratory species known or predicted to occur within the Lower Hunter region (Appendix C). Of particular importance to Migratory species within the region are the following areas:

- Newcastle LGA:
 - ▶ Hunter River estuary– this area supports high number and diversity of migratory shorebirds Kooragang Island, Ash Island and Hexham Swamp.
- Port Stephens LGA:
 - ▶ estuarine habitats
 - ▶ sand dunes in Stockton Bight – regularly used by small migratory shorebirds for roosting.
- Lake Macquarie LGA:
 - ▶ estuarine habitats.

4.1.3 Wetlands of international importance

RAMSAR International Significance Wetlands are listed under the RAMSAR convention due to their high conservation value for wetland species. This listing of significant wetlands aims to maintain their ecological character and to plan their sustainable use. Two wetlands of international importance occur within the Lower Hunter region:

- the Hunter Estuary Wetlands, within the Newcastle LGA
- Myall Lakes, within the Port Stephens LGA (Environment Australia 2001a).

4.1.4 World Heritage and National Heritage

The Greater Blue Mountains was inscribed on the World Heritage List in 2000 and was included in the National Heritage List in 2007. Yengo National Park in the south western section of the Cessnock LGA forms part of the Greater Blue Mountains World Heritage Area listing. The values of the World Heritage Area are discussed in detail as part of another study (Parsons Brinckerhoff 2013b).

4.2 Regional wildlife corridors

Wildlife corridors can be defined as 'retained and/or restored systems of (linear) habitat which, at a minimum enhances connectivity of wildlife populations and may help them overcome the main consequences of habitat fragmentation' (Wilson & Lindenmayer 1995). Wildlife corridors comprised of remnant vegetation within the Lower Hunter region, are of high conservation value.

The National Wildlife Corridors Plan (Department of Sustainability Environment Water Population and Communities 2012) supports the development of a network of wildlife corridors across the continent at a range of scales, national, regional and local-scale by:

- identifying National Wildlife Corridors to create major landscape links
- enhancing existing major corridor initiatives
- supporting local- and regional-scale corridor initiatives.

Wildlife corridors, such as those within the Lower Hunter region, provide ecological functions at a variety of spatial and temporal scales from daily foraging movements of individuals, to broad-scale genetic gradients across biogeographical regions. The Lower Hunter Regional Strategy (Planning 2006) identifies a key green

corridor linking large vegetated areas allowing the movement and dispersal of biodiversity within the region. This corridor links the Watagans and Yengo National Parks with the coastal plains of the Tomago Sand beds, Stockton Bight and Port Stephens. The sections of this green corridor and the conservation values within each are outlined below:

- south-western section links the ranges and the wetlands
- middle section contains koala habitat, heath and vulnerable aquifers that supply drinking water to the region
- north-eastern section contains wetlands and lowland coastal forests, fringing the shores of Port Stephens and containing the surface water catchment for Grahamstown Dam.

Key Habitats and Corridors have also been mapped within northern NSW to provide a framework of key fauna habitats and linking habitat corridors (Scotts 2001). These form a network across the region.

The Landscape Conservation Strategy developed as part of the Cessnock Biodiversity Management Plan (Office of Environment and Heritage 2011) has identified a number of HPCA that are predominantly located in the landscape conservation corridors listed below:

- Bow Wow corridor
- Molly Morgan corridor
- Mount View corridor Ellalong corridor
- National Park corridor
- Richmond Vale corridor.

5. High priority conservation areas

The Lower Hunter region has areas of significant conservation value. Of high significance is the Greater Blue Mountains World Heritage Area (encompassing Yengo National Park in the south western section of Cessnock LGA). Other areas of high conservation priority were identified based on available literature and, consultation with stakeholders.

Key criteria used to determine areas of high priority conservation areas within the region were:

- patch size- larger patch size generally being of better condition and more resilient
- connectivity to existing reserves
- occurrence within wildlife corridor
- rare or threatened status of the vegetation.
- co-occurrence with MNES

The conservation value of vegetation within the Lower Hunter was further assessed through a conservation model based on the parameters and weighting outlined in Section 2.2.4 and the conservation values outlined in Section 4. and mapped in Figure 5.1. Through this process a number of High Priority Conservation Areas were identified within the Lower Hunter region (Table 5.1 and Figure 5.2). These generally corresponded to those high priority conservation areas identified during the expert workshop.

It is important that high conservation priority is given to Hunter Valley remnants that occur on the floodplains and the valley floor within the Lower Hunter Region, such as areas in Maitland LGA, near Kurri Kurri and in the Wollombi Valley. The majority of vegetation remaining in these areas are continually threatened by clearing and weed invasion, resulting in fragmentation and isolation. Unlike the vegetation found on the slopes and higher grounds of the Hunter Valley region (such as that found in Yengo National Park), the floodplains and valley floor are poorly represented emphasising the importance in prioritising conservation in areas outside of existing reserves.

Due to the highly fragmented and isolated nature of the remnant vegetation within the Lower Hunter it is also important that the remaining wildlife corridors are conserved to ensure connectivity between remnants is retained. Buffer zones should also be included for high priority conservation areas to reduce edge and barrier effects. Including buffer zones within the conservation areas will provide the core habitat protection against the establishment and spread of weeds species and predation of pest fauna species.

High Priority Conservation Areas identified in the region should be preserved and managed in order to maintain and improve (through rehabilitation and revegetation) the vegetation, habitats and connectivity within the Lower Hunter region. Conservation efforts will be more efficient and effective if they are concentrated in these High Priority Conservation Areas.

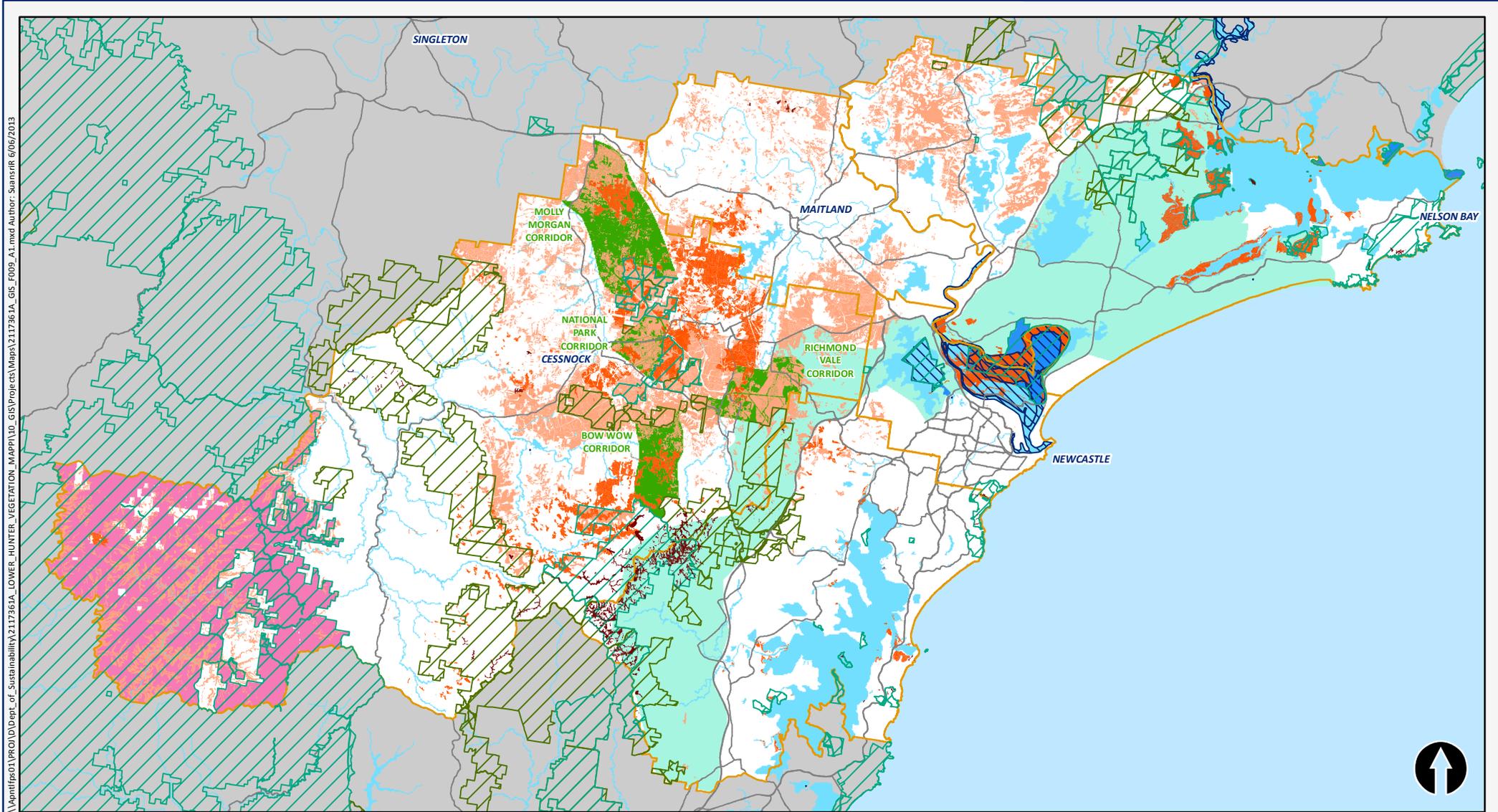
Table 5.1 High Priority Conservation Areas within the Lower Hunter region

Parameters used to identify High Priority Conservation Areas								
High Priority Conservation Area	Connectivity to nature reserves	Threatened Ecological Community	Threatened flora habitat	Threatened fauna habitat	Patch size	Habitat connectivity	Identified in expert workshop	Additional notes
N	Vegetation occurs adjacent to and forms part of Watagans National Park	Lowland Rainforest of Subtropical Australia	Yes	Yes	Large patch size	Occurs within the Lower Hunter Regional Green Corridor	No	
R	Yes, contains Wallarah National Park and parts of Munmorah National Park	Contains small areas of Littoral Rainforest	Yes, provides habitat for a range of threatened flora including <i>Tetratheca juncea</i> and <i>Diuris praecox</i>	Yes, provides habitat for a range of fauna including Grey-headed Flying-fox	Large	Not within an identified corridor.	Yes. Wallarah Peninsulat identified as having some of best examples of Littoral Rainforest	
L	Contains and is in proximity to Hunter Estuary National Park	Subtropical and temperate coastal saltmarsh-nominated community	Yes, <i>Euphrasia arguta</i>	Yes, specifically migratory wading birds	Large	Forms part of Lower Hunter Regional Corridor	Yes	RAMSAR listed, specifically due to their triggering RAMSAR threshold numbers for migratory wading birds Identified in expert workshop as high priority Hunter River estuary includes: Kooragang Island, Ash Island
C	Yes, is adjacent to and forms part of Worimi Nature Reserve	Subtropical and temperate coastal saltmarsh-nominated community	Not known	Yes, important habitat for migratory species	Large	Forms part of the Lower Hunter Regional Corridor	Yes	

Parameters used to identify High Priority Conservation Areas								
High Priority Conservation Area	Connectivity to nature reserves	Threatened Ecological Community	Threatened flora habitat	Threatened fauna habitat	Patch size	Habitat connectivity	Identified in expert workshop	Additional notes
B	Yes, in proximity to Karuah National Park		Not known	Not known	Moderate	Corridor	No	
J	Occurs in proximity to Werakata National Park	Hinterland Sand Flats Forest and Woodland of the Sydney Basin Bioregion and Hunter Valley Remnant Woodlands and Open Forests	Yes, including <i>Grevillea parviflora</i> ssp <i>parviflora</i> , <i>Acacia bynoeana</i> , <i>Eucalyptus glaucina</i> , <i>Eucalyptus parramattensis</i> ssp <i>decadens</i> , <i>Rutidosis heterogama</i>	Yes, including, Swift Parrot, Regent Honeyeater, Koala, Grey-headed Flying-fox	Large	Forms part of the Richmond Vale Corridor	Yes	
H	Yes, is adjacent to and forms part of Werakata National Park		Yes, including <i>Grevillea parviflora</i> ssp <i>parviflora</i> , <i>Acacia bynoeana</i> , <i>Eucalyptus glaucina</i> , <i>Eucalyptus parramattensis</i> ssp <i>decadens</i> , <i>Rutidosis heterogama</i>	Yes, including <i>Swift Parrot</i> , <i>Regent Honeyeater</i> , <i>Koala</i> , <i>Grey-headed Flying-fox</i>	Large	Forms part of the Lower Hunter Regional Corridor	Yes	

Parameters used to identify High Priority Conservation Areas								
High Priority Conservation Area	Connectivity to nature reserves	Threatened Ecological Community	Threatened flora habitat	Threatened fauna habitat	Patch size	Habitat connectivity	Identified in expert workshop	Additional notes
S	Yes, is adjacent to and forms part of Werakata National Park		Yes, including <i>Grevillea parviflora</i> ssp <i>parviflora</i> , <i>Acacia bynoeana</i> , <i>Eucalyptus glaucina</i> , <i>Eucalyptus parramattensis</i> ssp <i>decadens</i> , <i>Rutidosis heterogama</i>	Yes, including <i>Swift Parrot</i> , <i>Regent Honeyeater</i> , <i>Koala</i> , <i>Grey-headed Flying-fox</i>	Large	Forms part of the Lower Hunter Regional Corridor	Yes	
A	No	Threatened Ecological Community	Yes, Critically endangered <i>Persoonia pauciflora</i> known from only this location. Also, <i>Macrozamia flexuosa</i>	Yes, including Southern Bent-wing Bat, Swift Parrot	Large	Occurs within Molly Morgan Corridor	Yes	
O	Yes, Connected to Watagan National Park	Subtropical and temperate coastal saltmarsh	Yes, including <i>Prostanthera cineolifera</i>	Yes, including Regent Honeyeater, Swift Parrot, Helmeted Honeyeater, Grey-headed Flying-fox	Large	No	No	

Parameters used to identify High Priority Conservation Areas								
High Priority Conservation Area	Connectivity to nature reserves	Threatened Ecological Community	Threatened flora habitat	Threatened fauna habitat	Patch size	Habitat connectivity	Identified in expert workshop	Additional notes
K	Includes parts of Heaton and Awaba State Forests	Contains small areas of Hunter Valley Remnant Woodland and Open Forest (nominated community)	Not known	Yes, including Helmeted Honeyeater, Grey-headed Flying-fox	Large	Yes, is within the Lower Hunter regional Corridor and part of this area also forms part of the Richmond Vale Corridor.	No	
Q	Includes Corrabare and Watagan State Forests. In proximity to Watagans National Park	Contains small areas of Hunter Valley Remnant Woodland and Open Forest (nominated community) and Lowland Rainforest	Yes, including <i>Neoastelia spectabilis</i> and <i>Pimelea curviflora</i>	Yes, including Spotted-tailed Quoll, Regent Honeyeater	Large	Not within an identified corridor	Yes	



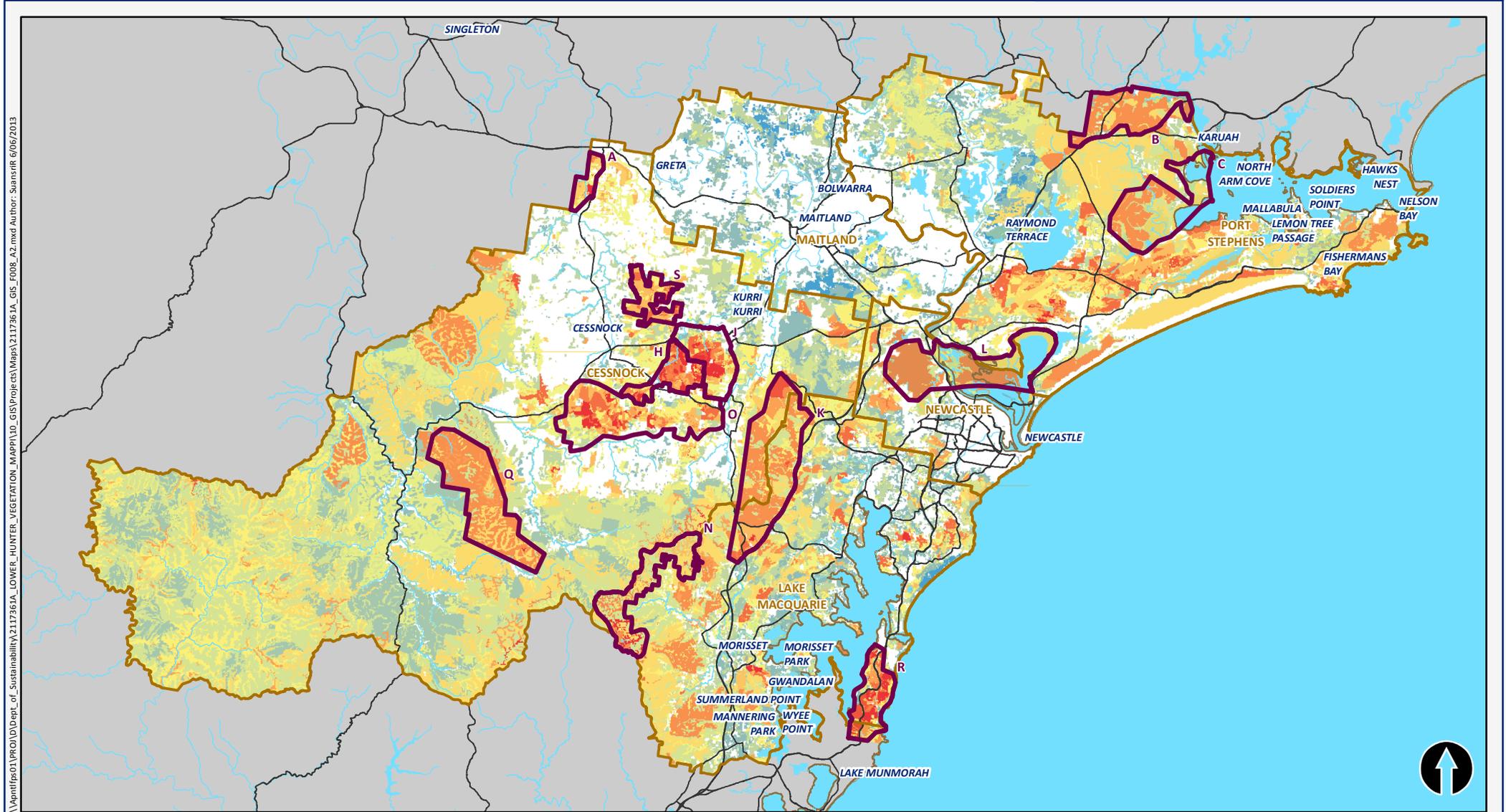
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- | | | |
|-----------------|---------------------------------|--|
| — Major Road | Important Wetlands of Australia | Listed Ecological Communities |
| RAMSAR Wetlands | LHRs Green Corridors | Nominated Ecological Communities - Higher Confidence |
| LGA Boundary | NSW World Heritage Area | Nominated Ecological Communities - Lower Confidence |
| NPWS Estate | River / Creek / Lake | |
| State Forest | Cessnock Biodiversity Corridor | |

Note -
Mapping is based on nomination information as available in April 2013



Figure 5.1
Conservation values of region



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- Major Road
- River / Creek
- River / Creek / Lake
- LGA Boundary
- High Priority Conservation Area
- Sensitivity values
- High
- Low



Figure 5.2
High Priority Conservation Areas

6. Key threatening processes

Key Threatening Processes (KTPs) are processes that threaten or potentially threaten the survival and/or establishment of biodiversity. KTPs can lead to decreases in population size, species diversity, area of occupancy for threatened species and the resilience of species. The Cessnock LGA is subject to a number of KTPs listed under the EPBC Act that are likely to impact threatened biodiversity within the region (Table 6.1). “Land Clearance” is considered the most threatening of these processes as it is contributing to habitat loss and fragmentation directly impacting biodiversity. Although not listed as KTPs, mining and infection and spread of Myrtle Rust are emerging threats identified during the expert workshop with potentially catastrophic consequences within the region.

