rainforest pockets'. Subsequent analysis is being undertaken with this data in the Macleay River Estuary Management Study (EMS) to identify high conservation values or priority areas for protection, regeneration and/or restoration management works.

4.2 Identify High Conservation Value Flora and Fauna on the Floodplain and Their Habitat

4.2.1 Background Information

Previous studies of the Macleay estuary area have identified that this area provides habitat for a variety of high conservation value flora and fauna (ID Landscape Management 2005), including known habitat for 46 threatened species and potential habitat for a further 21 species. ID Landscape Management (2005) also identified potential "riparian corridor" habitats for threatened flora and fauna species.

The draft *Comprehensive Koala Plan of Management* (*CKPoM*) *for the Eastern Portion of Kempsey Shire Council LGA* (Phillips and Hopkins 2009a, 2009b) incorporates the MREMP study area floodplain. The CKPoM is a local broadscale species specific investigation that encompasses the study area. The document provides mapping of Koala records and potential Koala habitat on the Macleay floodplain, with mapping based on field surveying, reviewing existing data and Koala habitat modelling.

The draft *Shorebird Data Audit – Northern New South Wales* was undertaken by Sandpiper Ecological Surveys (2009) with the aim of providing a baseline dataset that can be used for planning and management within the Northern Rivers Catchment Management Authority (NRCMA) region. This includes the Macleay estuary. A summary of this document and specific finding relevant to the MREMP study area is provided in **Section 4.2.7**.

There are four wetlands sites within the Macleay River catchment listed on the Directory of Important Wetlands in Australia (Environment Australia 2001, cited in DECC 2009). They encompass a total area of 8497 ha which largely overlap some of the wetlands areas in the northern portion of the MREMP study area (e.g. near the Macleay River mouth).

4.2.2 Aims

One of the main aims of the ecological processes study is to identify high conservation value habitat areas on the MREMP study area floodplain to help identify priority areas for conservation and management actions. Consequently, this would help to promote the long term maintenance of biodiversity values of the floodplain. This component of the study aims to identify high conservation value terrestrial habitat areas for threatened and migratory species by:

- identifying high conservation value flora and fauna associated with the MREMP study area floodplain; and
- identify known/potential habitat areas on the floodplain based on species' habitat requirements, local records and vegetation mapping for relevant high conservation value flora and fauna.

The purpose of this study is not to provide a local environmental study or similar environmental planning assessments which would require significantly more investigations. Instead, the scope of this study is to identify the known and likely high conservation habitat areas within the MREMP study area floodplain on a broad landscape scale

4.2.3 Habitats in the Study Area

Telfer and Kendall (2006) mapped 87 vegetation types (1227 vegetation polygons) across the MREMP study area floodplain. A total of eight vegetation types have also been identified by GHD (2007) as occurring in the small areas on the western fringes of the MREMP study area floodplain not encompassed in the Telfer and Kendall (2006) mapping.

Threatened species habitat requirements are generally provided in broad structural forms (e.g. coastal scrub, dry sclerophyll forest, swamp sclerophyll forest) rather than floristic type (e.g. Banksia, Swamp Oak). For the purpose of this investigation vegetation types identified by Telfer and Kendall (2006) and GHD (2007) within the study area were therefore designated into the broad categories listed below. These categories are based on the original Comprehensive Regional Assessment Air Photo Interpretation Project (CRAFTI) or Forest Ecosystems Classification and Mapping for Lower North East CRA Regions descriptions, as follows:

- Dry Sclerophyll Forest;
- Wet Sclerophyll Forest;
- Swamp Sclerophyll Forest;
- Coastal Scrub/Heath;
- Rainforest;
- Estuarine;
- Wetland (Freshwater);
- Water surfaces;
- Cleared, partly cleared;
- Agricultural Plantations / Orchards;
- Urban;
- Other; and
- Unknown

Table 4.9 shows which vegetation type identified by Telfer and Kendall (2006) and GHD (2007) have been nominated into each broad vegetation class. This simplifies the process of identifying high conservation value habitats for significant species within the study area (refer to **Figures 4.5**, **4.6** and **4.7**). Additionally this helps eliminate some the vegetation identification limitations identified in **Section 4.1** of this study, where differences in the floristic forest types were identified between mapped vegetation type and the vegetation present at some EEC sample sites.

4.2.4 Threatened and Migratory Species Records

Opportunistic Threatened and Migratory Species Recorded During Ecological Process Study Field Work

Field work undertaken within the study area on the 7, 8 and 9 January 2010 incorporated opportunistic recordings of threatened and migratory species. The Eastern Osprey (*Pandion cristatus*) was the only TSC Act listed threatened species recorded. The individual was identified flying over the Macleay River to the south of Gladstone (refer to **Illustration 4.8**). The species is also dually listed as a migratory species under the EPBC Act. No other threatened species were recorded.

The following other EPBC Act listed migratory species were also recorded during the survey:

- Great Egret (*Ardea alba*); and
- Cattle Egret (*Ardea ibis*).

Threatened Fauna Records

Searches were undertaken for all TSC Act and EPBC Act threatened fauna records located on the MREMP study area floodplain or within a 5 km radius, from the following sources:

- Department of Environment, Climate Change and Water (DECCW) Atlas of NSW Wildlife database;
- Department of Industry and Investment (DII, formerly Department of Primary Industries) BioNet database;
- Fishermans Bend Nature Reserve Plan of Management (DEC 2005), Hat Head National Park Plan of Management (NPWS 1998) and Clybucca Historic Site Draft Plan of Management (DECC 2007a);
- Kempsey Shire Council (KSC) GIS layers; and
- Kempsey and Macksville 1:100,000 threatened species map sheets obtained from DECCW under a data licence agreement.

The species identified by the searches are listed in **Appendix A**. The location of the threatened species records held on the Kempsey and Macksville 1:100,000 map sheets are shown in **Figure 4.8** while the location of KSC GIS records are shown in **Figures 4.9**, **4.10** and **4.11**.

In addition, a search using a 22 km buffer from the centre of the MREMP study area was undertaken on the EPBC Act Protected Matters Search Tool for threatened "*species or species habitat*" that may occur within the search area. The EPBC search results included a variety of threatened 'pelagic' and/or 'oceanic' species such as whales, albatross; however, the majority of these species are not included in the list provided in **Appendix A** given the lack of suitable habitat and known records within the study area.

Table 4.9 Broad habitat description classes

Broad Habitat Description Class	*Telfer and Kendall (2006) Vegetation Type*	*GHD (2007) Vegetation Type*
Dry Sclerophyll Forest	Blackbutt (c); Blackbutt Co-dominant (c); Blackbutt ~ Bloodwood/Apple (c); Blackbutt ~ Coastal stringybarks (c); Blackbutt ~ Grey Gum-Grey Ironbark-Mahogany complex (c); Blackbutt ~ Rough-barked Apples (c); Blackbutt ~ Scribbly Gum (c); Blackbutt ~Spotted Gum complex (c); Bloodwood/Apple (c); Bloodwood/Apple ~ Blackbutt (c); Bloodwood/Apple ~ Grey Gum-Grey Ironbark-Mahogany complex (c); Coastal Pink Bloodwood; Coastal Sands Blackbutt; Dry Blackbutt (c); Dry Foothills Blackbutt-Turpentine; Dry Grassy Blackbutt-Tallowwood; Dry Grassy Tallowwood-Grey Gum; Eastern Red Gums; Escarpment Redgum; Eucalyptus pilularis/E. planchoniana/E. gummifera (c); Eucalyptus pilularis-E. gummifera/E. planchoniana (c); Eucalyptus pilularis-E. intermedia (c); Eucalyptus planchoniana-E. signata (c); Eucalyptus signata/Eucalyptus pilularis-E. gummifera/E. planchoniana (c); Eucalyptus tereticornis-E. siderophloia (c); Grey Gum-Grey Ironbark-Mahogany complex (c); Grey Gum-Grey Ironbark-Mahogany complex ~ Blackbutt (c); Grey Gum-Grey Ironbark-Mahogany complex ~ Bloodwood/Apple (c); Grey Gum-Grey Ironbark-Mahogany complex ~ Eastern Red Gums (c); Heathy Scribbly Gum; Low Relief Coastal Blackbutt; Lowland Red Gum; Lowlands Scribbly Gum; Macleay Lowland Spotted Gum; Needlebark (c); Scribbly Gum (c); Scribbly Gums ~ Blackbutt (c); Scribbly Gums ~ Bloodwood/Apple (c).	Dry Foothills Blackbutt-Turpentine; Eastern Red Gums; Foothill Grey Gum-Ironbark-Spotted Gum.
Wet Sclerophyll Forest	Brush Box (c); Coastal Flooded Gum; Flooded Gum; Open Coastal Brushbox; River Oak; Wet Flooded Gum Tallowwood.	Open Coastal Brushbox; Wet Spotted Gum-Tallowwood; Central Mid Elevation Sydney Blue Gum; River Oak.
Swamp	Eucalyptus robusta-Melaleuca quinquenervia (c); Melaleuca	Swamp Oak.

Sclerophyll Forest	quinquenervia (c); Melaleuca quinquenervia-Casuarina glauca (c); Paperbark; Paperbark complex ~ Wattle / Native Pioneers (c); Swamp Mahogany; Swamp Oak.	
Coastal Scrub/Heath	Banksia; Banksia aemula (c); Banksia oblongifolia-Leptospermum liversidgei-Lepyrodia interrupta-Sprengelia sprengelioides-Xanthorrhoea fulva (c); Callitris rhomboidea (c); Coastal Complex; Gahnia sieberiana-Gleichenia dicarpa (c); Heath; Leptospermum juniperinum/Gahnia sieberiana-Gleichenia dicarpa (c); Moist Coastal complex (c); Wattle.	-
Rainforest	Cupaniopsis anacardioides (c); Rainforest; Rainforest w/ Eucalypt (c).	-
Estuarine	Avicennia marina var. australasica (c); Estuarine complex (c); Mangrove; Saltmarsh; Sand Ridge.	-
Wetland (Freshwater)	Eleocharis equisetina-Triglochin procerum s. lat.-Paspalum distichum (c); Sedgeland (c); Sedgeland ~ Paperbark complex (c); Swamp.	-
Water surfaces	Water Surfaces.	-
Cleared, partly cleared	Cleared, partly cleared; Isolated or Individual Fig Trees; Wattle / Native Pioneers (c).	Other Than Woody Vegetation
Agricultural Plantations / Orchards	Agricultural Plantations / Orchards; Hardwood Plantations.	-
Water surfaces	Water surfaces.	-
Unknown	Excluded (c); Unmapped – NPWS Estate (c).	-
Other	Bare ground (c); Camphor laurel; Introduced; Other (c); Rock; Urban.	-

ID Landscape Management (2005) provides a summary of known/potentially occurring threatened fauna in the Macleay estuary area. As the exact location of the known ID Landscape Management (2005) records is not provided, these records were not able to be included as known occurrences specifically within the MREMP study area floodplain in **Appendix A**.

The Kempsey and Macksville 1:100,000 threatened species map sheets and KSC GIS records were inserted as a layer over the habitat mapping to indicatively identify known habitats for these species in the study area floodplain. Potential key habitat areas in the study area based on broad species habitat requirements for each species are also provided in **Appendix A**.

The table in **Appendix A** shows that 41 threatened fauna species have been recorded in the MREMP study area floodplain. It should be noted that using the location of records of fauna alone to identify key habitat areas is not considered sufficient due a number of key factors affecting the location of key habitat areas, including species detectability; observer bias; location of fauna and flora investigations locally, etc. Consequently, in review of the table (i.e. both known habitat types and key known/potential habitats within the study area), the key habitat types for terrestrial threatened fauna within the study area appears to be:

- Dry Sclerophyll Forest;
- Wet Sclerophyll Forest;
- Swamp Sclerophyll Forest;
- Coastal Scrub/Heath;
- Rainforest;
- Estuarine;
- Wetland (Freshwater);
- Estuary; and
- Water surfaces.

Drainage lines and creeks within other mapped areas (e.g. Cleared, partly cleared areas) may also provide key habitat areas for the Black-necked Stork (*Ephippoorhynchus asiaticus*) and Brolga (*Grus rubicunda*). These habitats are shown in **Figure 4.11**. Significant micro-habitat habitat features for specific species may also occur in other habitat areas (e.g. Cleared, partly cleared areas may support isolated hollow-bearing trees that may provide roosting/denning/nesting habitat for hollow-dependant species; or mature trees along the estuary may provide nesting and roosting sites for the Osprey). Identifying all of the micro-habitat features is beyond the scope of this project.

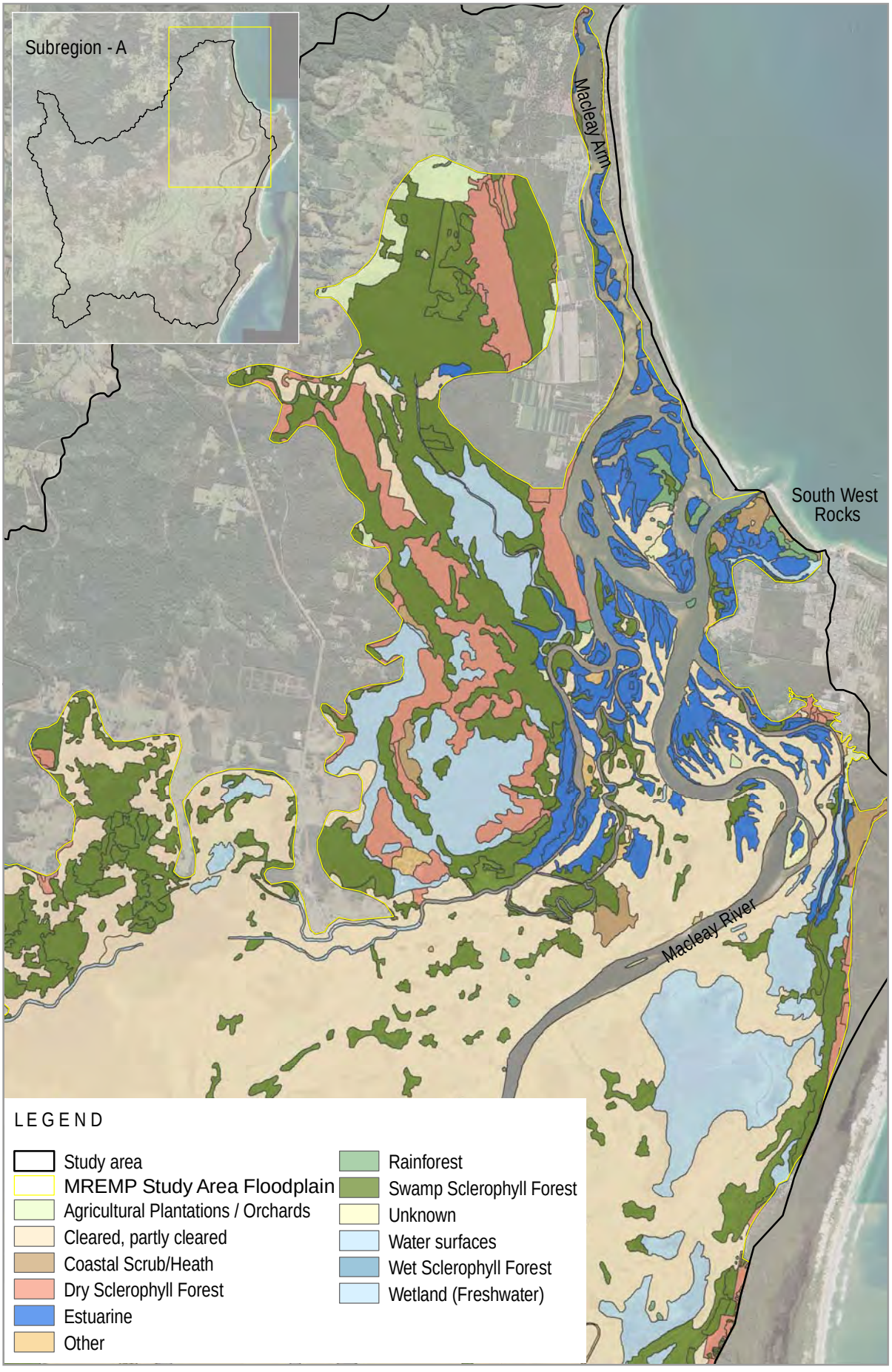
Some highly modified vegetation types (e.g. Agricultural Plantations / Orchards, etc) may also contain suitable habitat elements for various subject species with somewhat habitat generalist requirements (e.g. nectar and fruit resources for Flying-foxes). These anthropogenic habitats are; however, less likely to provide key habitat for the local known/potential population of the subject fauna.

