

Kempsey Shire Biodiversity Strategy – Background Information

Overview of Biodiversity in Kempsey Local Government Area

Owing to its location, size and topography, the Kempsey LGA spans both subtropical and temperate climatic zones, which influences the flora and fauna found within the region. It has a varied topography which has been formed by major tectonic and other geomorphological processes throughout a long geological history.

Elevation

The LGA rises from sea level at the coast through to elevations of around 1400 metres on the north-western margins of the LGA which border on the edge of the NSW New England Tablelands (Figure 1). As a general rule, slope steepness increases away from the coastal plain and reaches maximum steepness within those parts defined as the Escarpment Ranges.

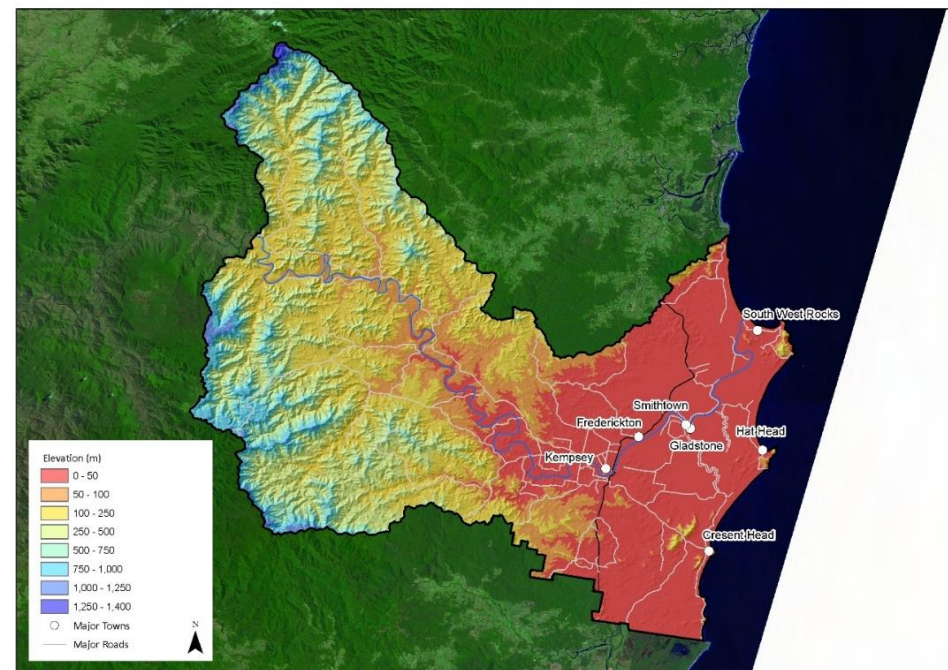
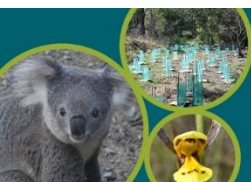


Figure 1: Elevation classes across Kempsey LGA



Geology

The predominant broad rock type within the LGA is sedimentary however other geological units of metamorphic, igneous extrusive and intrusive rock types also occur to a lesser degree (Figure 2).

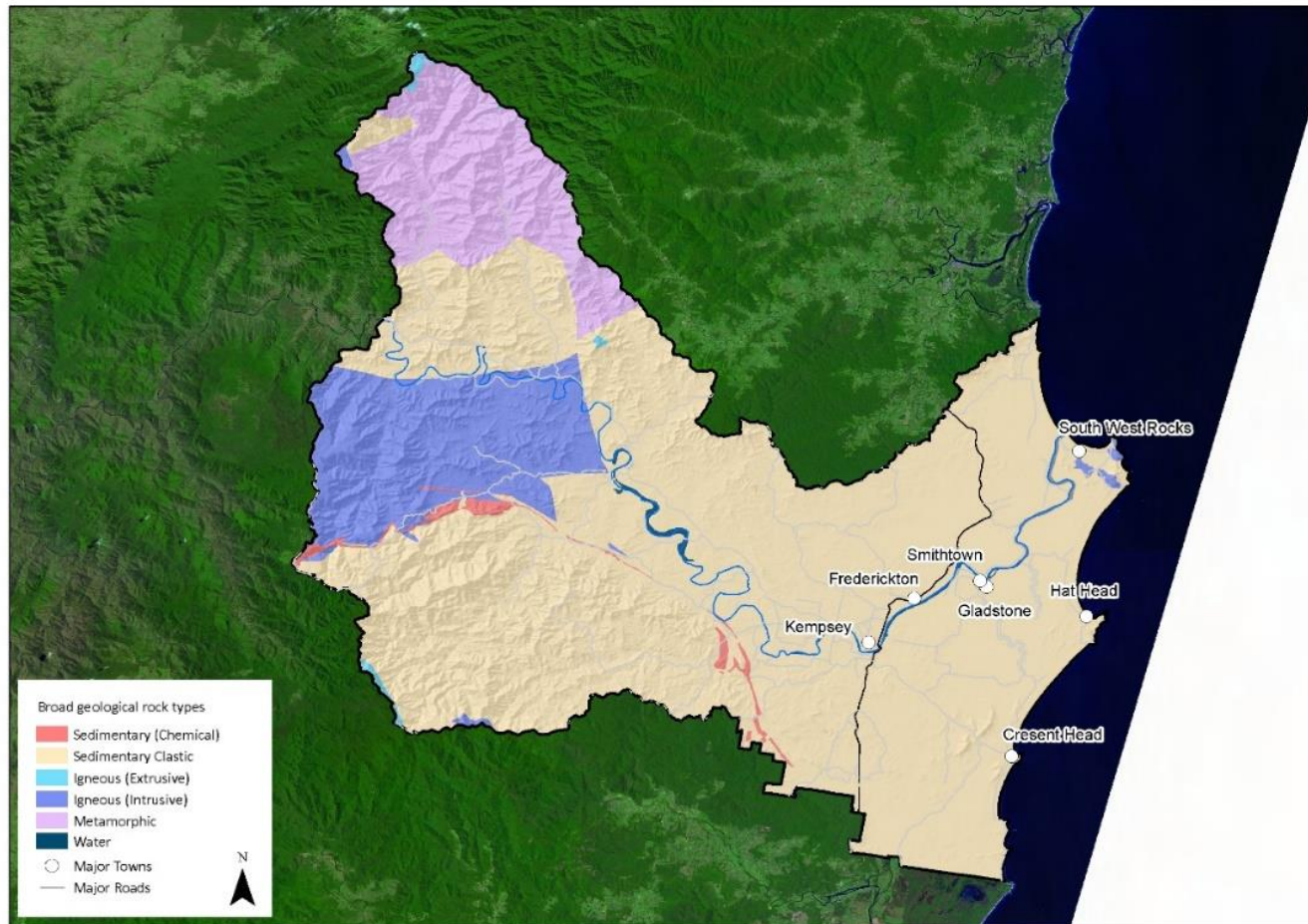
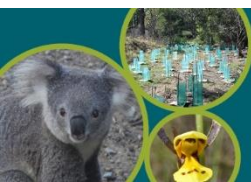


Figure 2: Broad geological rock types



Climate

The size of the LGA and the significant variation in altitude means that the region experiences both subtropical and temperate climatic zones. Rainfall distribution and temperatures vary across the LGA. The coastal areas receive around 1300 to 1400mm annually with rainfall decreasing on a westward gradient with the upper reaches of the Macleay River receiving the lowest annual totals (around 1000 – 1100mm). The north-west and south-west portions of the escarpment ranges however, experience the greatest annual rainfall of up to 1700mm (Figure 3).

The greatest temperatures of the hottest months are experienced around 30 to 70km inland from the coast within the midland hills and escarpment ranges. The very highest parts of the escarpment ranges experience the least high temperatures and the high elevations of the Escarpment Ranges on the edge of the New England Tablelands experience the coldest temperatures.