KTPs impact biodiversity with the potential to reduce or cause localised or broadscale extinction of species, populations or communities. The high diversity and distinct fauna, flora, communities and ecosystems within the Cessnock, Newcastle, Port Stephens, Lake Macquarie and Maitland LGAs are susceptible to a number of these KTPs. In order to conserve the remnant biodiversity within the LGAs it is important that these KTPs are managed, in particular land clearance.

Table 6.1 EPBC listed Key Threatening Processes (KTPs)

Priority ¹	EPBC KTPs	Importance within region ¹	Recommendations
Highest	Land clearance	Primary threat within region	<p>Conservation – conserve areas that contain high biodiversity conservation value such as those areas outlined in the CBMP. Ensure these areas are protected in reserves, national parks or under legislation.</p> <p>Rehabilitation programs – rehabilitate and revegetate areas that provide habitat for threatened species. Increase the quality of remaining habitat and revegetate areas that have been removed.</p> <p>Threatened biodiversity – revise and assess species and communities within the Cessnock LGA for listing under the EPBC Act.</p> <p>Community awareness – educate the community & industry on the impacts associated with land clearing. Involve them in the rehabilitation programs such as Bushcare and Landcare. (Tischendorf & Fahrig 2000)</p>
High	Loss and degradation of native plant and animal habitat by invasion of escaped garden plants and other weeds of national significance, including aquatic plants	Weed invasion is second greatest threat within the region, particularly at the interface of urban areas and native vegetation.	<p>Priority areas – identify areas that would best benefit from coordinated weed control, specifically in areas with high biodiversity conservation value (for example areas that contain threatened species susceptible to weeds). Focus weed control budgets in these areas that are likely to be most effective, cost-efficient and protect threatened biodiversity, as above.</p> <p>Noxious weeds – identify weeds of greatest concern in the region). Generate management plan to eradicate or limit the spread of these species.</p> <p>Research – determine the significance of invasion of escaped garden and aquatic plants. Identify the level of control required to manage these such as chemical, manual, biological and/or mechanical controls.</p> <p>Community awareness – educate community of the impacts and weed controls associated with escaped garden and aquatic plants. (With 2004)</p>

Priority1	EPBC KTPs	Importance within region1	Recommendations
High	Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases	Although effects not currently known, this has potentially drastic, broadscale impacts, particularly for saltmarsh and littoral rainforest.	<p>Energy efficiency – promote and educate the community to reduce the use of vehicles and machinery that emit large volumes of greenhouse gases.</p> <p>Threatened species – adaptive requirements of species likely to be affected should be given a greater priority. (Gray & Macnish 1985)</p>
High	Mining2	Is one of the largest threats within the region, particularly in areas with coal seams.	<p>Priority areas – identify areas of high conservational value that should not be impacted upon. For example Critically Endangered communities or vegetation likely to provide habitat for threatened species.</p> <p>Biobanking – identify potential biodiversity offset areas for remnant vegetation likely to be impacted by mining.</p> <p>Rehabilitation – rehabilitate mine sites after completion to a condition that is equal to or better than the original remnant vegetation.</p> <p>Research – research methods of mining and rehabilitation to reduce the impacts of mining.</p>
Moderate	Competition and land degradation by rabbits	Not a major issue in the region, however, main threat to native vegetation as vectors to weeds	<p>Priority areas – identify areas that would best benefit from coordinated rabbit control, specifically in areas with high biodiversity conservation value (for example areas that contain threatened species susceptible to rabbits). Focus rabbit control budgets in these areas that are likely to be most effective, cost-efficient and protect threatened biodiversity.</p> <p>Research – conduct research on the benefits of different rabbit control methods and the effects rabbit control has for example on threatened species and communities.</p> <p>Community involvement – educate the community and relevant landowners of rabbit control methods. Coordinate and integrated management between key groups.</p> <p>Monitoring – undertake monitoring of strategies used to identify native species recovery and effectiveness of strategies. Modify management strategies according to results. (Orell & Morris 1994)</p>
Moderate	Predation by European red fox	Not a major issue in the region, however, in coastal areas foxes are known to predate on coastal birds and also act as weed vectors, particularly asparagus weed	<p>Priority areas – identify areas that would best benefit from coordinated fox control, specifically in areas with high biodiversity conservation value (for example areas that contain threatened species susceptible to foxes). Focus fox control budgets in these areas that are likely to be most effective, cost-efficient and protect threatened biodiversity.</p> <p>Research – conduct research on the most cost-effective and effective in controlling foxes for example on threatened species and communities and within different habitat types.</p> <p>Community involvement – educate the community and relevant landowners of fox control methods. Coordinate and integrated management between key groups.</p> <p>Monitoring – undertake monitoring of strategies used to identify native species recovery and effectiveness of strategies. Modify management strategies according to results. (Parnaby 1995)</p>

Priority1	EPBC KTPs	Importance within region1	Recommendations
Moderate	Predation by feral cats	Largely unknown in region, however predation by domestic cats likely to occur particularly at interface of urban and conservation areas.	<p>Priority areas – identify areas that would best benefit from coordinated feral cat control, specifically in areas with high biodiversity conservation value (for example areas that contain threatened species susceptible to cats). Focus cat control budgets in these areas that are likely to be most effective, cost-efficient and protect threatened biodiversity.</p> <p>Strategies – undertake appropriate management strategies in the focus areas:</p> <ul style="list-style-type: none"> ■ Sustained management: controls implemented on a continual basis; short term management to reduce impacts to an acceptable level. ■ Intermittent management: controls implemented during critical periods of the year when damage is greatest. ■ Experimental control: using control methods as research experiments. <p>Research – conduct research on management techniques most suitable for feral cat eradication (best method of controlling cats), impacts feral cats on native species.</p> <p>Community involvement – educate the community and relevant landowners of fox control methods. Coordinate and integrated management between key groups.</p> <p>Monitoring – undertake monitoring of strategies used to identify native species recovery and effectiveness of strategies. Modify management strategies according to results. (Parnaby 1995)</p>
Moderate	Myrtle Rust2	Recorded within the LGA (Yengo and Wollemi National Parks) and is likely to spread.	<p>Education – educate the community on strategies likely to minimise the spread and introduction of the fungus.</p> <p>Monitoring – continual monitoring of identified infested sites and areas considered likely to be infected (e.g. close to infestations).</p> <p>Quarantine – signage, creation of exclusion zones and barriers to isolate infested sites and to reduce the spread of the fungus.</p>
Low	Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris	Largely unknown in region, however injuries and fatality to marine life likely to occur within the coastal boundaries	<p>Research – conduct appropriate research including degradable pathways of synthetic debris in the marine environment. Monitor and investigate marine life harmed and killed by marine debris. Coordinate abatement strategies and recovery plans.</p> <p>Waste management – promote best practise waste management strategies on land and sea and implement appropriate measures for waste management.</p> <p>Community involvements – raise public awareness and improve education campaigns about the prevention of littering on land and at sea.</p> <p>Evaluation – conduct an independent review of the plan's effectiveness in accordance with the EPBC Act. Review should involve all key stakeholders and provide recommendations to revise the plan.</p>

Priority1	EPBC KTPs	Importance within region1	Recommendations
Low	Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs	Largely unknown in region	<p>Research – identify the distribution of feral pigs within the LGA and key management areas. These would include areas with high conservation value and areas free of or contain low numbers of feral pigs.</p> <p>Collaborate current feral pig management with stakeholders and assess the need for development of more effective and humane techniques and strategies to manage feral pigs.</p> <p>Management plans and natural resource planning – identify key concerns, establish protocols and use available funding to improve consistency and coordination of management.</p> <p>Education – assess and update existing information regarding feral pigs, such as impacts and best management techniques. Prepare and distribute appropriate material to inform key groups concerned.</p> <p>Monitoring – undertake monitoring of strategies used to identify native species recovery and effectiveness of strategies. Modify management strategies according to results. (Dominelli 2000)</p>
Low	Competition and land degradation by unmanaged goats	Largely unknown in region	<p>Research – determine the significance of unmanaged goat competition and land degradation. Identify the level of control required to manage.</p> <p>Control strategies – develop and implement control strategies to manage goats such as:</p> <ul style="list-style-type: none"> ■ Localised control: localised eradication in specific areas of high conservation value; long term management. ■ Sustained management: controls implemented on a continual basis; short term management to reduce impacts to an acceptable level. ■ Intermittent management: controls implemented during critical periods of the year when damage is greatest. ■ Buffer zones: buffer zones developed with aid of all landowners to reduce or stop reinvasion of unmanaged goats in small areas. ■ Adaptive management: experimental control techniques used within a regional scale to integrate goat control with other biodiversity conservation programs. <p>Monitoring – undertake monitoring of strategies used to identify native species recovery and effectiveness of strategies. Modify management strategies according to results. (Turbill et al. 2008)</p>
Low	Infection of amphibians with chytrid fungus resulting in <i>chytridiomycosis</i>	Largely unknown in region	<p>Research – identify any infections. If present, monitor populations to gain a greater understanding of distribution and incidences of the fungus and to identify outbreaks.</p> <p>Focus species – identify key threatened species to undertake management including restocking and treatment.</p> <p>Education – educate community and promote research programs and community programs to aid in the management.</p> <p>On-line database – developed and maintained to provide the latest data on where the disease has been observed for interested parties. (Department of the Environment and Heritage 2006)</p>

Priority1	EPBC KTPs	Importance within region1	Recommendations
Low	<i>Psittacine Circoviral</i> (beak and feather) Disease affecting endangered psittacine species	Largely unknown in region	Education – education and materials are required for field workers and wildlife managers to detect the presence of the disease in the Cessnock LGA and priority psittacine species. This will allow for the true impact of the disease, if any, to be identified. Protocols – develop and implement correct handling, post-mortem, quarantine and transport of psittacine infected individuals. On-line database – develop and maintain an on-line database to provide the latest data on where the disease has been observed for interested parties. (Department of the Environment and Heritage 2005)
Low	The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, <i>Solenopsis invicta</i> (fire ant)	Largely unknown in region	Research – identify areas that are or are likely to be affected by fire ants, specifically areas that have threatened biodiversity susceptible to fire ants. Control Strategies – identify areas that most require management and select control strategies most effective to eradicate. (Serena & Soderquist 1995)
Low	Dieback caused by the root-rot fungus (<i>Phytophthora cinnamomi</i>)	Largely unknown in region	Quarantine – monitor plant material entering NSW that has the potential to be infected by the pathogen, specifically in areas with high biodiversity and conservation value. (Environment Australia 2001b)
Low	The biological effects, including lethal toxic ingestion, caused by Cane Toads (<i>Bufo marinus</i>)	Cane toads uncommon in region.	Research – conduct research into control methods (for example biological) that will eradicate the Cane Toad and reduce their rapid spread. (Department of Environment and Resource Management 2011)
Low	Predation by exotic rats on Australian offshore islands of less than 1,000 km ² (100,000 ha)	Potential issue on Cabbage Tree Island due to presence of critical habitat for Gould's Petrel (rat predation on eggs and chicks may be of concern).	Control Strategies – conduct a feasibility study to determine the likely effectiveness of eradication and quarantine without adverse impacts on native wildlife (specifically on Gould's Petrel populations on Cabbage Tree Island). Education – education for visitors and the community of how best to decrease spread and/or prevent the re-introduction of rats. Quarantine – prevent and control re-introduction (Threatened Species Scientific Committee 2006).
N/A	Invasion of northern Australia by Gamba Grass and other introduced grasses	N/A	Not applicable. Outside Lower Hunter region
N/A	Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations	N/A	Not applicable. Outside Lower Hunter region

Priority1	EPBC KTPs	Importance within region1	Recommendations
N/A	Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South	N/A	Not applicable. Outside Lower Hunter region
N/A	Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (<i>Anoplolepis gracilipes</i>) on Christmas Island, Indian Ocean	N/A	Not applicable. Outside Lower Hunter region

Note:

- (1) KTP priority and importance within region was extrapolated from expert workshop and available literature. Therefore, information provided may not be comprehensive.
- (2) KTPs not listed under the EPBC Act. These threatening processes are however considered major threats within the Cessnock LGA and require prioritised action.

7. Conclusions and recommendations

Existing vegetation mapping projects within the region were reviewed and prioritised according to their resolution. The review prioritised the more detailed local vegetation mapping and mapping of conservation reserves over the broadscale vegetation mapping within the region (such as LHCCREMS or GHM). In this way, the more detailed information and mapping was captured with broader scale vegetation mapping filling the gaps in areas without the detailed mapping.

The refinement of vegetation mapping with the Cessnock LGA was one of the key outcomes of this project and was based on a 'desk-top' review of existing vegetation data that was verified and refined in a field survey. Four main investigation areas within the Cessnock LGA were chosen for detailed survey based on the literature review and consultation with the stakeholders and corresponded to those areas containing relatively poor resolution broad-scale vegetation mapping (GHM and/or LHCCREMS mapping only), limited vegetation survey field data and potential for future threats to conservation management in the form of development pressures and threatened processes.

Field surveys within Cessnock LGA were based on Rapid Data Point (RDP) roadside surveys. RDP surveys are a quick record of floristic information collected at specific points in the field. A total of 239 RDP surveys were completed and the majority of vegetation within the key focus investigation areas was remapped, covering a total of 30,054 ha and equivalent to 15% of the entire LGA.

The prioritisation of vegetation mapping resulted in the consolidation of fourteen separate projects across the Lower Hunter into a single vegetation map for the region, including the refined mapping within Cessnock LGA. Vegetation communities across the Lower Hunter were aligned to draft Plant Community Types being developed by the OEH to provide a single standardised list of communities across the region. Based on the consolidated mapping, a total of 102 PCTs were mapped across the region.

High priority conservation areas within the region were modelled and mapped based on a range of parameters including patch size, threatened biodiversity and connectivity. Weightings were applied to each parameter to ensure the most important parameters were modelled as higher priority in the mapping process. Other areas of high conservation priority were identified in existing conservation plans for the region and through the expert workshop and consultation with key stakeholders. Specific conservation areas are identified within the report. Broadly, these focus on larger areas of good condition remnant vegetation that maintain corridors and/or support threatened or migratory species listed under the EPBC Act.

The identified High Priority Conservation Areas should be considered for preservation and appropriate management to maintain and improve biodiversity values in the region. Conservation efforts would be more efficient and effective if they are concentrated in these High Priority Conservation Areas.

Key Threatening Processes within the Lower Hunter region were identified, the principal threat being land clearance which is contributing to habitat loss and fragmentation directly impacting biodiversity. The highest priority threats in the region are:

- Land clearance – key recommendations are to:
 - ▶ minimise further clearing of native vegetation in the region where possible, particularly within High Priority Conservation Areas
 - ▶ ensure that listings under the EPBC Act of species and ecological communities are regularly assessed and revised to take into consideration ongoing land clearance

- ▶ educate the community on the impacts associated with land clearing. Involve the community in the rehabilitation programs such as Bushcare and Landcare
- ▶ provide long-term protection for suitable areas of native vegetation within the region, such as through new national parks or under legislation.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants – key recommendations are to:
 - ▶ identify areas that would best benefit from coordinated weed control with reference to High Priority Conservation Areas
 - ▶ identify weeds of greatest concern in the region and generate management plan to eradicate or limit the spread of these species
 - ▶ undertake research to identify significance of invasion and control methods
 - ▶ educate community of the impacts and weed controls associated with escaped garden and aquatic plants.
- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases – key recommendations are to:
 - ▶ promote and educate the community in energy efficiency
 - ▶ prioritise adaptive requirements of species.

As a result of this study, it is recommended that:

- Refinement of this mapping be undertaken as resources allow including:
 - ▶ undertaking detailed vegetation mapping within Port Stephens and Newcastle LGAs as these areas are generally only covered by broad-scale vegetation mapping, such as LHCCREMS (Lower Hunter and Central Coast Regional Environmental Management Strategy, 2003) and the Greater Hunter Vegetation Mapping (Sivertsen et al. 2011).
 - ▶ undertaking further detailed quadrat surveys and analysis of all available data using PATN analysis (or similar) for vegetation classification across the whole Cessnock LGA
 - ▶ undertaking additional review and correlation of existing vegetation mapping projects which were not available at time of this assessment, including mapping of:
 - Wollemi conservation lands
 - Sugarloaf State Conservation Area
 - Singleton army base
 - Themeda Coastline Mapping - Bushland Inventory Quadrats, Creekline Vegetation Surveys (Newcastle LGA)
 - Coal and Allied areas
 - Vegetation of the Worimi Conservation Lands Port Stephens (Eastcoast Flora Survey, 2010)
 - Vegetation of Columbey National Park update with Duns Creek Addition (Eastcoast Flora Survey, 2010)
 - *Mapping the habitats of NSW estuaries* (Creese et al. 2009).
- Revise the High Priority Conservation Areas based on refined or additional information as it become available, such as additional or refined mapping.
- Although not listed as a KTP, infection and spread of Myrtle Rust is an emerging threat with potentially catastrophic consequences within the region. Consideration should be given to the listing of spread and infection of Myrtle Rust as a Key Threatening Process.
- This consolidated mapping and identification of High Priority Conservation Areas be considered for regional planning in the Lower Hunter.