Known Grey-headed Flying-fox (*Pteropus poliocephalus*) roosts occur locally near Kempsey, Belmore, South West Rocks, Clybucca and Aldavilla (DECC 2009), is a particularly significant site for this species in the MREMP study area floodplain. The exact locations of these sites are however not known to the author, though should be identified as part of the MREMP as high priority conservation and management areas.

To assess the actual potential occurrence for each species within individual mapping units would require considerably greater investigations outside the scope of this project. Thus to identify priority key habitat area for broadscale management purposes, other ecological factors should be taken into consideration (refer to **Section 4.2.8**).

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

Information shown is for illustrative purposes only



0 2 km

North

Simplified Study Area Habitat Mapping - Subregion A

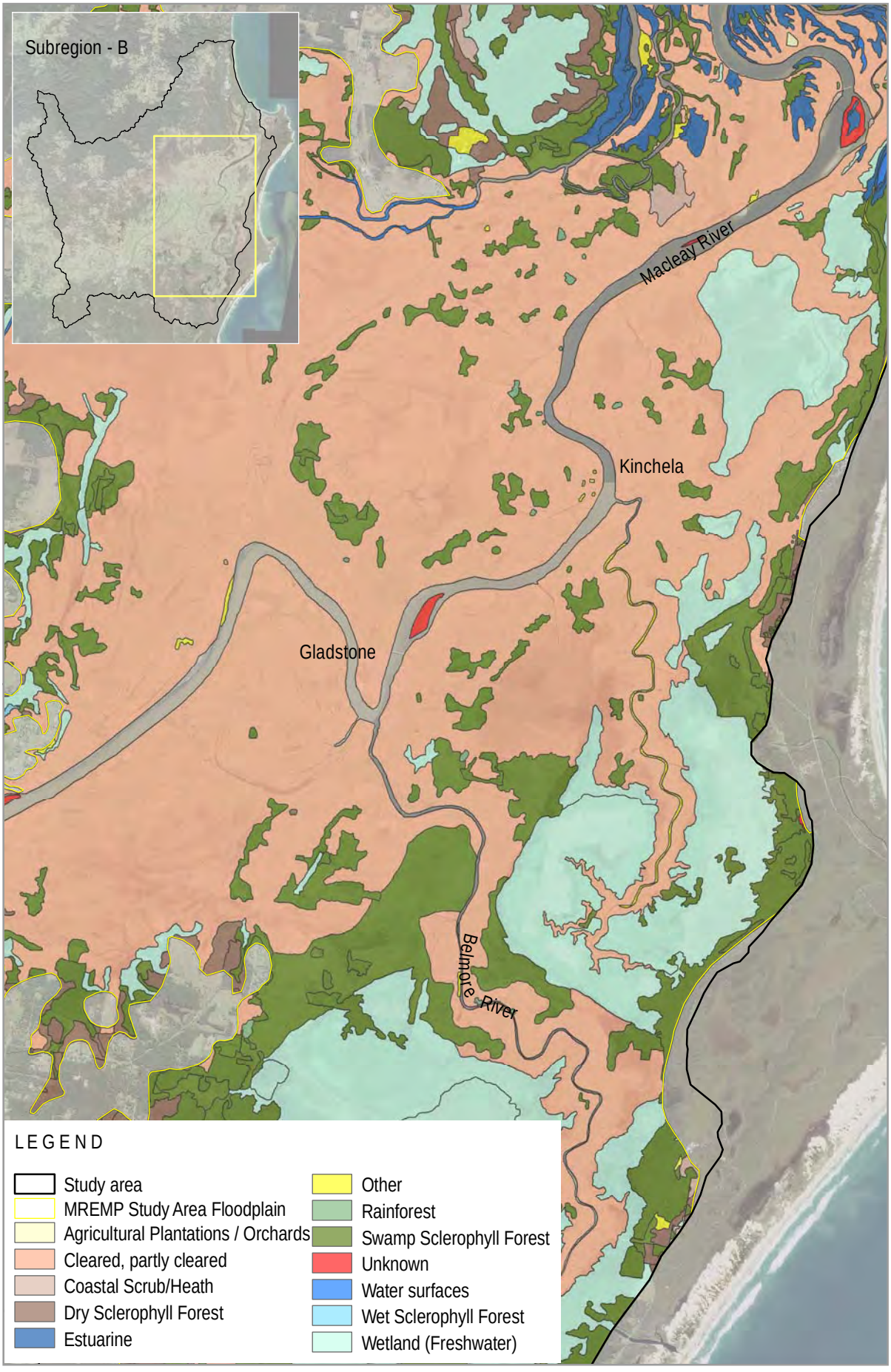
Figure 4.5

GeoLINK environmental management and design

Macleay Ecological Study
1484840

Information shown is for illustrative purposes only

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



0 2 km

North

Simplified Study Area Habitat Mapping - Subregion B

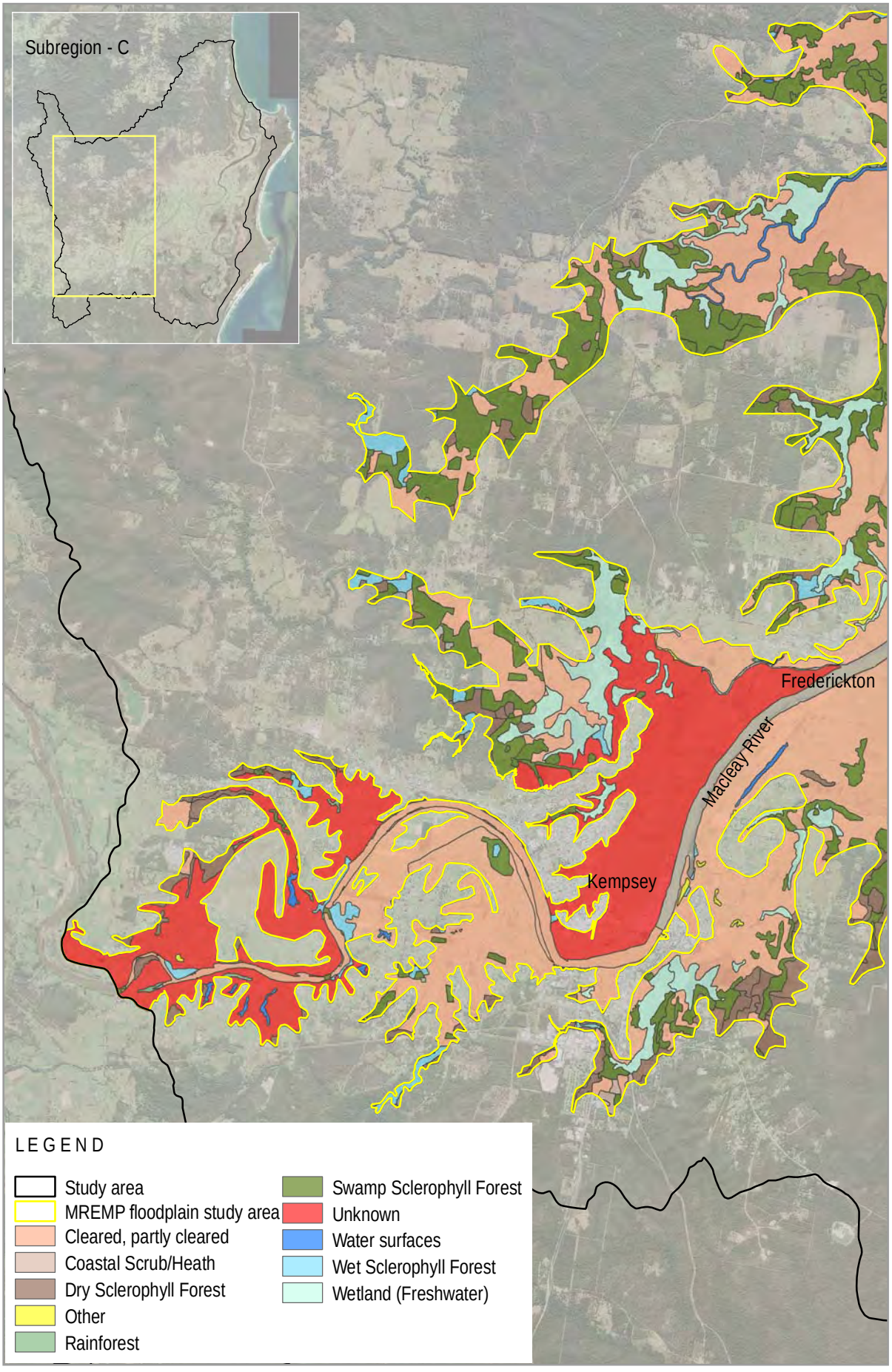
GeoLINK environmental management and design

Macleay Ecological Study
1484841

Figure 4.6

Information shown is for illustrative purposes only

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



0 2 km

North

Simplified Study Area Habitat Mapping - Subregion C

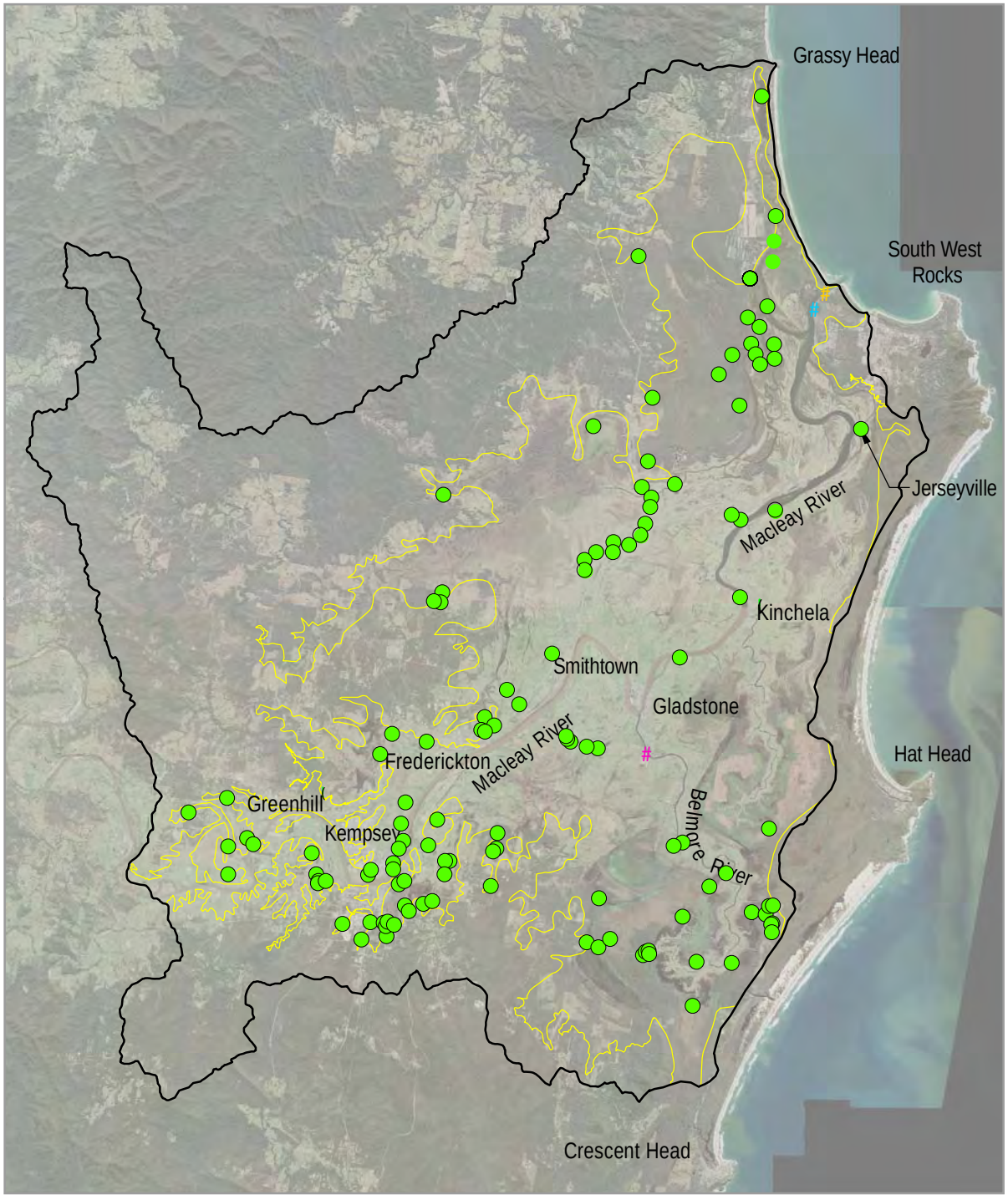
GeoLINK environmental management and design

Macleay Ecological Study
1484842

Figure 4.7

Information shown is for illustrative purposes only

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



LEGEND

- Study area
- MREMP Study Area Floodplain
- # Site Inspection Osprey Recording
- Australasian Bittern
- Black Bittern
- Black-breasted Buzzard
- Black-necked Stork
- Blue-billed Duck
- Brolga
- Brush-tailed Phascogale
- Comb-crested Jacana
- Eastern Bentwing-bat
- Eastern Freetail-bat
- Glossy Black-Cockatoo
- Grass Owl
- Green and Golden Bell Frog
- Green-thighed Frog
- Grey-headed Flying-fox
- Hoary Wattled Bat
- Koala
- Little Bentwing-bat
- Little Tern
- Osprey
- Rose-crowned Fruit-Dove
- Sooty Owl
- Spotted-tailed Quoll
- Square-tailed Kite
- Wallum Froglet
- Barred Cuckoo-shrike
- Greater Broad-nosed Bat
- Magpie Goose
- Pied Oystercatcher
- Squirrel Glider
- # Site Inspection Black Cod Recording
- # Site Inspection Green Turtle Recording

