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Conservation Assessment of Wetlands in the Clarence Lowlands IBRA Subregion



Australian Government

Department of Environment & Climate Change NSW



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Published by:

Department of Environment and Climate Change NSW
59–61 Goulburn Street Sydney
PO Box A290
Sydney South 1232
Phone: (02) 9995 5000 (switchboard)
Phone: 131 555 (environment information and publications requests)
Fax: (02) 9995 5999
TTY: (02) 9211 4723
Email: info@environment.nsw.gov.au
Website address: www.environment.nsw.gov.au

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EXECUTIVE SUMMARY

This project was funded by the Australian Department of the Environment, Water, Heritage and the Arts (DEWHA). The objective of the project was to undertake a conservation assessment of wetlands in the Clarence Lowlands IBRA subregion in order to make recommendations for their management and protection that may contribute to improving the comprehensiveness, adequacy and representativeness of the National Reserve System (NRS).

The NSW Department of Environment and Climate Change (DECC) were engaged to complete this project, which included a desktop conservation assessment and expert panel workshop to identify priority wetland areas and to direct the future development of the NRS.

This report was prepared by Eco Logical Australia, in collaboration with DECC, and provides findings from an assessment of the conservation values and threats to 19 wetland complexes (clusters). These wetland clusters represent a significant proportion of the remaining high conservation value aquatic ecosystems in the Clarence Lowlands.

A major component of the assessment was an expert panel workshop. Representatives from local councils, government agencies, conservation groups and independent ecologists were invited to attend a workshop in Grafton, NSW on Tuesday 19 August 2008. In combination with a desktop assessment this provided the best level of information available on each wetland cluster, which is detailed in 19 individual wetland profiles (Appendix 3).

This report documents a number of wetland ecosystems which are considered to be a very high priority for addition to the NRS. This includes estuarine and intertidal areas such as the Clarence Estuary, Richmond Estuary and The Broadwater, and freshwater swamp and forested wetland areas such as the Bungawalbin, Shark Creek, Everlasting Swamp, Tabbimoble, and Wardell wetland clusters.

Throughout the project a range of limitations were identified due to the lack of a standardised approach to wetland mapping and classification. This is exacerbated by the absence of comprehensive field survey data for wetlands in the Clarence Lowlands.

To enhance future assessments of the comprehensiveness, representativeness and adequacy of the wetlands and lowlands protected area system in the Clarence Lowlands IBRA subregion systematic mapping and survey is therefore recommended

Additionally, the criteria used for future wetland assessments should be reviewed and appropriate decision support tools (eg Expert Choice) be used to determine wetland priorities. Strategically, introduction of long term wetland monitoring sites and identification of a system of wetland and lowland corridors and key habitats are also recommended.

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The study team included Mike Rowland, Paul Sheringham, Hugh Robertson, Andrew Steed, Mick Andren and Joanna Muldoon (DECC) and Sarah Wain, Julian Wall, Martin Stuart and Phil Gilmour (Eco Logical Australia).

The contribution of participants at the expert panel workshop held in Grafton, NSW on 19 August 2008 is particularly acknowledged.

CONTENTS

EXECUTIVE SUMMARY	I
ACKNOWLEDGEMENTS	II
CONTENTS	III
1. INTRODUCTION	1
1.1 DESCRIPTION OF PROJECT	1
1.2 CONTEXT	1
1.3 STUDY AREA.....	2
1.4 WETLAND CLUSTERS FOR INVESTIGATION	5
2. PROJECT BACKGROUND	8
2.1 EXISTING STUDIES	8
2.2 RESTORATION PROJECTS	10
2.3 NSW PLANNING CONTEXT	10
2.4 NATIONAL AND INTERNATIONAL PLANNING CONTEXT.....	13
3. CONSERVATION VALUES AND THREATS	16
3.1 CONSERVATION VALUES	16
3.2 THREATS	21
4. CONSERVATION VALUES AND THREATS ASSESSMENT	24
4.1 INTRODUCTION.....	24
4.2 ASSESSMENT METHODOLOGY	24
4.3 OUTCOMES OF CONSERVATION VALUES AND THREATS ASSESSMENT.....	28
4.4 DISCUSSION ON LIMITATIONS OF ASSESSMENT.....	34
5. RECOMMENDATIONS	35
5.1 KEY PRIORITY AREAS FOR THE NATIONAL RESERVE SYSTEM.....	35
5.2 CONSIDERATION OF CLIMATE CHANGE IN SETTING PRIORITIES	36
5.3 APPLICATIONS OF STUDY	36
5.4 FUTURE PROJECTS.....	36
6. REFERENCES	38
APPENDIX 1 - RESTORATION PROJECTS	40
APPENDIX 2 – EXPERT WORKSHOP OUTCOMES	43
APPENDIX 3 – WETLAND PROFILES	45
ALUMY CREEK/BUNYIP CREEK.....	45
BUNGAWALBIN	48
CASINO	51
CHAFFIN SWAMP	54
CLARENCE ESTUARY	57
COLDSTREAM.....	61
COUTTS CROSSING/ORARA RIVER	64
EVANS RIVER/ROCKY MOUTH CREEK	67
EVERLASTING SWAMP	70
HALFWAY CREEK.....	73
MANGROVE CREEK.....	76
NEWRYBAR.....	79
RICHMOND ESTUARY	82
SHARK CREEK	85
SOUTH CLARENCE	88
TABBIMOBLE	91
THE BROADWATER	94

TUCKEAN..... 97
WARDELL..... 100
APPENDIX 4 – RESULTS FROM CONSERVATION VALUE AND THREAT ASSESSMENT..... 103

1. INTRODUCTION

1.1 Description of Project

This project was funded by the Australian Department of the Environment, Water, Heritage and the Arts (DEWHA). The objective of the project was to undertake a conservation assessment of wetlands in the Clarence Lowlands IBRA subregion in order to make recommendations for their management and protection that may contribute to improving the comprehensiveness, adequacy and representativeness of the National Reserve System (NRS).

The NSW Department of Environment and Climate Change (DECC) were engaged to complete this project, which was subsequently undertaken by Eco Logical Australia in collaboration with DECC. The project includes a desktop conservation assessment and expert panel workshop to identify priority wetland areas and to direct the future development of the NRS.

Through this study the NRS is seeking to identify wetlands that will protect:

- Representative examples of wetland types and wetland ecosystems in the Clarence Lowlands IBRA subregion;
- Core habitat for rare and threatened species, and ecosystems, dependant on wetlands;
- Refuges for species and ecosystems that are vulnerable to climate change;
- Wetlands that provide critical habitat for migratory or nomadic species; and
- Places of national / international and regional environmental significance (e.g. National Heritage List, World Heritage Area, Ramsar, DIWA, endemic species, biogeographic extremes, species richness).

In determining the priorities for protection, the report will seek to identify wetland areas that are well placed in the landscape by being ecologically connected, large enough to sustain biological values and have a high degree of certainty that key resources like water and threatening processes like Acid Sulphate Soils do not compromise the long term survival of the wetland ecosystems.

This conservation assessment will also facilitate development of new protected area proposals, including conservation agreements and covenants on private lands, and will inform the development of Property Vegetation Plans where key values are identified.

This report provides:

1. Background information on the Clarence Lowlands IBRA subregion, the wetland clusters selected for assessment, previous reports and relevant policies and legislation;
2. General information on the conservation values and threats to wetlands in the Clarence Lowlands;
3. Wetland profiles documenting the bio-physical values of each wetland cluster, and comments of the potential contribution of different wetlands to the NRS;
4. An assessment of the overall conservation value and threat status of wetlands in the Clarence Lowlands; and
5. Recommendations for development of the NRS and other future projects

1.2 Context

The NRS comprises Australia's network of protected areas, conserving examples of natural landscapes and native plants and animals for future generations. The reserve system includes over 9,000 protected areas and over 89 million hectares is currently protected (DEWHA, 2008). A key objective of the NRS is to protect and conserve ecological communities which exhibit high conservation value, both intrinsic and extrinsic. Unreserved private remnant wetlands of the Clarence Lowlands subregion provide an opportunity to contribute to the NRS on the North

Coast of NSW, through direct acquisition, establishment of private land conservation agreements and covenants and through NRCMA catchment management programs.

There is widespread recognition that aquatic ecosystems have been poorly protected in many parts of Australia (Fitzsimons and Robertson 2005, Nevill 2006,). Nevill (2006) also noted that while Australia's Ramsar sites, as well as a few of the largest national parks, do protect many important freshwater ecosystems, the coverage of these reserves is neither representative nor comprehensive, and it is highly likely that many aquatic ecosystems are not represented at all within the NRS.

Therefore, projects that identify which wetlands and other aquatic ecosystem types are not well protected, and which are under most immediate threat are a priority for the conservation of biological diversity (Kingsford *et al.* 2006).

In determining national and regional priorities for the protection of wetland ecosystems, an assessment of the comprehensiveness, adequacy and representativeness (CAR) is often utilised by the NRS Program (Gilligan, 2006). However, a systematic assessment of CAR is typically reliant on consistent mapping of ecological communities at an appropriate spatial resolution. The lack of consistent wetland and vegetation mapping in the Clarence Lowlands is recognised as a limitation of this project.

In addition to CAR criteria, there has been recent debate about other indices for comparing the importance of different wetland ecosystems, such as the *National Framework for the Identification and Management of Australia's High Conservation Value Aquatic Ecosystems*, (SKM 2007). Further discussions on methods to identify priority areas for the NRS are also occurring at the Commonwealth level (T. Bond pers. comm. 2008), including possible criteria relating to the *ecological integrity* of different landscapes.

For the current project, estimates of the comprehensiveness and representativeness of the existing NRS in the Clarence Lowlands subregion will be presented. Other criteria relating to the conservation values and threats to different wetland clusters will also be presented. By considering this information, and using expert opinions on the potential contribution of different wetlands to the NRS (in terms of connectivity, species richness, threatened species protection, etc) this report aims to identify a range of conservation options.

1.3 Study Area

The study area is the Clarence Lowlands IBRA subregion (Clarence Lowlands). Sections of the Richmond-Tweed Scenic Rim and Woodenbong subregions were originally included in the assessment, however no significant wetland areas were identified and therefore the investigation was limited to the Clarence Lowlands subregion. The Clarence Lowlands covers an area of 520,496 hectares and stretches from Ballina in the north to Coutts Crossing in the south, and is located entirely within the Northern Rivers Catchment Management Authority (NRCMA) area. The Clarence Lowlands spans the local government areas (LGAs) of the Clarence Valley, Richmond Valley, Lismore, Ballina, Kyogle and Byron Shire councils (Figure 1).

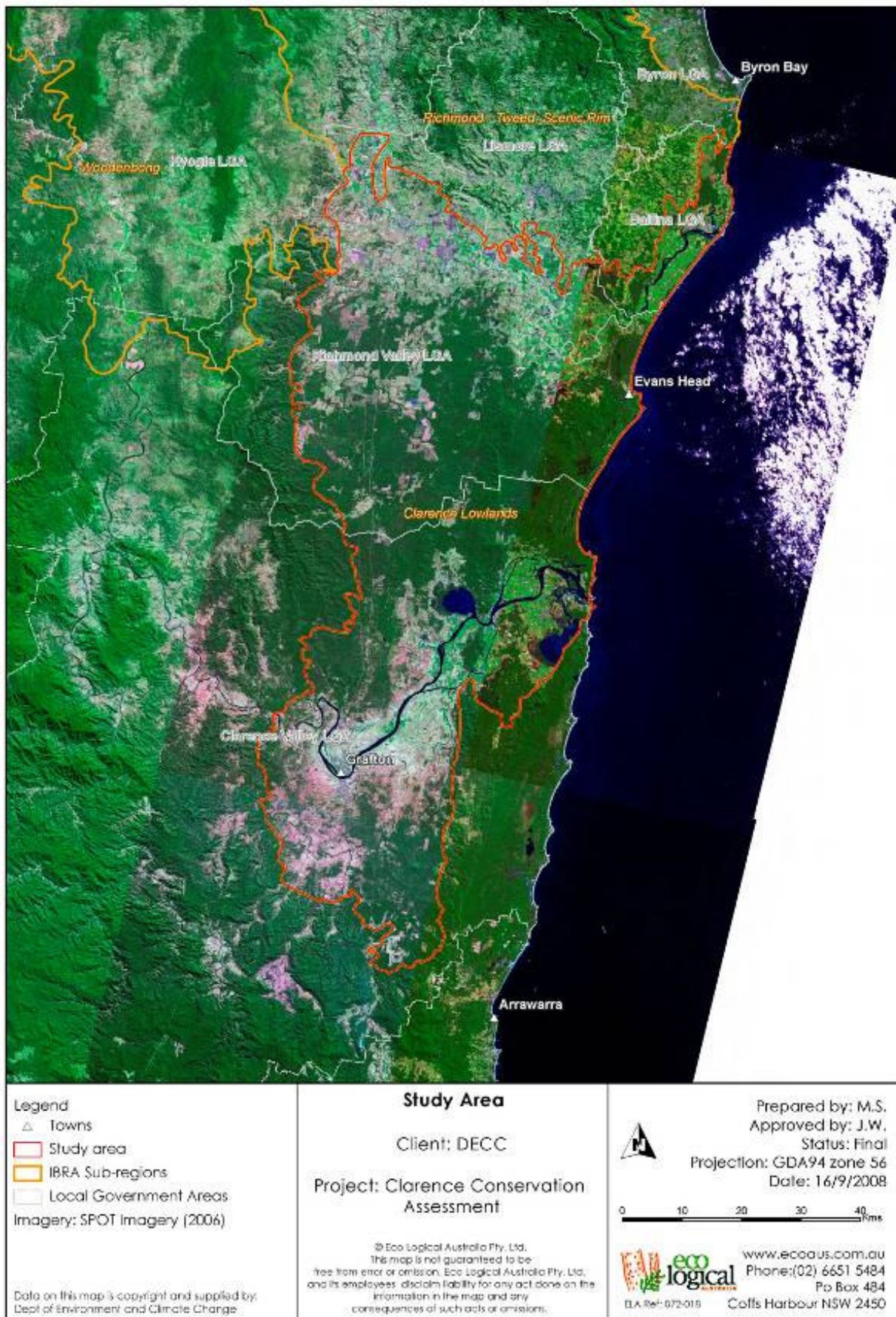


Figure 1: Study Area

The region has a humid sub-tropical climate (Stern *et al.*, 2000) with a late winter - early spring dry period. It is located within the Clarence-Moreton Basin within which the geology includes Jurassic and Cretaceous lithic, quartz sandstones, claystones and shales exposed in valleys. There are extensive areas of quaternary alluvials and coastal barrier sands in addition to tertiary volcanics of the Mount Warning complex (Morgan, 2001). The Clarence Lowlands supports saline basins, swamps and tidal delta flats in the main estuaries and meander plains, and backswamps, levees and terraces along the major drainage lines of the alluvial plain.

The population throughout the Clarence Lowlands is increasing rapidly, with major population centres located at Grafton and Casino. Over two-thirds of land in the region is freehold tenure and almost half of the Clarence Lowlands has been cleared of its original native vegetation. The main land uses are grazing, cropping (particularly sugar cane), conservation reserves, forestry and tourism. Important Macadamia, Tea-tree and commercial fishing industries also occur.

There is a history of intensive land use on the coastal floodplain. Approximately 60% of floodplain vegetation has been cleared (including wetlands). Many of the remaining wetlands have also been drained for agriculture. This change in land use has resulted in a significant decline in the extent and condition of coastal wetlands in NSW. The changes in hydrology due to drainage, increased water diversion (including farm dams) and reduced tidal exchange (e.g. floodgates) has also impacted on wetland ecosystems.

Hydrology is dominated by the Clarence River catchment to the south and the Richmond River catchment to the north. The Clarence River is the largest coastal river in NSW in terms of annual flows. The Clarence catchment does not have any major dams or regulating infrastructure, except for weirs, floodgates and off-river storages. The Richmond River is also predominantly unregulated with only a small regulated section below the 11,000 ML capacity Toonumbar Dam situated upstream of Casino.

Both river systems have extensive floodplains which cover over 260,000 ha (>50%) of the Clarence Lowlands. Periods of heavy rainfall often result in the many wetland depressions on the Clarence and Richmond floodplain becoming inundated, particularly during summer months. However the impact of drainage has reduced the extent and duration of inundation. Major flood events that inundate significant areas of the floodplain are less regular. Due to the alienation of the floodplain and the increase in terrestrial plants species (e.g. pasture grasses) major flooding can lead to a decline in water quality due to low dissolved oxygen, reduced pH levels and increased heavy metal levels in coastal waterways.

Protected areas on the NSW North Coast are predominately located along the coast and escarpment, with relatively low levels of reservation on the floodplains and lowlands. This bias in reservation is inconsistent with the objectives of the NRS for a representative reserve system.

Table 1 provides a summary of the conservation status of the Clarence Lowlands. The subregion has an overall reservation level of 9.4 %, and there has been a loss of 45% of native vegetation. There is a significantly greater loss of native vegetation cover on the floodplain (loss of 60%), and it is the alluvial plain (36.6% native vegetation remaining) and the estuarine plain (35.5%) on the floodplain that has been most impacted.

Although the level of reservation on the floodplain (9.5%) is equivalent to the whole subregion, reservation on the alluvial plain (5.1%) is considerably less than other geomorphic regions (Table 1).

Table 1: Native vegetation cover and conservation status in the Clarence Lowlands subregion

Geomorphic Region	Total Area (ha)	Area extant vegetation (ha)*	% native vegetation remaining	Area in NP Estate (ha)	% region in NP Estate	% extant vegetation in NP Estate
Clarence Lowlands subregion	520,496	287,359	55.2	48,945	9.4	17.0
Floodplain	266,694	107,738	40.4	25,419	9.5	23.6
- Alluvial Plain	219,473	80,368	36.6	11,219	5.1	14.0
- Estuarine Plain	25,283	8,982	35.5	2,853	11.3	31.8
- Coastal Barrier	21,506	18,348	85.3	11,341	52.7	61.8
- Anthropogenic	432	40	9.3	0	0.0	0.0

* Note: large areas of extant floodplain vegetation are also degraded due to drainage and grazing.

Source: Area estimates are based on best available GIS information held by DECC for the Clarence lowlands subregion. Some of these datasets are out of date (e.g. extant vegetation cover) and a review of mapping is recommended.

1.4 Wetland Clusters for Investigation

There were 19 wetland clusters in the Clarence Lowlands that were included in the conservation assessment (Table 2 and Figure 2).

The wetland clusters represent groups of inter-related wetlands and adjacent riparian habitat, with cluster groups defined by their similarity in terms of:

- 1) Hydrology (are hydrologically connected or associated to same river or creek system);
- 2) Spatial proximity (are located close to one another, 'in a cluster');
- 3) Ecological similarity (support similar ecological communities); and
- 4) Geomorphological similarity (have formed due to similar geological processes).

The 19 wetland clusters represent the most outstanding wetland complexes within the Clarence Lowlands as identified from the NRCMA mapping, classification and prioritisation project (Burns *et al.*, 2006), previous surveys (e.g. Goodrick, 1970; Pressey, 1987), existing literature (Burns and Smith, 2004; DECC, 2007; Griffith, 2005; Kingsford *et al.*, 2004; Soros-Longworth and McKenzie, 1980; Tulau, 1999; and West *et al.*, 1985) and expert knowledge.

Major water bodies such as the Clarence River, Richmond River, The Clarence Broadwater and Wooloweyah Lagoon were not included in the assessment, and were therefore not mapped. This is because the focus of the study is on priority areas of land for inclusion in the NRS. However, it is important to note that wetlands considered important for the conservation of major estuaries are described in the report. This includes wetlands where rehabilitation and protection will significantly improve the condition of estuaries such as Wooloweyah Lagoon.

Changes to the boundary of some wetland clusters were recommended in the expert workshop held on 19 August 2008. These recommendations are outlined in the Wetland Profiles (Appendix 3).

Table 2: Wetland clusters within the Clarence Lowlands

Wetland Cluster	Subregion	LGA	Wetland types represented
Clarence River Catchment			
Alamy Creek/Bunyip Creek	Clarence lowlands	Clarence Valley	Swamp Sclerophyll Forest Freshwater Wetland
Chaffin Swamp	Clarence lowlands	Clarence Valley	Swamp Sclerophyll Forest Freshwater Wetland
Clarence Estuary	Clarence lowlands	Clarence Valley	Coastal Saltmarsh Swamp Oak Forest Swamp Sclerophyll Forest Mangrove
Coldstream	Clarence lowlands	Clarence Valley	Swamp Sclerophyll Forest Freshwater Wetland
Coutts Crossing/Orara River	Clarence lowlands	Clarence Valley	Swamp Sclerophyll Forest Freshwater Wetland
Everlasting Swamp	Clarence lowlands	Clarence Valley	Freshwater Wetland Swamp Sclerophyll Forest Swamp Oak Forest
Halfway Creek	Clarence lowlands	Clarence Valley	Swamp Sclerophyll Forest Subtropical Coastal Floodplain Forest Freshwater Wetland
Mangrove Creek	Clarence lowlands	Clarence Valley	Swamp Sclerophyll Forest Mangrove
Shark Creek	Clarence lowlands	Clarence Valley	Swamp Sclerophyll Forest Swamp Oak Forest Subtropical Coastal Floodplain Forest Freshwater Wetland
South Clarence	Clarence lowlands	Clarence Valley	Freshwater Wetland Swamp Sclerophyll Forest
Tabbimoble	Clarence lowlands	Clarence Valley and Richmond Valley	Swamp Sclerophyll Forest Subtropical Coastal Floodplain Forest Freshwater Wetland
The Broadwater	Clarence lowlands	Clarence Valley	Swamp Oak Forest Swamp Sclerophyll Forest Freshwater Wetland Mangrove Saltmarsh
Richmond River Catchment			
Bungawalbin	Clarence lowlands	Clarence Valley and Richmond Valley	Swamp Oak Forest Paperbark Forest Freshwater Wetland Swamp Box and Mahogany Forest
Casino	Clarence lowlands	Richmond Valley	Freshwater wetland
Evans River/Rocky mouth Creek	Clarence lowlands	Richmond Valley	Swamp Sclerophyll Forest Swamp Oak Forest Freshwater Wetland Saltmarsh
Newrybar	Clarence lowlands	Ballina	Dry Sclerophyll Forest Swamp Sclerophyll Forest Wallum sedgelands Wet Heath
Richmond Estuary	Clarence Lowlands	Ballina	Swamp Sclerophyll Forest Saltmarsh Swamp Oak Forest Mangrove
Tuckean	Clarence Lowlands	Ballina and Lismore	Paperbark Forest Freshwater Wetland
Wardell	Clarence lowlands	Ballina	Swamp Sclerophyll Forest Riparian Rainforest Wallum sedgelands

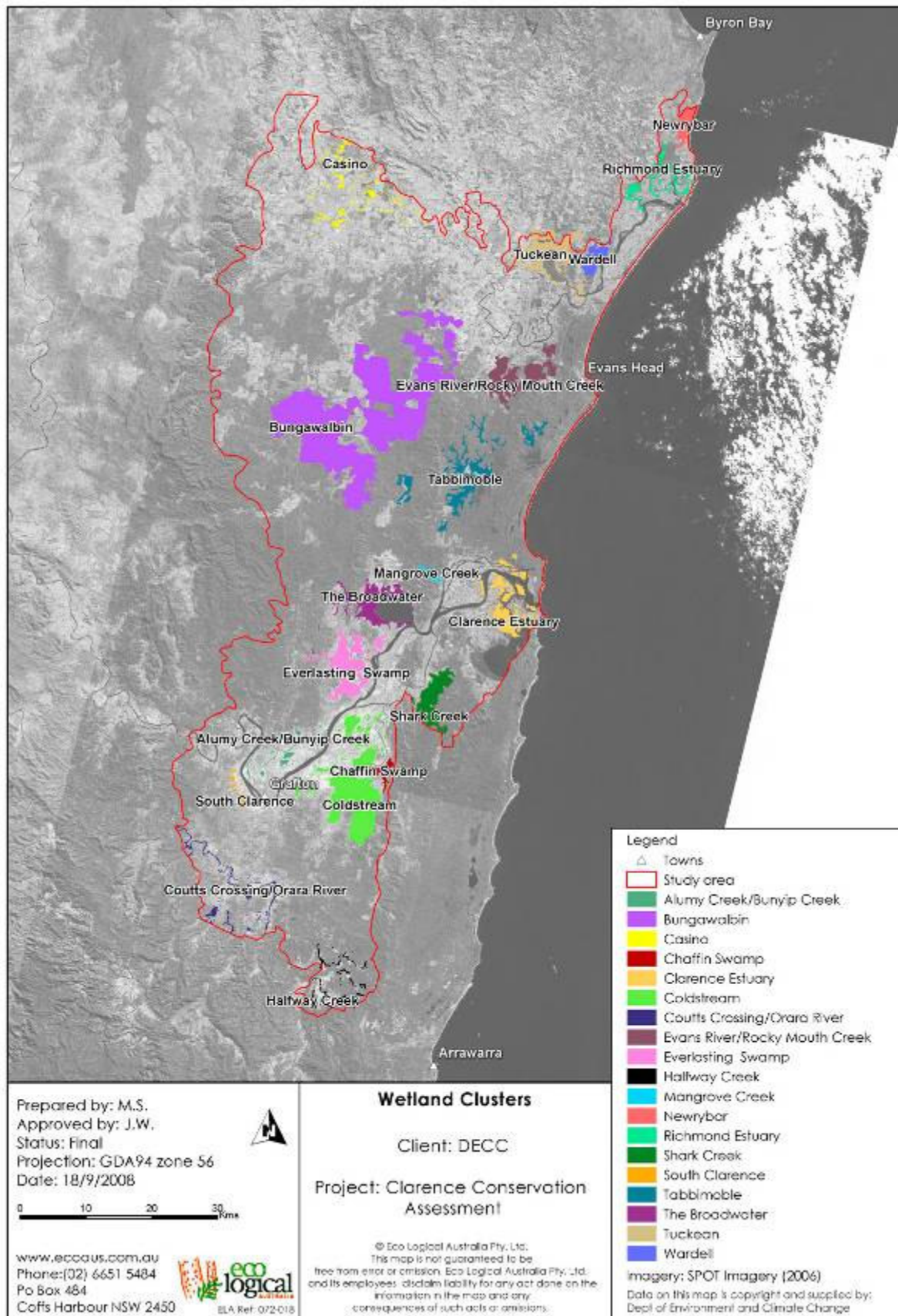


Figure 2: Wetland clusters within the Clarence Lowlands

2. PROJECT BACKGROUND

2.1 Existing Studies

Previous vegetation surveys and mapping within the Clarence Lowlands has largely targeted forest environments and vegetation of quaternary sands, mainly on public land. Flora and fauna survey mapping of wetlands in the Clarence Lowlands subregion remains relatively poor. Detailed surveys are now mostly over twenty years old.

Previous conservation assessments have largely been based on using existing spatial data and developing criteria from which to prioritise wetlands from high-low conservation value. One of the shortfalls or previous wetland assessments has been the reliance on spatial datasets, especially in regions where there is extensive local and expert knowledge.

2.1.1 Pressey (1987)

Pressey (1987) surveyed non-estuarine wetlands on the lower Clarence floodplain. This survey of non-estuarine wetlands on alluvium was part of a detailed inventory of floodplain wetlands in coastal NSW. A total of 755 wetlands were sampled and evaluated based on twelve criteria. These criteria included size, diversity and interspersion of vegetation and habitat types, cover, condition of marginal vegetation, water sources and land use, tenure and special natural values.

A total of 56 wetlands of outstanding value were identified on the Clarence floodplain. Most wetlands were located on freehold land. Grazing had affected almost all the wetlands to some extent and drainage regimes had altered most wetlands.

Wetlands identified in the Clarence Lowlands by Pressey (1987) as having outstanding value are listed below. Some of these wetlands overlap with the 19 wetland clusters in this report (as indicated in italics).

- Bunyip swamp (*Alumy Creek/Bunyip Swamp*);
- Carrs Creek (Junction Hill);
- Alumy Creek (*Alumy Creek/Bunyip Swamp*);
- Southgate Creek (*Alumy Creek Bunyip Swamp*);
- Long Waterhole Creek (*Everlasting Swamp*);
- Everlasting Swamp (*Everlasting Swamp*);
- Sportsman Creek (*Everlasting Swamp*);
- Large Gully;
- The Broadwater (*The Broadwater*);
- Roberts Creek (Woodford Island);
- Waterview Heights (*South Clarence*);
- Cowans Pond (*South Clarence*);
- Upper Coldstream (Harrington Lagoon, McLachlan Waterhole) (*Coldstream*);
- Lower Coldstream (*Coldstream*);
- Glenugie Creek;
- Swan Creek (*Coldstream*);
- Chaffin Swamp (*Chaffin Swamp*);
- Champions Swamp (*Chaffin Swamp*); and
- Shark Creek (*Shark Creek*).

2.1.2 Kingsford et al. (2004)

Kingsford *et al.* (2004) conducted an inventory of wetlands in NSW. Coastal wetlands were mapped using a classification based from satellite imagery and ancillary data. It was estimated that only 9% of wetlands in the Clarence catchment were reserved. Over 20% of wetlands in the Brunswick and Richmond catchments and 10-20% in the Tweed catchment were reserved.