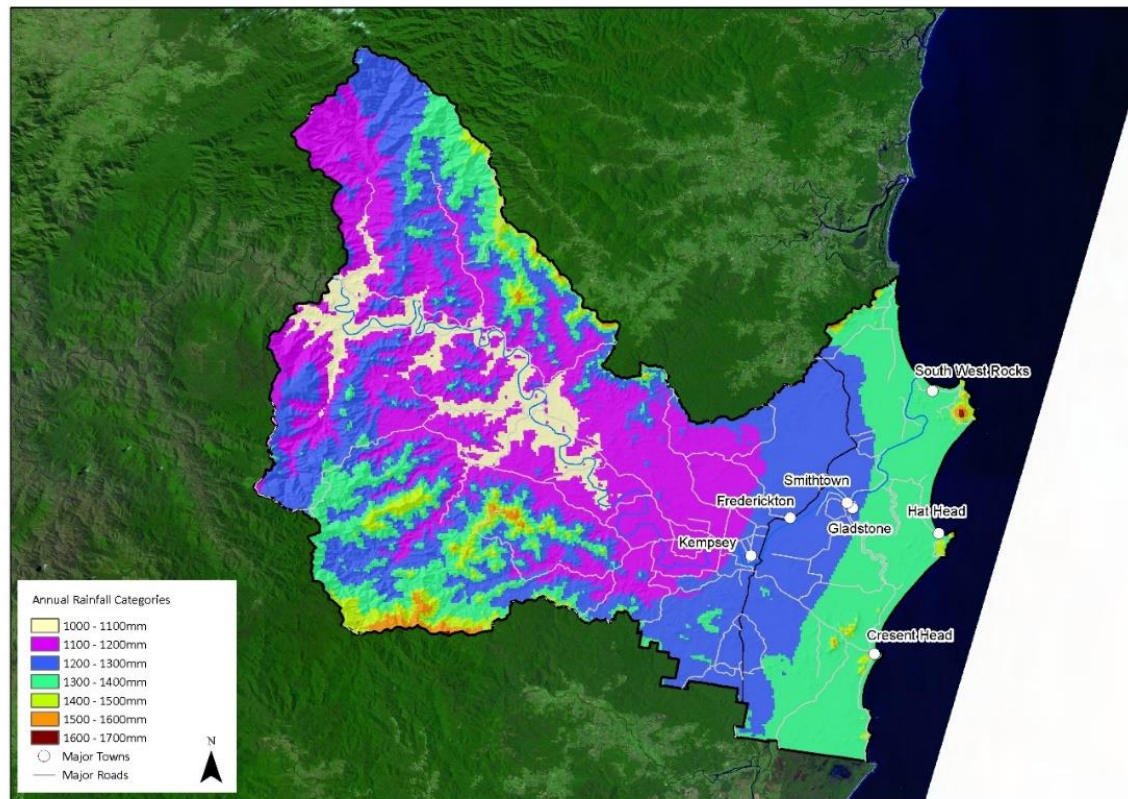
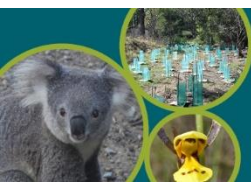


Figure 3: Annual rainfall distribution in 100mm intervals



Vegetation

The LGA is covered by around 261,000 ha of native woody vegetation cover (including for the purposes of this plan, native grasslands). A wide range of broad vegetation types are represented across the LGA (table 1).

Table 1. Vegetation formations by area and percentage of total

Keith Formation	Area Ha	% of Total
Dry Sclerophyll Shrub Forests	7,737	2.96
Dry Sclerophyll Shrub/Grass Forests	69,508	26.61
Estuarine and Saline Wetlands	1,438	0.55
Freshwater Wetlands	7,792	2.98
Grasslands	26	0.01
Heathlands	3699	1.42
Rainforests	6,3365	24.26
Sclerophyll Grassy Woodlands	612	0.23
Swamp Sclerophyll Forests	23,940	9.16
Wet Sclerophyll Forests	1,261	0.48
Wet Sclerophyll Grass Forests	15,015	5.75
Wet Sclerophyll Shrub Forests	66,835	25.58
Total Vegetation	261,228	100

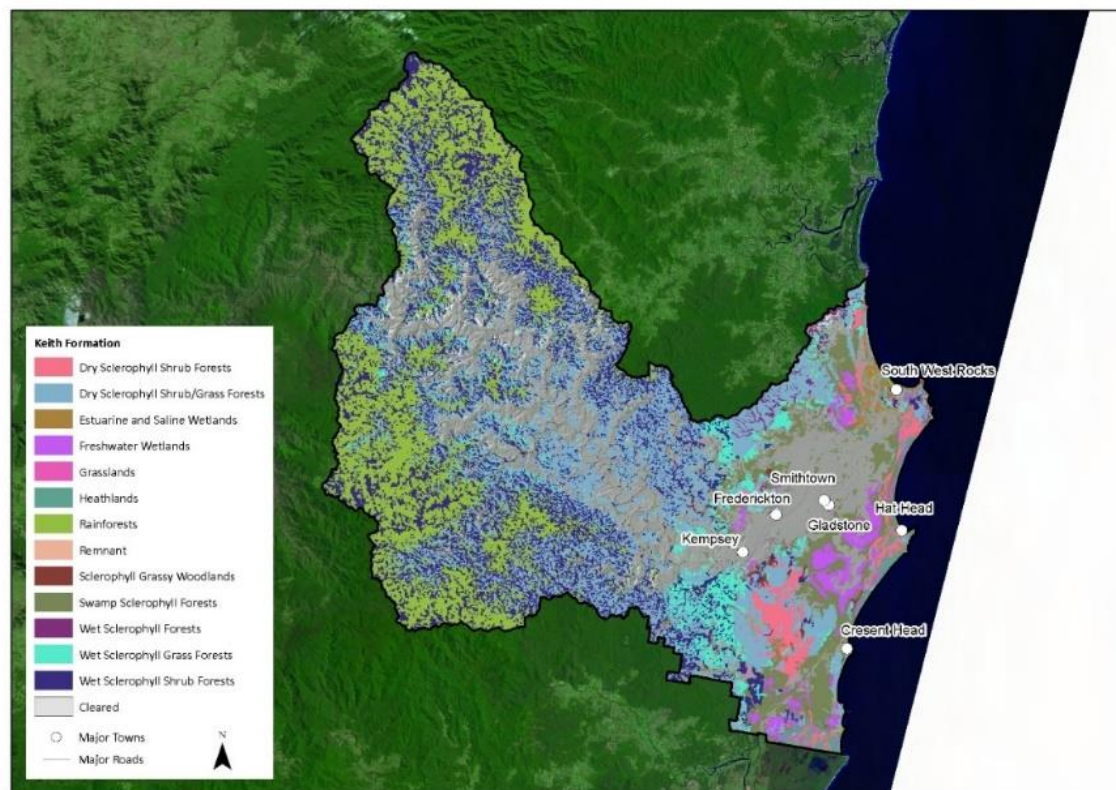
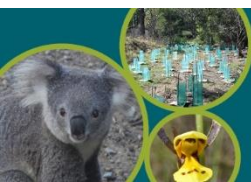


Figure 4: Native vegetation formations

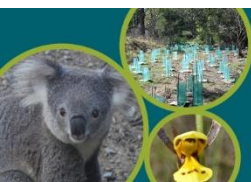


Public conservation land

Public conservation land (state forests and national parks) accounts for 36% (~121,500 ha) of the entire Kempsey LGA. Conservation land is represented across all landscapes within the shire however 53% of the National Park and State Forest estates occur within the Escarpment Ranges. Table 2 contains a breakdown by landscape unit of the area occupied by National Park or State Forest estate.

Table 2. Area and percentages of National Park and State Forest estates

Landscape and Tenure Type	Area Ha	% of Landscape
Coastal Plains - National Parks	14,148	20.3
Coastal Plains – State Forests	95	0.15
Coastal Plains - Total	14,243	20.45
Midland Hills – National Park	5,601	5.5
Midland Hills – State Forests	13,692	13.5
Midland Hills – Total	19,293	19
Escarpment Ranges – National Park	76,870	46.2
Escarpment Ranges – State Forests	10,965	6.5
Escarpment Ranges - Total	87,835	52.7
Total National Park and State Forests Kempsey LGA	121,371	36% of Kempsey LGA



Landuse

The Kempsey shire has a population of 28,885 people as at the 2016 census (ABS 2016). The main population centres include Kempsey (14,754), South West Rocks (4,603), Frederickton (1,391), Gladstone/Smithtown (932), Stuarts Point (766), Kundabung (555) and Crescent Head (1531) (ABS 2016). All of these localities are located within the Coastal Plains and account for around two-thirds of the total population of the LGA.

While there are a vast range of land use classes within the Kempsey Shire, it is dominated by 3 broad categories; Conservation land, Grazing, and, Tree and Shrub Cover. National Park Estate and State Forests (classified as Conservation land) account for around 36% of the total LGA (Figure 5). Grazing land use types tend to occur on the flatter parts of the coastal plains and the central parts of the midland hills and escarpment ranges. Tree and shrub cover class predominantly occurs on the flanks of the Midland Hills and Escarpment Ranges.