0 5 km

North

Site Inspection and DECCW Threatened Fauna Records within MREMP Study Area Floodplain

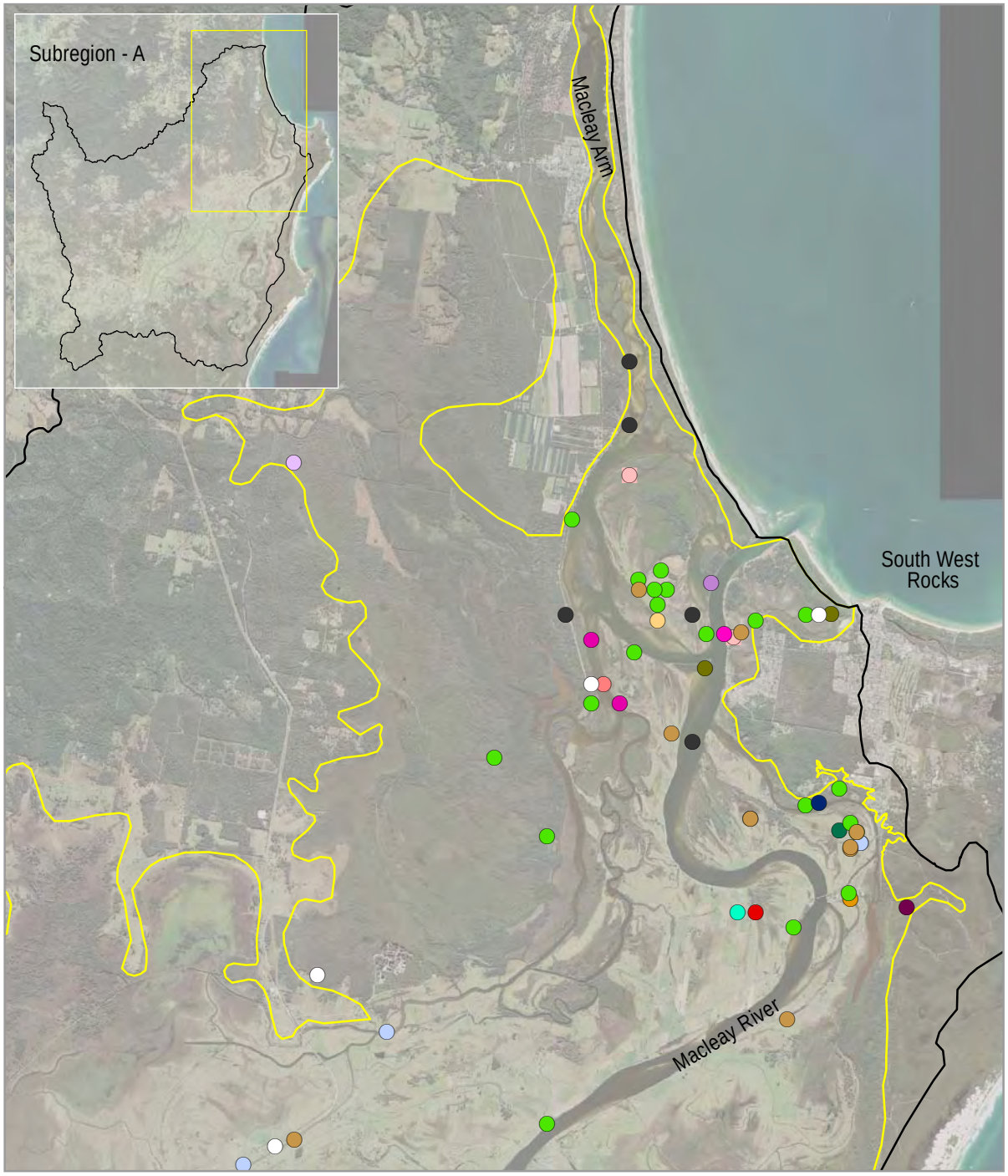
GeoLINK environmental management and design

Macleay Ecological Study
1484844

Figure 4.8

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
- Black-necked Stork
- Little Tern
- Barred Cuckoo-shrike
- Black-tailed Godwit
- Comb-crested Jacana
- Eastern Freetail-bat
- Glossy Black-Cockatoo
- Greater Broad-nosed Bat
- Green Turtle
- Grey-headed Flying-fox
- Hoary Wattled Bat
- Leathery Turtle
- Little Bentwing-bat
- Magpie Goose
- Osprey
- Pied Oystercatcher
- Sooty Oystercatcher
- Square-tailed Kite
- Squirrel Glider
- Wallum Froglet

North

0 2 km

GeoLINK environmental management and design

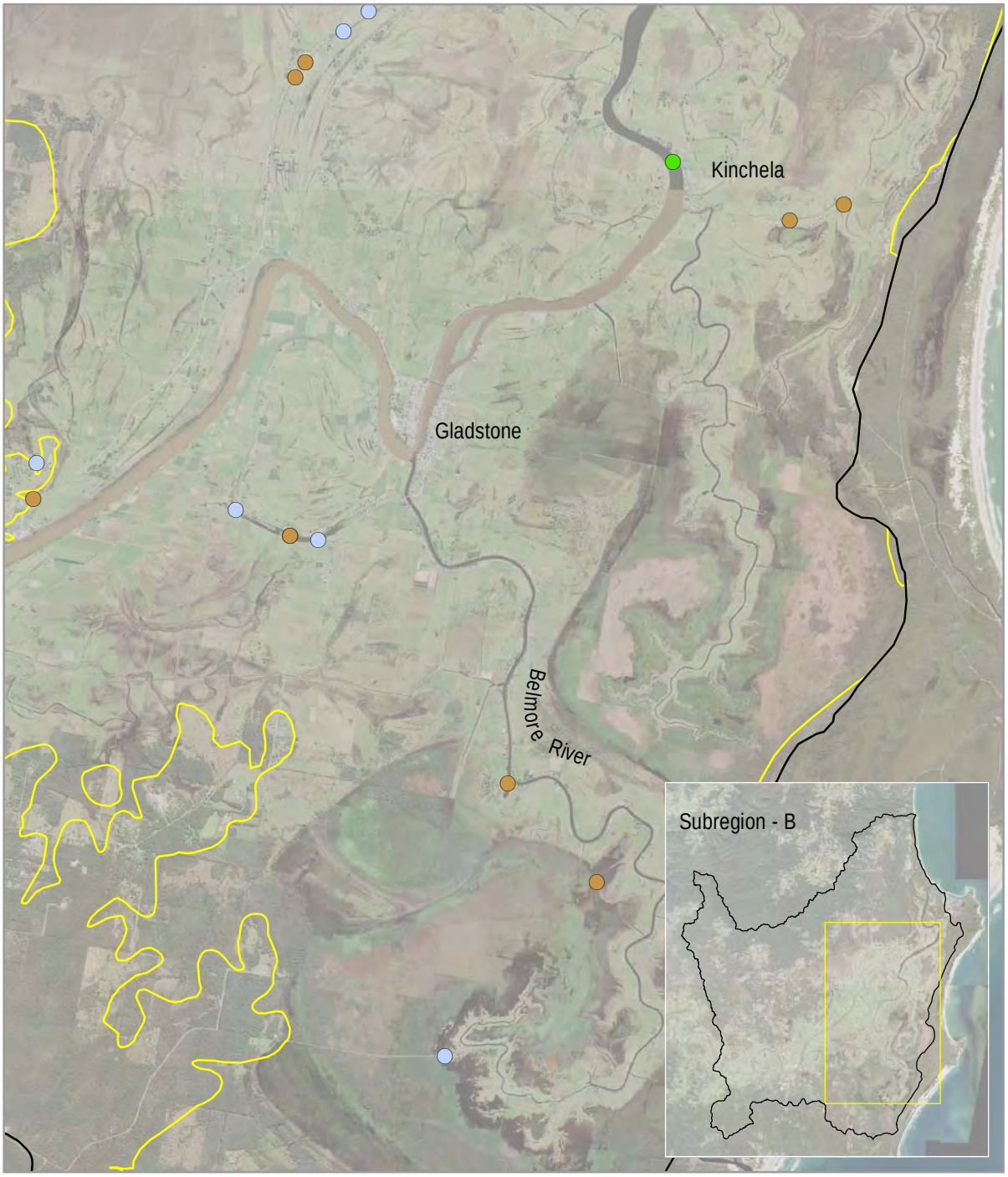
Macleay Ecological Study
1484846

Kempsey Shire Council GIS Threatened Fauna Records within the MREMP Study Area Floodplain - Subregion A

Figure 4.9

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

Information shown is for illustrative purposes only



LEGEND

- Study area
- MREMP floodplain study area
- Black-necked Stork
- Comb-crested Jacana
- Osprey

0 2 km

North

Kempsey Shire Council GIS Threatened Fauna Records within the MREMP Study Area Floodplain - Subregion B

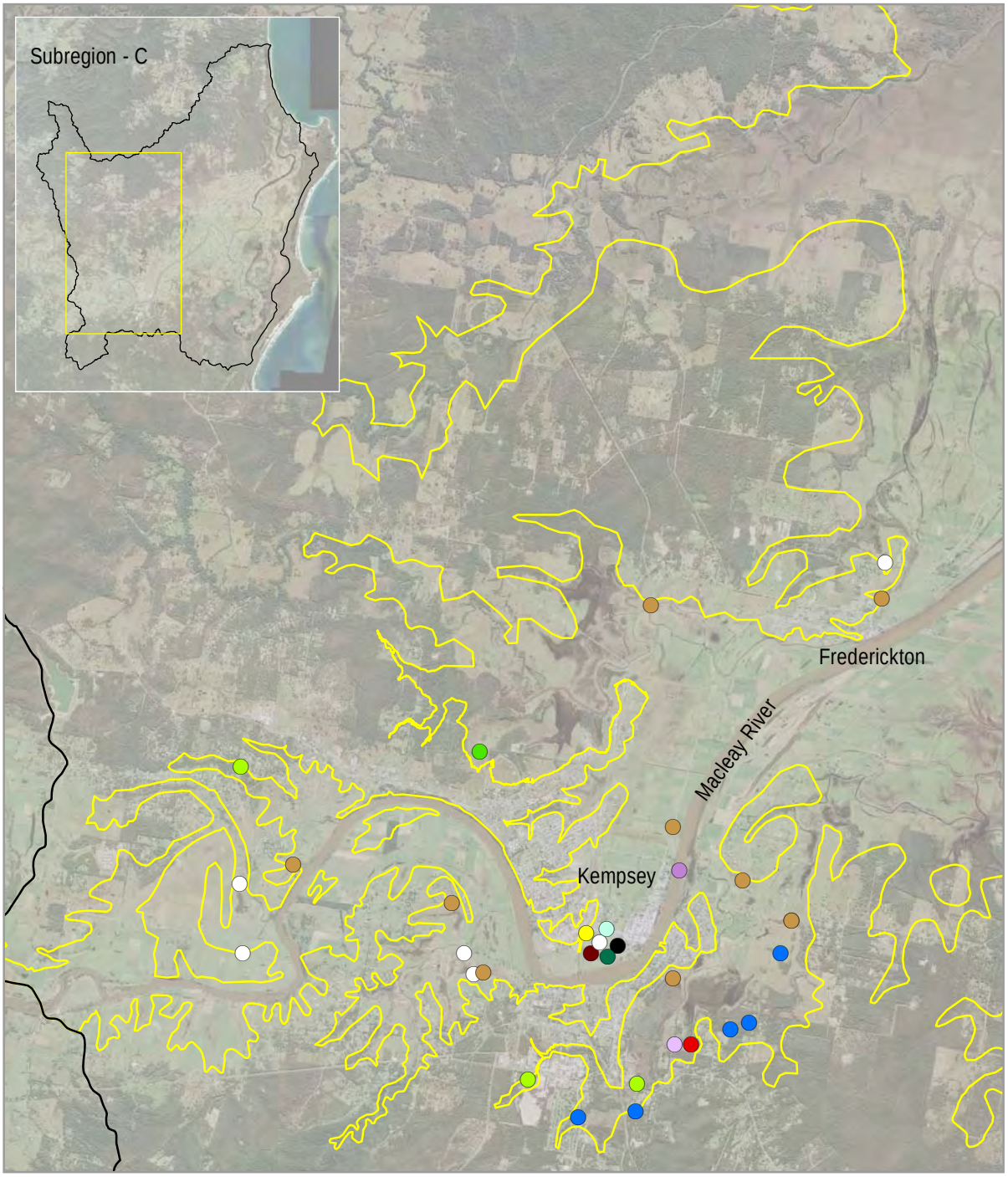
GeoLINK environmental management and design

Macleay Ecological Study
1484847

Figure 4.10

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

Information shown is for illustrative purposes only



LEGEND

- Study area
- MREMP floodplain study area
- Black-necked Stork
- Little Tern
- Black Bittern
- Black-breasted Buzzard
- Brush-tailed Phascogale
- Comb-crested Jacana
- Eastern Freetail-bat
- Grey-headed Flying-fox
- Koala
- Little Bentwing-bat
- Osprey
- Sooty Owl
- Square-tailed Kite

North

0 2 km

Kempsey Shire Council GIS Threatened Fauna Records within the MREMP Study Area Floodplain - Subregion C

GeoLINK environmental management and design

Macleay Ecological Study
1484851

Figure 4.11

4.2.5 Migratory Fauna Records

The NSW Wildlife and DII BioNet databases were searched for records of EPBC Act 1999 listed migratory species within a 32 km wide (east-west) and 40 km long (north-south) area encompassing the MREMP study area floodplain. In addition, a search using a 22 km buffer from the centre of the MREMP study area was undertaken on the EPBC Act Protected Matters Search Tool for migratory "*species or species habitat*" that may occur within the search area. These species, along with their key likely potential habitat areas are provided in **Table 4.11** below. Oceanic species such as Albatross have not been included as this component of the study focuses on the MREMP study area floodplain which lacks potential habitat for such species. As illustrated in **Table 4.11**, 26 EPBC Act listed migratory species (excluding oceanic species) are known occurrences on or in proximity to the study area, while another eight species were identified as potential occurrences by the EPBC Act Protected Matters Search Tool.

Due to the diverse range and habitat requirements of known/potentially occurring EPBC Act listed migratory species within the MREMP study area floodplain, virtually the entire study area may contain suitable habitat for migratory species in general. The ranging lifecycle requirements of the various migratory species are also diverse, and such requirements can be further governed by the presence of particular habitat elements. This creates additional complexity in identifying key habitat areas for migratory species without undertaking comprehensive investigations beyond the scope of this study. Consequently further studies are considered essential to identify priority habitat areas for migratory species on the MREMP study area floodplain for conservation and management purposes. Broadscale protection and management of habitats for locally recorded threatened species however should have an umbrella effect for protecting and management habitats for most migratory species groups.

