



Stage 3 Report - Final

Southern Estuaries Coastal Management Program

MidCoast Council

3 October 2025



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Project Name	Southern Estuaries Coastal Management Program
Client	MidCoast Council
Client Project Manager	Erin Masters
Water Technology Project Manager	Neil Dufty
Water Technology Project Director	Chris Beadle
Authors	Courtney Smith
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Suite 3, Level 1, 20 Wentworth Street
Parramatta NSW 2150
Telephone (02) 9354 0300
ACN 093 377 283
ABN 60 093 377 283





ACKNOWLEDGEMENT OF COUNTRY

The Board and employees of Water Technology acknowledge and respect the Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of Country throughout Australia. We specifically acknowledge the Traditional Custodians of the land on which our offices reside and where we undertake our work.

We respect the knowledge, skills and lived experiences of Aboriginal and Torres Strait Islander Peoples, who we continue to learn from and collaborate with. We also extend our respect to all First Nations Peoples, their cultures and to their Elders, past and present.



Artwork by Maurice Goolagong 2023. This piece was commissioned by Water Technology and visualises the important connections we have to water, and the cultural significance of journeys taken by traditional custodians of our land to meeting places, where communities connect with each other around waterways.

The symbolism in the artwork includes:

- Seven circles representing each of the States and Territories in Australia where we do our work
- Blue dots between each circle representing the waterways that connect us
- The animals that rely on healthy waterways for their home
- Black and white dots representing all the different communities that we visit in our work
- Hands that are for the people we help on our journey



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1 INTRODUCTION

1.1 Background

Under the NSW Coastal Management Framework and the *NSW Coastal Management Act 2016* (CM Act), the future management of the Southern Estuaries in the MidCoast Council Local Government Area (LGA) will be guided by a Coastal Management Program (CMP). The Southern Estuaries are comprised of:

- Wallis Lake
- Smiths Lake
- Myall Lakes
- Karuah River
- Kore Kore Creek
- North Arm Cove
- Black Head Lagoon
- Khappinghat Creek.

Details of the study area for the Southern Estuaries CMP are provided in Stage 1 of the CMP (Water Technology, 2022)

The development of the Southern Estuaries CMP is supported by funding and technical assistance from the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEWS).

The purpose of the CMP is to set the long-term strategy for the coordinated management of the Southern Estuaries and their contributing catchments. The CMP seeks to achieve the objectives of the CM Act through a program that will identify coastal management issues, pressures, and risks - and the actions required to address these issues in a strategic and integrated way.

The CMP is being prepared through the five-stage process prescribed in the NSW Coastal Management Manual and depicted in Figure 1-1.



Stage 1 of the CMP (Water Technology, 2022) was adopted by Council in 2022. It included a review of relevant background information, a first pass risk assessment, a data gap analysis, and a forward program for the CMP.

Stage 2 delivered several technical studies to improve understanding of the threats and risks to the environmental, social, and economic values of the system, and to support informed decision-making in Stage 3. These studies comprised:

- Coastal Wetland Mapping and Condition Assessment (Eco Logical Australia, 2024)
- Tidal Inundation Study and Risk Assessment (JB Pacific, 2024)
- Risk Based Framework Assessment (Blackhead and Khappinghat catchments)
- Human Health Indicators Assessment.

Subsequently, the purpose of Stage 3 is to identify and assess coastal management options that can address coastal management issues such as threats, risks, and hazards, take advantage of opportunities, and give effect to the objectives of the CM Act.

This report has been prepared to fulfill the requirements of Stage 3 of the CMP process. It has been prepared on behalf of MidCoast Council, and in consultation with relevant State agencies, First Nations Groups, and local communities of the CMP study area.

1.2 Approach to Stage 3

The recommended approach to Stage 3 is set out in the NSW Coastal Management Manual (OEH, 2018d) and is summarised in Figure 1-2.

The primary objective of Stage 3 is to develop a long list of potential management options to address the risks and opportunities identified in Stage 2. These options are then assessed, ranked, and prioritised using a robust and transparent decision-making framework. The outcome is a short list of preferred management actions to progress to Stage 4 for detailed planning and, ultimately, implementation in Stage 5.

The assessment framework used in this study was designed to enable consistent, objective comparison of options, ensuring that those delivering the greatest overall benefit to the coastal zone and its contributing catchment are identified and advanced.

Stage 3 of the CMP has included a comprehensive community and stakeholder engagement program. This program was designed to ensure that the values, priorities, and local knowledge of communities and stakeholders across the Southern Estuaries were meaningfully captured and considered in the development of management options. The engagement process included a wide range of activities and consultation methods, including the development of 15 Issues Papers, to incorporate diverse knowledge, and reach audiences across the study area and its catchments. A summary of the engagement program, including its scope, methods, and key findings, is provided in Appendix A.