This project provides a GIS database of vegetation mapping for the Lower Hunter Region including refined mapping based on RDP survey data in Cessnock LGA and existing mapping projects combined in one singular layer. This provides a sound base for future refinement as resources allow. Through the mapping vegetation across the region and identification of High Priority Conservation Areas, this project provides a single consolidated vegetation map for the region and a suitable resource to support regional sustainability planning, particularly the preparation of the Lower Hunter Regional Strategy and Regional Conservation Plan.

8. References

- Bell S 1998, *Woolemi National Park Vegetation Survey- A Fire Management Document*, NSW National Parks and Wildlife Service Upper Hunter District, Hunter Valley.
- Bell S 2004, 'Vegetation of Werakata National Park, Hunter Valley, New South Wales', *Cunninghamia*, vol. 8, no. 3, pp. 331-47.
- Bell S 2006, *Glenrock State Recreation Area and Awabakal Nature Reserve Vegetation Survey*.
- Bell S 2009, 'Vegetation and floristics of Columbey National Park, lower Hunter Valley, New South Wales', *Cunninghamia*, vol. 11, no. 2, pp. 241-75.
- Bell S & Driscoll C 2006a, *Vegetation mapping of Watagans National Park and Jiliby State Conservation Area* Parks and Wildlife Division and Department of Environment and Conservation.
- Bell S & Driscoll C 2006b, *Vegetation of the Tomago and Tomaree Sandbeds, Port Stephens, New South Wales. Management of Groundwater Ecosystems. Part 1-2.*, Eastcoast Flora Survey, September 2006, Unpublished report to Hunter Water.
- Bell S & Driscoll C 2007, *Vegetation of the Cessnock-Kurri Region, Cessnock LGA, New South Wales: Survey, Classification & Mapping*, Unpublished report to the Department of Environment & Climate Change.
- Bell S & Driscoll C 2012, *Vegetation mapping of Lake Macquarie LGA: Stages 1-3*, Lake Macquarie City Council.
- Bell S, Vollmer J & Gellie N 1993, *Yengo National Park and Parr State Conservation Area Vegetation Survey for use in fire management*.
- 'Blue Gum Hills Vegetation', 1997.
- Department of Environment & Climate Change 2008, *The Native Vegetation of Yengo and Parr Reserves and Surrounds*, Department of Environment and Climate Change, Hurstville, NSW.
- Department of Environment and Resource Management 2011, *Bell's Turtle*, Department of Environment and Resource Management, viewed 21/12 2011.
- Department of Industry and Investment 2010, *Threatened species conservation web page*, Department of Industry and Investment, viewed 4 June 2010, <<http://www.dpi.nsw.gov.au/fisheries/species-protection/conservation>>.
- Department of the Environment and Heritage 2005, *Threat abatement plan for beak and feather disease affecting endangered Psittacine species*, Natural Heritage Trust and the Department of the Environment and Heritage, Canberra.
- Department of the Environment and Heritage 2006, *Threat Abatement Plan for infection of amphibians with chytrid fungus resulting in chytridiomycosis* Department of Environment and Heritage, viewed 15 March 2013, <<http://www.deh.gov.au/biodiversity/threatened/publications/tap/chytrid/index.html>>.
- Dominelli, S 2000, *Distribution, roost requirements and foraging behaviour of the Greater Long-eared Bat (Nyctophilus timoriensis) and the Little Pied Bat (Chalinolobus picatus) in the Bookmark Biosphere Reserve*, Unpublished report, Bookmark Biosphere Trust, South Australia,

Ecological Australia 2003, *An investigation and description of the vegetation of the Pambalong Swamp (Pambalong Nature Reserve) NSW National Parks and Wildlife Service*, Newcastle.

Environment Australia 2001a, *A directory of important wetlands in Australia third edition*, Environment Australia, Canberra.

Environment Australia 2001b, *Threat Abatement Plan for Dieback Caused by the Root-rot Fungus *Phytophthora cinnamomi**, Department of Environment and Heritage, Canberra.

Geering, A, Agnew, L & Harding, S 2007, *Shorebirds of Australia*, CSIRO Publishing, Melbourne.

Gray, HJ & Macnish, SE 1985, *Land Management Field Manual Wandoan District*, Queensland Department of Primary Industries.

Hill L 2003, *The Natural Vegetation of the Maitland LGA, New South Wales*, Maitland.

Hunter Central Coast Regional Environmental Management Strategy 2006, *Vegetation survey and mapping-Hunter, Central and Lower North Coast region of NSW HCCREMS*, Thornton.

Lower Hunter and Central Coast Regional Environmental Management Strategy 2003, *Lower Hunter and Central Coast Regional Biodiversity Conservation Strategy Technical Report 2003, Digital Aerial Photo Interpretation and Updated Extant Vegetation Community Map*, Lower Hunter and Central Coast Regional Environmental Management Strategy, Callaghan, NSW.

Maitland City Council 2011, *Maitland City Council - Supplementary State of the Environment Report 2010/2011*, Maitland.

Office of Environment and Heritage 2011, *Cessnock Biodiversity Management Plan*.

Orell, P & Morris, K 1994, *Chuditch Recovery Plan 1992-2001*. [Online], WA Government Department of Conservation and Land Management, Wanneroo.

Parnaby, H 1995, *Greater Long-eared Bat *Nyctophilus timoriensis**, Reed Books, Chatswood, NSW.

Parsons Brinckerhoff 2013a, *EPBC Act ecological communities mapping in the Lower Hunter*, Parsons Brinckerhoff, Newcastle.

Parsons Brinckerhoff 2013b, *Greater Blue Mountains World Heritage Area Values Study*, Parsons Brinckerhoff, Newcastle.

Planning, NDo 2006, *Lower Hunter Regional Strategy*, NSW Department of Planning, Sydney.

Scotts, D 2001, *Key habitats and corridors for fauna of north-east NSW limitations and decision rules inherent within the mapping*, NPWS, Coffs Harbour.

Serena, M & Soderquist, TR 1995, 'Western quoll', in R Strahan (ed.), *The Mammals of Australia*, Reed New Holland, Sydney, pp. 62-4.

Sivertsen, D 2009, *Native vegetation interim type standard*, Department of Environment & Climate Change & Water,, Sydney.

Sivertsen, D, Roff, A, Somerville, M, Thonell, J & Denholm, B 2011, *Greater Hunter Native Vegetation Mapping Geobase Guide (Version 4.0)*, Internal report for the Office of Environment and Heritage, Department of Premier and Cabinet, Sydney, Australia.

Threatened Species Scientific Committee 2006, *Predation by exotic rats on Australian offshore islands of less than 1000 km² (100,000 ha) listing advice*, Canberra,

Tischendorf, L & Fahrig, L 2000, 'How should we measure landscape connectivity?', *Landscape Ecology*, vol. 15, pp. 633-41.

Turbill, C, Lumsden, L & Ford, G 2008, *South-eastern Long-eared Bat Nyctophilus sp.* In: Van Dyck, S. and R. Strahan, (eds.), eds. *The Mammals of Australia.*, New Holland, Sydney.

Wilson, A & Lindenmayer, DB 1995, *Wildlife Corridors and the Conservation of Biodiversity: A Review.*, National Corridors of Green Program, Green Australia Ltd., Canberra.

With, KA 2004, 'Metapopulation dynamics: perspectives from landscape ecology', in I Hanski & O Gaggiotti (eds), *Ecology, Genetics and Evolution of Metapopulations*, Elsevier, San Diego, pp. 23-44.

Appendix A

Rapid Data Point form



A1. Rapid Data Point form

GPS ID	
Date	
Recorder	
<i>Dominant stratum</i>	
Database	
Community	
<i>Vegetation Data</i>	
Upper Stratum Cover (%)	
Upper Stratum Height (m)	
Upper Stratum Species 1	
Upper Stratum Species 2	
Upper Stratum Species 3	
Mid Stratum Cover (%)	
Mid Stratum Height (m)	
Mid Stratum Species 1	
Mid Stratum Species 2	
Mid Stratum Species 3	
Lower Stratum Cover (%)	
Lower Stratum Height (m)	
Lower Stratum Species 1	
Lower Stratum Species 2	
Lower Stratum Species 3	
% Bare_Ground/Rock	
<i>Comments</i>	
<i>Photos</i>	<i>Photo ID (e.g. 230)</i>
Horizontal: _H	
Horizontal bearing: _H	
Vertical: _V	
Ground: _G	

Appendix B

Vegetation communities within Cessnock LGA



B1. Vegetation communities within Cessnock LGA

Table B1.1 Vegetation communities within the Cessnock LGA

Vegetation community name	Vegetation profile source	Map unit number in source report	Area (ha)
Hunter Range Stinging Tree Dry Rainforest	Yengo Vegetation (DECC, 2008)	01	35.4
Sydney Hinterland Warm Temperate Rainforest	Yengo Vegetation (DECC, 2008)	02	82.3
Hunter Range Grey Myrtle Dry Rainforest	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	03	45.2
Hunter Range Grey Myrtle Dry Rainforest	Yengo Vegetation (DECC, 2008)	03	34.5
Sydney Hinterland Blue Gum-Turpentine Gully Forest	Yengo Vegetation (DECC, 2008)	04	3980.3
Hunter Range Hillgrove Gum Gully Forest	Yengo Vegetation (DECC, 2008)	05	933.0
Hunter Range Basalt Red Gum-Grey Box Forest	Yengo Vegetation (DECC, 2008)	09	171.1
Coastal Wet Gully Forest	Jilliby Vegetation (Bell & Driscoll, 2006)	1	24.4
Coastal Wet Gully Forest	LHCCREMS Vegetation (2003)	1	1774.3
Coastal Wet Gully Forest	Watagans Vegetation (Bell & Driscoll, 2006)	1	2445.4
Sandstone Grey Myrtle Sheltered Forest	LHCCREMS Vegetation (2003)	10	1296.2
Sydney Hinterland Diatreme Forest	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	10	19.4
Sandstone Hills Bloodwood Woodland	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	105a	561.1
Sandstone Hills Transition Forest (C. eximia variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	105b(i)	70.1
Sandstone Hills Transition Forest (C. gummifera variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	105b(ii)	63.6
Sandstone Hills Transition Forest (E. prominula variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	105b(iii)	2.7
Quorrobolong Scribbly Gum Forest (type variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	106a	55.6
Quorrobolong Scribbly Gum Forest (Mulbring variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	106b	11.2
Quorrobolong Scribbly Gum Forest (Nth Mulbring variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	106c	4.7
Quorrobolong Scribbly Gum Forest (Ellalong variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	106d	20.8
Ellalong Grey Gum - Stringybark - Apple Forest (type variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	107(i)	520.4
Ellalong Grey Gum - Stringybark - Apple Forest (stringybark variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	107(ii)	5.1

Vegetation community name	Vegetation profile source	Map unit number in source report	Area (ha)
Paperbark Depression Forest	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	108	28.9
Aberdare Upland Box Forest (Grey Box variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	109a	318.1
Aberdare Upland Box Forest (Ironbark variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	109b	81.9
Grey Myrtle - Paperbark Gully Forest	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	10a	47.1
Hunter Range Flats Apple-Stringybark-Gum Forest	Yengo Vegetation (DECC, 2008)	11	3311.5
Kurri Sand Swamp Woodland	LHCCREMS Vegetation (2003)	11	3.7
Red Ironbark - Paperbark Forest	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	110	1215.2
Hunter Range Flats Red Gum-Apple Forest	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	12	53.9
Hunter Valley Moist Forest	LHCCREMS Vegetation (2003)	12	127.8
Hunter Valley Moist Forest	Watagans Vegetation (Bell & Driscoll, 2006)	12	111.0
Freshwater Wetland Complex	LHCCREMS Vegetation (2003)	13	35.4
Central Hunter Swamp Oak Forest (Swamp Oak variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	13a(i)	823.4
Central Hunter Swamp Oak Forest (River Oak variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	13a(ii)	52.6
Paperbark Floodplain Forest	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	13d	4.2
Cabbage Gum Floodplain Woodland	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	13e	553.0
Cabbage Gum Floodplain Woodland	LHCCREMS Vegetation (2003)	13e	255.4
Riparian Grey Box - Ironbark Clay Forest	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	13f	90.0
Hunter Range Grey Gum Sheltered Forest	Yengo Vegetation (DECC, 2008)	14	4305.2
Hunter Range Sheltered Grey Gum Forest	Yengo Vegetation (DECC, 2008)	14	0.2
Wollombi Redgum - River Oak Forest	LHCCREMS Vegetation (2003)	14	423.9
Riparian Apple - Grey Gum Dune Forest	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	14h	124.4
Coastal Foothills Spotted Gum - Ironbark Forest	LHCCREMS Vegetation (2003)	15	3214.1
Coastal Foothills Spotted Gum - Ironbark Forest	Watagans Vegetation (Bell & Driscoll, 2006)	15	730.3
Coastal Foothills Spotted gum - Ironbark Forest (main variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	15d(i)	1948.8
Coastal Foothills Spotted Gum - Ironbark Forest (Mt View variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	15d(ii)	792.8
Coastal Foothills Spotted Gum - Ironbark Forest (E. punctata variant)	Cessnock-Kurri Region Vegetation (Bell & Driscoll, 2007)	15d(iii)	91.5

Vegetation community name	Vegetation profile source	Map unit number in source report	Area (ha)
Coastal Foothills Spotted Gum - Ironbark Forest (riparian variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	15d(iv)	7.8
Coastal Foothills Transition Forest (<i>E. fergusonii</i> variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	15f(i)	78.9
Coastal Foothills Transition Forest (stringybark variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	15f(ii)	803.9
Coastal Foothills Transition Forest (<i>E. beyeriana</i> variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	15f(iii)	460.0
Seaham Spotted Gum Iron Bark Forest	LHCCREMS Vegetation (2003)	16	1.5
<i>Callistemon lineariifolius</i>	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	17	0.1
<i>Corymbia maculata</i> , <i>Eucalyptus mollucana</i> , <i>Eucalyptus paniculata</i>	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	17	0.9
Kurri Kurri Swamp Woodland Transitional lacking parramattensis	LHCCREMS Vegetation (2003)	17	4.8
Lower Hunter Spotted Gum - Ironbark Forest	LHCCREMS Vegetation (2003)	17	5925.5
Sydney Hinterland Peppermint-Apple Forest	Yengo Vegetation (DECC, 2008)	17	7107.6
Lower Hunter Spotted Gum - Red Ironbark Forest (main variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	17a(i)	6549.9
Lower Hunter Spotted Gum - Red Ironbark Forest (<i>E. longifolia</i> variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	17a(ii)	14.2
Lower Hunter Spotted Gum - Red Ironbark Forest (<i>E. placita</i> variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	17a(iii)	33.8
Lower Hunter Beyer's Ironbark Low Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	17c	29.2
Lower Hunter Grey Box Grassy Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	17i	287.3
Lower Hunter Narrow-leaved Ironbark Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	17m	149.4
Central Hunter Ironbark - Spotted Gum - Grey Box Forest	LHCCREMS Vegetation (2003)	18	33
Hunter Narrow-leaf Ironbark - Spotted Gum Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	18	948.4
Sydney Hinterland Sheltered Turpentine-Apple Forest	Yengo Vegetation (DECC, 2008)	18	1586.8
Hunter Bulloak-Spotted Gum Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	18a	10.4
Central Hunter Grey Box Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	18b	17.7
Hunter Spotted Gum - Cypress Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	18c	12.0
Hunter Red Ironbark - Spotted Gum Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	18h	761.3
Hunter Redgum - Ironbark Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	18i	95.3

Vegetation community name	Vegetation profile source	Map unit number in source report	Area (ha)
Hunter Lowland Redgum Forest	LHCCREMS Vegetation (2003)	19	232.3
Hunter Lowlands Redgum Forest	Watagans Vegetation (Bell & Discoll, 2006)	19	7.6
Grey Gum - Red Gum - Paperbark Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	19a	127.0
Coastal Warm Temperate- Subtropical Rainforest	LHCCREMS Vegetation (2003)	1a	292.3
Bow Wow Subtropical Rainforest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	1b	14.1
Alluvial Tall Moist Forest	LHCCREMS Vegetation (2003)	2	762.8
Hunter Range Ironbark Forest	Yengo Vegetation (DECC, 2008)	20	10172.2
Hunter Range Grey Gum Forest	LHCCREMS Vegetation (2003)	21	18378.4
Hunter Range Grey Gum Forest	Watagans Vegetation (Bell & Discoll, 2006)	21	93.6
Coastal Narabeen Shrub Forest	LHCCREMS Vegetation (2003)	22	643.5
Sydney Hinterland Exposed Red Bloodwood-Stringybark Forest	Yengo Vegetation (DECC, 2008)	22	3167.5
Broken Back Grey Gum - StringybarkForest	LHCCREMS Vegetation (2003)	23	69.2
Hunter Range Exposed Stringybark-Grey Gum Woodland	LHCCREMS Vegetation (2003)	25	10150.6
Hunter Range Exposed Stringybark-Grey Gum Woodland	Yengo Vegetation (DECC, 2008)	25	2589.5
Sheltered Dry Hawkesbury Woodland	LHCCREMS Vegetation (2003)	25	1277.3
Exposed Hawkesbury Woodland	LHCCREMS Vegetation (2003)	26	201.8
Exposed Yellow Bloodwood Woodland	LHCCREMS Vegetation (2003)	27	765.1
Hawkesbury Coastal Banksia Woodland	LHCCREMS Vegetation (2003)	29	1.2
Sydney Hinterland Exposed Scribbly Gum Woodland	Yengo Vegetation (DECC, 2008)	29	311.5
Coastal Plains Smooth-barked Apple Woodland	LHCCREMS Vegetation (2003)	30	2763.3
Sydney Hinterland Rocky Yellow Bloodwood Woodland	Yengo Vegetation (DECC, 2008)	30	1082.7
Sydney Hinterland Dwarf Apple Scrub	Yengo Vegetation (DECC, 2008)	32	12.2
Sydney Hinterland Rock Complex	Yengo Vegetation (DECC, 2008)	33	22.8
Coastal River Oak Forest	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	34	0.7
Coastal River Oak Forest	Yengo Vegetation (DECC, 2008)	34	1.3
Sydney Hinterland Sandstone Riparian Complex	Yengo Vegetation (DECC, 2008)	35	133.2
Kurri Sands Heath Woodland	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	35a	1302.9
Kurri Sands Drooping Redgum - Stringybark Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	35b	387.5
Kurri Sands Shrub Forest (main variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	35c(i)	97.4