4.2.6 Threatened Flora Records

Searches were undertaken for all TSC Act and EPBC Act threatened flora records located on the MREMP study area floodplain or within a 5 km radius from the following sources:

- DECCW Atlas of NSW Wildlife database;
- DII BioNet database;
- Fishermans Bend Nature Reserve Plan of Management (DEC 2005), Hat Head National Park Plan of Management (NPWS 1998), Clybucca Historic Site Draft Plan of Management (DECC 2007a)
- KSC GIS layers; and
- Kempsey and Macksville 1:100,000 threatened species map sheets obtained from DECCW under a data license agreement.

The species identified by the searches are listed in **Table 4.12** below, which also provides potential key habitat areas in the study area based on broad species habitat requirements. It should be noted that no threatened flora species were identified on the actual MREMP study area floodplain from the KSC GIS layers or Kempsey and Macksville 1:100,000 threatened species map sheets.

Table 4.10 EPBC Act 1995 Migratory Birds Recordings and Key Potential Habitats on the Study Area

Scientific Name	***Common Name***	***Type of Presence (as listed on EPBC Act Protected Matters Report)***	***Recorded on BioNet and/or Atlas of NSW Wildlife in Search Area***	***Key Potential Habitats in the Study Area***
Actitis hypoleucos	Common Sandpiper	Roosting likely to occur within area	Yes	Estuary*; Estuarine; Wetland (Freshwater); Water surfaces.
Anthochaera phrygia (formerly *Xanthomyza phrygia*)	Regent Honeyeater	Species or species habitat likely to occur within area	Yes	Dry Sclerophyll Forest; Wet Sclerophyll Forest; Swamp Sclerophyll Forest.
Apus pacificus	Fork-tailed Swift	Species or species habitat may occur within area	Yes	All – aerial forager (foraging habitat only).
Ardea alba	Great Egret, White Egret	Species or species habitat may occur within area	Yes	Estuary*; Estuarine; Wetland (Freshwater); Water surfaces; Cleared, partly cleared; Agricultural.
Ardea ibis	Cattle Egret	Species or species habitat may occur within area	Yes	Estuary*; Estuarine; Wetland (Freshwater); Water surfaces; Cleared, partly cleared.
Arenaria interpres	Ruddy Turnstone	Roosting likely to occur within area	Yes	Estuary*; Estuarine.
Calidris acuminata	Sharp-tailed Sandpiper	Roosting likely to occur within area	Yes	Estuary*; Estuarine; Wetland (Freshwater); Water surfaces.
Calidris alba	Sanderling	Roosting likely to occur within area	No	Estuary*; Estuarine.
Calidris canutus	Red Knot, Knot	Roosting likely to occur within area	No	Estuary*; Estuarine; Wetland (Freshwater).
Calidris ferruginea	Curlew Sandpiper	Migratory Roosting likely to occur within area	Yes	Estuary*; Estuarine; Wetland (Freshwater); Water surfaces.
Calidris ruficollis	Red-necked Stint	Roosting likely to occur within area	Yes	Estuary*; Estuarine; Other.

Scientific Name	*Common Name*	*Type of Presence (as listed on EPBC Act Protected Matters Report)*	*Recorded on BioNet and/or Atlas of NSW Wildlife in Search Area*	*Key Potential Habitats in the Study Area*
Calidris tenuirostris	Great Knot	Roosting likely to occur within area	No	Estuary*; Estuarine.
Charadrius bicinctus	Double-banded Plover	Roosting likely to occur within area	Yes	Estuarine; Wetland (Freshwater); Cleared, partly cleared.
Charadrius leschenaultii	Greater Sand Plover, Large Sand Plover	Migratory Roosting likely to occur within area	No	Estuary*; Estuarine; Wetland (Freshwater).
Charadrius mongolus	Lesser Sand Plover, Mongolian Plover	Roosting likely to occur within area	Yes	Estuary*; Estuarine.
Glareola maldivarum	Oriental Pratincole	Roosting likely to occur within area	No	Estuary*; Estuarine; Wetland (Freshwater); Cleared, partly cleared.
Heteroscelus brevipes	Grey-tailed Tattler	Migratory Roosting likely to occur within area	Yes	Estuary*; Estuarine.
Limicola falcinellus	Broad-billed Sandpiper	Migratory Roosting likely to occur within area	No	Estuary*; Estuarine; Wetland (Freshwater); Water surfaces.
Limosa limosa	Black-tailed Godwit	Roosting likely to occur within area	Yes	Estuary*; Estuarine; Wetland (Freshwater); Water surfaces.
Merops ornatus	Rainbow Bee-eater	Species or species habitat may occur within area	Yes	Dry Sclerophyll Forest; Wet Sclerophyll Forest; Coastal Scrub/Heath; Cleared, partly cleared.
Monarcha melanopsis	Black-faced Monarch	Breeding may occur within area	Yes	Dry Sclerophyll Forest; Wet Sclerophyll Forest; Swamp Sclerophyll Forest; Rainforest; Estuarine.
Monarcha trivirgatus	Spectacled Monarch	Breeding likely to occur within area	Yes	Wet Sclerophyll Forest; Rainforest; Estuarine.
Myiagra cyanoleuca	Satin Flycatcher	Breeding likely to occur within area	Yes	Dry Sclerophyll Forest; Wet Sclerophyll Forest; Swamp Sclerophyll Forest; Coastal Scrub/Heath; Estuarine.

Scientific Name	***Common Name***	***Type of Presence (as listed on EPBC Act Protected Matters Report)***	***Recorded on BioNet and/or Atlas of NSW Wildlife in Search Area***	***Key Potential Habitats in the Study Area***
Numenius madagascariensis	Eastern Curlew	Roosting likely to occur within area	Yes	Estuary*; Estuarine.
Numenius minutus	Little Curlew, Little Whimbrel	Roosting likely to occur within area	No	Dry Sclerophyll Forest; Estuarine; Wetland (Freshwater); Cleared, partly cleared.
Numenius phaeopus	Whimbrel	Roosting likely to occur within area	Yes	Estuary*; Estuarine.
Pluvialis fulva	Pacific Golden Plover	Roosting likely to occur within area	Yes	Estuary*; Estuarine.
Rhipidura rufifrons	Rufous Fantail	Breeding may occur within area	Yes	Dry Sclerophyll Forest; Wet Sclerophyll Forest; Swamp Sclerophyll Forest; Rainforest; Estuarine.
Rostratula benghalensis s. lat.	Painted Snipe	Migratory Species or species habitat may occur within area	Yes	Wetland (Freshwater); Water surfaces.
Sterna albifrons	Little Tern	Migratory Breeding may occur within area	Yes	Estuary*; Estuarine.
Tringa glareola	Wood Sandpiper	Migratory Roosting likely to occur within area	Yes	Estuarine; Wetland (Freshwater); Cleared, partly cleared.
Tringa nebularia	Common Greenshank, Greenshank	Roosting likely to occur within area	Yes	Estuary*; Estuarine; Wetland (Freshwater); Water surfaces.
Tringa stagnatilis	Marsh Sandpiper, Little Greenshank	Roosting likely to occur within area	Yes	Estuarine; Wetland (Freshwater); Water surfaces.
Xenus cinereus	Terek Sandpiper	Roosting likely to occur within area	No	Estuary*; Estuarine; Wetland (Freshwater); Water surfaces.

In addition, a search using a 22 km buffer from the centre of the MREMP study area was undertaken on the EPBC Act Protected Matters Search Tool for threatened flora "*species or species habitat*" that may occur within the search area.

ID Landscape Management (2005) provides a summary of known/potentially occurring threatened fauna in the Macleay estuary area. Those species identified as known occurrences, that have not been identified by the above record searches are included in **Table 4.11**.

Field work undertaken within the study area on the 7, 8 and 9 January 2010 incorporated opportunistic recordings of threatened flora species. No threatened flora species were recorded.

Table 4.11 shows that six threatened flora species have been recorded in the MREMP study area floodplain. In review of the table above, the key potential habitat types for locally recorded threatened flora within the study area appears to be:

- Dry Sclerophyll Forest;
- Wet Sclerophyll Forest;
- Swamp Sclerophyll Forest;
- Coastal Scrub/Heath;
- Rainforest;
- Wetland (Freshwater); and
- Areas along watercourses.

These habitats are shown in **Figure 4.13**. As with threatened fauna, to assess the actual occurrence potential of each species within each individual mapping unit would require considerably greater investigations outside the scope of this project. Thus to identify priority key habitat area for broad scale management purposes, other ecological factors should be taken into consideration (refer to **Section 4.2.8**).

Table 4.11 Threatened Flora and Known/Potential Habitats

Scientific Name	***Common Name***	***Status***		***Habitat Requirement*** *Source: DECCW undated*	***Recorded on the MREMP Study Area Floodplain***	***Key Known/Potential Habitats Within the Study Area (Based on Habitat Requirements)***
		TSC Act	***EPBC Act***			
Acronychia littoralis	Scented Acronychia	E	E	Littoral rainforest on sand, between Port Macquarie and Frazer Island.	Yes	Rainforest.
Allocasuarina defungens	Dwarf Heath Casuarina	E	E	Tall heath on sand, also on clay and sandstone. Found only in NSW from the Nabiac area to Byron Bay. The species also extends onto exposed nearby-coastal hills or headlands adjacent to sandplains.	Yes	Coastal Scrub/Heath.
Asperula asthenes	Trailing Woodruff	V	V	Damp sites, often along river banks. Occurs only in NSW, in scattered locations from Bulahdelah north to near Kempsey, with several records from the Port Stephens/Wallis Lakes area.	No	Wetland (Freshwater); Swamp Sclerophyll Forest.
Chamaesyce psammogeton	Sand Spurge	E	-	Coastal sand dunes and exposed sites on headlands along the coast from south of Jervis Bay to Queensland.	No	Coastal Scrub/Heath.
Cryptocarya foetida	Stinking Cryptocarya	V	V	Found in littoral rainforest, usually on sandy soils, but mature trees are also known on basalt soils. In NSW, north from Iluka.	No	Rainforest.

Scientific Name	*Common Name*	*Status*		*Habitat Requirement* *Source: DECCW undated*	*Recorded on the MREMP Study Area Floodplain*	*Key Known/Potential Habitats Within the Study Area (Based on Habitat Requirements)*
		TSC Act	*EPBC Act*			
Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Does not have well defined habitat and is known from a range of communities, including swamp-heath and woodland. Recorded from Gibraltar Range National Park south into Victoria.	No	Swamp Sclerophyll Forest; Coastal Scrub/Heath.
Cynanchum elegans	White-flowered Wax Plant	E	E	Dry, littoral or subtropical rainforest, and occasionally in scrub or woodland. Distributed in eastern NSW from Brunswick Heads to Gerroa.	No	Rainforest; Coastal Scrub/Heath.
Diuris sp. aff. chrysantha	Byron Bay Diuris	E	-	Occurs in low-growing grassy heath on clay soil.	No	Coastal Scrub/Heath.
Eucalyptus tetrapleura	Square-fruited Ironbark	V	V	Dry or moist eucalypt forest on moderately fertile soil, often in low areas with poor drainage. Restricted to the coastal lowlands and foothills of northern NSW around Casino and Grafton.	Yes	Dry Sclerophyll Forest, Moist Sclerophyll Forest, Wet Sclerophyll Forest.
Haloragis exalata subsp. Velitina	Tall Velvet Sea-berry	V	V	Damp places near watercourses, also in woodland and steep rocky slopes of gorges.	No	Wetland (Freshwater); Swamp Sclerophyll Forest.
Hydrocharis dubia	Frogbit	-	V	Grows in small shallow freshwater bodies or swamps; uncommon. In NSW, north from the Clarence River.	No	Wetland (Freshwater).

Scientific Name	*Common Name*	*Status*		*Habitat Requirement* *Source: DECCW undated*	*Recorded on the MREMP Study Area Floodplain*	*Key Known/Potential Habitats Within the Study Area (Based on Habitat Requirements)*
		TSC Act	*EPBC Act*			
Marsdenia longiloba	Clear Milkvine	E	V	Subtropical and warm temperate rainforest, lowland moist eucalypt forest adjoining rainforest and, sometimes, in areas with rock outcrops.	No	Wet Sclerophyll Forest; Rainforest.
Maundia triglochinoides	-	V	-	Grows in swamps, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients.	No	Wetland (Freshwater); Along watercourses*
Melaleuca groveana	Grove's Paperbark	V	-	Heath and shrubland, often in exposed sites, rocky outcrops and cliffs at high elevations, also in dry woodlands.	No	Dry Sclerophyll Forest; Coastal Scrub/Heath.
Niemeyera whitei (formerly *Amorphospermum whitei*)	Rusty Plum	V	-	Rainforest and adjoining moist eucalypt forest.	Yes	Rainforest; Wet Sclerophyll Forest.
Parsonsia dorrigoensis	Milky Silkpod	V	E	Subtropical and warm temperate rainforest, on rainforest margins, and in moist eucalypt forest up to 800 m, on brown clay soils.	No	Wet Sclerophyll Forest; Rainforest.
Peristeranthus hillii	Brown Fairy-chain Orchid	V		Restricted to coastal and near-coastal environments, particularly Littoral Rainforest and Lowland Rainforest on Floodplain.	Yes	Rainforest.
Quassia sp. Mooney Creek	Moonee Quassia	E	E	Shrubby layer below tall moist and dry eucalypt forest, including forest edges, generally at low altitudes.	No	Dry Sclerophyll Forest; Wet Sclerophyll Forest.

Scientific Name	*Common Name*	*Status*		*Habitat Requirement* *Source: DECCW undated*	*Recorded on the MREMP Study Area Floodplain*	*Key Known/Potential Habitats Within the Study Area (Based on Habitat Requirements)*
		TSC Act	*EPBC Act*			
Taeniophyllum muelleri	Minute Orchid	-	V	Grows on outer branches and branchlets of rainforest trees; coast and coastal ranges, from sea level to 250 m alt., north from the Bellinger River.	No	Rainforest; Wet Sclerophyll Forest.
Thesium australe	Austral Toadflax	V	V	Grassland or grassy eucalypt woodland where *Themeda triandra* is predominant, on grassy headlands.	Yes	Dry Sclerophyll Forest; Coastal Scrub/Heath.

4.2.7 Comprehensive Koala Plan of Management for Eastern Portion of Kempsey Shire LGA Volume 1 and 2

Background Information: Records and Koala Habitats

As mentioned previously, the *Comprehensive Koala Plan of Management for Eastern Portion of Kempsey Shire LGA (Draft) Volume 1* and *2* (Phillips and Hopkins 2009a, 2009b) encompasses the MREMP study area floodplain. The MREMP thus should be given due consideration to the draft CKPoM when identifying key habitat areas in the study area for conservation purposes.