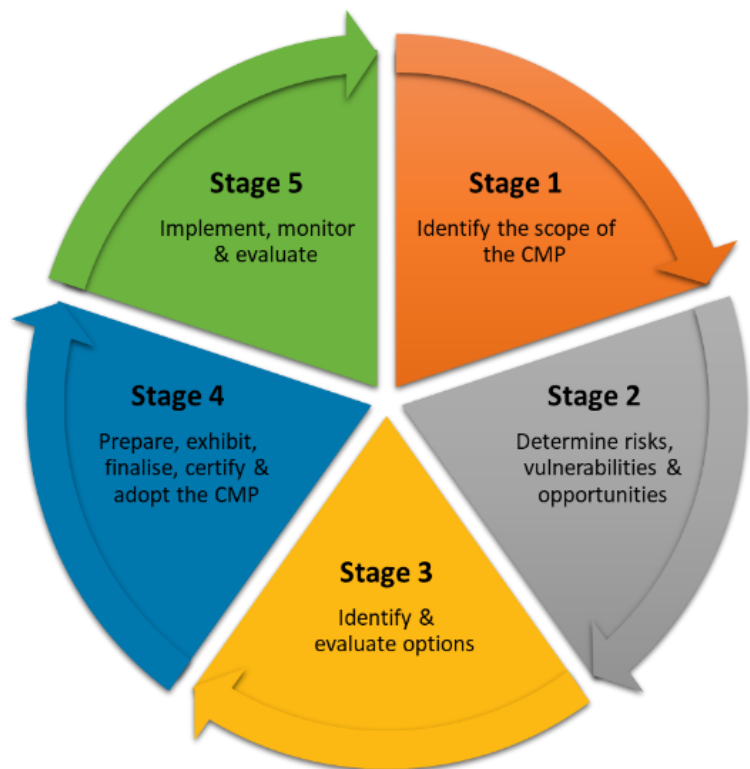


Figure 1-1 The CMP process



Figure 1-2 The approach to Stage 3 of the CMP

1.3 The Structure of this Report

The structure of this report has been designed to align with the staged delivery of Stage 3 of the CMP.

- Sections 2 to 5 summarise Steps 1 to 4 of the process (as illustrated in Figure 1-2 above). Given the large number of potential management options assessed throughout these steps, these sections focus on outlining the methodology and presenting key outcomes.
- Section 4.5 provides a summary of community and stakeholder engagement activities undertaken in Stage 3. As engagement has been integrated throughout each step in Stage 3 (and built on previous engagement from Stages 1 and 2), this section provides important context for the overall development and assessment of management options and progression of the CMP.
- Appendices provide supporting detail for each component of Stage 3:
 - Appendix A – Detailed Community and Stakeholder Engagement Report for Stage 3, outlining processes and outcomes.
 - Appendix B – An Electronic Appendix (contained within a separate Microsoft Excel file) comprising the Options Assessment Spreadsheet. This includes:
 - Descriptions of all potential management options considered in Stage 3 (the full options long list).



- The Outcomes of the Acceptability, Feasibility, and Viability Assessments, and the Total Options Ranking for Each Option.
- Appendix C – Outcomes of the Acceptability Assessment
- Appendix D – Outcomes of the Feasibility Assessment
- Appendix E – Outcomes of the Viability Assessment
- Appendix F – Issues Papers

1.4 Guiding Documents

This report and its analysis have been undertaken in accordance with, and with a clear understanding of, the key requirements and guidance outlined in the following documents:

- *NSW Coastal Management Manual Part B: Stage 3 – Identify and evaluate options* (OEH, 2018d)
- *NSW Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions* (OEH, 2017).
- *NSW Marine Estate Management Strategy 2018 – 2028* (MEMA, 2018)
- *NSW Coastal Design Guidelines* (DPE, 2023a)
- *Coastal Crown Land Guidelines* (DPE, 2023b)
- *NSW Guide to Cost-Benefit Analysis* (NSW Treasury, 2023)
- *DPE Guidelines for using Cost-Benefit Analysis to Assess Coastal Management Projects* (DPE, 2020)
- *DCCEEW Guidelines for Applicants 2024-25, Coastal and Estuary Grants Program* (DCCEEW, 2024).
- *The Engineers Australia National Committee on Coastal and Ocean Engineering - Climate Change Adaptation Guidelines in Coastal Management and Planning* (NCCOE, 2012)
- *Guidelines for responding to the effects of climate change in coastal and ocean engineering* (NCCOE, 2017)
- *ISO 14090:2019 Adaptation to climate change — Principles, requirements and guidelines* (ISO , 2019)

These documents have informed the approach to option identification, assessment, and prioritisation throughout Stage 3 of the CMP.



2 STEP 1: STRATEGIC DIRECTION

2.1 Vision, Purpose, and Objectives

The purpose of the CMP is to create a comprehensive framework for the future management of the Southern Estuaries. This framework aims to align with the principles of ecologically sustainable development and promote the well-being of the community in social, cultural, and economic aspects.