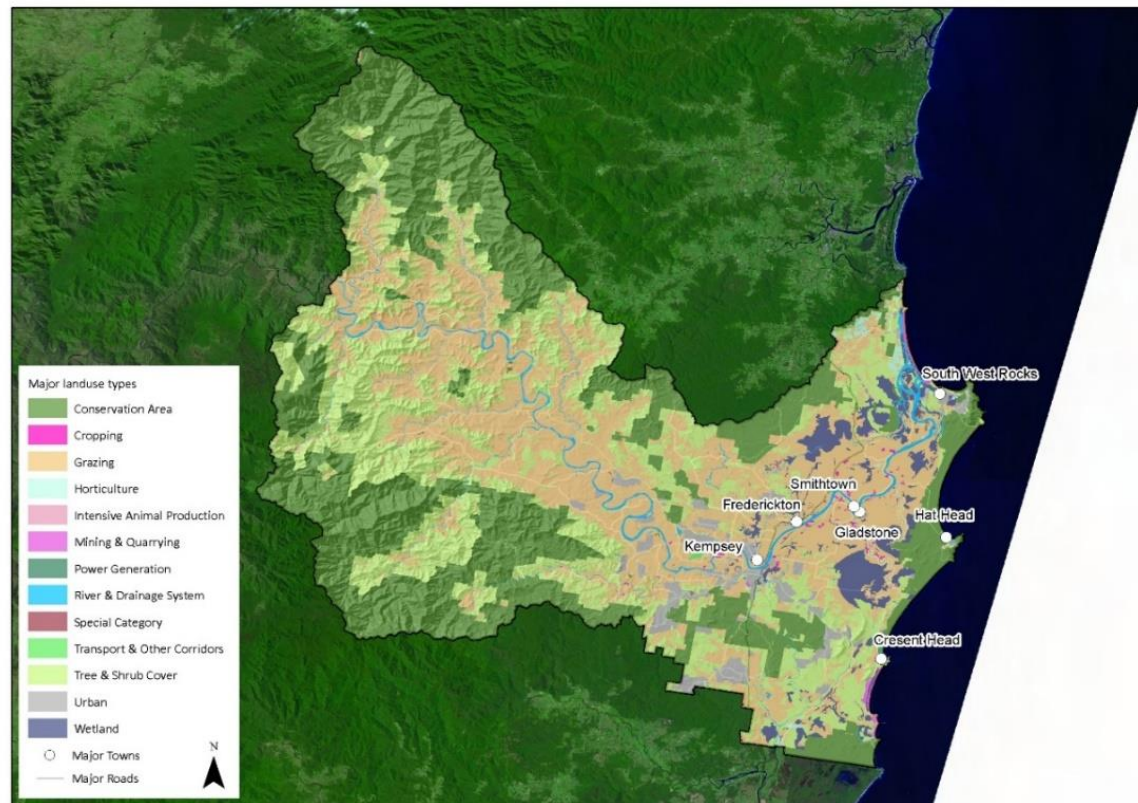
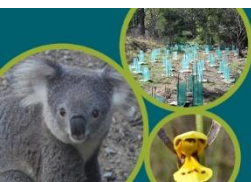


Figure 5: Major land use types



Landscapes

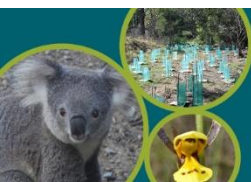
The Kempsey Local Government Area (LGA) comprises a rich and precious variety of biodiversity across some 337,000 ha of the mid-north coast region of NSW. In order to understand the biodiversity of the area the LGA has been divided into three distinct landscape units;

- **Coastal Plains** - The majority of the tenure of the 70,000 ha that comprises the Coastal Plains is private land. Private land accounts for some 51,000 ha or 73% of the total area. Of this, approximately 27,500 ha is classified as grazing land use. Public land estate (National Park and State Forest estate), accounts for around 14,250 or 20% of the coastal plains with the bulk of National Park area occurring along the coastline margins. Hat Head National Park is the largest National Park in the coastal plains landscape at 7,397 ha. Other sizeable National Park areas are Yarrahapinni Wetlands National Park at 1300ha and Limeburners Creek National Park occupies around 2,800 ha. An estimated 75% of the linear coastline portion in the Kempsey LGA is under National Park status. Crown reserve land occupies an area of around 4,715ha or approximately 7% of the coastal plains landscape unit. State forest estate is essentially absent with only 95 ha identified as occurring within the Coastal Plain.
- **Midland Hills** - the dominant land use is grazing. It accounts for just over 48,000 ha or 48% of the total landscape unit. A further 21,500 ha or 21% is identified as tree and shrub cover which often includes grazing activities but possesses higher woody vegetation cover than land identified as grazing.
- **Escarpment Ranges** - The dominant land use within the Escarpment Ranges is land identified as Conservation, that is, National Park or State Forest estate. This land use accounts for around 88,000 ha or 53% of the landscape unit. The two largest National Parks in this landscape are New England National Park and Willi Willi National Park. Grazing is also a significant activity with just over 50,000 ha or around 30% of the landscape unit under this land use type.

The division of the LGA into 3 landscapes helps show the conservation status, land-uses and clearing rates across the LGA. A number of factors including historic clearing and settlement patterns, current population and development pressures, topography and climate as well as the availability of public lands all combine to determine the differences in each landscape.

Table 3. Estimates of public land, private woody vegetation and cleared land per landscape unit

Landscape and Woody Vegetation	Area Ha	Approx % of Landscape
Coastal Plains Private Land Woody Vegetation	32,758	47
Coastal Plains NP & SF	14,243	20
Coastal Plains Estimated Cleared	22,697	33
Midland Hills Private Land Woody Vegetation	51,918	51
Midland Hills NP & SF	19,293	19
Midland Hills Estimated Cleared	29,920	30
Escarpment Ranges Private Land Woody Vegetation	61,087	37
Escarpment Ranges NP & State Forests	87,835	53
Escarpment Ranges Estimated Cleared	17,430	10



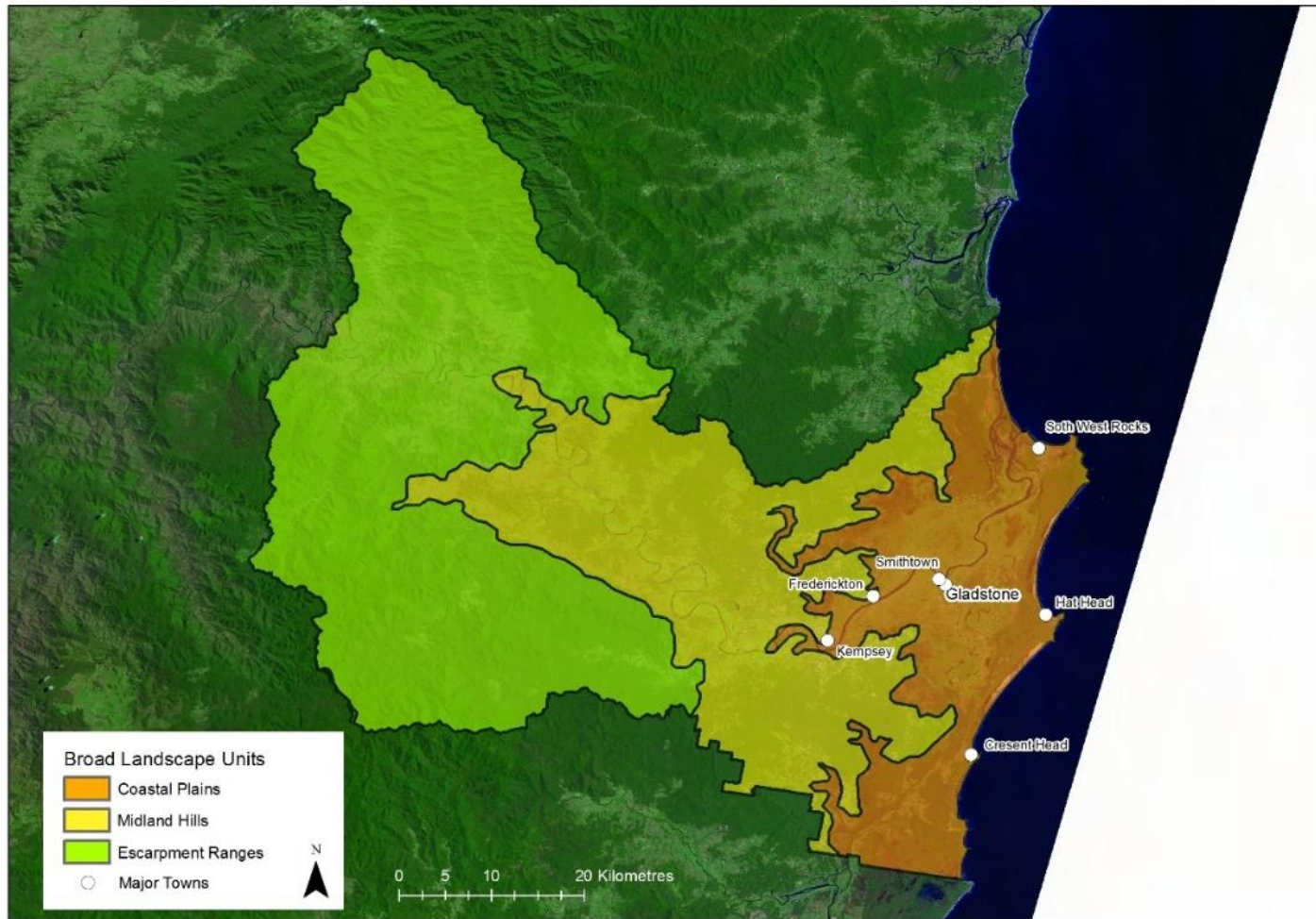
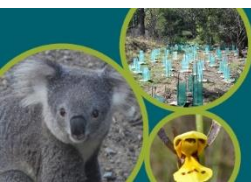