The wetlands mapping was only at a scale of 1:100,000 and did not map some permanent wetlands and many of the temporary wetlands on the coastal floodplain. In addition, the reservation assessment did not appear to recognise the strong bias in wetland conservation towards coastal barrier sands environments.

2.1.3 Griffith (2005)

Griffith (2005) identified 164 wetland communities in a literature review of coastal wetland vegetation of the NSW North Coast. Vegetation communities which were identified included sedgeland, rushland and fernland, grassland, forbland and chenopod shrubland, heathland, shrubland, mallee, forest and woodland vegetation formations.

The reservation status of 71% of all wetland communities were assessed as poor, including wetland plant communities in the Clarence and Richmond valleys.

2.1.4 Burns and Smith (2004)

WetlandCare Australia in partnership with the former Department of Infrastructure Planning and Natural Resources (DIPNR) completed a broad-scale health assessment of targeted wetlands. The resulting mapping and database aimed to assist in developing a register of wetlands and to identify those most suitable for implementation of conservation and restoration strategies.

2.1.5 Burns et al. (2006)

The NRCMA Wetland Mapping, Classification and Prioritisation project completed by WetlandCare Australia aimed to map, classify and prioritise wetlands across the NR CMA area based on existing spatial data. This broad-scale assessment of wetlands identified priority wetland areas, and in the Clarence Lowlands these include the Esk River, Tabbimoble, Jerusalem Creek, Clarence Broadwater and the Lower Clarence Islands (Burns *et al.*, 2006).

2.1.6 DECC (2007)

A targeted vegetation survey of floodplain and lowlands was undertaken by DECC, which aimed to fill gaps in the knowledge of vascular plant biodiversity on the far north coast of NSW. The project included surveys in the northern region of the Clarence Lowlands subregion. A combination of vegetation formation, geology and landform attributes were used to randomly stratify sites, with emphasis on estuarine and alluvial plain and lower slope sites on basalt and high and low sedimentary quartz geology.

A total of 346 sites were sampled and numerically analysed, which lead to derivation of 62 vegetation communities. The vegetation communities identified within the estuarine plain included saltmarsh, mangrove, saline grasslands, reedlands and rushlands. The reservation status of alluvial, estuarine plain and lowland vegetation communities in the Richmond River catchment was assessed as very poor.

Several Endangered Ecological Communities (EECs) were identified:

- Coastal Saltmarsh;
- Freshwater Wetlands on Coastal Floodplains;

- Swamp Sclerophyll Forest on Coastal Floodplains;
- Swamp Oak Floodplain Forest;
- Subtropical Coastal Floodplain Forest;
- Lowland Rainforest on Floodplain;
- *Themeda* Grassland on Sea Cliffs and Coastal Headlands; and
- Littoral Rainforest.

This survey improved knowledge of the floristic, structural composition and environmental influences on these EECs. Nearly 300 records of 50 significant taxa were made during the survey, including 39 threatened plant species, 10 Rare or Threatened Australian Plant (ROTAP) species and a number of other rare species, including species at the limit of their distribution.

2.1.7 Other Studies

The environmental values of areas within the Lower Clarence have been recognised for some time. Goodrick (1970) recommended the preservation or rehabilitation of a number of wetland areas, including at Everlasting Swamp and the upper reaches of Shark Creek. Soros-Longworth & McKenzie (1980) identified a number of wetland areas of high conservation value, including Everlasting Swamp, The Broadwater, swamps of the Coldstream River, Shark Swamp, and Wooloweyah Lagoon and associated channels and islands. West *et al.* (1985) mapped estuarine wetlands, including saltmarsh, mangroves and seagrasses, along the NSW coast including the lower Clarence (Tulau, 1999).

Richmond Valley Council recently undertook mapping and assessment of the conservation values of the wetlands within their jurisdiction. The boundary of the study area included all of the Richmond Valley LGA excluding NP Estate and State Forests. It encompassed 305,100 ha, within which a total of 10,705 hectares of wetlands was mapped. These wetlands comprised 13 wetland types, and 885 individually mapped wetlands were considered highly significant, 10% of which were significant on a regional basis (Chenoweth, 2007).

2.2 Restoration Projects

Numerous wetland restoration projects within the Clarence Lowlands have been completed over the past few years. This includes projects undertaken by the Northern Rivers Catchment Management Authority (NRCMA), WetlandCare Australia, DPI-Fisheries, local councils and DECC. Refer to Appendix 1 for further details of recent wetland restoration projects.

2.3 NSW Planning Context

A range of planning instruments applies to the Clarence Lowlands, including State Environmental Planning Policies (SEPPs), Regional Environmental Plans (REPs) and Local Environmental Plans (LEPs). Other plans and policies that may apply are also listed.

2.3.1 State Environmental Planning Policies

SEPP 14 – Coastal Wetlands

SEPP No. 14 – Coastal Wetlands, was enacted in 1985 to protect the conservation values of remaining coastal wetlands in NSW. This was amid concerns that this ecosystem type had experienced considerable depletion and degradation due to unfavourable land use practices.

Of the mapped coastal wetlands, 22,754 hectares of SEPP 14 wetlands are located in the Clarence Lowlands with 9,216 hectares of this located within the wetland clusters (Figure 3).

SEPP 26 – Littoral Rainforest

SEPP 26 – Littoral Rainforest was enacted in 1988 to provide a mechanism for the consideration of applications for development that are likely to damage or destroy littoral rainforest areas with a view to the preservation of those areas in their natural state. The policy applies to land described in maps administered by the Department of Planning and to land within a distance of 100 metres from the edge of the mapped area except residential land.

Of the mapped littoral rainforest, 70 hectares of SEPP 26 rainforests are located in the Clarence Lowlands subregion with 2.4 hectares of this located within the Newrybar wetland cluster (Figure 3).

SEPP 71 - Coastal Protection

SEPP 71 – Coastal Protection was enacted in 2002 and predominately aims to protect and manage the natural, cultural, recreational and economic attributes of coastal NSW.

2.3.2 Regional Environmental Plans

The Clarence Lowlands lies within the jurisdiction of the North Coast Regional Environmental Plan (REP). The Plan aims to develop regional policies that protect the natural environment, encourage an efficient and attractive built environment and guide development into a productive yet environmentally sound future. The REP outlines the catchment management development controls that local councils must abide by when dealing with land containing rivers, streams, wetlands or fishery habitats.

2.3.3 Local Environmental Plans

Relevant LGAs include the Clarence Valley, Richmond Valley, Lismore, Ballina, Byron and Kyogle Shire LGAs. The former council's of Casino, Copmanhurst, Grafton, Maclean, Pristine Waters and Richmond River were amalgamated into the Clarence and Richmond Valley Council. Numerous LEPs exist within these areas and may apply. These include:

- Ballina LEP 1987;
- Byron LEP 1988;
- Casino LEP 1992;
- Copmanhurst LEP 1990;
- Grafton LEP 1988;
- Kyogle IDO 1976;
- Lismore LEP 2000;
- Maclean LEP 2001;
- Nymboida LEP 1986;
- Richmond River LEP 1992; and
- Ulmarra LEP 1992.

Notably, a number of LEPs do not contain specific zoning to provide for environmental and wetland protection.

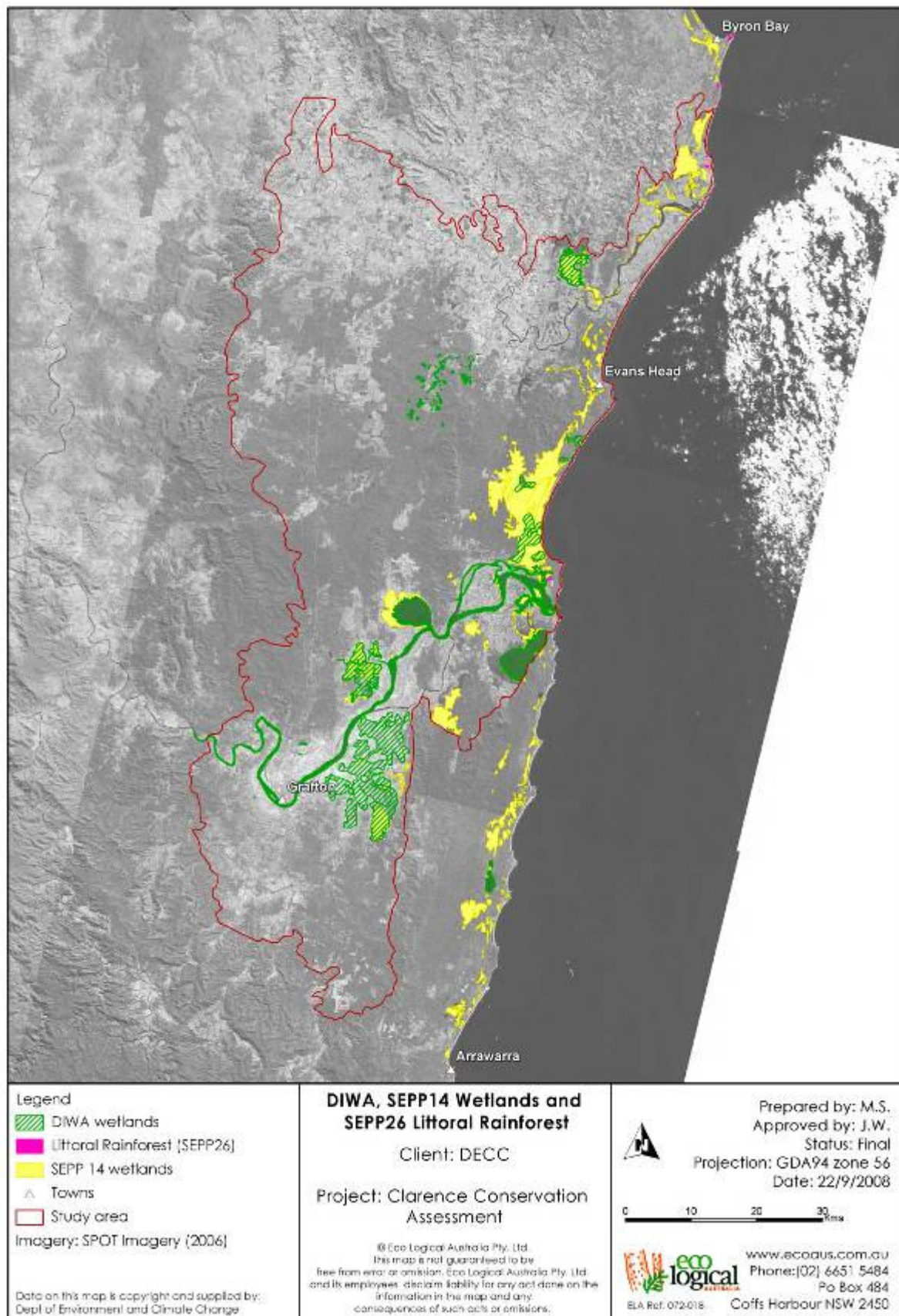


Figure 3: DIWA, SEPP 14 Wetlands and SEPP 26 Littoral Rainforest located within the study area

2.3.4 Plans of Management (PoM)

The *National Parks and Wildlife Act 1974* requires that a PoM be prepared for each National Park (NP) and Nature Reserve (NR). PoM outline how the natural and cultural heritage values within an area will be managed. Relevant PoMs include:

- Lennox Head Aboriginal Area PoM;
- Broadwater NP, Bundjalung NP and Iluka NR PoM;
- Yuraygir NP and Yuraygir State Conservation Area PoM;
- Ballina NR PoM;
- Tuckean NR PoM; and
- Richmond River NR PoM.

2.3.5 Estuary Management Plans

The Clarence River, its estuary and coastal floodplain comprise the largest coastal river system in NSW. The Clarence Estuary Management Plan (EMP) was developed in 2003 with significant community involvement. The EMP seeks to build on the achievements to date, and to guide the management process so that the community's aspirations can be met and maintained in the long-term (Umwelt, 2003).

Evans River EMP was developed in 2002 on behalf of the Evans River Coastline and Estuary Management Committee, Richmond Valley Council and the former Department of Land and Water Conservation (DLWC). The Plan provides a program of strategic actions to assist government authorities and other stakeholder groups to sustain a healthy estuary through appropriate waterway, foreshore and catchment management (Haines and Nelson, 2002).

The Richmond River EMP is also currently under development.

2.3.6 Other Policies and Strategies

The NSW Wetlands Management Policy 1996 is one of the component policies of the *NSW State Rivers and Estuaries Policy*, and outlines objectives for the wise use, best management practice and rehabilitation of wetlands.

In addition to this policy, other policies and strategies that may apply to the study area include:

- NSW Reserve Establishment Plan;
- NSW Water Conservation Strategy;
- NSW State Rivers and Estuary Policy;
- NSW Water Quality and River Flow Objectives;
- Far North Coast Regional Strategy; and
- Draft Mid-North Coast Regional Strategy.

2.4 National and International Planning Context

2.4.1 International Agreements – Migratory Birds

The first two bilateral agreements relating to the conservation of migratory birds were formed with the Government of Japan in 1974 and the People's Republic of China in 1986. The Japan Australia Migratory Bird Agreement (JAMBA) and China Australia Migratory Bird Agreement (CAMBA) agreements list terrestrial, wetland and shorebird species which migrate between Australia and the respective countries. Most recently an agreement with the Republic of Korea and Australia was formed in July 2007 (Republic of Korea Australia Migratory Bird Agreement - ROKAMBA).

Each of these agreements provide for the protection of migratory birds from take or trade except under limited circumstances, the protection and conservation of habitats, the exchange of information, and building cooperative relationships. The majority of listed species are shorebirds (DEWHA, 2008). There are approximately 60 species listed under migratory bird agreements in the Clarence Lowlands.

2.4.2 Ramsar and DIWA Wetlands

The signing of the Convention on Wetlands occurred in 1971 at Ramsar, Iran. Since then, the Convention on Wetlands has taken the common name of the Ramsar Convention. The Ramsar Convention's broad aims are to halt the worldwide loss of wetlands and to conserve through wise use and management those that remain. Australia currently has 65 Wetlands of International Importance listed under the Ramsar Convention covering approximately 7.5 million hectares. However, there are currently no Ramsar-listed wetlands in the Clarence Lowlands.

The Directory of Important Wetlands in Australia (DIWA) is a cooperative project involving the Australian and state and territory governments. It is coordinated by the Australian Government Department of Environment, Water, Heritage and the Arts (DEWHA) and was first published in 1993. DIWA identifies nationally important wetlands and documents their key attributes. At present, nine wetlands in the Clarence Lowlands are DIWA listed (Figure 3). These include Alamy Creek/Bunyip Swamp, The Broadwater, Clarence River Estuary, Bundjalung National Park, Cowans Pond, Everlasting Swamp, Lower Bungawalbin Creek, Tuckean Swamp and Wooloweyah Lagoon (Environment Australia, 2001).

2.4.3 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) established a legislative framework that allows the Australian Government to manage environmental protection through an assessment and approvals process; and biodiversity conservation through species and site listing, recovery and management planning.

Under the EPBC Act any action that has, will have, or is likely to have a significant impact on a matter of National Environmental Significance (NES) is required to undergo an assessment and approvals process. Matters of NES cover a range of issues including Ramsar wetlands and migratory species listed under international treaties.

Similarly, the EPBC Act allows for the preparation of wildlife conservation plans, which may be of assistance in the management and protection of listed migratory waterbirds. The Act also provides for the development of plans to conserve listed species, of which the *Wildlife Conservation Plan for Migratory Shorebirds* was the first to be made under the Act in 2006.

2.4.4 International Conventions

The Convention on the Conservation of Migratory Species of Wild Animals (also known as the Bonn Convention) aims to conserve terrestrial, marine and avian migratory species throughout their range. The Convention on Biological Diversity is an international treaty that was adopted in Rio de Janeiro in June 1992. The objective of the Bonn Convention is to develop national strategies for the conservation and sustainable use of biological diversity. Australia is a signatory to both the Bonn Convention and the Convention on Biological Diversity.

2.4.5 National Strategies and Plans

Wetlands Policy of the Commonwealth Government of Australia

The Wetlands Policy of the Commonwealth Government of Australia forms a platform for the development of a national framework of wetland policies and strategies. An Implementation Plan for the Commonwealth Wetlands Policy has been developed.

Directions for the National Reserve System

Directions for the National Reserve System - A Partnership Approach (the Directions Statement) has been prepared to assist government agencies, non-government organisations and the community in the ongoing development of the National Reserve System, and delivery of the National Reserve System Program (NRSP).

The Directions Statement outlines a strategic national approach for making quantifiable progress towards the establishment and management of a comprehensive, adequate and representative protected area system.

Climate Change Action Plan

In 2001 The Review of the National Strategy for the Conservation of Australia's Biological Diversity (ANZECC 2001) identified the need to Plan to minimise the potential impacts of human-induced climate change on biological diversity. The National Biodiversity and Climate Change Action Plan 2004 – 2007 has also been developed, which has objectives to:

- Identify priority areas for research and monitoring, and improve understanding of potential climate change impacts on biodiversity to a point where specific strategies can be developed ;
- Use existing knowledge about the impacts of climate change and draw from ecological principles to review and amend current biodiversity conservation policies and strategies;
- Improve communication about the impacts of climate change on biodiversity between researchers, resources managers and decision makers; and
- Raise community awareness of the potentially significant and specific impacts of climate change on biodiversity.

3. CONSERVATION VALUES AND THREATS

General information on conservation values (3.1) and threats (3.2) for the Clarence Lowlands subregion is described in this section.

However, more detailed information on conservation values and threats for the 19 wetland clusters assessed in the Clarence Lowlands are described in individual wetland profiles (Appendix 3). These profiles make up a large component of this report (65 pp.) and include specific information on threatened species, hydrology and key threatening processes. The potential contribution of wetland clusters to meeting the NRS objectives is also described.

The information provided in section 3.1, section 3.2 and the profiles was collated from existing spatial data (e.g. Atlas records, drainage layers, soils mapping) and from local knowledge. The draft profiles were substantially updated following the expert panel workshop in Grafton during August 2008.

3.1 Conservation Values

3.1.1 Hydrology

Major rivers in the study area include the Richmond, Clarence and Evans Rivers. These river systems contain both freshwater and tidal (estuarine) inflows.

It is important to identify the hydrological values of each individual wetland, and understand the water requirements of native fauna and flora. Protection of the water regime (frequency, duration and extent of inundation) and the salinity regime (fresh or intertidal/estuarine) is an important driver for the conservation of wetland biodiversity in the Clarence lowlands and for determining the potential contribution of wetlands to the NRS.

Macro Water Sharing Plans (WSP) under the *Water Management Act 2000* (WMA Act) are currently under development for the Clarence River Catchment and Richmond River Catchment (H. Robertson pers. comm. 2008). The only formally gazetted plan under the WMA Act for the Clarence Lowlands is the Alstonville Basalt Plateau Groundwater Source WSP.

Appendix 3 provides further information on the drainage impacts and hydrology/water source (i.e. fresh or intertidal/estuarine) for the 19 wetland clusters in the Clarence lowlands.

3.1.2 Flora

Over 71 plant species within the study area are listed on the TSC Act and many of these are also nationally listed species on the EPBC Act (refer Appendix 3).

There is a high level of endemism of rainforest trees and shrubs in the study area and many plant species reach the southern limit of their distribution. Some examples include Giant Waterlily *Nymphaea gigantea*, endangered Weeping Paperbark *Melaleuca irbyana*, *Hygrophila angustifolia* and Mangrove Fern *Acrostichum speciosum*. The Water Plantain *Alisma plantago-aquatica* is at its most northern limit of distribution.

Threatened species mainly dependent on wetlands include the endangered Spider Orchid *Dendrobium melaleucaphilum*, endangered Southern Swamp Orchid *Phaius australis* and vulnerable *Maundia triglochinosides*.

3.1.3 Fauna

There are many species of birds, fish, frogs, mammals and reptiles that depend on wetlands for breeding habitat, shelter, foraging sites, and movement corridors in addition to wetland dependent plant species. Fauna largely dependent on wetlands include the Black-necked Stork, Comb-crested Jacana, Magpie Goose and Painted Snipe.

Over 103 fauna species within the Clarence Lowlands subregion are listed on the TSC Act and a number of these species are nationally listed on the EPBC Act (refer Appendix 3). Approximately 60 species listed on migratory bird agreements (JAMBA, CAMBA and ROKAMBA) have also been observed, with significant foraging and breeding habitat for migratory waders located in the Clarence River estuary and Richmond River estuary.

The Mitchell's Rainforest Snail *Thersites mitchellae* is identified as occurring within the Clarence Lowlands and this species is listed as critically endangered on the EPBC Act. The endangered Oxleyan Pygmy Perch *Nannoperca oxleyana* is also recorded in the Clarence Lowlands subregion.

3.1.4 Ecosystems

The Clarence Lowlands contains a wide variety of wetland vegetation communities including Swamp Oak Forests, Coastal Saltmarsh and Mangrove Forests on the estuarine plain, Swamp Sclerophyll Forests and Freshwater Wetlands, Lowland subtropical and dry 'gallery' floodplain rainforest on the alluvial plain, and Wallum heaths, Swamp Sclerophyll Forests, and Sedgeland on the coastal barrier sand systems.

However, there has been a significant loss of wetland and lowland ecosystems in the study area and the majority of remaining ecosystems are listed as Endangered Ecological Communities (EECs) under the TSC Act. Ten (10) EECs are present in the Clarence Lowlands study area, specifically:

- Coastal Saltmarsh;
- Swamp Oak Floodplain Forest;
- Freshwater Wetlands on Coastal Floodplains;
- Littoral Rainforest;
- Lowland Rainforest;
- Subtropical Coastal Floodplain Forest;
- Swamp Sclerophyll Forest on Coastal Floodplains;
- Lowland Rainforest on the Floodplain;
- Coastal Cypress Pine Forest; and
- *Themeda* grassland on seacliffs and coastal headlands.

There is approximately 55% of native vegetation remaining in the Clarence Lowlands and only 40% remaining on the floodplain (Table 1, pg. 9). Although there are no reliable datasets to estimate the natural (pre-1750) extent of different ecosystems in the Clarence Lowlands, the pre-1750 extent of wetlands across the larger Northern Rivers CMA region has been previously calculated (Table 3). There has been significant loss of Estuarine Wetlands, Freshwater Wetlands, and Swamp Sclerophyll Forest in the CMA region, with between 60% and 80% of wetlands lost. Although it is important to note that Freshwater Wetlands (Table 3) includes both open freshwater swamps and wet heath, which may distort area calculations.

Table 3: Conservation status of estuarine wetlands, freshwater wetlands and Swamp Sclerophyll Forest in the Northern Rivers CMA region

Ecosystem	Pre-1750 Area (ha)	Area extant vegetation (ha)*	% Extant vegetation remaining
Estuarine wetlands (mangrove / saltmarsh)	53,600	8,631	16.1
Freshwater wetlands	113,668	46,506	40.9
Swamp Sclerophyll Forest (incl. Swamp Oak)	226,608	72,544	32.0

Source: Area estimates are based on best available GIS information held by DECC for the NRCMA region. There are recognised inaccuracies in vegetation mapping of wetlands therefore the information is only indicative and a review of mapping is recommended.

The conservation status of Estuarine Wetlands, Freshwater Wetlands, and Swamp Sclerophyll Forest in the Clarence Lowlands is presented in Table 4. Notably, only between 19% and 28% of the extant wetland vegetation is protected in the National Park estate (Table 4). This means that many of the remaining wetlands occur on private land or unreserved crown land. The conservation status of wetland ecosystems would be substantially lower if it was based on pre-1750 vegetation extent.

Table 4: Conservation status of estuarine wetlands, freshwater wetlands and Swamp Sclerophyll Forest in the Clarence Lowlands subregion

Ecosystem	Pre-1750 Area (ha)	Area extant vegetation (ha)*	% native vegetation remaining	Area in NP Estate (ha)	% pre-1750 in NP Estate	% extant vegetation in NP Estate
Estuarine wetlands (mangrove / saltmarsh)	unknown	1,989	unknown	386	unknown	19%
Freshwater wetlands	unknown	17,555	unknown	4,054	unknown	23%
Swamp Sclerophyll Forest (incl. Swamp Oak)	unknown	25,945	unknown	7,210	unknown	28%

Refer to Table 1 for information on the total floodplain area in the Clarence lowlands

* Note: large areas of extant floodplain vegetation are degraded due to drainage and grazing.

Source: Area estimates are based on best available GIS information held by DECC for the Clarence lowlands subregion. There are recognised inaccuracies in vegetation mapping of wetlands therefore the information is only indicative and a review of mapping is recommended.

3.1.5 Conservation Mechanisms

There is a wide variety of conservation mechanisms and programs available to protect high conservation value ecosystems and landscapes across NSW (DECC, 2008).

These include:

- National Parks and Nature Reserves;
- Wilderness Areas;
- Flora Reserves;
- Private Land Agreements including Voluntary Conservation Agreements, Property Agreements, Wildlife Refuges and Covenants;
- Regional Parks; and
- Historic Sites/Aboriginal Areas;

Approximately 9.4% of the Clarence Lowlands subregion is currently within the NP Estate, although there is a bias towards the protection of the habitats of forest environments of the escarpment and of coastal sand barriers. For the purposes of the project, national parks and reserves have not been included in the wetland clusters although there are approximately 51,851 hectares of protected reserves in the Clarence lowlands. Recent additions in the study area have resulted in 15,000 hectares being added to reserves, including several coastal lowland and wetland reserves. These include Bundjalung State Conservation Area (SCA), Bungawalbin NP, Bungawalbin NR, Everlasting Swamp SCA, Jackywalbin SCA, Tabbimoble Swamp NR, and Yaegl NR. Most of these additions were as a result of finalization of the Comprehensive Regional Assessment (CRA)/Regional Forest Agreement (RFA) process for Forest Management Zone (FMZ) areas and forest icons. Yaegl NR, Everlasting Swamp SCA and Yarrigully NR were purchased under the National Reserve System program.

In terms of private land agreements, there are currently 22 wildlife refuges and eight conservation agreements within the Clarence Lowlands. The CMA also has Property Vegetation Plan (PVP) agreements for 108 ha under the Bush Recovery Program and a further 313.5 ha of other PVPs. Landholder Management Agreements in accordance with the Conservation Contract Program encompass a total area 133 ha (see Figure 4). The Nature Conservation Trust of NSW is also working to establish a number of properties under covenant in the Clarence Lowlands.

Table 5 outlines the land tenures that apply to the wetland clusters in the Clarence Lowlands.

Table 5: Land tenure within the wetland clusters

Wetland cluster	Total wetland area (ha)	Area within State Forests (ha)	Area within Crown Land (ha)	Area under private land conservation (ha) [^]
Alumy Creek/Bunyip Creek	856	-	171	-
Bungawalbin	26,966*	8713	591	-
Casino	1464	-	0	30
Chaffin Swamp	348	-	2	-
Clarence Estuary	3,043	-	616	37
Coldstream	8,006*	-	205	-
Coutts Crossing/Orara River	1269	-	168	-
Evans River/Rocky mouth Creek	3,534	-	125	-
Everlasting Swamp	3,932	-	73	-
Halfway Creek	669	-	0	-
Mangrove Creek	343	51	0	30
Newrybar	995	-	295	-
Richmond Estuary	1,623	-	171	-
Shark Creek	2,687	8	17	-
South Clarence	212	-	6	8
Tabbimoble	4,063	1500	0	-
The Broadwater	2,449	-	504	-
Tuckean	3,550	-	574	-
Wardell	1,095	-	55	-
TOTAL	86,864	10,272	3,575	105

[^]Areas under private land conservation include wildlife refuges, voluntary conservation agreements, LMAs and PVPs.

* Area calculations may include adjacent non-wetland ecological communities.