During Stage 1 of the CMP (Water Technology, 2022), the Vision, Purpose, and Management Objectives for the project were developed. The Vision and Purpose play a crucial role in the CMP hierarchy, as they provide the framework for defining strategic objectives. These strategic objectives, in turn, enable the establishment of specific objectives. The relationship between the Vision, Purpose, and Specific Objectives is illustrated in Figure 2-1.

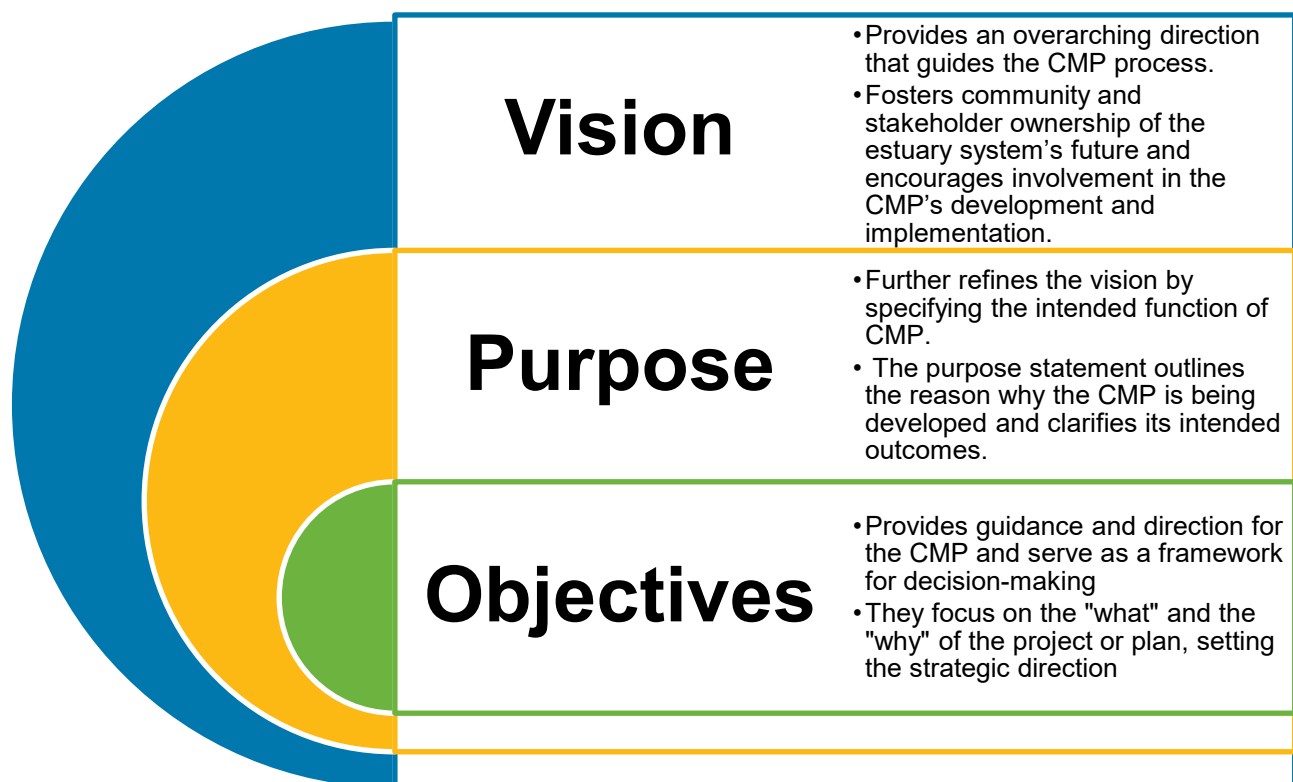


Figure 2-1 The Vision, Purpose, and Objectives of the CMP

2.1.1 Vision

The vision statement derived in Stage 1 of the CMP (Water Technology, 2022) provides an overarching direction that guides the CMP process:



■ ■ ■

The Southern Estuaries CMP will guide the integrated management of our estuaries and respond to present, evolving and future challenges. It will protect and enhance the social, economic and environmental values supporting the exceptional biodiversity, and resources that connect our community.

■ ■ ■

2.1.2 Purpose

The purpose statement further refines the vision by specifying the intended function or role of CMP:

■ ■ ■

The purpose of the CMP is to set the long-term strategy for the coordinated management of the MidCoast Southern Estuaries. The CMP seeks to achieve the objects of the CM Act through a program to identify coastal management issues, pressures, risks and opportunities – and provide a 10-year framework for the actions required to address these issues in a strategic and integrated way.

■ ■ ■

The purpose of the CMP is to set the long-term strategy for the coordinated management of the Southern Estuaries.