Figure 6: Distribution of the three broad landscape units within the Kempsey LGA



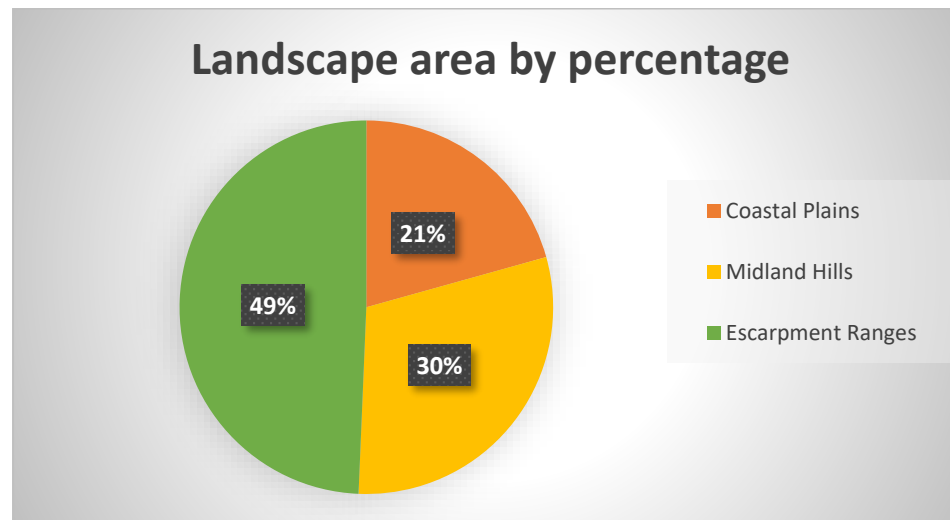


Figure 7: Percentage of landscapes occupying the Kempsey LGA

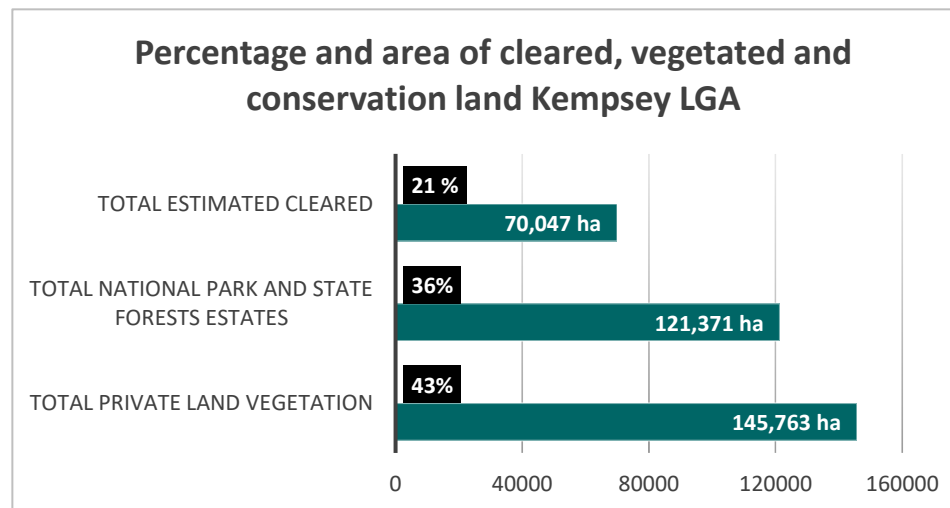
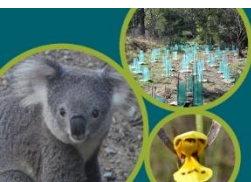


Figure 8: Percentage of estimated cleared, vegetated and conservation land – LGA total



Threat assessment

An assessment of 'threats to biodiversity' was undertaken where threatening activities have been considered across each landscape and then assigned to each of the landscapes they occur within. A further ranking assessment has been undertaken which identifies the level of each threat within a particular landscape; the same threat can occur across all of the landscapes, however the intensity or severity of that same threat can differ between landscapes. This threat assessment helps to understand the types and severity of threats to biodiversity across the region and may assist in targeting appropriate mitigating actions to protect or enhance biodiversity.

Coastal Plains threat activities and ranking

Table 4 lists each threat activity and rating (very high to very low) based on the geographical extent of the activity and its impact on biodiversity within the coastal plains landscape. Within the coastal plains, 64 threat activities impact on biodiversity. Of these activities, 26 are encompassed by key threatening processes listed under the Biodiversity Conservation Act (see Table 4 below) and 1 listed under the *Fisheries Management Act 1994* (FM Act).

The coastal plains, in comparison to the two other landscapes, records the highest overall number of threat activities and the most number of threats unique to a landscape. This reflects the relatively high population density and diversity and intensity of landuse practices.

The coastal plains area provides an attractive 'sea change' lifestyle for many people seeking to move out of capital cities into smaller coastal towns, villages and rural residential acreages. This shift in demographics as well as increased tourism is placing increased pressure on the natural environment, leading to further clearing and fragmentation of existing vegetation and habitats to satisfy an increased demand for urban and rural residential land, infrastructure and services. In addition, there are increased risks of fires, weed invasion, pollution, accidental mortality of fauna and predation on wildlife by domestic and wild cats and dogs.

Many habitats in the coastal plains are highly disturbed and fragmented and major roads such as the Pacific Highway act as significant barriers to the movement of species. This causes genetic isolation of populations and an inability for species to recolonise areas after local extinctions. Flying-fox camps on the coastal plains are often within or adjoining urban areas, making them vulnerable to intentional or unintentional disturbances and habitat loss.

The coastal koala population concentrated towards the southern end of the shire is under significant levels of threats from cars, dogs, fragmented habitat and potential wildfire. Disease is also an on-going problem. The potential for wildfire in the coastal national parks which support key koala populations is a significant risk.

Midland Hills threat activities and ranking

In the midland hills, 60 threat activities impact on biodiversity. Of these 60 threat activities, 23 are encompassed by key threatening processes listed under the Biodiversity Conservation Act (see Table 4 below) and 1 listed under the *Fisheries Management Act 1994* (FM Act).

The midland hills, in comparison to the coastal plains, has a slightly lower number of overall threat activities reflecting the relatively lower population density. The diversity of land uses are less and are mainly associated with agricultural activities, primarily cattle grazing. Forestry is also wide spread on both private land and Forests Corporation NSW estate. Table 4 lists each threat activity and rating (very high to very low) based on the geographical extent of the activity and its impact on biodiversity within the midland hills landscape.

The main threats include; clearing and disturbance of vegetation for agriculture, invasion from introduced plant species; the establishment and spread Lantana; competition and predation by the European Red Fox, feral deer and feral pigs and in some locations inappropriate fire regimes. Competition, predation and disease by feral Cats is also of high concern within this landscape. Cane Toads are presently not established in the LGA, however they are a potential threat. Some areas are also subject to urban, rural-residential and industrial development (including clearing setbacks for fire protection);

The impacts associated with climate change are likely to be less in the midland hills than in the coastal plains landscape. There may however be impacts from increased wildfire potential and the invasion of new weeds and pest species such as the Cane Toad may occur. Some plant species and the floristics of some vegetation communities may also change as a result of changes in the current range and distribution of temperature and rainfall. Increasing stochastic events such as cyclones, storms and floods may also alter or impact on important habitats.

Escarpment Ranges threat activities and ranking

In the escarpment ranges, 28 threat activities impact on biodiversity. Of these 28 threat activities, 19 are encompassed by listed key threatening processes (Table 4). The number of threats impacting on this landscape is far less than in the midland hills and in the coastal plains landscape. Threat ratings are generally also lower in the escarpment ranges. This reflects the low levels of human settlement, difficulty of the steep terrain for undertaking agriculture or other human activities and the relatively large area of national parks and state forests.

The escarpment ranges is a dramatically different landscape to the other landscapes in the region due largely to the steep, rugged landforms. These have precluded, in many areas, the intensive development and widespread distribution of land uses that are major threats to biodiversity in the other landscapes.

Threats to the conservation areas of this landscape, although much reduced compared to other land uses, are still present and include inappropriate fire regimes as a result of wildfires. These can result in the burning of large inaccessible areas, including rainforest under extreme conditions. Inappropriate fire regimes encompass those that are too frequent, or not frequent enough, dependent on the ecosystem. Predation from foxes, feral cats and wild dogs can also occur throughout these areas, predominantly in disturbed forest areas, along forest edges and in the rural agricultural lands. Feral goats and deer may be an emerging issue in some areas.

Overall the escarpment ranges is likely to be more resilient to the potential impacts of climate change because of the highly variable topography, occurrence of sheltered sites, and the mosaic of vegetation communities. Nevertheless, restricted vegetation communities such as upland wetlands, rocky outcrops, dry rainforest and cool temperate rainforest are vulnerable to the catastrophic consequences of climate change as a result of extended dry periods, changes in frequency and volume of rainfall and increased fire and/or storm intensities. Bell Miner associated dieback may be an emerging threat to the escarpment ranges. Chytrid fungus is a serious threat to the many frogs that inhabit the streams and moist forests and may be an emerging threat in the escarpment ranges. Weed invasion in disturbed areas may be a problem.

