# 5 Key Threatening Processes

## 5.1 Threatening Processes Affecting Estuary Ecology

### 5.1.1 General Threats to Estuary Ecology

The integrity of the ecological systems of an estuary can be placed under threat by a range of factors. Many of these are general and apply to most, if not all estuaries. General classes of threats that have been described in the past include land use and population density, declining water quality, degradation and loss of estuarine habitats, hydrological changes, unsustainable use of estuarine resources and climate change related impacts. This section of the report contains an assessment of how threats from among these classes apply to the Macleay River.

**Land use and population density**

There are a wide variety of ways that land use and population density can impact upon estuary ecology. Across NSW, urban, industrial and port development, tourism, and other uses have been responsible for significant changes to the ecological function of estuaries. Despite a trend towards increasing population, population density is not a key issue on the Macleay floodplain. However, over 90% of the floodplain is zoned for agricultural landuse (see **Section 5.35**) and historical and current agricultural practices have resulted in acid sulfate soil disturbance and the draining of wetland areas.

The disturbance and exposure of acid sulfate soils is of major concern to all users of the estuary. Runoff from acid sulfate soil hotspots has been associated with catastrophic fish kills, oyster mortality, estuary acidification, mobilisation of toxic concentrations of metals such as iron and aluminium and the formation of monosulfidic black oozes.

Drainage works on Macleay floodplain wetlands have also has a significant impact on estuary ecology. The loss of wetland areas have affected fish and birds that use these habitats, led to acid sulfate soil disturbance and reduced the productivity of the estuary in general. These effects are well described elsewhere and, though the most serious threat to the ecology of the estuary, will not be considered in detail in this study.

**Declining water quality**

Declining water quality is most commonly associated with increased sediment and nutrient inputs, and pollution in the form of heavy metals, oils and grease or gross pollutants.

Sedimentation appears to be a significant issue on the Macleay and could be associated with the loss of productive fishing grounds, changes in the distribution, health and productivity of seagrass habitats and declining productivity of benthic microalgae. The main source of excess sediment to the Macleay is probably overland runoff though bank erosion also contributes.

Elevated nutrients can lead to eutrophication. Signs of eutrophication including algal blooms around the Gladstone wastewater treatment plant, in the upper Macleay Arm (WMA Water 2009) and the Belmore River (John Schmidt *pers comm* 2010) have been observed. A nutrient budget compiled for the Macleay showed that nutrient input

is dominated by land runoff, though sewage inputs are also significant, as is the contribution of nutrients from coastal upwelling and marine sediments. Contributions from stormwater runoff were also noted.

Pollution from heavy metals is a localised problem. The Macleay has a history of arsenic and antimony enrichment derived from historical mining practices in the upper catchment. The distribution and concentration of arsenic and antimony in sediments is well characterised (Ashley *et al* 2007). Both arsenic and antimony are elevated in estuarine sediments and in floodplain wetland sediments, and the delivery of arsenic and antimony to these areas is likely to be ongoing for hundreds to thousands of years. The effects of this on estuary ecology are uncertain and difficult to prove though some negative impacts upon the oyster aquaculture industry are possible (WMA Water 2009).

Oil and grease contamination and gross pollutants have not been identified as significant issues on the Macleay.

**Degradation and loss of estuarine habitats**

The loss of key estuarine habitats like seagrass, mangroves and saltmarsh is a threat to overall estuary ecology. Floodplain wetland degradation and loss is also known to impact upon estuary ecology (See **Section 2**)

Seagrass beds are very important ecosystems. Elevated nutrients and sediments can have negative impacts on seagrasses, as can inappropriate development and physical disturbances. To date around half of the seagrass beds in the estuaries of NSW have been lost. On the Macleay, an overall loss of approximately 8% of seagrass habitats has been measured between 2004 and 2009 along with changes in distribution (see **Section 7.3**).

Significant losses of saltmarshes and mangroves can occur near urban areas through reclamations, drainage and other developments. This affects fish and other marine life, which are dependent on these areas as nursery and feeding grounds. On the Macleay both saltmarsh and mangrove habitats appear to have expanded between the early 1980s and 2004 though some of the perceived increases may be due to improved detection.

Significant losses of floodplain wetlands have occurred as a result of agricultural drainage, flood mitigation works and other developments. On the Macleay, these activities have disturbed acid sulfate soils, restricted habitat connectivity and resulted in an overall reduction in the area of tidal penetration.

**Hydrodynamic alterations**

Changing the hydrodynamics of estuary systems can affect the rate and magnitude of tidal-flushing and tidal range within the waterway. This can have follow on effects to the distribution and abundance of biota and water chemistry. The changes to the hydrodynamics of the Macleay estuary have included training wall construction, rock revetment works, and levee building. However, the most serious effects are most likely associated with the installation of barrages on the Clybucca Creek, Belmore River and Kinchela Creek systems.

**Unsustainable use of estuarine resources**

Estuarine resources are very important to the economies of coastal areas. Uses include fishing, tourism and services such as waste water disposal. The extent of these uses

that can be supported sustainably depends on the individual estuary though concern has been raise in many areas about the effects of various uses on the ecology of the estuary.

Sharp declines in commercial fish catches occurred on the Macleay in the 1970s though it is unlikely that this was a result of fishing pressure alone. Whilst interannual variability is a feature of the local estuary general fishery, catch levels have stabilised over the last decade or so (see **Section 3**). Despite this, many of the species of importance to the estuary general fishery are considered fully fished at a state level.

The Macleay River is a significant tourist attraction for the local area. The use of the estuary by tourists generally involves some form of fishing and/or boating, activities that can have an impact upon the ecology of the estuary.

**Climate change**

Climate change, sea level rise and the associated impacts are considered in detail in **Section 8** of this report.

### 5.1.2 Threats Operating on the Macleay River Estuary

***Juncus acutus***

*Juncus acutus*, commonly known as sharp rush or spiny rush, is an invasive weed that can quickly overtake wetland habitat, displacing natural species and causing an overall reduction in biodiversity. It is commonly found in NSW in areas of low fertility and coastal flats, particularly where they are saline. In terms of weed species that pose a threat to the community structure and function of saltmarsh ecosystems, *J. acutus* is considered the most serious (NSW Scientific Committee 2004*f*). It should be noted that *J. acutus* can also rapidly replace pasture in lowland areas and is regarded as not palatable to stock animals.

*J. acutus* was identified and mapped on the lower Macleay in riparian and saltmarsh areas around Rainbow Reach during the preparation of the Macleay River Estuary Data Compilation Study (Telfer 2005). The data compilation report suggested that a more detailed appraisal of the extent of *J. acutus* should be undertaken and that a control plan should be put in place. A subsequent mapping exercise (Telfer and Kendall 2006) used aerial photography and existing GIS databases to identify a number of (more extensive) areas on the lower Macleay River system where *J. acutus* could potentially occur.

## Juncus Acutus Mapping 2010

### Introduction

Following the suggestion of Gerrand (in Telfer 2005), it was considered important to identify the extent of the *J. acutus* outbreak on the lower Macleay River floodplain as a first step in the development of management strategies to control it.

### Methods

Preliminary identification of the extent of *J. acutus* has been undertaken by Gerrand (in Telfer 2005) and by Telfer and Kendall (2006). Their work is available as GIS mapping layers and was used to develop a field plan for this study. Telfer and Kendall (2006) used aerial photography and existing GIS datasets to map the potential extent of *J. acutus* throughout the study area. Each of the areas identified by Telfer and Kendall (2006) was visited on January 16th 2010 and informally surveyed for the occurrence of *J. acutus*. Gerrand (2006) produced a map of known locations of *J. acutus* developed from incidental sightings

during field work for the Macleay River Estuary Data Compilation Study. Each of these areas was revisited on February 17th or June 12th and the exact spread of *J. acutus* mapped out. In addition to this, incidental sightings during field work were recorded and subsequently mapped. Finally, the most current available aerial photography layer (ADS 40) for the study area was surveyed for potential occurrence of *J. acutus* and locations were visited where access was available and time permitted on Jun 12th.

Mapping was undertaken using a Garmin 12 handheld GPS unit. The survey method involved circumnavigating stands of *Juncus acutus* by foot with the GPS unit automatically recording waypoints every 5 seconds. A stand was defined as any four or more plants occurring with a gap of not more than 15m between individuals. Stands were mapped by starting on the outside of the stand moving from one individual plant to the next nearest plant on the outer edge of the colony. A gap of greater than 15m constituted a separate stand. When the stand had been circled an estimate of the total coverage of *J. acutus* within the stand was made, using the broad categories 1-25%, 26-50%, 51-75% and 75-100%. Individual plants less than 1m tall and not in flower were not included in the mapping exercise. This was done in order to diminish the possibility of misidentification between separate *Juncus* species and to improve the possibility for the detection of expansion among colonies in the near future. Where possible, the occurrence of individual plants was also mapped.

## Results

Ground truthing of the potential occurrences of *J. acutus* from the areas identified by Telfer and Kendall (2006) did not identify any communities not previously identified by Gerrand (in Telfer 2005). Expansion of *J. acutus* communities identified by Gerrand was noted in every instance except at the most downstream community mapped where no plants were found. In addition, a number of previously unidentified communities were found and mapped as a result of incidental observation and through careful surveying of new aerial photography resources.

The mapped occurrence of *J. acutus* in the lower Macleay River system is shown in Figure 5.1.

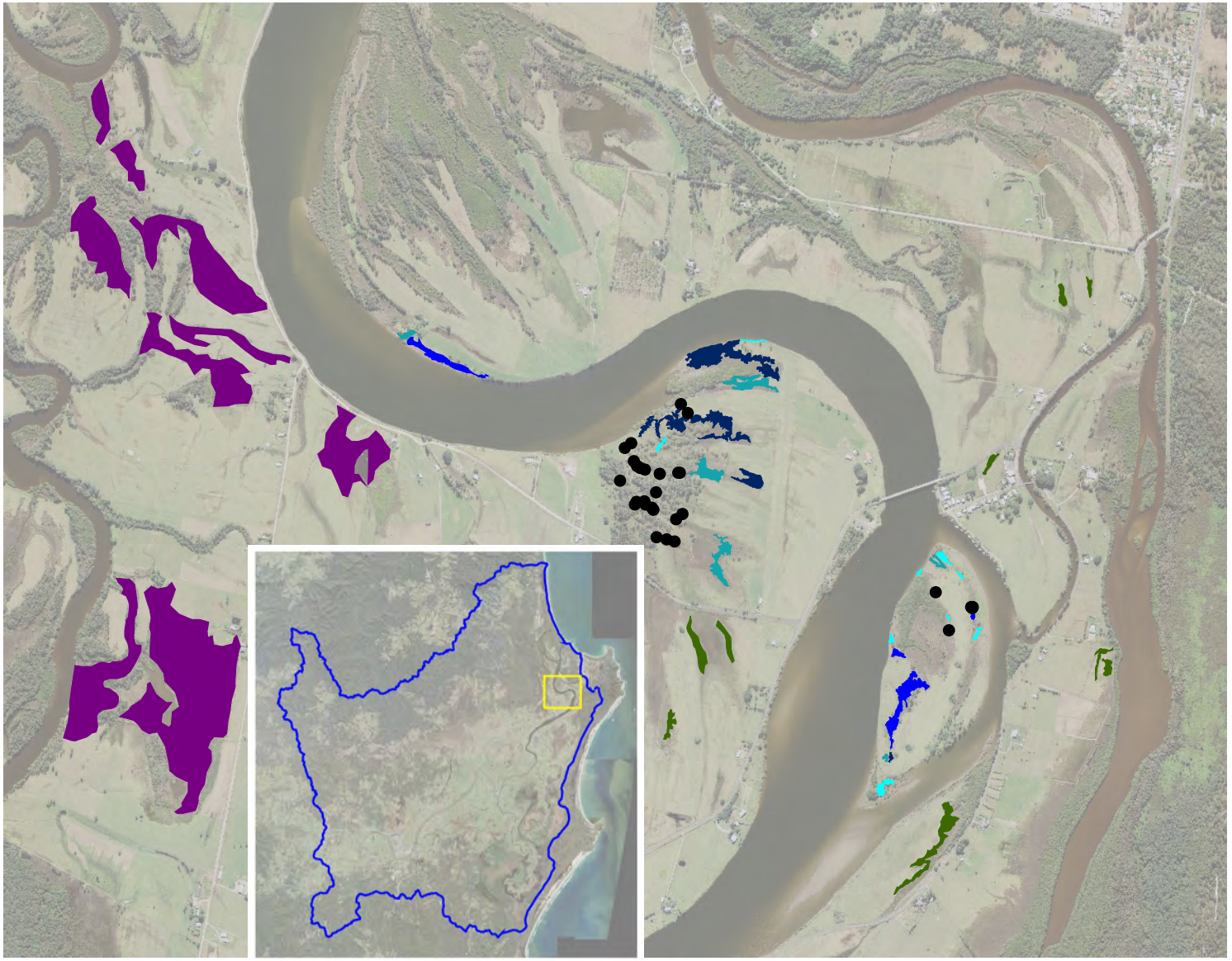
## Discussion

Whilst the occurrence of J. acutus on the lower Macleay is presently contained to a relatively small area it presents a particular threat to the rehabilitation of saltwater wetlands in the Yarrahapinni Wetlands National Park. As the restoration of tidal action returns to the Yarrahapinni Wetlands some areas that are currently vegetated with freshwater, brackish or terrestrial plant species will be temporarily disturbed and replaced with saltwater wetland habitats such as saltmarsh, mangroves and seagrass. This is likely to present an opportunity for colonisation of the area with Juncus acutus and a subsequent reduction in the future biodiversity and habitat value of saltmarsh within the park boundaries.