2.1.3 Objectives

The strategic management objectives determined during Stage 1 of the CMP are summarised in Table 2-1

Table 2-1 Strategic objectives of the CMP

Objectives
a. to protect and enhance the integrity and resilience of the environmental values of the MidCoast Southern Estuaries for current and future generations;
b. to maintain and protect water quality across the system and its impacts on environmental, social and economic values - including ecological condition, recreational amenity and agricultural uses;
c. to promote community understanding, a sense of connection and stewardship of estuary values;
d. to maintain and preserve the unique scenic amenity and natural character of the estuaries;
e. to support the social and cultural values of the estuaries and maintain safe public access and recreational amenity;
f. to acknowledge and support Aboriginal peoples' spiritual, social, customary and economic use of the study area and to protect local indigenous cultural heritage;
g. to recognise the coastal zone as a vital economic resource for the region and to support sustainable



Objectives

- h. coastal economies;
- i. to facilitate appropriate management of the coastal zone through ecologically sustainable development, and the promotion of sustainable land use planning and decision-making that is consistent with regional and local strategic plans;
- j. to mitigate and manage current and future risks from population growth, urbanisation and coastal hazards, taking into account the effects of climate change;
- k. to encourage co-ordination of the policies and activities of the relevant government and public authorities relating to the coastal zone - and to facilitate the proper integration of their management activities across all levels of government;
- l. to maintain meaningful engagement with the community, and to support public participation in coastal management and planning, and to foster greater public awareness, education and understanding of coastal processes and management actions;
- m. to encourage and facilitate research and monitoring – and to maintain scientific and educational values of the study area;
- n. to support the objects of the *Marine Estate Management Act 2014*.

2.2 Key Challenges and Strategic Direction

Numerous challenges facing the CMP have been highlighted, including:

- **Addressing Strategic, Large Scale Risks and Opportunities** The CMP must address a range of interconnected issues at a system-wide scale, spanning the catchment, waterways, and foreshores of the Southern Estuaries. This includes managing estuary health, water quality, ecological risks, coastal hazards, and development pressures in a coordinated and integrated way.
- **Maintaining Local Focus:** While addressing broad-scale issues, the CMP must also retain sufficient detail and granularity to respond effectively to the many localised risks, challenges, and opportunities across the expansive study area.
- **Collaboration and Efficiency:** The CMP must support a collaborative approach between stakeholders while clearly defining roles, responsibilities, and financial or resourcing commitments to enable efficient implementation.

A key bureaucratic challenge for the CMP is integrating coastal and catchment management objectives within a statutory framework that limits formal recognition of areas outside the coastal zone. While improving estuary health remains a central focus of the CMP, the CM Act does not permit the inclusion of land or actions located outside the legally defined coastal zone in a certified CMP (DPE, 2022).

This limitation stems from Section 13(2) of the CM Act, which states: “A *Coastal Management Program* may be made in relation to the whole, or any part of the area included within the coastal zone.”

As a result, any land or management action situated beyond the mapped coastal zone - defined by the application of the relevant Coastal Management Areas under the Resilience and Hazards State Environmental Planning Policy (RH SEPP) - cannot be formally certified under the Act. These areas are:

- Coastal Use Area – generally a 250 m buffer around the estuary foreshore.
- Coastal Environment Area – estuarine waterways plus a variable 100–500 m buffer landward.
- Coastal Wetlands and Littoral Rainforest Area(s).



- Coastal Vulnerability Area – areas directly impacted by coastal hazards. Mapping for the CVA has not been provided from the R&H SEPP, and no such CVA map yet exists for the study area. Nonetheless, it is recognised that the Southern Estuaries are subject to coastal hazards and that the scope of this CMP also covers managing coastal vulnerability.

Due to this statutory limitation, the certified CMP study area comprises only a small section of the catchment, presenting a significant constraint to achieving integrated, catchment-wide outcomes through the CMP alone.

2.2.1 CMP Structure and Delivery Mode

To effectively address the diverse challenges facing the CMP, a matrix delivery structure was adopted, enabling targeted action at both Study Area wide and local estuary scales.

The CMP will also include a catchment-based companion section which identifies actions or strategies located outside the legally defined coastal zone. While clearly marked as non-certifiable under the CM Act, these actions will be included within the CMP document to maintain integration with coastal zone actions and to support holistic estuary management.

This approach aligns with the NSW Government's guidance on *Coastal Management Programs and Integration with Catchment Management* (DPE, 2022). The guidance notes that actions within the companion section may still be eligible for funding under the Coastal and Estuary Grants Program, provided they meet all three of the following criteria:

- Significantly benefit the coastal zone and is a critical factor in estuary health.
- Give effect to the management objectives for the coastal management areas and the objects of the CM Act.
- Assist in addressing a key coastal management issue affecting the areas to which a certified applies.