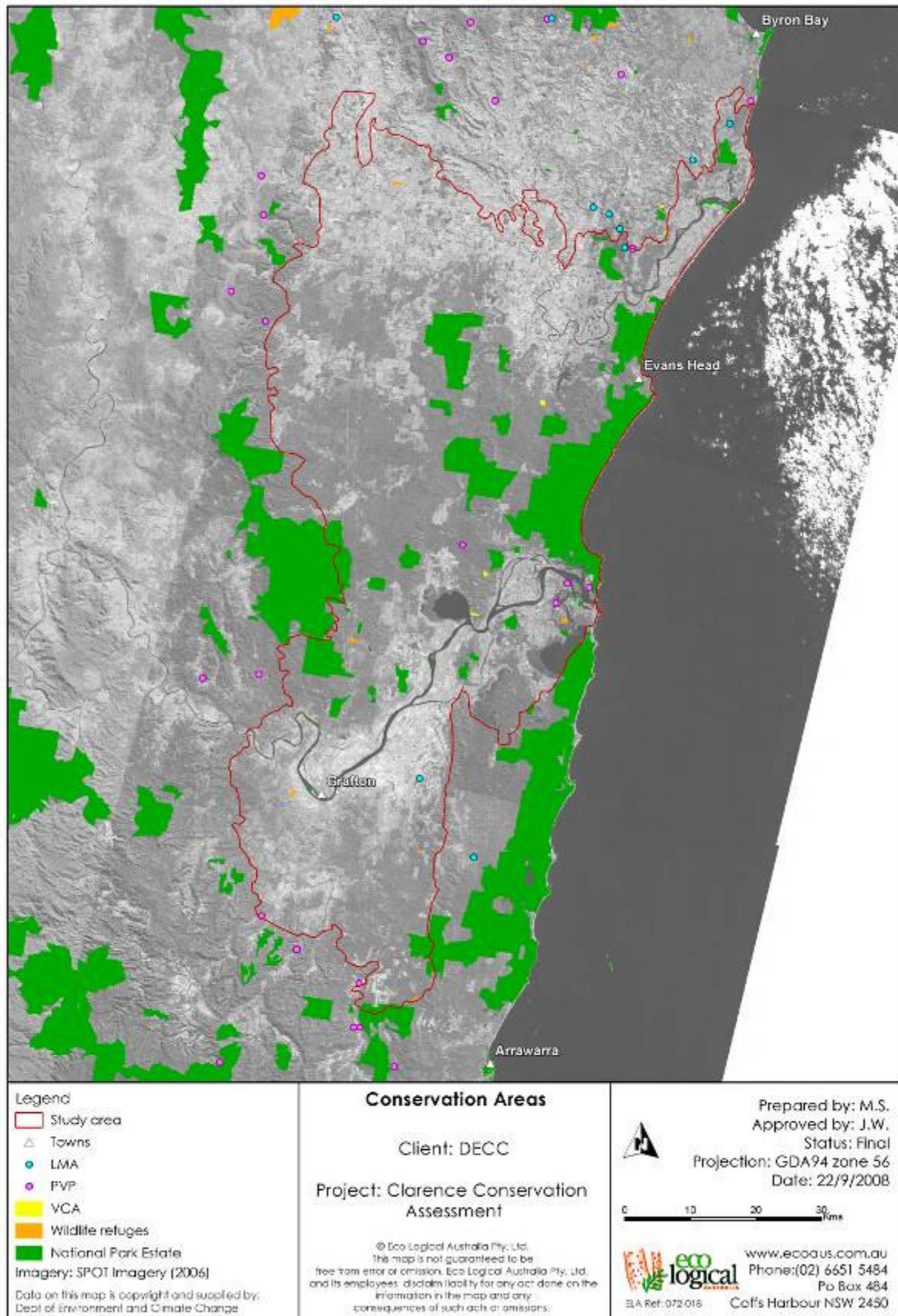


Figure 4: Conservation Mechanisms within the study area

3.2 Threats

A variety of threats face wetlands in the Clarence Lowlands including catchment-scale and site-specific threats. These include drainage, acid sulphate soils, urban development, pollution, feral pests, weed species and poor land management practices. Wetland loss and/or degradation can result in habitat loss, reduced water quality, sedimentation, changed hydrologic regime and disrupted water bird and fish breeding cycles. Many of these threats could be managed and reduced through landholder education, management planning and on-ground rehabilitation (Burns and Smith, 2004).

3.2.1 Acid Sulphate Soils

Acid sulfate soils (ASS) are naturally occurring sediments and soils containing iron sulfides (principally pyrite) and/or their precursors or oxidation products. The exposure of the sulfides to oxygen by drainage or excavation leads to the generation of sulfuric acid. Tulau (1999) identified several priority areas for ASS management in the lower Clarence system including Everlasting Swamp, Shark Creek, Alamy Creek and the lower estuary. Much of the potential ASS does not pose a significant risk to wetlands or water quality in the Clarence Lowlands. However actual ASS poses a substantial threat. Much of the high risk ASS is under active management via CMA, local council and DECC funded catchment management programs.

3.2.2 Water Quality

Water quality is one of the major threats to wetlands of the Clarence Lowlands. Because of the high rainfall compared to other areas of Australia many of the important wetlands in the region still receive frequent inflows of freshwater. However, the quality of that water can vary considerably. Nutrients, dissolved oxygen, heavy metals, pH and salinity levels are the main water quality variables that can affect the condition of coastal wetlands in the region.

Barriers to flow can result in a change in salinity levels which can limit the species of flora and fauna that occur. For example, various weirs in the Clarence Lowlands limit tidal exchange which in turn have made some backswamps become more fresh (decreased salinity).

Changes in catchment management have also led to significant nutrient inputs to aquatic ecosystems. Elevated nitrogen and phosphorus levels can cause a shift in the vegetation community and promote the establishment of aquatic weeds. Loss of aquatic vegetation is also a contributing factor to low dissolved oxygen levels. Drops in available oxygen can have catastrophic effects on native fish and other aquatic fauna.

3.2.3 Non-sustainable Grazing

Wetlands can provide valuable grazing land. However, overgrazing can degrade conservation values through loss of vegetation (grazing and trampling), compacting soil, disturbing sediments and increasing nutrient levels. Many freshwater wetlands in the Clarence Lowlands, especially those areas supporting wet pasture species (fresh meadows) are currently used for cattle grazing. However, many of these freshwater wetlands still retain significant conservation values. Establishing an appropriate grazing regime for those wetlands managed for conservation outcomes as well as agriculture will form an important component of management agreements relating to private land conservation. Forested wetlands are not as heavily grazed in the Clarence Lowlands.

3.2.4 Pest Plants

Aquatic weeds are a major threat to wetlands in the Clarence Lowlands. Aquatic weed species such as Water Hyacinth (*Eichhornia crassipes*), Salvinia (*Salvinia molesta*), Spiny Rush *Juncus acutus* and Parrot's Feathers *Myriophyllum aquaticum*, have resulted in a significant loss of

habitat for native flora and fauna. The feasibility of controlling infestations of aquatic weeds at different wetlands is considered an important factor in determining management priorities. For example, the isolation of wetlands from areas of known infestation therefore may be a key determinant.

Terrestrial weeds such as Bitou Bush, Groundsel, Camphor Laurel, vine weeds and introduced pasture grasses are also widespread in the Clarence Lowlands. Some species have been listed as key threatening processes under the TSC Act (DECC, 2008).

3.2.5 Invasive Pest Animals

Introduced animals are believed to have caused the decline or extinction of many native species. Throughout the Clarence Lowlands pest species are fairly widespread, and include cane toads, foxes, rabbits, feral pigs, feral cats and wild dogs. Other pest animals that may occur in the study area include feral bees, feral goats, feral horses, introduced ants, introduced rats and plague minnows (DECC, 2008).

3.2.6 Fire

Fire is a natural process and many native species have adapted to survive and regenerate in a fire prone environment. Historically lightning would have caused the majority of fires. There is now an increased occurrence of fires in some areas due to deliberate and accidental fires caused by humans. The growing need to contain fires to a small size and suppress bushfires to protect life and property are also changing the natural fire regime. This regime will potentially be further influenced by the onset of climate change which predicts more extreme fire weather conditions (DECC 2008). In general, however, the ecological fire requirements of wetlands in the Clarence Lowlands are not well understood.

3.2.7 Drainage and Barriers to Flow

Possibly the greatest impact on the water regime of wetlands in the Clarence Lowlands has come from drainage and barriers to flow. The floodplains of the Richmond River and Clarence River have been extensively drained for agriculture and flood control. While floodgates and weirs were installed on a number estuarine creeks and rivers to limit the extent of tidal exchange and reduce the extent of flooding.

Drainage and the barriers to flow have consequently reduced the extent and duration of inundation (reduced water availability), affecting the regeneration of wetland vegetation and limiting habitat for native fauna. Barriers to flow have also altered the salinity regime in many wetlands and restricted the connectivity between aquatic habitats for fish and macro invertebrates.

Detailed information on the drainage and hydrology for each of the 19 wetland clusters is provided in the profiles in Appendix 3.

3.2.8 Change in Land Use

Rural, urban and industrial development resulting in a change in land use remains a threat to wetland ecosystems of the NSW North Coast. Development and illegal clearing of vegetation can result in loss of vegetation, dredging and indirect environmental affects (e.g. sedimentation). Change in land use in the catchment surrounding the wetland from activities such as agriculture and forestry to more intensive land (e.g. rural residential) can also lead to changes in the patterns of water flow (e.g. increased number of farm dams), increased sediment runoff and decreased buffer zones around wetlands.

3.2.9 Pacific Highway Upgrade

The Pacific Highway upgrade is one of the largest infrastructure projects in NSW, which includes sections of highway in the Clarence Lowlands. The proposed highway upgrade routes may pass through some wetland areas in the Coldstream and Tabbimoble wetland clusters. Other wetlands may also be impacted.

Identifying those wetlands, and wetland processes (e.g. hydrology) likely to be impacted by the highway upgrade is important for conservation planning. This includes identifying critical habitat and corridors for native flora and fauna such as the endangered Coastal Emu population. This report and conservation assessment may provide assistance in describing the impact of the highway on important wetlands and endangered ecological communities. This report may also inform decisions about potential offset areas.

3.2.10 Climate Change

Climate change could pose a major threat to coastal wetlands. In a recent assessment of risks from climate change, coastal wetlands were identified as a regional priority for conservation (Dunlop and Brown 2008). Impacts associated with climate change which pose a significant threat to wetlands includes:

- Sea level rise, which is likely to cause erosion and inundation of areas immediate to the coast. This effect may be exacerbated if storm intensity increases. Saline incursion into groundwater is likely to occur and tidal limits in estuaries may extend inland.
- Alterations to hydrology, for example, changes to rainfall, runoff, stream flow and soil moisture. Conditions predicted to be drier overall, with seasonal drying more extreme.
- Increased fire frequency, intensity and extent. This has the potential to cause major changes to structure and species composition to wetland ecosystems.
- The arrival of new species in the region, with the potential for major changes in species composition and abundance.

Potential impacts of climate change on wetland ecosystems in the Clarence lowlands are summarised in Table 6. This provides a preliminary basis for setting priorities between different wetland types when considered as part of a broader prioritisation framework (e.g. IBRA). For further discussion on adaptation to climate change, particularly in reference to the protection of wetland ecosystems in the Clarence lowlands refer to Section 5.2.

Table 6: Climate change and the impacts on wetland ecosystem types

Ecological Community	Potential reasons for changes to structure, species composition and extent
Coastal Heath Swamps	Sea level rise, saline intrusion, temperature increase, evaporation increase and altered fire regimes
Coastal Freshwater Lagoons	Sea level rise, temperature increase, evaporation increase
Coastal Swamp Forests	Sea level rise, saline intrusion, temperature rises, CO ₂ fertilisation, altered fire, storms
Coastal Floodplain Wetlands	Sea level rise, saline intrusion temperature rises, CO ₂ fertilisation, altered fire regime and changes in storm behaviour
Riverine Forests	Sea level and temperature rises, CO ₂ fertilisation, altered fire regime and changes in storm behaviour
Mangroves	Inundation, temperature rises, availability of new habitat
Saltmarshes	Inundation, new habitat limited.
Wallum Sand Heaths	Sea level rise, storm events, increased evaporation and changes to fire regimes

4. CONSERVATION VALUES AND THREATS ASSESSMENT

4.1 Introduction

A framework has been developed to evaluate the conservation values and threats to wetlands in the Clarence Lowlands subregion.

This framework assists with the identification of high priority wetland clusters for the NRS.

Several previous wetland assessments have been carried out on a subset of the Clarence Lowlands, or where the Clarence Lowlands are a subset of the assessment. These assessments were described in section 2.1 of this report (pg. 12). For the purposes of this project, components of these previous projects have been consolidated to form a framework that is applicable for informing on key areas for future acquisition and/or protective zoning and the development of a NRS.

The national and international literature also documents a number of other methods to assess conservation priorities for aquatic ecosystems (e.g. Butcher and Hale 2005, Fitzsimons and Robertson 2005, Abell 2007, etc). This rapid development of prioritisation approaches highlights the need to develop a consistent methodology across Australia for identifying the values of aquatic ecosystem at different spatial scales (e.g. within subregions, catchments, climate zones), which has been the topic of recent discussions by both state and federal governments (DEWHA 2008, Gillagan 2006, SKM 2007).

4.2 Assessment Methodology

The assessment framework has been developed to assist prioritisation of the wetland clusters for a variety of purposes. This includes identifying potential sites for land acquisition and private land conservation, as well as identifying important areas for other specific attributes (e.g. threatened species).

Wetland clusters were assessed for their conservation value using a variety of ecological and other conservation criteria. The criteria used are weighted. Wetland clusters were also assessed for the potential threat that exists using several threat criteria. Refer to section 4.3.2.

An expert panel was also utilised to validate information used in the assessment framework during a workshop in Grafton, NSW on 19 August 2008. Panel members included representatives from local councils, government agencies (e.g. CMA, NPWS) and independent ecologists. The expert panel was divided into a Clarence and Richmond River group based on their particular expertise (Appendix 2). Each group were then given a set wetland clusters and asked to discuss the conservation values and threats to different wetlands. During the workshop some additional wetlands areas were identified that were subsequently incorporated. For further information on the expert panel workshop refer to Appendix 2.

The information provided can be used to prioritise the importance of each wetland cluster according to the end use desired. That is, in some circumstances it may be decided to only use a subset of the conservation value criteria.

4.2.1 Conservation Values and Threatening Process Data

A variety of data was used to develop GIS information of conservation values and potential threats. Each layer was intersected with the wetland cluster mapping layer to provide information about the characters of each wetland and the degree to which wetlands are impacted by nearby threatening processes.

Conservation values were based on a number of datasets including:

- Presence of terrestrial or aquatic threatened fauna and fauna species (listing on DECC Wildlife Atlas, EPBC Protected Matters search tool, expert knowledge and in relevant plans. NB: Assessment based only on the 'known or near species' within the profiles (Appendix 3));
- Migratory Bird Species (JAMBA, CAMBA and ROKAMBA);
- National Importance (DIWA listing);
- SEPP 14 Wetland (SEPP 14 mapping); and
- Adjacency (desktop analysis and mapping).

Threat status was based on a variety of spatial datasets that were used as surrogates to characterise potential threatening processes occurring in and around wetlands. Datasets to be included in this analysis include:

- Surrounding Land use (as determined during mapping);
- Land use change (as determined during mapping and expert knowledge);
- Drainage Impacts (previous assessments, literature and expert knowledge);
- Barriers to flow and fish passage (as determined during GIS analysis and expert knowledge);
- ASS hazard (as determined during analysis, previous assessments and expert knowledge); and
- Introduced weed species (listing on DECC Wildlife Atlas, previous assessments and expert knowledge).

It should be noted that all data used was be in the form provided by DECC and other agencies. Additional quality assurance to verify the accuracy or currency of the data was not undertaken.

4.2.2 Calculating Conservation Value and Threat

The spatial data on conservation values and threats, combined with additional expert panel information was used to rank each wetland cluster based on individual criteria (Tables 7; 8).

It should be noted that issues such as cultural heritage, and hydrological connectivity, were not considered due to lack of available data and time. These should be considered in future assessments.

For each dataset, alternative states were ranked according to the degree of conservation value or threat posed (very high, high, moderate or low). The rankings used for all datasets are presented in Tables 7 and 8. After ranking, each value/threat level was assigned a similar threat number: very high = 3, high = 2, moderate = 1, low = 0.

Because of the complex interaction between conservation values and threats at the wetland-scale it is recommended that in future assessments a more robust decision support system be implemented to assist with prioritisation (e.g. Expert Choice).

Table 7: Conservation Value dataset for assessment of wetlands in Clarence Lowlands

CONSERVATION VALUE DATASET	LEVEL	NUMBER
EPBC Act listed threatened flora and fauna species †		
EPBC Act threatened species (≥ 10)	Very high	3
EPBC Act threatened species (5-9)	High	2
EPBC Act threatened species (≤ 4)	Moderate	1
No known species occur in wetland cluster locality	Low	0
TSC Act listed terrestrial or aquatic threatened flora and fauna species †		
TSC Act threatened species (≥ 30)	Very high	3
TSC Act threatened species (15-29)	High	2
TSC Act threatened species (≤ 14)	Moderate	1
No known species occur in wetland cluster locality	Low	0
Migratory Bird Species (JAMBA, CAMBA, ROKAMBA) †		
Species known to inhabit wetland cluster locality (≥ 7)	Very High	3
Species known to inhabit wetland cluster locality (4-6)	High	2
Species known to inhabit wetland cluster locality (≤ 3)	Moderate	1
No known species occur in wetland cluster locality	Low	0
National Importance		
DIWA listing	Moderate	1
No listing	Low	0
SEPP 14 Wetland		
At least part of wetland identified as SEPP 14 Wetland	Moderate	1
Not identified as SEPP 14 Wetland	Low	0
Adjacency^		
Protected Reserves	Very High	3
State Forest	Moderate	1
Crown Land	Moderate	1
No public land	Low	0

† A 500 metre buffer was originally applied to this dataset i.e. if a threatened species presence is recorded or has the potential to be found within 500 metres of the wetland cluster it is considered to be present. However, other species from expert panel workshop also included.

^Adjacency refers to the proximity to other 'protected' areas. In this case the most common area within 1 kilometre adjacent to the cluster will be used.

Table 8: Threat dataset for assessment of wetlands in Clarence Lowlands

THREAT DATASET	THREAT RANKING	NUMBER
Surrounding Land Use [^]		
Intensive Agriculture [†]	Very high	3
Agriculture	High	2
Urban	High	2
Timber (outside conservation areas)	Moderate	1
Riparian vegetation	Low	0
Conservation	Low	0
Land Use Change (within cluster)		
Native Vegetation Clearing	High	2
Infrastructure	High	2
No known land use change	Low	0
Drainage Impacts		
Major impacts of drainage	Very High	3
Minor impacts of drainage	Moderate	1
No Drainage History	Low	0
Barriers to flow and fish passage		
Presence of flow barriers [•]	High	2
Presence of other barriers [#]	Moderate	1
No known barriers present	Low	0
ASS hazard		
Present	Very high	3
Potential ASS	Moderate	1
Absent	Low	0
Introduced Weed Species		
Major impact	High	2
Minor impact	Moderate	1
No information	Moderate	1

[^]The most dominant land use will be used for this interpretation as most clusters will have a combination of land uses.

[†] Intensive agriculture involves the use of irrigation or activities that drain the area for cropping mainly sugar cane.

[•]Flow barriers include weirs, floodgates, road crossings, dams, causeways etc.

[#] Other barriers include hydraulic or chemical barriers.

Each wetland cluster was assigned scores using the above process. For an indication of the overall conservation value) and overall threat level (i.e. very high, high, moderate, low) the sum of the individual scores was calculated. Overall conservation value scores range from 0-14, and overall threat scores range from 0-15. Wetland clusters were then assigned into very high, high, moderate and low groups based on the thresholds in Table 9 (overall conservation value) and Table 10 (overall threat value).

It needs to be recognised that this additive model for prioritisation has a number of limitations. Refer to Section 4.5 for discussion on the limitations encountered during this assessment.

Table 9: Broad ecological categories

OVERALL SCORE	CONSERVATION VALUE
≥11	VERY HIGH
8-10	HIGH
5-7	MODERATE
≤4	LOW

Table 10: Broad threat categories

OVERALL SCORE	THREAT LEVEL
≥12	VERY HIGH
9-11	HIGH
6-8	MODERATE
≤5	LOW

4.3 Outcomes of Conservation Values and Threats Assessment

The 19 wetland clusters were assessed within the Clarence Lowlands and assigned an overall conservation values score and threats score. Preliminary results are summarised in Table 11. For detailed information on the individual criteria refer to Appendix 4.

4.3.1 Conservation Values

Of the 19 clusters, seven received an overall conservation value rank of 'very high', seven were 'high', and five ranked 'moderate'. No wetland clusters were identified as 'low' conservation value.

During the assessment, it was identified that almost half of the wetland clusters provided habitat for more than 30 threatened flora and fauna species listed on the TSC Act. Both the Bungawalbin and Richmond Estuary clusters have recorded over 52 threatened species. Six of the 19 clusters recorded over 10 EPBC Act listed threatened species. Newrybar, Richmond Estuary, Tuckean and Wardell clusters all recorded over 16 EPBC Act listed species. The Broadwater, Casino and Coutts Crossing/Orara River demonstrated the highest number of migratory bird species listed on JAMBA, CAMBA and ROKAMBA international treaties, although this may have been due to observation bias.

Interestingly, 12 of the 19 clusters were adjacent (within 1 kilometre) of protected reserves. Chaffin Swamp is within close proximity to State Forest and Coutts Crossing/Orara River is adjacent to crown land. This highlights the potential for wetlands in the Clarence Lowlands to expand on the existing conservation reserve estate. The five remaining clusters were not adjacent to protected reserves, or significant areas of state forest or crown land.

Consideration should be given to separating flora and fauna data to provide better definition in future assessments. Further investigation of the dependence of different species of flora and fauna on the wetlands (water-dependence) is also recommended.

4.3.2 Threats

Five wetland clusters received an overall threats rank of 'very high', seven were 'high', and six ranked 'moderate'. Mangrove Creek was the only cluster to score a 'low' threat score, which is possibly due to the intact nature of the Mangrove Creek catchment.

Barriers such as weirs and floodgates are present in eight of the clusters, while ASS affects 10 of the wetlands clusters (Potential ASS and Actual ASS). Pacific Highway upgrades will impact on Chaffin Swamp, Coldstream, Newrybar, Tabbimoble and Wardell clusters. Only Clarence Estuary, Mangrove Creek, South Clarence and Tuckean clusters were recorded as having no known land use change in relation to vegetation clearing and infrastructure upgrades.

However, there is a low level of confidence in some of the threat datasets and these will require review, in particular land use change, weed species, barriers and drainage.

Table 11: Outcomes of wetland assessment for the Clarence Lowlands IBRA subregion

Wetland Cluster	Conservation Value	Threat	Details	Potential contribution to the NRS
Alumy Creek/ Bunyip Creek	Moderate	Very High	Area – 856ha Polygons – 67 LGA – Clarence Valley	<ul style="list-style-type: none"> ▪ Except for Bunyip Swamp, most wetlands not considered a high priority except as habitat for avifauna. ▪ Suitable for small scale NRM projects and private land conservation. ▪ Increased protection of Bunyip Swamp is recommended.
Bungawalbin	Very High	High	Area – 26,966ha Polygons – 10 LGA – Richmond & Clarence	<ul style="list-style-type: none"> ▪ The Bungawalbin cluster is a high priority for protection due to the biodiversity significance, excellent condition, landscape values and representativeness with surrounding protected areas by providing a corridor reserve system. ▪ Potential for protecting the existing State Forest. ▪ May be more cost-effective to purchase freehold land within this cluster.
Casino	Moderate	Moderate	Area – 1464 Polygons – 140 LGA – Richmond Valley	<ul style="list-style-type: none"> ▪ Private land management initiatives and / or conservation measures would be more ideal as the cluster is fragmented. ▪ Workshop participants identified this cluster as a low priority.
Chaffin Swamp	Moderate	High	Area – 348 Polygons – 3 LGA – Clarence Valley	<ul style="list-style-type: none"> ▪ Due to the limited drainage and other impacts Chaffin Swamp retains a near natural water regime. There is consequently no requirement for landholder support to modify hydrology. ▪ Close proximity to large area of native vegetation in State Forest, and potential offsets required for Pacific Highway, increases the potential contribution of this site to the NRS. ▪ Protection of wetland biodiversity at Chaffin Swamp is considered more feasible than at other sites in the Coldstream region. However, investment in conservation at this site should be considered in comparison with Shark Creek.
Clarence Estuary	Very High	High	Area – 3043 Polygons – 77 LGA – Clarence Valley	<ul style="list-style-type: none"> ▪ Very high potential to contribute to the NRS. ▪ Significant freshwater and intertidal habitat, particularly for migratory species. ▪ Potential to improve the protection of wetlands in existing NP and NR, such as Swamp Sclerophyll forest at Woombah (Bundjalung NP), intertidal habitat (Clarence Estuary NR) and at Wooloweyah Lagoon (Yuraygir NP). ▪ Recommended to investigate both private land conservation and land acquisition options.
Coldstream	High	High	Area – 8006 Polygons – 61 LGA – Clarence Valley	<ul style="list-style-type: none"> ▪ Not a high priority for biodiversity conservation due to highly fragmented nature and land use history. ▪ Options for private land conservation should be investigated, particularly for wetlands not reliant on inflows from other private land. ▪ Investigate potential offsets and on-ground management options in relation to the Pacific Highway upgrade.

Wetland Cluster	Conservation Value	Threat	Details	Potential contribution to the NRS
Coutts Crossing/Orara River	High	Moderate	Area – 1269 Polygons – 67 LGA – Clarence Valley	<ul style="list-style-type: none"> ▪ Possible formal protection of the Braunstone Travelling Stock reserve to protect nationally important populations of threatened species and poorly represented vegetation types including Endangered Ecological Communities. ▪ The Orara River Valley is a priority for the conservation of poorly represented habitat and maintenance and restoration of highly important regional wildlife corridor.
Evans River/Rocky Mouth Creek	High	High	Area – 3534 Polygons – 6 LGA – Richmond Valley	<ul style="list-style-type: none"> ▪ It has been recommended that for the purposes of acquisition and reservation, rehabilitation should be undertaken prior to acquisition. ▪ Potential for working with private landholders for management of conservation values.
Everlasting Swamp	Very High	Very High	Area – 3932 Polygons – 27 LGA – Clarence Valley	<ul style="list-style-type: none"> ▪ Floodplain wetlands of this size are rare nationally and are not well represented in reserves. ▪ Expansion of the Everlasting Swamp SCA recommended via private land conservation or land acquisition. ▪ Also investigate options to ensure long-term protection of Imesons Swamp (including State Forest parcels) and Little Broadwater. However, community interest in private land conservation (e.g. covenants) may be limited with some landholders expressing interest in land acquisition.
Halfway Creek	Moderate	Moderate	Area – 669 Polygons – 47 LGA – Clarence Valley	<ul style="list-style-type: none"> ▪ A priority for the maintenance and restoration of highly important regional wildlife corridor linking Sherwood Nature Reserve to Yuraygir SCA. ▪ Encourage investment in off park conservation mechanisms such as incentives, conservation covenants. ▪ Investigate possible acquisition of lands adjoining Sherwood Nature Reserve and Yuraygir State Conservation Area.
Mangrove Creek	Moderate	Low	Area – 343 Polygons – 8 LGA – Clarence Valley	<ul style="list-style-type: none"> ▪ High priority site for addition of wetland and lowlands to Chatsworth Hill State Conservation Area. ▪ Protection of an intact catchment containing floodplain EECs, threatened plants and animal species that are poorly represented in the National Reserve System, and establishment of a formally reserved important habitat corridor.
Newrybar	High	High	Area – 995 Polygons – 27 LGA – Ballina	<ul style="list-style-type: none"> ▪ The ecosystems present in this cluster is represented reasonably well throughout bioregion although elements of this cluster are worthy of increased protection.
Richmond Estuary	Very High	Very High	Area – 1623 Polygons – 28 LGA – Ballina	<ul style="list-style-type: none"> ▪ Increased protection particularly for wetlands adjacent to existing nature reserves is recommended, to provide buffers, connect corridors and improve water quality.
Shark Creek	High	High	Area – 2687 Polygons – 3 LGA – Clarence Valley	<ul style="list-style-type: none"> ▪ Upper Shark Creek has largely natural hydrology and supports ecological communities that retain ecological integrity, including old growth Swamp Sclerophyll vegetation. ▪ Close proximity to large areas of native

Wetland Cluster	Conservation Value	Threat	Details	Potential contribution to the NRS
				<p>vegetation in State Forest and NP Estate (e.g. Yuraygir NP).</p> <ul style="list-style-type: none"> Goodrick (1970) recommended the preservation of 610 hectares of seasonal fresh swamp at Upper Shark Creek, and the NPWS has recommended the preservation of the 'Shark Swamp' area (north of Tyndale Swamp).
South Clarence	High	Moderate	Area – 212 Polygons – 11 LGA – Clarence Valley	<ul style="list-style-type: none"> Wetlands in the South Clarence region have lower overall value in terms of wetland biodiversity compared to other areas on the Clarence floodplain (except for avifauna). This is due to their small and fragmented nature.
Tabbimoble	Very High	Moderate	Area – 4063 Polygons – 23 LGA – Richmond & Clarence	<ul style="list-style-type: none"> Considered one of most important wetland areas in the Clarence lowlands subregion due to its intactness and because of the threatened flora, fauna and ecological communities it supports. Strategic conservation has potential to improve connectivity between NP, NR and SCA in the Tabbimoble swamp region (e.g. unreserved areas east of Pacific Highway). Recommended to assess the conservation value of wetlands currently within State Forest. Because no major change in hydrology is required to protect ecological values, a piece by piece approach to private land conservation and land acquisition can be implemented.
The Broadwater	Very High	Very High	Area – 2490 Polygons – 7 LGA – Clarence Valley	<ul style="list-style-type: none"> Considered one of the most important unprotected sites in Clarence lowlands subregion. Recognised importance for fisheries habitat particularly seagrass beds. The large area of intact remnant vegetation that surrounds the main estuarine water body is important for the biodiversity it supports and for its function of regulating and maintaining aquatic habitat in The Broadwater. Some interest from landholders adjacent to Broadwater Ck in acquisition.
Tuckean	Very High	Very High	Area – 3550 Polygons – 11 LGA – Ballina & Lismore	<ul style="list-style-type: none"> Increased restoration investment should be implemented prior to further protection. Potential for the eastern section of the cluster to be conserved as this is in better condition. Interest from private landholders for private conservation measures.
Wardell	High	Moderate	Area – 1095 Polygons – 3 LGA – Ballina	<ul style="list-style-type: none"> Wetland types in this cluster are considered poorly represented within the reserve system. Land acquisition and or private land conservation recommended due to high ecological values. There are large areas of aboriginal land. The potential of leaseback and assistance with management could be discussed with the LALC.