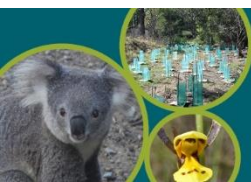
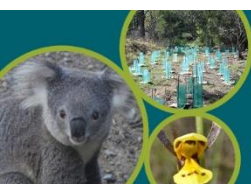
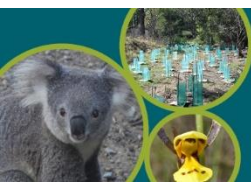


Table 4. Coastal Plains, Midland Hills and Escarpment Ranges activities and threat ranking

Threat Group / Activity	LANDSCAPE AREA		
	Coastal Plains	Midland Hills	Escarpment Ranges
Clearing and fragmentation^{1,2}			
Clearing for urban and industrial development	Very High	Very Low	Not Applicable
Rural residential	High	Very Low	Not Applicable
Agricultural clearing	High	Medium	Low
Asset protection zones (fire)	Low	Very Low	Very Low
Removal of hollow bearing trees	Medium	Medium	Medium
Clearing for plantations ²	Very Low	Low	Very Low
Fire			
Inappropriate fire regime ²	High	Medium	Medium
Weeds			
Weed invasion	Very High	Medium	Medium
Invasion of native plant communities by Bitou Bush & Boneseed	High	Not Applicable	Not Applicable
Invasion, establishment and spread of <i>Lantana camara</i> ²	High	Medium	Low
Invasion and establishment of exotic vines and scramblers ²	Low	Low	Low
Invasion of native plant communities by exotic perennial grasses ²	Low	Very Low	Very Low
Pests			
Competition and predation by the European Red Fox (<i>Vulpes vulpes</i>) ^{1, 2}	High	Medium	Low
Competition, predation and disease from feral Cats ^{1, 2}	Medium	Medium	Low
Competition from introduced birds	Very Low	Very Low	Very Low
Competition, predation and disease from feral Dogs ²	Medium	Medium	Medium
Competition, grazing and land degradation from feral Goats ^{1, 2}	Very Low	Very Low	Low
Predation by the Plague Minnow (<i>Gambusia holbrooki</i>) ²	Very Low	Very Low	Very Low
Competition, grazing and degradation from feral Deers ²	Low	Medium	Medium
Competition, predation, grazing, habitat degradation and disease transmission by feral Pigs (<i>Sus scrofa</i>) ^{1, 2}	Very Low	Low	Low
Competition, land degradation and grazing from Rabbits ^{1, 2}	Very Low	Low	Very Low
Competition, predation and mortality from ingestion of Cane Toad (significant potential threat) ^{1, 2}	Very Low	Very Low	Not Applicable
Competition and predation from feral fish	Very Low	Very Low	Very Low



Competition from feral Honey Bees ²	Low	Very Low	Very Low
Importation of tramp ants into NSW (significant potential threat) ^{1, 2}	Very Low	Very Low	Very Low
Introduction of the Large Earth Bumblebee (<i>Bombus terrestris</i>) (significant potential threat) ²	Very Low	Very Low	Very Low
Predation by introduced rodents	Very Low	Very Low	Very Low
Competition and predation by Pandanus Plant-Hopper	Very Low	Not Applicable	Not Applicable
Forestry			
Forestry	Low	High	High
Hydrology and water quality			
Alteration to the natural flow regimes of floodplains from habitat modification and degradation ²	Medium	Very Low	Very Low
Alteration to the natural flow regimes of wetlands from habitat modification and degradation ²	Medium	Low	Very Low
Pollution from stormwater	Medium	Very Low	Very Low
Activation of acid sulphate soils	Low	Very Low	Not Applicable
High nutrient loads, sediment loads, contaminant loads and thermal pollution	Low	Very Low	Very low
Alteration to the natural flow regimes of rivers and streams from habitat modification and degradation ²	Low	Low	Very Low
Altered groundwater hydrology	Very Low	Very Low	Very Low
Siltation/sedimentation	Very Low	Very Low	Very low
Alteration to the natural flow of coastal lakes and estuaries from habitat modification and degradation	Very Low	Not Applicable	Not Applicable
Diseases and pathogens			
Infection of amphibians with chytrid fungus resulting in chytridiomycosis ^{1, 2}	Very Low	Medium	Low
Dieback caused by the root-rot fungus (<i>Phytophthora cinnamomi</i>) ^{1, 2}	Very Low	Low	Very Low
Human interference			
Removal of dead wood and dead trees ²	Low	Low	Very low
Irresponsible ownership of domestic pets	Medium	Low	Very Low
Road mortality	Medium	Low	Very Low
Hunting/fishing	Low	Low	Very Low
Loss or degradation of estuarine nursery habitats	Low	Not Applicable	Not Applicable
Removal, degradation and disturbance of nests and roosts	Low	Very Low	Very Low
Human induced mortality	Very Low	Very Low	Very Low



Human activity by vehicles off road	Very Low	Very Low	Very Low
Impediments to movement of fish	Very Low	Very Low	Very Low
Dead wood removal from stream ³	Very Low	Very Low	Very Low
Human activity by visitors	Low	Very Low	Very Low
Collection of seed	Very Low	Very Low	Very Low
Vandalism	Very Low	Very Low	Very Low
Horse recreational use	Very Low	Very Low	Very Low
Entanglement in, or ingestion of anthropogenic debris in marine and estuarine environments ^{1, 2}	Very Low	Not Applicable	Not Applicable
Electrocution	Very Low	Very Low	Very Low
Boat mortality	Very Low	Not Applicable	Not Applicable
Livestock			
Domestic livestock grazing, trampling and competition	Medium	High	Low
Chemicals and waste			
Application and pollution from urban, industrial and rural chemicals	Low	Low	Very Low
Poisoning due to pest control	Very Low	Very Low	Very Low
Illegal rubbish dumping	Very Low	Very Low	Very Low
Rubbish dumping / landfill	Very Low	Very Low	Very Low
Demographic effects and small populations			
Demographic effects and small populations	Medium	Low	Very Low
Genetic contamination/hybridisation	Very Low	Very Low	Very Low

¹ Key Threatening Process listed under EPBC Act 1994

² Key Threatening Process listed under BC Act 2016

³ Key Threatening Process listed under FM Act 1994

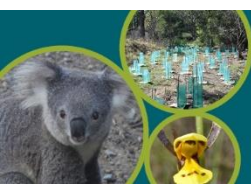


Table 5. Listed Endangered Ecological Communities

Community Name	Status	Coastal	Midlands	Escarpment
NSW TSC Act				
Carex Sedgeland of the New England Tableland, Nandewar, Brigalow Belt South and NSW North Coast Bioregions	E3			✓
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3	✓		
Freshwater Wetlands on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3	✓		
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3	✓		
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	E3	✓	✓	
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	E3	✓	✓	
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	E3			✓
New England Peppermint (<i>Eucalyptus nova-anglica</i>) Woodland on Basalts and Sediments in the New England Tableland Bioregion	E4B			✓
Ribbon Gum-Mountain Gum-Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion	E3			✓
Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion	E3	✓	✓	
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3	✓		
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	E3	✓		
Themeda grassland on seaciffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner Bioregions	E3	✓		
Upland Wetlands of the Drainage Divide of the New England Tableland Bioregion	E3			✓
White Box Yellow Box Blakely's Red Gum Woodland	E3			✓
White Gum Moist Forest in the NSW North Coast Bioregion	E3			✓

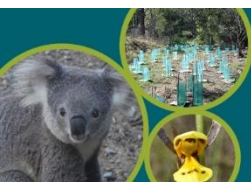


Table 6. Commonwealth Listed Endangered Ecological Communities

Community Name	Status	Coastal	Midlands	Escarpment
Commonwealth EPBC Act				
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	V	✓		
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	CE	✓		
Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions	CE	✓	✓	
Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion	CE	✓	✓	
Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps bioregions	E			✓
New England Peppermint (<i>Eucalyptus nova-anglica</i>) Woodland on Basalts and Sediments in the New England Tableland Bioregion	CE			✓
Upland Wetlands of the Drainage Divide of the New England Tableland Bioregion	E			✓
White Box Yellow Box Blakely's Red Gum Woodland	CE			✓

Table 7. Endangered populations

Community Name	Status	Coastal	Midlands	Escarpment
Tusked Frog population in the Nandewar and New England Tableland Bioregions	E2			✓

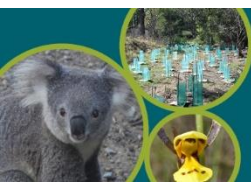
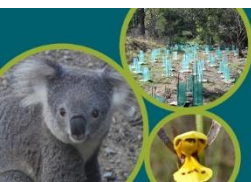
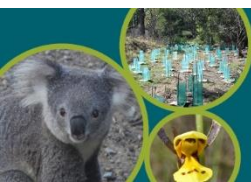


Table 8. Key Threatening Processes operating in the Kempsey LGA

Key Threatening Process	EPBC Act	BC Act	FM Act
Pest animals			
Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy Miners <i>Manorina melanocephala</i>	✓	✓	
Competition & grazing by the feral European Rabbit <i>Oryctolagus cuniculus</i>	✓	✓	
Competition and habitat degradation by Feral Goats, <i>Capra hircus</i> Linnaeus 1758	✓	✓	
Competition from feral Honeybees <i>Apis mellifera</i>		✓	
Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners		✓	
Herbivory and environmental degradation caused by feral deer		✓	
Importation of Red Imported Fire Ants <i>Solenopsis invicta</i> Buren 1972	✓	✓	
Invasion & establishment of the Cane Toad <i>Bufo marinus</i>	✓	✓	
Introduction of the Large Earth Bumblebee <i>Bombus terrestris</i>		✓	
Invasion of the Yellow Crazy Ant <i>Anoplolepis gracilipes</i> into NSW		✓	
Predation by Plague Minnow <i>Gambusia holbrooki</i>		✓	
Predation by European Red Fox <i>Vulpes vulpes</i>	✓	✓	
Predation by feral Cat <i>Felis catus</i>	✓	✓	
Predation, habitat degradation, competition & disease transmission by feral Pigs <i>Sus scrofa</i>	✓	✓	
Predation and Hybridisation by feral dogs (<i>Canis lupus familiaris</i>)		✓	
Weeds			
Invasion & establishment of exotic vines and scramblers		✓	
Invasion and establishment of Scotch Broom (<i>Cytisus scoparius</i>)		✓	
Invasion of native plant communities by African Olive <i>Olea europaea</i> subsp. <i>cuspidata</i>		✓	
Invasion of native plant communities by Chrysanthemoides <i>monilifera</i>		✓	
Invasion of native plant communities by exotic perennial grasses		✓	
Invasion, establishment & spread of Lantana <i>Lantana camara</i> ²		✓	
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	✓	✓	