This structured and integrated delivery model ensures that the CMP remains both strategically focused and locally responsive - enabling coordinated action across the entire Southern Estuaries, while meeting statutory requirements and maximising opportunities for implementation funding.



3 STEP 2: OPTION IDENTIFICATION

3.1 Strategic Approach

Coastal management is generally approached through the lens of five different strategic approaches as described in the NSW Coastal Management Manual (OEH, 2018d) and outlined in Figure 3-1.



Figure 3-1 The five strategic approaches to coastal management (adapted from the NSW Coastal Management Manual)

Different strategic approaches are relevant to different levels of risk and attitudes to risk. However, they are often combined, or the emphasis may change from one to another over time as circumstances change. Therefore, the derivation of management options for Stage 3 of the CMP has been undertaken with consideration of these five strategic approaches.

1. For coastal environments such as the study area, **Alert** responses may be implemented to monitor conditions and ensure communities are aware of emerging changes to the environment. *Low regrets* responses are generally cost-effective, low impact options that yield multiple net benefits now, and



help communities prepare for future changes to risk exposure. Often, low regrets options can be insufficient to manage medium to high risks on their own, but they do allow coastal managers to strengthen coastal resilience and build management capacity.

2. Reducing current and future pressures on ecosystem health may also be achieved through **Avoid** approaches, such as recommending appropriate land use planning and infrastructure planning decisions that support appropriate community uses of the coastal environment and avoid future irreversible impacts.
3. If coastal hazard risk is high, or coastal ecosystem health is poor, then management options may seek to improve the safety, resilience, health or function of coastal landforms and ecosystems through a range of **Active Intervention** approaches – such as remediation, rehabilitation, and implementation of environmental improvement programs and coastal protection works.
4. **Planning for change** and allowing coastal environments to adapt to climate change is often a more cost-effective approach that will lead to higher value environmental outcomes. Fostering strategic adaptation in coastal environments to address climate change is frequently a more economically efficient strategy that yields enhanced environmental benefits. Contemplating habitat migration becomes advisable when vigilant monitoring substantiates the impending or irreparable nature of such changes. This entails establishing a comprehensive set of protocols and tactics to be activated when inescapable transformations (like coastal erosion) render a region unsuitable for human occupancy or utilization.
5. **Emergency Response** is a strategic approach incorporating immediate actions designed to be implemented during extreme coastal hazards events, providing a set of actions to be followed during times of emergency.

3.2 Issues Papers

The development of Issue Papers was a central component of the Stage 3 option development process. Priority issues were originally identified through the Stage 1 CMP process, and then further informed from Council's operational experience. Their primary purpose was to consolidate relevant background information to support the identification and refinement of practical and implementable management options for the CMP for each of the 15 issues identified in Table 3-1. Each paper drew on existing plans and strategies, supplemented by recent research where available, and built on the issue identification developed during the Stage 1 Scoping Study (Water Technology, 2022) and the Stage 2 studies.

The Issue Papers incorporated scientific knowledge, historical context, current management approaches and professional insight. Draft versions were used as the basis for a series of 15 workshops for each Issue with stakeholders and the Community Reference Group. These workshops provided an opportunity to refine background information, capture community ideas and sentiment, and identify potential management options and opportunities, and was a critical component of the option identification process. Each paper addressed key elements, including a situational analysis of pressures and stressors, existing management approaches, relevant stakeholders, knowledge gaps, and potential management options. The scope of the papers covered both coastal zone and broader catchment issues, with catchment-specific matters clearly identified to ensure their appropriate consideration through the CMP process.

Table 3-1 Issue Paper Topics

1. Climate Change	6. Coastal Wetlands	11. Recreation
2. Governance	7. Entrance Modification and Dredging	12. Biodiversity Conservation
3. Community Stewardship	8. Human Health	13. Land Use Planning



4. Agricultural Impacts	9. Tidal and Coastal Inundation	14. Erosion and Sedimentation
5. Aquaculture and Commercial Fishing	10. Freshwater Flows	15. Urban Stormwater and Litter

Notes from the 15 Issues Papers Workshops are provided in Appendix F.

3.3 Identification of Options

Once the strategic direction and key issues were confirmed and examined through the Issues Papers, the next step of the assessment was to develop a suite of potential options to address the risks identified in Stage 2 and achieve the objectives of the CMP. A “long list” of potential options to consider for further assessment was compiled, as outlined in the NSW Coastal Management Manual (OEH, 2018d). This resulted in a ‘long list’ of 520 potential options, developed from the following sources:

- Investigating prior works such as historic and current management plans, including:
 - Wallis Lake Estuary Catchment Management Plan
 - Smiths Lake Coastal Zone Management Plan
 - Great Lakes Water Quality Improvement Plan: Wallis, Smiths and Myall. Forster, NSW
 - Karuah River Catchment Management Plan
 - Crawford River Catchment Management Plan
 - Lower Wallamba River Rivercare Plan
 - Pindimar Foreshore Study
 - MidCoast Council Biodiversity Framework
 - Port Stephens Foreshore Plan
 - Draft Marine Park Management Plan
 - Port Stephens Estuary Coastal Management Program
 - Southern Wallis Foreshore Plan
 - Our Water Our Future
 - Coomba Park Stormwater Management Plan
- Historical studies and Stage 2 Studies
- Issues Papers – developed for 15 key issues impacting the Southern Estuaries through a collaborative community and stakeholder workshop approach, with a key outcome of option identification
- Community and stakeholder engagement (see Section 4.5)
- Council, State Agency and Indigenous groups experience and knowledge of the Southern Estuaries, and understanding of priority options
- Risk-based analysis of key environmental datasets.

The initial database of potential options was based on actions previously identified in historic and current management plans. This was refined through a series of workshops with relevant Council staff. Feedback during these workshops highlighted that historical plans often contained lengthy “wish lists” of actions, many of which proved difficult to implement due to budget and resourcing constraints. This approach for the previous plans was considered unsustainable and ultimately contributed to stakeholder frustration over the



limited progress on implementation. Accordingly, the Stage 3 process prioritised the development of a more concise, coordinated, and achievable program of actions.

A range of technical studies from Stage 2, along with historical studies identified in the Stage 1 Scoping Study, were reviewed to inform the CMP option development. This process helped identify site-specific coastal management issues and incorporate relevant mitigation recommendations into the long list of options.

The development of the 15 Issues Papers, along with the accompanying workshops with the Community Reference Group and stakeholder discussions, formed the cornerstone of the option development process. This collaborative approach generated a wide range of management options and was strongly supported by community members, industry groups, and state agencies involved throughout. Issues workshops were held involving 131 attendees, providing a range of option suggestions and insight into the key issues. An additional three Reference Group meetings were held to obtain community feedback and ideas across the Southern Estuaries.

Further refinement was undertaken through engagement with key stakeholders, including local First Nations Groups, State Government agencies, and industry groups such as oyster growers, boating and fishing industry, and agriculture.

Stakeholder meetings with 5 groups were also held to gather feedback. Further details of the community and stakeholder engagement process are provided in Section 4.5 and Appendix A.

The identification of potential management options was also informed by a technical, risk-based analysis that assessed threats to key environmental, social, cultural, and infrastructure values within the coastal zone. This process included a detailed geospatial assessment, supported by a broad range of datasets and technical guidelines. The analysis incorporated (but was not limited to) the following:

■ **Environmental Assets and Estuary Health Datasets:**

- The NSW Estuary Health Risk Dataset (DPIE, 2019b)
- The NSW Estuary Water Quality Data Compilation: 2007 – 2020 (DCCEEW, 2025)
- Southern Estuaries CMP Stage 2: Coastal Wetland Mapping (Eco Logical Australia, 2024).
- Coastal Wetland and Littoral Rainforest Mapping provided in the State Environmental Planning Policy (Resilience and Hazards) 2021

■ **Coastal and Estuarine Hazard Datasets:**

- Bank erosion mapping.
- Coastal inundation mapping for the Southern Estuaries prepared as part of the Stage 2 Coastal Inundation Study (JB Pacific, 2024).
- The NSW Estuary Tidal Inundation Exposure Assessment (OEH, 2018g)

■ **Assets, Infrastructure, and Social Values:**

- Geospatial data (GIS) utilised by Council to determine assets at risk or new asset requirements:
 - Coastal and estuary infrastructure (e.g. boat ramps, wharves, jetties, and seawalls)
 - Community and recreational infrastructure (e.g. access paths and public foreshore amenities)
 - Road networks and car parks
 - Stormwater infrastructure (e.g. outlets, pits, and drainage systems, where available)
 - Council-managed reserves and open spaces.



This multi-layered risk assessment allowed the project team to identify spatially explicit vulnerabilities and target areas where management actions would deliver the greatest benefit to the health, function, and resilience of the Southern Estuaries.



Audit of Historical CZMPs and EMPs

- An audit of the historical CZMPs and EMPs across the Southern Estuaries was undertaken in order to determine where actions from those prior plans had the capacity to control emerging threats and risks, and support emerging opportunities.
- Where these actions were considered fit-for-purpose, they were carried forward to the CMP option long list.



Review of Stage 2 Studies and Other Historical Technical Studies

- There have been a range of studies undertaken in Stage 2 in order to investigate localised coastal management issues and recommend potential mitigation options. A thorough review of these studies identified where site-specific recommendations could be included in the CMP option long list.
- The Stage 1 Scoping Study also identified a wide range of historical technical studies that were reviewed during the option identification phase.