Adapted from Burns *et al.* (2006)

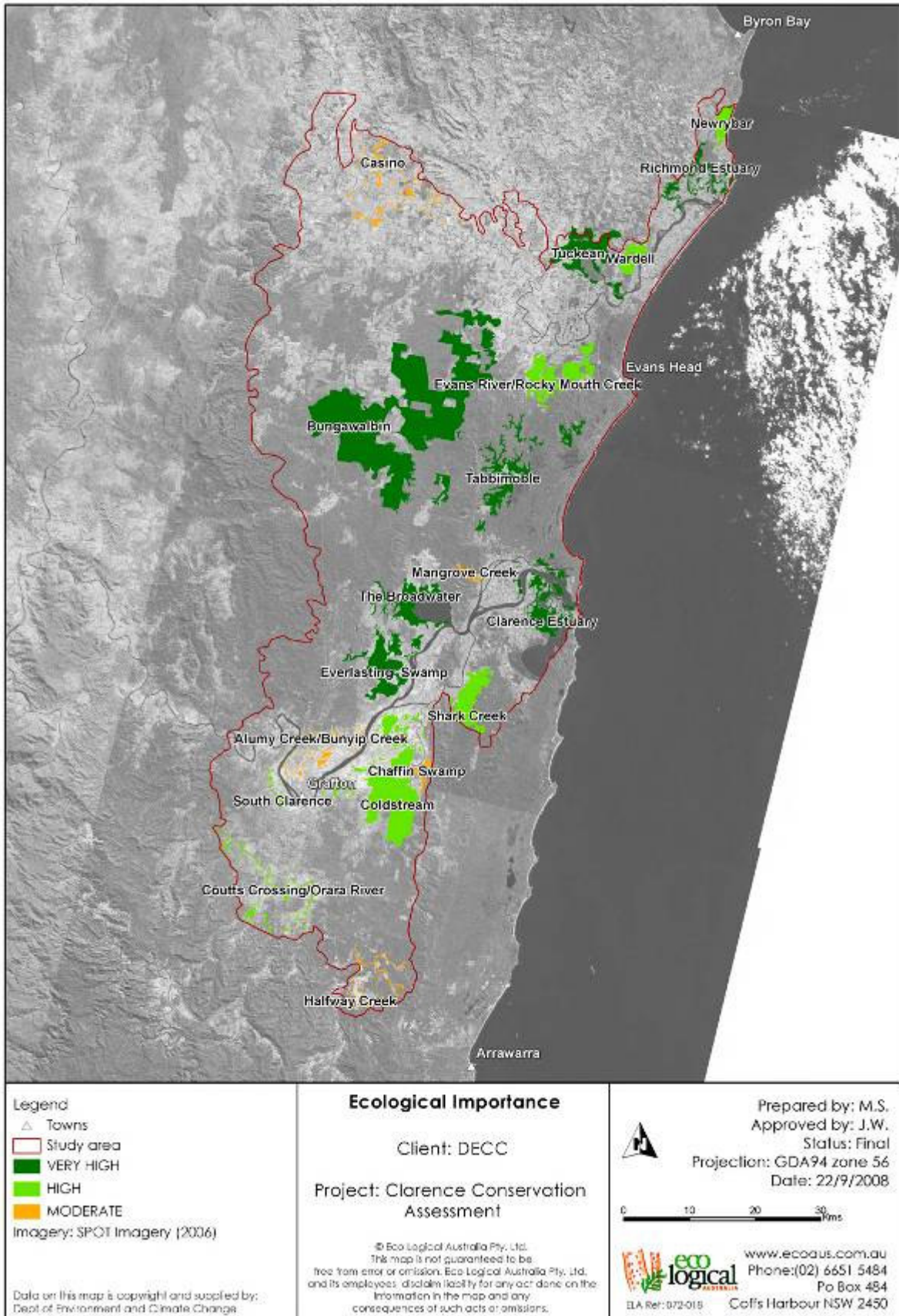


Figure 5: Overall Conservation Value of Wetland Clusters

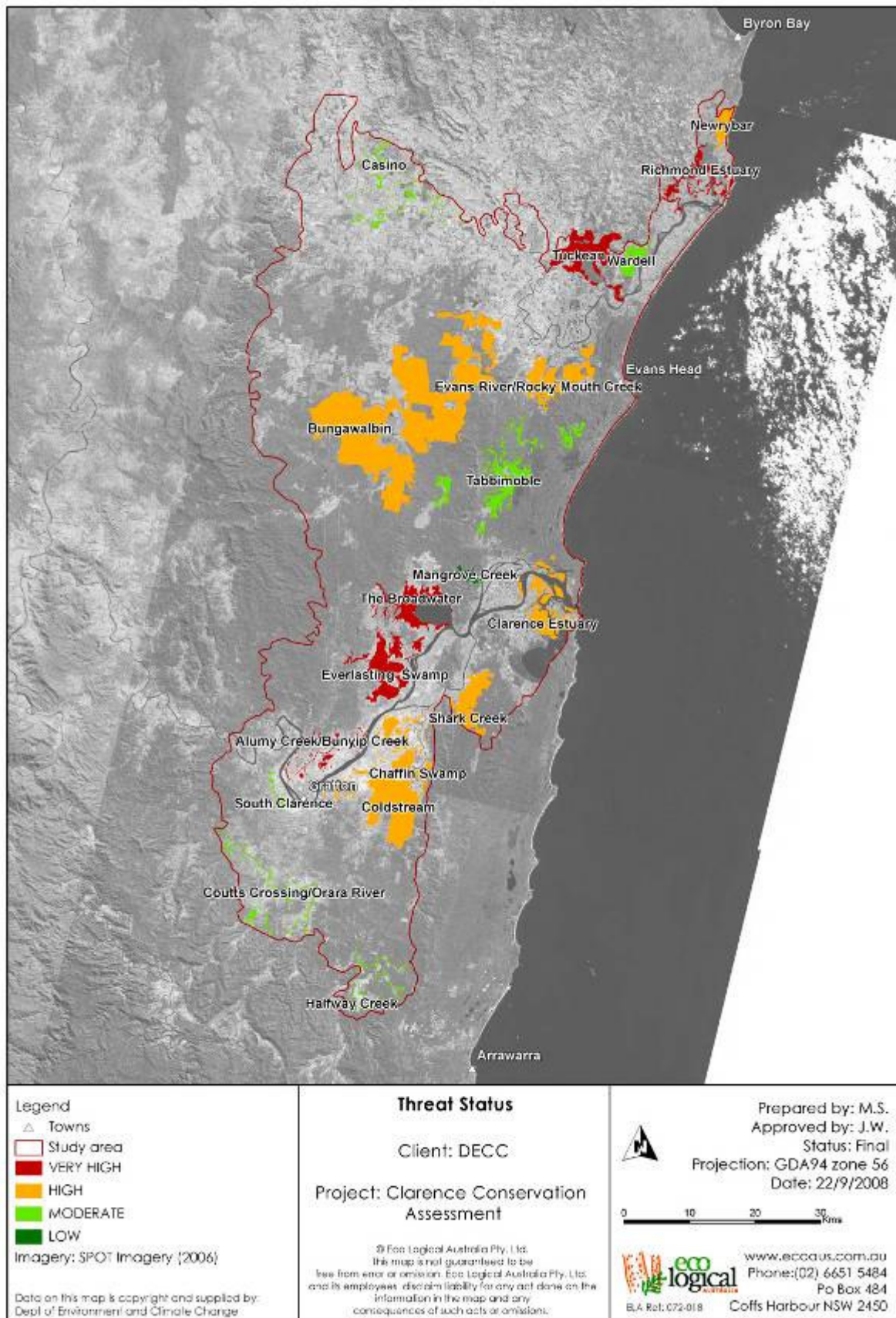


Figure 6: Overall Threat Levels of Wetland Clusters

4.4 Discussion on Limitations of Assessment

Valuable information about the conservation values of, and major threats to wetlands in the Clarence Lowlands subregion were obtained from this assessment.

Throughout the preparation of the project a range of limitations were identified due to the lack of a standardised approach to wetland mapping and condition assessment in NSW.

Therefore it is important to note that decisions about conservation actions are limited by the available data, particularly in relation to wetland condition, baseline biodiversity data and ecological function. Other datasets that could be used to further refine the assessment include:

- Wetland condition indicators
- Vegetation buffer between wetland and high risk land use
- Wetland classification (standardised)
- Connectivity (hydrological connectivity, etc.)
- Representativeness (dependent on "classification")
- Pest species abundance
- Threatened species status (vulnerable or endangered)
- Wetland-dependent species
- Cultural heritage values
- Aquatic habitat (e.g. fish habitat)
- Endemism and limits of distribution
- Climate change threat
- Fire impacts and threats

This data is currently unavailable or analysis was not within the scope of the study. However, the definitions and threat rankings that are presented above can be modified and additional data incorporated if it becomes available.

There was general agreement amongst workshop participants that there are major gaps in wetland and lowland data for flora, fauna species and ecosystems. Additionally there are issues with the spatial accuracy of existing wetland and lowland mapping and modelled predictions. The current assessment can only be considered preliminary in nature given the limitations of current data availability. A proposal to fill some of these gaps is made in recommended in section 5.4.

A considerable amount of data used for the purposes of the assessment was obtained from local experts, which was not accounted for in current literature and mapping. This includes threatened species records not on the DECC Atlas. This suggests that the outcomes of the assessment may have been considerably different if solely based on current desktop information.

One of the other major limitations of the assessment is the grouping of wetlands into wetland clusters. It may often be the case that a wetland assessed as having a "very high" conservation value, will include areas that are degraded and not suitable for conservation or protection.

Similarly, wetland clusters that may have been assessed as being impacted by drainage may include individual wetlands that are in near pristine condition. Therefore, the effect of lumping wetlands into wetland clusters needs to be considered when making judgements about the value of one wetland area over another.

In the future, a rapid field assessment to document the threats (e.g. drainage, aquatic weeds, ASS, etc) for individual wetlands is recommended. If this field assessment was completed, the specific threats to isolated wetlands could be quantified more accurately.

5. RECOMMENDATIONS

5.1 Key Priority Areas for the National Reserve System

The overall aim of this study is to inform the development of the NRS in the Clarence Lowlands, including land acquisitions, private land conservation and restoration projects.

Findings from the conservation assessment identified many of the wetland clusters with “very high” conservation values. This includes: Bungawalbin, Everlasting Swamp, Richmond Estuary, Tabbimoble, Clarence Estuary, The Broadwater and Tuckean (Table 11). Other wetlands clusters were identified during the expert panel workshop as being largely free from impacts, and of high potential contribution to the NRS. This included the wetlands in the upper part of Shark Creek, at Wardell and at Mangrove Creek.

Notably, the outcomes from this conservation assessment are considered generally consistent with the DECC staff and local/expert opinion regarding the areas of the Clarence Lowlands that represent the most outstanding areas not currently protected.

Those wetlands generally determined to be of lower conservation value include South Clarence, Alamy Creek/Bunyip Creek and Casino. These wetlands are in landscapes that have been heavily modified and generally isolated (hydrologically and spatially) from other ecosystems.

It was evident from the assessment of conservation status that the wetlands on the alluvial plain and estuarine plain of the Clarence Lowlands are poorly represented in the reserve system. This was in contrast to wetlands on coastal barrier sands, which are relatively well protected.

In determining priorities for expansion of the NRS for land acquisition and for private land conservation (e.g. covenants) the difference in land use between forested and non-forested wetlands needs to be considered. It is likely that covenants and other private land incentives will be significantly more successful (in terms of area protected) in forested wetlands, or wetlands that are not currently used for agriculture. This is because the single incentive payment for private land conservation may not be sufficient financial incentive result in a change in land use. The alternative is that stewardship system similar to that is being trialled by DEWHA for Grassy-Box Woodlands be implemented for freshwater wetlands.

Future projects therefore may want to target estuarine wetlands, freshwater forested wetlands and freshwater swamps with different objectives. Key priority areas for these different wetland types can be determined from this report by referring to the assessment framework (Table 11, Appendix 4) and to the individual wetland profiles (Appendix 3).

Ultimately, the provision of a suitable water regime for the wetland ecosystem may be more important than the reserve (or covenant) itself. Therefore, those wetlands where the water regime is largely non-impacted or where there is community capacity to manage the freshwater or estuarine flows for biodiversity conservation should be a priority.

Before the findings from this project are implemented, consideration of a number of factors at the wetland scale is recommended. This includes:

- community interest/capacity for private land conservation
- determine whether strategic grazing is feasible
- costs of land acquisition/covenant incentive costs
- hydrological connectivity (landholder agreement required to restore hydrology)
- feasibility of managing key threats (e.g. aquatic weeds)

5.2 Consideration of Climate Change in setting priorities

Consideration of climate change in setting conservation priorities poses a challenge. It needs to be recognised that a suite of factors will influence the degree and nature of climate change threats at any particular site, many of which cannot be currently determined. Nonetheless the current focus of conservation, to preserve biodiversity in situ, may need to shift to accommodate the need for adaptation, which in turn would influence conservation priorities.

Some general principles suggested by Dunlop and Brown (2008) can be applied when considering the conservation priorities for wetlands in recognition of climate change, specifically:

- Building comprehensiveness, representativeness and adequacy in the reserve system is likely to facilitate adaptation to climate change.
- The potential advantages and disadvantages of landscape connectivity need to be taken into account when designing reserves.
- Resilience should be considered at the species and landscape scales, and in terms of social- ecological interaction (ecosystem services and land uses).
- Potential refugia should be identified. Areas with more reliable water sources are likely to become increasingly important as refugia.

It is recommended to adopt these principles when identifying lands for acquisition and private land conservation in the Clarence Lowlands. Comparing the South Grafton wetland cluster with The Broadwater wetland cluster provides a useful example. Wetlands in the South Grafton cluster are poorly connected to other native ecosystems, and may not provide long-term refugia due to the temporary nature of the freshwater wetlands in that region. The Broadwater, in comparison, includes a range of wetland types ranging from estuarine to fresh (i.e. resilient to changes in hydrology) and is known to provide refugia for migratory species and waterbirds from inland Australia.

5.3 Applications of study

Findings from this conservation assessment will have a number of immediate and future applications in the Clarence Lowlands. This includes:

- Identification of priority areas for private land conservation, e.g. covenants (Northern Rivers CMA application to NRS, 2008)
- CMA and Caring for our Country investment programs
- Conservation planning, e.g. Biodiversity Management Plans, Local Environment Plans.
- Informing land purchase priorities, i.e. background information for the DECC State Reserve System Committee
- Identify offsets areas associated with developments, e.g. Pacific Highway upgrade

5.4 Future Projects

Completion of this project highlighted a number of key areas for further investigation and further assessment. If implemented, these projects would improve future conservation assessments and support the conservation and management of wetland ecosystems in the Clarence Lowlands subregion. Some of the more immediate projects include:

- Ecological survey to improve understanding of the hydrology and ecology of wetlands and lowlands in the Clarence Lowlands. This will inform on-ground implementation of conservation programs.
- Further consideration of the potential contribution of individual wetlands and wetland clusters to NRS, in terms of protecting aquatic habitat, connectivity, endemism and cultural heritage values.

- Site assessment of the threatening processes at individual wetlands, including drainage impacts, weeds, ASS and barriers to flows.
- Further assessment of the options to adapt to climate change.
- A review of the 'adequacy' of the NRS in protecting aquatic ecosystems in the Clarence Lowlands, including research to quantify the importance of the NP Estate in protecting critical aquatic ecosystems and ecosystem processes.
- Development of a Biodiversity Forecasting Tool that is applicable to wetland ecosystems (a 'Wetland BFT').

It is recommended that a wetland and lowland comprehensive regional assessment be implemented to address these issues.

Components of a wetland and lowland CRA could include:

Phase 1: Data collection

- Develop extant maps of wetlands and lowlands ecosystems.
- Targeted survey of wetland and lowland vegetation
- Develop a consistent and comprehensive classification of wetland and lowland ecosystems.
- Mapping and site assessment of wetland lowland vegetation condition

Phase 2: Data assessment

- The criteria for wetland assessment should be reviewed and appropriate tools used to determine wetland priority would need to be determined and adopted. Use of a decision support tool such as Expert Choice is proposed.

Phase 3: Strategic management

- Establish long term wetland monitoring sites to determine impacts of changes in tidal flow and potential impacts of climate change on wetlands.
- Delineate a system of wetland and lowland corridors and key habitats that ensures the viability and connectivity of wetland and lowland habitats for flora and fauna.

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APPENDIX 1 - RESTORATION PROJECTS

Northern Rivers Catchment Management Authority (NRMCA)

In addition to funding and collaboratively working on many projects with WCA (see below), NRMCA are also involved in a number of other NRM projects within the Clarence Lowlands. Wetland Management Plans have been prepared for several wetland areas within the NRMCA region (e.g. Tuckean Swamp). Wetland conservation and restoration works have also been completed, including projects funded through the *Priority Wetlands* project and through Acid Sulphate Soil (ASS) management programs.

Wetland Care Australia

WetlandCare Australia (WCA) have completed a number of projects within the Clarence and Richmond valleys including wetland health assessments, riparian restoration projects, and threatened species projects.

Wetland Health Project

This project was based in the Bungawalbin catchment and funded by the Myer Foundation and completed in 2005. It focused on reducing the impacts of acid sulphate soils (ASS) and blackwater in the Kookami Swamp (west of Coraki) in northern NSW. The project produced a series of wetland management plans, and weirs were installed in the Sandy Creek Drain to maintain groundwater levels.

Riparian Restoration Project

The Lower Bungawalbin Riparian Restoration Project was a three-year project funded by the NSW Environmental Trust. The project study area was located in the lower Bungawalbin south-west of Coraki. The project was established by the Bungawalbin Catchment Management Group, with 14 kilometres of creek bank fenced to date, with ongoing weed removal works.

UNC – Fencing Initiatives to promote Private Wetland Rehabilitation

This project directed landholders to the various options for funding of aquatic ecosystem management on private land, including fencing initiatives.

Banrock Station Oyster Channel Project

WCA has facilitated and undertaken approximately 90 ha of wetland restoration in the Clarence River estuary, near Yamba. Banrock Station provided \$50,000 sponsorship, which was used to leverage additional funding. As a result, landowners have been assisted to reinstate former saltmarsh, mangrove, floodplain and estuarine wetlands at Oyster Channel. Birrigan Gargle Local Aboriginal Land Council received funding for 34 ha of bush regeneration of Coastal saltmarsh and Swamp Oak Forest EECs.

Estuarine Wetland Health Assessment

The Estuarine Wetland Assessment project is funded by the NSW Environmental Trust. It will develop a sound methodology for assessing and prioritising estuarine wetlands, including intertidal mangroves and saltmarsh and dunal swamps and lagoons by reviewing and adapting existing assessment techniques. Selected wetlands will be assessed in sub catchments in the Tweed, Brunswick, Richmond and Clarence catchments.

Black-necked Stork and Comb-crested Jacana Project

Funded by the former Department of Natural Resources (DNR) State Wetland Advisory Council. This project identified and mapped properties within the Bungawalbin sub-catchment where sightings of these two bird species had been recorded. Wetlands were assessed and management plans completed, which allowed future targeting of available funds for on-ground works.

Little Broadwater: Wetland Rehabilitation, Fish Passage

WCA secured Recreational Fishing Trust funds to restore natural tidal flow to approximately 100 hectares of former fish habitat by opening floodgates to a former estuarine wetland known as Little Broadwater Swamp. Historically, Little Broadwater Swamp was important habitat for juvenile and adult fish species and was a significant contributor to the fisheries of the Clarence River estuary.

The project provided stewardship payments for landholders to encourage sustainable grazing regimes and to gain support for the reintroduction of tidal flows.

Local Councils**Clarence Valley Council**

The 'Clarence Floodplain Project' commenced in 1997 when a group of stakeholders formed a partnership to tackle environmental issues on the Clarence River floodplain and estuary. The project is administered by Council and continues to be guided by a steering committee with representatives from industry, government and non-government organisations. The main objectives of the project are to:

- Increase tidal exchange to improve water quality in creek systems.
- Improve the water quality of the Clarence River and its tributaries.
- Improve fish passage and provide habitat or breeding areas for fish and other aquatic species.
- Restore wetlands and improve grazing productivity to previously drained wetlands.
- Provide habitat for waterbirds.
- Raise water tables in acid sulfate areas and neutralise acid water in creeks with salt or sea water.

Through the Clarence Floodplain Project many improvements have occurred to the environment including improved water quality, improved access to habitat and breeding areas for aquatic species, reduced acid discharges from acid sulfate areas, re-inundation of previously drained wetlands, improved waterbird habitat and increased grazing productivity on some wetlands. More than 70 floodplain watercourses and wetlands have been "revived" with assistance from landowners and other stakeholders. Over 250 landholder volunteers have signed management plans and actively manage the watercourses adjoining their properties. The Clarence Floodplain Project has been actively involved with various research projects undertaken by the Department of Primary Industries (Agriculture and Fisheries), the University of New England and Southern Cross University.

Council has established a Working Group to look at urban pest issues in an effort to better manage the impacts of introduced species on native fauna. Controlled pests include rabbits, foxes, cane toads, Pandanus planthopper infestations, yellow crazy ants, and Jack Dempsey fish.

Lismore Shire Council

Lismore Shire Council has engaged in numerous projects for the conservation of wetlands in the Clarence Lowlands subregion. A Pelican Creek Management Plan and East Coraki Management Plan were implemented in 2006 in collaboration with the Natural Heritage Trust, NRCMA and Richmond River County Council. This project aimed to describe the current management issues and future activities that will promote sustainable management under a project called 'Wetland conservation and repair'.

A River Reach Plan was funded by the NRCMA for a 7km reach of Tucki Tucki Creek in the Rous Road area. The plan is being developed in partnership with 28 landowners and aims to restore healthy riparian vegetation along the creek.

Ballina Shire Council

Ballina Shire Council recently prepared the Ballina Coastline Management Study to support the preparation of the Coastline Management Plan. While, a Wardell and Cabbage Island Floodplain Management Study has been prepared to inform the regional Floodplain Management Plan. It assesses the impacts of the predicted major floods, and identifies mitigation options to minimise impacts.

Kyogle Shire Council

Kyogle Shire Council participated in the monitoring program – 'Target Pesticides Monitoring Program' a project jointly funded by the NSW Department of Health, Kyogle Council and Richmond Valley Council for the development of a river quality-monitoring program that includes stations located on the Richmond, Tweed and Clarence Rivers.

The Kyogle Shire Council is currently considering undertaking an LGA wide flora study to map significant areas of native vegetation and wildlife and habitat corridors.

Byron Shire Council

Byron Shire Council completed a Biodiversity Conservation Strategy in 2004. This directed a variety of conservation projects including a biodiversity levy to local ratepayers, funding for a bush regeneration team and the establishment of a Biodiversity Extension Service to assist landholders to restore native vegetation and improve wildlife habitat across the Shire. A Cane Toad Muster was held in 2006 in addition to Cane Toad Control projects. Dunecare, Rivercare and Landcare groups are also active throughout the Shire.

Regular bird-watching permits are also issued at the west Byron wetlands and integrated water management reserve and a Coastal Zone Management Plan is currently being prepared.

Department of Primary Industries - Fisheries**Fixing freshwater fish habitat in the Clarence Estuary**

In 2002 the NSW Recreational Fishing Saltwater Trust Expenditure Committee (RFSTEC) provided \$120,000 for a two year, pilot fish habitat rehabilitation program in the lower Clarence. Local government, Landcare and Rivercare groups, angling clubs and individual landholders were eligible to apply. The pilot program, managed under the NSW Department of Primary Industries Aquatic Habitat Rehabilitation (AHR) program, provided grants varying from \$5,160 to \$10,000 to 13 successful applicants for innovative rehabilitation projects to improve native fish habitat and ultimately enhance recreational fishing opportunities and commercial fishing in the catchment.

Other

DPI-Fisheries also provide for funding for aquatic ecosystem restoration through the aquatic habitat rehabilitation grants program. This supports riparian fencing and restoration projects, seagrass management, re-snagging, floodgate management, weir remediation and installation of fish friendly road crossings.

Department of Environment and Climate Change (incl. NPWS)

DECC has an ongoing estuary management program in collaboration with local councils. This includes support for the development of estuary management plans and restoration projects.

The NPWS is also involved in a number of wetland conservation and restoration projects. This includes ongoing management of wetlands on NP Estate at Everlasting Swamp SCA, Tuckean Swamp NR and Clarence Estuary NR.

DECC also developed a POM for The Broadwater, Clarence Estuary in collaboration with the University of New England (DEC, 2006).

APPENDIX 2 – EXPERT WORKSHOP OUTCOMES

Representatives from local councils, government agencies, conservation groups and independent experts were invited to attend a workshop in Grafton, NSW on 19 August 2008. Of the 16 representatives invited, 11 participated in the workshop.

A preliminary ranking of the 16 clusters was undertaken by each participant as an exercise to identify the higher value clusters based on their own opinion and knowledge. Overall, higher rated clusters included the Bungawalbin, Tabbimoble, Coldstream and Wardell wetlands.

They were then divided into a Clarence River and Richmond River groups based on their relevant expertise.

Clarence Discussion Group	Richmond Discussion Group
1. Greg Clancy (Ecologist)	1. Mark Graham (Ecologist)
2. Alan Cibilic (Wetland Care Australia)	2. Yasmin Cabot (Richmond River County Council)
3. Nigel Blake (NRCMA)	3. Ian Gaskill (Ballina Shire Council)
4. Peter Wilson (Clarence Valley Council)	4. Garry Owers (Wetland Care Australia)
5. Jennifer Kingston (Ranger – NPWS)	5. Tony McAteer (Richmond Valley Council)
6. Adam Smith (University of New England)	

Each group were allocated wetland clusters (see below) and provided information on an A0 sheet under appropriate headings such as Conservation Values, Threat Status and Conservation/Restoration Actions. The Tabbimoble cluster was assessed by both groups.

Clarence Catchment Clusters	Richmond Catchment Clusters
1. Alamy Creek/Bunyip Creek	1. Bungawalbin
2. Chaffin Swamp	2. Casino
3. Clarence Estuary	3. Evans River/Rocky mouth Creek
4. Coldstream	4. Newrybar
5. Everlasting Swamp	5. Richmond Estuary
6. Shark Creek	6. Tuckean
7. South Clarence	7. Wardell
8. The Broadwater	8. Tabbimoble
9. Tabbimoble	

Engaging an expert panel provided feedback regarding the criteria and scoring used in the wetland assessment (Section 4). Additional criteria for conservation values were also recommended was identified such as endemism, limits of species distribution, aquatic habitat, representativeness in reserve system, connectivity, species status (e.g. EPBC Act versus TSC Act), cultural heritage, and wetland dependent species.

A number of these variables have been included in the revised report. However some of them were not within the scope of the project (e.g. endemism and limits of distribution) or omitted due to lack of available data. Additional threat criteria were also identified and this included climate change, adjacent landuse, fire, infrastructure impacts such as highway upgrades, and native vegetation clearing.

Information relating to conservation actions proved useful as each cluster was assessed based on its potential contribution to the NRS; proximity to existing protected areas and management requirements.

Other sites not identified as wetland clusters were also discussed. Areas such as Coutts Crossing, Mangrove Creek, Forest Red Gum (Bungawalbin area), Orara/Halfway Creek and Woombah (south of Bundjalung NP) were agreed to have outstanding values and were included as additional wetland clusters.

APPENDIX 3 – WETLAND PROFILES

ALUMY CREEK/BUNYIP CREEK

Wetland Cluster No:	1
No. Polygons:	67
Area (ha):	856
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	3 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Listed (part)
SEPP14 (ha):	0

Location: Located north of the Clarence River near the town of Grafton.

Geology and landform: Situated on floodplain, levees and backswamps of the alluvial plain of Bunyip, Alummy and Southgate Creek areas in the Clarence River catchment. Alummy Creek is an old flood channel incised into the surrounding floodplain near Grafton. No detailed soil information exists for deep estuarine materials underlying the floodplain in the vicinity of Alummy Creek.

Sub-catchments: The majority of wetlands are in the Alummy Creek sub-catchment. A few wetlands to the south west (Clarence tidal pool sub-catchment) and north east (Clarence coastal sub-catchment) are not part of the Alummy Creek sub-catchment.

Water source: Fresh (although Alummy Creek historically intertidal/estuarine).