Some efforts to manage *J. acutus* on the lower Macleay have been made (Max Osborne *pers comm*.). The methods trialled have been based around the use of a mixture of the herbicides glyphosate and metsulphuron methyl diluted at 1:200. The results have been positive, with low levels of regrowth and some native species growing up through the mat of dead spiny rush (Max Osborne *pers comm*.).

*Information shown is for illustrative purposes only*

*Map Created by Aquatic Science and Managment, June 2010*
*Data Sources: Data generated by Aquatic Science and Management*



LEGEND

- unknown density
- 1-25%
- 25-50%
- 50-75%
- 75-100%
- Individual plants
- Possible occurence

N

0 500 1000 M

Mapped and potential occurences of *Juncus acutus* on the lower Macleay

The management of *J. acutus* in other areas has seen mixed results. At the Kooragang Wetlands site on the Hunter River floodplain a variety of management techniques have been applied over a 15 year period. The most successful techniques used there have involved herbicides and excavator use. In particular (Robert Henderson *pers comm*.);

- Where large stands have been encountered on pasture, a 12-15 tonne excavator with an articulated bucket has been most successful. The excavated plant material can then be buried in shallow pits or flattened out into a mat for post excavation control by livestock;
- In regularly inundated areas, ie saltmarsh, the excavator has been used to eliminate large stands, placing them into a truck to remove the excavated plant material from the site;
- Where excavators have been used around saltmarsh areas, particular attention has been required to leave as smooth a surface as possible, to reduce the occurrence of regrowth of *J. acutus* and maximise the opportunities for colonisation by native saltmarsh species;
- Small outbreaks of *J. acutus* have been controlled with a double strength (ie 1:100) dilution of glyphosate and/or teams of volunteers with mattocks.
- Post control measures have included the use of cattle and pasture management, herbicide application and revegetation of saltmarsh species such as *J. kraussi*.

Management with fire has been trialled in Western Australia but has been largely unsuccessful as the plants resprout following fire and the conditions created by fire (open bare ground with lots of light) create optimal conditions for the germination of *J. acutus* seeds (Brown & Bettink 2006). Fire is, however, considered a useful part of a strategic approach using a combination of methods. Management with herbicides has been successful in controlling the growth of *J. acutus* but has the effect of leaving a large biomass which restricts the regeneration potential for native species and can leave high fuel loads (Brown & Bettink 2006). Specific information about the success of particular herbicides can be found in Longman (*ed.* 2006). *J. acutus* plants grow rapidly throughout the spring and the period following this growth is considered the best time to apply control methods.

**Egeria**

Egeria (*Egeria densa*), commonly known as dense waterweed or leafy elodea, 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 (Sainty and Jacobs 1994). Studies on the growth of egeria in California resulted in the following conclusions (Johnstone *et al*. 2006);

- Growth of egeria occurs at temperature between 10 ºC and 35ºC and is at a maximum at temperatures of around 25ºC;
- Egeria grows best under low light conditions and prefers light from the red end of the spectra, generally found in shallow or surface waters. Ideal water depths for growth are between 1 and 3 metres;
- Turbid waters tend to improve the growth of egeria with maximum shoot elongation recorded at 15mg/L suspended solids (SS). Lower concentrations of SS resulted in shorter shoot length but higher levels of branching;

- Increasing salinity results in both reduced growth and reduced root formation. In Chile, egeria was not found to grow at salt concentrations above 5ppt in the field or 8ppt in the laboratory (reported in Johnstone *et al* 2006).

Egeria flowers throughout summer and early autumn but the primary method of spread is through stem pieces breaking off from the main plant and budding to form new plants. There is a reported lack of female plants in Australia limiting reproduction to asexual measures (Roberts *et al*. 1999). Flood action has been considered responsible for downstream spread of the plants in the Hawkesbury-Nepean system (Roberts *et al*. 1999) though this is unlikely to be a factor on the Macleay as egeria would presently be growing at the extent of its salinity tolerance. Segments caught on propellers, boat trailers and fish traps can survive long enough to cause outbreaks in other areas upon translocation (DPI, no date). Evidence of egeria outcompeting and displacing native aquatic species has been collected from the Hawkesbury River (Roberts *et al*. 1999). Other potential problems associated with egeria outbreaks are restrictions to navigation and boating, limits to other recreational activities, clogging water supply structures, altering local fish and invertebrate ecology, slowing river flow and restricting fish migration (Roberts *et al*. 1999).

Mechanical control is useful for reducing the biomass of the plant but has the effect of creating large numbers of small segments, each of which is capable of forming a new plant. The primary methods of control in NSW are reducing nutrient inputs and water flow management (DPI, no date). Shading is also known to reduce growth rates. No herbicides are registered for use controlling this plant and NSW I&I do not currently have a control program for the spread of the plant (Jane Frances *pers comm.*).

On the Macleay River estuary egeria has been described from the reaches upstream and downstream of Frederickton (MHL 1998, West *et al* 2004, Telfer 2005, WMA Water 2009). MHL (1998) described the occurrence of egeria on the Macleay River during a survey of aquatic habitats along four transects in the reaches upstream and downstream of Frederickton. Their report described it as occurring at only one of the four transects and only from one side of the river at that transect. During a survey of habitats for Australian bass (*Maquaria novemaculeata*) on the Macleay River, egeria was mapped and the total area recorded to be 1.1ha (with a further 82.85ha of elodea (*Elodea canadensis*) recorded). It is uncertain how much of this area was recorded outside of the tidal reaches, ie. upstream of Belgrave Falls. Due to its intolerance of salinities above 5ppt it is likely that egeria has reached the downstream limit of its distribution within the Macleay system.

Egeria is a possible habitat for the Australian Bass (West *et al*. 2004) though to what extent is uncertain. During the present study, eels, sea mullet, glass fish and a variety of gudgeons and gobies have been observed swimming among it. In addition, a variety of water birds including pelicans, black swans, great commorants and little black commorants have been observed feeding amongst it. More detailed studies of the fauna that utilise egeria habitat are difficult as the dense growth prevents the use of fishing nets. It is also thought to be a nutrient sink on the Macleay River estuary and may play some role in preventing algal blooms in the upper reaches as it assimilates nutrients from West Kempsey and Frederickton effluent discharges (WMA Water 2009). Anecdotal evidence suggests that the majority of the biomass of

egeria is removed during large floods (Rod McDonagh *pers comm*.). This is consistent with biological descriptions of the plant and the general consensus that it prefers slower moving waters.

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.

# Egeria Mapping 2010

## Introduction

Following the suggestion of Telfer (2005), it was considered important to investigate the dynamics of the egeria population on the Macleay River estuary. A subsequent aim of the investigation was to generate an accurate spatial layer of the extent of egeria with clearly defined methods for any future monitoring of the plant that may be required. Two prior studies (MHL 1998 and West *et al*. 2004) were used as a basis for the study.

## Methods

Two methods were chosen, based upon the two existing sets of information. The first method involved the replication of the survey described by MHL (1998), where the aquatic habitat across four transects (see Figure 5.2) was described semi quantitatively. This was carried out on February 19th and May 27th. The second method involved the mapping of egeria using orthorectified aerial photography captured in 1997 (West *et al*. 2004). West *et al*. (2004) mapped the occurrence of aquatic macrophytes at resolutions between 1:1000 and 1:5000 depending on the clarity of the photo. Digital maps were then taken into the field and key species of individual macrophyte beds identified. To compare the current extent of egeria in the lower Macleay River with this information the macrophytes in the Macleay River between the Pacific Highway bridge at Kempsey and the Smithtown – Gladstone bridge were mapped from the ADS40 imagery (collected in April 2009). The Gladstone – Smithtown bridge is the downstream limit of the distribution of the egeria on the system and the waters upstream of Kempsey were not mapped due to resource and time constraints. In order to map the macrophytes the visible extent of the beds were traced in a GIS platform with the resolution of the image set to 1:1500. Following field visits in February/March 2010 it was assumed that the macrophyte beds present at the time of the photo were primarily made up of egeria. No elodea was identified during these surveys.

## Results

The results of the field survey of aquatic habitats are reported in Table 5.1. The results indicate the dynamic nature of aquatic flora over medium to long time frames, as they are dependent upon shifting sediments and variable flow regimes. The results also indicate that egeria is spreading in the reaches of the river surveyed and that it is replacing habitat that in 1997 was primarily made up of native species including curly pond weed (*Potomageton crispus*), clasped pondweed (*Potomageton perfoliatus*), ribbon weed (*Vallisneria americana*) and water nymph (*Najas tenuifolia*). Of the eight riverside locations surveyed, egeria was only noted at one location during the MHL (1997) survey, but was present at all eight locations during the 2010 survey. In addition to this, wide, presumably well established, beds that were formerly made up mostly of pond weed and other native species on the right bank at transects 1 and 2, and the left bank of transect 3, have

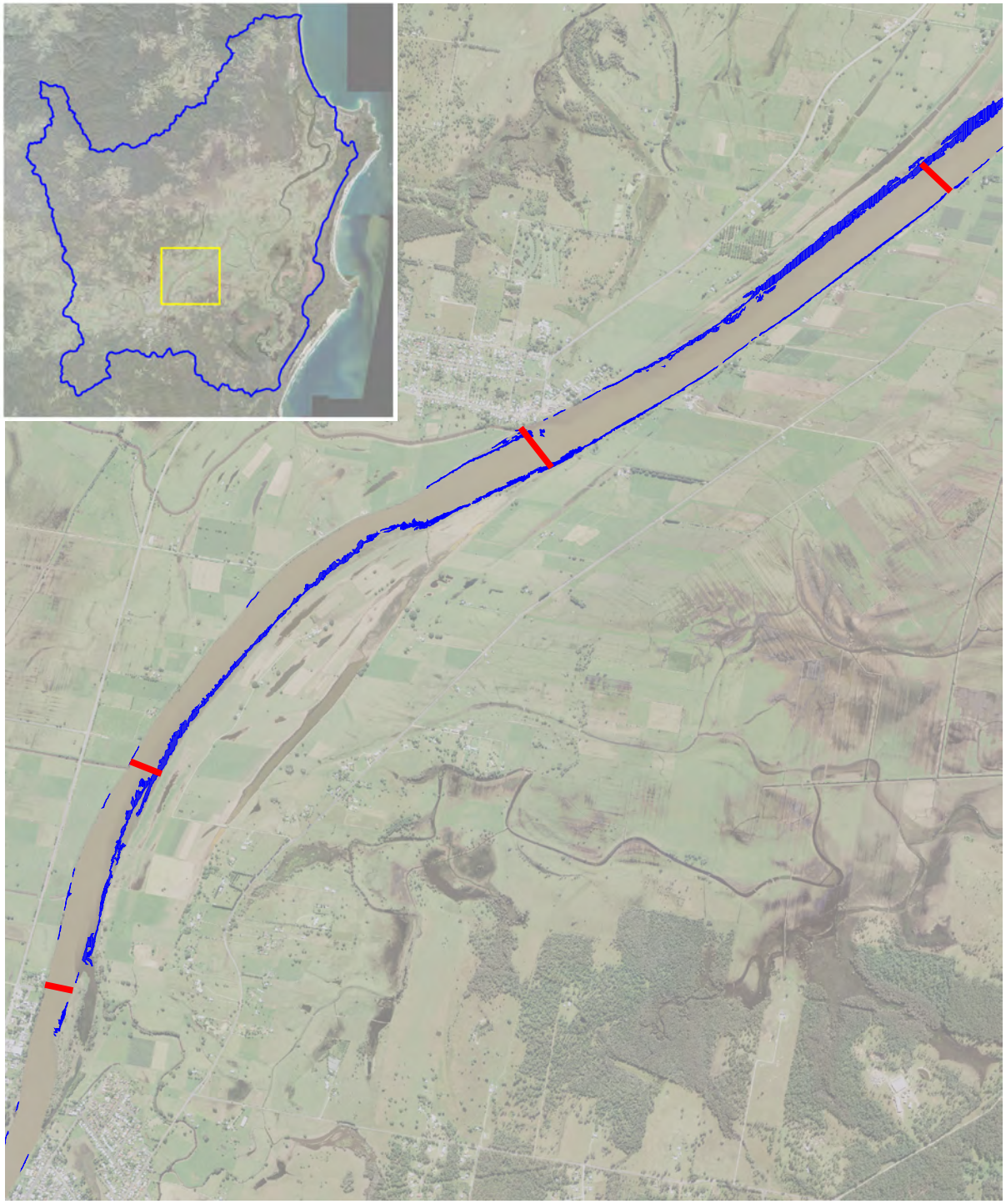
been replaced by dense beds of egeria. The mapped extent of macrophyte beds is shown in Figure 5.3. The total area mapped between Gladstone and Kempsey was 36.39ha.