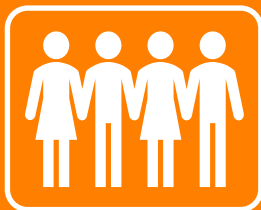
Issue Papers - Council and Community Workshops

- A series of workshops were held with Council in order to review historical management approaches
- Workshop participants included representatives from estuary management, environmental services, asset management, community engagement and waste services.
- Workshop activities focussed on addressing emerging issues, and identifying opportunities for improved coordinated management across departments, and developing synergies between plans.
- Issue Paper development involved community and stakeholders, and was pinnacle in developing options and overall priorities of the CMP.



Stakeholder Engagement

- Engagement with key project stakeholders provided the opportunity to harness collective knowledge for option identification. This included engagement with:
 - First Nations Groups
 - Relevant State Government Agencies / Entities
 - Industry and Community groups.
- More information is provided in Appendix A.



Community Engagement

- The Stage 3 community engagement process - which included drop-in sessions and an online engagement portal - were used to allow the community to suggest potential options to be included in the CMP and to provide feedback on the "long-list" of options.
- More information is provided in Appendix A



Risk-Based Analysis

- The project team included a wide range of coastal & estuary management experts, coastal engineers, terrestrial and aquatic ecologists, and coastal/environmental planners.
- A key focus of this expertise was to address risks and opportunities identified in Stage 2 - using geospatial datasets and hazard mapping provided through the various Stage 2 studies and NSW Governmental datasets.

Figure 3-2 Identification of potential management options



4 STEP 3: OPTIONS ASSESSMENT

4.1 Overview

Once the long list of management options was developed in Step 2, the next step was to assess and prioritise these options. Decision making in coastal and estuary management can be complex and multifaceted due to the inherent trade-offs required between social, environmental, economic, and political factors. The identification of appropriate management options therefore requires the consideration of a range of criteria, many of which cannot be easily quantified into common units or monetary values. Traditionally, optioneering undertaken as part of coastal and estuary management plans has applied qualitative methods that aim to simplify this complexity. Whilst practical, this can sometimes lead to over-simplifications whereby important information may be lost, opposing points of view may be discarded, and elements of uncertainty may be ignored.

To ensure the program of management options are appropriate, are able to be implemented and meets the objectives the CM Act, Stage 3 of the CMP has employed a robust multi-criteria decision-making framework. The purpose of this approach is to evaluate and choose among alternatives through a systematic analysis that uses stakeholder participation to inform economic, social, and environmental criteria. This provides a tool that enables different stakeholders' perspectives and values to be explicitly included in the analysis.

The options assessment has followed a 3-step process, as outlined in the NSW Coastal Management Manual (OEH, 2018d), and summarised in Figure 4-1 below.

