Estuary Management Study and Coastal Zone Management Plan for the Richmond River Estuary

Summary Document



March 2011

Suite 6, 26-54 River Street
PO Box 7059, BALLINA NSW 2478
Telephone: 02 6686 0006
Facsimile: 02 6686 0078

© Copyright 2011 Hydrosphere Consulting

Synopsis

This document provides a summary of the Estuary Management Study (Volume 1) and Coastal Zone Management Plan for the Richmond River (Volume 2). The aim is to provide an overview of the key issues for the estuary and the management strategies that have been developed to address these issues.

For a full explanation and further technical details, please refer to the original documents which are on public display until 6 May 2011.

Cover photo: Clockwise from left: Sediment laden freshwater plume discharging from the Richmond River Estuary to the Pacific Ocean at Ballina after a moderate rainfall event (Photo: C. Cooksey);

PROJECT 10-008 – RICHMOND RIVER ESTUARY MANAGEMENT STUDY AND COASTAL ZONE MANAGEMENT PLAN

REV	DESCRIPTION	AUTHOR	REVIEW	APPROVAL	DATE
0	Draft issued for Client review	R Campbell, K Pratt	M Howland	M Howland	18/2/11
1	Final issued for Public Exhibition	K Pratt	R Campbell	M Howland	24/2/11
2	Final issued for Public Exhibition amended submission details	K Pratt	R Campbell	M Howland	3/3/11

Clean up after a major fish kill in the Richmond (Source: M. Riches); Backswamps of the Richmond River floodplain in flood (Source: B. Eggins); Boating in the lower estuary.

PROJECT 10-008 – RICHMOND RIVER ESTUARY MANAGEMENT STUDY AND COASTAL ZONE MANAGEMENT PLAN

REV	DESCRIPTION	AUTHOR	REVIEW	APPROVAL	DATE
0	Draft issued for Client review	R Campbell, K Pratt	M Howland	M Howland	18/2/11
1	Final issued for Public Exhibition	K Pratt	R Campbell	M Howland	24/2/11
2	Final issued for Public Exhibition amended submission details	K Pratt	R Campbell	M Howland	3/3/11

CONTENTS

1. BACKGROUND 1
1.1 The Richmond River Estuary Management Program 1
2. DEVELOPMENT OF THE EMS AND CZMP 2
3. STUDY AREA 3
4. ESTUARY VALUES 5
4.1.1 Economic Values 5
4.1.2 Social Values 5
4.1.3 Ecological Values 5
5. MANAGEMENT ISSUES 6
5.1 Administration and Governance 6
5.2 Climate Change Adaptation 6
5.3 Monitoring and Evaluation 6
5.4 Poor Water Quality Episodes and Fish Kill Events 7
5.5 Floodplain Vegetation Clearing and Modification 7
5.6 Floodplain Drainage Infrastructure 8
5.7 Acid Sulfate Soils (ASS) and Monosulfidic Black Ooze (MBO) 8
5.8 Diffuse Pollutant Loadings from Agricultural Land 9
5.9 Poor Condition of Riparian Zone 10
5.10 Vegetation Management 11
5.11 Waterway Usage 12
5.12 Wastewater and Urban Inputs 12
5.13 Cultural Heritage 13
5.14 Fisheries and Aquaculture Management 13
6. MANAGEMENT OBJECTIVES 14
7. MANAGEMENT STRATEGIES 15
7.1 Fundamental Management Strategies 15
7.2 High Priority Strategies 15
7.3 Medium Priority Strategies 16
7.4 Low Priority Strategies 16
8. IMPLEMENTATION 17
GLOSSARY AND ABBREVIATIONS 20
REFERENCES 21

1. BACKGROUND

The Richmond River estuary is highly valued by the community and is a focal point for local commerce, tourism and recreation. The estuary, with its associated wetlands and waterways, supports a rich biodiversity and a range of important environmental functions and local industry. Despite these recognised values, the system is under pressure from past and existing development, catchment disturbance and hydrological modification, land use management and large-scale vegetation changes. Looking forward, the estuary faces continued pressure from future development within the catchment.

The natural characteristics of the Richmond River catchment and floodplain, such as the presence of potential acid sulfate soils, a large floodplain to catchment ratio and poor flushing characteristics are all elements that interact with and exacerbate the impact of human pressures. Together these factors contribute to the degradation of the waterway and occurrence of undesirable events such as poor water quality episodes and fish kills, particularly following some flood events.

1.1 The Richmond River Estuary Management Program

The NSW Estuary Management Program was established with the aim of protecting and restoring the health and functionality of estuaries along the NSW coastline and to implement the State Government's Estuary Management Policy, 1992. The program encourages local stakeholders to responsibly manage their local estuaries through the formation of an Estuary Management Committee and the development of an Estuary/Coastal Zone Management Plan that reflects the needs of the local community and the environment, identifying issues, possible solutions and methods to implement them.

The estuary management process consists of seven steps as shown in Figure 1. The Estuary Management Study (EMS, Volume 1) achieves Step 4 of the estuary management program for the Richmond River. It is a culmination of the Data Compilation Study and Estuary Processes Study (EPS) and brings together the information gathered during previous steps to identify the issues and formulate options for management. The EMS brings together the latest scientific knowledge and goals of the community and government agencies to identify estuary values, issues, objectives and develop management options with the aim of improving the health of the estuary and providing for the various uses of the estuary.

A Coastal Zone Management Plan (CZMP), the equivalent of an Estuary Management Plan, has been prepared for the Richmond River Estuary as step 5 of the estuary management process for the Richmond River (Volume 2). The CZMP is the culmination of the Estuary Management process and has been developed from the outcomes reported in the EMS (Volume 1) and supported by the scientific knowledge from the Estuary Processes Study. The CZMP is synonymous with an Estuary Management Plan as described in the Estuary Management Manual (1992) however the CZMP terminology has been adopted to provide consistency with amendments to the Coastal Protection Act 1979 and new guidelines for preparing CZMPs. The new Guidelines for Preparing Coastal Zone Management Plans 2010 has replaced the Coastline Management Manual (NSW Government 1990), and the Estuary Management Manual (NSW Government 1992).