Vegetation community name	Vegetation profile source	Map unit number in source report	Area (ha)
Kurri Sands Shrub Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	35c(ii)	63.6
Kurri Sands Stringybark Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	35d	784.0
Kurri Sands Paperbark Heath	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	35e	5.6
Kurri Sands Claypan Scrub (E. parramattensis variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	35f(i)	6.4
Kurri Sands Claypan Scrub (E. fibrosa variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	35f(ii)	45.7
Hunter Range Flats Paperbark Thicket	Yengo Vegetation (DECC, 2008)	38	18.4
Hunter Valley Dry Rainforest (gully variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	3c(i)	31.5
Hunter Valley Dry Rainforest (scrub variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	3c(ii)	31.3
Hunter Valley Moist Forest	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	4	1609.1
Riparian Melaleuca Swamp Woodland	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	42	1.3
Acacia Regeneration	Yengo Vegetation (DECC, 2008)	44	314.6
Regenerating Trees and Shrubs	Yengo Vegetation (DECC, 2008)	45	92.4
Fresh water wetland complex	LHCCREMS Vegetation (2003)	46	2.4
Freshwater Wetlands (general variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	46(i)	73.5
Freshwater Wetlands (<i>Phragmites</i> variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	46(ii)	1.7
Freshwater Wetlands (<i>Typha</i> variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	46(iii)	7.6
Freshwater Wetlands (<i>Cladium</i> variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	46(iv)	1.3
Exotic Species	LHCCREMS Vegetation (2003)	47	2.5
Alluvial Tall Moist Forest	LHCCREMS Vegetation (2003)	5	29.4
Central Hunter Riparian Forest	LHCCREMS Vegetation (2003)	5	43.3
Coastal Narrabeen Moist Forest	Jilliby Vegetation (Bell & Discoll, 2006)	6	16.7
Coastal Narrabeen Moist Forest	LHCCREMS Vegetation (2003)	6	8597.3
Coastal Narrabeen Moist Forest	Watagans Vegetation (Bell & Discoll, 2006)	6	1182.8
Other Landscape Features	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	60	5.1
Sheltered Rough Barked Apple Forest	LHCCREMS Vegetation (2003)	7	383.6
Sheltered Blue Gum Forest	LHCCREMS Vegetation (2003)	8	4270.3
Sheltered Blue Gum Forest (creekline variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	8a(i)	51.7
Sheltered Blue Gum Forest (escarpment variant)	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	8a(ii)	94.9

Vegetation community name	Vegetation profile source	Map unit number in source report	Area (ha)
Coastal Ranges Open Forest	LHCCREMS Vegetation (2003)	9	3215.7
Coastal Ranges Open Forest	Watagans Vegetation (Bell & Discoll, 2006)	9	518.8
Rocky Outcrop	Cessnock-Kurri Region Vegetation (Bell & Discoll, 2007)	R	8.6
Plantation Eucalypt Forest	Jilliby Vegetation (Bell & Discoll, 2006)	X	16.6
Plantation Eucalypt Forest	Watagans Vegetation (Bell & Discoll, 2006)	X	331.3
Coastal Foothills Spotted Gum - Ironbark Forest	Pambalong Vegetation (EcoLogical, 2003)	-	0.1
<i>E. paniculata</i> , <i>E. umbra</i> , <i>Syncarpia glomulifera</i> , <i>C. maculata</i> , <i>M. stypheloides</i>	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	-	2.1
<i>Eucalyptus amplifolia</i> , <i>Eucalyptus paniculata</i> , <i>Eucalyptus mollucana</i>	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	-	2.3
Introduced Grassland	Pambalong Vegetation (EcoLogical, 2003)	-	1.1
Paperbark - Sedgeland Woodland	Pambalong Vegetation (EcoLogical, 2003)	-	0.6
Paperbark Woodland with Grassland	Pambalong Vegetation (EcoLogical, 2003)	-	1.9
Standing Water	Pambalong Vegetation (EcoLogical, 2003)	-	1.1
Swamp Meadow	Pambalong Vegetation (EcoLogical, 2003)	-	6.4
Swamp Meadow/Spikerush Sedgeland	Pambalong Vegetation (EcoLogical, 2003)	-	0.0
Wollonbi Redgum - Cabbage Gum Floodplain Woodland	Lower Hunter, Cessnock LGA Vegetation (Parsons Brinckerhoff, 2013)	-	81.0
Unknown	Watagans Vegetation (Bell & Discoll, 2006)		0.5

Appendix C

EPBC listed species and communities



C1. EPBC listed threatened biodiversity

Threatened species and communities predicted or known to occur within the Lower hunter region are listed in Tables C.1 – C.4 below.

Table C.1 EPBC Threatened communities within the Lower Hunter region

Threatened Ecological Community	EPBC Act Status ¹	Likelihood of occurrence within the study area
Threatened ecological communities currently listed under the EPBC Act		
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	CE	Low , does not occur
Littoral rainforest and coastal vine thickets of eastern Australia	CE	High , known to occur.
Lowland rainforest of subtropical Australia	CE	High , known to occur.
Threatened ecological communities currently nominated for listing under the EPBC Act		
Subtropical and temperate coastal saltmarsh	N/A	High , known to occur.
Hinterland sand flats and woodlands of the Sydney Basin Bioregion	N/A	High , known to occur.
Hunter Valley remnant open forests and woodlands	N/A	High , known to occur

Note:

1. Listed as Critically Endangered (CE) under the EPBC Act.

Table C.2 Likelihood of occurrence of Threatened species of plants within the study area

Species Name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Occurrence within Lower Hunter region ³
<i>Acacia bynoeana</i> (Bynoes Wattle)	E	V	Occurs south of Dora Creek-Morisset area to Berrima and the Illawarra region and west to the Blue Mountains. It grows mainly in heath and dry sclerophyll forest on sandy soils (Harden 2002). Seems to prefer open, sometimes disturbed sites such as trail margins and recently burnt areas. Typically the species occurs in association with <i>Corymbia gummifera</i> , <i>Eucalyptus haemastoma</i> , <i>E. gummifera</i> , <i>E. parramattensis</i> , <i>E. sclerophylla</i> , <i>Banksia serrata</i> and <i>Angophora bakeri</i> (NSW National Parks and Wildlife Service 1999a).	K
<i>Acacia gordonii</i>	E	E	Occurs in the lower Blue Mountains from Bilpin to Faulconbridge and also in the Glenorie district. Grows on sandstone outcrops and amongst rock platforms in dry sclerophyll forest and heath (Harden 2002; NSW Scientific Committee 1997). Specifically this species occurs in Sydney Sandstone Ridgetop Communities (James 1997).	P
<i>Acacia pubescens</i>	V	V	Restricted to the Sydney Region from Bilpin to the Georges River and also at Woodford where it usually grows in open sclerophyll forest and woodland on clay soils. Typically it occurs at the intergrade between shales and sandstones in gravelly soils often with ironstones (Harden 2002; NSW National Parks and Wildlife Service 2003a).	P
<i>Allocasuarina defungens</i> (Dwarf Heath Casuarina)	E	E	Only occurs in NSW, from the Napiac area (north-west of Forster) to Byron Bay on the NSW north coast. It grows mainly in tall heath on sand, but can also occur on clay soils and sandstone. It also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains (Department of Environment and Conservation 2005b).	K
<i>Allocasuarina glareicola</i>	E	E	Restricted to the Sydney basin where it occurs north east of Penrith in or near Castlereagh State Forest. Grows on lateritic soil in open forest (Harden 2000).	P
<i>Allocasuarina simulans</i> (Napiac Casuarina)	V	V	Very rare, this species is restricted to the mid-north coast of NSW, from Napiac to Forster. It grows in heath on coastal sands (Department of Environment and Conservation 2005b; Royal Botanic Gardens 2005).	P
<i>Angophora inopina</i> (Charmhaven Apple)	V	V	Restricted to the Charmhaven - Wyee area where it grows in open dry sclerophyll woodland of <i>Eucalyptus haemastoma</i> and <i>Corymbia gummifera</i> with a dense shrub understorey. Occurs on deep white sandy soils over sandstone, often with some gravelly laterite (Harden 2002; NSW Scientific Committee 1998a).	K
<i>Asperula asthenes</i> (Trailing Woodruff)	V	V	This small herb occurs only in NSW in scattered locations from Bulahdelah north to near Kempsey, with several records from the Port Stephens/Wallis Lakes area. It grows in damp sites, often along river banks (Department of Environment and Conservation 2005b; Harden 1992).	K
<i>Asterolasia elegans</i>	E	E	Only known to occur in one locality, north of Maroota, where it grows in wet sclerophyll forest on moist hillsides (Harden 2002).	P

Species Name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Occurrence within Lower Hunter region ³
<i>Astrotricha crassifolia</i> (Thick-leaf Star-hair)	V	V	Occurs near Patonga and in the Royal National Park and inland to Glen Davis where it grows in dry sclerophyll woodland on sandstone (Department of Environment and Climate Change 2007b; Harden 1992, 1993).	P
<i>Bothriochloa biloba</i> (Lobed Bluegrass)		V	Has a widespread distribution and grows in woodland on poorer soils (Harden 1993). Occurs on basaltic hills and grassland on drainage slopes on a variety of soils in association with <i>Eucalyptus punctata</i> , <i>E. albens</i> , <i>E.camaldulensis</i> , <i>E. tereticornis</i> , <i>E. populnea ssp bimbil</i> and <i>Angophora floribunda</i> (DLWC, 2001).	P
<i>Caladenia tessellata</i> (Thick Lip Spider Orchid)	E	V	Occurs south of Swansea where it grows on clay loam or sandy soils (Harden 1993). Prefers low open forest with a healthy or sometimes grassy understorey (Bishop 2000). Within NSW, currently known from two disjunct areas; one population near Braidwood on the Southern Tablelands and three populations in the Wyong area on the Central Coast. Previously known also from Sydney and South Coast areas (NSW Scientific Committee 2002).	K
<i>Cryptostylis hunteriana</i> (Leafless Tongue Orchid)	V	V	Occurs south from the Gibraltar Range, chiefly in coastal districts but also extends on to tablelands. Grows in swamp-heath and drier forest on sandy soils on granite & sandstone. Occurs in small, localised colonies most often on the flat plains close to the coast but also known from some mountainous areas growing in moist depressions and swampy habitats (Harden 1993; NSW National Parks and Wildlife Service 1999g).	K
<i>Cynanchum elegans</i> (White-flowered Wax Plant)	E	E	Occurs from the Gloucester district to the Wollongong area and inland to Mt Dangar where it grows in rainforest gullies, scrub and scree slopes (Harden, 1992). This species typically occurs at the ecotone between dry subtropical forest/woodland communities (James 1997).	K
<i>Darwinia biflora</i>	V	V	Occurs from Cheltenham to Hawkesbury River where it grows in heath on sandstone or in the understorey of woodland on shale-capped ridges (Harden 2002). Occurs on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include <i>Eucalyptus haemastoma</i> , <i>Corymbia gummifera</i> and/or <i>E. squamosa</i> . The vegetation structure is usually woodland, open forest or scrub-heath (Department of Environment and Climate Change 2008).	P
<i>Diuris pedunculata</i> (Small Snake Orchid)	E	E	Occurs chiefly from Port Jackson to Tenterfield where it grows in moist grassy areas in sclerophyll forest (Harden 1993). It typically occurs on stony soils on low ridges or moist flats (Bishop 2000), often on peaty soils in moist areas but also on shale and trap soils, on fine granite, and among boulders (Department of Environment and Conservation 2005b).	P
<i>Diuris praecox</i> (Rough Double Tail)	V	V	Occurs in coastal and near-coastal districts from Ourimbah to Nelson Bay where it grows in sclerophyll forest (Harden 1993) often on hilltops or slopes (Bishop 2000).	K

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<i>Eucalyptus camfieldii</i> (Heart-leaved Stringybark)	V	V	Occurs from Norah Head, on the NSW Central Coast, to Waterfall and the Royal National Park, south of Sydney (Fairley, Alan 2004). Within this area it occurs in scattered locations including Peats Ridge, Mt Colah, West Head, Terrey Hills, Killara, North Head, Menai, Wattamolla and a few other sites within the Royal National Park (Fairley, Alan 2004). Camfield's Stringybark occurs in shallow sandy soils overlying Hawkesbury sandstone within coastal heath, generally on exposed sandy ridges. It occurs mostly in small scattered stands near the boundary of tall coastal heaths and low open woodlands of the slightly more fertile inland areas (Department of Sustainability Environment Water Population and Communities 2012). Associated species frequently include Brown Stringybark (<i>E. capitellata</i>), Scribbly Gum (<i>E. haemastoma</i>), Narrow-leaved Stringybark (<i>E. oblonga</i>), Silvertop Ash (<i>E. sieberi</i>), Smooth-barked Apple (<i>Angophora costata</i>), Dwarf Apple (<i>A. hispida</i>), Red Bloodwood (<i>Corymbia gummifera</i>), Scrub She-oak (<i>Allocasuarina distyla</i>), Slender Tea Tree (<i>Leptospermum trinervium</i>), and Fern-leaved Banksia (<i>Banksia oblongifolia</i>) (Department of Sustainability Environment Water Population and Communities 2012).	K
<i>Eucalyptus glaucina</i> (Slaty Red Gum)	V	V	Occurs from Taree to Broke where it is locally frequent but very sporadic and grows in grassy woodland on deep, moderately fertile and well-watered soil (Harden 2002). Endemic on low coastal ranges and tablelands of central NSW, Taree to Broke, also near Casino (Brooker & Kleinig 1999).	K
<i>Eucalyptus parramattensis</i> <i>subsp. decadens</i>	V	V	Occurs as two separate populations; the Kurri Kurri and Tomago Sandbeds meta-populations. The species is locally frequent, growing in dry sclerophyll woodland on sandy soils in low, often wet sites. Is the characteristic species of the Kurri Sand Swamp Woodland in the Sydney Basin Bioregion that is included in the nominated Hinterland sand flats forest and woodlands of the Sydney Basin Bioregion community (Harden 2002).	K
<i>Eucalyptus pumila</i> (Pokolbin Mallee)	V	V	Now only known from a single stand near Pokolbin where it grows in sclerophyll shrubland on skeletal soil on sloping sandstone (Harden 2002). Previously recorded from Muswellbrook and Wyong (Brooker & Kleinig 1999).	K
<i>Euphrasia arguta</i>	CE	CE	Rediscovered in the Nundle area of the NSW north western slopes and tablelands in 2008, it had not been collected for 100 years. Historically, it was recorded from relatively few places within an area extending from Sydney to Bathurst and north to Walcha. Ecological information from historical records is scarce including, 'in the open forest country around Bathurst in sub humid places', 'on the grassy country near Bathurst', 'in meadows near rivers'. The populations that are currently known are located in the Nundle State Forest and on nearby private land, in eucalypt forest with a mixed grass and shrub understory.	P
<i>Genoplesium littorale</i> (Tuncurry Midge Orchid)	E	CE	Known from only one population in the Tuncurry district. The population occurs on well-drained, open sand ridge sites in low dense heath dominated by <i>Ochrosperma lineare</i> or in sparse shrubland of <i>Monotoca elliptica</i> , <i>Brachyloma daphnoides</i> and/or <i>Leptospermum</i> spp. (Jones, D.L. 2006a; Paget 2008). The life cycle of <i>Genoplesium littorale</i> is not well known, with the above-ground parts dying back after fruiting and the species existing as underground tubers for most of the year. The flowering period is from March to May (Jones, D.L. 2006a).	P
<i>Grevillea caleyi</i> (Caley's Grevillea)	E	E	Occurs in the Terrey Hills-Belrose area north of Sydney where it grows in woodland on laterized sandstone ridgetops (Harden 2002).	P

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<i>Grevillea guthrieana</i> (Guthrie's Grevillea)	E	E	Occurs on the north coast of NSW, at Booral near Bulahdelah and on the Carrai Plateau, south-west of Kempsey. It grows along creeks and cliff lines in moist eucalypt forest, on granitic or sedimentary soil (Department of Environment and Conservation 2005b; Royal Botanic Gardens 2005).	P
<i>Grevillea parviflora</i> <i>subsp. parviflora</i> (Small-flower Grevillea)	V	V	Mainly known from the Prospect area (but now extinct there) and lower Georges River to Camden, Appin and Cordeaux Dam areas, with a disjunct populations near Putty, Cessnock and Cooranbong. Grows in heath or shrubby woodland in sandy or light clay soils usually over thin shales (Harden 2002; NSW Scientific Committee 1998b).	K
<i>Hakea archaeoides</i> (Big Nellie Hakea)	V	V	Found only in NSW, between Kempsey and Taree, around Mt Boss, Broken Bago and Landsdowne to Wauchope. It is restricted to the hinterland on near coastal ranges above 230 metre altitude where it is found on steep, rocky, sheltered slopes and in deep gullies in open eucalypt forest. Commonly occurs at the interface of dry eucalypt forest and gully communities (Department of Environment and Conservation 2005b; Royal Botanic Gardens 2005).	P
<i>Grevillea shiressii</i>	V	V	<i>Grevillea shiressii</i> is a tall shrub Grows along creek banks in wet sclerophyll forest with a moist understorey in alluvial sandy or loamy soils. The species is a fire sensitive obligate seeder that is highly susceptible to local extinction due to frequent fire. Known only from two populations near Gosford, on tributaries of the lower Hawkesbury River north of Sydney (Mooney Mooney Creek and Mullet Creek). Both populations occur within the Gosford Local Government Area (Department of Environment and Climate Change 2007).	K
<i>Haloragis exalata</i> <i>subsp. Exalata</i> (Square Raspwort)	V	V	Found in the south coast, central coast and north west slopes botanical regions where it appears to require protected and shaded damp situations in riparian habitats (Department of Environment and Climate Change 2008; Harden 2002).	P
<i>Haloragodendron lucasii</i>	E	E	Confined to the Sydney area where it grows in dry sclerophyll open forest on sheltered slopes near creeks on sandstone (Harden 2002). Reported to grow in moist sandy loam soils in sheltered aspects, and on gentle slopes below cliff-lines near creeks in low open woodland. Associated with high soil moisture and relatively high soil-phosphorus levels (Department of Environment and Conservation 2005b).	P
<i>Kunzea rupestris</i>	V	V	Grows in shallow depressions on large flat sandstone rock outcrops, characteristically found in short to tall shrubland or heathland (Department of Environment and Climate Change).	P
<i>Lasiopetalum joyceae</i>	V	V	Occurs on lateritic to shaley ridgetops of the Hornsby Plateau where it grows in heath and open woodland in sandy soils on sandstone (Fairley, A. & Moore 2002; Harden 2000; NSW Scientific Committee 1999a).	P
<i>Leptospermum deanei</i>	V	V	Only occurs near the watershed of Lane Cove River where it grows on forested slopes (Harden 2002).Woodland on lower hills and slopes or near creeks, sandy alluvial soil or sand over sandstone. Occurs in Riparian Scrub- e.g. <i>Tristaniopsis laurina</i> , <i>Baechea myrtifolia</i> , Woodland- e.g. <i>Eucalyptus haemstoma</i> and Open Forest - e.g. <i>Angophora costata</i> , <i>Leptospermum trinervium</i> and <i>Banksia ercifolia</i> (Department of Environment and Climate Change).	P