Phillips and Hopkins (2009a) correlated Koala records for the draft Koala Plan of Management study area, and subsequently identified 303 Koala records in the entire CKPoM study area. The occurrence of these records within the MREPM study area floodplain is sparse, with the majority of records located in the Aldavilla/ Kempsey/ Crescent Head Road area, and a handful of records located near Hat Head and Stuarts Point. Phillips and Hopkins (2009a) acknowledge that "*the first Koala record for the study area post dates the clearing of vegetation on the Macleay River Floodplain; based on vegetation remnants that remain, it was likely that much of this area not only supported Koala Habitat per se, but also resident populations*"

Phillips and Hopkins (2009a) also undertakes potential Koala habitat mapping based on Telfer and Kendall (2006) and GHD (2007 - cited in Phillips and Hopkins 2009a) mapping. **Figure 4.14** shows the Phillips and Hopkins (2009a) potential Koala habitat mapping within the MREMP study area floodplain. The study area is mapped as (in descending order):

- **Unknown** – defined as areas for which insufficient information regarding community composition was available;
- **Other** - defined as communities within which Koala food trees were absent;
- **Secondary (Class A)** – defined as primary food tree species present but not dominant or co-dominant and usually (but not always) growing in association with one or more secondary food tree species;
- **Secondary (Class B)** – defined as primary food tree species absent, habitat comprised of secondary and supplementary food tree species only; and
- **Primary** – defined as areas of forest and/or woodland wherein primary food tree species comprise the dominant or co-dominant (i.e. ≥ 50%) overstorey tree species).

While the floodplain naturally includes treeless and non-Koala habitat communities (e.g. saltmarsh, treeless freshwater wetlands, Mangrove forest, etc), this is likely to be largely attributed to historic vegetation clearing across much of the Macleay River floodplain.

Management Implications Relevant for the MREMP Study Area Floodplain

If formally adopted, the provisions of the draft CKPoM would be activated upon Council Officers receiving a development or rezoning application that occurs within an area of potential Koala habitat or identified Koala Management Area (KMA), or

under Kempsey Shire Councils Tree Preservation Order. The identified KMAs are cadastral based areas which currently and historically support the bulk of the Koala population in the study area. The KMAs are defined by a 1250 m buffering of areas of generational persistence and intersection the total area of generational persistence and buffer within the cadastre (Phillips and Hopkins 2009a). The purpose of identifying these areas in the draft CKPoM is to:

- provide a focus for Koala management and conservation efforts; and
- encourage stewardship without unduly compromising other landuse activities.

The KMAs are shown in Figure 6.1 of Phillips and Hopkins (2009b) and are identified as:

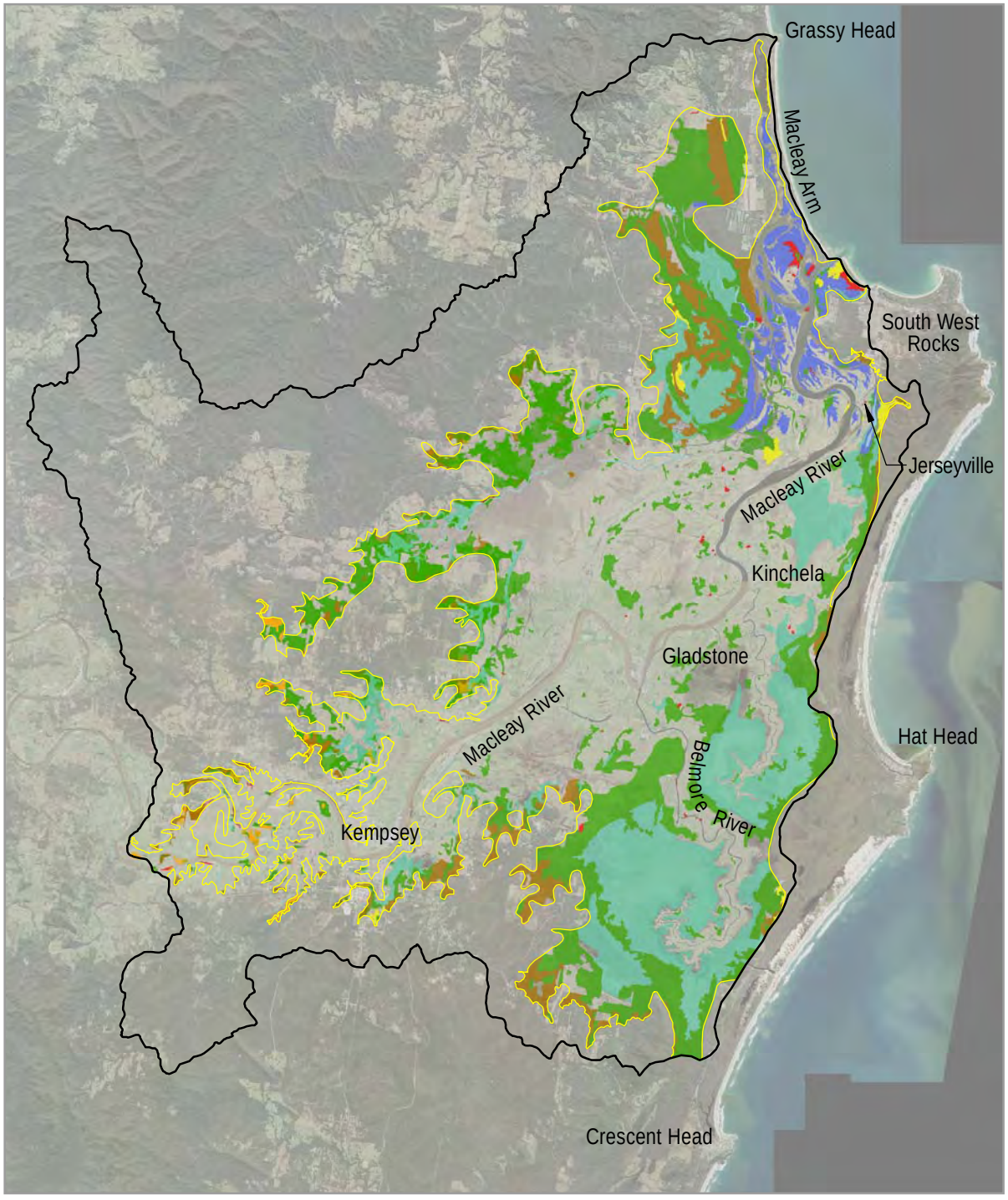
- Eungai Rail – Stuarts Point – Grassy Head KMA;
- South West Rocks KMA; and
- Dongdingalong – Kundabung – Crescent Head KMA.

A proportion of each KMA overlap small areas of the MREMP study area floodplain (refer to **Figure 4.14**).

With regards to the identification of high conservation value areas for flora and fauna on the MREMP study area floodplain, the overlapping KMAs, and 'Primary', 'Secondary (Class A)', and 'Secondary (Class B)' potential Koala habitat areas are considered priority areas for conservation management efforts. This is not to say that areas identified as 'Other' and 'Unknown' in the Phillips and Hopkins (2009a) potential Koala habitat mapping may not constitute potential or known Koala habitat, or other values for local Koala populations (e.g. as habitat linkages) that may be identified by more detailed site specific investigations. However this is beyond the scope of this study.

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
- Coastal Scrub/Heath
- Dry Sclerophyll Forest
- Estuarine
- Rainforest
- Swamp Sclerophyll Forest
- Water surfaces
- Wet Sclerophyll Forest
- Wetland (Freshwater)

0 5 km

North

Key Habitat Areas for Threatened Fauna within the MREMP Study Area Floodplain

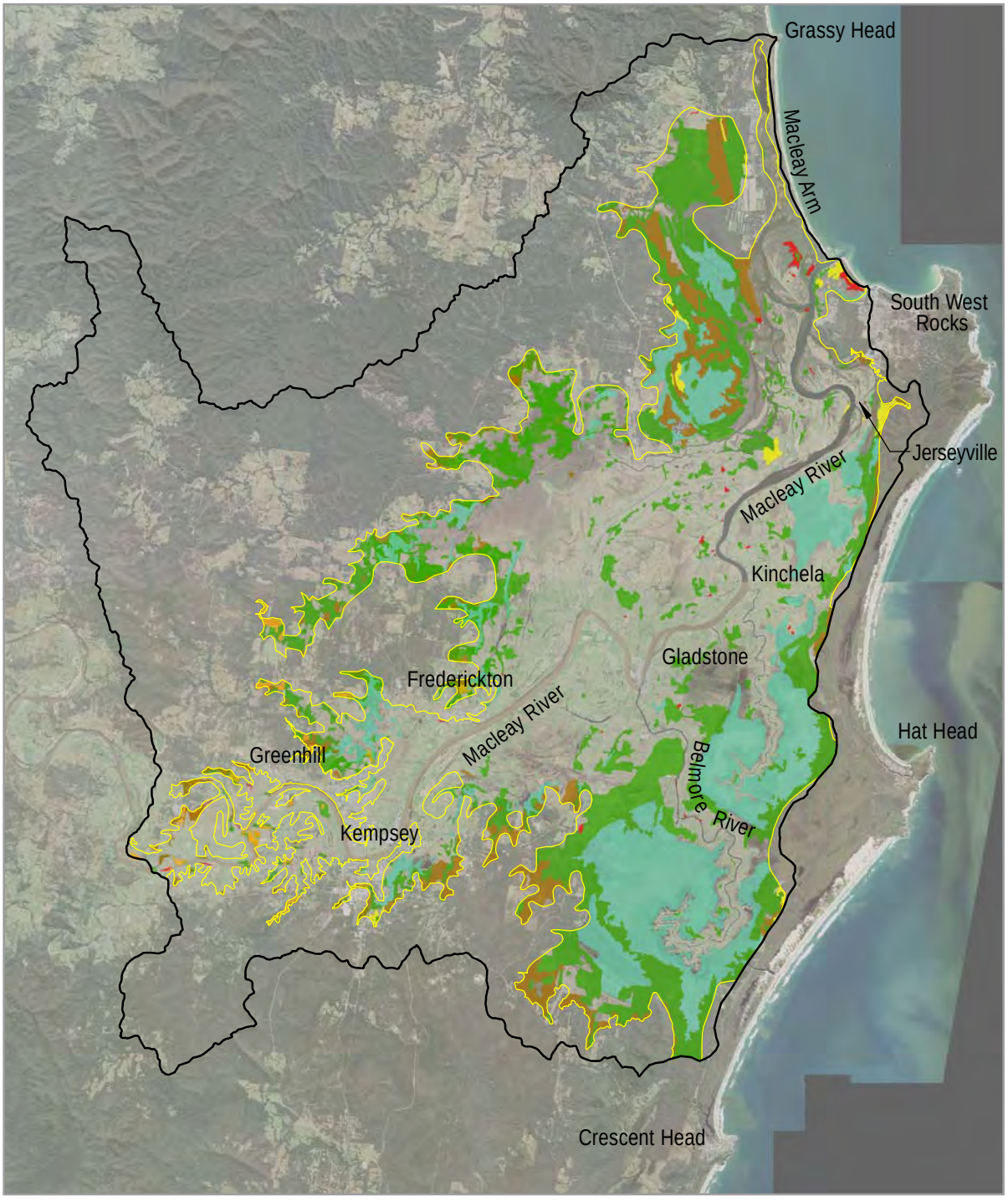
GeoLINK environmental management and design

Macleay Ecological Study
1484853

Figure 4.12

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
- Coastal Scrub/Heath
- Dry Sclerophyll Forest
- Rainforest
- Swamp Sclerophyll Forest
- Wet Sclerophyll Forest
- Wetland (Freshwater)

0 5 km

North

Key Habitat Areas for Threatened Flora within the MREMP Study Area Floodplain

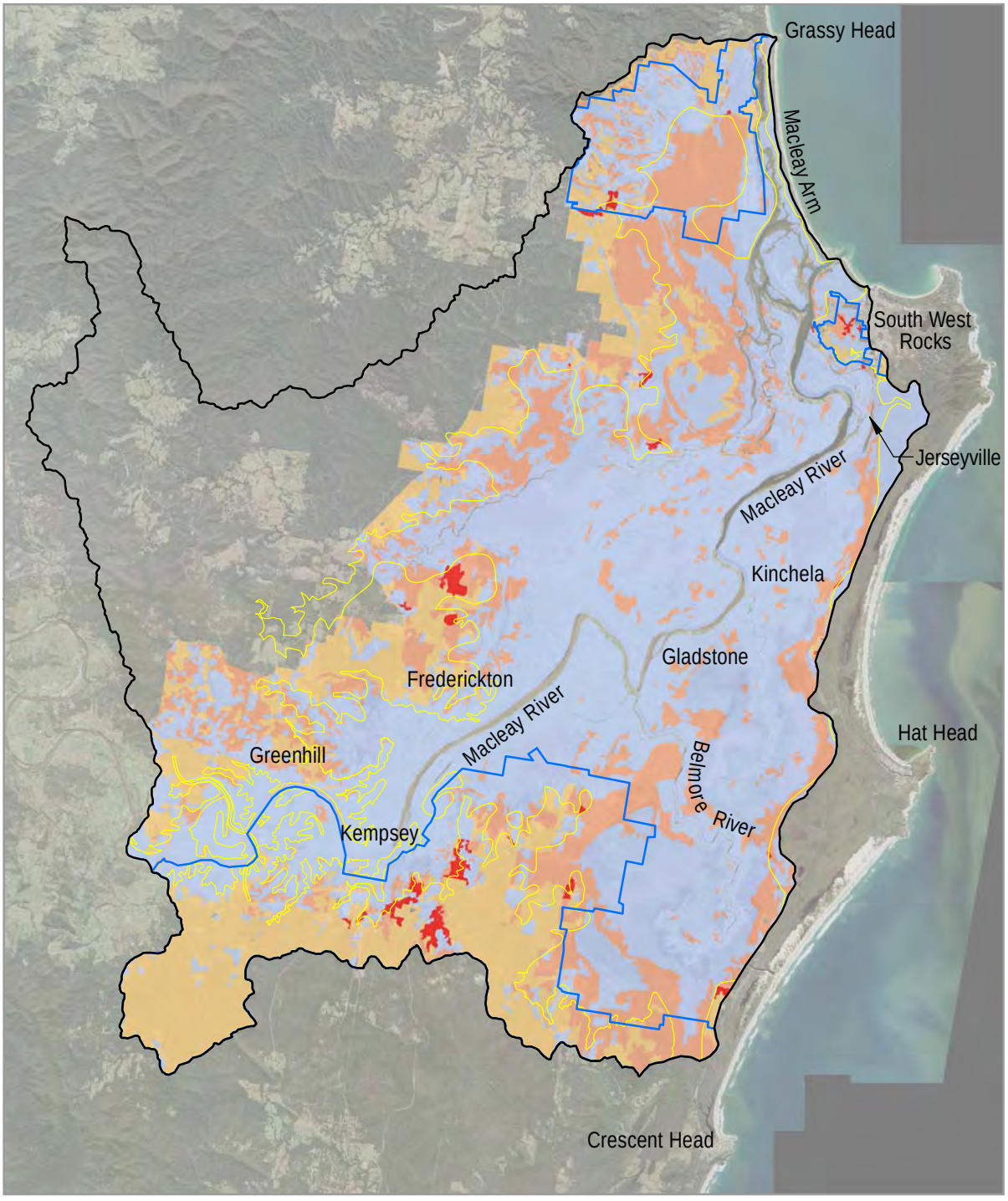
GeoLINK environmental management and design

Macleay Ecological Study
1484854

Figure 4.13

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
- Draft CKPoM Koala Habitat Mapping and Koala Management Areas
- Primary
- Secondary (Class A)
- Secondary (Class B)
- Unknown

0 5 km

North

Draft CKPoM Koala Habitat Mapping and Koala Management Areas

GeoLINK environmental management and design

Macleay Ecological Study
1484855

Figure 4.14

4.2.8 Draft Shorebird Data Audit – Northern New South Wales

Summary

As mentioned previously the draft *Shorebird Data Audit – Northern New South Wales* (Sandpiper Ecological Surveys 2009) was undertaken to provide a baseline dataset that can be used for planning and management within the NRCMA region, which includes the Macleay estuary. The report is made up of seven parts, several of which do not directly relate to the Macleay Estuary.