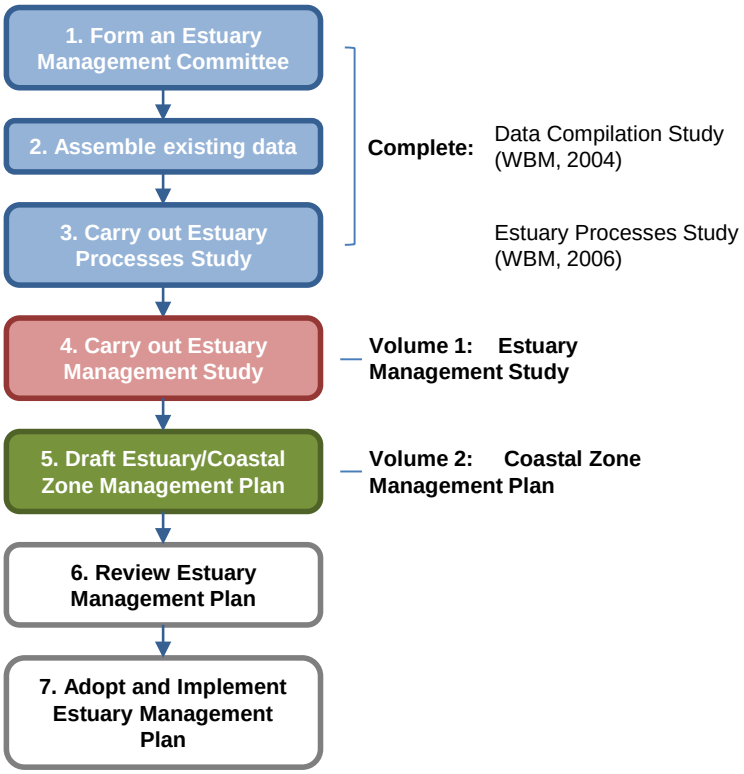


Figure 1 - The Richmond River Estuary Management Process

2. DEVELOPMENT OF THE EMS AND CZMP

The EMS and CZMP have been developed through a systematic process which focused on addressing the priority issues and achieving management objectives for the Richmond River Estuary as shown in Figure 2. This summary document provides an overview of the main outcomes of the process (Estuary Management Zones, Values, Issues, Objectives and Management Strategies).

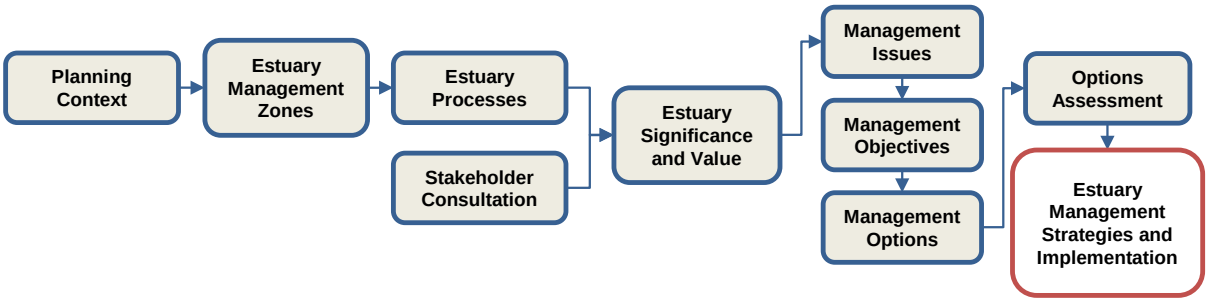


Figure 2: Process followed in the development of the EMS and CZMP (Blue boxes = EMS, Red box = CZMP)

3. STUDY AREA

The Richmond River estuary is located on the far north coast of NSW. The estuary is situated within three local government areas (Ballina Shire, Lismore City and Richmond Valley council areas). It includes the tidal waters of the Richmond River to Casino, Wilsons River to Boatharbour, Bungawalbin and North Creek, and incorporates foreshore and adjacent lands. There is specific focus on the mid and lower reaches of the Richmond River and surrounding floodplain, as this is considered to have the most immediate impact on the health of the estuary and will form the focus for future estuary management. The upper catchment is also considered where it affects the issues to be addressed by the study such as urban and agricultural runoff.



Figure 3 - The Richmond River Catchment and Estuary Management Study Area

Given the large size of the Richmond River floodplain (>1,000 km^2) and three local government jurisdictions, twelve Management Zones were developed dividing the floodplain into smaller units. In defining the zones, the objective was to provide a manageable breakdown of the floodplain area to facilitate implementation of the management actions. The zone boundaries align with sub-catchments or key geographical features or infrastructure such as roads. The zones also break the study area down to a more suitable scale on which to describe and map the major geographical features of the landscape and to introduce some of the key issues (Figure 4).