**Table 5.1** Results of the survey of aquatic weeds in reaches of the Macleay River around Frederickton following the methods reported in MHL (1997).

| | ***Left Bank*** | | ***Right Bank*** | |
|---|---|---|---|---|
| ***Line*** | ***1997 (MHL)*** | ***2010*** | ***1997 (MHL)*** | ***2010*** |
| 1 | 1m wide submerged bed of water nymph, clasped pond weed and egeria. | <1m wide bed of pond weed and scattered water weed. | 1m wide dense bed of pond weed, then 2m bare, then 25m wide dense bed of pond weed. | 2m wide mixed bed of water nymph and curly pond weed, then 19m of bare sediment then 15m wide dense bed of egeria. |
| 2 | 20-30m wide bed of submerged mixed pond weed, water nymph and ribbon weed across from Christmas Creek channel | 1m wide bed of egeria on bank of Christmas Ck then a deep channel then 55m of scattered mixed ribbon weed, water nymph, clasped and curly pond weed and egeria. | 10-15m wide bed of mixed pond weed, water nymph and ribbon weed 5m out from bank. | >1m wide mixed bed of water nymph and egeria then 27m wide dense bed of egeria. |
| 3 | 20m of dense submerged *Chara sp*, ribbon weed, water nymph and pond weed. Then 20m of pond weed in deeper water | Dense bed of egeria 43m wide then some bare silt followed by a discontinuous 1m wide bed of water weed. | 2m wide dense strip of pond weed located 2m out from shore. | 2m wide discontinuous bed of egeria 5m out from shore. |
| 4 | 2m wide bed of clasped pond weed | <1m wide bed of mixed ribbon weed, curly pond weed and egeria. | 15m wide bed of patchy pond weed growing 1m out from the bank. | 1m wide bed of egeria mixed with curly pond weed. |

*Information shown is for illustrative purposes only*

*Map Created by Aquatic Science and Managment, June 2010*
*Data Sources: Data generated by Aquatic Science and Management*



LEGEND

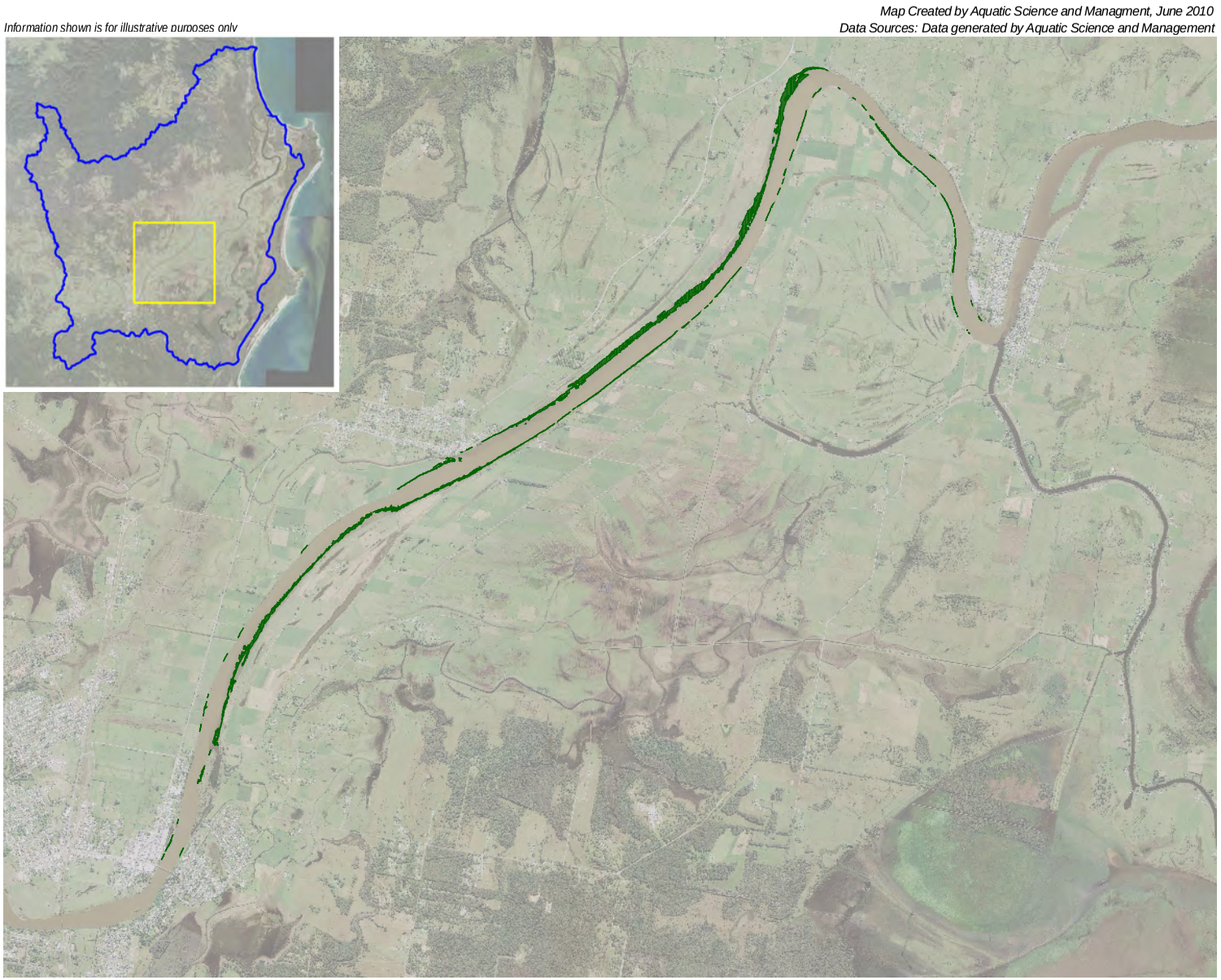
Transect locations

Macrophyte beds

N

0 500 1000 m

Aquatic Macropytes around Frederickton and location of MHL (1998) transects




Mapped extent of macrophyte beds containing *Egeria densa* on the Macleay River

## 5.2 Threatening Processes Affecting Floodplain Ecology

### 5.2.1 Introduction

The EPBC Act defines threatening processes as "*processes that threaten or may threaten the survival, abundance or evolutionary development of a native species or ecological community*". The TSC Act defines a key threatening process as a "*process that threatens, or could threaten, the survival or evolutionary development of species, populations or ecological communities*". Existing information regarding threatening processes and impacts on local biodiversity specific to the MREMP study area floodplain is limited (GeoLINK 2009). Such information is critical in order to identify management objectives and actions to ensure the ecological values of the Macleay floodplain are protected for future generations (GeoLINK 2009).

**Aim**

The aim of this component of the study is to:

- identify threatening processes currently operating within the study area, which are a specific threat to EECs and significant flora and fauna species; and
- identify preliminary management actions to manage key threats to assist the Macleay Estuary Management Plan.

**Methods**

The methodology undertaken for this component of the project involved:

- identifying potentially affected local threatened species and EECs (**Section 4**);
- reviewing the local occurrence of threats listed in the TSC Act, EPBC Act and the *Draft Northern Rivers Biodiversity Management Plan* (DECCW 2009);
- identifying other threats to local biodiversity at a landscape scale;
- identifying management issues associated the identified threats; and
- development of management options at a broad landscape management level.

### 5.2.2 Listed Key Threatening Process

**TSC Act Listed Key Threatening Processes**

Current Key Threatening Processes listed under the TSC Act are provided in **Table 5.2** below. Those that are known or potentially occurring within the MREMP study area floodplain are also highlighted, along with the main locally recorded threatened species and EECs that are potentially affected by each threat.

**EPBC Act Listed Key Threatening Process**

Current Key Threatening Processes listed under the EPBC Act are provided in **Table 5.3** below. Those that are known or potentially occurring within the MREMP study area floodplain are also highlighted, along with the main locally recorded threatened species and EECs that are potentially affected by each threat.

**Table 5.2** TSC Act Listed Key Threatening Processes and Susceptible Known Occurring Threatened Species and EECs within the MREMP Study Area.

| ***TSC Act Key Threatening Processes*** | ***Nature of Listing*** | ***Occurrence in the MREMP Study Area Floodplain*** | ***Main Known Occurring Threatened Species and EECs on the MREMP Study Area Floodplain Potentially at Affected from Key Threatening Process*** | | |
|---|---|---|---|---|---|
| | | | ***Flora (refer to Table 4.12 for full species list )*** | ***Fauna (refer to Table 4.10 for full species list)*** | ***EECs (refer to Section 4.1 for full list of locally occurring EEC types )*** |
| Alteration of habitat following subsidence due to longwall mining | Habitat loss/change | Not relevant to the study area | - | - | - |
| Alteration to the natural flow regimes of rivers, streams, floodplains & wetlands | Habitat loss/change | Known | All through habitat modification due to location of study area on floodplain | All through habitat modification due to location of study area on floodplain. | All through habitat modification due to location of study area on floodplain |
| Anthropogenic Climate Change | Habitat loss/change | Possible | All | All | All |
| Bushrock Removal | Habitat loss/change | Possible | - | Brush-tailed Phascogale, Spotted-tailed Quoll, Stuttering Frog. | - |
| Clearing of native vegetation | Habitat loss/change | Known | All | All | All |
| Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*) | Pest animal | Known | All, particularly Austral Toadflax (*Thesium australe*) | All to varying extends (excluding shorebirds, forest owls, Osprey and marine species) through habitat degradation and/or competition. | All |
| Competition and habitat degradation by Feral Goats (*Capra hircus*) | Pest animal | Possible | All | All to varying extends (excluding shorebirds, Osprey and marine species) through habitat degradation and/or competition. | All |
| Competition from feral honeybees (*Apis mellifera*) | Pest animal | Known | - | Glossy Black-Cockatoo, Little Lorikeet, Powerful Owl, Hoary Wattled Bat, Eastern Quoll, Spotted-tailed Quoll, Eastern False Pipistrelle, Little Bentwing-bat, Eastern Bentwing-bat, Eastern Freetail-bat, Large-footed Myotis, Yellow-bellied Glider, Squirrel Glider, Brush-tailed Phascogale, Yellow-bellied Sheathtail-bat, Greater Broad-nosed Bat and Stephens' Banded Snake. | - |

| *TSC Act Key Threatening Processes* | *Nature of Listing* | *Occurrence in the MREMP Study Area Floodplain* | *Main Known Occurring Threatened Species and EECs on the MREMP Study Area Floodplain Potentially at Affected from Key Threatening Process* | | |
|---|---|---|---|---|---|
| | | | *Flora (refer to Table 4.12 for full species list )* | *Fauna (refer to Table 4.10 for full species list)* | *EECs (refer to Section 4.1 for full list of locally occurring EEC types )* |
| Death or injury to marine species following capture in shark control programs on ocean beaches | Other threat | Not relevant to study area | - | Green Turtle, Leathery Turtle and Humpback Whale. | - |
| Entanglement in, or ingestion of anthropogenic debris in marine and estuarine environments | Other threat | Possible | - | Green Turtle, Leathery Turtle, Humpback Whale, Osprey and shorebirds. | - |
| Forest eucalypt dieback associated with over-abundant psyllids and Bell Miners | Other threat | Possible | - | All Eucalypt forest dwelling species through habitat degradation. | Subtropical Coastal Floodplain Forest, Swamp Sclerophyll Forest, River-Flat Eucalypt Forest |
| Herbivory and environmental degradation caused by feral deer | Pest animal | Known | All | All (excluding estuarine/sea birds and marine species) through habitat degradation. | All |
| High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition. | Habitat loss/change | Possible | All | All (excluding estuarine/sea birds and marine species) through habitat degradation. | All |
| Importation of Red Imported Fire Ants (*Solenopsis invicta*) | Pest animal | Possible | All | All (excluding estuarine/sea birds and marine species). | All |
| Infection by Psittacine Circoviral (beak & feather) Disease affecting endangered psittacine species | Disease | Possible | - | Swift Parrot and Little Lorikeet. | - |
| Infection of frogs by amphibian chytrid fungus causing the disease chytridiomycosis | Disease | Possible | - | Green and Golden Bell Frog, Wallum Froglet, Green-thighed Frog and Stuttering Frog. | - |
| Infection of native plants by *Phytophthora cinnamomi* | Disease | Possible | All | All (excluding estuarine/sea birds and marine species). | All |
| Introduction of the Large Earth Bumblebee (*Bombus terrestris*) | Pest animal | Possible | All | All (excluding estuarine/sea birds and marine species) through habitat degradation. | All |