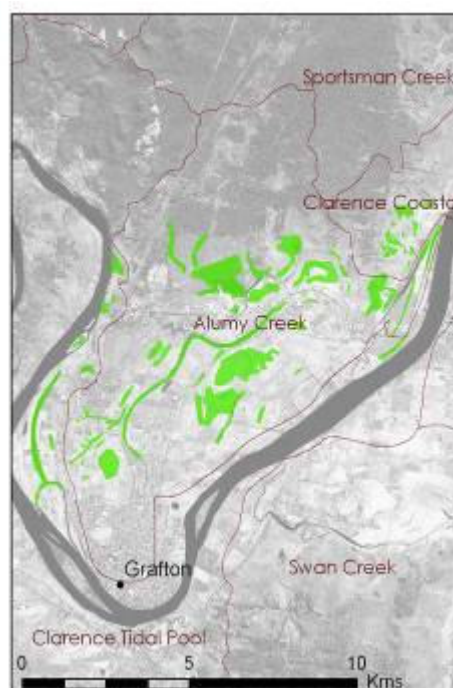
Hydrology and drainage: Historically Alummy Creek was a tidal creek connected to the Clarence River. It is now managed as freshwater system due to the weir (floodgate) at the downstream end of Alummy Creek. Floodplain wetlands adjacent to the creek would have historically been fresh. Approximately 60% of the runoff from Grafton flows into the Alummy Creek, the remainder of the input waters being agricultural runoff. Bunyip Creek flows into Alummy Creek downstream of Bunyip Swamp. Alummy Creek is used as a reservoir for storm water and local floodwaters, and a source of water for stock and irrigation (Tulau, 1999). A number of drains occur across the floodplain which discharges into Alummy Creek, Bunyip Creek and some wetland depressions.

Land use and tenure: The Alummy Creek catchment is mostly private land, apart from small areas of Crown Reserve. Main land uses include forestry (incl. plantations), grazing, irrigation, industrial and rural residential developments. Expansion of forestry plantations in close proximity to important wetlands such as Bunyip Swamp is considered a major threat.

Conservation values:

General: The majority of the vegetation of this area is encompassed within the Freshwater Wetlands and Swamp Sclerophyll Forest, which are EECs.

Flora: Three threatened species have been listed as occurring within this cluster.



Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR			
Weeping Paperbark	<i>Melaleuca irbyana</i>	✓	

Fauna: Threatened fauna species (19) known to occur within the site are listed below and of these 3 migratory species are listed on international treaties.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Magpie Goose	<i>Anseranas semipalmata</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Bubulcus ibis</i>			✓
Bush Stone-curlew	<i>Burhinus grallarius</i>	✓		
Three-toed Snake-tooth Skink	<i>Coeranoscincus reticulatus</i>		✓	
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>		✓	
Eastern Bentwing-bat	<i>Eastern Bentwing-bat</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i> (nesting)	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Black-chinned Honeyeater	<i>Melithreptus gularis gularis</i>	✓		
Barking Owl	<i>Ninox connivens</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Brush-tailed Phascogale	<i>Pascogale tapoatafa</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Glossy Ibis	<i>Plegadis falcinellus</i>			✓
Grey-crowned Babbler	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Speckled Warbler	<i>Pyrrholaemus sagittatus</i>	✓		
Diamond Firetail	<i>Stagonopleura guttata</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	✓
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	✓

Significant wetland areas within Cluster: Bunyip Swamp is an area of deep open water and was considered a wetland of outstanding value due to the role it plays as a drought refuge for wetland fauna, in particular the Black necked Stork (Pressey, 1987). Goodrick (1970) recognised Alamy Creek as an important wetland area that should be retained. Soros-Longworth and McKenzie (1980) also recommended that Alamy Creek be considered for wetland preservation.

Threats: Due to the nature of land use in the catchment, Alamy Creek experiences a range of water quality problems. Soil and water acidification in the wetlands can largely be attributed to the restriction of through-flow by the construction of levees and floodgates, and by artificial drainage and irrigation which has lowered watertable levels and exposed pyrite to oxidation (Tulau, 1999). Invasive aquatic weeds notably Water Hyacinth (*Eichhornia crassipes*) and Salvinia (*Salvinia molesta*) pose an ongoing threat to aquatic habitat.

Management / Rehabilitation: Various individual wetland depressions could be targeted for rehabilitation. It would be optimal to restore tidal flows to Alamy Creek but may not be feasible

due to existing water licences. An integrated approach to catchment management is required to limit inappropriate forestry plantations and to reduce nutrient and sediment inputs.

Proximity to existing protected areas: No protected areas adjacent or in close proximity.

Potential contribution to NRS: Except for Bunyip Swamp, most wetlands not considered a high priority except as habitat for avifauna. Suitable for small scale NRM projects and private land conservation. Increased protection of Bunyip Swamp is recommended.

Other wetland areas in cluster (not currently mapped): None identified.

BUNGAWALBIN

Wetland Cluster No:	2
No. Polygons:	10
Area (ha):	26,966
IBRA sub region:	Clarence lowlands
Catchment:	Richmond River
No. Subcatchments:	4 (see below)
CMA:	Northern Rivers
LGA:	Richmond & Clarence
DIWA:	Listed
SEPP14 (ha):	0

Location: Thirty kilometres south of Casino, between Coraki and Whiporie.

Geology and Landform: Occurs on the Alluvial plain associated with tributaries of the Richmond River, such as Bungawalbin and Myrtle Creeks.

Sub-catchments: The majority of wetlands and lowlands are within the Myrtle Creek sub-catchment and Double Duke area sub-catchment. Small areas also located in Myall Creek and Sandy Creek sub-catchments.

Water Source: Fresh

Hydrology and Drainage: The Bungawalbin and Myrtle Creeks drain this cluster across broad meander plains through backswamps and levees to eventually discharge into the Richmond River. The unique riverine environment is in excellent condition. It has been identified as the largest tidal waterpool in Australia.

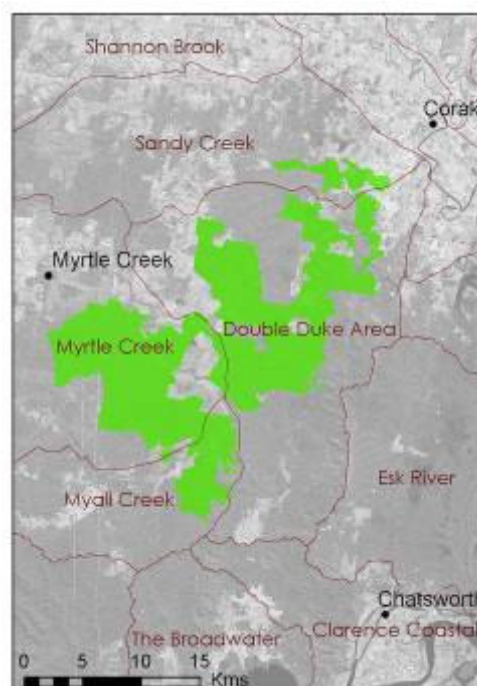
Land use and tenure: The main land uses include agriculture, forestry and conservation. The wetland cluster includes a large area of State Forest estate (8713 hectares) and freehold land tenure. Adjoining land tenures include a significant area of NP, NR and SCA, as well as several smaller crown reserve and leasehold lands. Some significant wetlands on freehold land are carefully protected by landholders through the Bungawalbin Catchment Management Group.

Conservation values:

General: A large area of contiguous wetland and lowland vegetation exists within this cluster which contains highly significant old growth habitat for many threatened fauna species. This cluster provides a broad forest corridor and is representative of open wetland lagoons and lowland mosaics.

Flora: The Bungawalbin cluster has a broad range of freshwater and floodplain wetlands including: Paperbark, Swamp Oak, Swamp Box and Swamp Mahogany forested wetlands, lowland floodplain rainforests, Red Mahogany, Pink Bloodwood and swamps dominated by *Melaleuca alternifolia* and *Lepironia articulata*. This cluster includes Freshwater Wetlands on coastal floodplains, Lowland Rainforest and Swamp Sclerophyll Forest EECs.

There are 13 threatened plant species (see below) listed on the TSC Act and EPBC Act.



Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR:			
Slaty Red Gum	<i>Eucalyptus glaucina</i>		
Weeping Paperbark	<i>Melaleuca irbyana</i>		
Mason's Grevillea	<i>Grevillea masonii</i>		

Common Name	Species Name	TSC Act	EPBC Act
Sweet False Galium	<i>Hedyotis galioides</i>		
Square-fruited Ironbark	<i>Eucalyptus tetrapleura</i>	✓	✓
LIKELY OR POTENTIALLY OCCURRING:			
Hairy-joint Grass	<i>Arthraxon hispidus</i>	✓	✓
	<i>Hibbertia marginata</i>	✓	✓
Tall Knotweed	<i>Persicaria elatior</i>	✓	✓
	<i>Polygala linariifolia</i>	✓	

Fauna: Bungawalbin is a key habitat and corridor for native fauna. It was assessed as one of the most significant areas of fauna biodiversity in the upper north-east NSW during the CRA process. It has a high marsupial population, high arboreal mammal distribution and large numbers of threatened species (39 listed threatened species).

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Rufous Bettong	<i>Aepyprymnus rufescens</i>	✓		
Magpie Goose	<i>Anseranas semipalmata</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Bush Stone-curlew	<i>Burhinus grallarius</i>	✓		
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Brown Treecreeper	<i>Climacteris picumnus victoriae</i>	✓		
Wallum Froglet	<i>Crinia tinnula</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Emu (population in the NSW North Coast Bioregion)	<i>Dromaius novaehollandiae</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	✓		
Stephens' Banded Snake	<i>Hoplocephalus stephensii</i>	✓		
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Green-thighed Frog	<i>Litoria brevipalmata</i>	✓		
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Hooded Robin (south-eastern form)	<i>Melanodryas cucullata cucullata</i>	✓		
Black-chinned Honeyeater	<i>Melithreptus gularis gularis</i>	✓		
Little Bentwing-bat	<i>Miniopterus australis</i>	✓		
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Giant Barred Frog	<i>Mixophyes iteratus</i>	✓	✓	
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Barking Owl	<i>Ninox connivens</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Yellow-bellied Glider	<i>Petaurus australis</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Grey-crowned Babbler	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	✓		
Speckled Warbler	<i>Pyrrholaemus sagittatus</i>	✓		
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Diamond Firetail	<i>Stagonopleura guttata</i>	✓		

Common Name	Species Name	TSC Act	EPBC Act	MBA
Common Blossom-bat	<i>Syconycteris australis</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	
LIKELY OR POTENTIALLY OCCURRING:				
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Hooded Robin	<i>Melanodryas cucullata</i> <i>cucullata</i>	✓		
Rainbow Bee-eater	<i>Merops ornatus</i> .			✓
Speckled Warbler	<i>Pyrrholaemus sagittatus</i>	✓		

Significant wetland areas within cluster: Entire wetland cluster is considered significant.

Threats: The main threat to the Bungawalbin cluster is private native forestry due to high timber values. Vegetation is being cleared to make way for plantations and tea tree establishments. Clearing may cause increased siltation and affect water quality (increased turbidity). Pest species include the Feral Pig and Cane Toad and numerous weed species. Fire is an ongoing threat due to the large vegetated areas. ASS are present to the north of the cluster. Blackwater events (low dissolved oxygen) and ASS impacts have potential to impact on water quality, and lead to fish kill events. Potential for wetlands to be affected by climate change through tidal influence and soil shrinkage.

Management / Rehabilitation: Ongoing maintenance (i.e. weed and pest fauna control).

Proximity to existing protected areas: Bungawalbin NP, NR and SCA adjoin the cluster in addition to Bundjalung SCA, Yarrigully NR and Yarrigully SCA. Banyabba NR and Tabbimoble Swamp NR are also in close proximity.

Potential contribution to NRS: The Bungawalbin cluster is a high priority for reservation due to the biodiversity significance, ecological integrity and diversity of wetland types it supports. A number of wetland areas are adjacent to NP Estate, and increased protection would improve fauna corridors and hydrological connectivity. Private land conservation is also advocated, including covenants and private land incentives. Options to increase protection of wetlands in existing State Forest recommended. May be more cost-effective to purchase freehold land within this cluster, especially wetlands not been use for agriculture.

Other wetland areas in cluster (not currently mapped): Additions to the west including areas within Clearfield, Rappville, Busbys Flat and into the incised valleys of the Richmond Range. Areas to the north and north east were also identified.

CASINO

Wetland Cluster No:	3
No. Polygons:	140
Area (ha):	1464
IBRA sub region:	Clarence lowlands
Catchment:	Richmond River
No. Sub-catchments:	4 (see below)
CMA:	Northern Rivers
LGA:	Richmond Valley
DIWA:	Not listed.
SEPP14 (ha):	0

Location: Situated in the Casino locality, approximately 30 kilometres west of Lismore.

Geology and landform: Situated on floodplain backswamps and alluvial fans of the alluvial plain of the Richmond River, Barlings Creek and Tomki Creek.

Sub-catchments: The majority of the cluster is located within the Coraki Area sub-catchment. Small areas lie within Kyogle Area, Shannon Brook and Wyrallah Area sub-catchments.

Water Source: Fresh

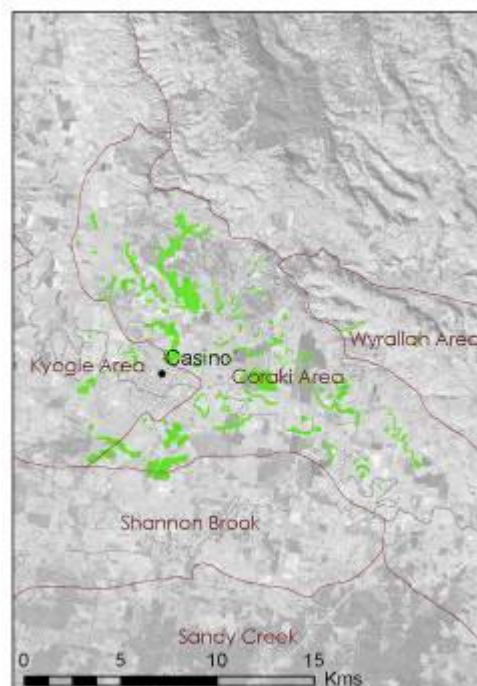
Hydrology and Drainage: Much of the cluster has been cleared and grazed for agriculture. There is a moderate level of drainage, which differs between individual wetlands. Flood levees in the Richmond Valley have altered flow paths during flood events.

Land use and tenure: The Casino wetland cluster is predominantly located on freehold and Crown leasehold land. There is a small area of Travelling Stock Reserves managed by the Rural Lands Protection Board. Wetlands are mainly used for cropping and grazing.

Conservation values:

General: Most of the wetlands are Freshwater Wetlands that are poorly protected in the Casino region. Contains areas of fresh meadow, which is an example of the freshwater wetland EEC. Although more degraded than other areas of Clarence Lowlands, wetlands are particularly significant for avifauna such as the Black-necked Stork.

Flora: The landscape is fragmented with scattered remnants of Swamp Box / Forest Red Gum Forest and examples of freshwater meadows and sedgelands. Listed threatened plants recorded in the wetland cluster are listed below (4 species listed on TSC Act and EPBC Act). The endangered herb *Rotala tripartita*, is only known to occur in freshwater sedgelands near Casino.



Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR:			
Thorny Pea	<i>Desmodium acanthocladum</i> – (probably unlikely)	✓	✓
Sweet Myrtle	<i>Gossia fragrantissima</i>	✓	✓
Weeping Paperbark	<i>Melaleuca irbyana</i>	✓	
<i>Rotala tripartita</i>	<i>Rotala tripartita</i>	✓	

Fauna: The freshwater wetlands of the Casino cluster contain records of many threatened fauna species. In particular, the Jabiru Geneebinga wetland on the outskirts of Casino is significant for several threatened fauna species (20 species) and several migratory bird species (9) listed on international treaties.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Magpie Goose	<i>Anseranas semipalmata</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
White-crowned Snake	<i>Cacophis harriettae</i>	✓		
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>			✓
Glossy Black-cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	✓		
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Little Bentwing-bat	<i>Miniopterus australis</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Blue-billed Duck	<i>Oxyura australis</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Glossy Ibis	<i>Plegadis falcinellus</i>			✓
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Rose-crowned Fruit-Dove	<i>Ptilinopus regina</i>	✓		
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Painted Snipe	<i>Rostratula benghalensis</i>			✓
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	✓		
Freckled Duck	<i>Stictonetta naevosa</i>	✓		
Common Greenshank	<i>Tringa nebularia</i>			✓
Marsh Sandpiper	<i>Tringa stagnatilis</i>			✓
Red-backed Button-quail	<i>Turnix maculosa</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	✓		
White-throated Needle-tail	<i>Hirundapus caudacutus</i>			✓
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Speckled Warbler	<i>Pyrrholaemus saggittatus</i>	✓		
Diamond Firetail	<i>Stagonopleura guttata</i>	✓		
Grass Owl	<i>Tyto capensis</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within cluster: None identified.

Threats: The Casino cluster is highly disturbed through grazing, clearing and cropping. Horses and cattle impede regeneration of native vegetation. Land use change was also resulted in poor water quality (i.e. high nutrient levels, blackwater). The Jabiru Geneebinga wetlands are

threatened by the invasive weed Chinese Tallowwood *Triadica sebifera*. Cocks Comb Coral Tree *Erythrina crista-galli* is also present.

Management/Rehabilitation: Restoration of wetlands to increase the regeneration of vegetation, improve water quality and protect habitat for wetland birds required.

Proximity to existing protected areas: The surrounding catchment is generally fragmented and cleared. Bungabbee Nature Reserve is located to the north-east.

Potential contribution to NRS: Private land conservation initiatives and restoration projects are recommended, however overall contribution to the NRS considered less significant than other sites.

Other wetland areas in cluster (not currently mapped): Additional wetland areas to the east and south east of the wetland cluster. Refinement of wetland mapping recommended.

CHAFFIN SWAMP

Wetland Cluster No:	4
No. Polygons:	3
Area (ha):	348
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	1 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Not listed.
SEPP14 (ha):	185

Location: Located approximately 18 kilometres east of Grafton, near the township of Tucabia. Cluster includes Chaffin Swamp (south) and Champions Swamp (north)

Geology and landform: Occupies the lower section of the alluvial floodplain of Chaffin Creek.

Sub-catchments: Entirely within the Coldstream Creek sub-catchment.

Water source: Fresh.

Hydrology and drainage: This is a freshwater wetland system that is not extensively drained. Major source of freshwater inflow is from the surrounding catchment. During periods of high rainfall water may back up the Coldstream River into Chaffin Swamp and Champions Swamp. The Coldstream River is managed as a freshwater system via a floodgate restricting tidal inflows. The main road across Chaffin Swamp and Champions Swamp acts as a barrier/levee although some hydrological connectivity is maintained via culverts.

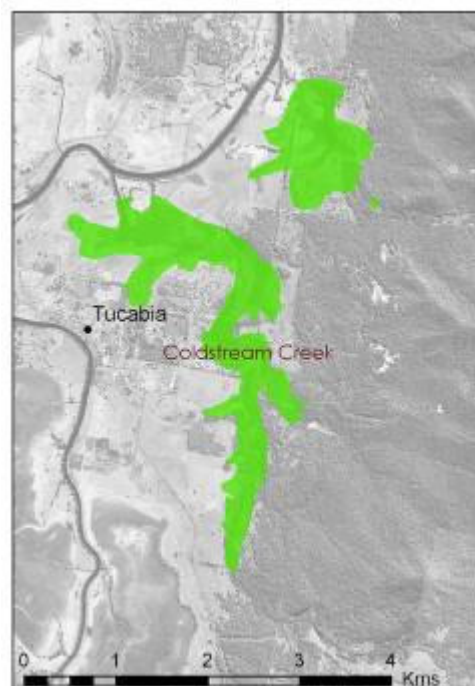
Land use and tenure: The main land use is grazing. The majority of the cluster is located in freehold tenure with a small area within Crown reserve land. Other land uses include rural residential and transport (main road across Chaffin Swamp and Champions Swamp). The proposed route for the Pacific Highway upgrade is likely to impact on these wetlands.

Conservation values:

General: This is a good example of a coastal floodplain wetland which represents excellent breeding habitat for waterbirds, contains EECs and threatened wetland plant species.

Flora: The threatened plant species *Maundia triglochoides* was located at Chaffin Swamp (Pressey, 1987) (see table below for more threatened plant species). The swamp contains freshwater meadows (including open water supporting Giant Water-lily), sedgelands, and Swamp Sclerophyll Forest wetlands, which are all considered EECs.

Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR		✓	✓
Maundia triglochoides	<i>Maundia triglochoides</i>	✓	
Weeping Paperbark	<i>Melaleuca irbyana</i>	✓	



Fauna: Chaffin Swamp is an important drought refuge and is a known breeding area for waterbirds with high bird diversity (Pressey, 1987). The wetlands were also previously used by 20-30 Black Swans for nesting. Threatened fauna (11) species have been recorded in the cluster. The wetland is also highly significant habitat for some (3) migratory bird species listed on international treaties.

Common Name	Species Name	TSC Act	EPBC Act	Migratory
KNOWN IN OR NEAR:				
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Emu population in the NSW North Coast Bioregion	<i>Dromaius novaehollandiae</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Grey-crowned Babbler	<i>Pomatostomus temporalis temporalis</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Swift Parrot	<i>Lathamus discolor</i>		✓	
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Barking Owl	<i>Ninox connivens</i>	✓		
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Diamond Firetail	<i>Stagonopleura guttata</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>		✓	

Significant wetland areas within Cluster: Both Chaffin and Champions Swamp are considered to have high conservation values, although Chaffin Swamp is considered better for overall wetland biodiversity values.

Threats: Incremental loss of EECs from vegetation clearing. Impacts associated with the Pacific Highway upgrade. Non-sustainable grazing and ongoing threat of invasive aquatic plants, particularly Water Hyacinth.

Management / Rehabilitation: Protection of hydrological regime (i.e. limit drainage). Control the extent of vegetation clearing. Ongoing maintenance activities also required, particularly control of pest plants and animals. Local managers noted that the upper and lower parts of Chaffin Swamp could be managed as two separate areas if required.

Proximity to existing protected areas: No protected areas are adjacent or in close proximity to these wetlands. However, there is significant area of native vegetation to the east of Chaffin Swamp, including land managed by State Forests. Yuraygir NP is located 7km east.

Potential contribution to NRS: Due to the limited drainage and other impacts Chaffin Swamp retains a near natural water regime. There is consequently no requirement for landholder support to modify hydrology. Close proximity to large area of native vegetation in State Forest, and potential offsets required for Pacific Highway, increases the potential contribution of this site to the NRS. Protection of wetland biodiversity at Chaffin Swamp is considered more feasible than

at other sites in the Coldstream region. However, investment in conservation at this site should be considered in comparison with Shark Creek.

Other wetland areas in cluster (not currently mapped): None identified.

CLARENCE ESTUARY

Wetland Cluster No:	5
No. Polygons:	77
Area (ha):	3043
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	3 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Listed
SEPP14 (ha):	817

Location: Adjacent to Yamba and Iluka at the mouth of the Clarence River.

Geology and landform: Tidal Islands, inlets, basins, delta flats and river channels of the estuarine plain of the Clarence River, including the large coastal lake, Wooloweyah Lagoon.

Sub-catchments: The majority of wetland cluster is within Clarence Coastal and Wooloweyah Lake sub-catchments. Small area to the north part of the Esk River sub-catchment.

Water source: Intertidal/estuarine (majority), Fresh (minority).

Hydrology and drainage: This is one of the major NSW estuaries. Clarence River is the largest coastal river in NSW based on annual flows. Some intertidal areas modified by river training walls and dredging. Floodplain impacted by drainage and levee construction, particularly areas west of Wooloweyah Lagoon. Works to restore tidal flows to estuarine waterways (e.g. Shallow Channel) have been undertaken.

Land use and tenure: Vacant and reserved Crown land and large areas of freehold land tenure. The Clarence River Estuary NR adjoins the cluster and conserves parts of Micalo Island, Dart Island and Rabbit Island. A large proportion of the estuary remains unprotected. Main land uses include sugar cane, grazing, oyster fishing, commercial and recreational fishing, urban and rural residential development.

Conservation values:

General: Estuary of the largest coastal river in NSW and a key coastal habitat and regional corridor linking coastal and hinterland habitats for many fauna species (Scotts, 2003). Very high diversity of ecological communities represented.

Flora: Tidally influenced vegetation of the littoral zone exists within this cluster, from seagrass beds, mangrove, Saltmarsh, saline grasslands and sedgeland and Swamp Oak. Saltmarsh and Swamp Oak are EECs. Three threatened species are known to occur within this cluster (see below).



Common Name	Species Name	TSC Act	EPBC Act
LIKELY OR POTENTIALLY OCCURRING:			
Scented Acronychia	<i>Acronychia littoralis</i>	✓	✓
Rusty Rose Walnut	<i>Endiandra hayesii</i>	✓	✓
Lesser Swamp-orchid	<i>Phaius australis</i>	✓	✓

Fauna: There is littoral, marine and terrestrial habitat for a large number of species listed on the TSC Act in the Clarence Estuary (44 species below). The Clarence estuary is one of the most important migratory wader and waterbird habitats in NSW for rare and endangered birds (Sandpiper Environmental 2004), including at least 6 species protected under international agreements.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Sanderling	<i>Calidris alba</i>	✓		
Great Knot	<i>Calidris tenuirostris</i>	✓		
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Greater Sand-plover	<i>Charadrius leschenaultii</i>	✓		✓
Lesser Sand Plover	<i>Charadrius mongolus</i>	✓		
Barred Cuckoo-shrike	<i>Coracina lineata</i>	✓		
Wallum Froglet	<i>Crinia tinnula</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Emu population in the NSW North Coast Bioregion	<i>Dromaius novaehollandiae</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Sooty Oystercatcher	<i>Haematopus fuliginosus</i>	✓		
Pied Oystercatcher	<i>Haematopus longirostris</i>	✓		
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Mangrove Honeyeater	<i>Lichenostomus fasciolaris</i>	✓		
Broad-billed Sandpiper	<i>Limicola falcinellus</i>	✓		
Black-tailed Godwit	<i>Limosa limosa</i>	✓		
Olongburra Frog	<i>Litoria olongburensis</i>	✓	✓	
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
White-eared Monarch	<i>Monarcha leucotis</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Oxleyan Pygmy Perch	<i>Nannoperca oxleyana</i>		✓	
Barking Owl	<i>Ninox connivens</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Whimbrel	<i>Numenius phaeopus</i>			✓
Eastern Long-eared Bat	<i>Nyctophilus bifax</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		

Common Name	Species Name	TSC Act	EPBC Act	MBA
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Eastern Ground Parrot	<i>Pezoporus wallicus wallicus</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	✓		
Rose-crowned Fruit-Dove	<i>Ptilinopus regina</i>	✓		
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Common Blossom-bat	<i>Syconycteris australis</i>	✓		
Grass Owl	<i>Tyto capensis</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
Terek Sandpiper	<i>Xenus cinereus</i>	✓		✓
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Bush Stone-curlew	<i>Burhinus grallarius</i>	✓		
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Green and Golden Bell Frog	<i>Litoria aurea</i>	✓	✓	
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Eastern Ground Parrot	<i>Pezoporus wallicus wallicus</i>	✓		
Pacific Golden Plover	<i>Pluvialis fulva</i>			✓
Superb Fruit-Dove	<i>Ptilinopus superbis</i>			
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within Cluster: Areas adjacent to NP estate with vegetation in good condition (e.g. at Woombah, near Iluka and crown land north of Wooloweyah Lagoon). Islands in Clarence estuary (e.g. Joss Island, Freeburn Island). Prawn farms.

Threats: Major threats include urban and rural residential development, increased sediment and nutrient loads from floodplains and the Clarence River catchment and non-sustainable fishing practices (recreational and commercial). Other threats include loss of saltmarsh habitat due to potential sea-level rise and increased abundance of invasive plants and animals (e.g. Cane Toad, vine weeds, Groundsel and Prickly Pear).

Management / Rehabilitation: Drainage restoration (areas west of Wooloweyah Lagoon). Catchment management particularly management of sediment and nutrient inputs to the estuary and control of invasive plants and animals.

Proximity to existing protected areas: Clarence estuary wetlands are directly adjacent to four protected areas; Bundjalung NP, Iluka NR, Clarence Estuary NR and Yuraygir NP.

Potential contribution to NRS: Very high potential to contribute to the NRS. Significant freshwater and intertidal habitat, particularly for migratory species. Potential to improve the protection of wetlands in existing NP and NR, such as Swamp Sclerophyll forest at Woombah (Bundjalung NP), intertidal habitat (Clarence Estuary NR) and at Wooloweyah Lagoon (Yuraygir NP). Recommended to investigate both private land conservation and land acquisition options.

Other wetland areas in cluster (not currently mapped): Number of areas recommended during expert workshop. This includes the entire Wooloweyah Lagoon and fringing wetlands. Prawn farms north of Wooloweyah Lagoon, unmapped islands (e.g. Rabbit Island) and intertidal deltas in Clarence River estuary, and Swamp Sclerophyll Forest and wetlands north of Woombah (south of Bundjalung NP) also considered significant.

COLDSTREAM

Wetland Cluster No:	6
No. Polygons:	61
Area (ha):	8006
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	4 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Listed
SEPP14 (ha):	889

Location: Approximately 13 kilometres east of Grafton, between Ulmarra and Pillar Valley.

Geology and landform: Quaternary alluvial deposits associated with the floodplain of the Coldstream River. Consists of a 'mosaic' of temporary and semi-permanent water bodies.

Sub-catchments: Wetland cluster split between the Coldstream Creek (west) and Swan Creek (east) sub-catchments. Small areas lie within Alummy Creek and Clarence Coastal sub-catchments to the north.

Water source: Fresh (although Coldstream River and Swan Creek historically with intertidal/estuarine influence).