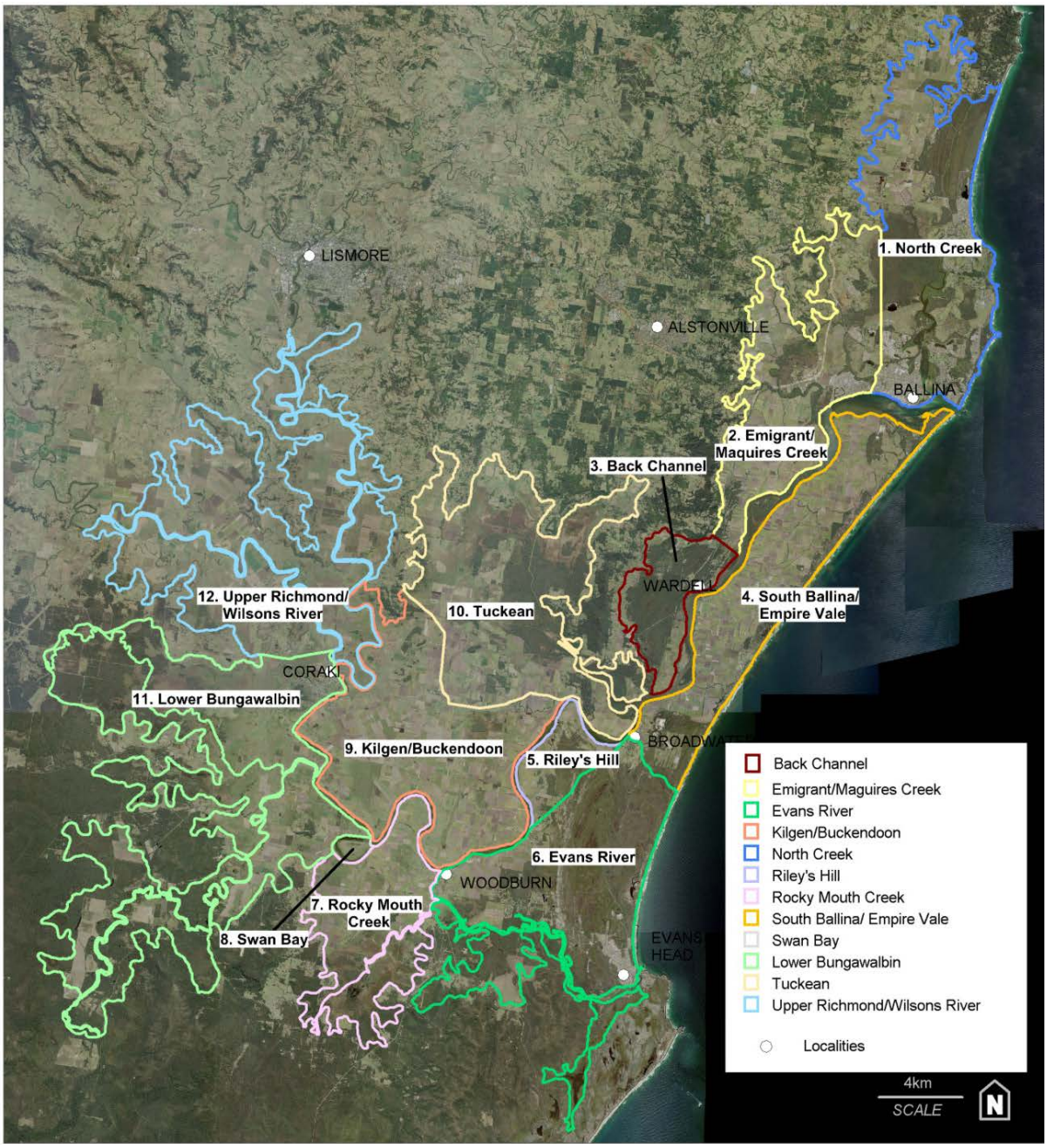


Figure 4 - Richmond River Estuary Management Zones

4. ESTUARY VALUES

The main aim of the estuary management planning process is to increase resilience within the estuary and to protect and enhance the key values. Key statements describing the values identified for the Richmond River Estuary are provided below.

4.1.1 Economic Values

- The Richmond River catchment supports a wide range of land uses which are important contributors to the local and regional economy (particularly agricultural uses).
- Commercial fishing and oyster aquaculture contribute to the local and regional economy.
- The estuary and particularly the lower estuary is considered to be a key attraction for tourists and recreational users to the area, with associated economic benefits.
- The freshwater sections of the estuary are a valuable source of water for the agricultural industry and also provide potable town water supply from the tidal pool upstream of Lismore.

4.1.2 Social Values

- The Richmond River Estuary has high cultural and spiritual significance to local Aboriginal communities.
- A number of European cultural heritage sites and items exist in and around the estuary and their acknowledgement and protection is important to the community..
- The estuary and foreshore areas are highly valued by the community and visitors for recreational activities.
- Scenic amenity is valued highly by the local community and visitors.

4.1.3 Ecological Values

- The Richmond River Estuary and wetlands provide a diversity of habitats for a range of terrestrial and aquatic species.
- The estuary supports a number of rare and threatened communities.
- Estuarine wetlands including mangroves, saltmarsh and seagrass areas provide an important role in healthy ecosystem function.
- The Richmond River estuary is recognised as one of the two most important locations for shorebird habitat in Northern NSW (DECCW, 2010b). The Clarence estuary is the other important site.
- The riparian zone provides a number of important ecological functions.
- Good water quality is highly valued by the community.

5. MANAGEMENT ISSUES

The key issues affecting the Richmond River estuary were identified in the Estuary Processes Study (WBM, 2006; ABER, 2007). The following discussion summarises the current status of identified issues.

5.1 Administration and Governance

The existing estuary management and governance model for the Richmond River estuary needs improvement. The issues raised during development of this study were primarily regarding the lack of a holistic approach to estuary management and poor coordination between the various management entities. It is believed that this presents a significant barrier to efficient delivery of on-ground programs and effective estuary management. The issues have come about due to the large number of stakeholders with a range of responsibilities including three Local Councils, three County Councils and various government agencies and organisations. Current legislated responsibilities do not allow any one party to provide an over-arching governance and administration role. Community confusion about the role of the various local and state departments in estuary management was also identified as an issue during the community consultation phase of this study.

Improved governance arrangements will rely on clearly defined responsibilities and adequate funding to implement these responsibilities.

5.2 Climate Change Adaptation

The NSW Government's Sea Level Rise Policy (DECCW, 2009) states that sea level rise is inevitable and establishes planning benchmarks to be adopted in NSW. These benchmarks are an increase above 1990 sea levels of 40 cm by 2050 and 90 cm by 2100, an average increase of 1 cm per year.

Sea level rise adjacent to the Richmond River estuary is anticipated to result in a broad range of issues including inundation and landward recession of low lying ecosystems, increased salt penetration through the estuary and adjoining wetland systems as well as implications for drainage and flooding in urban and agricultural areas. This issue has broad implications, affecting most of the other estuary issues in some way and therefore needs to be considered as part of all management and planning for the estuary.