Sandpiper Ecological Surveys (2009) identified that shorebirds (sub-order Charadrii) represent a substantial portion of estuarine/coastal vertebrate fauna, and occur in habitats that are utilised intensely or by great concentrations of birds. These habitats typically occur in high use recreational areas, and usually occur in systems that are affected by industry, urban development and agriculture. Most of the habitats for shorebirds occur outside conservation areas (Sandpiper Ecological Surveys 2009), though due to threats such as human disturbance and predation, protection of habitats alone is not sufficient to ensure the long-term protection of these species.

The shorebird data audit by Sandpiper Ecological Surveys (2009) identified that of the 47 count data and 5 spatial data sources reviewed within the NRCMA, only two studies were undertaken in the Macleay Estuary and these studies were limited to a sample period of two years. Both surveys were undertaken at high tide. These factors impose some doubt in the accuracy of shorebird population estimates and species diversity in the Macleay Estuary. A total of 14 migratory shorebird species and five resident shorebird species were recorded in the Macleay Estuary, four of which are listed as threatened. Estimates of the population summer average and maximum summer population is provided for the Lesser Sand Plover, Bar-tailed Godwit, Whimbrel, Eastern Curlew, Grey-tailed Tatter, Common Greenshank and Sharp-tailed Sandpiper. Records of nine migratory shorebird species and three resident shorebird species (five of which were also threatened species) were also recorded along the local coastline between Laggers Point and Crescent Head.

Sandpiper Ecological Surveys (2009) found that comparison of maximum and average migration period population estimates illustrates the importance of major estuaries to the diversity and abundance of shorebirds in northern NSW. The five large estuaries in the NRCMA, which included the Macleay Estuary, provide the habitat for the majority of the shorebird populations in this region.

Sandpiper Ecological Surveys (2009) identified and prioritised 33 recommendations relating to five topics: Data and Research, Threat Identification and Analysis, Management, Mapping and Planning. Those particularly relevant to the Macleay Estuary included:

- *Recommendation 1: Undertake shorebird surveys in the Macleay Estuary to gather up-to-date information on population size, species richness and the distribution of roost and foraging areas (High Priority).*

  This data is considered essential in terms of identifying high conservation value habitats for shorebirds. Once high conservation values sites are accurately identified and priorities subsequent investigations are considered

necessary to identify and prioritise threats at each site, and devise appropriate management actions.

- *Recommendation 19: Where possible ensure that shorebird habitat mapping, site prioritisation data and information on threats are included in Estuary Management Plans (High Priority).*

It is not currently possible to include such data in the MREMP due to information deficiencies as detailed previously.

- *Recommendation 30: Liaise with local councils in the NRCMA region to prepare educational information for identifying priority areas to improve management of shorebird habitat. (High Priority).*

NRCMA should ensure KSC are included once the relevant information becomes available.

4.2.9 Conclusion

In summary of the above information, key habitat areas for threatened flora and fauna on the MREMP study area floodplain appear to be:

- Dry Sclerophyll Forest;
- Wet Sclerophyll Forest;
- Swamp Sclerophyll Forest;
- Coastal Scrub/Heath;
- Rainforest;
- Estuarine;
- Wetland (Freshwater);
- Water surfaces;
- Watercourses (including the Macleay River); and
- Phillips and Hopkins (2009a, 2009b) KMAs, and Primary, Secondary (Class A) Secondary (Class B) potential Koala habitat areas.

These areas are shown in **Figures 4.12**, **4.13** and **4.14**.

As historic clearing and habitat modification has resulted in a highly modified and fragmented floodplain landscape, the potential values for significant flora and fauna of many of the above areas are likely to have been reduced (e.g. due to isolation and habitat degradation). Subsequently further investigations would be required to prioritise areas for conservation and management efforts, as well as identify and prioritise associated actions.

With regards to EPBC Act listed migratory species, further investigations are considered essential to identify priority habitat areas for migratory species on the MREMP study area floodplain for conservation and management purposes. This should involve:

- identifying priority species and their habitat (e.g. species or species habitats most at threat);

- identifying priority sites;
- identifying threats at priority sites; and
- identifying and prioritising appropriate conservation and management actions.

4.3 *Candidate Marine Protected Areas*

4.3.1 Introduction to Marine Protected Areas

In NSW a variety of reserve arrangements for marine and estuarine systems have been put in place. These include Marine Parks, aquatic reserves, marine extensions to national parks and intertidal protected areas and are collectively referred to as Marine Protected Areas.

Marine Parks are established and managed by the Marine Parks Authority under the *Marine Parks Act 1997*. The aim of marine parks in NSW is to conserve habitats and biodiversity in estuarine, oceanic and coastal environments and to help ensure that marine resources are used sustainably. Marine Parks are typically multiple use with a variety of differently zoned areas including sanctuary zones, habitat protection zones and general use zones. Sanctuary zones are designed to provide maximum protection from on anthropogenic impacts through restrictions on all activities that have an impact. Habitat protection zones are generally designed to reduce impacts upon physical (eg. reef complexes) and living habitat (eg. seagrass) but still allow for commercial and recreational fishing activities. General use zones are areas zoned as marine parks but do not entail restrictions upon most activities. Special use zones have been incorporated into some Marine Parks to allow for pre-existing or other activities, for example, oyster aquaculture.

Aquatic Reserves are managed by DECCW under the *Fisheries Management Act 1994*. In NSW they are located almost exclusively within the greater Sydney region and for the most part protect rocky headlands and associated waters. The aim of the aquatic reserve system is to protect important habitats, nursery areas, threatened and endangered species and to be used for education and research activities.

The Aquatic Reserve system allows the customisation of protection measures and specific restrictions for the reserved area in question. The types of management tools that can be used include;

- Fishing restrictions;
- Restrictions on the collection, catch and retention of specific species;
- Mooring restrictions;
- Restrictions upon collection activities, such as bait or shell collection;
- Permit requirements for scheduled activities;

Many of the twelve NSW aquatic reserves allow specific forms of fishing within their boundaries. They range in size from 1.6ha at Shiprock Aquatic Reserve to 1400ha at Towra Point Aquatic Reserve.

Intertidal Protected Areas (IPAs) were developed as a temporary measure to protect intertidal communities in high traffic areas from collecting activities and to ensure the

conservation of representative intertidal biodiversity was protected for the ready restocking of exploited areas. The primary restricted activity in IPAs is the collection of seashore flora and fauna. Fourteen IPAs were gazetted in 1993 and subsequently administered under the *Fisheries Management Act 1994* protecting rocky shores on coastal lands between the high tide mark and waters 10m seaward of the low tide mark. Six of the IPAs were formerly gazetted as Aquatic Reserves in 2002 and are now offered permanent protection under that system.

A number of National Parks and Nature Reserves in NSW include subtidal or intertidal marine systems with their gazetted areas. These areas can offer protection to habitats and substrata, but not to fish or marine invertebrates as defined by the *Fisheries Management Act 1994*. The methods available for habitat protection include mooring and motor vessel access restrictions, protection of flora and terrestrial management strategies. Protection for aquatic fauna via fishing closures or restrictions are not available under the *Protection of the Environment Operations Act 1997* but can be arranged via cooperative agreements with NSW I&I who can use their authority under the *Fisheries Management Act 1997*.

A commonly described threat associated with the establishment of new conservation areas is associated with the subsequent intensification of fishing and collection efforts outside of sanctuary zones (eg, Winn 2008). One example of this is that the Hastings and Bellinger Rivers are now recreational fishing havens and that remaining commercial fishers from these areas are licensed (as they always were), and now more likely to fish the waters of the Macleay. Little, if any, information exists, however, to document the actual extent of this intensification of effort.

The Australian Marine Scientists Association (AMSA) position statement on Marine Protected Areas indicate that AMSA members (following Gladstone and Booth 2008);

- Believe that MPAs are an essential tool for the management of marine and estuarine resources;
- Believe that MPAs have been successfully used to facilitate the long term conservation of biodiversity, protection for threatened species and improved natural resource management; and
- Believe that the establishment of MPAs is typically accompanied by increased size and abundance of aquatic fauna, increased fecundity of some target species, increased catch rates in adjacent waters and alteration of ecological processes and community structure.

For an aquatic reserve to be declared by the Minister for the Environment a number of preliminary steps are required. These are as follows (A. Reid *pers comm.*);

- The candidate area should be assessed against criteria as set out by ANZECC (1998) and measure favourably;
- The candidate area should be found to contribute to the bioregional network of MPAs, ie. Should have been identified by Breen *et al*. (2004);
- The candidate area should be found represent important local environmental values;
- Community support should be assessed and be found to be universal or there should be very little opposition;

- The land owner, ie (NSW Land and Property Management Authority, NSW National Parks, Private Owners) must be found to be in agreement;
- If positive results are achieved in the above steps then the organising body (in this case the local council) should draft a letter with supporting evidence to the Minister for the Environment. The support of the Local Member to the State Government would also be useful at this stage;

4.3.2 Existing Marine Protected Area Network

Within NSW

There are currently 6 Marine Parks, 12 Aquatic Reserves, 62 National Parks with marine extensions and 8 Intertidal Protected Areas in NSW. A total of 36% of NSW waters fall within the boundaries of MPAs. However, only 18% of these areas (or 6.5% of total NSW waters) are protected within sanctuary zones (Winn 2008). Approximately 6.5% of the area of *estuarine waters* of NSW is represented in the reserve system as sanctuary zones. However, the area of wave dominated estuaries, such as the Macleay River estuary represented is more like 0.6% of the state total (Winn 2008). The most widely reported target figure for a comprehensive, adequate and representative MPA system is as follows:

- 20% of all recognised habitat types within a given area should be protected within the boundaries of sanctuary zones (Winn 2008);

The appropriate spatial scale for this target figure is generally within a bioregion or statewide, nationally or globally though it could be applied to an individual estuary system such as the Macleay.

Within the Manning Shelf Bioregion

The Macleay Estuary falls within the Manning Shelf Bioregion. Of the marine and estuarine waters in the Manning bioregion, 6.6% are currently fully protected (ie declared sanctuary zones) by the reserve system. However, this percentage basically refers to a single reserve, the Port Stephens-Great Lakes Marine Park. Aside from the Port Stephens-Great Lakes Marine Park the majority of aquatic areas under conservation in the bioregion are within the gazetted boundaries of national parks and nature reserves. These areas include parts of Korogoro Creek and Saltwater Lagoon, both located just outside of the study area. With respect to estuarine habitats, the percentage that fall within protected areas are as follows (Breen *et al*. 2004 based on mapped areas from West 1985);

- 29% of mangroves within the Manning Shelf Bioregion fall within recognised marine extensions to National Parks and Nature Reserves;
- 43% of the mangroves within the Manning Shelf Bioregion fall within National Parks and Nature Reserves when those without recognised marine extensions are included;
- 4% of the saltmarshes within the Manning Shelf Bioregion fall within recognised marine extensions to National Parks and Nature Reserves;
- 47% of the mangroves within the Manning Shelf Bioregion fall within National Parks and Nature Reserves when areas landward of the mapped coastline are included;
- Seagrass occurs within 12 recognised marine extensions of National Parks though the percentage of the total seagrass area in the bioregion is uncertain.

In short, without commenting upon the specific habitat protection measures offered by individual reserves, the current reserve system is adequate for the conservation of vegetative estuarine habitats within the Manning Bioregion. However, the protected areas of estuarine habitats are biased towards the terrestrial fringe of waterways and no protection of fish or aquatic invertebrates is offered by these reserves.

The Macleay River is one of 9 wave dominated barrier estuaries within the Manning Shelf Bioregion. To date, no wave dominated barrier estuary is represented within the various marine protected areas in the Manning Shelf bioregion. An aim of the MPA network is to include an example of each of the broad ecosystem types found within the bioregion. To achieve the 'comprehensiveness' goals of Marine Protected Areas it is important that one of the nine wave dominated barrier systems described above is included.

Within the Study Area

On the Macleay River system there are currently no gazetted aquatic reserves or marine parks. However, the gazetted area of the Yarrahapinni Wetlands National Park incudes Borigalla Creek and the Broadwater, areas that are being returned to estuarine wetlands via the reintroduction of tidal movement through newly opened floodgates and the eventual removal of a section of the bund wall levee between the Broadwater and Clybucca Creek. The Yarrahapinni Wetlands National Park also includes substantial areas of mangrove and very limited areas of saltmarsh habitats, found on the Muzzers, Snake and Whiskey Islands near Fishermans Reach in the Macleay Arm. These islands are included within the park boundaries, despite being geographically isolated from the rest of the park. The combination of a fishing closure (all methods illegal, all the time) in the waters upstream of the floodgates and the bund wall levee and access restrictions due to the floodgates and levee mean that the Yarrahapinni Wetlands National Park acts as a *de facto* MPA, most similar to an aquatic reserve in nature.

The Mangrove communities in the Yarrahapinni Wetlands were formerly mapped to cover 84ha and the saltmarsh to cover 340ha. There are currently few and scattered mangroves, most of which are either sprouting or juvenile trees, newly recruited due to recent improvements in tidal flushing. The saltmarsh area now covers less than 4ha, though recent changes to the tidal flushing will alter the extent and distribution of these populations. Due to recent changes in the management of the floodgates, and further planned changes to floodgates and the bund wall levee, the estuarine habitats within the Yarrahapinni Wetlands are in a state of rapid flux and will continue to be for some time into the future. This is likely to result in the large and rapid expansion of mangrove habitats and less rapid (due to the slow growing nature of many salt marsh plants) but similarly large expansion of salt marsh habitats. It is also likely that sea grass will recolonise parts of the subtidal regions as water levels and salinity regimes stabilise.