Key Threatening Process	EPBC Act	BC Act	FM Act
Disease			
Infection of frogs by amphibian chytrid causing chytridiomycosis	✓	✓	
Infection of native plants by <i>Phytophthora cinnamomi</i>	✓	✓	
Psittacine circoviral (beak and feather) disease affecting endangered psittacine species and populations	✓	✓	
Aquatic & hydrological			
Alteration to natural flow regimes of rivers, streams, their floodplains & wetlands		✓	
Death or injury to marine species following capture in shark control programs on ocean beaches		✓	
Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments	✓	✓	
Degradation of native riparian vegetation along New South Wales water courses			✓
Instream structures & other mechanisms that alter natural flow regimes of rivers and streams			✓
Introduction of fish to waters within a catchment outside their natural range			✓
Removal of large woody debris from NSW rivers & streams			✓
Clearing, fragmentation & alteration of habitat			
Anthropogenic climate change	✓	✓	
Alteration of habitat following subsidence due to longwall mining	✓		
Bushrock removal		✓	
Clearing of native vegetation	✓	✓	
High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition		✓	
Loss and/or degradation of sites used for hill-topping by butterflies		✓	
Loss of hollow-bearing trees		✓	
Removal of dead wood & dead trees		✓	



Pressures on Biodiversity in the Kempsey Shire

Impacts on biodiversity

Population growth in the region, particularly on the coast, continues to result in greater demand for development. This causes subsequent pressure on biodiversity due to land clearing for residential and rural residential developments. Land clearing and modification for rural activities, including agriculture (primarily cattle grazing) also apply direct pressure on biodiversity.

Exotic weeds

Further pressures placed on biodiversity in the Shire include the prevalence of exotic weed species and feral animals. Introduced plants that result in weed infestations including noxious weeds and garden escapees are a major threat to biodiversity in the Kempsey Shire. Exotic species of particular concern especially in riparian zones include Camphor Laurel, Willow, Large-Leaved Privet, Small-Leaved Privet, Wandering Jew, Blackberry, and particularly Lantana that was prevalent at all sites surveyed within the Shire. Exotic species applying the most significant pressure in biodiversity in high conservation areas of National Parks estate, primarily in the coastal region, are Bitou Bush and Lantana.

Feral animals

Feral animals apply a significant amount of pressure on native fauna and flora and therefore the overall biodiversity in the region. Some have been listed under the Biodiversity Conservation and EPBC Acts as Key Threatening Processes (KTPs). KTPs occurring (or likely to be occurring) in the region in relation to introduced animals include:

- Competition and land degradation by feral goats;
- Competition and land degradation by feral rabbits;
- Predation by feral cats;
- Predation by the European Red Fox;
- Predation, habitat degradation, competition and disease transmission by feral pigs;
- Competition from feral honey bees; and
- Predation by *Gambusia holbrooki* (Plague Minnow or Mosquito Fish).

Feral animals of particular significance known to exist in the Shire, include; hares, rabbits, foxes, black rat, brown rat, common mouse, feral cats, starlings, Indian Myna birds, house sparrows, mosquito fish, goldfish/carp, trout, European honey bees and feral dogs and cross-bred dingoes.



Bushfires

Bushfires also impact on the biodiversity of the Shire. Fire is a natural process to which native animals and plants have adapted to. Groups of animals and plants that constitute an ecosystem respond similarly to fire according to the characteristics of their life-history. Many small mammals and most birds breed in Spring and Summer (commonly the fire period). As burned areas regenerate, different species find suitable habitat at the various levels of regeneration. Changing fire regimes have been associated with the decline of many biological communities. The correct management of fire is thus essential to avoid disruption of ecosystems and extinction of species.

- Clearing and fragmentation of native vegetation
- Weeds and Pest animals
- Water quality and hydrology
- Urbanisation
- Grazing of livestock in native vegetation and sensitive environments

Existing Biodiversity work of Council

Comprehensive Koala Plan of Management

The ultimate purpose of the Kempsey Comprehensive Koala Plan of Management (CKPoM) is to provide a strategic and consistent approach to koala management and planning throughout the eastern portion of the Kempsey Shire at a landscape scale. The CKPoM for the eastern portion of the Kempsey Shire seeks to manage the threats operating on koalas and conserve their natural habitat by incorporating koala conservation and management into Local Government planning processes.

The provisions of the plan aim to provide conservation of areas of important koala habitat within the shire and in order to ensure generation persistence of populations within their current range. It also aims to increase koala habitat in key areas and to increase knowledge regarding the current distribution and abundance of koalas where it is currently inadequate.



Figure 9: Koala



The Ecohealth Waterway Monitoring Program outlines a framework for the development of a catchment-based aquatic health monitoring program for rivers and estuaries with the aim of providing consistency in aquatic ecosystem monitoring and reporting.

Macleay Ecohealth Project 2015-16

The Macleay Ecohealth Project 2015-16 provides the first baseline dataset for water quality, freshwater macroinvertebrates, and freshwater riparian and geomorphic condition in the Macleay catchment. Forty-four sites across the Macleay catchment; 32 freshwater sites and 12 estuarine sites were sampled 6 times from April 2015 to February 2016.

The aims of the Macleay Ecohealth Program are;

- 1) Assess the health of the Macleay catchment using standardise indicators and reporting for estuaries and freshwater river reaches using hydrology, water quality, riparian vegetation and habitat quality, geomorphic condition and macroinvertebrate assemblages as indicators of aquatic ecosystem health,
- 2) Inform management priorities and actions for sub-catchments of the Macleay River, and
- 3) Contribute scientific information to the development of a report card system for communicating the health of the estuarine and freshwater systems in the Macleay catchment.

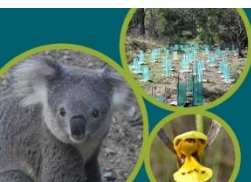
Freshwater Fish Community Study 2016

The aim of the Freshwater fish community study was to determine the relative health of the fish communities in the Macleay Basin as part of the North Coast Ecohealth Program. Fish were sampled at 27 sites throughout the Macleay Basin between 16th December 2014 and 18th February 2015, using combinations of electrofishing, seine netting and bait trapping.

The relatively high species richness found in the current study suggests that the overall structure of the fish community in the Macleay Basin has changed little since European settlement. Of the ~26 native freshwater species thought to have occurred naturally throughout the basin pre-1770, 19 were captured during the current survey.



Figure 10: The upper Macleay River



Estuary Management Plans

Estuary Management Plans were developed through the NSW Estuary Management Policy 1992 and NSW Coastal Policy 1997. This was a NSW Government initiative aimed at managing the increasing pressures on estuarine systems.

Macleay River Estuary

The Macleay River estuary provides significant recreational boating opportunities with a diversity of waterways in the lower reaches of the estuary. Recreational boating forms a vital component of the tourism sector of the lower Macleay River Valley and a significant lifestyle activity enjoyed by a large proportion of the community. The lower estuary is also the main departure point for commercial dive and fishing charter vessels which provides significant economic and tourism based benefits to the area.

The purpose of the Estuary Management Plan is to detail priority strategies and actions that need to be undertaken to address key environmental issues for the estuary (e.g. improve water quality, protection of floodplain wetlands) and community issues associated with the estuary (e.g. improve boating facilities).



Figure 11: The Macleay Estuary System



Figure 12: The Macleay entrance



Figure 13: The Macleay Estuary

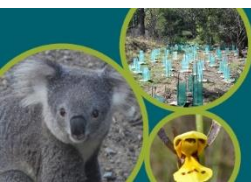
Killick Creek Estuary Management Plan 2006

Kempsey Shire Council prepared the Killick Estuary Management Plan in 2006. Killick Creek is a small estuary on the mid north coast of NSW connected to the ocean adjacent to the township of Crescent Head. Killick Creek is the principal natural waterway through the township and consequently is used by residents for a variety of recreational activities.

A combination of scientific investigations and community consultation was adopted in preparing the Plan. Based on a detailed understanding of the environmental processes and the concerns and aspirations of the community and stakeholders, a series of strategies were developed to meet long term objectives for the Killick Creek estuary.