| *TSC Act Key Threatening Processes* | *Nature of Listing* | *Occurrence in the MREMP Study Area Floodplain* | *Main Known Occurring Threatened Species and EECs on the MREMP Study Area Floodplain Potentially at Affected from Key Threatening Process* | | |
|---|---|---|---|---|---|
| | | | *Flora (refer to Table 4.12 for full species list )* | *Fauna (refer to Table 4.10 for full species list)* | *EECs (refer to Section 4.1 for full list of locally occurring EEC types )* |
| Invasion and establishment of exotic vines and scramblers | Weed | Known | All | Main species through habitat degradation include: Common Blossom-bat, Grey-headed Flying-fox , Koala, Squirrel Glider, Golden-tipped Bat, Sooty Owl, Rose-crowned Fruit-Dove, Wompoo Fruit-Dove, Powerful Owl, Square-tailed Kite, Swift Parrot, Little Lorikeet, Glossy Black-Cockatoo, Barred Cuckoo-shrike and Regent Honeyeater. | All |
| Invasion and establishment of Scotch Broom (*Cytisus scoparius*) | Weed | Low | All | All (excluding estuarine/sea birds and marine species) through habitat degradation. | All |
| Invasion and establishment of the Cane Toad (*Bufo marinus*) | Pest animal | Known | - | Wallum Froglet, Green and Golden Bell Frog, Green-thighed Frog, Magpie Goose, Blue-billed Duck, Black-necked stork, Square-tailed Kite, Australian Painted Snipe, Grass Owl, Sooty Owl, Powerful Owl, Eastern Quoll, Spotted-tailed Quoll and Stephens' Banded Snake. | - |
| Invasion, establishment and spread of Lantana (*Lantana camara*) | Weed | Known | All | All (excluding shorebirds and marine species) through habitat degradation. | All |
| Invasion of native plant communities by *Chrysanthemoides monilifera* | Weed | Known | All, particularly Sand Spurge (*Chamaesyce psammogeton*) | Main species potentially affected through habitat degradation: Common Blossom-bat, Grey-headed Flying-fox, Koala, Squirrel Glider, Golden-tipped Bat, Rose-crowned Fruit-Dove, Wompoo Fruit-Dove, Swift Parrot, Little Lorikeet, Glossy Black-Cockatoo, Barred Cuckoo-shrike, Regent Honeyeater, Stuttering Frog, Green-thighed Frog and Wallum Froglet. | All, particularly Littoral Rainforest |
| Invasion of native plant communities by exotic perennial grasses | Weed | Known | All | All (excluding shorebirds and marine species) through habitat degradation. | All |
| Invasion of the Yellow Crazy Ant (*Anoplolepis gracilipes*) | Pest animal | Possible | - | All (possibly excluding shorebirds and marine species) through habitat degradation) | - |

| *TSC Act Key Threatening Processes* | *Nature of Listing* | *Occurrence in the MREMP Study Area Floodplain* | *Main Known Occurring Threatened Species and EECs on the MREMP Study Area Floodplain Potentially at Affected from Key Threatening Process* | | |
|---|---|---|---|---|---|
| | | | *Flora (refer to Table 4.12 for full species list )* | *Fauna (refer to Table 4.10 for full species list)* | *EECs (refer to Section 4.1 for full list of locally occurring EEC types )* |
| Loss of hollow-bearing trees | Habitat loss/change | Known | | Stephens' Banded Snake, Glossy Black-cockatoo, Masked Owl, Hoary Wattled Bat, Eastern Quoll, Spotted-tailed Quoll, Eastern False Pipistrelle, Eastern Freetail-bat, Squirrel Glider and Brush-tailed Phascogale. | |
| Loss or degradation (or both) of sites used for hill-topping by butterflies | Habitat loss/change | Not relevant to study area | - | - | - |
| Predation and hybridisation by Feral Dogs (*Canis lupus familiaris*) | Pest animal | Known | - | Brush-tailed Phascogale, Koala, Sooty Owl, Grass Owl, Little Tern, Eastern Osprey, Powerful Owl, Square-tailed Kite, Black Bittern, Comb-crested Jacana, Sooty Oystercatcher, Pied Oystercatcher , Black-breasted Buzzard, Brolga, Black-necked stork, Australasian Bittern and Magpie Goose | - |
| Predation by the *Gambusia holbrooki* | Pest animal | Known | - | Green and Golden Bell Frog and Wallum Froglet. | - |
| Predation by the European Red Fox (*Vulpes vulpes*) | Pest animal | Known | - | All (excluding Humpback Whale), particularly mammals and birds through either direct predation and/or competition. | - |
| Predation by the Feral *Cat* (*Felis* catus) | Pest animal | Known | - | All (excluding Humpback Whale), particularly mammals and birds through either direct predation and/or competition. | - |
| Predation by the Ship Rat (*Rattus rattus*) on Lord Howe Island | Pest animal | Not relevant to the study area | - | - | - |
| Predation, habitat degradation, competition and disease transmission by Feral Pigs (*Sus scrofa*) | Pest animal | Known | White-flowered Wax Plant | All (excluding estuarine/sea birds and Humpback Whale). | - |

| *TSC Act Key Threatening Processes* | *Nature of Listing* | *Occurrence in the MREMP Study Area Floodplain* | *Main Known Occurring Threatened Species and EECs on the MREMP Study Area Floodplain Potentially at Affected from Key Threatening Process* | | |
|---|---|---|---|---|---|
| | | | *Flora (refer to Table 4.12 for full species list )* | *Fauna (refer to Table 4.10 for full species list)* | *EECs (refer to Section 4.1 for full list of locally occurring EEC types )* |
| Removal of dead wood and dead trees | Habitat loss/change | Known | - | Stephens' Banded Snake, Greater Broad-nosed Bat, Yellow-bellied Sheathtail-bat, Brush-tailed Phascogale, Squirrel Glider, Eastern Freetail-bat, Eastern Bentwing-bat, Little Bentwing-bat, Spotted-tailed Quoll, Hoary Wattled Bat, Sooty Owl, Eastern Osprey, Powerful Owl, Square-tailed Kite, Little Lorikeet and Glossy Black-Cockatoo. | - |

**Table 5.3** EPBC Act Listed Key Threatening Processes and Susceptible Known Occurring Threatened Species and EECs within the MREMP Study Area.

| ***EPBC Act Key Threatening Processes*** | ***Nature of Listing*** | ***Occurrence in the MREMP Study Area Floodplain*** | ***Main Known Occurring Threatened Species and EECs on the MREMP Study Area Floodplain Potentially at Affected from Key Threatening Process*** | | |
|---|---|---|---|---|---|
| | | | ***Flora (refer to Table 4.12 for full species list )*** | ***Flora (refer to Table 4.12 for full species list )*** | ***Flora (refer to Table 4.12 for full species list )*** |
| Competition and land degradation by rabbits | Pest animal | Known | All, particularly Austral Toadflax (*Thesium australe*) | All to varying extends (excluding shorebirds, forest owls, Osprey and marine species) through habitat degradation and/or competition. | All |
| Competition and land degradation by unmanaged goats | Pest animal | Possible | All | All to varying extends (excluding shorebirds, Osprey and marine species) through habitat degradation and/or competition. | All |
| Dieback caused by the root-rot fungus (*Phytophthora cinnamomi*) | Disease | Possible | All | All (excluding estuarine/sea birds and marine species). | All |
| Incidental catch (bycatch) of Sea Turtle during coastal otter-trawling operations within Australian waters north of 28 degrees South | Other threat | Not relevant to the study area | - | - | - |
| Incidental catch (or bycatch) of seabirds during oceanic longline fishing operations | Other threat | Not relevant to the study area | - | - | - |
| Infection of amphibians with chytrid fungus resulting in chytridiomycosis | Disease | Possible | - | Green and Golden Bell Frog, Wallum Froglet, Green-thighed Frog and Stuttering Frog. | - |
| Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris | Other threat | Possible | - | Green Turtle, Leathery Turtle, Humpback Whale, Osprey and shorebirds. | - |
| Invasion of northern Australia by Gamba Grass and other introduced grasses | Weed | Not relevant to the study area | - | - | - |
| Land clearance | Habitat loss/change | Known | All | All (excluding non-vegetation roosting/nesting shorebirds and Humpback Whale). | All |

| ***EPBC Act Key Threatening Processes*** | ***Nature of Listing*** | ***Occurrence in the MREMP Study Area Floodplain*** | ***Main Known Occurring Threatened Species and EECs on the MREMP Study Area Floodplain Potentially at Affected from Key Threatening Process*** | | |
|---|---|---|---|---|---|
| | | | ***Flora (refer to Table 4.12 for full species list )*** | ***Flora (refer to Table 4.12 for full species list )*** | ***Flora (refer to Table 4.12 for full species list )*** |
| Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants | Weeds, Habitat loss/change | Known | All | All (excluding non-vegetation roosting/nesting shorebirds and Humpback Whale). | All |
| Loss of biodiversity and ecosystem integrity following invasion by the Yellow Crazy Ant (*Anoplolepis gracilipes*) on Christmas Island, Indian Ocean | Pest Animal | Not relevant to the study area | - | - | - |
| Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases | Habitat loss/change | Possible | All | All | All |
| Predation by European red fox | Pest animal | Known | - | All, particularly mammals and birds through either direct predation or competition. | - |
| Predation by exotic rats on Australian offshore islands of less than 1000 km2 (100,000 ha) | Pest animal | N/A | - | - | - |
| Predation by feral cats | Pest animal | Known | - | All (excluding Humpback Whale), particularly mammals and birds through either direct predation and/or competition. | - |
| Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs | Pest animal | Known | White-flowered Wax Plant | All (excluding estuarine/sea birds and Humpback Whale). | - |
| Psittacine Circoviral (beak and feather) Disease affecting endangered psittacine species | Disease | Possible | - | Swift Parrot and Little Lorikeet | - |

| ***EPBC Act Key Threatening Processes*** | ***Nature of Listing*** | ***Occurrence in the MREMP Study Area Floodplain*** | ***Main Known Occurring Threatened Species and EECs on the MREMP Study Area Floodplain Potentially at Affected from Key Threatening Process*** | | |
|---|---|---|---|---|---|
| | | | ***Flora (refer to Table 4.12 for full species list )*** | ***Flora (refer to Table 4.12 for full species list )*** | ***Flora (refer to Table 4.12 for full species list )*** |
| The biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*) | Pest animal | Known | - | Wallum Froglet, Green and Golden Bell Frog, Green-thighed Frog, Magpie Goose, Blue-billed Duck, Black-necked stork, Square-tailed Kite, Australian Painted Snipe, Grass Owl, Sooty Owl, Powerful Owl, Eastern Quoll, Spotted-tailed Quoll and Stephens' Banded Snake. | - |
| The reduction in the biodiversity of Australian native fauna and flora due to the red imported fire ant, *Solenopsis invicta* (fire ant) | Pest animal | Possible | All | All (excluding estuarine/sea birds and marine species). | All |

**Draft Northern Rivers Biodiversity Management Plan**

The draft Northern Rivers Biodiversity Management Plan (DECCW 2009) identified 14 threat categories (two "universal" and 12 "regional") for the Northern Rivers Catchment Management Authority Region, which includes the KSC LGA. These threat categories are listed below along with their relevance to the MREMP study area floodplain:

- *Anthropogenic climate change* (universal): Refer to **Section 8**.
- *Decision-making and knowledge gaps* (universal): The MREMP study area floodplain encompasses a number of different landuse zones under the KSC *Local Environment Plan 1987*, (which holds substantial weight on local landuse decision making), and each zoning objective imposes varying implications for achieving biodiversity outcomes. This study has identified a number of significant information gaps relevant to the management of the biodiversity values of the MREMP study area floodplain. This includes a lack of comprehensive knowledge of shorebirds usage in the Macleay Estuary (Sandpiper Ecological Surveys 2009), definitively identifying local impacts of anthropogenic climate change (refer to **Section 8**), etc. The Macleay estuary EMS and EMP would assist local decision making and identify relevant knowledge gaps necessary to ensure long-term conservation and management of the ecological values of the MREMP study area.
- *Clearing and fragmentation* (regional): The impact of habitat clearing and fragmentation on biodiversity has been well documented (DECCW 2009). Historic land clearing and artificial drainage has resulted in substantial habitat loss, modification and fragmentation on the Macleay Estuary floodplain (Telfer 2005, WMA Water 2009). Current legislation and landuse zoning in the MREMP study area floodplain allows further potential habitat clearing and fragmentation to continue to impose a threat to local biodiversity. Protection of remnant native vegetation and the maintenance and enhancement of local wildlife corridors is considered necessary to help maintain the native biodiversity value of the study area (this is discussed further in **Section 6**).
- *Inappropriate fire regimes* (regional): refer to **Section 5.2.4**.
- *Weeds* (regional): Refer to **Section 5.3.2**.
- *Pests* (regional): Refer to **Section 5.3.3**.
- *Forestry* (regional): Review of the KSC LEP in **Section 5.2.3** shows that only a relatively small area of the MREMP study area floodplain is zoned for forestry activities. Hence, while potentially a significant threat to some fauna groups such as Koalas (Phillip and Hopkins 2009a) this threat is not relevant to the majority of the study area floodplain. Ensuring any local logging is undertaken in accordance with the relevant legislative requirements and guidelines, and adoption of the draft CKPoM (Phillip and Hopkins 2009b) should help reduce the impacts of logging on local biodiversity.
- *Dieback* (regional): This is considered a possible occurrence locally and would impose a threat to many threatened species and EECs

relevant to the MREMP study area floodplain. Restricting the spread of known occurrences of *Phytophthora cinnamomi* and transfer into the study area is a primary action to managing this threat. The regional management of this threat is beyond the scope of the MREMP.