5.3 Monitoring and Evaluation

Current monitoring does not provide a consistent approach over the catchment. It is generally carried out by a range of agencies and organisations for various reasons and over varying timescales. This means that there is currently no comprehensive way to assess the on-going health of the estuary over time or to compare relative sources of water quality degradation across the catchment. Additionally, there is no integrated environmental monitoring and reporting system in place at a scale that is meaningful to determine the effectiveness of management and investment in programs and projects that affect the estuary. These are considered to be fundamental requirements for the effective management of the estuary.

5.4 Poor Water Quality Episodes and Fish Kill Events

The Richmond River Estuary has a history of poor water quality episodes, particularly following flood events which are periodically associated with fish kills. There is now recognition of the significant detrimental impact of historic broad-scale land clearing and floodplain drainage and regulation on floodplain wetlands, acid sulfate soil (ASS) management and water quality affecting the overall health of the estuary. While fish kills are a naturally occurring phenomenon, research has indicated that their frequency and severity are greatly exacerbated by catchment and floodplain modification. The contributing issues are discussed in the following sections.



Plate 1: The 2008 Richmond River fish kill (Source: M. Riches)



Plate 2: Clean-up after fish kill in 2008 (Source: P. Dwyer)

5.5 Floodplain Vegetation Clearing and Modification

From early colonisation, European land clearing on the floodplain has replaced flood adapted native trees and shrubs with exotic grasses and crops which quickly die and decompose in summer when flooded. This was found to be a major factor in fish kill events in the Richmond River in the EPS (WBM, 2006) and recent studies have offered greater insight into the nature and extent of blackwater events. Prolonged inundation of the floodplain during and immediately following flooding can cause the decay of the underlying vegetation and rapid decomposition of accumulated organic matter (Eyre et al., 2006). The decomposition process strips oxygen from the overlying water, creating 'blackwater'.



Plate 3: Blackwater plume entering Ballina Quays Estate after a moderate summer flood in January 2006
(Source: C. Cooksey, 2000)

The mass drainage of this ponded blackwater via the drainage network and tributaries as floodwaters recede can cause hypoxic (very low dissolved oxygen) conditions along large stretches of the estuary (Wong et al., 2010). Low dissolved oxygen levels in water cause stress to fish and other aquatic organisms and in extreme cases can result in widespread fish kills such as those observed in the Richmond River in 2001 and 2008.

5.6 Floodplain Drainage Infrastructure

The Richmond River floodplain has been extensively modified by a complex network of constructed drains, modified canals, artificial levee banks and floodgates. Installation of floodplain drainage channels began in 1888 and accelerated in the early 1900s for the purpose of draining wetlands for agriculture and for flood mitigation. Floodgates were installed to prevent back-flooding of drains, creeks and tributaries and subsequently the inundation of agricultural land on the floodplain during minor flood events or by salt water from high tides.



Plate 4: Closed floodgates on Empire Vale Creek, South Ballina

The impacts of historical and on-going drainage works are now known to have significant environmental impacts on the estuary. These include the exposure and oxidation of ASS, formation of monosulfidic black ooze (MBO) (discussed in Section 5.7 below), drainage providing a conduit to more effectively convey pollutants to the estuary and disruption of tidal flushing regimes affecting water quality and ecological processes.

Addressing the environmental impacts of floodplain drainage infrastructure whilst maintaining adequate protection against flooding is a key challenge for managing the on-going health of the estuary.

5.7 Acid Sulfate Soils (ASS) and Monosulfidic Black Ooze (MBO)

ASS is the common name given to naturally occurring sediments and soils containing iron sulfides. The exposure of the these soils to oxygen by drainage or excavation leads to the generation of sulfuric acid often also releasing toxic quantities of iron, aluminum and heavy metals (DERM, 2009). Approximately 68,000 ha of the Richmond River floodplain is classified as having some level of ASS risk (ABER, 2007). Disturbance of these areas by historical and on-going drainage and agricultural practices has resulted in the oxidation of ASS resulting in chronic and acute discharges of acid and associated pollutants to adjacent waterways (ABER, 2007).



Plate 5: Acid scald in the Tuckean (Source: M. Wood)

Five priority areas for the management of ASS in the study area were identified and mapped by Tulau in 1999 during a state-wide study of ASS. These are Tuckean Swamp, Rocky Mouth Creek, Sandy Creek – Bungawalbin Creek, Maguires Creek - Emigrant Creek, and Newrybar-North Creek (refer Figure 4).

Monosulfidic black ooze (MBO) is created by rotting organic matter in ASS environments and typically occurs on drain bottoms and sides. When disturbed and transported during flow events, MBOs have the capacity to rapidly deoxygenate water and severely disrupt the ecology of waterways (Bush et al., 2003). MBOs are known to occur in the Richmond River estuary and have been identified as a contributing factor in fish kills (ABER, 2007). The Tuckean has one of the highest recorded concentrations of MBOs in the world (Bush *et al*., 2004).



Plate 6: Monosulfidic Black Ooze (Source: R. Bush)

5.8 Diffuse Pollutant Loadings from Agricultural Land

Agriculture is an important contributor to the local economy and is a key component in the social fabric of the region. Agricultural land use and some management practices are also identified as one of the major causes of poor water quality in the catchment and contribute to a broad range of issues in the estuary including the contribution of significant sediment, chemical and nutrient loads to the estuary during runoff (rain) events (WBM, 2006). Agricultural fertilisers are reported as a major source of nutrients.



Plate 7: Cattle grazing the banks of the Richmond River near Casino. The green tinge to the water indicates an algal bloom.

Transportation of nutrients to waterways during rainfall events dominate the annual nutrient budget for the estuary (ABER, 2007). Grazing is a dominant land use in the Richmond River catchment and unrestricted stock access to waterways creates issues of bank instability and erosion through trampling, damage to riparian vegetation and direct input of nutrients and contaminants from direct contact. Contaminant inputs and increased turbidity have flow-on effects to estuarine ecosystems and productivity in the immediate vicinity and downstream in the estuary (WBM, 2006).