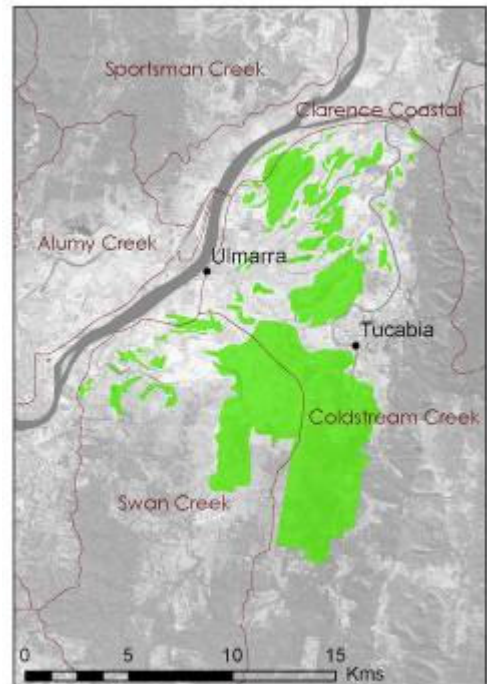
Hydrology and drainage: High degree of drainage, particularly in the Lower Coldstream. Swan Creek also heavily modified. Works are soon to commence on the Coldstream East No. 4 drain as part of the Clarence Floodplain project. Like other wetlands on the eastern side of the Coldstream, it is fed by an intermittent stream running west from the coastal range. Works will include a floodgate winch and an adjustable retention structure enabling landholders to control water levels within the wetland (Clarence Valley Council, 2006).

Land use and tenure: Almost entirely freehold and Crown leasehold land. The area has been extensively cleared and is now used for grazing purposes. Other major land uses include sugar cane and rural residential.

Conservation values:

General: Wetland is affected by drainage but good quality habitat remains (Environment Australia, 2001).

Flora: The cluster is characterised by large areas of open freshwater meadows, sedgeland (e.g. dominated by *Eleocharis equisetina*) and open water. There are possibly significant areas of derived wetland resulting from prior clearing of existing Swamp Sclerophyll Forest vegetation. The remaining wetland vegetation is either freshwater wetland or Swamp Sclerophyll Forest EEC. Remnant wetland vegetation in the south east of the Upper Coldstream is considered to be in good condition.



Two threatened flora species have been recorded from the Coldstream wetlands.

Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR			
	<i>Maundia triglochoides</i>	✓	
Weeping Paperbark	<i>Melaleuca irbyana</i>	✓	

Fauna: In total 26 threatened species have been identified as inhabiting the wetland cluster.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Rufous Bettong	<i>Aepyprymnus rufescens</i>	✓		
Magpie Goose	<i>Anseranas semipalmata</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Bush Stone-curlew	<i>Burhinus grallarius</i>	✓		
White-crowned Snake	<i>Cacophis harriettae</i>	✓		
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Brown Treecreeper	<i>Climacteris picumnus</i>	✓		
Emu population in the NSW North Coast Bioregion	<i>Dromaius novaehollandiae</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Pied Oystercatcher	<i>Haematopus longirostris</i>	✓		
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Black-chinned Honeyeater (eastern subspecies)	<i>Melithreptus gularis gularis</i>	✓		
Little Bentwing-bat	<i>Miniopterus australis</i>	✓		
Cotton-pygmy Goose	<i>Nettapus coromandelianus</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Yellow-bellied Glider	<i>Petaurus australis</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Grey-crowned Babbler	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Speckled Warbler	<i>Pyrrholaemus sagittatus</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>			✓
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Green and Golden Bell Frog	<i>Litoria aurea</i>	✓	✓	
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		

Common Name	Species Name	TSC Act	EPBC Act	MBA
Whimbrel	<i>Numenius phaeopus</i>			✓
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within Cluster: Upper Coldstream is considered to have greater ecological integrity and biodiversity value compared to Lower Coldstream and Swan Creek.

Threats: Major infestations of aquatic weeds (Water Hyacinth, Salvinia). Although situated on low-lying floodplain ASS is not a major issue. High density of roads in region has increased the fragmentation of wetland habitat. Major infrastructure (i.e. Pacific Highway upgrade) may affect parts of the Upper and Lower Coldstream. Due to changed drainage patterns and dominance of pasture species, flooding can cause major 'blackwater events' (low dissolved oxygen). Non-sustainable grazing, drainage and the Pacific Highway upgrade are considered the major threats.

Management / Rehabilitation: Drainage management required to restore hydrology, particularly in Lower Coldstream, which will require significant landholder cooperation. Upper Coldstream has been less impacted by drainage therefore implementation of wetland conservation more feasible.

Proximity to existing protected areas: No protected areas adjacent or in close proximity.

Potential contribution to NRS: Not a high priority for biodiversity conservation due to highly fragmented nature and land use history. Options for private land conservation should be investigated, particularly for those wetlands that are not reliant on inflows from other private land. Investigate potential offsets and on-ground management options in relation to the Pacific Highway upgrade.

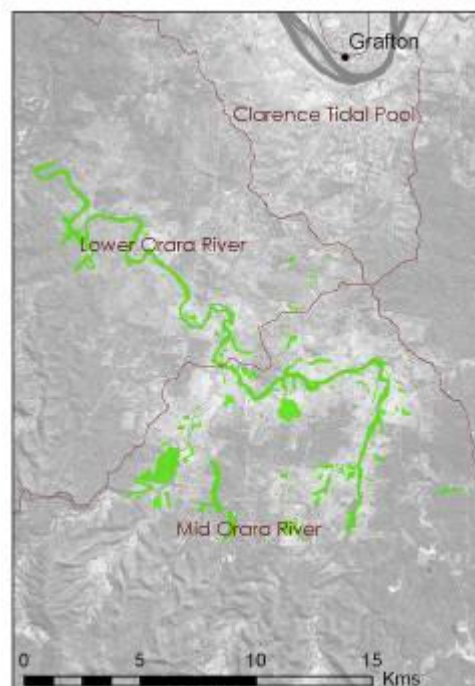
Other wetland areas in cluster (not currently mapped): None identified.

COUTTS CROSSING/ORARA RIVER

Wetland Cluster No:	7
No. Polygons:	67
Area (ha):	1269
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	2 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Not listed
SEPP14 (ha):	0

Location: About 13 kilometres south of Grafton and tracing the course of the Orara River and Blaxlands Creek between Braunstone to Coutts Crossing and north west to Bawdens Bridge.

Geology and landform: Alluvial riparian corridors draining adjoining areas of Kangaroo Creek sandstone. Ephemeral freshwater wetlands and backswamps of the floodplain of the main drainage lines.



Sub-catchments: Located across the Mid Orara and Lower Orara sub-catchments.

Water source: Fresh.

Hydrology and drainage: A number of small wetland depressions on floodplain of Orara River, Blaxlands Creek and other creek and drainage lines. In some instances wetlands have been drained for agriculture.

Land use and tenure: Almost all of the wetlands are in freehold agricultural land used for cattle grazing with minor areas of Travelling Stock Reserves and Crown Leasehold land. Some wetlands are close to rural residential developments. A significant Travelling Stock Reserve occurs to the north of Coutts Crossing and other Crown leasehold land.

Conservation values:

General: The cluster contains examples Lowland Rainforest, Freshwater Wetland, and Swamp Sclerophyll Endangered Ecological Communities. The Orara Valley is part of a highly important fauna corridor linking coastal to escarpment habitats.

Flora: Vegetation types include freshwater open swamps, riparian subtropical rainforests, freshwater wetlands and swamp sclerophyll forests. The threatened plants Weeping Paperbark (*Melaleuca irbyana*), and Native Milkwort (*Polygala linariifolia*), and Swamp Foxglove (*Centranthera cochinchinensis*) have been recorded near Coutts Crossing. Much of the natural vegetation has been cleared however some good stands of riparian forests and *Melaleuca* still remain.

Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR:			
Swamp Foxglove	<i>Centranthera cochinchinensis</i>	✓	
Weeping Paperbark	<i>Melaleuca irbyana</i>	✓	
Native Milkwort	<i>Polygala linariifolia</i>	✓	

Fauna: The Black-necked Stork (*Ephippiorhynchus asiaticus*), Comb-crested Jacana (*Irediparra gallinacea*) and White-bellied Sea-Eagle have been recorded nesting in the area. Up to 12-15 pairs of Black Swans now regularly nest on a small wetland of only a few hectares in size. In total 32 threatened species have been identified as inhabiting the wetland cluster and eight migratory bird species listed on international treaties.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Rufous Bettong	<i>Aepyprymnus rufescens</i>	✓		
Magpie Goose	<i>Anseranas semipalmata</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
White-crowned Snake	<i>Cacophis harriettae</i>	✓		
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>			✓
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Brown Treecreeper	<i>Climacteris picumnus</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Emu population in the NSW North Coast Bioregion	<i>Dromaius novaehollandiae</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
Brolga	<i>Grus rubicunda</i>	✓		
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Black-chinned Honeyeater (eastern subspecies)	<i>Melithreptus gularis gularis</i>	✓		
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
Giant Barred Frog	<i>Mixophyes iteratus</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Barking Owl	<i>Ninox connivens</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Yellow-bellied Glider	<i>Petaurus australis</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	✓		
Speckled Warbler	<i>Pyrholaemus saggitatus</i>	✓		
Yellow-bellied Sheathtail-bat	<i>Saccolaimus flaviventris</i>	✓		
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Common Greenshank	<i>Tringa nebularia</i>			✓
Marsh Sandpiper	<i>Tringa stagnatilis</i>			✓
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Eastern Bentwing-bat	<i>Miniopterus schreibersii</i>	✓		

Common Name	Species Name	TSC Act	EPBC Act	MBA
	<i>oceanensis</i>			
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within Cluster: The Braunstone Travelling Stock Reserve.

Threats: Threatened by non-sustainable grazing practices and vegetation clearing. Rural residential development is encroaching on some wetlands and a proposed sawmill is located in the drainage area of another wetland. The biodiversity and corridor value of the cluster is threatened by continued fragmented of the lowland and wetland vegetation of this area.

Management / Rehabilitation: Encourage regeneration of wetland vegetation (by fencing selected areas) including the southernmost known stand of *Melaleuca irbyana*. Restoration and revegetation of lowland and riparian wetland vegetation to improve the viability of the important corridor value of the Orara River area. Limit inappropriate development.

Proximity to existing protected areas: Wetlands in the Coutts Crossing cluster are largely surrounded by freehold or unreserved Crown land. Nearest protected areas are Chambigne NR (2.5km south west) and Koukandowie NR (1.5km south).

Potential contribution to NRS: Possible formal protection of the Braunstone Travelling Stock reserve to protect nationally important populations of threatened species and poorly represented vegetation types including Endangered Ecological Communities. The Orara River Valley is a priority for the conservation of poorly represented habitat and maintenance and restoration of highly important regional wildlife corridor. Linkages via corridors are essential to ensure the viability and adequacy of conservation of the national reserve system.

Other wetland areas in cluster (not currently mapped): None identified.

EVANS RIVER/ROCKY MOUTH CREEK

Wetland Cluster No:	8
No. Polygons:	6
Area (ha):	3534
IBRA sub region:	Clarence lowlands
Catchment:	Richmond River
No. Sub-catchments:	2
CMA:	Northern Rivers
LGA:	Richmond Valley
DIWA:	Not listed
SEPP14 (ha):	45

Location: Located south of Woodburn.

Geology and landform: Occupies the alluvial plain of Rocky Mouth Creek and the upper Evans River estuary, including the tidally influenced Sawpit and Brandy Arm Creek tributaries.

Sub-catchments: The majority of the wetland cluster lies within the Evans River sub-catchment. A small area to the north lies within Coraki Area sub-catchment.

Water Source: Intertidal/ Estuarine and Fresh

Hydrology and Drainage: The Evans River is connected to the Richmond River at Woodburn via the Tuckombil Canal which is operated to mitigate flooding and improve drainage in the mid-Richmond River area. Rocky Mouth Creek is also intertidal but tidal flow has historically been restricted by an instream floodgate. Floodplain wetlands in the cluster are typically fresh. However some areas have been significantly drained which has resulted in acid runoff from disturbed ASS.

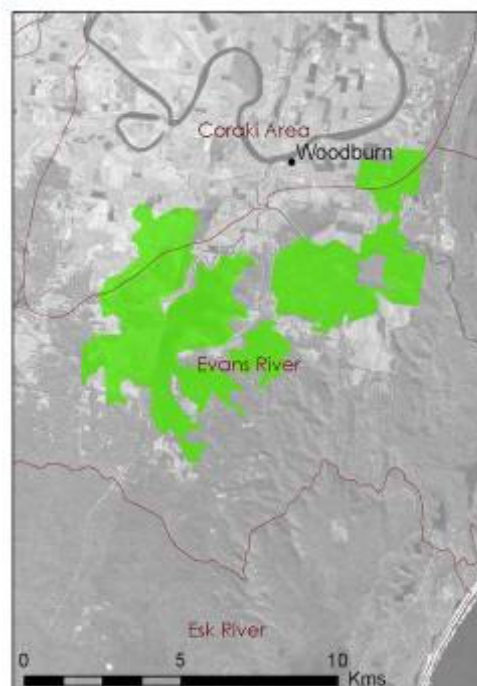
Land use and tenure: Predominantly freehold tenure and Crown leasehold land used for agriculture and grazing, although low-lying areas have relatively low productivity. Apart from Brandy Arm Creek, few parcels have good riparian vegetation. Sugar cane and private native forestry is known to occur within the catchment. An area of high conservation value vegetation on Brandy Arm Creek is managed sympathetically for conservation.

Conservation values:

General: The area is an important regional fauna corridor linking coastal NPs and provides key habitat for fauna. Provides a transitional point between various coastal. There seems to be limited numbers of introduced weed species.

Flora: Rocky Mouth Creek contains areas of freshwater meadows and Swamp Sclerophyll Forest (EEC). It includes derived coastal floodplain wetlands from past clearing of floodplain forest vegetation. Much of the vegetation has characteristics of Freshwater Wetland and Swamp Sclerophyll Forest EECs, although the area has been poorly assessed for its flora values.

Evans River/Brandy Arm Creek is a highly significant area of wetland vegetation located on tributaries of the Evans River. It contains important samples of estuarine and alluvial plain vegetation types. EEC known to occur here includes Saltmarsh, Swamp Oak Floodplain Forest, Subtropical Coastal Floodplain Forest and Swamp Sclerophyll Forest on floodplains. Threatened plant species (8) identified on the TSC Act and EPBC Act within this cluster are listed below.



Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR			
Spider Orchid	<i>Dendrobium melaleucaphyllum</i>	✓	
Sweet Myrtle	<i>Gossia fragrantissima</i>	✓	✓
	<i>Oberonia complanata</i>	✓	
Brown Fairy-chain Orchid	<i>Peristeranthus hillii</i>	✓	
LIKELY OR POTENTIALLY OCCURRING:			
Southern Swamp Orchid	<i>Phaius australis</i>	✓	✓

Fauna: The Evans River/ Brandy Arm Creek area provides habitat for several threatened fauna species (23 species) including many nectar-dependent species. There is a large Koala community and numerous values for migratory shorebirds.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Pied Oystercatcher	<i>Haematopus longirostris</i>	✓		
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Olongburra Frog	<i>Litoria olongburensis</i>	✓		
Little Bentwing-bat	<i>Miniopterus australis</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Oxleyan Pygmy Perch	<i>Nannoperca oxleyana</i>		✓	
Eastern Long-eared Bat	<i>Nyctophilus bifax</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Eastern Ground Parrot	<i>Pezoporus wallicus wallicus</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Common Blossom-bat	<i>Syconycteris australis</i>	✓		
Grass Owl	<i>Tyto capensis</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Wallum Froglet	<i>Crinia tinnula</i>			
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Rainbow Bee-eater	<i>Merops ornatus</i>			✓

Common Name	Species Name	TSC Act	EPBC Act	MBA
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Whimbrel	<i>Numenius phaeopus</i>			✓
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within cluster: The wetlands in Evans River part of the cluster in are in better condition than Rocky Mouth Creek.

Threats: Rocky Mouth backswamp area is an ASS hotspot and is affected by drainage and blackwater events. There are annual algae events within Rocky Mouth creek and this can lead to fish kills. Grazing, removal of native vegetation and the highway upgrades are major threats. Increased sedimentation is a threat to aquatic habitat (e.g. seagrass) in the Evans River. Sea-level rise due to climate change is a potential risk.

Management / Rehabilitation: Agencies (incl. DPI Fisheries, CMA and council) are currently undertaking tidal flushing, drain infilling and laser levelling to improve floodplain management and improve water quality. Further restoration is required including grazing management; saltmarsh rehabilitation within Rocky Mouth Creek; improved management of tidal barrier between the estuarine and freshwater areas. The large-sized landholdings in this cluster increases the feasibility of achieving conservation outcomes.

Proximity to existing protected areas: The cluster adjoins and is in close proximity to Tabbimoble Swamp NR, Broadwater NP and Bundjalung NP.

Potential contribution to NRS: It has been recommended that for the purposes of reservation, rehabilitation should be undertaken prior to land acquisition. Private land conservation options are recommended, particularly due to the significant improvements to water quality that changed land management can facilitate.

Other wetland areas in cluster (not currently mapped): None identified

EVERLASTING SWAMP

Wetland Cluster No:	9
No. Polygons:	27
Area (ha):	3932
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	2 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Listed
SEPP14 (ha):	1757

Location: Everlasting Swamp is an infilled back lagoon system located on the north-western side of the Clarence River near Lawrence.

Geology and landform: The name 'Everlasting Swamp' may be attributed to the larger geomorphic basin, which includes a number of intermittent wetlands including Grasshopper Swamp, the Horseshoe, Imesons Swamp, and Little Broadwater, as well as the semi-permanent wetland of Teal Lagoon.

Sub-catchments: The majority of Everlasting Swamp is within Sportsmans Creek sub-catchment. There is a small area to the north of Lawrence in the Clarence Coastal sub-catchment.

Water source: Fresh (majority); Intertidal/estuarine (minority).

Hydrology and drainage: Sportsmans Creek drains through the Everlasting Swamp, and Woody and Reedy Creeks form smaller tributary systems from Sportsmans Creek (Tulau, 1999). Although parts of Everlasting Swamp have been extensively drained it retains large areas that are inundated for prolonged periods. Drainage has caused major ASS risk including salt and acid scalds which produce low pH conditions. ASS risk can be mitigated by improved drainage management. A number of levees impede flows within the wetlands. Sportsmans Creek weir restricts tidal inflows into the main part of Everlasting Swamp. However, restoration of estuarine flows has occurred into Little Broadwater (north of Sportsmans Creek) via installation of a tidal gate.

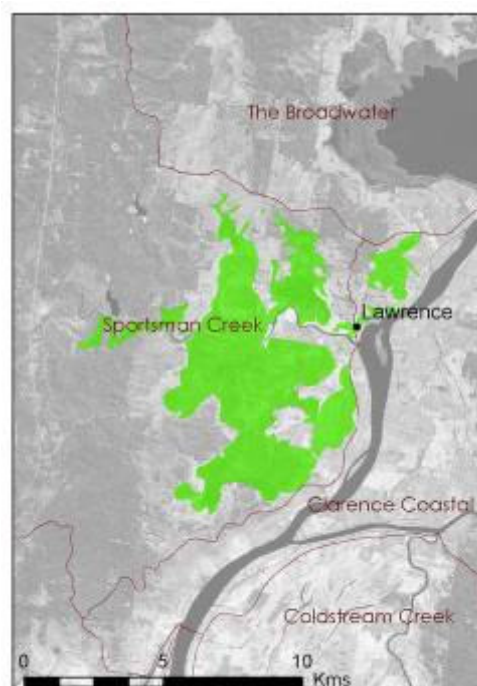
Land use and tenure: This cluster is largely freehold tenure used for dairying and beef cattle grazing (Environment Australia, 2001). Everlasting Swamp SCA (309 hectares) was purchased with the support from the NRS Program in 2003.

Conservation values:

General: This is one of the largest remaining coastal floodplain wetlands in NSW. Everlasting Swamp is listed on the Register of the National Estate, is an internationally significant water bird habitat and is listed in the DIWA (Environment Australia, 2001).

Flora: The cluster contains extensive freshwater meadows and seasonal fresh swamps, sedgelands (dominated by *Cyperus polystachyos* and *Eleocharis equisetina*), grasslands, forblands (dominated by *Persicaria* sp.) and reedlands (dominated by *Phragmites australis*). The Giant Water-lily *Nymphaea gigantea* which is near the southern limit of its distribution in the Clarence lowlands subregion is also known to occur. Broad-leaved Paperbark *Melaleuca quinquenervia* and *Melaleuca alternifolia* of the Swamp Sclerophyll Forest EEC is also present (Pressey, 1987). Other EECs include Freshwater Wetlands and Swamp Oak Forest.

Fauna: Everlasting Swamp is an important drought refuge for water birds and also an important breeding area for species such as the Black Swan (Pressey, 1987) and Cattle Egret (colony north



of Lawrence ~ 2000 pairs). In a recent study Everlasting Swamp recorded the highest water bird diversity of 13 wetlands surveyed in Clarence floodplain. In particular, Everlasting Swamp is a stronghold for Brolga populations in the Clarence Floodplain and includes some of the biggest flocks recorded in NSW in recent years. Threatened species within the cluster (26 species) are listed below. Everlasting Swamp is also habitat for migratory bird species listed on international treaties (7 species).

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Magpie Goose	<i>Anseranas semipalmata</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>			✓
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Wallum Froglet	<i>Crinia tinnula</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Emu population in the NSW North Coast Bioregion	<i>Dromaius novaehollandiae</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
Brolga	<i>Grus rubicunda</i>	✓		
Pied Oystercatcher	<i>Haematopus longirostris</i>	✓		
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Olongburra Frog	<i>Litoria olongburensis</i>	✓		
Little Bentwing-bat	<i>Miniopterus australis</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Eastern Ground Parrot	<i>Pezoporus wallicus wallicus</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Freckled Duck	<i>Stictonetta naevosa</i>	✓		
Common Blossom-bat	<i>Syconycteris australis</i>	✓		
Common Greenshank	<i>Tringa nebularia</i>			✓
Marsh Sandpiper	<i>Tringa stagnatilis</i>			✓
Grass Owl	<i>Tyto capensis</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Whimbrel	<i>Numenius phaeopus</i>			✓
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	

Common Name	Species Name	TSC Act	EPBC Act	MBA
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within Cluster: Everlasting Swamp (south of Sportsmans Creek), Little Broadwater and Imesons Swamp.

Threats: Altered hydrology from drainage, levees and management of Sportsmans Creek weir. Other threats include development of ASS, increased abundance of aquatic weeds, non-sustainable grazing and vegetation clearing.

Management / Rehabilitation: Drainage management at Imesons Swamp and Everlasting Swamp to increase inundation, manage ASS and enhance biodiversity. Hydrological management will require landholder support, such as that achieved at Little Broadwater to restore tidal flows. Restoration of tidal flows by operation of Sportsmans Creek Weir to be investigated. Upgrading status of SCA to NR also recommended.

Proximity to existing protected areas: Everlasting Swamp SCA (309 ha) is situated in the centre of Everlasting Swamp (south of Sportsmans Creek) and forms part of a much larger freshwater wetland - the majority of which is on freehold land. Little Broadwater to the north of Sportsmans Creek is managed under an agreement (LMA) with the NRCMA.

Potential contribution to NRS: Floodplain wetlands of this size are rare nationally and are not well represented in reserves. There are only four freshwater meadow dominated wetlands greater than 100 hectares in Victoria (Norman and Corrick, 1988) and Everlasting Swamp is one of only two freshwater swamps over one thousand hectares in NSW. Goodrick (1970) recommended the preservation of 2,880 hectares of seasonal freshwater swamps in the Everlasting Swamp-Sportsmans Creek-Little Broadwater area, primarily on the basis of bird habitat. Expansion of the Everlasting Swamp SCA recommended via private land conservation or land acquisition. Also investigate options to ensure long-term protection of Imesons Swamp (including State Forest parcels) and Little Broadwater. However, community interest in private land conservation (e.g. covenants) may be limited with some landholders expressing interest in land acquisition.

Other wetland areas in cluster (not currently mapped): None identified.

HALFWAY CREEK

Wetland Cluster No:	10
No. Polygons:	47
Area (ha):	669
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	1 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Not listed
SEPP14 (ha):	0

Location: Approximately 30 kilometres south of Grafton.

Geology and landform: Alluvial floodplain and valleys of Halfway Creek, Dundoo and Sherwood Creeks.

Sub-catchments: Entirely within the Mid Orara sub-catchment.

Water source: Fresh.

Hydrology and drainage: Freshwater wetlands depressions that typically fill during significant rainfall events. Limited drainage, although rural residential development and roads have created some barriers to flow.

Land use and tenure: Predominately freehold tenure although also some areas of unreserved Crown land. Land uses include rural residential development and grazing. The Pacific Highway passes through the Halfway Creek cluster.

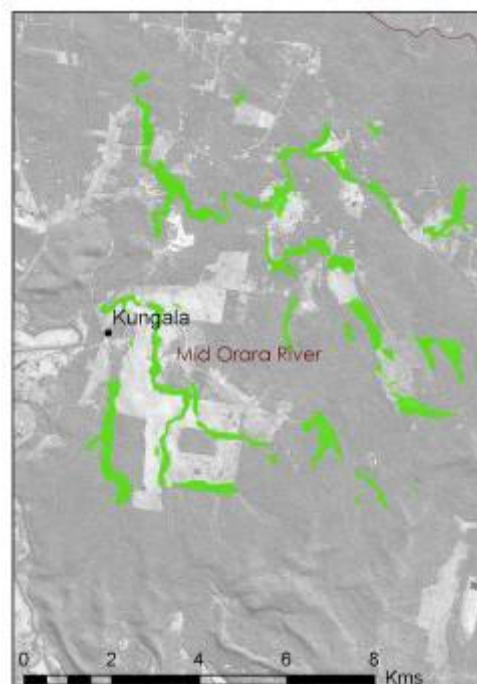
Conservation values:

General: A highly valuable area of lowland and wetland vegetation, which forms a key habitat link between existing reserves. Habitat is present for many threatened flora and fauna species restricted to lowland and wetland habitats. The area samples Swamp Sclerophyll Forest and Freshwater Wetland endangered ecological communities.

Flora: There are examples of Freshwater Wetlands and Swamp Sclerophyll Forest EEC present along creeks and floodplains in the area. The threatened Slender Screw fern (*Lindsaea incisa*) occurs in the area. Adjoining areas of dry sclerophyll forest contain populations of the vulnerable Square-fruited Ironbark (*Eucalyptus tetrapleura*).

Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR:			
Slender Screw fern	<i>Lindsaea incisa</i>	✓	
LIKELY OR POTENTIALLY OCCURRING:			
Square-fruited Ironbark	<i>Eucalyptus tetrapleura</i>	✓	✓

Fauna: The lowland and wetland habitats of the Halfway Creek cluster provide habitat for numerous native fauna, including threatened species (26 species). Potential habitat also present for the Giant Dragonfly (*Petalura gigantea*).



Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Rufous Bettong	<i>Aepyprymnus rufescens</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Bush Stone-curlew	<i>Burhinus grallarius</i>	✓		
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Brown Treecreeper	<i>Climacteris picumnus</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Green-thighed Frog	<i>Litoria brevipalmata</i>	✓		
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Black-chinned Honeyeater (eastern subspecies)	<i>Melithreptus gularis gularis</i>	✓		
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Giant Barred Frog	<i>Mixophyes iteratus</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Yellow-bellied Glider	<i>Petaurus australis</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Emu population in the NSW North Coast Bioregion	<i>Dromaius novaehollandiae</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Barking Owl	<i>Ninox connivens</i>	✓		
Giant Dragonfly	<i>Petalura gigantea</i>	✓		
Speckled Warbler	<i>Pyrrholaemus saggitatus</i>	✓		
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within cluster: Wells Crossing Flora Reserve. A number of other wetlands are also considered significant. More detailed investigation is suggested to identify the most outstanding sites.

Threats: Under considerable threat of continued habitat fragmentation due to land clearing, inappropriate rural subdivisions, road construction and logging.

Management / Rehabilitation: Protection of key habitats and restoration and maintenance of wildlife corridor values.

Proximity to existing protected areas: A number of wetlands in this cluster are adjacent to Sherwood NR and Yuraygir SCA. Flaggy Creek NR is located 2.5km south west.

Potential contribution to NRS: A priority for the maintenance and restoration of highly important regional wildlife corridor linking Sherwood Nature Reserve to Yuraygir State Conservation Area. Linkages via corridors are essential to ensure the viability and adequacy of conservation of the national reserve system. Encourage investment in off park conservation mechanisms such as incentives, and conservation covenants. Also investigate possible acquisition of lands adjoining Sherwood Nature Reserve and Yuraygir State Conservation Area.

Other wetland areas in cluster (not currently mapped): None identified.

MANGROVE CREEK

Wetland Cluster No:	11
No. Polygons:	8
Area (ha):	343
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	1 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Not listed
SEPP14 (ha):	45

Location: About 8 kilometres north of Maclean.

Geology and landform: Situated on the alluvial floodplain, backswamps and alluvial fans of Mangrove Creek. In the lower catchment are low lying tidal delta flats with sediments of estuarine/deltaic origin. The upper catchment comprises a gently undulating alluvial floodplain with sediments derived from coarse grained sandstones (Morand, 2001).

Sub-catchments: Entirely within the Clarence Coastal sub-catchment.

Water source: Fresh. Although lower sections intertidal/estuarine.