- *Hydrology and water quality* (regional): Artificial drainage of the floodplain has substantially modified the local ecology of the study area (Telfer 2005, WMA Water 2009). The water quality of the Macleay Estuary has been documented by WMA Water (2009), who identified a number of different potential sources of pollutants including diffuse runoff from the upper and lower catchment, urban runoff, and point sources discharges from wastewater treatment plants. These are also considered relevant water quality pollutant sources for the floodplains environment and associated habitats. Management of this is currently being investigated as part of the EMS, hence are not detailed further as part of this study.
- *Disease and pathogens* (regional): Disease and pathogens are a significant threat to a number of known/potentially occurring threatened species on the MREMP study area floodplain. Disease is also a major threat to the Koala (Phillip and Hopkins 2009a).
- *Human interference* (regional): Impacts of human presence (including noise and artificial lighting) have reportedly found varying results for fauna. With regards to the Macleay Estuary, estuarine birds have been identified as a fauna group particularly susceptible to human interference as much of their estuarine habitats are subject to a range of human disturbances including commercial (e.g. fisheries) and recreational (e.g. fishing, boating, etc) (Sandpiper Ecological Surveys 2009). Identifying, prioritising and managing significant habitats for threatened and migratory listed estuarine birds, is considered a high priority action for the Macleay Estuary (Sandpiper Ecological Surveys 2009).
- *Livestock* (regional): Impacts of livestock grazing on native biodiversity include:
    - native vegetation loss or degradation through grazing and trampling;
    - competition for foraging sources;
    - soil disturbance and associated erosion and sedimentation impacts;
    - water quality degradation (e.g. eutrophication and faecal coliform); and
    - pastoral improvement by land managers, replacing native groundcovers with exotic pastoral grasses.

  As the majority of the MREMP study area floodplain comprises of rural land subject to livestock grazing, livestock management, particularly at high conservation value habitat areas would form an important component of protecting the ecological values of these areas.
- *Chemical and waste* (regional): As the majority of the MREMP study area floodplain comprises of rural land, the use of agricultural chemicals (e.g. fertilisers, pesticides, etc) potentially imposes a threat

to biodiversity, particularly where key habitat areas occur adjacent to or down catchment of agricultural areas. Encouraging relevant landowners/stakeholder to obtain chemical users certification is an important component to reduce the risk of such impacts, as these courses inform pupils of their responsibilities and best practice chemical application practices. Other chemical (including ASS) and waste issues relevant to the MREMP study area are currently being investigated as part of the EMS, hence are not detailed further as part of this study.

- *Demographic and small population effects* (regional): This is likely to be a threat to local biodiversity and population viability due to the fragmented distribution and degraded condition of many local habitats on the MREMP study area floodplain. Protection of remnant vegetation, and maintenance and enhancement of local wildlife corridors is essential to help mitigate against this threat.

### 5.2.3 Landuses and Threats

The *Kempsey Shire Council Local Environmental Plan 1987* (KSC LEP 1987) was reviewed along with the corresponding GIS layer to identify different landuse zonings within the MREMP study area floodplain (refer to **Figure 5.4**). In total 25 zonings apply to the MREMP study area floodplain, which are listed in **Table 5.4** below. The spatial area occupied by each zone and the main potential biodiversity threats associated with each relevant zoning is also provided.

**Table 5.4** illustrates that the 41280.23 ha (93.75%) of the MREMP study area floodplain is under rural zonings in the KSC LEP 1987. However review of recent national parks estate GIS mapping identified 3199.11 ha (7.27%) of the MREMP study area floodplain as national parks estate; only 524.78 ha (1.19%) of which is zoned 8(a) (Existing National Parks, Nature Reserves) (refer to **Figure 5.4**). The majority of the remainder of national parks estate occurs in rural zoned land. Council may consider reviewing the LEP mapping to amend this inconsistency.

**Table 5.4** LEP Zoning and Key General Biodiversity Threats

| ***LEP Zoning*** | ***Area (Ha)*** | ***MREMP Study Area (%)*** | ***Potential General Biodiversity Threats*** ***(Note: some actions associated with the specific threats require Council approval)*** |
|---|---|---|---|
| 1(a1) (Rural "A1" Zone) | 20216.74 | 45.91 | Direct impacts include:<br>▪ livestock impacts;<br>▪ modification of natural hydrological systems; and<br>▪ habitat clearing/modification/fragmentation in accordance with the *Native Vegetation Act 2003* permitted activities.<br>Indirect impacts include:<br>▪ degradation of habitat through receiving agricultural runoff (e.g. sediment and/or nutrient laden water changing nutrient cycling, favouring weeds growth etc);<br>▪ spread of weeds and agricultural flora species into native habitats; and<br>▪ human presence (e.g. noise, fauna disturbance, artificial lighting, etc). |
| 1(a3) (Rural "A3" Agricultural Protection Zone) | 19772.83 | 44.90 | As for 1(a1) (Rural "A1" Zone). |
| 1(c) (Rural (Small Holdings) "C" Zone) | 349.27 | 0.79 | As for 1(a1) (Rural "A1" Zone). |
| 1(d) (Rural (Investigation) D Zone) | 277.32 | 0.63 | As for 1(a1) (Rural "A1" Zone). |
| 1(e) (Rural (Floodway) "E" Zone) | 339.03 | 0.77 | Generally as for 1(a1) (Rural "A1" Zone), however any development requires Council consent. |
| 1(f) (Rural (Forestry) "F" Zone) | 8.73 | 0.02 | As for 1(a1) (Rural "A1" Zone), as well as forestry activities (e.g. logging). |
| 1(g) (Rural (Small Agricultural Enterprises) "G" Zone) | 316.31 | 0.72 | As for 1(a1) (Rural "A1" Zone). |
| 2(a) (Residential "A" Zone) | 66.64 | 0.15 | Direct impacts include:<br>▪ habitat loss/modification/fragmentation through urban development; and<br>▪ modification of natural hydrological systems.<br>Indirect impacts include:<br>▪ degradation of habitat through receiving urban runoff (e.g. sediment and/or nutrient laden water |

| *LEP Zoning* | *Area (Ha)* | *MREMP Study Area (%)* | *Potential General Biodiversity Threats (Note: some actions associated with the specific threats require Council approval)* |
|---|---|---|---|
| | | | changing nutrient cycling, favouring weeds growth etc);<br>▪ fauna injury or mortality through traffic collision;<br>▪ fauna injury/mortality by domestic pets and recruitment source for "feral" population;<br>▪ fauna mortality through powerline collision;<br>▪ spread/source of garden escapes flora species into native habitats; and<br>▪ human presence (e.g. noise, fauna disturbance, artificial lighting, etc). |
| 2(b1) (Residential "B1" Zone) | 1.55 | 0.003 | As for 2(a) (Residential "A" Zone). |
| 2(v) (Village or Township Zone) | 139.43 | 0.32 | As for 2(a) (Residential "A" Zone). |
| 3(a) (Business (General) "A" Zone) | 18.94 | 0.04 | Direct impacts include:<br>▪ habitat loss/modification/fragmentation through urban development; and<br>▪ modification of natural hydrological systems.<br>Indirect impacts include:<br>▪ degradation of habitat through receiving urban runoff (e.g. sediment and/or nutrient laden water changing nutrient cycling, favouring weeds growth etc);<br>▪ fauna injury or mortality through traffic collision;<br>▪ fauna mortality through powerline collision; and<br>▪ human presence (e.g. noise, fauna disturbance, artificial lighting, etc). |
| 3(c) (Business (Special) "C" Zone) | 43.84 | 0.01 | As for 3(a) (Business (General) "A" Zone). |
| 4(a) (Industrial (General) "A" Zone) | 32.67 | 0.07 | Direct impacts include:<br>▪ habitat loss/modification/fragmentation through industrial development.<br>Indirect impacts include:<br>▪ degradation of habitat through receiving industrial runoff (e.g. sediment and/or nutrient laden water changing nutrient cycling, favouring weeds growth etc);<br>▪ fauna injury or mortality through traffic collision;<br>▪ fauna mortality through powerline collision; and<br>▪ human presence (e.g. noise, fauna disturbance, artificial lighting, etc). |
| 4(a) (Light Industrial) "B" Zone) | 0.94 | 0.002 | As for 4(a) (Industrial (General) "A" Zone). |
| 4(e) (Industrial (Extractive) "E" | 13.24 | 0.03 | As for 4(a) (Industrial (General) "A" Zone). |

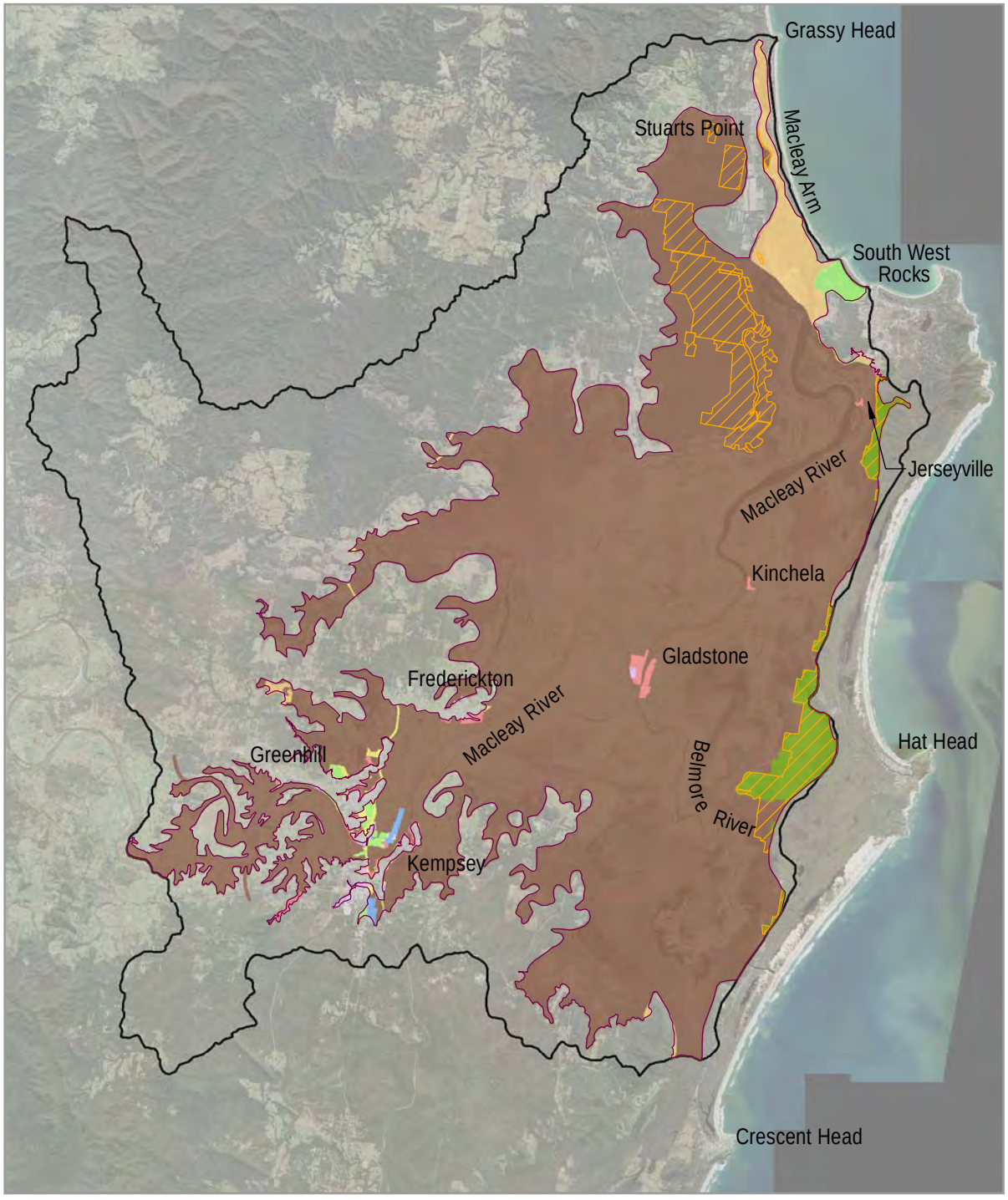
| *LEP Zoning* | *Area (Ha)* | *MREMP Study Area (%)* | *Potential General Biodiversity Threats (Note: some actions associated with the specific threats require Council approval)* |
|---|---|---|---|
| Zone) | | | |
| 5(a) (Special Uses "A" Zone) | 53.85 | 0.12 | Direct impacts include:<br>▪ habitat loss/modification/fragmentation through public utility development; and<br>▪ modification of natural hydrological systems.<br>Indirect impacts include:<br>▪ degradation of habitat through receiving industrial runoff (e.g. sediment and/or nutrient laden water changing nutrient cycling, favouring weeds growth etc);<br>▪ fauna injury or mortality through traffic collision;<br>▪ fauna mortality through powerline collision; and<br>▪ human presence (e.g. noise, fauna disturbance, artificial lighting, etc). |
| 5(b) (Special Uses "B" Zone) | 31.58 | 0.07 | As for 5(a) (Special Uses "A" Zone). |
| 6(a) (Open Space "A" Zone) | 251.14 | 0.57 | Direct impacts include:<br>▪ habitat loss/modification through public space development; and<br>▪ modification of natural hydrological systems.<br>Indirect impacts include:<br>▪ degradation of habitat through receiving industrial runoff (e.g. sediment and/or nutrient laden water changing nutrient cycling, favouring weeds growth etc);<br>▪ fauna injury/mortality by domestic pets and recruitment source for "feral" population;<br>▪ spread of garden escapes flora species into native habitats; and<br>▪ human presence (e.g. noise, fauna disturbance, artificial lighting, etc). |
| 6(b) (Open Space "B" Zone) | 29.83 | 0.07 | As for 6(a) (Open Space "A" Zone). |
| 7(a) (Wetlands Protection Zone) | 14.63 | 0.03 | Direct impacts include:<br>▪ livestock impacts;<br>▪ habitat loss/modification/habitat fragmentation through public utility, advertisement and/or recreational area developments; and<br>▪ modification of natural hydrological systems.<br>Indirect impacts include:<br>▪ degradation of habitat through receiving degraded runoff (e.g. sediment and/or nutrient laden water changing nutrient cycling, favouring weeds growth etc);<br>▪ fauna injury or mortality through traffic collision;<br>▪ fauna mortality through powerline collision; and |