Addressing the impacts of agricultural land use on the estuary, while continuing to enhance the local economy and protecting rural lifestyles, is one of the biggest challenges facing long-term management of the estuary. Approximately 75% of the Richmond River estuary study area considered in the EPS (WBM, 2006) is zoned for various forms of agricultural use. Management of these lands has a large bearing on future outcomes for estuarine values.



Plate 8: Active erosion of topsoil from young Macadamia plantation (Source: P. Dwyer)

5.9 Poor Condition of Riparian Zone

The riparian zone (the interface between land and waterways) bordering the Richmond River estuary and tributaries is generally devoid of vegetation for much of the area. Where riparian vegetation is present it is generally degraded, with only a few examples of intact riparian vegetation in good condition.

The issues associated with the poor condition or lack of a vegetated riparian zone are associated with the loss of the functions and values of this important zone. Riparian zone functions include fisheries habitat, terrestrial habitat, bank stability and maintenance of soil structural integrity, land use buffering, water quality filtering, lowering water temperature and reducing aquatic weeds as well as providing scenic amenity. The absence of many of these functions is apparent throughout the majority of the study area.



Plate 10: Bare riparian zone and active bank erosion along Tuckombil Canal



Plate 9: Severe bank erosion and degraded riparian zone on the Richmond River near Casino

5.10 Vegetation Management

With the exception of the Bungawalbin Creek subcatchment and the Border Ranges, the majority of the Richmond River catchment has been extensively cleared of native vegetation. The effects of vegetation clearing include:

- Loss of vegetation and associated fauna species resulting in reduced biodiversity values of the Richmond River and its catchment;
- Fragmentation of habitats where fauna rely on vegetated “movement” corridors to move between remaining vegetation remnants and in many places these corridors do not exist;
- Increased sediment and nutrient loads to the estuary; and
- Changes in morphological (erosion, accretion) processes within the estuary (WBM, 2006).



Plate 11: Weed encroachment along Rocky Mouth Creek

Any further clearing will further exacerbate these issues and therefore remaining vegetation needs to be protected and enhanced wherever possible.

Outbreaks of aquatic weeds are known to occur in several locations within the study area. These weeds can reduce the ecosystem values of open water for birds and fish. Aquatic weeds can cause diurnal fluctuations of dissolved oxygen and provide a source of organic matter for the production of MBOs, which when mobilised by flood flows can completely deoxygenate the water column.



Plate 12: Aquatic and Riparian weeds at Swan Bay (Source: M. Wood)

5.11 Waterway Usage

The Richmond River estuary is highly valued for various forms of recreational use and these pursuits constitute the dominant use of the estuary. Commercial boats also utilise the estuary for fishing, oystering and tourism activities which are also of high significance in the region. The key issues identified for management include:

- Current boating facilities are not adequate to meet current (at peak usage) and projected future demand;
- Concern about cooperative use of the waterway between various forms of recreational and commercial users; and
- The protection of the ecological values of the estuary from recreational pursuits such as propeller damage to seagrass beds in Mobbs Bay.

The community perceptions around the need for dredging in the lower estuary and concern about impacts on estuarine ecosystems are also issues that continue to be raised within the community.



Plate 13: Recreational users at the sand spit in the Richmond River near the Ballina Sailing Club

5.12 Wastewater and Urban Inputs

The relative impact of sewerage systems (including sewage treatment plans (STPs) and overflow structures) and urban stormwater outlets on estuary water quality varies greatly and depends on the volume and quality of flows from these sources compared to loading from diffuse sources in the catchment. In general the EPS reported that during significant rainfall events, the impact of nutrient loads and pollutants from urban runoff and sewerage systems was negligible in comparison to the impact of diffuse loads. Pollutant loads from urban inputs become relatively more important to water quality during the dry season when catchment inputs are low. The EPS identifies sewerage system inputs during these dry times as a potential risk to water quality although a comprehensive assessment of risk across the study area has not been conducted to date.

Sewerage systems are licensed by DECCW and Councils monitor water quality discharged to the environment to ensure compliance with licence conditions. Upgrades to STPs occur on an as needs basis to cater for increased population growth, meet environmental standards and to replace aging infrastructure.

Rural areas that are not serviced by a reticulated sewage system rely on on-site sewage management systems (OSSMs) such as traditional septic tanks or other treatment systems. Past investigations have indicated that many systems are failing to meet appropriate standards and are potential contributors of contaminants to the estuary. Many OSSMs in the catchment are not registered and condition and impact of systems on water quality in the catchment is unknown. The Councils undertake on-site sewage and wastewater management programs including specification of design requirements and audit and inspection of on-site systems.

All councils within the study area are actively involved in the management of urban stormwater through a variety of projects, programs and policies including Stormwater Management Plans and Development Control Plans.

5.13 Cultural Heritage

The Richmond River estuary has high spiritual and cultural significance for local communities. Both European and Aboriginal heritage sites and items exist in and around the estuary and their recognition and protection are important to the local community.

All levels of Government maintain registers of important sites, which are then afforded varying levels of protection under current legislation. During the community consultation phase of this project, the issue was raised that there were a number of sites of Aboriginal cultural heritage significance in the Richmond area that were currently not registered with relevant authorities and therefore there was concern about the on-going protection of sites.

5.14 Fisheries and Aquaculture Management

There is concern that the findings and strategies documented in the General Fisheries Environmental Impact Statement (EIS, NSW Fisheries, 2003) are not well understood within the community and that commercial fishers are being unfairly blamed for fish decline in the estuary.

Despite this, there is increasing recognition in both the recreational and commercial fishing sectors that their respective activities are highly regulated and that factors such as the major fish kills in 2001 and 2008, as well as the cumulative effects of habitat degradation, fish migration barriers and declining water quality are all contributing to reduced fish stocks. The 2008 fish kill and ensuing temporary fishing closure polarised community views on who was to blame and what was to be done to avoid repeat occurrences.



Plate 14: Oysters collected from the Richmond River with QX disease (Source: WBM, 2006)

There are a range of issues affecting the oyster aquaculture industry in the Richmond River estuary such as QX disease, water quality issues, vandalism of oyster racks and theft of oysters and the presence of pesticide residues.