Figure 14: Killick Creek Estuary



Korogoro Creek Estuary Management Plan 2009

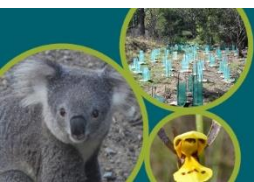
Kempsey Shire Council prepared the Korogoro Estuary Management Plan in 2009. Korogoro Creek is a small coastal creek with no significant tributaries that runs through Hat Head, located within the Kempsey Shire Council on the mid-north coast of New South Wales. Korogoro Creek can be considered estuarine for its entire length, the upstream marker being the floodgates that separate it from a large wetland known as 'Swan Pool'. The entrance of the creek is untrained and believed to be permanently open. The estuary is approximately 5.4km long and has a water surface area of approximately 0.2 km². The Korogoro Creek estuary is a valuable asset to the local and broader community.



Figure 15: Korogoro Creek Estuary



Figure 16: Korogoro Creek



Saltwater Creek Estuary

Kempsey Shire Council prepared the Saltwater Creek & Lagoon Estuary Management Plan in 2006. Saltwater Creek and Lagoon is a small estuary adjacent to the township of South West Rocks. The estuary is an Intermittently Closed and Open Lake or Lagoon (ICOLL), meaning that the waterway is not permanently connected to the ocean. In fact beach sand keeps the entrance closed for about 70% of the time, resulting in no tidal variability, and water levels that respond to catchment runoff and evaporation.

Saltwater Creek and Lagoon are important features of the local landscape. The waterway provides for a combination of passive recreation activities, such as canoeing, bushwalking and fishing, and natural habitat values. The downstream end of Saltwater Creek near the ocean entrance is also used for swimming, and is valued for quiet and safe bathing conditions.

A combination of scientific investigations and community consultation was adopted in preparing the Plan. Strategies were designed and customised to address 14 separate objectives, each aiming to ensure long term sustainability of the estuary.



Figure 17: Saltwater Creek

Macleay Macrophyte Report

Egeria densa has been recognised as one of the most invasive macrophyte species in the world and is an invasive aquatic weed that is native to regions of South America and was introduced through the aquarium trade. It has spread to many regions of NSW and tends to prefer warm, slow flowing or still waters that are high in nutrients, although it is cold tolerant.

The distribution and abundance of egeria on the Macleay River appears to fluctuate with floods removing large volumes of the plant matter. The primary management issues associated with the presence of egeria in the estuarine waters of the Macleay River are associated with: the potential spread to upstream areas via translocation on propellers and boat trailers etc; restrictions to navigation, boating and other recreational activities; and dominance over favourable native species.

Twenty-one (21) different macrophyte species were observed from twelve (12) different families throughout the study reach in the main trunk of the Macleay River. Fifteen (15) of these species were native species while six (6) were exotic species. Of the six exotic species, four are recognised by the Local Control Authority (Kempsey Shire Council) as noxious weed species. Of the 21 species, five were present throughout the entire 215-km reach. This included *Egeria densa*. *Hydrocharitaceae* was the most diverse macrophyte family in the Macleay (with six genera), followed by *Potamogetonaceae* with five genera.

Shorebird Survey and Management Plan

Macleay River Estuary Migratory and Threatened Shorebird Species Management Strategy (2017)

Worldwide, shorebird populations have been declining (Kirby et al., 2008). As migratory shorebird populations decline there is a growing need to minimise threats to remaining habitats which are important for their ongoing survival (MacKinnon et al. 2012)

The aim of the strategy is to gather essential spatial and temporal information to assist in identifying high and important conservation value habitats for migratory, threatened and resident shorebird species in the Kempsey LGA coastal zone, and subsequently develop appropriate management strategies for shorebirds protection in the coastal zone.

A total of 1,653 birds from 50 aquatic species were recorded during the surveys. Of these, 273 individuals were shorebirds from 16 different species. These included 10 long-distance migratory species and 6 resident or dispersive species. This result was affected by record high summer temperatures and 34% below-average rainfall received in the area during the survey period. Other records were used to augment the survey data. A number of significant shorebird foraging and roosting sites were recorded based on direct observations made during the surveys and from discussions with local bird observers.

A follow-up shorebird survey has been undertaken and survey report prepared with the aim of this survey is to review the findings and recommendations of the 2017 Strategy and gather additional spatial and temporal information to assist in identifying high and important conservation value habitats for migratory, threatened and resident shorebird species in the Kempsey LGA coastal zone.

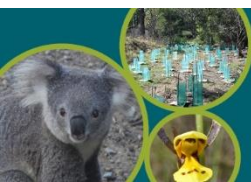




Figure 18: Pied Oyster Catchers



Figure 19: Terek Sandpiper

Belmore River Rehabilitation Project

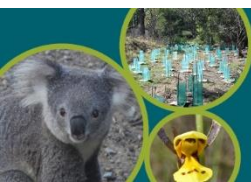
The Upper Belmore River Riparian Rehabilitation Project (UBRRRP) has been developed in partnership between Kempsey Shire Council (KSC) and landholders directly connected to a five (5) kilometre stretch of Upper Belmore River – from the Upper Belmore Bridge to the head of the Belmore River.

The UBRRRP is fundamentally an environmental rehabilitation project that includes *strategies* and *actions* to address weed management, re-establishment of native vegetation, abate riverbank erosion and return natural hydraulic flow regimes within the Upper Belmore River with the aim of increasing native ecological biodiversity, improving environmental water quality parameters, and fostering improved landscape aesthetic values.

Boyers Lane Rehabilitation Project

Kempsey Shire Council purchased the 25.8ha property for the purpose of creating playing fields. When acquired by Council, the majority of the site consisted of salt and freshwater wetland environments in both natural and altered states. Ecological assessments of the site identified that; the ecological integrity of the site was significantly impacted on and adversely modified by past land use practices.

Recognising the ecological sensitivity of the site, Council engaged Environmental Consultants (Australian Wetlands) to prepare a Plan of Management for the site, to reduce and minimise the potential impacts of the playing fields on the surrounding ecosystems.



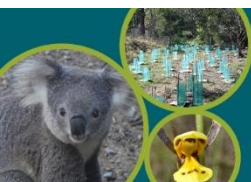
The objectives of the Boyter's Lane revegetation project are to;

- 1) Revegetate areas of the Boyter's Lane site with native vegetation
- 2) Improve and protect the ecological character of the site, and
- 3) Improve community environmental awareness

To date over 15,000 native trees and shrubs have been planted within the Boyter's Lane site. In addition, saltmarsh & mangrove protection measures have been introduced and improved community usage infrastructure constructed including 2km of walkway and environmental information hut and bird hide.



Figure 20: Boyters Lane Environmental Project Site



Gill Bridge Creek Rehabilitation Project

The visual appearance of Gills Bridge Creek had been declining for a number of years, while water quality monitoring indicated some impacts from the surrounding urban, commercial and industrial environment. Council and the community recognised the declining health of the Creek and the need for action to be taken. The Gills Bridge Creek Rehabilitation plan was developed and adopted by Council in 2007. In order to implement the actions of the Rehabilitation Plan, a three year Environmental Trust funded project commenced in 2008 and finished in 2011. Further external funding and funding from Council continued rehabilitation works of the Gills Bridge Creek area. The project has aimed at protecting intact native riparian vegetation and aquatic habitats, and to rehabilitate degraded ecological assets, such as water quality and the extent of weed coverage. The project has seen extensive community involvement and over 10ha of area has received ongoing weed control, over 2500 native, endemic riparian species have been planted in the area and a nest box installation program was implemented. A flora and fauna study carried out identified a number of threatened species utilising the habitat of Gills Bridge Creek and rehabilitation works targeted the rehabilitation and enhancement of habitat for these particular species.

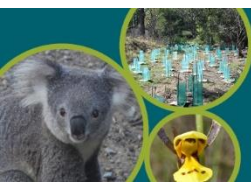
Community involvement in the project has included local schools, local businesses, Macleay Landcare and Green core teams.



Figure 21: Gills Bridge Creek



Figure 22: Rehabilitation area Gills Bridge Creek



Sherwood Bore Fields Rehabilitation Project

The Northern Rivers Catchment Management Authority (NRCMA) in conjunction with Kempsey Shire Council (KSC) Water Services submitted a funding application to the Australian Governments 2011-12 Biodiversity Grant Fund to undertake environmental restoration and rehabilitation works within the Sherwood Bore-field precinct.

The Sherwood Bore fields Rehabilitation Project was developed and implemented to improve the quality and extent of river bank and floodplain vegetation at the Kempsey town water bore fields site. The project aims to capture and store carbon and improve the biodiversity value of existing riparian vegetation through revegetation and weed control whilst improving water quality for the town water supply and down stream users.

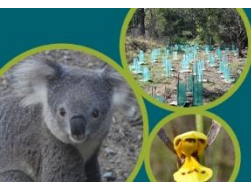
More than 30,000 native trees and shrubs were planted on the site over 6.0 hectares.