A broad-scale biodiversity assessment of the Manning Shelf Bioregion identified South West Rocks Creek, the Macleay Arm and the Macleay River delta as candidate areas for the conservation of aquatic resources (Breen *et al*. 2004).

The Hat Head National Park includes the majority of the East Kinchela wetland complex, a.k.a. the Swanpool. The adequacy of the reserve system to protect the

floodplain wetlands associated with the Macleay River estuary will not be further assessed in this study.

4.3.3 Aims of the Marine Protected Area Network

Clearly stated objectives are a key part of reserve design (Breen *et al*. 2004). The aims of the Marine Protected Area network nationally are to be comprehensive, adequate and representative in the protection of biodiversity and ecosystems in marine and estuarine waters. The same aims apply to the NSW network. To achieve this, the network aims to conserve representative ecosystems and habitats with identified bioregions considered an appropriate spatial scale (the Macleay River falls within the Manning Shelf bioregion). Secondary aims of the MPA network are to provide for a number of beneficial or low impact human uses and the education of the public with respect to the ecological values of marine and estuarine waters.

On the Macleay River estuary the aims of a marine protected area would be to contribute to the comprehensiveness, adequacy and representativeness of the reserve system on the Manning Shelf, within NSW and nationally whilst providing an area for the protection of habitats, and conservation of biodiversity and important ecosystem processes locally.

In order to achieve these objectives, it is important that the regional significance of the Macleay River estuary is assessed, the potential conservation value of the system measured and the local ecosystem processes and ecological values understood.

The regional significance of the Macleay River estuary has been adequately assessed as part of the Manning Shelf Bioregional Assessment (Breen *et al*. 2004). The results of that assessment are too detailed for reproduction here but include;

- The Macleay River estuary contains the largest area of mangroves and the largest total area of vegetated estuarine habitats of any estuary in the northern half of the bioregion;
- The length of artificial intertidal rocky shores on the Macleay is regionally significant;
- The Macleay contains the largest areas of intertidal and supratidal flats in the northern part of the bioregion
- The Macleay was the least irreplaceable estuary in the bioregion (of the subset sampled) with respect to the representation of fish species. In effect, the diversity of species and presence of uncommon species was low in the Macleay;
- The Macleay River was not mentioned with respect to the sighting of threatened or protected fish species;
- The Macleay system was around average compared with other estuaries in the bioregion with respect to the available habitat for shorebirds, the total number of bird species and the number of threatened or protected birds;
- The Directory of Important Wetlands of Australia lists two locations from the lower Macleay – The Kinchela/Belmore swamp system and the ‘Clybucca Creek estuary’, which includes the Macleay Arm, Clybucca Creek and the most downstream section of the Macleay River;

- Disturbance of shore and water on the Macleay was ranked as very high;
- Conservation value for the Macleay was ranked as moderate whilst conservation threat was ranked as real (as opposed to none or perceived);
- Fisheries value and fisheries threat were both ranked as high, ecological status was ranked as moderately affected and water quality as poor;
- The Macleay estuary had amongst the lowest percentages of adjacent National Parks (<5%) and state forests (0%) of all the estuaries in the bioregion;
- The mean catchment disturbance, river disturbance and flow disturbance indices for the Macleay were among the highest recorded;
- The summed 'irreplacibility' of the Macleay when both estuarine habitats and broad scale ecosystem types were considered was the highest of the wave dominated barrier estuaries in the northern half of the bioregion;
- Multiple criteria analysis of the comprehensiveness and representativeness of estuaries scored the Macleay second lowest of the wave dominated barrier estuaries within the bioregion;
- Multiple criteria analysis of the adequacy of estuaries scored the Macleay second lowest of all estuaries within the bioregion;

The interpretation of these results used for the present study is that the Macleay River estuary is not a suitable candidate as a core MPA within the Manning Shelf Bioregion but could contribute useful aspects as part of a broader MPA network within the bioregion, state and nation.

The ability of a MPA on the Macleay to achieve the above stated goals has not yet been considered. The basic task of identifying candidate areas on the Macleay is to replicate the system used to identify areas bioregionally, but on a finer scale.

4.3.4 Identifying Candidate Marine Protected Areas

Type of Marine Protected Area

Without the creation of a large multiple use Marine Park incorporating oceanic waters, open beaches and a variety of subtidal and intertidal habitats in the surrounding area, it is considered highly unlikely that a Marine Park for the Macleay River system would be feasible or practical. The reasons for this are as follows;

- An MPA for the Macleay River estuary that would be widely acceptable to the general community is likely to be relatively small, due to the popularity of recreational fishing, boating and the presence of stable aquaculture and commercial fishing activities;
- A small MPA would not justify the necessary infrastructure in terms of staff, equipment and offices, and the nearest existing Marine Parks Authority offices lie in Coffs Harbour;
- There are a number of factors on the Macleay such as the estuary general fishery and oyster aquaculture industry that would complicate the planning and management of a Marine Park on the Macleay;

A Marine Park is not considered as an appropriate reserve type for the Macleay River estuary.

The general consensus is that MPAs should be as large as possible, incorporating entire ecosystems and habitats and maximising connectivity between habitats where possible. The effects of incorporating whole systems include improved resilience, reduced 'spillover' of organisms and protection of the full range of variation within the system. However, initial consultation has shown that a system wide reserve for the Macleay is unlikely to gather public support. In a general survey 38% of the respondents indicated strong support for the creation of a sanctuary zone and 35% of respondents indicated no support (GeoLINK 2010). In addition to this information, the importance of the Macleay to a bioregional system of Marine Parks is not such that a system wide reserve is required. Hence, an aquatic reserve or National Park extension with a cooperative agreement to control fishing activity could be an appropriate reserve type for the Macleay.

There are various existing reserves, crown land and SEPPs in force on land adjacent to the Macleay River estuary. These are shown in **Figure 4.15**.

Requirements of a Marine Protected Area

The national identification criteria for MPAs are as follows (ANZECC 1998);

- Representativeness;
- Comprehensiveness;
- Ecological Importance;
- International importance;
- Uniqueness;
- Productivity;
- Vulnerability assessment;
- Biogeographic Importance; and
- Naturalness.

The national selection criteria for MPAs are;

- Economic interests;
- Social interests;
- Scientific interests;
- Practicality/Feasibility;
- Vulnerability assessment; and
- Replication.

The Broadscale Biodiversity Assessment of the Manning Shelf Bioregion (which stretches from just north of the Hunter River to just north of the Nambucca River) identified parts of the study area, South West Rocks (or Back) Creek, the Macleay Arm and the Macleay River delta, that could achieve some of the goals of an MPA network within the bioregion. The document also describes the criteria, methods and information used to identify potential conservation areas in NSW waters. South West Rocks Creek was included as a small, relatively unimpacted estuary worthy of conservation for the 'high proportion… occupied by mangrove saltmarsh and seagrass in close proximity to built-up areas'. The Macleay Arm and the Macleay River delta were included as the least impacted subcatchments of a larger system due to the 'large areas of mangrove, saltmarsh and seagrass, adjacent wetlands and the importance to migratory waders and other bird life'.

The identification of the above parts of the study area as suitable for conservation was completed using broad-scale methods such as ecosystem units and mapped habitat units. Finer scale information is required to determine the planning, management, research and monitoring required for the creation and operation of protected areas. The type of information includes (following Breen *et al*. 2004);

- Community level information based on more detailed physical surrogates, dominant biota or species associations; and
- Estimated distributions or abundances of species or populations.

4.3.5 Identifying a Candidate Marine Protected Area for the Macleay

Introduction

The goals of an MPA located within the Macleay River estuary would be to;

- Conserve, where possible, unique biological or physical features of the system;
- Provide an area for the conservation of key features of the estuary;
- Provide a refuge for fish and invertebrates from fishing pressures; and
- Provide an area for education and a research.

Six candidate MPAs were chosen to compare the ability of each to meet the stated goals. The justification for the locations and boundaries chosen was as follows;

- The candidates covered significant areas of estuarine habitat, primarily mangroves, saltmarsh, seagrass and intertidal flats. Rocky shores (artificial) were included in two of the candidate areas;
- The candidate areas were located adjacent to existing terrestrial reserves, such as the Yarrahapinni Wetlands National Park, Clybucca Historic Site or the Fishermans Bend Nature Reserve. This factor could potentially facilitate the creation and management of an MPA; and
- The boundaries were chosen to reflect significant natural boundaries within the estuary, such as confluences, point bars and shore lines.

To avoid a situation where candidate MPAs included portions of privately owned land the boundaries of the candidate MPAs reflect the location of terrestrial property boundaries, ie. only areas currently defined as waterway (using the cadastre geographic dataset provided by KSC for the project) were included. This is significant for a number of reasons. Firstly, a large proportion of mangroves and the majority of saltmarsh habitat are located above the mean high tide mark and therefore on areas mapped as terrestrial, meaning that the areas of saltmarsh and mangrove habitats included in the candidate areas are constrained. Secondly, the exact boundaries of the high water mark are not accurately reflected by the dataset. Additionally, some areas of crown reserve may be located adjacent to the identified candidate MPAs, meaning that saltmarsh and mangrove habitats not currently included within the boundaries could potentially be included.

The candidate areas chosen are listed in **Table 4.12** and pictured in **Figure 4.15**. The areas range from 295ha to 21ha in size. The names were chosen only to reflect the location of the candidate MPA. The Yarrahapinni area was included for the sake of comparison, despite being currently protected within the Yarrahapinni Wetlands National Park and by a fishing closure within its waters.

Table 4.12 Candidate MPAs on the lower Macleay investigated as part of this study.

MPA Name	*Water Area (ha)*	*%Total Water*	*Mangrove (ha)*	*% Total Mangroves*	*Saltmarsh (ha)*	*% Total Saltmarsh*	*Seagrass (ha)*	*% Total Seagrass*
Back Creek	21.35	0.83	3.95	0.62	0.30	0.07	0.20	0.20
Clybucca	294.68	11.47	35.94	5.65	9.61	2.20	20.24	21.09
Fishermans Reach	95.96	3.74	11.58	1.82	0.25	0.06	19.78	20.61
New Entrance	221.55	8.63	61.19	9.62	4.52	1.04	9.42	9.81
Stuarts Point	26.56	1.03	2.92	0.46	0.10	0.02	10.10	10.53
Yarrahapinni	63.02	2.45	0.01	0.00	18.00	4.13	0.00	0.00

4.3.6 Community Perceptions to an MPA on the Macleay

A general survey undertaken as part of the Macleay Estuary Management Study returned the following results with respect to the creation of a fish sanctuary zone;

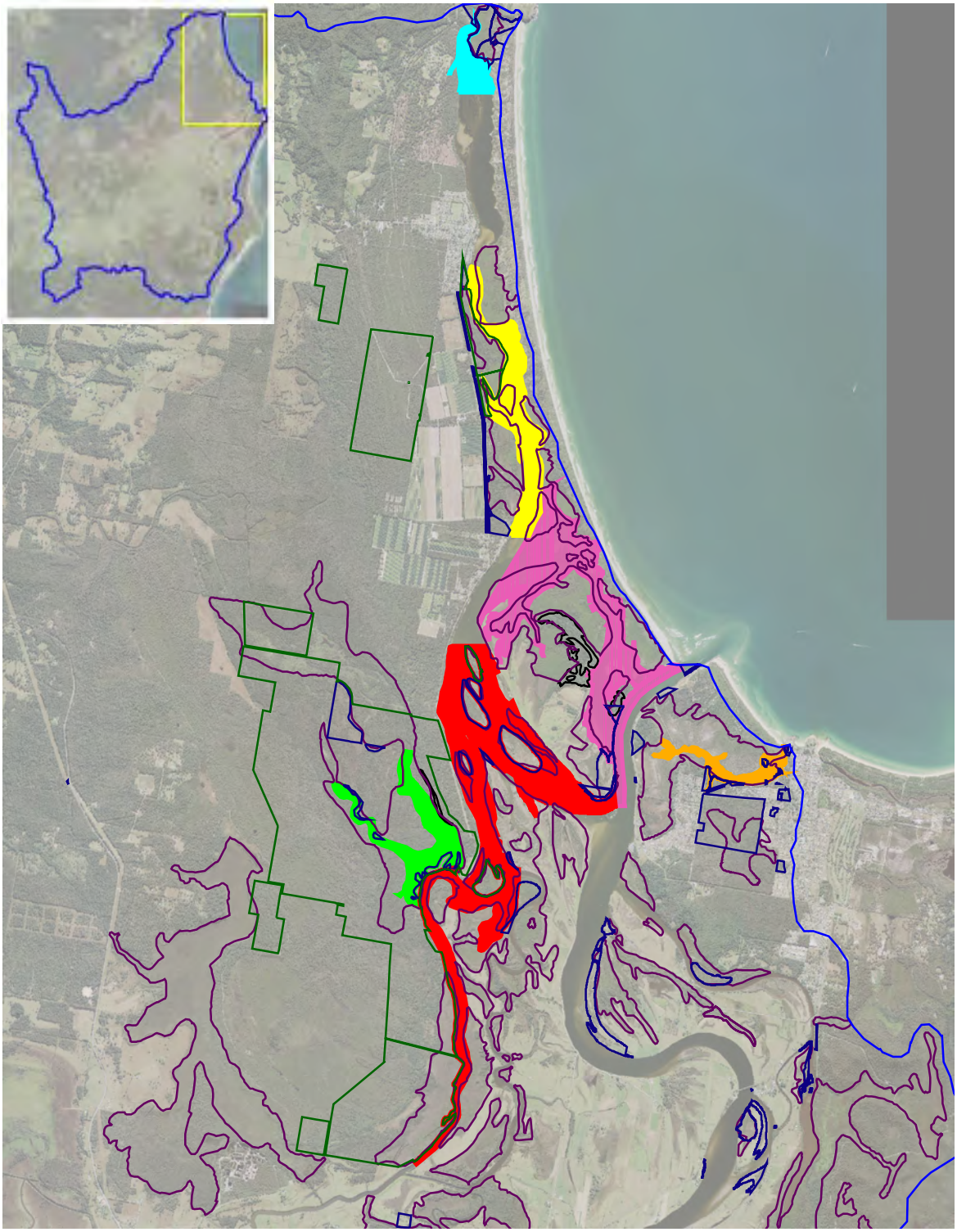
- 38% indicated “strong support”;
- 21% indicated “moderate support”;
- 35% indicated “no support”;
- 9% indicated “don’t know”; and
- there were some comments indicating concern that this question may lead to the creation of sanctuary zones without any further consultation beyond the survey.

These results give the indication that there would be some community opposition to the creation of a marine protected area on the Macleay River. However, from these results it is difficult to judge the potential response to the individual candidate areas described in this report.

A meeting with commercial fishers operating as part of the Estuary General Fishery on the Macleay River indicated that commercial fishers would be strongly opposed to the creation of an MPA on any part of the estuary system, perhaps with the exception of the Yarrahapinni Wetlands, to which access is already restricted. The key justifications for this opposition were related to the many regulations that already govern their industry and the fact that over the long term, the entire area of the estuary has the potential to represent productive fishing grounds.