| *LEP Zoning* | *Area (Ha)* | *MREMP Study Area (%)* | *Potential General Biodiversity Threats (Note: some actions associated with the specific threats require Council approval)* |
|---|---|---|---|
| | | | ▪ periodic human presence (e.g. noise, fauna disturbance, artificial lighting, etc). |
| 7(b) (Environmental Protection (Habitat) Zone) | 34.97 | 0.08 | Direct impacts include:<br>▪ habitat loss/modification/fragmentation through public utility, advertisement and/or recreational area developments; and<br>▪ modification of natural hydrological systems.<br>Indirect impacts include:<br>▪ degradation of habitat through receiving degraded runoff (e.g. sediment and/or nutrient laden water changing nutrient cycling, favouring weeds growth etc);<br>▪ fauna injury or mortality through traffic collision;<br>▪ fauna mortality through powerline collision; and<br>▪ periodic human presence (e.g. noise, fauna disturbance, artificial lighting, etc). |
| 7(d) (Scenic Protection Zone) | 77.24 | 0.18 | Direct impacts include:<br>▪ habitat degradation through livestock trampling and grazing;<br>▪ habitat loss/modification/fragmentation through public utility, advertisement and/or recreational area developments; and<br>▪ modification of natural hydrological systems.<br>Indirect impacts include:<br>▪ degradation of habitat through receiving degraded runoff (e.g. sediment and/or nutrient laden water changing nutrient cycling, favouring weeds growth etc);<br>▪ fauna injury or mortality through traffic collision;<br>▪ fauna mortality through powerline collision; and<br>▪ periodic human presence (e.g. noise, fauna disturbance, artificial lighting, etc). |
| 7(f1) (Coastal Lands Protection Zone) | 901.76 | 2.05 | Generally as for 7(d) (Scenic Protection Zone). |
| 8(a) (Existing National Parks, Nature Reserves) | 524.78 | 1.19 | Nil. |
| 8(b) (Proposed National Parks Extension Zone) | 515.97 | 1.17 | Direct impacts include:<br>▪ habitat degradation through livestock trampling and grazing;<br>Indirect impacts include:<br>▪ degradation of habitat through receiving agricultural runoff (e.g. sediment and/or nutrient laden water changing nutrient cycling, favouring weeds growth etc);<br>▪ spread of weeds and agricultural flora species into native habitats; and |

| *LEP Zoning* | *Area (Ha)* | *MREMP Study Area (%)* | *Potential General Biodiversity Threats (Note: some actions associated with the specific threats require Council approval)* |
|---|---|---|---|
| | | | ▪ human presence (e.g. fauna disturbance). |
| **Total** | **44033.23** | **100** | |

*Information shown is for illustrative purposes only*

*Drawn by: RE Reviewed by: MVE Date: May 2010*
*Source of base data: Kempsey Shire Council*




LEGEND

- Study area
- MREMP floodplain study area
- National Parks Estate_Clipped to MREMP Study Area Floodplain
- Rural (1)
- Residential (2)
- Business (3)
- Industrial (4)
- Special Uses (5)
- Open Space (6)
- Protection (7)
- National Parks (8)

0 5 km

North

Kempsey Shire Council LEP 1987 Zoning in the MREMP Study Area Floodplain and National Parks Estate

Overall, approximately 86% of the MREMP study area floodplain is directly managed under rural zonings, hence direct landuse threats to biodiversity would largely be associated with agricultural development and landuse practices. Re-zoning of high conservation value threatened species habitats and EECs for habitat protection purposes may therefore be required.

### 5.2.4 High Intensity Bushfires and Inappropriate Bushfire Regime

High intensity bushfires and inappropriate fire regimes are a major threat to a large number of threatened species and EECs (DECCW undated), many of which are associated with the MREMP study area floodplain. This includes the Koala (*Phascolarctos cinereus*), Dwarf Heath Casuarina (*Allocasuarina defungens*), Coastal Saltmarsh, Swamp Sclerophyll Forest, etc (DECCW undated). The fragmented and/or isolated distribution of most of the habitat on the MREMP study area floodplain means dependent fauna (particularly those with limited mobility) have limited opportunities to escape or seek alternative refuge. This also reduces the potential for re-colonisation. Overall, high intensity bushfires and inappropriate bushfire regimes are considered a potential major threat to the biodiversity values of the MREMP study area floodplain.

It may be considered however, that the fragmented occurrence and generally moist nature of the habitats on the floodplain may reduce the risk and inhibit the spread of wildfire locally. These factors may also reduce the desire of the local community to undertake prescription burning of local floodplain habitats.

Review of the DECCW wildfire and prescription burn records that occurred within the MREMP study area floodplain (including those that overlap) from 1980/81 to 2009/10 (29 years) is summarised in **Table 5.5** below. The results indicate that wildfires are the main type of fires that affect the MREMP study area floodplain. Arson was considered the cause of four of the 23 wildfires. The causes of the remaining 19 fires were not stated or unknown.

**Table 5.5** DECCW Wildfire and Prescription Burning Records for the MREMP Study Area Floodplain (1980/81 to 2009/10).

| *Year* | *Wildfire* | | *Prescription Burning* | | *Total* | |
|---|---|---|---|---|---|---|
| | *Number of Fires* | *Total Area Burnt* | *Number of Fires* | *Total Area Burnt* | *Number of Fires* | *Total Area Burnt* |
| 2009-10 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2008-09 | 1 | 173.37 | 0 | 0 | 1 | 173.37 |
| 2007-08 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2006-07 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2005-06 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2004-05 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2003-04 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2002-03 | 3 | 1445.34 | 0 | 0 | 3 | 1445.34 |
| 2001-02 | 2 | 449.99 | 1 | 0.08 | 3 | 450.07 |
| 2000-01 | 1 | 1800.88 | 0 | 0 | 1 | 1800.88 |
| 1999-00 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998-99 | 0 | 0 | 0 | 0 | 0 | 0 |

| *Year* | *Wildfire* | | *Prescription Burning* | | *Total* | |
|---|---|---|---|---|---|---|
| | *Number of Fires* | *Total Area Burnt* | *Number of Fires* | *Total Area Burnt* | *Number of Fires* | *Total Area Burnt* |
| 1997-98 | 3 | 327.04 | 0 | 0 | 3 | 327.04 |
| 1996-97 | 0 | 0 | 1 | 23.9 | 1 | 23.9 |
| 1995-96 | 0 | 0 | 1 | 3.96 | 1 | 3.96 |
| 1994-95 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993-94 | 2 | 39.19 | 0 | 0 | 2 | 39.19 |
| 1992-93 | 1 | 115.19 | 0 | 0 | 1 | 115.19 |
| 1991-92 | 1 | 47.49 | 0 | 0 | 1 | 47.49 |
| 1990-91 | 2 | 3411.36 | 0 | 0 | 2 | 3411.36 |
| 1889-90 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988-89 | 1 | 2.42 | 0 | 0 | 1 | 2.42 |
| 1987-88 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986-87 | 2 | 30.12 | 1 | 1.36 | 3 | 31.48 |
| 1985-86 | 1 | 4.55 | 1 | 12.32 | 2 | 16.87 |
| 1984-85 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1983-84 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1982-83 | 1 | 0.21 | 0 | 0 | 1 | 0.21 |
| 1981-82 | 2 | 404.79 | 0 | 0 | 2 | 404.79 |
| 1980-81 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **23** | **8251.94** | **5** | **41.62** | **28** | **8293.56** |

### 5.2.5 Wildlife Traffic Collision

Wildlife road kills and injuries are a well documented as a significant threat to native biodiversity (QLD DMR undated). Factors affecting a species' risk of traffic collision include:

- species ecology and behaviour (e.g. species with large home range sizes that travel large distances are more susceptible; reptiles may use roads as basking sites, etc);
- proximity of habitat to roads (e.g. fauna that utilise habitat roadside habitats such as scavengers; or whose habitat is fragmented by roads are generally more susceptible) (QLD DMR undated); and
- road design (e.g. traffic collision generally occurs on high volume and high speed roads with poor sight lines, limited cleared verges and poor visibility (e.g. poor street lighting in urban areas) (Darkheart Eco-Consultancy 2005).

Pressure on population viability/dynamics from traffic collision mortality is generally greater for larger fauna than small species (QLD DMR undated).

The main high speed and high traffic volume roads within the MREMP study area floodplain include:

- Pacific Highway;
- Smithtown Road;
- South West Rocks Road;
- Belmore Road (right bank);
- Belmore Road (left bank); and
- Plummers Lane.

Other arterial roads only intersect limited areas of the study area, and include Crescent Head Road, Old Station Road, Collombatti Road and Loftus Road. The alignment of these roads in the MREMP study area floodplain is largely restricted to cleared pastoral land or along cleared estuary banks. Areas where the subject roads intersect or occur parallel to habitat areas within the MREMP study area floodplain are generally limited in extent. Other roads within the study area are generally low speed design roads. Most would be expected to be subject to low traffic volumes (e.g. typically only used by local residents), while those potentially supporting moderate to high traffic rates are located in urban areas.

Phillips and Hopkin (2009b) recommended for Council to liaise with the RTA with a view to seek retro-fitting of underpasses and wildlife exclusion fencing along suitable sections of the Pacific Highway within the identified Koala Management Areas (KMA). Where the limited section of the MREMP study area floodplain overlaps the Dongdingalong – Kundabung – Crescent Head KMA (particularly adjacent to the Kempsey Golf Course) should be investigated during this process.

Overall there is insufficient data to identify whether traffic collision is a key threat to biodiversity on the MREMP study area floodplain, though current information suggests that other biodiversity management and conservation actions are higher priorities in terms of manage biodiversity threats locally (e.g. protecting high conservation value areas).

### 5.2.6 Fences

Fencing, depending upon design and location, potentially imposes three main possible threats to biodiversity:

- habitat fragmentation and associated edge effects;
- barrier effect for fauna (DECC 2008); and
- injury or mortality risk through entanglement or collision (NPWS 2003, DECCW undated).

As mentioned previously, approximately 86% of the MREMP study area floodplain consists of rural zoned land, hence agricultural style fencing (i.e. post and wire fences) are considered the main fence type of interest for the study. Such fences are generally not considered to impose a barrier risk (e.g. clearance below the fence allows ground dwelling fauna movement, etc), especially as the study area has undergone substantial historical habitat loss and modification.

The main opportunities to minimise impacts of fencing on local biodiversity include:

- avoid establishing fences through key habitat areas (e.g. EECs, significant fauna habitat areas, etc);
- encourage landholders to use fauna ‘friendly’ fencing or devices to minimise the risk of collision/entanglement, particularly when undertaking livestock exclusion fences around high conservation value habitat areas or riparian zones; and

- retro-fit existing barbed wire fencing that intersect or are adjacent to significant fauna habitats, or that are known entanglement 'hotspots' to create fauna friendly fencing or improve the visibility of the fence.