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<i>Melaleuca biconvexa</i> (Biconvex Paperbark)	V	V	Occurs as disjunct populations, in coastal New South Wales, from Jervis Bay to Port Macquarie. The main concentration of records is within the Gosford/Wyong area (NSW Scientific Committee 1998c). Grows in damp places, often near streams, or low-lying areas on alluvial soils of low slopes or sheltered aspects (Department of Environment and Climate Change 2008; Harden 2002).	K
<i>Melaleuca deanei</i> (Deane's Paperbark)	V	V	Occurs in coastal districts, including western Sydney (e.g. Baulkham Hills, Liverpool shires) from Berowra to Nowra where it grows in wet heath on sandstone and shallow/skeletal soils near streams or perched swamps (Harden 2002; James 1997).	P
<i>Micromyrtus blakelyi</i>	V	V	Restricted to areas near the Hawkesbury River where it grows in heath in depressions on sandstone rock platforms (Harden 2002).	P
<i>Microtis angusii</i>	E	E	Known from few small populations at Sunny Corner near Bathurst, Ingleside and Warringah. Known to occur within Duffy's Forest (Warringah Shire Council 2004).	K
<i>Olearia cordata</i>	V	V	Occurs chiefly from Wiseman's Ferry to Wollombi where it grows on sandstone in dry sclerophyll forest and open shrubland (Harden 1992). Specifically this species occurs on exposed Hawkesbury Sandstone ridges in shallow or skeletal soils. Occurs on Gynea and Hawkesbury soil types and may be associated with shale. Associated species include <i>Angophora costata</i> , <i>A. bakeri</i> , <i>Eucalyptus punctata</i> and <i>Corymbia eximia</i> with understorey including <i>Allocasuarina torulosa</i> , <i>Acacia linifolia</i> , <i>Persoonia linearis</i> , <i>Leucopogon muticus</i> and grasses. Also been recorded with <i>E. eugenioides</i> or near Wollemi with <i>E. oblonga</i> , <i>E. notabilis</i> and <i>Leptospermum trinervium</i> . <i>Corymbia gummifera</i> and <i>Angophora euryphylla</i> also noted in northern areas (NSW National Parks and Wildlife Service 2000a).	K
<i>Ozothamnus tessellatus</i>	V	V	Grows in eucalypt woodland. Restricted to a few locations north of Rylstone (NSW Department of Environment and Conservation 2005).	P
<i>Pelargonium sp. Striatellum</i> (G. W. Carr 10345), syn. <i>Pelargonium sp.</i> , <i>Pelargonium sp. 1</i> (Omeo Stork's-bill)	E	E	Known to occur in New South Wales and Victoria in habitat usually located just above the high water level of irregularly inundated or ephemeral lakes and in the transition zone between surrounding grasslands or pasture and the paludal and aquatic communities. During dry periods, the species is known to colonise exposed lake beds (Department of Sustainability Environment Water Population and Communities 2012).	P
<i>Persicaria elatior</i> (Tall Knotweed)	V	V	Occurs infrequently in coastal regions where it grows in damp places especially beside streams and lakes. Also occasionally occurs in swamp forest or associated with disturbance (Department of Environment and Conservation 2005b; Harden 2000).	K
<i>Persoonia hirsuta</i> (Hairy Geebung)	E	E	Occurs from Gosford to the Royal National Park and Hill Top to Glen Davis and Putty inland where it grows in woodlands and dry sclerophyll forest on sandstone or very rarely on shale (Harden 2002). Typically occurs as isolated individuals or very small populations (NSW Scientific Committee 1998d; Royal Botanic Gardens 2005). Often occurs in areas with clay influence, in the ecotone between shale and sandstone (James 1997). Habitat in Castle Hill is considered to be "critical habitat" (James 1997).	K

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<i>Persoonia mollis</i> <i>subsp. Maxima</i>	E	E	Restricted to the Hornsby Heights, Mt Colah area north of Sydney. It occurs on sheltered upper hillsides of narrow gullies of Hawkesbury sandstone characterised his by steep sideslopes, rocky benches and broken scarps, with creeks fed by small streams and intermittent drainage depressions. It grows in moist, tall forest (<i>Angophora costata</i> , <i>Eucalyptus piperita</i> , <i>Corymbia gummifera</i>), often with warm temperate rainforest influences (<i>Syncarpia glomulifera</i> , <i>Ceratopetalum apetalum</i> , <i>Callicoma serratifolia</i>). Sometimes recorded in low densities on the dry upper-hillsides of gullies and in more exposed aspects in association with <i>E. haemastoma</i> and <i>E. punctata</i> (NSW National Parks and Wildlife Service 2000b).	P
<i>Persoonia pauciflora</i> (North Rothbury Persoonia)	CE	V	Known distribution extremely restricted. All known individuals occur within 2.5km of the original or type specimen, which was recorded near North Rothbury in the Cessnock Local Government Area. Occurs in dry open-forest or woodland habitats, generally with projected foliage cover ranging between 10 to 40% and tree height range of between 6 to 18 metres. The lower stratum usually comprises of a moderate to sparsely distributed shrub layer, with a high percentage of groundcover species, particularly grasses. Vegetation communities are dominated by Spotted Gum (<i>Corymbia maculata</i>), Broad-leaved Ironbark (<i>Eucalyptus fibrosa</i>), and/or Narrow-leaved Ironbark (<i>E. crebra</i>). Sub-dominant species include Grey Gum (<i>E. punctata</i>) and Grey Box (<i>E. mollucana</i>). Common understorey shrubs include <i>Acacia parvipinnula</i> , <i>Daviesia ulicifolia</i> and <i>Bursaria spinosa</i> . The majority of the population is known to occur on silt- sandstone soils derived from the "Farley Formation"(Patrick 1999), (NSW National Parks and Wildlife Service 1999d).	K
<i>Phaius australis</i> (Southern Swamp Orchid)	E	E	Previously occurred as far south as Port Macquarie but is now thought to only occur north of Coffs Harbour. Grows in coastal areas in swampy grassland or forest including rainforest, eucalypt or paperbark forest. The species flowers annually between September and October (Harden 1993; NPWS 2002).	P
<i>Philothea ericifolia</i>		V	Grows chiefly in dry sclerophyll forest and heath on damp sandy flats and gullies, in the upper Hunter Valley and Pilliga to Peak Hill district (Royal Botanic Gardens 2004). It has been collected from a variety of habitats including heath, open woodland, dry sandy creek beds, and rocky ridge and cliff tops. Associated species include <i>Melaleuca uncinata</i> , <i>Eucalyptus crebra</i> , <i>E. rossii</i> , <i>E. punctata</i> , <i>Corymbia trachyphloia</i> , <i>Acacia triptera</i> , <i>A. burrowii</i> , <i>Beyeria viscosa</i> , <i>Philothea australis</i> , <i>Leucopogon muticus</i> and <i>Calytrix tetragona</i> . Noted as being a moisture-loving plant, with plants common on the sides of a particular spur of the Hervey Ranges where soakage from the high background provides sufficient moisture for the plants (Department of Environment and Conservation 2005b).	P
<i>Pimelea curviflora</i> <i>var. curviflora</i>	V	V	Confined to coastal areas around Sydney where it grows on sandstone and laterite soils. It is found between South Maroota, Cowan, Narrabeen, Allambie Heights, Northmead and Kellyville, but its former range extended south to the Parramatta River and Port Jackson region including Five Dock, Bellevue Hill and Manly. Usually occurs in woodland in the transition between shale and sandstone, often on Lucas Heights soil landscape (Harden 2000; James 1997; James <i>et al.</i> 1999; NSW Scientific Committee 1998e).	P
<i>Pomaderris reperta</i> (Denman Pomaderris)	E	CE	Recorded from a small number of sites along a single ridgeline near Denman in the upper Hunter Valley (Muswellbrook local government area). Occupies woodland in association with <i>Eucalyptus crebra</i> , <i>E. blakelyi</i> , <i>Notelaea microcarpa</i> , and <i>Allocasuarina littoralis</i> (NSW Department of Environment and Conservation 2005).	P

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<i>Pomaderris brunnea</i>	V	V	Confined to the Colo and Upper Nepean Rivers where it grows in open forest (Harden 2000); in western Sydney (Camden to Picton area) known from sandy alluvium on levee and creek banks. The species has been associated with <i>Eucalyptus amplifolia</i> , <i>Angophora floribunda</i> , <i>Acacia parramattensis</i> , <i>Bursaria spinosa</i> and <i>Kunzea ambigua</i> (James 1997).	K
<i>Prasophyllum</i> sp. <i>Wybong</i> (C. Phelps ORG 5269) (a leek orchid)		CE	<i>Prasophyllum</i> sp. <i>Wybong</i> (C. Phelps ORG 5269) is known from seven populations in open eucalypt woodland and grassland in NSW. The species' area of occupancy is estimated to be 1.5 km ² with an estimated population size based on surveys in 2006 of 460 mature individuals. This species occurs within the Sydney Basin, New England Tablelands, Brigalow Belt South and NSW South Western Slopes IBRA Bioregions and the Border Rivers-Gwydir, Namoi, Hunter-Central Rivers and Central West Natural Resource Management Regions. The distribution of this species overlaps with the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland EPBC Act-listed threatened ecological community (Department of Sustainability Environment Water Population and Communities 2012).	P
<i>Prostanthera askania</i> (Tranquility Mintbush)	E	E	Restricted to the Ourimbah--Narara area where it currently known to exist in five populations. It grows in sclerophyll forest on ridges in or adjacent to rainforest grows in sclerophyll forest on ridges in or adjacent to rainforest (Harden 1992; NSW Scientific Committee 1998f).	P
<i>Prostanthera cineolifera</i> (Singleton Mint Bush)		V	Thought to occur in north coast and central coast botanical subdivisions near Walcha, Scone, Cessnock and St Albans where it apparently grows in sclerophyll forest open woodlands or exposed sandstone ridges. The species is generally associated with shallow or skeletal soils (Department of Sustainability Environment Water Population and Communities 2012).	K
<i>Prostanthera cryptandroides</i> subsp. <i>Cryptandroides</i> (Wollemi Mint-bush)	V	V	Range extends from Lithgow to Queensland, however occurrence is disjunct within this range. Habitat is specific at each location, for example: Open forest dominated by <i>Eucalyptus fibrosa</i> at Glen Davis; variety of communities along rocky ridgelines on Narrabeen group Sandstones at Denman-Gungal and Widden-Baerami Valley such as rocky heath, Acacia woodland, exposed woodland, open heathland of <i>Calytrix tetragona</i> , <i>leptospermum parviflorum</i> and <i>Isopogon dawsonii</i> , and open scrubland of <i>Eucalyptus dwyeri</i> , <i>Baeckea densifolia</i> , <i>Dillwynia floribunda</i> , <i>Aotus ericoides</i> and <i>Hemigenia cunefolia</i> (Department of Environment and Climate Change 2008).	P
<i>Prostanthera densa</i> (Villous Mint-bush)	V	V	Occurs from Nelson Bay to Beecroft Peninsula where it grows in sclerophyll forest and shrubland, on coastal headlands and near-coastal ranges, on sandstone (Harden 1992).	K
<i>Prostanthera junonis</i> (Somersby Mintbush)	E	E	Grows in sclerophyll forest and woodland, usually near the coast, in sandy loamy soils, overlying sandstone. Occurs in Mangrove Mountain and Sydney districts (Harden 1992).	P

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<i>Prostanthera marifolia</i> (Seaforth Mintbush)	E	CE	Thought to be extinct. Previously occurred in Mangrove Mountain and Sydney districts usually near the coast. Recorded within sclerophyll forest and woodland in sandy loamy soils on sandstone Occurs in the Springwood area where it grows in woodland on lateritic soils (Harden 1992). The taxonomic status of this name is uncertain (Royal Botanic Gardens 2004).	P
<i>Pultenaea parviflora</i>	E	V	Restricted to the Cumberland Plain where it grows in dry sclerophyll forest on Wianamatta shale, laterite or alluvium (Harden 2002). Locally abundant within Castlereagh Ironbark Forest and Shale Gravel Transition Forest on tertiary alluvium or laterised clays. Also occurs in transitional areas where these communities adjoin Castlereagh Scribbly Gum Woodland (James 1997; NSW National Parks and Wildlife Service 2002a).	P
<i>Pterostylis gibbosa</i>	E	E	Occurs in the southern part of the Central Coast region with a disjunct population in the Hunter Valley. Grows among grass in sclerophyll forest (Harden 2002). In the Illawarra it grows in Coastal Grassy Red Gum Forest and in Lowland Woollybutt-Melaleuca forest (NSW National Parks and Wildlife Service 2003d).	K
<i>Rhizanthella slateri</i> (Eastern Australian Underground Orchid)	V	E	Highly cryptic as only the flowers may occur above ground. It is more frequent in areas of soil disturbance, but further habitat characteristics or associated vegetation types are poorly known, possibly occurring in sclerophyll forests (Harden 1993).	K
<i>Rulingia prostrata</i>	E	E	Occurs south of Picton lakes where it mainly grows in gullies along the escarpment, south from Picton Lakes (Harden 2000), on the Southern Tablelands (one plant at Penrose State Forest, one plant at Rowes Lagoon and one plant at Tallong) and on the North Coast (less than 100 plants at the Tomago sandbeds north of Newcastle). It occurs on sandy, sometimes peaty soils in a wide variety of habitats: Snow Gum (<i>Eucalyptus pauciflora</i>) Woodland at Rose Lagoon; Blue leaved Stringybark (<i>E. agglomerata</i>) Open Forest at Tallong; and in Brittle Gum (<i>E. mannifera</i>) Low Open Woodland at Penrose; Scribbly Gum (<i>E. haemostoma</i>) Swamp Mahogany (<i>E. robusta</i>) Ecotonal Forest at Tomago. Associated native species may include <i>Imperata cylindrica</i> , <i>Empodisma minus</i> and <i>Leptospermum continentale</i> (Department of Environment and Climate Change 2007b).	K
<i>Rutidosis heterogama</i> (Heath Wrinklewort)	V	V	Occurs in coastal districts from Maclean to the Hunter Valley and inland to the Torrington region. Grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides (Department of Environment and Conservation 2005b; Royal Botanic Gardens 2005).	K
<i>Streblus pendulinus</i> (Whalebone Tree)		E	On the Australian mainland, Siah's Backbone is found in warmer rainforests, chiefly along watercourses. The altitudinal range is from near sea level to 800 m above sea level. The species grows in well-developed rainforest, gallery forest and drier, more seasonal rainforest (Department of Sustainability Environment Water Population and Communities 2012)..	K
<i>Syzygium paniculatum</i> (Magenta Lilly Pilly)	E	V	Occurs between Buladelah and St Georges Basin where it grows in subtropical and littoral rainforest on sandy soils or stabilized dunes near the sea (Harden 2002). On the south coast the Magenta Lilly Pilly occurs on grey soils over sandstone, restricted mainly to remnant stands of littoral (coastal) rainforest. On the central coast Magenta Lilly Pilly occurs on gravels, sands, silts and clays in riverside gallery rainforests and remnant littoral rainforest communities (Department of Environment and Climate Change 2008).	K

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<i>Tetratheca glandulosa</i> (Glandular Pink-bell)	V	V	Occurs from Mangrove Mountain to the Blue Mountains where it grows in sandy or rocky heath or scrub (Harden 1992). Associated with shale-sandstone transition habitat where shale-cappings occur over sandstone, with associated soil landscapes such as Lucas Heights, Gynea, Lambert and Faulconbridge. Topographically, the plant occupies ridgetops, upper-slopes and to a lesser extent mid-slope sandstone benches. Soils are generally shallow, consisting of a yellow, clayey/sandy loam. Stony lateritic fragments are also common in the soil profile on many of these ridgetops. Vegetation structure varies from heaths and scrub to woodlands/open woodlands, and open forest. Vegetation communities correspond broadly to Benson & Howell's Sydney Sandstone Ridgetop Woodland (Map Unit 10ar). Common woodland tree species include: <i>Corymbia gummifera</i> , <i>C. eximia</i> , <i>Eucalyptus haemastoma</i> , <i>E. punctata</i> , <i>E. racemosa</i> , and/or <i>E. sparsifolia</i> , with an understorey dominated by species from the families Proteaceae, Fabaceae, and Epacridaceae (Department of Environment and Climate Change 2008).	K
<i>Tetratheca juncea</i> (Black-eyed Susan)	V	V	Occurs in coastal districts from Buladelah to Port Macquarie where it grows in dry sclerophyll forest and occasionally swampy heath in sandy, (Harden 1992) low nutrient soils with a dense understorey of grasses. Specifically it is known to occur within Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland (Payne <i>et al.</i> 2002).	K
<i>Velleia perfoliata</i>	V	V	Only known from the Hawkesbury district and upper Hunter Valley. Found in shallow depressions on Hawkesbury sandstone shelves or under cliffs. Occurs on fairly shallow soils of sandy loam texture. Generally found growing on moss mats formed on the rock shelf. Flowering variable and can occur in any season, though peaking generally in spring to early summer (DECC 2009).	K
<i>Zieria involuocrata</i>	E	V	Occurs in the Blue Mountains where it grows in wet sclerophyll forest (Harden 2002). Occurs primarily on Hawkesbury sandstone. Also occurs on Narrabeen Group sandstone and on Quaternary alluvium. Found primarily in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest, although some populations extend upslope into drier vegetation. Also known from at least two atypical ridgetop locations. The canopy typically includes <i>Syncarpia glomulifera</i> subsp. <i>glomulifera</i> (Turpentine), <i>Angophora costata</i> (Smooth-barked Apple), <i>Eucalyptus agglomerata</i> (Blue-leaved Stringybark) and <i>Allocasuarina torulosa</i> (Forest Oak) (Department of Environment and Climate Change 2008).	P

Notes:

1. Listed as Vulnerable (V), Endangered (E) or Critically Endangered (CE) under the TSC Act. TSC Act status is provided as a reference only; the table does not include a full list of the TSC ACT listed species within the region.
2. Listed as Vulnerable (V), Endangered (E) or Critically Endangered (CE) under the EPBC Act.
3. Likelihood of occurrence: K=known; P= Predicted; blank cells= Not known