Another important issue raised during community consultation phases was the importance of acknowledging and communicating traditional Aboriginal fishing rights and practices in accordance with Native Title.

6. MANAGEMENT OBJECTIVES

Based on the established values of the estuary and the issues summarised above, management objectives for the estuary were developed. The objectives set specific aims for future management of the estuary giving consideration to the values and key issues.

Table 1: Richmond River Estuary Management Objectives

O1	To encourage economically viable and environmentally sustainable land use practices in the catchment
O2	To ensure strategic planning instruments and programs are consistent with and where applicable, directly address the aims of the CZMP
O3	To ensure efficient and effective management of the estuary through appropriate governance, funding and monitoring
O4	To increase knowledge of the impact of existing practices on estuary values and facilitate continuous improvement
O5	To reduce pollutant loads to the estuary
O6	To protect and enhance the riparian zone
O7	To minimise the frequency and severity of environmental events such as fish kills
O8	To optimise flood mitigation works and flow control structures to improve estuarine water quality
O9	To minimise constraints to estuary adaptation to climate change
O10	To protect and enhance the biodiversity values of the estuary
O11	To provide for increased use of the estuary whilst minimising environmental impact and conflict between users
O12	To protect the cultural heritage values of the estuary
O13	To protect and enhance visual amenity/ aesthetic appeal of the estuary
O14	To enhance sustainable commercial return from industries relying on the estuary and the floodplain
O15	To minimise risk to the health and safety of users of the estuary

7. MANAGEMENT STRATEGIES

A suite of options available for the sustainable management of the estuary were compiled and developed to a point where the options can be compared and prioritised. The options were formulated to address the identified issues and achieve the management objectives and are made up of both short-term and long-term components.

The EMS followed a structured approach to assess management options built on current scientific understanding of the estuary, the established values and management objectives. Options were assessed in terms of their capacity to address the identified issues, taking into consideration social, environmental and economic factors in assigning an overall benefit/cost score. The prioritised options were grouped into thirteen strategies for on-ground implementation and it is these strategies that form the basis of the CZMP. The priorities assigned during the EMS have been used in the development of strategies and are reflected in the scheduled timing and degree of resources recommended. A brief outline of the key strategies is provided below.

7.1 Fundamental Management Strategies

Administration and governance, catering for climate change and on-going monitoring and evaluation were recognised as important for long-term effective management of the estuary and the successful implementation of this plan. As such, these strategies were not prioritised in the same way as other strategies but are included as fundamental management activities.

- Determining efficient and effective administrative arrangements for estuary management is important in order to minimise lack of coordination, administrative gaps or overlaps and to streamline decision making (Strategy 1). Improved governance arrangements will rely on clearly defined responsibilities and adequate funding to implement these responsibilities.
- Climate change (Strategy 2) is an overarching issue that needs to be an integral consideration for each management strategy.
- Monitoring and evaluation (Strategy 3) is a key component of the CZMP which should evaluate overall estuary health, identify relative sources of contamination and to assess the success of management efforts and enable direction of future efforts.

7.2 High Priority Strategies

Issues associated with floodplain infrastructure management and farm management are the greatest management challenges for the estuary and a high level of resources have been recommended for implementing strategies addressing these issues.

- Floodplain infrastructure including drains, levees and floodgates has greatly altered the Richmond River floodplain from its natural state and is recognised as a major contributor to estuary degradation. The strategy for floodplain infrastructure management (Strategy 4) contains a suite of actions to reduce the environmental impacts of floodplain infrastructure whilst maintaining the balance required for drainage and flood mitigation functions.

- Past and present farm management practices have been identified as having a high degree of impact on the estuary and improved practices and land uses are expected to result in major benefits to estuary health and flow-on benefits to tourism and other commercial industries. The strategy for farm management (Strategy 5) acknowledges the value of agriculture in the local economy and seeks to work with landholders and industry bodies to improve land management practices whilst maintaining long-term economic outcomes.

7.3 Medium Priority Strategies

Medium priority strategies identified in this plan include actions relating to riparian zone management, bank erosion, floodplain vegetation management, community education, waterway usage, wastewater management and urban runoff. All are considered to have a key role in improving estuary health and resilience.

- The poor condition of the majority of the riparian zone along the estuary means that complete restoration is an immense task. Resources have been allocated to prioritising sites for rehabilitation to best direct on-ground rehabilitation works for maximum benefit (Strategy 6). This strategy also provides for the dedication of buffer areas to direct future planning to conservation of the riparian zone.
- The strategy for vegetation management (Strategy 7) seeks to manage aquatic weeds and to retain and improve areas of remnant or regrowth floodplain vegetation. Conservation of remaining floodplain vegetation is considered to be of particular importance on a local scale due to the largely cleared landscape.
- Strategy 8 (education) provides the scope for an estuary-wide program of education and consultation to improve current understanding of estuary management.
- Strategic planning for waterway usage will be of increasing importance in the future as population growth continues and demand for boating facilities and water pursuits increases. The Waterway Usage Strategy (Strategy 9) combines a number of management actions and recommends the formulation of a strategic plan for waterway use. This recognises that although usage conflicts are currently rare, there will be increased pressure on the Richmond River estuary in the future and strategic planning is important to maintain estuarine values.
- Strategies 10 and 11 deal with wastewater discharge and urban runoff which are important issues for the community, particularly in regard to water quality impacts. Review of sewerage system risk to estuary health and continuation and review of the various existing council programs to manage on-site sewerage systems and stormwater is recommended.

7.4 Low Priority Strategies

Strategy 12 - Cultural Heritage and Strategy 13 - Fishery Management are related to important values of the Richmond River estuary. The classification of these strategies as low priority for management is not a reflection of the level of importance of these factors, but rather an indication of the capacity of the actions contained in these strategies to achieve the defined objectives in terms of overall estuary health.

- There are issues associated with the protection and preservation of cultural heritage sites within the estuary, and this has been recognised throughout the estuary planning process to

date. Strategy 12 seeks to identify unregistered sites and develop cultural management plans where appropriate to ensure on-going protection of cultural heritage around the estuary.