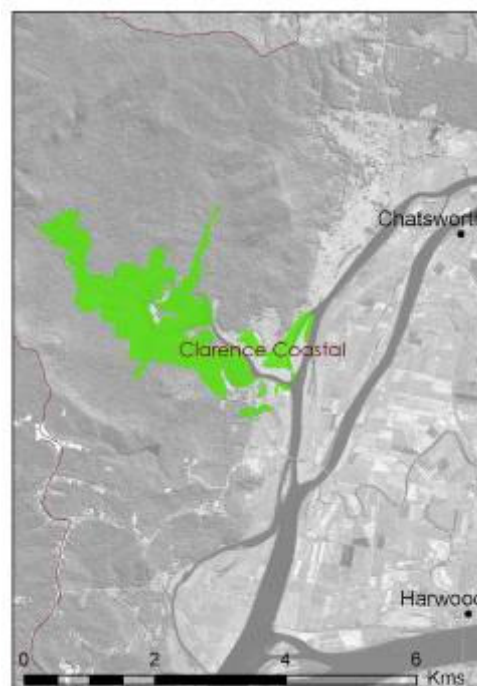
Hydrology and drainage: Contains both freshwater and estuarine/brackish habitat. No significant drainage has occurred.

Land use and tenure: A large part of the catchment is located within Gibberagee State Forest. The remaining area is freehold land which includes a few large blocks directly adjacent to Mangrove Creek. The cluster adjoins Chatsworth Hill State Conservation Area.

Conservation values:

General: One of few remaining freshwater creek systems flowing into the Clarence River estuary with a predominantly intact catchment in terms of native vegetation cover. This catchment is part of a regional fauna corridor linking Gibberagee State Forest through to the Broadwater.

Flora: Much of the vegetation of the area comprises the Swamp Sclerophyll Forest on Coastal Floodplains Endangered Ecological Community. The vulnerable plant species *Persicaria elatior*, Tall Knotweed has been sampled in the area. Significant areas of Swamp Mahogany and Broad-leaved Paperbark forest occur on alluvial floodplains adjacent to Mangrove Creek. The area remains poorly surveyed and the vegetation unreliably mapped.



Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR:			
Tall Knotweed	<i>Persicaria elatior</i>	✓	

Fauna: The cluster has been particularly poorly surveyed for fauna. A more adequate survey of the area would result in the recording of populations and habitat for many threatened and significant fauna species.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Brown Treecreeper	<i>Climacteris picumnus</i>	✓		
Barred Cuckoo-shrike	<i>Coracina lineata</i>	✓		
Emu population in the NSW North Coast Bioregion	<i>Dromaius novaehollandiae</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Barking Owl	<i>Ninox connivens</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	✓		
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within Cluster: Due to undistributed nature of this cluster all wetland areas are considered significant, including areas currently in State Forest.

Threats: Pest plants and change in land use such as rural residential development in the catchment are considered the major threats.

Management / Rehabilitation: Site does not require rehabilitation as it is largely intact. Ongoing control of pest species recommended.

Proximity to existing protected areas: Mangrove Creek is adjacent to the Chatsworth Hill SCA. Mororo Creek NR is located 4km north east.

Potential contribution to NRS: High priority site for addition of wetland and lowlands to Chatsworth Hill State Conservation Area. Protection of an intact catchment containing floodplain EECs, threatened plants and animal species that are poorly represented in the National Reserve System, and establishment of a formally reserved important habitat corridor.

Other wetland areas in cluster (not currently mapped): None identified.

NEWRYBAR

Wetland Cluster No:	12
No. Polygons:	27
Area (ha):	995
IBRA sub region:	Clarence lowlands
Catchment:	Richmond River
No. Subcatchments:	1 (see below)
CMA:	Northern Rivers
LGA:	Ballina
DIWA:	Not listed
SEPP14 (ha):	589

Location: North of Lennox Head in northern NSW.

Geology and landform: This cluster represents a coastal sandplain system consisting of Holocene foredune complexes, dune ridges and Pleistocene backbarrier flats, freshwater swamp and strand plains of the Newrybar Sandmass.

Sub-catchments: Newrybar wetland cluster is located entirely within Lennox Area sub-catchment.

Water Source: Fresh.

Hydrology and Drainage: Wetlands in the Newrybar are associated with underlying sand barrier alluvial system and are therefore highly groundwater dependent. Drawdown of the alluvial aquifer directly or indirectly may be considered a threat. The sand barrier swamps typically fill after rainfall events.

Land use and tenure: The area is freehold land and includes areas that were Vacant Crown land that were claimed under the *Aboriginal Land Rights Act 1983*.

Conservation values:

General: The cluster is a major key habitat and regional fauna corridor linking coastal wetland and lowland habitats. Native vegetation communities are in excellent condition and essentially weed-free.

Flora: The vegetation is a contiguous transition of coastal sand barrier foredune and ridge vegetation. It includes dry sclerophyll forest and woodland, dry heathland/dry sclerophyll shrubland (dominated by *Banksia aemula*) on dunes, ridges and dry strand plains. On back-barrier flats, swales and poorly drained strandplains on sand are Swamp Mahogany *Eucalyptus robusta*, Broad-leaved Paperbark *Melaleuca quinquenervia*, Swamp Sclerophyll Forest and woodlands *Melaleuca ericifolia*. Wet heathlands (dominated by *Banksia oblongifolia*), sedgeland, fernland and Swamp Water Fern *Blechnum indicum* also occur within the Newrybar cluster. Regionally significant communities of *Strangea linearis* also occur here in addition to numerous nectar bearing vegetation and remnants of sub-tropical rainforest. In total, 13 threatened plant species have been listed as occurring in this cluster.



Common Name	Species Name	TSC Act	EPBC Act
Scented Acronychia	<i>Acronychia littoralis</i>	✓	✓
Hairy Jointgrass	<i>Arthraxon hispidus</i>		✓
Stinking Cryptocarya	<i>Cryptocarya foetida</i>	✓	✓
Smooth Davidson's Plum	<i>Davidsonia johnsonii</i>		✓
Rough-shelled Bush Nut	<i>Macadamia tetraphylla</i>		✓
Onion Cedar	<i>Owenia cepiodora</i>		✓

Lesser Swamp-orchid	<i>Phaius australis</i>		✓
Spiny Gardenia	<i>Randia moorei</i>		✓
Red Lilly Pilly	<i>Syzygium hodgkinsoniae</i>		✓
Coolamon Rose Apple	<i>Syzygium moorei</i>		✓
Arrow-head Vine	<i>Tinospora tinosporoides</i>		✓

Fauna: In total 22 threatened species have been identified from this wetland cluster.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Barred Cuckoo-shrike	<i>Coracina lineata</i>	✓		
Wallum Froglet	<i>Crinia tinnula</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Pied Oystercatcher	<i>Haematopus longirostris</i>	✓		
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Olongburra Frog ^	<i>Litoria olongburensis</i>	✓	✓	
Little Bentwing-bat	<i>Miniopterus australis</i>	✓		
White-eared Monarch	<i>Monarcha leucotis</i>	✓		
Eastern Long-eared Bat	<i>Nyctophilus bifax</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Eastern Ground Parrot	<i>Pezoporus wallicus wallicus</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	✓		
Rose-crowned Fruit-Dove	<i>Ptilinopus regina</i>	✓		
Common Blossom-bat	<i>Syconycteris australis</i>	✓		
Grass Owl	<i>Tyto capensis</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Green and Golden Bell Frog	<i>Litoria aurea</i>	✓	✓	
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Rainbow Bee-eater	<i>Merops ornatus.</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Whimbrel	<i>Numenius phaeopus</i>			✓
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

^High Density

*The workshop participants stated that there are numerous shorebird species but not many migratory species; however the search has listed nine species that could occur in the area.

Significant wetland areas within cluster: Newrybar Swamp, directly north-west of the cluster identified to be included in the cluster (see below) due to the natural values of the vegetation. Significant Swamp Sclerophyll EEC and remnants of big scrub are found in this area.

Threats: Non-sustainable vehicle (4WD) use, domestic dumping, residential development, and water extraction are ongoing threats. Construction of roads in the catchment has impeded natural drainage and there is the potential for the west of the cluster to be affected by drainage. Catchment management and altered land use also though to be contributing to water quality issues in Lake Ainsworth (e.g. ongoing algae issues). ASS and firs are also potential threats.

Management/Rehabilitation: Fire management, rehabilitation of dunal systems, regeneration.

Proximity to existing protected areas: Ballina NR is located immediately south-west of the cluster with Broken Head NR directly north. Both reserves fringe the cluster.

Potential contribution to NRS: The ecological communities in this cluster are represented reasonably well in the existing NP Estate, although elements remain worthy of protection.

Other wetland areas in cluster (not currently mapped): Areas to the south of the cluster were identified in addition to areas to the west and north. Newrybar Swamp, directly north-west was also identified in particular. The additions would provide a corridor with existing reserved areas.

RICHMOND ESTUARY

Wetland Cluster No:	13
No. Polygons:	28
Area (ha):	1623
IBRA sub region:	Clarence lowlands
Catchment:	Richmond River
No. Sub-catchments:	2 (see below)
CMA:	Northern Rivers
LGA:	Ballina
DIWA:	Not listed
SEPP14 (ha):	1088

Location: Located between Lennox Head and Ballina in northern NSW.

Geology and landform: This alluvial landscape is very fertile and includes tidally influenced areas of the estuarine plain of Richmond River and North Creek, and floodplain and backswamps of Emigrant Creek.

Sub-catchments: The majority of the Richmond Estuary cluster is located within the Lennox Area sub-catchment. Areas to the west lie within the Alstonville Area sub-catchment.

Water Source: Intertidal/Estuarine and Fresh

Hydrology and Drainage: One of the major estuaries of the NSW North Coast, which supports both estuarine and brackish/freshwater wetlands. Many areas still retain tidal exchange, although in other areas tidal flows have been excluded by floodgates. Freshwater wetlands and forests occur upstream of the estuarine areas on floodplains that in parts have been extensively drained.

Land use and tenure: Includes urban, industrial, grazing and agriculture land uses. The area is mainly freehold with some areas of vacant and reserved Crown land.

Conservation values:

General: A key habitat and regional corridor, linking coast to escarpment areas, from Tyagarah NR through to Arakwal NP and Broken Head NR. Complex wetland and aquatic habitat, although somewhat fragmented. Supports high abundance of native fauna.

Flora: Vegetation communities within the cluster include the Swamp Oak/Broad-leaved Paperbark Swamp Sclerophyll Forests of the estuarine and alluvial plains, Saltmarsh and mangrove of the littoral zone and mesic, wet sclerophyll forests and rainforests. The Saltmarsh, Swamp Oak and Swamp Sclerophyll Forest and Lowland Rainforest are identified as EECs. The area is known to contain significant populations of the Southern Swamp Orchid *Phaius australis*. A high number of threatened species inhabit this cluster (15 species) as listed below.



Common Name	Species Name	TSC Act	EPBC Act
LIKELY OR POTENTIALLY OCCURRING:			
Scented Acronychia	<i>Acronychia littoralis</i>	✓	✓
White Laceflower	<i>Archidendron hendersonii</i>	✓	
Hairy JointGrass†	<i>Arthraxon hispidus</i>	✓	✓
Stinking Cryptocarya	<i>Cryptocarya foetida</i>	✓	✓
Smooth Davidson's Plum	<i>Davidsonia johnsonii</i>	✓	✓

Common Name	Species Name	TSC Act	EPBC Act
Ball Nut	<i>Floydia praealta</i>	✓	✓
Sweet Myrtle	<i>Gossia fragrantissima</i>	✓	✓
Rough-shelled Bush Nut	<i>Macadamia tetraphylla</i>	✓	✓
Onion Cedar	<i>Owenia cepiodora</i>	✓	✓
Southern Swamp Orchid	<i>Phaius australis</i>	✓	✓
Silver Bush	<i>Sophora tomentosa</i>	✓	
Red Lilly Pilly	<i>Syzygium hodgkinsoniae</i>	✓	✓
Arrow-head Vine	<i>Tinospora tinoporoides</i>	✓	✓

†Large population with local significance

Fauna: Richmond estuary provides significant habitat for migratory bird species (7 species) and threatened species (38 species).

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Bush hen	<i>Amaurornis olivaceus</i>	✓		
Magpie Goose	<i>Anseranas semipalmata</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Sanderling	<i>Calidris alba</i>	✓		
Great Knot	<i>Calidris tenuirostris</i>	✓		✓
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Greater Sand-plover	<i>Charadrius leschenaultii</i>	✓		✓
Lesser Sand Plover	<i>Charadrius mongolus</i>	✓		✓
Barred Cuckoo-shrike	<i>Coracina lineata</i>	✓		
Wallum Froglet	<i>Crinia tinnula</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
White Tern	<i>Gygis alba</i>	✓		
Sooty Oystercatcher	<i>Haematopus fuliginosus</i>	✓		
Pied Oystercatcher	<i>Haematopus longirostris</i>	✓		
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Mangrove Honeyeater	<i>Lichenostomus fasciolaris</i>	✓		
Broad-billed Sandpiper	<i>Limicola falcinellus</i>	✓		✓
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Eastern Long-eared Bat	<i>Nyctophilus bifax</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	✓		
Rose-crowned Fruit-Dove	<i>Ptilinopus regina</i>	✓		
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Sooty Tern	<i>Sterna fuscata</i>	✓		
Freckled Duck	<i>Stictonetta naevosa</i>	✓		

Common Name	Species Name	TSC Act	EPBC Act	MBA
Collared Kingfisher	<i>Todiramphus chloris</i>	✓		
Grass Owl	<i>Tyto capensis</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
Terek Sandpiper	<i>Xenus cinereus</i>	✓		✓
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Black-tailed Godwit	<i>Limosa limosa</i>	✓		✓
Green and Golden Bell Frog	<i>Litoria aurea</i>	✓	✓	
Olongburra Frog	<i>Litoria olongburensis</i>	✓	✓	
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
White-eared Monarch	<i>Monarcha leucotis</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Whimbrel	<i>Numenius phaeopus</i>			✓
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Pacific Golden Plover	<i>Pluvialis fulva</i>			✓
Common Blossom-bat	<i>Syconycteris australis</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within cluster: Areas adjacent to existing protected areas.

Threats: There are a large number of threats to this cluster including: Feral animals (pigs, cane toads), pest plants (Groundsel bush), urban and rural development, poor water quality (ASS, fish kills, blackwater), drainage and flood management altering the water regime of freshwater and estuarine wetlands and barriers to fish passage. Sea-level rise due to climate change is also a potential threat.

Management / Rehabilitation: Catchment management program to improve water quality and undertake weed control are a priority. Identifying options to improve freshwater and estuarine water regimes by improving drainage also recommended.

Proximity to existing protected areas: Ballina NR adjoins the cluster to the north and Richmond River NR to the south.

Potential contribution to NRS: Increased reservation to protect values of existing nature reserves is recommended. This will provide buffers to protected areas of aquatic habitat and improve water quality in the Richmond estuary. Increased protection of intertidal habitat would conserve important habitat for migratory bird species.

Other wetland areas in cluster (not currently mapped): Numerous wetland areas throughout to the south of the cluster not currently mapped. Review of wetland mapping is recommended.

SHARK CREEK

Wetland Cluster No:	14
No. Polygons:	3
Area (ha):	2687
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	2 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Not listed
SEPP14 (ha):	1343

Location: Shark Creek is a right bank distributary creek which joins the South Arm of the Clarence River, approximately 2 kilometres north of Tyndale.

Geology and landform: Alluvial channel and extensive backswamp system of Shark Creek with input of fine to coarse grained sediment rocks from Koukandowie formation sandstones of the Shark Creek Range.

Sub-catchments: Almost entirely within the Shark Creek sub-catchment. Minor areas part of the Clarence Coastal sub-catchment.

Water source: Fresh.

Hydrology and drainage: Drainage patterns in Shark Creek differ considerably between Lower Shark Creek (north) and Upper Shark Creek (south). Lower Shark Creek has been modified by drainage, which has reduced the extent and duration of inundation and led to encroachment of Broad-leaved Paperbark (*Melaleuca quinquenervia*) in some areas. Upper Shark Creek is largely unaffected by drainage.

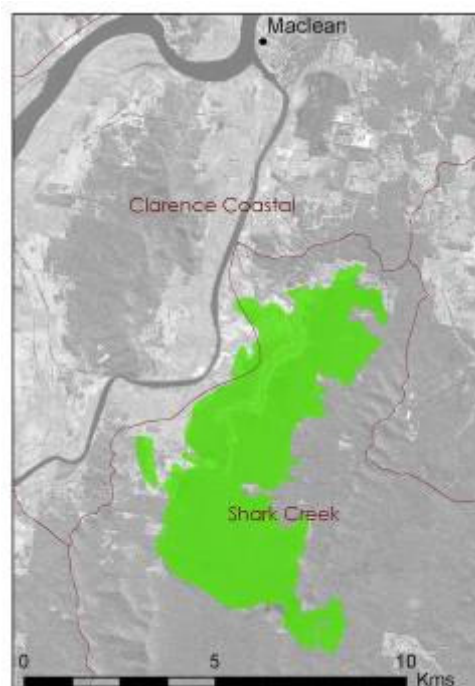
Land use and tenure: Entirely located within freehold land tenure. Upper Shark Creek is naturally vegetated and is known as Tyndale Swamp. The northern parts of the Shark Creek floodplain have been generally cleared and extensively drained for sugar cane (Tulau, 1999). Shark Creek is an ASS hotspot. Other major land uses include grazing, private forestry and rural residential.

Conservation values:

General: Shark Creek is recognised as key habitat that forms part of the Tyndale Swamp Regional Corridor linking hinterland areas.

Flora: Extensive areas of coastal floodplain forested woodlands and wetlands, which qualify as EEC (Swamp Sclerophyll Forest, Subtropical Coastal Floodplain Forest, Swamp Oak and Freshwater Wetland). The threatened wetland plant *Maundia triglochinos* was recorded in the southern half of the swamp (Pressey, 1987) although the vegetation of the area remains poorly surveyed.

Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR:			
Maundia triglochinos	<i>Maundia triglochinos</i>	✓	



Fauna: The southern part of the Shark Creek cluster is a large area of contiguous coastal wetland fauna habitat. The catchment of Sharks Creek is afforded additional catchment

protection by adjoining vegetated cover of the Shark Creek Range and such occurrences are rare on the North Coast. The habitats are utilised by 21 threatened fauna species.

Limited fauna species are recorded from the cluster compared to the other clusters possibly due to a lack of survey effort and access issues.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Rufous Bettong	<i>Aepyprymnus rufescens</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Emu population in the NSW North Coast Bioregion	<i>Dromaius novaehollandiae</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Barking Owl	<i>Ninox connivens</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Eastern Long-eared Bat	<i>Nyctophilus bifax</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Yellow-bellied Glider	<i>Petaurus australis</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>			
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Grass Owl	<i>Tyto capensis</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Common Blossom-bat	<i>Syconycteris australis</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within Cluster: Upper Shark Creek

Threats: NSW Fisheries noted that pH values <4 occurred often in runoff from the Shark Creek catchment, at times as low as pH 3, indicting the effects of ASS (Tulau, 1999). Non-sustainable agriculture and drainage are considered the most significant threats to wetland conservation. Aquatic weed impacts considered less of an issue at Shark Creek compared to other areas on the Clarence floodplain.

Management / Rehabilitation: Drainage management to restore hydrology in Lower Shark Creek. Upper Shark Creek does not require extensive rehabilitation except for ongoing maintenance (i.e. control of pest plants and animals).

Proximity to existing protected areas: Shark Creek provides a geographical link between three existing conservation reserves, Woodford Island NR (2.5km west), Yuraygir NP (3km east) and Yaegl NR (5 km north).

Potential contribution to NRS: Upper Shark Creek has largely natural hydrology and supports ecological communities that retain ecological integrity, including old growth Swamp Sclerophyll vegetation. Close proximity to large areas of native vegetation in State Forest and NP Estate (e.g. Yuraygir NP). Goodrick (1970) recommended the preservation of 610 hectares of seasonal fresh swamp at Upper Shark Creek, and the NPWS has recommended the preservation of the 'Shark Swamp' area (north of Tyndale Swamp).

Other wetland areas in cluster (not currently mapped): Low-lying areas to the south of Shark Creek.

SOUTH CLARENCE

Wetland Cluster No:	15
No. Polygons:	11
Area (ha):	212
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	1 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Listed
SEPP14 (ha):	0

Location: West to north-west of Grafton, near Waterview Heights.

Geology and landform: Located on backswamp and floodplains of Saltwater Creek and Cowans Creek.

Sub-catchments: Entirely within the Clarence Tidal Pool sub-catchment.

Water source: Fresh.

Hydrology and drainage: There has been significant drainage of floodplain and agricultural land in the region. Cowans Ponds is a semi-permanent freshwater swamp that has not been impacted by drains.

Land use and tenure: Freehold tenure, except for Cowans Pond which is partly a Council reserve. Main land uses include grazing, cropping and rural residential development.

Conservation values:

General: Cowans Pond is widely known for its value as a drought refuge and habitat for water birds.

Flora: The wetlands comprise areas of shallow and deep open water with adjoining freshwater meadows in which Swamp Ricegrass *Leersia hexandra*, Water Couch *Paspalum distichum* and *Pericaria* spp. are frequent (Pressey, 1987). These wetland vegetation types are equivalent to the Freshwater Wetland EEC.

Fauna: Over 20 threatened species have been identified within the cluster and 7 bird species listed on migratory bird agreements (see below).



Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Rufous Bettong	<i>Aepyprymnus rufescens</i>	✓		
Magpie Goose	<i>Anseranas semipalmata</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
White-crowned Snake	<i>Cacophis harriettae</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓

Common Name	Species Name	TSC Act	EPBC Act	MBA
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	✓		
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Black-tailed Godwit	<i>Limosa limosa</i>	✓		✓
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Black-chinned Honeyeater (eastern ssp)	<i>Melithreptus gularis gularis</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Glossy Ibis	<i>Plegadis falcinellus</i>			✓
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Sooty Tern	<i>Sterna fuscata</i>	✓		
Freckled Duck	<i>Stictonetta naevosa</i>	✓		
Common Greenshank	<i>Tringa nebularia</i>			✓
Marsh Sandpiper	<i>Tringa stagnatilis</i>			✓
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
White-throated Needle-tail	<i>Hirundapus caudacutus</i>			✓
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Barking Owl	<i>Ninox connivens</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

*One off record

Significant wetland areas within Cluster: Cowans Ponds and the two wetland depressions directly north of Cowans Ponds, particularly for avifauna.

Threats: High abundance of aquatic weeds, particularly Water Hyacinth. Non-sustainable land use including grazing and high nutrient inputs.

Management / Rehabilitation: Restoration of wetlands via stock management (fencing), catchment management (nutrient inputs) and drainage management. Currently limited community interest in large-scale wetland rehabilitation, however there is scope for small scale NRM projects and private land conservation. Recommended to protect remaining part of Cowans Pond on private land (e.g. fence and establish riparian zone).

Proximity to existing protected areas: No protected areas adjacent or in close proximity.

Potential contribution to NRS: Wetlands in the South Clarence region have lower overall value in terms of wetland biodiversity compared to other areas on the Clarence floodplain (except for avifauna). This is due to their small and fragmented nature.

Other wetland areas in cluster (not currently mapped): None identified.

TABBIMOBLE

Wetland Cluster No:	16
No. Polygons:	23
Area (ha):	4063
IBRA sub region:	Clarence lowlands
Catchment:	Clarence River
No. sub-catchments:	1 (see below)
CMA:	Northern Rivers
LGA:	Richmond & Clarence
DIWA:	Not listed
SEPP14 (ha):	552

Location: Approximately 50 kilometres south of Casino and 20 kilometres north of Yamba.

Geology and landform: Mostly floodplain and valley of the alluvial plain of Tabbimoble.

Sub-catchments: Almost entirely within the Esk River sub-catchment. One area within the Double Duke Area sub-catchment.

Water source: Fresh.

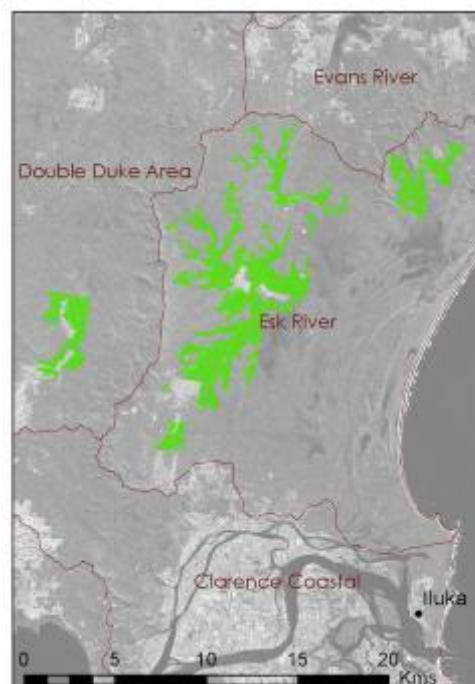
Hydrology and drainage: Freshwater wetland system that is fed by a number of small creeks and drainage lines. Not extensively drained or modified, and a number of areas retain natural hydrology. The highway acts as a levee and is underlain by series of floodway drains (Tabbimoble floodway drains 1, 2 & 3) which flow west to east.

Land use and tenure: Forestry and grazing are the main land uses. The cluster occurs on freehold and State Forest land tenure. The cluster adjoins Bundjalung NP and SCA and Tabbimoble Swamp NR. The Pacific Highway (which is to be widened) passes through the Tabbimoble wetlands.

Conservation values:

General: The cluster forms part of a major wetland and coastal lowland forest identified as a key habitat and regional corridor. Unique wetland ecological communities and landforms compared to other wetlands in the Clarence lowlands subregion, and recognised for the significant habitat it provides for mammal species.

Flora: The Forest Ecosystems (FE) types predicted to occur include the Paperbark, Lowland Red Gum and Swamp. These occurrences are equivalent to Freshwater Wetland, Swamp Sclerophyll Forest and Subtropical Coastal Floodplain Forest EECs. The cluster has a high flora species richness (e.g. estimated >1000 vascular plant taxa). The cluster has been identified as including 5 threatened plant species listed on the TSC Act and EPBC Act.



Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR			
Swamp Nut Grass	<i>Cyperus aquatilis</i>	✓	
Bordered Guinea Flower	<i>Hibbertia marginata</i>	✓	✓
Weeping Paperbark	<i>Melaleuca irbyana</i>	✓	
Knotweed	<i>Persicaria elatior</i>	✓	✓
Lesser Swamp-orchid	<i>Phaius australis</i>	✓	✓

Fauna: The fauna habitats present are particularly important for 32 threatened species.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Rufous Bettong	<i>Aepyprymnus rufescens</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Brown Treecreeper	<i>Climacteris picumnus</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Emu population in the NSW North Coast Bioregion	<i>Dromaius novaehollandiae</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
Pale-headed Snake	<i>Hoplocephalus bitorquatus</i>	✓		
Stephens' Banded Snake	<i>Hoplocephalus stephensii</i>	✓		
Green-thighed Frog	<i>Litoria brevipalmata</i>	✓		
Olongburra Frog	<i>Litoria olongburensis</i>	✓		
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Black-chinned Honeyeater (eastern ssp)	<i>Melithreptus gularis gularis</i>	✓		
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Oxyleyan Pygmy Perch	<i>Nannoperca oxleyana</i>		✓	
Barking Owl	<i>Ninox connivens</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Eastern Long-eared Bat	<i>Nyctophilus bifax</i>	✓		
Yellow-bellied Glider	<i>Petaurus australis</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Eastern Ground Parrot	<i>Pezoporus wallicus wallicus</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Eastern Chestnut Mouse	<i>Pseudomys gracilicaudatus</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Common Blossom-bat	<i>Syconycteris australis</i>	✓		
Grass Owl	<i>Tyto capensis</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Wallum Froglet	<i>Crinia tinnula</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Giant Barred Frog	<i>Mixophyes iteratus</i>	✓		
Whimbrel	<i>Numenius phaeopus</i>			✓

Common Name	Species Name	TSC Act	EPBC Act	MBA
Australian Painted Snipe	<i>Rostratula australis</i>		✓	
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within Cluster: All Swamp Sclerophyll and Subtropical Coastal Floodplain Forest, and freshwater wetland areas, in the Tabbimoble cluster are considered to be of high value for biodiversity conservation.

Threats: Fire is a significant threat due to the proximity of the Pacific Highway. Loss of remnant vegetation by clearing is also a key threat. Invasive plants and animals including Cane toads, Feral Pigs, vine weeds and Groundsel Bush are considered a moderate threat to biodiversity conservation. Increased rural residential development and widening of the Pacific Highway are additional threats.

Management / Rehabilitation: Tabbimoble does not require extensive rehabilitation except for ongoing maintenance (i.e. control of pest plants and animals). Investigation of drainage restoration options is recommended, although impacts from drainage are considered minor. Given large areas of this cluster occur in State Forest, development of management plans with DPI Forests is considered critical to ensure long-term protection.

Proximity to existing protected areas: Wetland habitat at Tabbimoble provides an important geographical link between four existing conservation reserves, Bundjalung NP (adjoins-west and east), Bundjalung SCA (adjoins-west), Tabbimoble Swamp NR (adjoins-north) and Jackywalbin SCA (1km northwest).