Table C.3 Likelihood of occurrence of Threatened species of animals within the study area

Species name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Likelihood of occurrence within Lower Hunter region ³
Amphibians				
Booroolong Frog (<i>Litoria booroolongensis</i>)	E	E	Confined to mountain streams of the Great Dividing Range (Cogger 2000). Usually found on or under boulders and debris in and beside the rocky beds of mountain streams; breeds in summer (Anstis 2002).	P
Giant Barred Frog (<i>Mixophyes iteratus</i>)	E	E	Terrestrial species which occurs in rainforests, Antarctic beech or wet sclerophyll forests. Feeds on insects and smaller frogs (Cogger 2000). The species is associated with permanent flowing drainages, from shallow rocky rainforest streams to slow-moving rivers in lowland open forest. It is not known to utilise still water areas (NSW Scientific Committee 1999b). More prevalent at lower altitudes and in larger streams than its congeners, although has been recorded up to 1000 metres asl. (NSW National Parks and Wildlife Service 1999g).	K
Giant Burrowing Frog (<i>Heleioporus australiacus</i>)	V	V	Exists as two distinct populations: a northern population on the sandstone geology of the Sydney Basin, from Wollemi National Park in the north, south to Jervis Bay; and a southern population in disjunct pockets from about Narooma south into eastern Victoria. In the northern population there is a marked preference for sandstone ridgetop habitat and broader upland valleys where the frog is associated with small headwater and slow flowing to intermittent creeklines. The vegetation is typically woodland, open woodland and heath and may be associated with 'hanging swamp' seepage lines and where small pools form from collected water. Also observed occupying artificial ponded structures such as fire dams, gravel 'borrows', detention basins and box drains that have naturalised and are surrounded by undisturbed habitat. In the southern population, records appear to be associated with Devonian igneous and sedimentary formations and Ordovician metamorphics and are generally from more heavily timbered areas. It is absent from areas that have been cleared for agriculture or for urban development. Breed in summer and autumn in burrows in the banks of small creeks (Cogger 2000; NSW National Parks and Wildlife Service 2001a).	K
Green and Golden Bell Frog (<i>Litoria aurea</i>)	E	V	Has a fragmented distribution of mainly near coastal locations from Lakes Entrance (Victoria) to south of the NSW-Queensland border. For breeding it utilises a wide range of waterbodies, including both natural and man-made structures, such as marshes, dams and stream sides, and ephemeral locations that are more often dry than wet. It is found in small pockets of habitat in otherwise developed areas and has the tendency of often turning up in highly disturbed sites. Fast flowing rivers and streams appear to be one of the few types of water body not utilized for breeding purposes. Habitat attributes associated with the species' presence include that the water body is shallow, still or slow flowing, ephemeral and/or widely fluctuating, unpolluted and without heavy shading. Permanent waterbodies are also known to be used and there is historical evidence of occupation of large, often deep and permanent bodies of water. There is a clear preference for sites with a complexity of vegetation structure and terrestrial habitat attributes that favour the species include extensive grassy areas and an abundance of shelter sites such as rocks, logs, tussock forming vegetation and other cover used for foraging and shelter. Over-wintering shelter sites may be adjacent to or some distance away from breeding sites but the full range of possible habitat used for this purpose is not yet well understood (Department of Environment and Conservation 2004, 2005a).	K ⁴

Species name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Likelihood of occurrence within Lower Hunter region ³
Littlejohn's Tree Frog, Heath Frog (<i>Litoria littlejohni</i>)	V	V	Distributed along the eastern slopes of the Great Dividing Range from Watagan State Forest near Wyong, south to Buchan in north-eastern Victoria. It appears to be restricted to sandstone woodland and heath communities at mid to high altitude. It forages both in the tree canopy and on the ground, and it has been observed sheltering under rocks on high exposed ridges during summer. It is not known from coastal habitats (NSW Scientific Committee 2000).	K
Stuttering Frog (<i>Mixophyes balbus</i>)	E	V	Terrestrial species, found in rainforest, Antarctic beech forest or wet sclerophyll forest. The species depends on freshwater streams and riparian vegetation for breeding and habitation. No records are known from riparian habitat that has been disturbed (Cogger 2000; NSW Scientific Committee 2003).	K
Birds				
Amsterdam Albatross (<i>Diomedea amsterdamensis</i>)		E	Breeding on Amsterdam Island and foraging mainly in the surrounding Indian Ocean, but possibly occurring as far afield as Tasmania and New Zealand. Breed biennially in colonies among grass tussocks (Garnett & Crowley 2000).	
Antipodean Albatross (<i>Diomedea antipodensis</i>)	V	V	A nomadic marine species that breeds in sub-antarctic waters to the southeast of New Zealand (Garnett & Crowley 2000).	P ⁵
Australasian Bittern (<i>Botaurus poiciloptilus</i>)	E	E	Occurs in shallow, vegetated freshwater or brackish swamps. Requires permanent wetlands with tall dense vegetation, particularly bulrushes and spikerushes. When breeding, pairs are found in areas with a mixture of tall and short sedges but will also feed in more open territory. (Garnett & Crowley 2000; NSW National Parks and Wildlife Service 2002b).	K
Australian Painted Snipe (Painted Snipe) (<i>Rostratula australis</i> (syn. <i>R. benghalensis</i>))	E	V	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as <i>Eucalyptus camaldulensis</i> (River Red Gum), <i>E. populnea</i> (Poplar Box) or shrubs such as <i>Muehlenbeckia florulenta</i> (Lignum) or <i>Sarcocornia quinqueflora</i> (Samphire). Feeds at the water's edge and on mudflats on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett & Crowley 2000).	K
Black-browed Albatross (<i>Thalassarche melanorhynchus</i>)	V	V	Nomadic marine species that breeds on subantarctic island outside Australian waters, but moves northwards in non-breeding seasons. The waters off southern Australia between Brisbane and Perth are the principal feeding area of birds (Garnett & Crowley 2000).	K ⁵

Species name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Likelihood of occurrence within Lower Hunter region ³
Buller's Albatross (<i>Thalassarche bulleri</i>)		V	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	K ⁵
Campbells Albatross (<i>Thalassarche impavida</i>)		V	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	K
Eastern Bristlebird (<i>Dasyornis brachypterus</i>)	E	E	The habitat of the Eastern Bristlebird is characterised by low dense vegetation. Fire is a feature of all areas where known populations occur. Given the poor flight ability of the species it is thought that few individuals survive the passage of fire, survival is dependent on the availability of fire refuges and recolonisation may be relatively slow. The bird is cryptic and camouflaged and rarely seen but may be detected by its distinctive, loud calls. Confined to NSW/Queensland border region, Illawarra region and NSW/Victorian border region (NSW National Parks and Wildlife Service 1997).	
Fairy Tern (Australian) (<i>Sternula nereis nereis</i>)		V	Fairy Terns utilise a variety of habitats including offshore, estuarine or lacustrine (lake islands, wetlands, beaches and spits. The subspecies may migrate within southern Western Australia and Tasmania, where they are seen less frequently during the winter months. They are more sedentary in the north of Western Australia, and in South Australia and Victoria. Fairy Terns nest in small colonies on coral shingle on continental islands or coral cays, on sandy islands and beaches inside estuaries, and on open sandy beaches (Higgins & Davies 1996). They nest above the high water mark often in clear view of the water and on sites where the substrate is sandy and the vegetation low and sparse. Colonies tend to occupy areas rather than specific sites, and nest sites are often abandoned after one year, even if they have been successful (Australian Transport Safety Bureau 2003).	
Gould's Petrel (<i>Pterodroma leucoptera</i>)	V	E	A marine species, it nests on islands among rocks and debris of Cabbage Tree Palms. It feeds on fish, cephalopods and other marine animals (Garnett & Crowley 2000).	K ⁵
Gibson's Albatross (<i>Diomedea gibsoni</i>)	V	V	A nomadic marine species that forages off the coast of New South Wales (Garnett & Crowley 2000).	K ⁵
Kermadec Petrel (<i>Pterodroma neglecta</i>)	V	V	An oceanic species that forages in the tropical and subtropical Pacific Ocean (Garnett & Crowley 2000).	K ⁷

Species name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Likelihood of occurrence within Lower Hunter region ³
Herald Petrel (<i>Pterodroma heraldica</i>)		CE	A species of tropical waters with normal range south to the NSW border, although it has been recorded off the NSW coast on a number of rare occasions (Simpson and Day 2004).	P ⁵
Northern Giant-Petrel (<i>Macronectes halli</i>)	V	V	Nomadic marine species, that nests as dispersed pairs, often amidst tussocks in dense vegetation. Forages in inshore waters of southern Australia and occasionally visits the coast of NSW (Garnett & Crowley 2000).	K ⁵
Red Goshawk (<i>Erythrotriorchis radiates</i>)	CE	V	Lives in coastal and sub-coastal tall open forests and woodlands, tropical savannas traversed by wooded or forested rivers and along edges of rainforest. Nests are only built in trees taller than 20 meters which occur within 1 kilometre of a watercourse or wetland. Has a home range of 200 square kilometres and hunts for medium to large birds in open forests and gallery forest (Garnett & Crowley 2000).	E
Regent Honeyeater (<i>Xanthomyza phrygia</i>)	CE	E	Occurs mostly in box-ironbark forests and woodland and prefers wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with <i>Casuarina cunninghamiana</i> and <i>Amyema cambagei</i> are important for feeding and breeding. Spotted Gum and Swamp Mahogany forests are also important feeding areas in coastal areas. Important food trees include <i>Eucalyptus sideroxylon</i> (Mugga Ironbark), <i>E. albens</i> (White Box), <i>E. melliodora</i> (Yellow Box) and <i>E. leucoxylon</i> (Yellow Gum) (Garnett & Crowley 2000).	K
Salvin's Albatross (<i>Thalassarche salvini</i>)		V	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	P ⁵
Shy Albatross (<i>Thalassarche cauta</i>)	V	V	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	K ⁵
Southern Giant-Petrel (<i>Macronectes giganteus</i>)	E	E	A partly nomadic marine species that forages off the coast of New South Wales (Garnett & Crowley 2000).	K ⁵

Species name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Likelihood of occurrence within Lower Hunter region ³
Swift Parrot (<i>Lathamus discolor</i>)	E	E	Breeding occurs in Tasmania, majority migrates to mainland Australia in autumn, over-wintering, particularly in Victoria and central and eastern NSW, but also south-eastern Queensland as far north as Duaringa. Until recently it was believed that in New South Wales, swift parrots forage mostly in the western slopes region along the inland slopes of the Great Dividing Range but are patchily distributed along the north and south coasts including the Sydney region, but new evidence indicates that the forests on the coastal plains from southern to northern NSW are also extremely important. In mainland Australia is semi-nomadic, foraging in flowering eucalypts in eucalypt associations, particularly box-ironbark forests and woodlands. Preference for sites with highly fertile soils where large trees have high nectar production, including along drainage lines and isolated rural or urban remnants, and for sites with flowering <i>Acacia pycnantha</i> , is indicated. Sites used vary from year to year. (Garnett & Crowley 2000),(Swift Parrot Recovery Team 2001).	K
Tristan Albatross (<i>Diomedea dabbena</i>)		E	Breeding range now restricted to Inaccessible and Gough Island., having been eliminated from the main island of Tristan de Cunha by 1907. Current global population estimated to contain about 1,000 breeding pairs. There is only one record from Australian waters. Breed biennially in colonies among grass tussocks on isolated sub-Antarctic islands and feed pelagically on squid, fish and crustaceans (Garnett & Crowley 2000).	
Wandering Albatross (<i>Diomedea exulans</i>)	E	V	Nomadic marine species, that breeds in small loose colonies among grass tussocks, using a large mud nets, sometimes off the coast of NSW (Garnett & Crowley 2000).	K
White-bellied Storm-Petrel (<i>Fregetta grallaria</i>)	V	V	Marine species, breeding on Lord Howe Island (Department of Environment and Climate Change 2007).	K
White-capped Albatross (<i>Thalassarche stead</i>)		V	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	P
Fish				
Australian Grayling (<i>Prototroctes maraena</i>)		V	It is a mid-water, freshwater species that occurs most commonly in clear, gravelly streams with a moderate flow. Prefers deep, slow flowing pools (NSW Fisheries 2004).	

Species name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Likelihood of occurrence within Lower Hunter region ³
Black Cod (<i>Epinephelus daemeli</i>)		V	Adult black cod are usually found in caves, gutters and beneath bomboras on rocky reefs. They are territorial and often occupy a particular cave for life. Small juveniles are often found in coastal rock pools, and larger juveniles around rocky shores in estuaries. Black cod are opportunistic carnivores, eating mainly other fish and crustaceans. They can change from one colour pattern to another in just a few seconds. They are usually black in estuaries and banded around clear water reefs. Black cod are apparently slow growing. Smaller fish are mostly females, but they generally change sex to become males at around 100-110 cm in length. (Department of Environment and Climate Change 2007a)	P
Green Sawfish (<i>Pristis zijsron</i>)		V	In Australia the species occurs mainly in the tropics from Broome to southern Queensland, with individuals found as far south as Sydney and a single record from Glenelg, South Australia (Last & Stevens, 1994). The last recorded museum specimen from NSW was in 1972 (Department of Environment and Climate Change 2007a). The Green Sawfish inhabits muddy bottom habitats and enters estuaries. It has been recorded in inshore marine waters, estuaries, river mouths, embankments and along sandy and muddy beaches (Threatened Species Scientific Committee (TSSC) 2008).	P
Macquarie Perch (<i>Macquaria australasica</i>)		E	The natural range of Macquarie Perch included the upper and middle reaches of the Murray-Darling basin as well as the Shoalhaven and Hawkesbury Rivers. However, this species has recently been sighted in only a few localities within these river systems. Preferred habitat is deep holes covered with rocks, and spawning occurs above shallow running water. Macquarie Perch is a schooling species (Department of the Environment and Water Resources, 2007).	
Mammals				
Corben's Long-eared Bat (<i>Nyctophilus corbeni</i>)	V	V	The species has a limited distribution that is restricted around the Murray-Darling Basin in south-eastern Australia (Turbill & Ellis 2006). It occurs in far eastern South Australia, in areas north of the Murray River (Turbill <i>et al.</i> 2008). It occurs in a range of inland woodland vegetation types being most abundant in vegetation with a distinct canopy and a dense cluttered shrub layer (Dominelli 2000; Ellis <i>et al.</i> 1999; Lumsden 1994; Parnaby 1995; Turbill & Ellis 2006). Roosting and breeding habitat includes in tree hollows and under loose bark in arid and semi-arid Australia (Strahan 1995) and forages in the understorey of woodlands and open savannah and swamps (Churchill 1998).	P
Brush-tailed Rock-wallaby (<i>Petrogale penicillata</i>)	E	V	Occurs in inland and sub-coastal south eastern Australia where it inhabits rock slopes. It has a preference for rocks which receive sunlight for a considerable part of the day. Windblown caves, rock cracks or tumbled boulders are used for shelter. Occur in small groups or "colonies" each usually separated by hundreds of metres (NSW National Parks and Wildlife Service 2003b).	K
Grey-headed Flying-fox (<i>Pteropus poliocephalus</i>)	V	V	Occurs in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps. Urban gardens and cultivated fruit crops also provide habitat for this species. Feeds on the flowers and nectar of eucalypts and native fruits including lily pillies. It roosts in the branches of large trees in forests or mangroves (Churchill 2008; NSW National Parks and Wildlife Service 2001b)	K

Species name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Likelihood of occurrence within Lower Hunter region ³
Hastings River Mouse (<i>Pseudomys</i>)	E	E	Recent sightings of the species has been made near low creek banks in tall, open eucalypt forest with dense ground cover of sedges, grasses and/or ferns (Strahan 1995).	
Koala (NSW, ACT & QLD - excluding SE QLD) (<i>Phascolarctos cinereus</i>)	V	V	Found in sclerophyll forest. Throughout New South Wales, Koalas have been observed to feed on the leaves of approximately 70 species of eucalypt and 30 non-eucalypt species. However, in any one area, Koalas will feed almost exclusively on a small number of preferred species. The preferred tree species vary widely on a regional and local basis. Some preferred species in NSW include Forest Red Gum <i>Eucalyptus tereticornis</i> , Grey Gum <i>E. punctata</i> , Monkey Gum <i>E. cypellocarpa</i> and Ribbon Gum <i>E. viminalis</i> . In coastal areas, Tallowwood <i>E. microcorys</i> and Swamp Mahogany <i>E. robusta</i> are important food species, while in inland areas White Box <i>E. albens</i> , Bimble Box <i>E. populnea</i> and River Red Gum <i>E. camaldulensis</i> are favoured (NSW National Parks and Wildlife Service 1999c, 2003c). Hawks Nest and Tea Gardens Population and population in the Pittwater LGA listed as Endangered under the NSW TSC Act.	K
Large-eared Pied Bat (<i>Chalinolobus dwyeri</i>)	V	V	Occurs in moderately wooded habitats, mainly in areas with extensive cliffs and caves and roosts in caves, mine tunnels and the abandoned, bottle-shaped mud nests of Fairy Martins (Churchill 1998; Parsons Brinckerhoff 2009). Breeding habitat (maternity roosts) is located in roof domes in sandstone caves (Parsons Brinckerhoff 2009). Thought to forage below the forest canopy for small flying insects (Churchill 1998).	K
Long-nosed Potoroo (SE mainland) (<i>Potorous tridactylus tridactylus</i>)	V	V	Disjunct distribution along coastal south-east Australia from near Gladstone in Queensland, to south-west Victoria and in Tasmania. Found from sea level up to 1500 metres in altitude generally in areas with rainfall greater than 760 millimetres. In NSW, it is found throughout coastal and subcoastal areas. Occurs in a range of habitats: coastal forest and woodland with a moderately dense heathy understorey, dense coastal scrubs or heath, wet and dry sclerophyll forest and sub-tropical, warm temperate and cool temperate rainforest of the eastern slopes and highlands. Often associated with gullies and forest ecotones. Open areas are used for foraging while areas of dense groundcover or understorey provide areas for shelter and protection from predators. Relatively thick ground cover is a major habitat requirement and it seems to prefer areas with light sandy soils. Feeds at dusk on roots, tubers, fungi, insects and their larvae and other soft bodied animals in the soil. Moves up and down slope as food resources become seasonally available (Johnston 1995; NSW National Parks and Wildlife Service 1999g).	K
New Holland Mouse (<i>Pseudomys novaehollandiae</i>)		V	The New Holland Mouse is a small, burrowing native rodent. The species is similar in size and appearance to the introduced house mouse (<i>Mus musculus</i>), although it can be distinguished by its slightly larger ears and eyes, the absence of a notch on the upper incisors and the absence of a distinctive 'mousy' odour. Known to inhabit open heathlands, open woodlands with a heathland understorey, and vegetated sand dunes (Sinclair Knight Merz 2008).	K