- Many of the major fisheries related issues (i.e. fish kills) are addressed by this plan by focussing on the source of issues, such as reducing environmental impacts of floodplain infrastructure (Strategy 4) and improving land management practices (Strategy 5). Other fisheries related issues are generally regulated by state government (principally Industry and Investment NSW) and the actions contained in Strategy 13 (Fishery Management) are related to improving community understanding of fisheries and aquaculture management in the local area and addressing specific concerns related to oyster harvest closures.

8. IMPLEMENTATION

The following table provides an overview of the recommended strategies, listing the key actions, responsibilities, location and indicative costs estimated over the ten year implementation period. The total cost of the CZMP implementation is estimated to be approximately $16.4 million over ten years.

Table 2: Overview of the CZMP implementation schedule

Action		Lead Organisation	Support Organisations	Management Zones	10 Year Cost ($'000)
FUNDAMENTAL MANAGEMENT STRATEGIES					
Strategy 1: Administration and Governance					
1.1	Review estuary governance and administration	EMC	BSC, LCC, RVC, RRCC, DECCW, I&I NSW, NRCMA, LPMA	Estuary-wide	**200**
Strategy 2: Climate Change Adaptation					
2.1	Planning for sea level rise and climate change impacts	EMC	BSC, LCC, RVC, RRCC, DECCW, I&I NSW, NRCMA, LPMA	Estuary-wide	**100**
Strategy 3: Monitoring and Evaluation					
3.1	EcoHealth monitoring program	EMC	BSC, LCC, RVC, RRCC, I&I NSW, DECCW, NRCMA, SCU	Estuary-wide	**2,000**
3.2	Develop catchment/water quality modelling tool to support decision making	EMC	BSC, LCC, RVC, RRCC, I&I NSW, DECCW, NRCMA, SCU	Estuary-wide	**45**
HIGH PRIORITTY					
Strategy 4: Floodplain Infrastructure Management					
4.1	Identify, prioritise and optimise drains and levees	RRCC	BSC, LCC, RVC, DECCW, I&I NSW	Estuary-wide	**3,420**
4.2	Review floodgate management protocols	RRCC	BSC, LCC, RVC, DECCW, I&I NSW	Estuary-wide	**55**

Action		Lead Organisation	Support Organisations	Management Zones	10 Year Cost ($'000)
Strategy 5: Farm Management					
5.1	Scientific investigations: strategies for retention of water on backswamp areas	I&I NSW	BSC, LCC, RVC, EMC, DECCW, RRCC, SCU	Zones 7, 10, 11	**300**
5.2	Farm management planning	I&I NSW	BSC, LCC, RVC, EMC, DECCW, RRCC	Estuary-wide	**5,000**
5.3	Liaise with agriculture industry bodies to improve education and ensure estuary friendly practices are incorporated into industry guidelines	I&I NSW	RRCC, EMC	Estuary-wide	**90**
MEDIUM PRIORITY					
Strategy 6: Riparian Zone Management and Erosion					
6.1	Identify priority riparian areas and rehabilitate	EMC	BSC, LCC, RVC, LPMA, NRCMA	Estuary-wide	**2,300**
6.2	Riparian buffer establishment (planning)	BSC, LCC, RVC	LPMA	Estuary-wide	**30**
Strategy 7: Vegetation Management					
7.1	Retain, rehabilitate and conserve existing native floodplain vegetation	BSC, LCC, RVC	RRCC, LPMA, NRCMA, DECCW, FNCW	Estuary-wide	**930**
7.2	Aquatic weed management	FNCW, I&I NSW RRCC	BSC, LCC, RVC	Estuary-wide	**1,000**
Strategy 8: Education					
8.1	Estuary-wide community education and consultation program	EMC	BSC, LCC, RVC, RRCC, DECCW, I&I NSW, NRCMA, FNCW	Estuary-wide	**500**
Strategy 9: Waterway Usage					
9.1	Develop strategic plan for estuary usage	EMC	BSC, LCC, RVC, NSW Maritime, LPMA, DECCW, I&I NSW	Estuary-wide	**75**
9.2	Cost benefit analysis of dredging operations in lower estuary	BSC	LPMA, DECCW, I&I NSW, NSW Maritime	Zones 1,2	**20**
Strategy 10: Wastewater Management					
10.1	Sewerage system risk assessment and prioritisation study	DECCW	BSC, LCC, RVC	Estuary-wide	**25**
10.2	On-going on-site sewerage management inspections and improvements	BSC, LCC, RVC		Estuary-wide	not estimated
Strategy 11: Urban Runoff					
11.1	Stormwater Management	BSC, LCC, RVC	DECCW	Estuary-wide	not estimated

Action		Lead Organisation	Support Organisations	Management Zones	10 Year Cost ($'000)
LOW PRIORITY					
Strategy 12: Cultural Heritage					
12.1	Identification and recording of cultural sites available to council planners	DECCW	BSC, LCC, RVC	Estuary-wide	**100**
12.2	Cultural Site Management Plans	DECCW	BSC, LCC, RVC	Estuary-wide	**155**
Strategy 13: Fishery Management					
13.1	Ensure key research findings in the fishing and aquaculture sector are communicated to the public	I&I NSW	BSC, LCC, RVC, RRCC, SCU	Estuary-wide	Included in Strategy 8
13.2	Identify and manage contamination sources in the estuary to minimise oyster harvest closures	I&I NSW	BSC	Zones 1,2,4	**40**
Total					**16,385**

EMC: Estuary Management Committee; BSC: Ballina Shire Council; LCC: Lismore City Council; RVC: Richmond Valley Council; RRCC: Richmond River County Council; DECCW: Department of Environment, Climate Change and Water; I&I NSW: Industry and Investment NSW; SCU: Southern Cross University; LPMA: Land and Property Management Authority; NRCMA: Northern Rivers Catchment Management Authority.