Potential contribution to NRS: Considered one of most important wetland areas in the Clarence lowlands subregion due to its intactness and because of the threatened flora, fauna and ecological communities it supports. There a number of options to enhance the NRS by protecting wetlands adjoining NP Estate. Strategic conservation has potential to improve connectivity between NP, NR and SCA in the Tabbimoble swamp region (e.g. unreserved areas east of Pacific Highway). Recommended to assess the conservation value of wetlands currently within State Forest. Because no major change in hydrology is required to protect ecological values, a piece by piece approach to private land conservation and land acquisition can be implemented.

Other wetland areas in cluster (not currently mapped): None identified.

THE BROADWATER

Wetland Cluster No:	17
No. Polygons:	7
Area (ha):	2490
IBRA sub region:	Clarence Lowlands
Catchment:	Clarence River
No. sub-catchments:	1 (see below)
CMA:	Northern Rivers
LGA:	Clarence Valley
DIWA:	Listed
SEPP14 (ha):	1277

Location: Approximately 30 kilometres north of Grafton and six kilometres north of Lawrence.

Geology and landform: The Broadwater, a 2,800 hectare off-stream tidal water body averaging less than one metre in depth, is the largest estuarine wetland in the Clarence River estuary.

Sub-catchments: Entirely within The Broadwater sub-catchment.

Water source: Fresh and intertidal/estuarine.

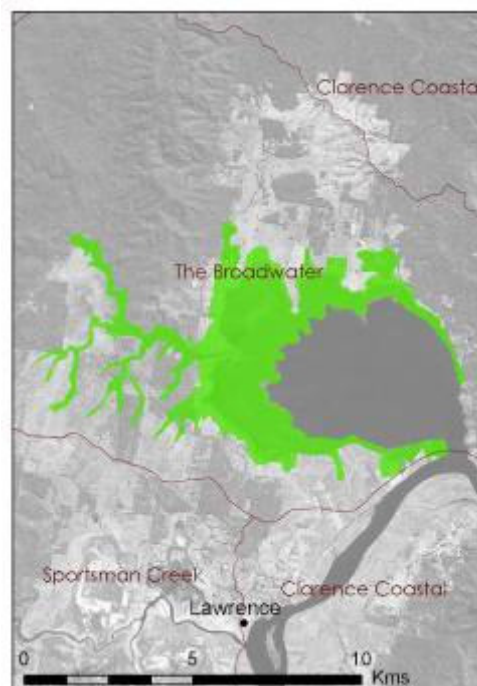
Hydrology and drainage: Broadwater Creek is the main source of freshwater flows, although a barrier across Broadwater Creek restricts tidal inflows. The barrier keeps Broadwater Creek fresh which supports extraction under water licences. Drainage has reduced the extent and duration of wetland inundation, however ASS are considered a significant issue.

Land use and tenure: Entirely freehold and Crown leasehold land tenure. Main land uses include grazing, sugar cane, horticulture and rural residential development. Cluster adjoins areas of State Forest. Forestry plantations are increasing in the region.

Conservation values:

General: The wetland comprises all stages of wetland vegetation from aquatic ecosystems of deep and shallow open water, to estuarine and alluvial wetland complexes and riparian and terrestrial vegetation types. The Broadwater is an important location for the Aboriginal community, and has European cultural values closely linked with the history of agricultural settlement and the character of the agricultural landscape (DEC, 2006).

Flora: It contains sub-tidal aquatic beds (e.g. seagrasses, marine meadows such as water couch and open water systems), estuarine waters, inter-tidal mud, sand and salt flats, inter-tidal forested wetlands (mangrove swamps), freshwater lagoons and marshes within the coastal zone (swamp forests – spike and pin rush swamps and Water Couch *Paspalum distichum* meadows), and non-tidal freshwater forested wetlands. It also contains the largest single area of the seagrass *Ruppia* sp. in the state. The cluster contains extensive samples of several EECs including Saltmarsh, Swamp Oak, Swamp Sclerophyll Forest, Subtropical Coastal Floodplain Forest and Freshwater Wetland.



Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR:			
Knotweed	<i>Persicaria elatior</i>	✓	✓
Mason's Grevillea	<i>Grevillea masonii</i>	✓	✓

Fauna: The Broadwater provides breeding and nursery grounds for over 31 birds (including at least 11 bird species listed under international treaties), fish (including a wide range of highly valued commercial and recreational species) and invertebrates. The wetland is an important habitat for many commercial fish species (Environment Australia, 2001). The open water body has previously supported high numbers (>10,000) of Black Swans.

Birds known to nest at The Broadwater site include Brolga, Black-necked Stork, Osprey and White-bellied Sea-Eagle. Other threatened species known to occur within the study area and listed on the TSC Act and EPBC Act include the following:

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Sharp-tailed Sandpiper	<i>Calidris acuminata</i>			✓
Red Knot	<i>Calidris canutus</i>			✓
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Brown Treecreeper	<i>Climacteris picumnus</i>	✓		
Barred Cuckoo-shrike	<i>Coracina lineata</i>	✓		
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Eastern False Pipistrelle	<i>Falsistrellus tasmaniensis</i>	✓		
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
Brolga	<i>Grus rubicunda</i>	✓		
Pied Oystercatcher	<i>Haematopus longirostris</i>	✓		
White-bellied Sea-Eagle	<i>Haliaeetus leucogaster</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Bar-tailed Godwit	<i>Limosa lapponica</i>			✓
Black-chinned Honeyeater (eastern ssp)	<i>Melithreptus gularis gularis</i>	✓		
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
Whimbrel	<i>Numenius phaeopus</i>			✓
Osprey	<i>Pandion haliaetus</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Long-nosed Potoroo (SE mainland)	<i>Potorous tridactylus tridactylus</i>	✓	✓	
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	✓		
Speckled Warbler	<i>Pyrrholaemus saggitatus</i>	✓		
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Little Tern	<i>Sterna albifrons</i>			✓
Common Greenshank	<i>Tringa nebularia</i>			✓
Marsh Sandpiper	<i>Tringa stagnatilis</i>			✓
LIKELY OR POTENTIALLY OCCURRING:				
Rufous Bettong	<i>Aepyprymnus rufescens</i>	✓		
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Lesser Sand Plover	<i>Charadrius mongolus</i>	✓		✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Barking Owl	<i>Ninox connivens</i>	✓		

Common Name	Species Name	TSC Act	EPBC Act	MBA
Powerful Owl	<i>Ninox strenua</i>	✓		
Eastern Long-eared Bat	<i>Nyctophilus bifax</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Pacific Golden Plover	<i>Pluvialis fulva</i>			✓
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Speckled Warbler	<i>Pyrrholaemus sagittatus</i>	✓		
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

Significant wetland areas within Cluster: The large area of remnant vegetation to the west of the main estuarine water body, to the north and south of Broadwater Creek. Riparian habitat along Broadwater Creek, and floodplain vegetation fringing The Broadwater (north, south and west) also significant.

Threats: Loss of saltmarsh due to sea-level rise (climate change). Loss of seagrass due to increased sedimentation and nutrient enrichment. Non-sustainable agriculture, increase in rural residential development, increase in forestry plantations, vegetation clearing and high abundance of pest plants (e.g. vine weeds) and animals (e.g. pigs) are considered major threats.

Management / Rehabilitation: PoM (DECC 2006) describes both broad and specific management recommendations. Catchment management programs to limit sediment and nutrient inputs are required. Options to restore tidal flows in Broadwater Creek to be discussed with landholders. Drainage management (infilling drains) and control of pest plants and animals also recommended. Estuarine water body is closed to trawling.

Proximity to existing protected areas: Lawrence Road SCA (1.5km west) and Kooyong SCA (2km northwest). Also in close proximity to NCT covenanted property further upstream of Broadwater Creek.

Potential contribution to NRS: Considered one of the most important unprotected sites in Clarence lowlands subregion. Recognised importance for fisheries habitat particularly the extensive seagrass beds. The large area of intact remnant vegetation that surrounds the main estuarine water body is important for the biodiversity it supports and for its function of regulating and maintaining aquatic habitat in The Broadwater. Some interest from landholders adjacent to Broadwater Creek in land acquisition.

Other wetland areas in cluster (not currently mapped): None identified.

TUCKEAN

Wetland Cluster No:	18
No. Polygons:	11
Area (ha):	3550
IBRA sub region:	Clarence lowlands
Catchment:	Richmond River
No. Sub-catchments:	2 (see below)
CMA:	Northern Rivers
LGA:	Ballina & Lismore
DIWA:	Listed
SEPP14 (ha):	627

Location: Located 18 kilometres south-east of Lismore, near Broadwater.

Geology and landform: Located on alluvium and contains estuarine environments of the Tuckean Broadwater and a transition to the alluvial floodplain and back-swamps of Tuckean Swamp.

Sub-catchments: Almost the entire Tuckean cluster is within the Tuckean Area sub-catchment. A few small areas to the south of the cluster are located within the Broadwater Area sub-catchment.

Water Source: Fresh and Intertidal/Estuarine

Hydrology and Drainage: This is a highly modified environment. A tidal barrage (Bagotville Barrage) has been constructed across the entrance of Tuckean Swamp that limits tidal inflow into the wetlands. This turned the swamp into a freshwater system. Recently management of the barrage has changed to allow some exchange of tidal water into the drainage system. Tuckean Swamp is also extensively drained. As a result of lowering of the water table there has been the exposure of ASS in some areas.

Land use and tenure: Mainly freehold with areas of Crown leasehold and Crown reserve land. National Park Estate adjoins the cluster.

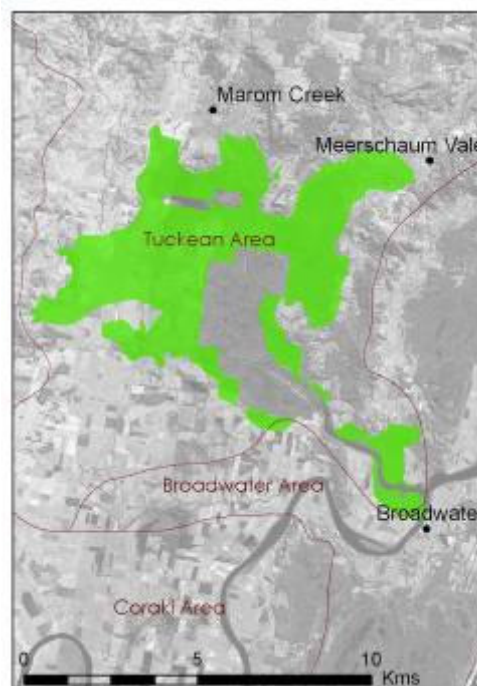
Conservation values:

General: The Tuckean Swamp and Tuckean Broadwater areas link important unprotected coastal wetland environments that adjoin Tuckean Swamp NR.

Flora: The Tuckean Swamp freshwater wetlands mainly consist of paperbark forests, many with intensive areas of regrowth, interspersed with areas of open wet meadows (freshwater wetlands). The Tuckean Broadwater comprises old-growth Swamp Sclerophyll Forests in good condition and contains old-growth Mangrove and Swamp Sclerophyll communities across the littoral zone to the upper limits of tidal influence and onto back-swamps of the alluvial plain. Important samples of Milky Mangrove *Excoecaria agallocha*, Swamp Oak and Grey Mangrove King Tide Forest are present, which is a rare estuarine community that occurs at the upper limit of tidal influence. This community also contains abundant Mangrove Fern *Acrosticum speciosum*, which is uncommon outside the Tweed and Brunswick River Valleys.

Samples of Swamp Sclerophyll Forest and Subtropical Coastal Floodplain Forest EECs are also found at Tuckean Broadwater in a relatively undisturbed state. Coastal Cypress Pine Forest preliminary listed EEC is also found within the cluster.

Records of threatened plant species (16 species) listed under the TSC Act and EPBC Act are included below.



Common Name	Species Name	TSC Act	EPBC Act
KNOWN IN OR NEAR:			
Rusty Rose Walnut	<i>Endiandra hayesii</i>	✓	✓
Palm Lily	<i>Cordyline congesta</i>	✓	
LIKELY OR POTENTIALLY OCCURRING:			
Stinking Cryptocarya	<i>Cryptocarya foetida</i>	✓	✓
Ball Nut	<i>Floydia praealta</i>	✓	✓
Sweet Myrtle	<i>Gossia fragrantissima</i>	✓	✓
Red Boppel Nut	<i>Hicksbeachia pinnatifolia</i>	✓	✓
Rough-shelled Bush Nut	<i>Macadamia tetraphylla</i>	✓	✓
Southern Ochrosia	<i>Ochrosia moorei</i>	✓	✓
Red Lilly Pilly	<i>Syzygium hodgkinsoniae</i>	✓	✓
Arrow-head Vine	<i>Tinospora tinosporoides</i>	✓	✓

Fauna: The Tuckean cluster has a large diversity of woodland bird species yet relatively poor waterbird diversity. It has also been identified as a roosting site for the Grey-headed Flying-fox. Over 26 threatened fauna species inhabit the cluster.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Bush hen	<i>Amaurornis olivaceus</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Lesser Sand Plover	<i>Charadrius mongolus</i>	✓		✓
Barred Cuckoo-shrike	<i>Coracina lineata</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Albert's Lyrebird	<i>Menura alberti</i>	✓		
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
White-eared Monarch	<i>Monarcha leucotis</i>	✓		
Eastern Long-eared Bat	<i>Nyctophilus bifax</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala	<i>Phascolarctos cinereus</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	✓		
Rose-crowned Fruit-Dove	<i>Ptilinopus regina</i>	✓		
Speckled Warbler	<i>Pyrrholaemus sagittatus</i>	✓		
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	✓		
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Grass Owl	<i>Tyto capensis</i>	✓		
Sooty Owl	<i>Tyto tenebricosa</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Magpie Goose	<i>Anseranas semipalmata</i>	✓		
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		

Common Name	Species Name	TSC Act	EPBC Act	MBA
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
Pied Oystercatcher	<i>Haematopus longirostris</i>	✓		
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Olongburra Frog	<i>Litoria olongburensis</i>	✓	✓	
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Large-footed Myotis	<i>Myotis adversus</i>	✓		
Powerful Owl	<i>Ninox strenua</i>	✓		
Whimbrel	<i>Numenius phaeopus</i>			✓
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Common Blossom-bat	<i>Syconycteris australis</i>	✓		
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

^Listed but unlikely to inhabit

Significant wetland areas within cluster: None identified.

Threats: Altered drainage, fire, weeds and non-sustainable agriculture (incl. grazing) are the main threats to the wetlands. Loss of habitat for waterbirds and amphibians as a result of the reduction and acidification of wetlands and water bodies is a consequence of drainage. Before the drainage system was established, the Tuckean Swamp was known as one of the most significant breeding and feeding grounds for waterbirds on the NSW North Coast. ASS is a major threat to this wetland cluster. A fire in 2002 left the vegetation in relatively poor condition with thick *Melaleuca* regrowth.

Management/Rehabilitation: An ongoing commitment to wetland restoration is required due to the significant drainage and water quality impacts. Richmond River County Council is currently undertaking remediation works, although increased resources for management is needed. The heterogeneity of wetland vegetation may migrate against future impacts from sea level rise.

Proximity to existing protected areas: This wetland cluster surrounds the existing Tuckean Nature Reserve.

Potential contribution to NRS: Increased restoration may be required before investing heavily in land acquisition. However there is potential to make additions to the Tuckean Swamp NR, such as areas on eastern edge of the cluster that are in better condition. There is interest from landholders in private land conservation.

Other wetland areas in cluster (not mapped): None identified.

WARDELL

Wetland Cluster No:	19
No. Polygons:	3
Area (ha):	1095
IBRA sub region:	Clarence lowlands
Catchment:	Richmond River
No. Sub-catchments:	1 (see below)
CMA:	Northern Rivers
LGA:	Ballina
DIWA:	Not listed
SEPP14 (ha):	1

Location: Located west of Wardell, approximately 25 kilometres south-east of Lismore.

Geology and landform: The Wardell cluster has been identified as the best example of a Pleistocene / Holocene dunal system. The area is a rare contiguous sample of the transition from alluvial floodplain to extensive coastal barrier sandplains and ranges of meta-sedimentary and basalt bedrock. It is characteristic of strandplains, ridges, swales and freshwater sand swamps on quaternary coastal sand barriers. These drain into the alluvial plain of Bingal Creek.

Sub-catchments: The Wardell wetland cluster is located within the Broadwater Area sub-catchment.

Water Source: Fresh

Hydrology and Drainage: The Wardell cluster is on an elevated sandplain not vulnerable to sea level rise although some backswamps are likely to be inundated into the future. To date, these wetlands have not been drained.

Land use and tenure: The Wardell cluster is owned by the Aboriginal Land Council and a few private land owners.

Conservation values:

General: The Wardell cluster is recognised as a key corridor and habitat for fauna of the coastal complex assemblage (Scotts, 2003). It is in excellent condition with negligible weeds and represents a suite of species in their southern-most extent due to the close proximity to the Mount Warning shield. The cluster also inhabits unique Swamp Oak communities although it is poorly surveyed.

Flora: This area contains superb examples of undisturbed old-growth Swamp Sclerophyll Forest, lowland floodplain and riparian rainforest, dry and wet sclerophyll forests and diverse wallum wet and dry heaths. It is a mosaic of unique and intact vegetation communities. Thirteen vegetation communities were recorded and this includes Swamp Sclerophyll Forest, Lowland Rainforest on floodplains and Subtropical Coastal Floodplain Forest EEC. There are over 62 records of native orchid species within this cluster and is possible the most significant patch of remnant vegetation within the Ballina Shire LGA due to the large diversity and complexity. Records of numerous (20) threatened plant species listed under the TSC Act and EPBC Act are listed below.



Common Name	Species Name	TSC Act	EPBC Act	ROTAP
KNOWN IN OR NEAR:				
	<i>Arthrochilus prolixus</i>			✓
Clear Milkvine	<i>Marsdenia longiloba</i>	✓	✓	
Palm Lily	<i>Cordyline congesta</i>			✓
Knotweed	<i>Persicaria elatior</i>	✓	✓	
	<i>Trichosanthes subvelutina</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Rusty Rose Walnut	<i>Endiandra hayesii</i>	✓	✓	
Ball Nut	<i>Floydia praealta</i>	✓	✓	
Red Boppel Nut	<i>Hicksbeachia pinnatifolia</i>	✓	✓	
Rough-shelled Bush Nut	<i>Macadamia tetraphylla</i>	✓	✓	
	<i>Oberonia titania</i>	✓		
Southern Ochrosia	<i>Ochrosia moorei</i>	✓	✓	
	<i>Peristeranthus hillii</i>	✓		
Southern Swamp Orchid	<i>Phaius australis</i>	✓	✓	
Red Lilly Pilly	<i>Syzygium hodgkinsoniae</i>	✓	✓	
Arrow-head vine	<i>Tinospora tinospoides</i>	✓	✓	

Fauna: The Wardell cluster contains a wide diversity of fauna habitats in good to excellent condition, which provides habitat for many coastal and lowland species. Many migratory forest birds and bats utilise the cluster regularly for breeding sites, roosting sites and foraging habitat. Threatened species (27 species) are listed on the TSC Act and EPBC Act.

Common Name	Species Name	TSC Act	EPBC Act	MBA
KNOWN IN OR NEAR:				
Bush hen	<i>Amauornis olivaceus</i>	✓		
Great Egret	<i>Ardea alba</i>			✓
Cattle Egret	<i>Ardea ibis</i>			✓
Barred Cuckoo-shrike	<i>Coracina lineata</i>	✓		
Wallum Froglet	<i>Crinia tinnula</i>	✓		
Spotted-tail Quoll (SE mainland)	<i>Dasyurus maculatus maculatus</i>	✓	✓	
Black-necked Stork	<i>Ephippiorhynchus asiaticus</i>	✓		
Brolga	<i>Grus rubicunda</i>	✓		
Black Bittern	<i>Ixobrychus flavicollis</i>	✓		
Albert's Lyrebird	<i>Menura alberti</i>	✓		
Little Bent-wing Bat	<i>Miniopterus australis</i>	✓		
White-eared Monarch	<i>Monarcha leucotis</i>	✓		
Oxleyan pygmy perch [#]	<i>Nannoperca oxleyana</i>		✓	
Powerful Owl	<i>Ninox strenua</i>	✓		
Eastern Long-eared Bat	<i>Nyctophilus bifax</i>	✓		
Osprey	<i>Pandion haliaetus</i>	✓		
Eastern Ground Parrot	<i>Pezoporus wallicus wallicus</i>	✓		
Brush-tailed Phascogale	<i>Phascogale tapoatafa</i>	✓		
Koala*	<i>Phascolarctos cinereus</i>	✓		
Common Planigale	<i>Planigale maculata</i>	✓		
Grey-headed Flying-fox	<i>Pteropus poliocephalus</i>	✓	✓	
Wompoo Fruit-Dove	<i>Ptilinopus magnificus</i>	✓		
Rose-crowned Fruit-Dove	<i>Ptilinopus regina</i>	✓		
Superb Fruit-Dove	<i>Ptilinopus superbus</i>	✓		
Yellow-bellied Sheath-tail-bat	<i>Saccolaimus flaviventris</i>	✓		
Greater Broad-nosed Bat	<i>Scoteanax rueppellii</i>	✓		
Common Blossom-bat	<i>Syconycteris australis</i>	✓		

Common Name	Species Name	TSC Act	EPBC Act	MBA
Red-backed Button-quail	<i>Turnix maculosa</i>	✓		
Grass Owl	<i>Tyto capensis</i>	✓		
LIKELY OR POTENTIALLY OCCURRING:				
Fork-tailed Swift	<i>Apus pacificus</i>			✓
Australasian Bittern	<i>Botaurus poiciloptilus</i>	✓		
Glossy Black-Cockatoo	<i>Calyptorhynchus lathami</i>	✓		
Hoary Wattled Bat	<i>Chalinolobus nigrogriseus</i>	✓		
Lesser Sand Plover	<i>Charadrius mongolus</i>	✓		✓
Latham's Snipe	<i>Gallinago hardwickii</i>			✓
White-throated Needletail	<i>Hirundapus caudacutus</i>			✓
Comb-crested Jacana	<i>Irediparra gallinacea</i>	✓		
Swift Parrot	<i>Lathamus discolor</i>	✓	✓	
Olongburra Frog	<i>Litoria olongburensis</i>	✓	✓	
Square-tailed Kite	<i>Lophoictinia isura</i>	✓		
Rainbow Bee-eater	<i>Merops ornatus</i>			✓
Eastern Bentwing-bat	<i>Miniopterus schreibersii oceanensis</i>	✓		
Oxleyan pygmy perch [#]	<i>Nannoperca oxleyana</i>		✓	
Whimbrel	<i>Numenius phaeopus</i>			✓
Squirrel Glider	<i>Petaurus norfolcensis</i>	✓		
Pacific Golden Plover	<i>Pluvialis fulva</i>			✓
Grey-crowned Babbler (eastern subspecies)	<i>Pomatostomus temporalis temporalis</i>	✓		
Long-nosed Potoroo	<i>Potorous tridactylus</i>	✓	✓	
Hastings River Mouse [^]	<i>Pseudomys oralis</i>	✓	✓	
Australian Painted Snipe	<i>Rostratula australis</i>	✓	✓	
Masked Owl	<i>Tyto novaehollandiae</i>	✓		
Regent Honeyeater	<i>Xanthomyza phrygia</i>	✓	✓	

*High Density

[^]Skull found in owl pellets

[#]Northern most extent in NSW based on Newcastle University data

Significant wetland areas within cluster: None identified.

Threats: The main threats to the Wardell cluster include vegetation clearing, highway upgrades and fire. Madiera Vine has been identified in surrounding land. Quarries, cane farming and other agricultural practices in the local catchment may affect water quality.

Management / Rehabilitation: Fire management and ongoing maintenance (pest plant and animal control).

Proximity to existing protected areas: Uralba NR lies approximately 5 kilometres to the north of the Wardell cluster.

Potential contribution to NRS: The wetland and lowland types represented in the Wardell cluster are not well protected in the existing reserve system. Both land acquisition and private land conservation are advocated.

Other wetland areas in cluster (not currently mapped): Remnant patches of native vegetation to the south of the cluster are a possible addition.

APPENDIX 4 – RESULTS FROM CONSERVATION VALUE AND THREAT ASSESSMENT

Threat Dataset

	Surrounding Land Use						Land Use Change (within cluster)		
	Intensive Agriculture (Very high 3)	Agriculture (High 2)	Urban (High 2)	Timber (outside conservation areas) (Moderate 1)	Riparian vegetation (Low 0)	Conservation (Low 0)	Native Vegetation Clearing (High 2)	Infrastructure (High 2)	No known land use change (Low 0)
Alumy Creek/Bunyip Creek	3						2		
Bungawalbin				1			2		
Casino	3						2		
Chaffin Swamp		2						2	
Clarence Estuary	3								0
Coldstream		2						2	
Coutts Crossing/Orara River		2					2		
Evans River/Rocky Mouth Creek		2					2		
Everlasting Swamp		2					2		
Halfway Creek		2					2		
Mangrove Creek				1					0
Newrybar			2					2	
Richmond Estuary	3						2		
Shark Creek				1			2		
South Clarence		2							0
Tabbimoble						0		2	
The Broadwater		2					2		
Tuckean	3								0
Wardell	3							2	

Drainage Impacts			Barriers to flow and fish passage			ASS hazard			Introduced Weed Species				
Major Impacts of drainage (very high 3)	Minor impacts of drainage (Moderate 1)	No Drainage History (Low 0)	Presence of visual barriers (High 2)	Presence of other barriers (Moderate 1)	No known barriers present (Low 0)	Present (Very high 3)	Potential ASS (High 1)	Absent (Low 0)	Major impact (High 2)	Minor impact (Moderate 1)	No information (moderate 1)	Total	THREAT STATUS
	1		2			3			2			13	VERY HIGH
	1			1		3				1		9	HIGH
	1				0			0	2			8	MODERATE
	1		2					0	2			9	HIGH
3				1			1		2			10	HIGH
3					0			0	2			9	HIGH
	1				0			0			1	6	MODERATE
3					0	3				1		11	HIGH
3			2			3			2			14	VERY HIGH
		0	2					0			1	7	MODERATE
		0			0			0	2			3	LOW
3					0	3					1	11	HIGH
3			2			3			2			15	VERY HIGH
3					0	3				1		10	HIGH
3					0			0	2			7	MODERATE
		0	2					0	2			6	MODERATE
3			2			3			2			14	VERY HIGH
3			2			3			2			13	VERY HIGH
		0			0			0		1		6	MODERATE

Ecological Importance Dataset

	EPBC Act listed threatened flora and fauna species				TSC Act listed terrestrial or aquatic threatened flora and fauna species				Migratory Bird Species (JAMBA, CAMBA and ROKAMBA)			
	EPBC Act threatened species (≥ 10) (very high 3)	EPBC Act threatened species (5-9) (high 2)	EPBC Act threatened species (≤ 4) (moderate 1)	no known species occur in wetland cluster locality (low 0)	TSC Act threatened species (≥ 30) (very high 3)	TSC Act threatened species (15-29) (high 2)	TSC Act threatened species (≤ 14) (moderate 1)	no known species occur in wetland cluster locality (low 0)	Species known to inhabit wetland cluster locality (≥ 7) (Very High 3)	Species known to inhabit wetland cluster locality (4-6) (High 2)	Species known to inhabit wetland cluster locality (≤ 3) (Mod 1)	No known species occur in wetland cluster locality (Low 0)
Alumy Creek/Bunyip Creek		2				2					1	
Bungawalbin	3				3						1	
Casino			1			2			3			
Chaffins Swamp			1			2					1	
Clarence Estuary		2			3					2		
Coldstream		2			3						1	
Coutts Crossing/Orara River			1		3				3			
Evans River/Rocky Mouth Creek		2				2					1	
Everlasting Swamp		2			3				3			
Halfway Creek			1			2					1	
Mangrove Creek				0			1				1	
Newrybar	3					2					1	
Richmond Estuary	3				3				3			
Shark Creek		2				2					1	
South Clarence		2				2			3			
Tabbimoble	3				3						1	
The Broadwater		2				2			3			
Tuckean	3				3						1	
Wardell	3				3						1	

National Importance		SEPP 14 Wetland		Adjacency					
DIWA listing (Moderate 1)	No listing (Low 0)	At least part of wetland identified as SEPP 14 Wetland (moderate 1)	Not identified as SEPP 14 Wetland (Low 0)	Protected Reserves (very high 3)	SF (moderate 1)	Crown land (moderate 1)	No public land (low 0)	Total	ECOLOGICAL IMPORTANCE
1			0				0	6	MODERATE
1			0	3				11	VERY HIGH
	0		0				0	6	MODERATE
	0	1			1			6	MODERATE
1		1		3				12	VERY HIGH
1		1					0	8	HIGH
	0		0			1		8	HIGH
	0	1		3				9	HIGH
1		1		3				13	VERY HIGH
	0		0	3				7	MODERATE
	0	1		3				6	MODERATE
	0	1		3				10	HIGH
	0	1		3				13	VERY HIGH
	0	1		3				9	HIGH
1			0				0	8	HIGH
	0	1		3				11	VERY HIGH
1		1		3				12	VERY HIGH
1		1		3				12	VERY HIGH
	0	1					0	8	HIGH



Conservation Assessment of
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