Fauna friendly fencing types include:

- full or part (top wire/s) plain wire fencing;
- timber post and rail fencing;
- split polypipe over the top wire; and
- nylon wire fencing.

Retro-fitting options include:

- white electric fence tape or white nylon wire above the top wire;
- timber rail above or instead of top wire;
- split polypipe over the top wire;
- 'quick fix tags' (place a series of tags or large objects to make the fence more visible); and
- stretching a bird wire 'apron' between the top and bottom wire (reportedly prevents the entangled fauna becoming wrapped around the wire) (Wildlife Friendly Fencing Project - undated).

## 5.3 Significant Exotic Weeds and Feral Fauna on the Macleay Floodplain

### 5.3.1 Introduction

Weeds and feral fauna pose significant threats to native biodiversity (DECCW undated, MNCWAC undated, Oakwood 2009). In NSW, invasive pest species have been identified as a threat to 70% of currently listed threatened species, endangered populations and EECs listed under the TSC Act (2007). The listing of several weeds and feral fauna species as Key Threatening Processes under both the TSC Act and EPBC Act is indicative of this.

ID Landscape Management (2005) has previous ranked locally recorded "Environmental Weeds" and assessed their occurrence along the Macleay Estuary riparian corridor. Documentation of the occurrence of feral fauna species in the MREMP study area in reports relevant to the MREMP is floodplain is negligible.

**Aim**

The aim of this component of the study is to identify significant feral fauna and exotic weeds associated with the MREMP study area floodplain. The purpose of gathering this information is to identify threats to biodiversity on the MREMP study area floodplain. Actions to manage these threats may subsequently be adopted into the MREMP to help maintain the biodiversity values of the floodplain.

**Methods**

Significant local feral fauna and weeds were identified through:

- review of records on the DECCW Atlas of NSW wildlife and DII BioNet databases;
- review relevant literature regarding locally occurring feral fauna species;
- consult with local government authorities (KSC, DECCW, NRCMA and Mid Coast Division of the Livestock Health and Pest Authority) regarding significant locally recorded feral species;
- review of key threatening processes;
- review of local exotic flora records on the DECCW Atlas of NSW wildlife and DII BioNet databases;
- review of The Mid North Coast Weeds Advisory Committee Inc (undated), *Regional Weeds Strategy – 2008 – 2012*;
- review of Oakwood (2009), *Northern Rivers Invasive Plants Action Strategy 2009-2013*;
- review of ID Landscape Management (2005) significant environmental weeds list;

### 5.3.2 Feral Fauna

**Database Records**

Searches were undertaken of the DECCW Atlas of NSW Wildlife database and DII BioNet database for records exotic fauna within a 32 km by 40 km area encompassing the MREMP study area floodplain. These species are listed in the table below in **Table 5.6**, which also provides a general comment of the impacts of the species and/or their Bureau of Rural Science ranking.

**Table 5.6** Feral Fauna Recorded within the Search Area

| ***Scientific Name*** | ***Common Name*** | ***Bureau of Rural Sciences Pest Rank*** ***Source: Hart and Bomford 2006*** | ***Comment*** |
|---|---|---|---|
| | | ***Aves*** | |
| *Acridotheres tristis* | Common Myna | Minor or non-pest | Known to evict native birds and their eggs or chicks from their nests and compete with hollow dependant species for nest/roosting/den sites. Also a competitor in rural areas, it competes for food and habitat with threatened species, e.g. Superb Parrot (*Polytelis swainsonii*) and Brown Treecreeper (*Climacteris picumnus*) (DECC undated). |
| *Anas platyrhynchos* | Mallard | Moderate | Increasing Mallard and Mallard - Black Duck (*Anas superciliosa*) hybrid populations in Australia has caused concern for the conservation of the Black Duck (Braithwaite and Miller 1975). |
| *Columba livia* | Rock Dove | Moderate | Considered a potential competitor for the TSC Act listed Vulnerable species Grey Ternlet (*Procelsterna cerulean*) (Coutts-Smith, *et al.*, 2007) by competing for nest sites with Feral Pigeon on sea cliffs of northern hills on Lord Howe Island (DECCW undated). This however is not directly relevant to the study area. |

| *Scientific Name* | *Common Name* | *Bureau of Rural Sciences Pest Rank* *Source: Hart and Bomford 2006* | *Comment* |
|---|---|---|---|
| *Lonchura punctulata* | Nutmeg Mannikin | Minor or non-pest | Aviary escapee, occurring along the east coast in areas of human activity (Morcombe 2003). |
| *Passer domesticus* | House Sparrow | Moderate | Impacts on biodiversity are reported limited due to occurrence primarily in urban areas. Can be highly aggressive towards other birds and reportedly will take over nest sites of native species. House Sparrows also reported may break the eggs of other birds, leading to declines in populations of native birds. Agricultural impacts include consumption of large quantities of grain and seed, resulting in yield reductions (NREAS undated). |
| *Streptopelia chinensis* | Spotted Turtle-Dove | Moderate | May compete for food and habitat with native pigeons, such as the Bar-shouldered Dove (*Geopelia humeralis*). It will eat germinating seedlings and chicken feed, and may spread the stickfast flea (*Echidnophaga galinaceae*), a chicken parasite (DECC undated). |
| *Sturnus vulgaris* | Common Starling | Serious | Agricultural pest. Impacts on biodiversity include competition for hollows with other birds, contamination of nesting sites and spread of invasive weeds (DECC undated). |
| ***Mammalia*** | | | |
| *Bos Taurus* | European Cattle | Feral Cattle - Moderate | Impacts of feral cattle include land degradation through trampling, soil compaction and erosion, increased nutrient loading, spread of weeds, and sedimentation of waterways. Agricultural impacts include competing with domestic livestock for water and feed, and carry and spread of disease (NREAS undated). |
| *Canis lupus* | Dog | Feral Dog - Serious | Feral dogs threaten the existence of dingoes through interbreeding. They also affect other species through predation such as the Koala (*Phascolarctos cinereus*). Also impose agricultural impacts (e.g. predation of livestock) (DECC undated). |
| *Cervus sp.* | Unidentified Deer | - | Herbivory and environmental degradation caused by feral deer is listed as a Key Threatening Process under the TSC Act. |

| *Scientific Name* | *Common Name* | *Bureau of Rural Sciences Pest Rank* *Source: Hart and Bomford 2006* | *Comment* |
|---|---|---|---|
| *Equus caballus* | Horse | Feral Horse – Moderate | Impacts of feral horses include erosion of soil and waterways, increased spread of weeds, trampling of native vegetation, consumption of native seedlings leading to reduced biodiversity, sedimentation of waterways and water bodies, destruction of infrastructure, competition with native species and domestic livestock for resources, and spread of disease and parasites to domestic livestock and native species (NREAS undated). |
| *Felis catus* | Cat | Feral Cat - Serious | Predation by feral cats is listed as a Key Threatening Process under the TSC Act (NSW Scientific Committee 2000) and EPBC Act. |
| *Lepus capensis* | Brown Hare | Low or non-pest | Impact on native species by competing for resources, altering the structure and composition of vegetation, and land degradation (NPWS 2008). |
| *Mus musculus* | House Mouse | Serious | The EPBC Act Key Threatening Process listing of predation by exotic rodents on Australian offshore islands of less than 100 000 ha includes the House Mouse, though this listing is not directly related to the study area which is on the mainland. |
| *Oryctolagus cuniculus* | Rabbit | Serious | Competition and land degradation by rabbits is listed as a Key Threatening Process by the EPBC Act (DEWHA website). |
| *Rattus rattus* | Black Rat | Moderate | The EPBC Act Key Threatening Process listing of predation by exotic rodents on Australian offshore islands of less than 100 000 ha includes the Black Rat, though this listing is not directly related to the study area which is on the mainland. |
| *Sus scrofa* | Pig | Feral Pig - Serious | Feral Pigs are listed as a TSC Act Key Threatening Process (NSW Scientific Committee 2004h) while predation, habitat degradation, competition and disease transmission by Feral Pigs is also a Key Threatening Process under the EPBC Act. |
| *Vulpes vulpes* | Fox | Serious | Predation by the European Red Fox is listed as a Key Threatening Process under the TSC Act (NSW Scientific Committee undated) and EPBC Act. |
| ***Amphibians*** | | | |
| *Bufo marinus* | Cane Toad | Serious | Listed as a Key Threatening Process under the TSC Act (NSW Scientific Committee 2006b) and EPBC Act. |
| ***Fish*** | | | |

| *Scientific Name* | *Common Name* | *Bureau of Rural Sciences Pest Rank* *Source: Hart and Bomford 2006* | *Comment* |
|---|---|---|---|
| *Gambusia holbrooki* | Plague Minnow | Serious | Predation by the Plague Minnow (*Gambusia holbrooki*) is listed as a TSC Act Key Threatening Process. An aggressive and voracious predator which impacts on fish, invertebrates and frogs (NSW Scientific Committee 1999). |

The KSC website also identifies the following feral animals of particular significance that are known to exist in the local government area:

- Brown Rat (*Rattus norvegicus*): Listed as a low or non-pest by the Bureau of Rural Sciences (Hart and Bomford 2006);
- Goldfish (*Carassius auratus*): Listed as a low or non-pest by the Bureau of Rural Sciences (Hart and Bomford 2006);
- Carp (*Cyprinus carpio*): Listed as a serious pest by the Bureau of Rural Sciences (Hart and Bomford 2006);
- Trout (*Oncorhynchus mykiss* or *Salma trutta*): Listed as a moderate pest by the Bureau of Rural Sciences (Hart and Bomford 2006); and
- European honey bees (*Apis mellifera*): Competition from feral honeybees is listed as a Key Threatening Process under the TSC Act (NSW Scientific Committee 2003).

It should be noted that despite some obvious negative impacts, in some situations several of the above listed species may still contribute to local ecological cycles in a positive manner. For examples the House Sparrow, Brown Hare, House Mouse, Rabbit and Black Rat may provide prey for high order predators. They may provide a particularly important food sources in some cases where the local occurrence of native prey species is insufficient to support the local occurrence of the predatory. This may be relevant to some areas of the MREMP study area floodplain due to substantial historic clearing, though this would require substantially greater investigations beyond the scope of this study.

**Mid Coast Division of the Livestock Health and Pest Authority**

The Mid Coast Division of the Livestock Health and Pest Authority (LHPA) provided GeoLINK with the results from the yearly pest animal survey results from 2007, 2008 and 2009. This community survey is provided to rural landholders when supplied with their annual Stock and Land Return forms. The basis for the survey is for landholders to provide a general indication of the occurrence of declared pest species under the *Rural Lands Protection Act 1998* (i.e. feral dogs, pigs, foxes, rabbits and deer) on their property. The results from these surveys for divisions encompassing the MREMP study area are provided in **Table 5.7** below.

Overall, the Mid Coast Division of the LHPA considers that wild dogs, foxes and feral cats are problematic in most areas of the floodplain and have been allegedly

attributed to reported increased livestock and native fauna losses. Feral deer have also reportedly increased in numbers during the past few years and are also considered to pose a significant threat. Mid Coast Division LHPA has advised other non *Rural Lands Protection Act 1998* declared pest animal such as cane toads and introduced myna birds, appear to be increasing in abundance each year in the region.

**Summary**

Review of the above information indicates that a number of feral fauna species have been recorded in the general MREMP study area floodplain vicinity, which includes a number of species which impose significant threats to biodiversity and local agriculture. Those considered a particular threat to biodiversity on the MREMP study area floodplain, given consideration to there legal status, include:

- Fox;
- Wild dogs;
- Feral cats;
- Plague Minnow;
- Pig;
- Rabbit;
- Deer;
- Cane Toad; and
- Common Myna.

Existing local and regional management programs of these species (e.g. wild dog baiting programs) should incorporate managing key habitat areas and adjoining land where appropriate.

For the above pest species without existing management programs operating locally, Council and other relevant stakeholders may consider developing and implementing programs to monitor and appropriately manage these species. Again such programs should include relevant key habitat areas (and adjacent land) on the MREMP study area floodplain.

**Table 5.7** Mid Coast LHPA Yearly Feral Fauna Survey Results, 2007 to 2009

| *Species* | *2007* | | | | *2008* | | | | *2009* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ***Not Present*** | ***Rare*** | ***Common*** | ***Very Common*** | ***Not Present*** | ***Rare*** | ***Common*** | ***Very Common*** | ***Not Present*** | ***Rare*** | ***Common*** | ***Very Common*** |
| **Dog** | 552 | 316 | 128 | 32 | 717 | 403 | 171 | 37 | 573 | 280 | 87 | 25 |
| **Pig** | 928 | 25 | 3 | 0 | 1279 | 40 | 11 | 0 | 938 | 19 | 6 | 2 |
| **Fox** | 351 | 400 | 232 | 50 | 611 | 494 | 186 | 36 | 389 | 369 | 177 | 30 |
| **Rabbit** | 452 | 265 | 168 | 135 | 644 | 334 | 230 | 119 | 534 | 202 | 139 | 90 |
| **Deer** | 847 | 87 | 30 | 11 | 1197 | 85 | 35 | 7 | 847 | 78 | 26 | 14 |

### 5.3.3 Significant Weeds

Two main documents prioritising weeds relevant to the MREMP study area floodplain were reviewed to identify priority weeds for management purposes on the MREMP study area. These were:

- The Mid North Coast Weeds Advisory Committee Inc (undated), *Regional Weeds Strategy – 2008 – 2012*; and
- Oakwood (2009), *Northern Rivers Invasive Plants Action Strategy 2009-2013*.