The implementation of the plan will be supported by a process for reviewing the effectiveness of the plan and adapting it as required. This aspect of the project is essential for ensuring that the estuary management options identified become a reality and that the estuary is sustainably managed into the future.

Following public exhibition and consideration of submissions, the draft CZMP will be adopted by Richmond River County, Ballina Shire, Lismore City and Richmond Valley Councils. The draft CZMP will also be submitted to the Minister administrating the Coastal Protection Act 1979 for certification under the Act.

HAVE YOUR SAY

The EMS and CZMP are available for comment until 6 May 2011 and can be accessed at Council offices and from Richmond River County Council website: www.rrcc.nsw.gov.au.

A public meeting to present the Plan will be held on 28 March 2011, commencing at 5:30pm at the Richmond Room, Regatta Avenue, Ballina.

Submissions can be made via email to floodplain@rrcc.nsw.gov.au or:

By Post:

The General Manager
Richmond River County Council
PO Box 230
LISMORE NSW 2480
Attention: CZMP Richmond River Estuary

Drop Off in person:

Submission Box: The General Manager
Richmond River County Council
Level 4, 218-232 Molesworth St
LISMORE NSW 2480
Attention: CZMP Richmond River Estuary

GLOSSARY AND ABBREVIATIONS

Acid sulfate soils (ASS)	Holocene soils occurring in low lying floodplain areas with high concentrations of iron pyrite, formed as the by-product of sulfate reduction. ASS formed approximately 7,000-3,000 years before present when post-glacial sea levels reached their current level creating vast intertidal mangrove swamps.
Algal bloom	The rapid growth of phytoplankton resulting in a high biomass in the water column.
Anoxic	An oxygen-free environment.
Anthropogenic	Any phenomenon caused by human activities.
Biomass	The living weight of plant or animal material (organic matter).
Blackwater	A collective term used to describe low oxygen floodwaters emanating from backswamp areas and floodplains.
BSC	Ballina Shire Council
CAP	Catchment Action Plan
CZMP	Coastal Zone Management Plan (equivalent to EMP).
DECCW	Department of Environment, Climate Change and Water
Diffuse Source Pollution	Non-point source pollution such as sediment or nutrients from catchment runoff or groundwater inputs.
Ecosystem	Refers to all the biological and physical parts of a biological unit (e.g. an estuary, forest, or planet) and their interconnections.
EMC	Estuary Management Committee
EMS	Estuary Management Study
EPA	Environment Protection Authority (part of DECCW)
Freshwater flushing time	The time (in days) that freshwater stays within an estuary before being transported to the sea by advection and tidal mixing.
Grazing	The eating of plants (e.g. phytoplankton) by animals (e.g. zooplankton).
Hypoxic	Critically low concentrations of dissolved oxygen (see anoxic).
I & I NSW	Industry and Investment NSW (incorporating Department of Primary Industries, Agriculture and Fisheries)
LCC	Lismore City Council
LEP	Local Environmental Plan
LPMA	Land and Property Management Authority (formerly Department of Lands)
Monosulfidic Black Ooze (MBO)	An iron sulfide compound formed as a by-product of sulfate reduction. MBOs commonly form in acid environments with high organic matter supply and have a high chemical oxygen demand.
NOW	NSW Office of Water
NPWS	National Parks and Wildlife Service (part of DECCW)
NRCMA	Northern Rivers Catchment Management Authority
NRM	Natural Resource Management

Point Source Pollution	A single point of pollutant discharge. For example, effluent from a sewage treatment plant.
Pristine	Undisturbed by human activities such as urban and agricultural development, pollution, erosion, weed infestations etc.
Reticulated Sewage System	Sewage piped to a centralised sewage treatment plant for treatment and disposal.
RRCC	Richmond River County Council
RVC	Richmond Valley Council
SEPP	State Environmental Planning Policy
Sulfate reduction	The bacterial breakdown of organic matter in anoxic sediments using sulfate instead of oxygen. Produces hydrogen sulfide, the 'rotten egg gas' smell common in muddy sediments.
STP	Sewage Treatment Plant. Raw sewage is collected from homes and businesses and transported via a network of pipes and pump stations to the sewage treatment plant, a centralised system for treatment and disposal.
Turbidity	A measure of the amount of light-attenuating particles in a water body.

REFERENCES

ABER (2007). Review of the Richmond River Estuary Process Study Report for Richmond River County Council, Lismore. 109p.

Bush, R.T., Sullivan, L.A., Fyfe, D (2003). Occurrence and abundance of monosulfidic black ooze in coastal acid sulfate soil landscapes. Australian Journal of Soil Research 42(6) 609–616.

Bush, R.T., Sullivan, L.A., Fyfe, D., and Johnston, S. (2004) Redistribution of monosulfidic black oozes by floodwaters in a coastal acid sulfate soil floodplain. Australian Journal of Soil Research 42:(5-6)603-607.

DECCW (2009). NSW Government Sea Level Rise Policy Statement.

DERM (2009). Acid sulfate soils in Queensland - L60 - fact sheet. Published by Department of Environment and Resource Management Accessed at: http://www.derm.qld.gov.au/services_resources/item_list.php?category_id=123&topic_id=25 11/10/2010.

Eyre, B.D., Kerr, G. & Sullivan, L.A. (2006). Deoxygenation Potential of the Richmond River Estuary Floodplain, Northern NSW, Australia. River Research and Applications, 22: 981-992 (2006).

NSW Fisheries (2003) Fishery Management Strategy for the Estuary General Fishery.

NSW Government (1992) Estuary Management Manual.

Tulau, M. J. (1999) Acid Sulfate Soil Priority Management Areas on the Lower Richmond Floodplain. Department of Land & Water Conservation.

WBM (2006). Richmond River Estuary Process Study. Report for Richmond River County Council, Lismore.

Wong, VNL, Johnston, SG, Bush, RT, Sullivan, LA, Clay, C, Burton, ED & Slavich, PG (2010). Spatial and temporal changes in estuarine water quality during a post-flood hypoxic event. Estuarine, Coastal and Shelf Science, vol. 87, no. 1, pp. 73-82.