Information shown is for illustrative purposes only

Map Created by Aquatic Science and Managment, June 2010
Data Sources: KSC (modifications to existing layers by ASM)



LEGEND

- Study Area
- National Parks
- Crown Land
- SEPP 14
- SEPP 26

Candidate MPAs

- Back Creek
- Clybucca
- Fishermans Reach
- New Entrance
- Stuarts Point
- Yarrahapinni

N

0 1 2 Km

Candidate MPAs and existing conservation network

4.3.7 Methods used to Rank Potential MPAs

To assess the identified candidate areas against recognised criteria, the methods described in **Table 4.13** were applied.

Table 4.13 Methods for the assessment of candidate MPAs on the Macleay River Estuary

Criteria	***Measure***	***Assessment Method***
Comprehensiveness	Inclusion of broad geomorphic process zones as defined in Telfer (2005). These are closely aligned with vegetative process zones.	Presence/Absence of Marine Delta, Transitional and Fluvial process zones. Score of 1 per process zone included within boundaries.
Representativeness	Inclusion of major estuarine habitat formations according to estuarine macrophyte mapping (CCA 2006) with consideration for intertidal flats and rocky shores.	Percentage of total estuary area of mangroves, saltmarsh, seagrass, intertidal rocky shores and intertidal flats. Candidate areas were ranked and scored by the percentage of each vegetative habitat type (see **Table 4.13**). They were scored for the presence of rocky shores and intertidal flats. The sums of scores were then used to rank the candidate areas and score them between 5 (ranked 1st) and 0 (ranked 6th) for their ranking.
Ecological Importance	Threatened and or endangered species according to existing databases and personal observation.	Areas were ranked and scored according to the number of threatened species known to utilise them (according to KSC and DECCW records and incidental observation during this study), ranked and scored according to the number of fish species detected during field work for this study. The sums of scores were then used to rank the candidate areas and score them between 5 (ranked 1st) and 0 (ranked 6th) for their ranking.
	Number of fish species according to scientific seining during this study.	
	Importance as a nursery area was not assessed as it is assumed to be relatively evenly spread between areas and also a function of habitat which is already assessed under 'representativeness'.	
International or National importance	Not assessed, all areas fall within the DIWA 'Clybucca Creek estuary'	
Uniqueness	Unique biological or physical features	Presence/absence of unique features. Scored 1 for presence, 0 for absence.
Productivity	Not assessed, the productivity of the candidate areas is assumed to be a reflection of estuarine habitat and thus adequately covered by 'representativeness'	
Vulnerability Assessment	Exposure to pressures that can not be controlled by the management tools available.	Risks were described and after due consideration of the severity of risks the candidate areas were ranked and scored between 5 (ranked 1st) and 0 (ranked 6th) for their ranking.
Biogeographic Importance	Not considered, this aspect was adequately covered by Breen *et al*. (2004)	
Naturalness	Riparian vegetation condition, s defined by ID Management in Telfer (2005)	A qualitative description of the riparian condition and presence and intensity of urban pressures were used to rank and

Criteria	*Measure*	*Assessment Method*
	Urban pressure within 1km radius	score candidate areas. Scores were between 5 (ranked 1st) and 0 (ranked 6th).
Economic Interests	Not considered, all areas assumed equal for this category.	
Indigenous Interests	Not considered, all areas of the Macleay estuary are assumed to be of equal value to the local indigenous population	
Social Interests	Capacity for use in education etc, which is measured only as a function of access in this case.	Areas were assessed for current and potential access and scored 0 (poor), 1 (average) or 2 (good).
Scientific Interests	Not assessed, all areas are assumed to be of equal value for scientific purposes. Where differences exist, they would be adequately considered under naturalness.	
Practicality/Feasibility	Location of adjacent reserves and ease of access for existing staff (ie DECCW staff)	Presence/Absence of adjacent reserves scored 1/0. Presence/Absence of adjacent unreserved Crown Land scored 0.5/0. Ease of access for existing staff scored 0/1. Scores summed.

4.3.8 Results of the Candidate MPA Ranking Exercise

The complete results of the ranking exercise are displayed in **Appendix B**. A summary of scores is reproduced below, in **Table 4.14**.

Table 4.14 Summary of results and ranking of candidate MPAs.

Criteria	*Clybucca*	*New Entrance*	*Fishermans Reach*	*Stuarts Point*	*Back Creek*	*Yarrahapinni*
Comprehensiveness	2	1	1	1	2	1
Representativeness	5	4	3	0	1.5	1.5
Ecological Importance	5	4	0	2.5	1	2.5
Uniqueness	0	0	0	1	1	1
Vulnerability Assessment	0	5	1	2	3	4
Naturalness	1	4	2.5	2.5		5
Social Interests	0	0	2	1	2	0
Practicality/Feasibility	1	0	1	0.5	1.5	1
Total Score	14	18	10.5	10.5	12	16
Ranking	3	1	5	5	4	2

The New Entrance candidate MPA was the top ranked area defined using the criteria and scoring techniques applied. The Yarrahapinni candidate area ranked second, followed by the Clybucca candidate area. The New Entrance MPA scored most highly for natural values such as ecological importance, naturalness and representativeness and was also considered the least vulnerable of the areas mapped. Yarrahapinni scored highly for naturalness and was considered less vulnerable than other areas largely due to recent changes in management. Clybucca, the largest of the candidate areas scored highly for the natural values but ranked lower due to vulnerability and riparian disturbance.

There are some limitations to the process used to score and rank the above candidate MPAs. There were some datasets used that did not cover all of the areas in question. Some of the criteria used subjective reasoning due to limited availability or applicability of data. In addition to this the criteria were not weighted in a systematic way and the actual scoring techniques used could be modified to the effect of changing the outcomes. Despite these limitations the process is useful in terms of highlighting the strengths and weakness of the areas chosen as candidate MPAs and the ranking largely reflect these.

The New Entrance area is the heart of the local oyster aquaculture industry. The high salinities, good flushing characteristics and calm waters found there that make it suitable for oyster aquaculture are also likely to enhance the natural characteristics that led to its high ranking as a candidate MPA for the Macleay. Oyster aquaculture was not measured in the assessment and could be considered a blockage to the operation of an MPA, with respect to reduced 'practicality' and 'naturalness'. The Yarrahapinni area is already operating as an aquatic reserve as the waterway is under NPWS tenure, total commercial and recreational fishing closures apply and there is restricted access to motor boating and traffic in general due to man made barriers and remoteness. In addition, the natural features of the wetlands such as the extent of mangroves, saltmarsh and probably seagrass are likely to improve over the coming years as a result of the recent reintroduction of tidal flows. The high ranking of the Yarrahapinni area in the above process, the likely acceptance of it to the general public and stakeholders and the existing barriers to access may make it ideal as a formalised sanctuary zone for the Macleay River estuary system. The drawbacks are the limited access to existing DECCW and I&I staff, and the relatively small area of total water area covered by the candidate MPA as described here. The Clybucca candidate MPA as described here, though scoring highly for some features, suffers the drawback of being a conduit for semi-regular inputs of poor quality water from above the floodgates. Continued improvements to the management of the floodplain upstream would improve the value of this area as a potential reserve.

4.4 Conservation Management Issues

4.4.1 Management Issues Relating to EECs

Issue 4.1: Prioritisation of EEC areas for conservation management
Figures 4.2, **4.3** and **4.4**, show large areas of the MREMP study area floodplain constituting known or likely EECs, though review of the mapping and corresponding habitat condition data shows many areas are isolated and highly degraded. Further investigations are therefore required to priorities areas to target conservation management efforts.

Issue 4.2: Landuse zoning and management
Only relatively small area of the Macleay estuary floodplain (including areas encompassing EECs) are zoned and managed for conservation purposes (refer to **Section 5.4**). Hence many areas constituting EECs are subject or vulnerable to landuse practices that may degrade or inhibit the natural regeneration of many EECs areas.

Issue 4.3: Threat management
Threats to local terrestrial biodiversity (including EECs), are detailed in **Section 5**. Management of threats, particularly at high priority sites is required to help protect and manage EECs locally.

4.4.2 Management Issues Relating to Threatened Species

Issue 4.4: Prioritisation of threatened species habitats for conservation management.
Figures 4.12, **4.13** and **4.14**, show large areas of the MREMP study area floodplain constituting key habitat types for threatened flora and fauna species. However, historic disturbances are likely to have substantially reduced the occurrence potential and/or habitat values of many of these areas for the relevant threatened species. Further investigations are therefore required to prioritise areas to focus conservation management efforts (this is being undertaken as part of the EMS).

Issue 4.5: Landuse zoning and management.
Only relatively small area of the Macleay estuary floodplain (including previously identified key threatened species habitat types) are zoned and managed for conservation purposes (refer to **Section 5.4**). Hence many areas constituting threatened species habitats are subject or vulnerable to landuse practices that may degrade or inhibit the natural regeneration of many threatened species habitat areas.

Issue 4.6: Threat management.
Threats to local terrestrial biodiversity (including habitat fragmentation and isolation) are discussed in **Section 5**.

Issue 4.7: Species specific information gaps
Many local threatened and migratory species/species groups should benefit from the blanket management approaches associated with the EMP (e.g. improvement of wetland health would benefit local wetland birds and frogs). However due to varying needs of many local threatened and migratory species, further investigations are

required to ensure local species specific key sites are adequately protected. Shorebirds (which include a number of locally recorded threatened and migratory species) have been identified locally as particularly vulnerable species associated with the Macleay estuary due to a lack of comprehensive information regarding shorebird use of the Macleay estuary. Additionally species declines have been recorded despite protection of habitat areas elsewhere in the NRCMA (Sandpiper Ecological Surveys 2009). Consequently these are considered a focal species group for the EMP to target.

4.5 Conservation Management Options

4.5.1 Management Options relating to EECs

Option 4.1: Maintain or improve biodiversity values of local EECs
In order to achieve this the following actions are suggested:

- use available information to identify high conservation value EEC (this is being undertaken as part of the EMS);
- identify threats at high conservation value EEC sites;
- identify and prioritise conservation and management actions at high conservation value EEC sites. This should include exploring both legislative and non-legislative protection approaches; and
- develop and implement local conservation and management programs to address threats and ensure protection of high conservation value EEC sites.

Option 4.2: Where possible implement DECCW Priority Action Statements
DECCW has developed Priority Action Statements (PAS) as recovery strategies for EECs. Review of the PAS's considered most relevant to the study area and EECs are provided below, and may be used as a base for developing conservation and management programs and actions:

1. Recovery strategy: Community and land-holder liaison/ awareness and/or education.
   - Liaise with community to improve recognition of values and encourage landholder participation in site management including weed control.
   - Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human disturbance.
   - Enhance the capacity of persons involved in the assessment of impacts on this EEC to ensure the best informed decisions are made.
2. Recovery strategy: Habitat Management: Site Protection (e.g. fencing/signage).
   - Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.
   - Educate appropriate agencies to prevent further clearing for rail, road and power easements and maintenance activities.
   - Fence ecological community to allow natural regeneration. Fencing must be linked to monitoring and weed control.
3. Recovery strategy: Habitat Rehabilitation/Restoration and/or Regeneration.

- Undertake bush regeneration to restore, expand and reconnect remnants where considered practical.

4. Recovery strategy: Habitat Management: Weed Control.
   - Undertake weed control for Bitou Bush and Boneseed at priority sites in accordance with the approved Threat Abatement Plan and associated PAS actions.
   - Undertake weed control and develop a future plan of management for controlling re-invasion.
5. Recovery strategy: Habitat Protection (inc vca/ jma/ critical habitat nomination etc).
   - Use mechanisms such as Voluntary Conservation Agreements to promote the protection of this EEC on private land.
   - Investigate acquisition of property that contains this EEC to complement and expand on existing areas reserved.
6. Recovery strategy: Research.
   - Determine location, species composition and threats to remaining remnants to assist with prioritising restoration works.
7. Recovery strategy: Habitat Management: Fire.
   - Implement appropriate fire management practices.
   - Modify hazard reduction strategy in reserves to include guidelines to protect community from fire.
8. Recovery strategy: Habitat Management: Feral Control.
   - Undertake control of feral pigs and horses at identified key sites.
9. Recovery strategy: Captive Husbandry or ex-situ collection/propagation.
   - Collect seed for NSW Seedbank. Develop collection program in collaboration with BGT - all known provenances (conservation collection).
   - Investigate seed viability, germination, dormancy and longevity (in natural environment and in storage).
10. Recovery strategy: Habitat Management: Grazing.
    - Fence the community to prevent grazing and encourage management of livestock grazing so as to maintain habitat and reduce trampling.
11. Recovery strategy: Habitat Management: Ongoing EIA - Advice to consent and planning authorities.
    - Ensure ecological community is considered in landuse planning processes at all levels of government (DECCW undated).

Other components of this study will also assist in the development of baseline information for the development of conservation and management programs and actions to address some of these PAS (e.g. threatening processes in **Section 5**).

4.5.2 Management Options Relating to Threatened Species

Option 4.3: Collect information relating to shorebirds

Undertake shorebird studies for the Macleay Estuary to determine population size, species richness, and roost and foraging areas. The study should identify priority roost and foraging sites for management including identification of threats at priority sites and appropriate management strategies to address the site specific threats.

Option 4.4: Develop a comprehensive conservation plan for the floodplain

Ideally, the following strategies would be implemented:

- where possible, use available information to identify high conservation value (or high priority) threatened species habitat areas at a broadscale level;
- identify threats at high conservation value threatened species habitat areas;
- identify and prioritise conservation and management actions at high conservation value threatened species habitat areas. This should include exploring both legislative and non-legislative protection approaches;
- maintain and enhance local connectivity between high conservation value habitat areas at a regional, sub-regional and local scale;
- develop and implement local conservation and management programs to address threats and ensure protection of high conservation value habitat areas; and
- liaise with relevant landowners and stakeholders to explore opportunities to protect and manage existing priority habitats.

In relation to identifying appropriate management actions and efforts, the relevant DECCW Priority Action Statements (PAS) may be useful as a tool for identifying appropriate management actions (refer to the DECCW threatened species website for further details: www.threatenedspecies.environment.nsw.gov.au).

4.5.3 Management Options Relating to Candidate MPAs

Option 4.5: Further investigate the possibility of establishing a sanctuary zone on the Macleay River estuary

According to this study, the most suitable place to do this is within the boundaries of the Yarrahapinni Wetlands National Park. The following justifications are considered relevant:

- Though the wetlands are in a dynamic state of recovery and there is little seagrass or mangrove habitat within its waters, the Yarrahapinni candidate MPA scored second most highly in the ranking exercise applied;
- The wetlands were once home to very large areas of mangroves, seagrass and saltmarsh and with the reintroduction of tidal flows are likely to be so once again;
- The current barriers to access and fishing closures make it a practical choice, as the commercial and recreational fishing communities will not be ‘losing’ areas currently regarded as productive fishing grounds and access for most motorised craft is impossible;