The *Regional Weeds Strategy -2008 – 2012* (MNCWAC undated) was developed to provide landholders and land managers with a set of standards and guidelines for implementing effective and coordinated weeds control programs. The priority list of weeds was developed using the Randall (2000) *'Which are my worst weeds'* priority weeds system (MNCWAC - undated). Four priority categories were identified, as follows:

- **Category A** - Weeds not currently in the MNCWAC area;
- **Category B** - Weeds present with limited distribution, several small infestations in the MNCWAC area;
- **Category C** - Weeds present with moderate distribution in the MNCWAC area, numerous to large partially dispersed infestations; and
- **Category D** - Weeds that are widespread throughout the region.

The *Northern Rivers Invasive Plants Action Strategy 2009-2013* (Oakwood 2009) species prioritisation was based on noxious weeds class of a species and/or a scoring system based on species impact, invasiveness, distribution, rate of spread and whether the species could, within 5 years, feasibly be eradicated (Oakwood 2009). The priority ranks are illustrated in **Table 5.8** below.

**Table 5.8** Inclusions in Each Priority Weed Category (Oakwood 2009)

| ***Priority (Rank)*** | ***Weed Species included*** |
|---|---|
| A | Noxious Weeds Class 1 and 2.<br>Weed Species on the National Alert List.<br>Weed species that scored 90+ in the prioritisation process. |
| Aa | Weeds currently absent in that Local Government Area. Includes noxious and environmental weeds. |
| B | Noxious Weeds Class 3.<br>Weed species that scored 80-89 (often only limited distribution).<br>These weed species are predominantly both highly invasive and have substantial impact. |
| C | Weed species that scored 70-79. |
| D | Weed species that scored 60-69. |
| E | Weed species that scored 50-59. |
| F | Weed species that scored less than 40. |

The Oakwood (2009) and MNCWAC (undated) prioritised species relevant to the MREMP study area floodplain are listed in the table in **Appendix C**, which also identifies the landscape type which the weeds are considered the main threat. Local records of these species were identified through:

- DECCW Atlas of NSW Wildlife database and DII BioNet database for records of environmental and exotic weeds within a 32 km by 40 km area encompassing the MREMP study area floodplain;
- review of locally recorded environmental weeds identified by ID Landscape Management (2005); and
- opportunistic recordings made during site inspection of the MREMP study area floodplain on the 7, 8 and 9 January 2010.

It should be noted that Oakwood (2009) acknowledges that other weed species of concern have not been included in the prioritisation process due to time constraints related to the project.

ID Landscape Management (2005) considered the other following additional species as locally recorded significant weeds in the Macleay Estuary study area, and ranked them as follows:

- *Category 1 – Most Serious Environmental Weeds (highly invasive and difficult to control)*: Spike Rush (*Juncus acutus*).
- *Category 2 – Troublesome Environmental Weeds (highly invasive and moderate degree of difficulty in control)*: Mulberry Tree (*Morus sp.*).
- Category 3 – Problematic Environmental Weed – invasive and moderate degree of difficulty in control: Bamboo (Bambussa sp.), Banana, Umbrella Sedge (Cypress involucratus), Gleditsea (Gleditsea sp.), Jacaranda (Jacaranda mimosifolia) and Poplar (Populus sp.).

**Summary**

In summary, the information above illustrates that a large number of weeds identified as priority species for management are relevant to the MREMP study area floodplain. Many of these species are also known occurrences in the general vicinity of the MREMP study area floodplain. These species should be prioritised when undertaking weed management works, using best practice management techniques. Those species whose invasion is listed as a Key Threatening Process (refer to **Section 5.4**) are considered a particular threat to local biodiversity, hence should be target species when undertaking weed management in or adjacent high conservation value habitat areas.

## *5.4 Management Issues Associated With Threats*

### 5.4.1 Issues Involving Threats to Estuary Ecology

**Issue 5.1: Current floodplain management**

The drainage of floodplain wetlands, clearing of floodplain wetland forests and exposure of acid sulfate soils have resulted in habitat reduction, reduced productivity and impacts associated with the export of poor quality water into the estuary.

**Issue 5.2: Elevated sediment loads**

Elevated sediment loads in runoff and due to riverbank erosion may be responsible for a loss of fishing grounds, observed reductions in the cover of seagrass and reduced

productivity of benthic microalgae and therefore productivity of the estuary in general.

#### Issue 5.3: Habitat loss

Flood mitigation and drainage works on the floodplain wetlands and the construction of floodgates and levees separating the Yarrahapinni Wetlands from the Macleay estuary have resulted in vast reductions in the availability of habitat to estuarine fauna.

#### Issue 5.4: The spread of *Juncus acutus* across the floodplain

The noxious weed, *J. acutus* appears to be spreading across the floodplain on the left and right banks of the river in the vicinity of Jerseyville. This poses a threat to saltmarsh habitats and a particular threat to the floristic integrity of the Yarrahapinni Wetlands National Park, where saltmarsh habitats will be particularly dynamic over the coming years.

#### Issue 5.5: The spread of *Egeria densa*

Egeria is the dominant macrophyte in the brackish reaches of the estuary upstream of Gladstone. It appears to have spread rapidly since 1998 and may be outcompeting native plants. Anecdotal evidence suggests that during dry times it can spread almost the entire width of the river in parts and poses a navigational obstacle.

### 5.4.2 Issues Involving Threats to Floodplain Ecology

#### Issue 5.6: Key Threatening Processes

Despite broad scale habitat modification and fragmentation the MREMP floodplain is known to support a large number of threatened species, EECs and migratory species. Management of threats at high conservation value habitat areas is therefore essential to conserve the biodiversity values of the study area for future generations. Threats of particular concern to biodiversity on the Macleay floodplain include:

- landuse management threats;
- feral fauna;
- weed invasion;
- inappropriate fire regimes;
- anthropogenic climate change (refer to **Section 8**); and
- habitat fragmentation and isolation.

#### Issue 5.7: Pest Flora and Fauna

The MREMP study area floodplain is known to support a number of feral fauna and significant weeds that impose a significant threat to local biodiversity. Significant feral fauna include:

- Fox;
- Wild dogs;
- Feral cats;
- Plague Minnow;
- Pig;
- Rabbit;
- Deer;

- Cane Toad; and
- Common Myna.

Locally recorded weeds which impose a significant threat to local biodiversity include:

- Madeira Vine (*Anredera cordifolia*);
- Moth Vine (*Araujia sericifera*);
- Ground/Basket Asparagus (*Asparagus aethiopicus*);
- Climbing Asparagus (*Asparagus plumosus*);
- Balloon Vine (*Cardiospermum grandiflorum*);
- Bitou Bush (*Chrysanthemoides monilifera*);
- Five Leaf Morning Glory (*Ipomoea cairica*);
- Blue Morning Glory (*Ipomoea indica*);
- Lantana (*Lantana camara*);
- Japanese Honeysuckle (*Lonicera japonica*);
- Cats Claw Creeper (*Macfadyena unguis-cati*);
- Giant Paspalum (*Paspalum urvillei*);
- *Passiflora spp.*;
- Climbing Nightshade (*Solanum seaforthianum*);
- Giant Parramatta Grass (*Sporobolus fertilis*);
- Giant Rats Tail Grass (*Sporobolus pyramidalis*);
- Trad/Striped Trad (*Tradescantia fluminensis*); and
- Spike Rush (*Juncus acutus*).

## *5.5 Management Options to Control Threats*

### 5.5.1 Management Options for Threats to Estuary Ecology

See **Options 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2** and **3.3** for strategies to reduce the impact of sediment loads and floodplain wetland management upon estuary ecology.

**Option 5.1: Continue to monitor the estuarine macrophytes to assess long term trends in habitat availability**

The monitoring of estuarine macrophytes should be undertaken as appropriate aerial photography becomes available. The Middelton zones, utilised in this study are ideal for assessing trends across the different regions. Consistency in the methods applied is key to the success of monitoring as shown by the difficulty in drawing conclusions from past studies that used different methods.

**Option 5.2: Undertake a control program for *Juncus acutus***

Prior to the development of a control program it is considered important to finalise the mapping undertaken in this study. The best methods for controlling *J. acutus* depend upon the terrain but may variously involve poisons or excavation.

**Option 5.3: Continue to monitor the spread of egeria**

The complicated logistics of a control program for egeria and the likely role it plays as a nutrient sink and habitat make its control unfeasible at present. However, it is important that efforts are made to reduce the spread of egeria to other waterways and to improve the understanding of the dynamics of egeria on the Macleay.

### 5.5.2 Management Options for Threats to Floodplain Ecology

**Option 5.4: Manage listed key threatening processes**

Preliminary mitigation measures to manage listed key threatening process relevant to the MREMP study area floodplain include:

- identify what current programs are being undertaken at a regional scale to actively manage relevant key threatening processes in the study area, in accordance with the current threat abatement plans;
- continue and monitor active threat abatement programs; and
- develop, implement and monitor new regional threat abatement programs where necessary.

**Option 5.5: Manage Landuse Threats**

Preliminary management actions for consideration in the MREMP to manage landuse threats to areas of significant biodiversity value include:

- update KSC LEP mapping to ensure consistency with other habitat protection based legislation (e.g. SEPP 14 and 26); current local landuses (e.g. national parks estate); and ensure adequate local protection of high conservation value habitat areas (e.g. to 7(b) (Environmental Protection (Habitat) Zone); and
- develop programs/incentives to encourage and assist landholders to protect and manage habitat areas through other legislative (e.g. BioBanking) and non-legislative approaches (e.g. CMA incentive programs).

**Option 5.6: Manage Wildfire**

Preliminary management actions for consideration in the MREMP to manage wildfire and fire intensity burning to protect the biodiversity values of the study area include:

- DECCW and relevant stakeholders should continue to monitor the occurrence of wildfires and prescription burning in the MREMP study area, and attempt to identify the cause of wildfires;
- identify local fire-sensitive threatened and migratory species habitats and EECs (particularly high conservation value areas);
- develop protocols and guidelines in association with relevant stakeholders (e.g. DECCW, CMA, NSW Rural Bushfire Service) to minimise risk to fire-sensitive species and ecosystems when undertaking fuel-reduction burning; and
- develop community and land-holder liaison and/or education programs to promote awareness of the impacts of fire to local biodiversity and prompt adoption of risk minimising protocols/guidelines.

**Option 5.7: Manage Roadkills**

Preliminary management actions for consideration in the MREMP to manage wildlife road kills and injuries to protect the biodiversity values of the study area include undertaking further investigation to:

- identify whether traffic collision is a major threat to biodiversity locally;
- identify potential collision ‘hot spots’; and

- identify appropriate management actions (e.g. retro-fitting the existing road design to reduce the collision threat, establishing "wildlife corridor" signage, etc).

However the above brief review suggests that this may be a lower priority than the management of more substantial biodiversity threats locally.

**Option 5.8: Manage Fencing**

Preliminary management actions for consideration in the MREMP to manage impacts on fencing impacts include:

- develop community and land-holder liaison/ awareness and/or education programs to:
  - avoid establishing fences through high conservation value habitat areas;
  - encourage landholders to use fauna 'friendly' fencing or devices to minimise the risk of collision/entanglement, particularly when undertaking livestock exclusion fences around high conservation value habitat areas or riparian zones; and
  - retro-fit existing barbed wire fencing that intersect or are adjacent to significant fauna habitats, or that are known entanglement 'hotspots' to create fauna friendly fencing or improve the visibility of the fence.
- develop community program to survey to identify potential to fauna/fence entanglement 'hotspots' to target fence 'retro-fitting'; and
- Council should ensure appropriate assessment and mitigation measures to prevent establishing high entanglement risk fencing in/adjacent to key habitat areas of high risk species (e.g. potential/known Grey-headed Flying-Fox roost habitat) are considered when assessing development applications.

**Option 5.9: Manage Pest Flora and Fauna**

Management options to mitigate impacts of significant feral fauna and weeds on local native biodiversity include:

- existing local and regional feral fauna management programs (e.g. during wild dog baiting programs) to include relevant high conservation value habitat areas;
- develop and implement programs to monitor and appropriately manage identified significant feral fauna which local management programs currently do not exist for (e.g. Cane Toad); and
- manage priority significant weeds at high conservation value habitat sites.