Figure 23: Tree planting Sherwood Bore field



Figure 24: Planted vegetation establishing Sherwood Bore Field site



Hastings Macleay Koala Fire Plan

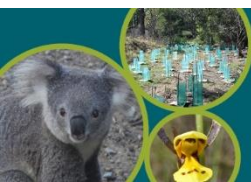
The Hastings-Macleay area has been identified by the NSW Office of Environment and Heritage as an Area of Regional Koala Significance (ARKS). This means that the koala population here, while facing threats, has been considered to be still resilient enough to 'bounce back' and be sustainable in the longer-term if threats are addressed. The Hastings-Macleay area is also important to koalas as it contains a number of distinct 'genomes'. Genetic diversity is particularly important to koalas with strong relationships between disease resistance and genetic traits.

The Saving Our Species (SOS) Program delivered by the NSW Office of Environment and Heritage funds activities that seek to reverse the decline of many threatened species. Kempsey Shire Council and Port Macquarie-Hastings Council received a grant under the SOS: Iconic Species: Koala fund to establish the Hastings-Macleay Fire and Biodiversity Consortium (FABCON). The FABCON seeks to bring together multiple stakeholders involved in land and fire management so as to manage fire in a way that better protects koalas and their habitat, while simultaneously considering the other primary objectives of the respective agencies (eg the protection of life, property, culture and other key assets).

This information was to be collated in a report and the information disseminated to each Rural Fire Service Brigade within the Study Area for discussion/education and report finalisation and then roll-out of the community engagement program.



Figure 25: Aftermath of wildfire in Koala habitat



Habitat Connectivity Mapping

Council has carried out habitat connectivity mapping using the GAPCLOSER software (General Approach to Planning Connectivity from Local Scales to Regional). The software was developed by Alex Lechner from University of Tasmania. The vegetation within the shire was mapped into a veg/no veg layer using colour infrared imagery. The vegetation was mapped to a 5m pixel size and the reflectivity methodology used was extremely accurate in separating woody and non-woody vegetation. The entire map was analysed and errors such as mapped agricultural vegetation or shadowing (that was mapped as vegetation) was manually removed. The software identified all patches of woody vegetation >10ha and land use costs were assigned to the patches which influenced the crossing ability of terrestrial fauna. The software drew a path of least resistance between patches. This demonstrated the importance of some areas for connectivity and that if certain linkages are lost it will impact a number of other patches that depend on this linkage.

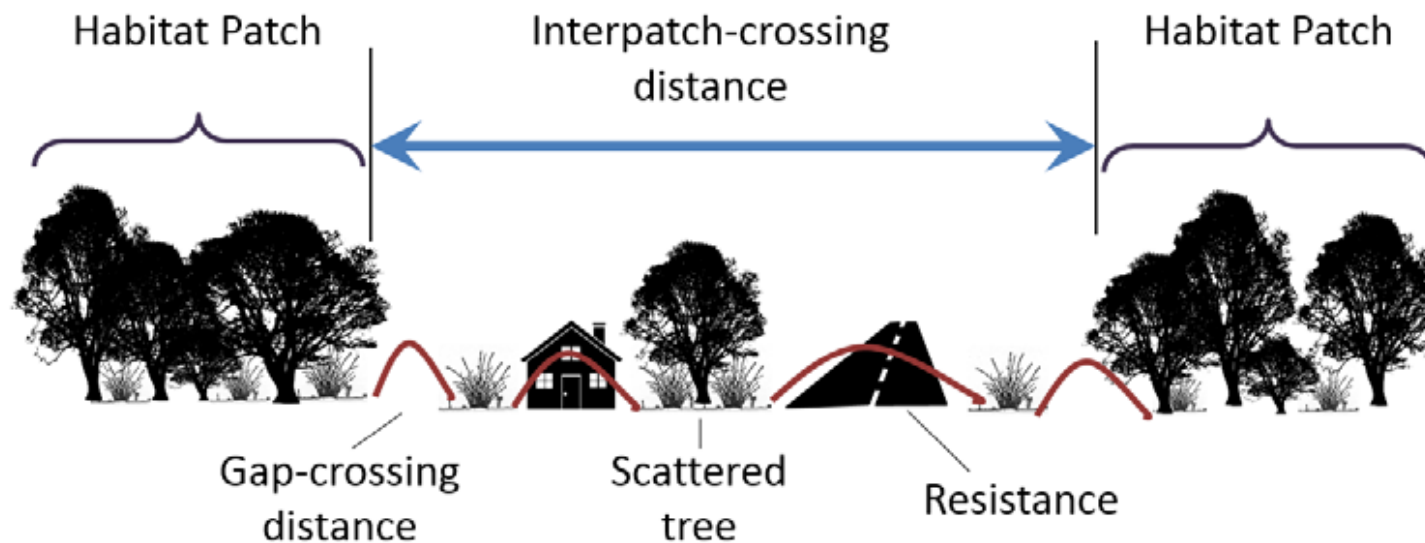
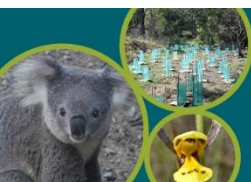


Figure 26: Habitat patch crossing barriers



The uses of the mapping include:

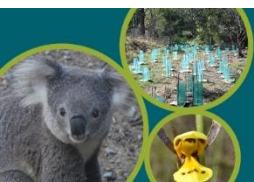
- Development Assessment (Rezoning or subdivision stage)
- Define habitat linkages throughout the Shire to inform Strategic planning (eg rural and residential lands strategies)
- Decision support tool
- Report card for connectivity in the LGA
- A tool to identify areas where improvements of connectivity is necessary



Figure 27: Mapped woody and non woody vegetation



Figure 28: Linkage between vegetation patches



Plant Community Type Mapping

It was identified that there was a need for improved vegetation mapping (from Council's 2006 vegetation mapping) for the purposes of:

- Being a guiding tool for Councils future strategic land use planning
- Identifying Koala habitat
- Identifying candidate Endangered Ecological Communities
- Identifying suitable areas of vegetation for development offsets

Plant Community Type mapping (PCT) is the type of vegetation mapping required for assessments under the Biodiversity Conservation Act and is much finer scale mapping than Councils previous 2006 vegetation mapping. Council engaged consultants to carry out a pilot study to develop the methodology and test accuracy prior to starting the large PCT mapping project. Ground-truthing assessment of the pilot study area found that the map had 82% accuracy in comparison to the 2006 mapping which had 53% accuracy.

As part of the PCT mapping project, the structural information of the vegetation is also being mapped. The three structural fields will be growth stage, disturbance and stand density. This map will be useful in identifying areas of land with potential high value biodiversity.

Council will be reviewing and updating our current Koala Habitat Map and potential Endangered Ecological Community mapping using the PCT data which will give a significantly improved mapping layer.

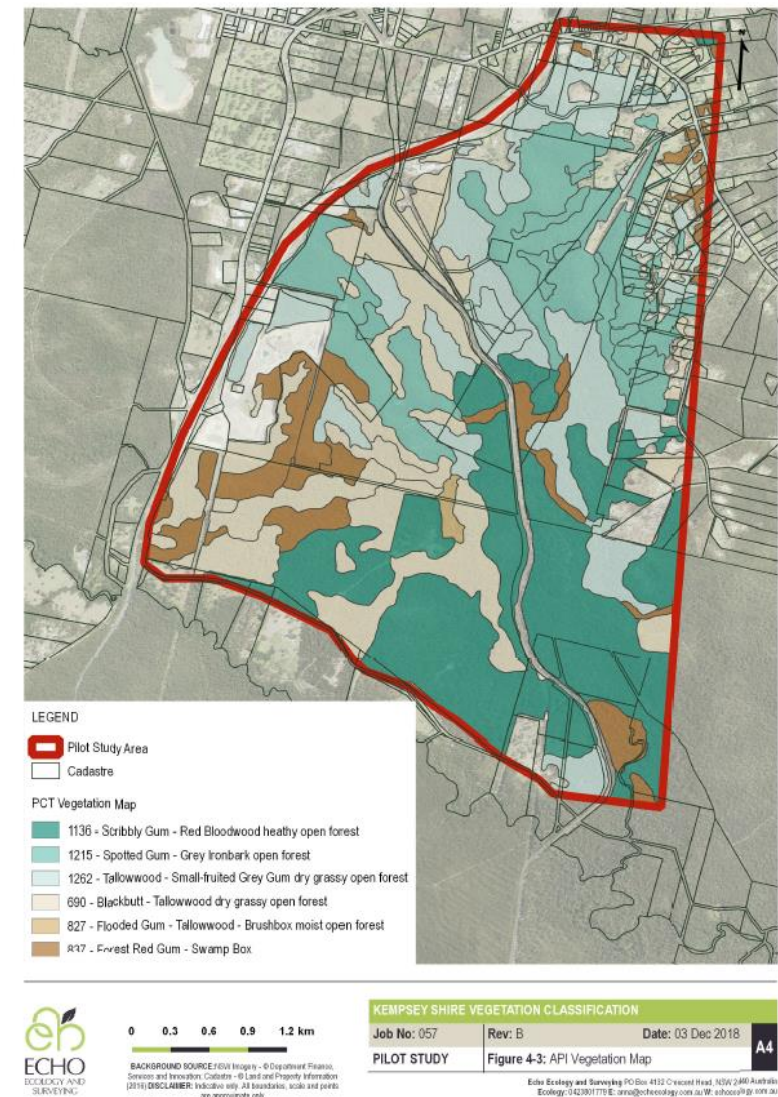


Figure 29: Plant Community Type Map