Species name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Likelihood of occurrence within Lower Hunter region ³
Southern Brown Bandicoot (eastern) (<i>Isoodon obesulus obesulus</i>)	E	E	Occurs in a variety of habitats in south-eastern Australia, including heathland, shrubland, dry sclerophyll forest with heathy understorey, sedgeland and woodland. Many of the habitats are prone to fire (NSW National Parks and Wildlife Service 1999e).	P
Spotted-Tailed Quoll (Southern Subspecies) (<i>Dasyurus maculatus maculatus</i>)	V	E	Occurs from the Bundaberg area in south-east Queensland, south through NSW to western Victoria and Tasmania. In NSW, it occurs on both sides of the Great Dividing Range and north-east NSW represents a national stronghold (NSW National Parks and Wildlife Service 1999g). Occurs in wide range of forest types, although appears to prefer moist sclerophyll and rainforest forest types, and riparian habitat. Most common in large unfragmented patches of forest. It has also been recorded from dry sclerophyll forest, open woodland and coastal heathland, and despite its occurrence in riparian areas, it also ranges over dry ridges. Nests in rock caves and hollow logs or trees. Feeds on a variety of prey including birds, terrestrial and arboreal mammals, small macropods, reptiles and arthropods (NSW National Parks and Wildlife Service 1999f, 1999g).	K
Broad-headed Snake (<i>Hoplocephalus bungaroides</i>)	E	V	A nocturnal species that occurs in association with communities occurring on Triassic sandstone within the Sydney Basin. Typically found among exposed sandstone outcrops with vegetation types ranging from woodland to heath. Within these habitats they generally use rock crevices and exfoliating rock during the cooler months and tree hollows during summer (Webb, J.K. & Shine 1994; Webb, J.K & Shine 1998).	K
Flatback Turtle (<i>Natator depressus</i>)		V	Inhabit soft bodied habitat over the continental shelf of northern Australia, extending into Papua New Guinea and Irian Jaya. The turtle feeds in turbid, shallow inshore waters north of latitude 25° S. Nesting habitat includes sandy beaches in the tropics and subtropics with sand temperatures between 25 °C and 33 °C. Hatchling to sub-adult Flatback Turtles lack a pelagic life stage and reside in the Australian continental shelf (Jones, D L 2006b).	K
Green Turtle (<i>Chelonia mydas</i>)	V	V	The species has been recorded in coastal waters of all Australian states. Nesting has been recorded in the vicinity of Shark Bay and Lacépède Islands in Western Australia, Cobourg Peninsula in the Northern Territory, and in the Gulf of Carpentaria, Raine Island, and the Capricorn and Bunker Groups of islands on the southern Barrier Reef in Queensland (Cogger <i>et al.</i> 1993).	K
Hawksbill Turtle (<i>Eretmochelys imbricate</i>)		V	Once Hawksbill Turtles reach 30 to 40 cm curved carapace length, they settle and forage in tropical tidal and sub-tidal coral and rocky reef habitat. They primarily feed on sponges and algae. They have also been found, though less frequently, within seagrass habitats of coastal waters, as well as the deeper habitats of trawl fisheries. Hawksbill Turtles have been seen in temperate regions as far south as northern NSW (Stevens <i>et al.</i> 2006).	K

Species name	TSC Act Status ¹	EPBC Act Status ²	Habitat requirements	Likelihood of occurrence within Lower Hunter region ³
Leatherback Turtle, Leathery Turtle (<i>Dermochelys coriacea</i>)	E	V	Marine species that can occur in bays, estuaries and rivers where they feed. Found in all coastal waters of Australia, but more commonly in temperate waters. Known to nest occasionally in Queensland (Cogger 2000).	K
Loggerhead Turtle (<i>Caretta caretta</i>)	E	E	Ocean dwellers that generally forage in deep water (NSW National Parks and Wildlife Service 2002b). Females come ashore during summer to lay eggs on beaches, with some nesting sites recorded in northern NSW (Department of Environment and Climate Change, 2007).	K
Pink-tailed Legless Lizard (<i>Aprasia parapulchella</i>)	V	V	This lizard is known from four sites in eastern Australia: near Canberra in the ACT, Tarcutta and Bathurst in NSW, and near Bendigo in Vic. In general, lizards occur in open grassland habitats that have a substantial cover of small rocks (Osbourne & Jones 1995). Lizards also show a preference for sunny aspects, avoiding south facing slopes. Some specimens have been collected from grassland sites that appear not to support any native grasses and several animals have been found on the edge of <i>Callitris enlicheri</i> woodland and <i>Eucalyptus macrorhyncha</i> woodland (Barrer 1992). A burrowing species, it is usually found under rocks on well-drained soil and in ant nests, occasionally with several individuals found under the same rock (Swan <i>et al.</i> 2004).	P

Notes:

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- Listed as Vulnerable (V), Endangered (E) or Critically Endangered (CE) under the EPBC Act.
- Likelihood of occurrence: K = Known; P = Predicted; blank cells = Not known
- Under EPBC act criteria Green and Golden Bell Frog is treated as occurring at a site if there are records since 1995. (K) a known designation in brackets for this species is a presence assessment under EPBC Act criteria.
- Species are not terrestrial apart from breeding Islands and occur off the coasts of designated LGA's.

Table C.4 Likelihood of occurrence of Migratory species within the study area

Species name	EPBC Act Status ¹	Habitat requirements	Likelihood of occurrence within rLower Hunter region ²
Amsterdam Albatross (<i>Diomedea amsterdamensis</i>)	E,M,A1	Breeding on Amsterdam Island and foraging mainly in the surrounding Indian Ocean, but possibly occurring as far afield as Tasmania and New Zealand. Breed biennially in colonies among grass tussocks (Garnett & Crowley 2000).	
Antipodean Albatross (<i>Diomedea antipodensis</i>)	V,M,A2S	A nomadic marine species that occasionally breeds off the southeast coast of New Zealand (Garnett & Crowley 2000).	P ³
Australian Painted Snipe (Painted Snipe) (<i>Rostratula australis</i> (syn. <i>R. benghalensis</i>))	V,M,C	Inhabits shallow, vegetated, temporary or infrequently filled wetlands, including where there are trees such as <i>Eucalyptus camaldulensis</i> (River Red Gum), <i>E. populnea</i> (Poplar Box) or shrubs such as <i>Muehlenbeckia florulenta</i> (Lignum) or <i>Sarcocornia quinqueflora</i> (Samphire). Feeds at the water's edge and on mudflats on seeds and invertebrates, including insects, worms, molluscs and crustaceans. Males incubate eggs in a shallow scrape nest (Garnett & Crowley 2000).	K
Bar-tailed Godwit (<i>Limosa lapponica</i>)	M,A2H,C,J,R	Occurs in coastal mudflats, sandbars, shores of estuaries, salt marsh and sewage ponds (Morcombe 2003).	K
Black-browed Albatross (<i>Thalassarche melanorhynchus</i>)	VM,A2S	Nomadic marine species that breeds on subantarctic island outside Australian waters, but moves northwards in non-breeding seasons. The waters off southern Australia between Brisbane and Perth are the principal feeding area of birds (Garnett & Crowley 2000).	K ³
Black-faced Monarch (<i>Monarcha melanopsis</i>)	M,A2H	Occurs in rainforests, eucalypt woodlands, coastal scrubs, damp rainforest gullies, eucalypt forest and in more open woodland when migrating (Pizzey & Knight 1997).	K
Black-tailed Godwit (<i>Limosa limosa</i>)	M,A2H,C,J,R	A coastal species found on tidal mudflats, swamps, shallow river margins and sewage farms. Also found inland on larger shallow fresh or brackish waters. A migratory species visiting Australia between September and May (Pizzey & Knight 1997).	K
Broad-billed Sandpiper (<i>Limicola falcinellus</i>)	M,A2H,C,J,R	A migratory species that breeds in the northern hemisphere between June and August. Individuals feed both on exposed mudflats and while wading in water (NSW National Parks and Wildlife Service 1999b).	K

Species name	EPBC Act Status ¹	Habitat requirements	Likelihood of occurrence within rLower Hunter region ²
Buller's Albatross (<i>Thalassarche bulleri</i>)	VM,A2S	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	K ³
Campbell Albatross (<i>Thalassarche impavida</i>)	VM,A2S	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	K ³
Cattle Egret (<i>Ardea ibis</i>)	M,C	Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands and very rarely in arid and semi-arid regions. High numbers may occur in moist, poorly drained pastures with high grass; it avoids low grass pastures but has been recorded on earthen dam walls and ploughed fields. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. It is known to follow earth-moving machinery and has been located at rubbish tips. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora (Marchant & Higgins 1990; Morton <i>et al.</i> 1989).	K
Common Sandpiper (<i>Actitis hypoleucos</i>)	M,A2H,C,J,R	The Common Sandpiper utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats. It has been recorded in estuaries and deltas of streams, banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties. The muddy margins utilised by the species are often narrow, and may be steep. The species is often associated with mangroves, and sometimes found in areas of mud littered with rocks or snags (Geering <i>et al.</i> 2007; Higgins & Davies 1996). Roost sites are typically on rocks or in roots or branches of vegetation, especially mangroves. The species is known to perch on posts, jetties, moored boats and other artificial structures, and to sometimes rest on mud or 'loaf' on rocks (Higgins & Davies 1996).	K
Curlew Sandpiper (<i>Calidris ferruginea</i>)	M,A2H,C,J,R	Occurs in inter-tidal mudflats of estuaries, lagoons, mangrove channels and also around lakes, dams, floodwaters and flooded saltbush surrounding inland lakes (Morcombe 2003).	K
Double-banded Plover <i>Charadrius bicinctus</i>)	M,A2H	The Double-banded Plover is found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands and pasture. It occurs on muddy, sandy, shingled or sometimes rocky beaches, bays and inlets, harbours and margins of fresh or saline terrestrial wetlands such as lakes, lagoons and swamps, shallow estuaries and rivers. It is sometimes associated with coastal lagoons, inland saltlakes, exposed seagrass beds, exposed reefs and rock platforms and coastal sand dunes (Marchant & Higgins 1993).	K
Eastern Curlew (<i>Numenius madagascariensis</i>)	M,A2H,C,J,R	Inhabits coastal estuaries, mangroves, mud flats and sand pits. It is a migratory shorebird which generally inhabits sea and lake shore mud flats, deltas and similar areas, where it forages for crabs and other crustaceans, clam worms and other annelids, molluscs, insects and whatever else it can dig out of the mud with its long, downward-turned bill. Its migration route ranges from its wintering grounds in Australia to its breeding grounds in northern China, Korea and Russia (Pizzey & Knight 1997).	K

Species name	EPBC Act Status ¹	Habitat requirements	Likelihood of occurrence within rLower Hunter region ²
Fork-tailed Swift (<i>Apus pacificus</i>)	M,C,J,R	Breeds in the northern hemisphere, wintering south to Australia. It is almost exclusively aerial, flying from less than 1 m to at least 300 m above ground. It mostly occurs over inland plains but sometimes above foothills or in coastal areas over cliffs, beaches, islands and well out to sea. It also occurs over towns and cities. It mostly occurs over dry and/or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh, grassland, spinifex sandplains, farmland and sand-dunes. It sometimes occurs above forests. It probably roosts aerially, but has occasionally been observed to land (Higgins 1999).	K
Gould's Petrel (<i>Pterodroma leucoptera</i>)	EM	A marine species, it nests on islands among rocks and debris of Cabbage Tree Palms. It feeds on fish, cephalopods and other marine animals (Garnett & Crowley 2000).	K ³
Gibson's Albatross (<i>Diomedea gibsoni</i>)	VM,A2S	A nomadic marine species that forages off the coast of New South Wales (Garnett & Crowley 2000).	P
Great Knot (<i>Calidris tenuirostris</i>)	M,A2H,C,J,R	Generally a coastal species found on tidal mudflats and sandy ocean shores. A migratory species visiting Australian waters between September and March (Pizzey & Knight 1997).	K
Greater Sand Plover (<i>Charadrius leschenaultia</i>)	M,A2H,C,J,R	Entirely coastal in NSW foraging on intertidal sand and mudflats in estuaries, and roosting during high tide on sand beaches or rocky shores. A migratory species it is found in New South Wales generally during the summer months (Pizzey & Knight 1997).	K
Grey Plover (<i>Pluvialis squatarola</i>)	M,A2H,C,J,R	In non-breeding grounds in Australia, Grey Plovers occur almost entirely in coastal areas, where they usually inhabit sheltered embayments, estuaries and lagoons with mudflats and sandflats, and occasionally on rocky coasts with wave-cut platforms or reef-flats, or on reefs within muddy lagoons. They also occur around terrestrial wetlands such as near-coastal lakes and swamps, or salt-lakes. The species is also very occasionally recorded further inland, where they occur around wetlands or salt-lakes (Marchant & Higgins 1993). They usually forage on large areas of exposed mudflats and beaches and occasionally in pasture and on muddy margins of inland wetlands (Marchant & Higgins 1993). They usually roost in sandy areas, such as on unvegetated sandbanks or sand-spits on sheltered beaches or other sheltered environments (Jaensch 1988; Pegler 1983).	K

Species name	EPBC Act Status ¹	Habitat requirements	Likelihood of occurrence within rLower Hunter region ²
Grey-tailed Tattler (<i>Tringa brevipes</i> (syn. <i>Heteroscelus brevipes</i>))	M,A2H,C,J,R	It is often found on sheltered coasts with reefs, rock platforms or with intertidal mudflats. It is also found at intertidal rocky, coral or stony reefs, platforms and islets that are exposed at low tide. It has also been found in embayments, estuaries and coastal lagoons, especially fringed with mangroves. It is rarely seen on open beaches and occasionally found around near-coastal wetlands, such as lagoons, lakes and ponds in sewage farms and saltworks. Inland records for the species are rare (Higgins & Davies 1996). The species forages in shallow water, hard intertidal substrates, rock pools, intertidal mudflats, mangroves, banks of seaweed and among rocks and coral rubble, over which water may surge. The species roosts in mangroves, dense stands of shrubs, snags, rocks, beaches, reefs, artificial structures (sea walls, oyster racks), occasionally in near-coastal saltworks and sewage ponds and rarely on sandy beaches or sand banks (Higgins & Davies 1996; Rogers 1999).	K
Latham's Snipe (<i>Gallinago hardwickii</i>)	M,A2H,C,J,R	Occurs in freshwater or brackish wetlands generally near protective vegetation cover. This species feeds on small invertebrates, seeds and vegetation. It migrates to the northern hemisphere to breed (Garnett & Crowley 2000).	K
Lesser Sand Plover (<i>Charadrius mongolus</i>)	M,A2H,C,J,R	Migratory bird that migrates from the northern hemisphere to coastal areas of northern and east coast of Australia (Garnett & Crowley 2000).	K
Little Curlew (<i>Numenius minutus</i>)	M,A2H,C,J,R	On passage the species shows a preference for foraging and resting in swampy meadows near lakes and along river valleys. It overwinters on dry inland grassland, bare cultivation, dry mudflats and coastal plains of black soil with scattered shallow pools of freshwater, swamps, lakes or flooded ground. It shows a preference for short grass swards of less than 20 cm tall, and occasionally occurs in dry saltmarshes, coastal swamps, mudflats or sandflats in estuaries, or on the beaches of sheltered coasts (BirdLife International 2009).	K
Little Tern (<i>Sterna albifrons</i>)	M,C,J,R	A coastal species found along the coast of New South Wales. They nest between the high tide mark and shore vegetation on undisturbed and un-vegetated sites near estuaries and adjacent freshwater lakes. They feed on fish taken from inshore waters (Garnett & Crowley 2000).	K
Marsh Sandpiper (<i>Tringa stagnatilis</i>)	M,A2H,C,J,R	Occurs in coastal and inland wetlands (salt or fresh water), estuarine and mangrove mudflats, beaches, shallow or swamps, lakes, billabongs, temporary floodwaters, sewage farms and saltworks ponds (Morcombe 2003).	K
Northern Giant-Petrel (<i>Macronectes halli</i>)	VM,A2S	Nomadic marine species, that nests as dispersed pairs, often amidst tussocks in dense vegetation. Forages in inshore waters of southern Australia and occasionally visits the coast of NSW (Garnett & Crowley 2000).	K ³
Pacific Golden Plover (<i>Pluvialis fulva</i>)	M,A2H,C,J,R	Prefers sandy, muddy or rocky shores, estuaries and lagoons, reefs, saltmarsh, and or short grass in paddocks and crops. The species is usually coastal, including offshore islands; rarely far inland. Often observed on beaches and mudflats, sandflats and occasionally rock shelves, or where these substrates intermingle; harbours, estuaries and lagoons (Marchant & Higgins 1993).	K

Species name	EPBC Act Status ¹	Habitat requirements	Likelihood of occurrence within rLower Hunter region ²
Rainbow Bee-eater (<i>Merops ornatus</i>)	M,J	Usually occur in open or lightly timbered areas, often near water. Breed in open areas with friable, often sandy soil, good visibility, convenient perches and often near wetlands. Nests in embankments including creeks, rivers and sand dunes. Insectivorous, most foraging is aerial, in clearings (Higgins 1999).	K
Red Knot (<i>Calidris canutus</i>)	M,A2H,C,J,R	In Australasia the Red Knot mainly inhabit intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours; sometimes on sandy ocean beaches or shallow pools on exposed wave-cut rock platforms or coral reefs. They are occasionally seen on terrestrial saline wetlands near the coast, such as lakes, lagoons, pools and pans, and recorded on sewage ponds and saltworks, but rarely use freshwater swamps. They rarely use inland lakes or swamps (Higgins & Davies 1996).	K
Red-necked Stint (<i>Calidris ruficollis</i>)	M,A2H,C,J,R	Mostly found in coastal areas, including sheltered inlets, bays lagoons and estuaries. They also occur in shallow wetlands near the coast or inland, including lakes, waterholes and dams (Higgins & Davies 1996). They forage in mudflats, shallow water, sandy open beaches, flooded paddocks and in samphire feeding along the edges. The species roosts on sheltered beaches, spits, banks or islets, of sand, mud, coral or shingle. Occasionally they roost on exposed reefs or shoals (Higgins & Davies 1996) and amongst seaweed, mud and cow-pats (Hobbs 1961). During high tides they may also use sand dunes and claypans.	K
Regent Honeyeater	EM	Occurs mostly in box-ironbark forests and woodland and prefers wet, fertile sites such as along creek flats, broad river valleys and foothills. Riparian forests with <i>Casuarina cunninghamiana</i> and <i>Amyema cambagei</i> are important for feeding and breeding. Spotted Gum and Swamp Mahogany forests are also important feeding areas in coastal areas. Important food trees include <i>Eucalyptus sideroxylon</i> (Mugga Ironbark), <i>E. albens</i> (White Box), <i>E. melliodora</i> (Yellow Box) and <i>E. leucoxyton</i> (Yellow Gum) (Garnett & Crowley 2000).	K
Ruddy Turnstone (<i>Arenaria interpres</i>)	M,A2H,C,J,R	Occurs at beaches and coasts with exposed rock, stony or shell beaches, mudflats, exposed reefs and wave platforms (Morcombe 2003).	K
Rufous Fantail (<i>Rhipidura rufifrons</i>)	M,A2H	Occurs in a range of habitats including the undergrowth of rainforests/wetter eucalypt forests/gullies, monsoon forests paperbarks, sub-inland and coastal scrubs, mangroves, watercourses, parks and gardens. When migrating they may also be recorded on farms, streets and buildings. Migrates to SE Australia in October-April to breed, mostly in or on the coastal side of the Great Dividing Range (Pizzey & Knight 1997).	K
Salvin's Albatross (<i>Thalassarche salvini</i>)	VM,A2S	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	P
Satin Flycatcher (<i>Myiagra cyanoleuca</i>)	M,A2H	Occurs in heavily vegetated gullies, in forests and taller woodlands. During migration it is found in coastal forests, woodlands, mangroves, trees in open country and gardens (Pizzey & Knight 1997).	P

Species name	EPBC Act Status ¹	Habitat requirements	Likelihood of occurrence within rLower Hunter region ²
Sharp-tailed Sandpiper (<i>Calidris acuminata</i>)	M,A2H,C,J,R	Occurs in a variety of habitats: tidal mudflat, mangrove swamps, saltmarshes, shallow fresh, brackish, salt inland swamps and lakes; flooded and irrigated paddocks, sewage farms and commercial saltfields (Pizzey & Knight 1997).	K
Shy Albatross (<i>Thalassarche cauta</i>)	VM,A2S	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	K ³
Southern Giant-Petrel (<i>Macronectes giganteus</i>)	EM,A2S	A partly nomadic marine species that forages off the coast of New South Wales (Garnett & Crowley 2000).	K ³
Streaked Shearwater (<i>Calonectris leucomelas</i>)	M,C,J,R	Habitat largely restricted to pelagic seas, shelf waters and further out. Unusual inshore (Morcombe 2003).	K ³
Terek Sandpiper (<i>Xenus cinereus</i>)	M,A2H,C,J,R	Found on tidal mudflats and estuaries and on shores and reefs of offshore islands (Pizzey & Knight 1997).	K
Tristan Albatross (<i>Diomedea dabbona</i>)	EM,A2S	Breeding range now restricted to Inaccessible and Gough Island, having been eliminated from the main island of Tristan de Cunha by 1907. Current global population estimated to contain about 1,000 breeding pairs. There is only one record from Australian waters. Breed biennially in colonies among grass tussocks on isolated sub-Antarctic islands and feed pelagically on squid, fish and crustaceans (Garnett & Crowley 2000).	P ³
Wandering Albatross (<i>Diomedea exulans</i>)	VM,A2S,J	Nomadic marine species that breeds in small loose colonies among grass tussocks, using a large mud nets, sometimes off the coast of NSW (Garnett & Crowley 2000).	K ³
Whimbrel (<i>Numenius phaeopus</i>)	M,A2H,C,J,R	Migrates to Taiwan, Philippines, PNG, and a race breeding in NE Siberia is found on the north and south-eastern coastlines of Australia. Juveniles arrive to Australia from spring to early summer. Usually only juveniles remain in Australia but very occasionally adults in breeding plumage may be seen in Australian winters (Pizzey & Knight 1997).	K
White-bellied Sea-Eagle (<i>Haliaeetus leucogaster</i>)	M,C	Occurs in coastal areas including islands, estuaries, inlets, large rivers, inland lakes and reservoirs. Builds a huge nest of sticks in tall trees near water, on the ground on islands or on remote coastal cliffs (Pizzey & Knight 1997).	K

Species name	EPBC Act Status ¹	Habitat requirements	Likelihood of occurrence within rLower Hunter region ²
White-capped Albatross (<i>Thalassarche steadii</i>)	VM,A2	An oceanic species that has been recorded off the coast of New South Wales (Garnett & Crowley 2000).	P ³
White-throated Needletail (<i>Hirundapus caudacutus</i>)	M,C,J,K	Occurs in airspace over forests, woodlands, farmlands, plains, lakes, coasts and towns. Breeds in the northern hemisphere and migrates to Australia in October-April (Pizzey & Knight 1997).	K

- Notes:
1. Listed as Vulnerable (V), Endangered (E) or Critically Endangered (CE) under the EPBC Act; and Listed as Migratory (M), and/or, under CAMBA(C). ROKAMBA (K) or Bonn convention Appendices: (A2), (A2S), (A2H).
 2. Likelihood of occurrence: K = Known; P = Predicted; blank cells = Not known
 3. Species are not terrestrial apart from breeding Islands and largely occur off the coasts of designated LGA's. Land fall is likely to only be associated with stochastic weather anomalies.

References

- Anstis, M 2002, *Tadpoles of South-eastern Australia: a Guide with Keys*, vol. 1, 1 vols., New Holland Publishers, Sydney.
- Australian Transport Safety Bureau 2003, *The Hazard Posed to Aircraft by Birds*, Australian Transport Safety Bureau, Canberra.
- Barrer, P 1992, *A survey of Aprasia parapulchella along parts of the lower Molonglo River corridor*, ACT Parks & Con. Wildlife Research Unit, Canberra.
- BirdLife International 2009, *Numenius minutus*. In: IUCN 2011. *IUCN Red List of Threatened Species. Version 2011.2*, viewed 18 January 2012.
- Bishop, T 2000, *Field guide to the orchids of New South Wales and Victoria*, Second edn, University of New South Wales Press Pty. Ltd., Sydney.
- Brooker, MIH & Kleinig, DA 1999, *Field guide to Eucalypts, Volume 1: South-eastern Australia*, Blooming Books, Hawthorn, Australia.
- Churchill, S 1998, *Australian Bats*, Reed New Holland, Sydney.
- Churchill, S 2008, *Australian Bats*, 2nd edn, Allen & Unwin, Sydney.
- Cogger, HG 2000, *Reptiles and Amphibians of Australia*, Reed Books, Sydney.
- Cogger, HG, Cameron, EE, Sadler, RA & Egger, P. 1993, *Action Plan for Australian Reptiles*, Australian Nature Conservation Agency, Canberra.
- Department of Environment and Climate Change *Threatened Species Profile: Kunzea rupestris* Department of Environment and Climate Change, viewed 9th June 2009
<<http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10447>>.
- Department of Environment and Climate Change *Threatened Species Profile: Leptospermum deanei*, Department of Environment and Climate Change, viewed 9th June 2009
<<http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10468>>.
- Department of Environment and Climate Change 2007a, *Threatened and pest animals of Greater Southern Sydney*, Department of Environment and Climate Change, Hurstville.
- Department of Environment and Climate Change 2007b, *Threatened species, populations and ecological communities*, NSW Department of Environment and Conservation, 2007,
<<http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>>.
- Department of Environment and Climate Change 2008, *Threatened species, populations and ecological communities*, NSW Department of Environment and Conservation, 2008,
<<http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>>.
- Department of Environment and Conservation 2004, *Green and Golden Bell Frog environmental impact assessment guidelines* Department of Environment and Conservation (NSW), Hurstville.
- Department of Environment and Conservation 2005a, *Draft Recovery Plan for the Green and Golden Bell Frog (Litoria aurea)*, Department of Environment and Conservation (NSW), Hurstville, NSW,
- Department of Environment and Conservation 2005b, *Threatened species, populations and ecological communities*, NSW Department of Environment and Conservation, 2006,
<<http://www.threatenedspecies.environment.nsw.gov.au/index.aspx>>.

Department of Sustainability Environment Water Population and Communities 2012, *Paradelma orientalis in Species Profile and Threats Database*, Department of Sustainability Environment Water Population and Communities, <<http://www.environment.gov.au/sprat>>.

Dominelli, S 2000, *Distribution, roost requirements and foraging behaviour of the Greater Long-eared Bat (Nyctophilus timoriensis) and the Little Pied Bat (Chalinolobus picatus) in the Bookmark Biosphere Reserve*, Unpublished report, Bookmark Biosphere Trust, South Australia,

Ellis, M, Lumsden, L, Schultz, M, Reardon, T, Richards, G & Hoy, G 1999, 'Eastern Long-eared Bat Nyctophilus timoriensis', in A Duncan, G Baker & M N. (eds), *The Action Plan for Australian Bats*, Environment Australia, Canberra, pp. 42-3.

Fairley, A 2004, *Seldom Seen: Rare Plants of Greater Sydney.*, 1st edn, Reed New Holland, Sydney.

Fairley, A & Moore, P 2002, *Native plants of the Sydney district. An identification guide*, Revised Edition edn, Kangaroo Press, Sydney.

Garnett, ST & Crowley, GM 2000, *The Action Plan for Australian Birds*, Environment Australia, Canberra.

Geering, A, Agnew, L & Harding, S 2007, *Shorebirds of Australia*, CSIRO Publishing, Melbourne.

Harden, G 1992, *Flora of New South Wales Volume 3*, University of New South Wales Press Ltd., Kensington.

Harden, G 1993, *Flora of New South Wales Volume 4*, University of New South Wales Press Ltd., Kensington.

Harden, G 2000, *Flora of New South Wales Volume 1 (Revised Edition)*, University of New South Wales Press Ltd., Kensington.

Harden, G 2002, *Flora of New South Wales Volume 2 (Revised Edition)*, 2nd edn, vol. 2, University of New South Wales Press Ltd., Kensington.

Higgins, PJ (ed.) 1999, *Handbook of Australian, New Zealand and Antarctic Birds Volume 4: Parrots to Dollarbirds*, Volume 4: Parrots to Dollarbird, Oxford University Press, Melbourne.

Higgins, PJ & Davies, SJF (eds) 1996, *Handbook of Australian, New Zealand and Antarctic Birds.*, Volume 3 Snipe to Pigeons, Oxford University Press, Melbourne.

Hobbs, JN 1961, 'The birds of south-west New South Wales', *Emu*, vol. 61, pp. 21-55.

Jaensch, RP, R.M. Vervest & M.J. Hewish 1988, 'Waterbirds in nature reserves of south-western Australia 1981-1985: reserve accounts', *RAOU Report Series*, vol. 30.

James, T 1997, *Urban bushland biodiversity survey. Native flora in western Sydney.*, NSW National Parks and Wildlife Service, Hurstville,

James, T, McDougall, L & Benson, D 1999, *Rare bushland plants of western Sydney*, Royal Botanic Gardens, Sydney.

Johnston, PG 1995, 'Long-nosed Potoroo', in R Strahan (ed.), *The Mammals of Australia*, Reed New Holland, Sydney, pp. 301-2.

Jones, DL 2006a, *A complete guide to to native orchids of Australia including island Territories*, Reed New Holland, Sydney.

Jones, DL 2006b, 'Specularantha vernali (Orchidaceae), a critically endangered new species from south-eastern New South Wales', *The Orchadian*, vol. 15, pp. 277-81.

Lumsden, LF 1994, 'The distribution, habitat and conservation status of the Greater Long-eared Bat *Nyctophilus timoriensis* in Victoria', *Victorian Naturalist*, vol. 111, pp. 4-9.

Marchant, S & Higgins, PJ 1990, *Handbook of Australian, New Zealand and Antarctic Birds*, Volume One - Ratites to Ducks, Oxford University Press, Melbourne.

Marchant, S & Higgins, PJ (eds) 1993, *Handbook of Australian, New Zealand and Antarctic Birds Volume 2: Raptors to Lapwings*, vol. 2, Volume 2: Raptors to Lapwings, Oxford University Press, Melbourne.

Morcombe, M 2003, *Field guide to Australian birds*, Steve Parish Publishing, Archerfield, Queensland.

Morton, SR, Brennan, KG & Armstrong, MD 1989, *Distribution and Abundance of Waterbirds in the Alligator Rivers Region, Northern Territory Volume 1*.

NSW Department of Environment and Conservation 2005, *Threatened Species: Species, Populations and Ecological Communities of NSW Catchments*, NSW Department of Environment and Conservation, 2005, <<http://203.202.1.211/tsprofile/index.aspx>>.

NSW Fisheries 2004, *Status and monitoring of the Australian Grayling in NSW*, NSW Fisheries.

NSW National Parks and Wildlife Service 1997, *Submission to the mining warden's inquiry into the renewal of special leases 567 and 568 for the extraction of peat from Wingecarribee Swamp*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999a, *Acacia bynoeana threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999b, *Broad-billed Sandpiper threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999c, *Koala threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999d, *Persoonia pauciflora threatened species information*, NSW National Parks and Wildlife Service, Hurstville. .

NSW National Parks and Wildlife Service 1999e, *Southern Brown Bandicoot threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999f, *Spotted-tailed Quoll threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 1999g, *Terms of licence under the Threatened Species Conservation Act 1995. Appendix B of the Integrated Forestry Operations Approval for the Upper North East Region.*,

NSW National Parks and Wildlife Service 2000a, *Olearia cordata threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2000b, *Persoonia mollis ssp. maxima threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2001a, *Giant Burrowing Frog threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2001b, *Grey-headed Flying Fox threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002a, *Pultenaea parviflora threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2002b, *Threatened Species of the Upper North Coast of New South Wales - Fauna*, NSW National Parks and Wildlife Service, Northern Directorate, Coffs Harbour.

NSW National Parks and Wildlife Service 2003a, *Acacia pubescens threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2003b, *Brush-tailed Rock Wallaby Warrumbungles endangered population threatened species information*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2003c, *Draft Recovery Plan for the Koala*, NSW National Parks and Wildlife Service, Hurstville.

NSW National Parks and Wildlife Service 2003d, *Native vegetation of the Illawarra escarpment and coastal plain*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1997, *Final determination to list Acacia gordonii as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1998a, *Final determination to list Angophora inopina as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1998b, *Final determination to list Grevillea parviflora ssp. parviflora as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1998c, *Final determination to list Melaleuca biconvexa as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1998d, *Final determination to list Persoonia hirsuta as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1998e, *Final determination to list Pimelea curviflora var curviflora as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1998f, *Final determination to list Prostanthera askania as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1999a, *Final determination to list Lasiopetalum joyceae as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 1999b, *Final determination to list the Giant Barred Frog as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 2000, *Final determination to list Littlejohn's tree Frog as a vulnerable species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 2002, *Final determination to list Caladenia tessellata as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

NSW Scientific Committee 2003, *Final determination to list the Stuttering Frog as an endangered species*, NSW National Parks and Wildlife Service, Hurstville.

Osbourne, WS & Jones, SR 1995, *Recovery Plan for the Pink-tailed Worm Lizard (Aprasia parapulchella). Technical Report No. 10*, Department of Environment, Land and Planning, Canberra.

Paget, A 2008, *Results of searches for the Tuncurry Midge-Orchid (Genoplesium littorale, syn. Corunastylis littoralis)*. NSW Scientific Committee, Sydney.

Parnaby, H 1995, *Greater Long-eared Bat Nyctophilus timoriensis*, Reed Books, Chatswood, NSW.

Parsons Brinckerhoff 2009, *Flora and Fauna assessment: Lawson Road Springwood*, Parsons Brinckerhoff, Sydney.

Patrick, G 1999, *Initial flora survey to sample potential habitat: abundance and distribution of the new plant species Persoonia (North Rothbury)*. , Report prepared for the NSW National Parks and Wildlife Service, Hurstville.

Payne, R, Stevenson, D & Wellington, R 2002, *A standardised approach for counting black-eyed susan populations*, NSW National Parks and Wildlife, Hurstville.

Pegler, JM 1983, 'A brief survey of the water birds in the Shoalhaven-Crookhaven estuary', *Australian Birds*, vol. 17, pp. 38-42.

Pizzey, G & Knight, F 1997, *Field Guide to the Birds of Australia*, Harper and Collins, Sydney.

Rogers, D 1999, 'Roost choice in the waders of Roebuck Bay: is avoiding heat stress their main consideration?', *Stilt*, vol. 35, p. 65.

Royal Botanic Gardens 2004, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, Sydney,

Royal Botanic Gardens 2005, *PlantNet - The Plant Information Network System of Botanic Gardens Trust (version 2.0)*, Royal Botanic Gardens, Sydney,

Sinclair Knight Merz 2008, *Erskine Park Link Road Concept Plan Flora and Fauna assessment*.

Stevens, J, Fowler, SL, Soldo, A, McCord, M, Baum, J, Acuña, E, Domingo, A & Francis, M 2006, *IUCN Red List of Threatened Species Version 2011.2. Lamna nasus*, viewed 17 January 2012.

Strahan, R 1995, *The Mammals of Australia*, Reed New Holland, Sydney.

Swan, G, Shea, G & Sadler, R 2004, *A Field Guide to Reptiles of New South Wales*, Reed New Holland, Sydney.

Swift Parrot Recovery Team 2001, *Swift Parrot Recovery Plan*, Department of Primary Industries, Water and Environment, Hobart.

Threatened Species Scientific Committee (TSSC) 2008, *Guidelines for Assessing the Conservation Status of Native Species according to the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act) and EPBC Regulations 2000.*, Department of the Environment Water Heritage and the Arts, Canberra.

Turbill, C & Ellis, M 2006, 'Distribution and abundance of the south eastern form of the Greater Long-eared Bat Nyctophilus timoriensis', *Australian Mammalogy*, vol. 28, pp. 1-7.

Turbill, C, Lumsden, L & Ford, G 2008, *South-eastern Long-eared Bat Nyctophilus sp.* In: Van Dyck, S. and R. Strahan, (eds.), eds. *The Mammals of Australia.*, New Holland, Sydney.

Warringah Shire Council 2004, <http://www.warringah.nsw.gov.au/index.htm>, Warringah Shire Council.

Webb, JK & Shine, R 1994, *Habitat use by the broad-headed snake, Hoplocephalus bungaroides*, Environment Australia, Canberra.

Webb, JK & Shine, R 1998, 'Ecological characteristic of an endangered snake species Hoplocephalus bungaroides (Serpentes: Elapidae)', *Animal Conservation*, vol. 1, pp. 185-93.