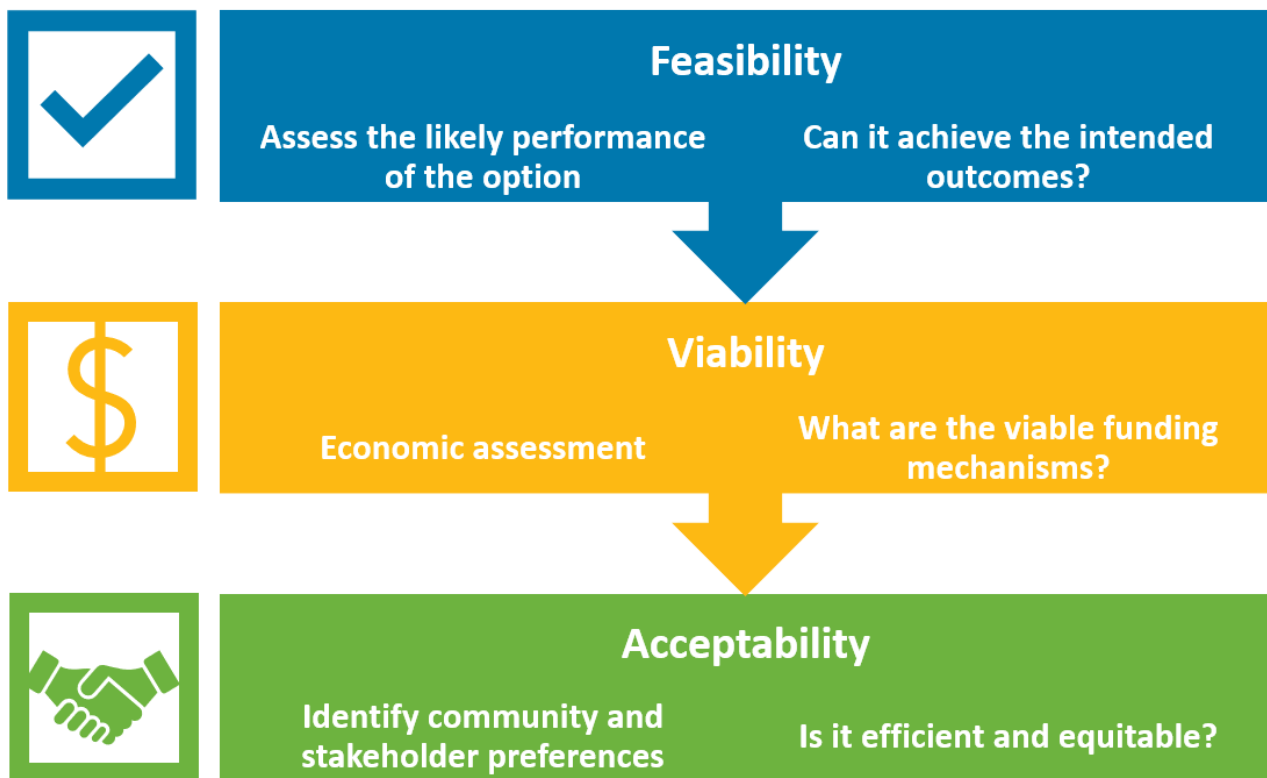


Figure 4-1 The Stage 3 options assessment process (adapted from the NSW Coastal Management Manual)

The overarching approach has been to undertake a discrete (but interrelated) assessment of each of these three components. The output of each assessment was a numerical score –: a Feasibility Score, a Viability



Score, and an Acceptability Score. These three scores will be subsequently combined in order to calculate a total Options Ranking Score that can be used to rank and compare the various options.

4.2 Preliminary Screening of Options

Prior to undertaking a detailed options assessment, a series of preliminary screening assessments were undertaken through workshops and detailed engagement with Council, community and State Government Agencies through a transparent and robust process. As part of the screening process, an audit of historical CZMPs and EMPs was undertaken to remove options that were either already completed or no longer relevant, or refinement of the action was needed to address new priorities. Similar or duplicate actions across the study area were consolidated to reduce redundancy and improve clarity.

Further refinement was made by streamlining suggestions that duplicated existing options or were already covered under broader management strategies. Many community-suggested options aligned with existing items, often adding valuable detail or specificity to improve their definition. Options considered routine operational tasks or already addressed through other established plans of management were also removed to ensure the resulting long list remained focused, strategic, and fit for further assessment.

Ten strategic alignment meetings were held within Council departments and across State Government Agencies and Indigenous groups to co-develop management options, and ensure they were feasible and viable to all parties, prior to detailed assessment. If, for example, a State Agency or Council department did not wish to pursue an option further, it was excluded from the 'long-list' through this preliminary screening process.

Before progressing to the long-list development and broader community engagement, all options were reviewed by the Council Leadership Team to ensure alignment with Council priorities, feasibility, and strategic direction. This step confirmed that each option was within Council's capacity and risk appetite for further consideration.

This process is summarised in Table 4-1.

Table 4-1 Option Long List Development and Preliminary Screening Process

Option Identification Source	Total Number of Actions
Starting Point - Review of Historical CZMP and EMPs	
CZMPs and EMPs	
Additional Options Identified During Stage 3	
Options derived from review of Stage 2 studies (and other historical technical studies), PC workshops, stakeholder engagement, and risk-based analysis	
Community Engagement – Issue Papers	
Community Engagement – Community Suggestions for Options through the Stage 3 Engagement Process	
Sub-Total of Preliminary Long List Options	520



Option Identification Source	Total Number of Actions
Preliminary screening of options through: <ul style="list-style-type: none"> ▪ CZMP/EMP audit (removal of completed or outdated actions) ▪ Consolidation of duplicate/similar actions ▪ Identifying community suggestions that are inconsistent with government policy or legislation ▪ Identifying community suggestions that are already covered by existing lost-list actions ▪ Exclusion of options covered by other plans or considered “business-as-usual” operational activities ▪ Exclusion of options that were considered out of budget, even when other funding sources were considered 	
Second Pass Screening of Options through Council Engagement, Workshopping with State Agencies and Indigenous Groups, and final Leadership team review	
Total Actions on Refined Long list	72

This consultative and rigorous screening process was applied to ensure only relevant, implementable, and strategic actions remained, culminating in a refined list of 72 management options for consideration in the CMP. This refined list reflects a coordinated and considered approach, ensuring the final program of actions is practical, aligned with community and stakeholder priorities, and supports the long-term objectives of the CMP.

4.3 Options Refined List

A full description of all options in the refined list is provided in Appendix B and Table 4-3, which includes a comprehensive set of information for each option, as summarised in Table 4-2. The refined list includes 72 options, each of which was assessed in detail using the methodology outlined in Figure 4-1 and described in Section 4.4 to 4.6.

Table 4-2 Snapshot of Refined List Information

CMP Document Location	Indicates whether the option will be included in the certifiable CMP or the catchment companion document.
Locality	Describes the specific location of the option, or “Study Area Wide”.
CMP Theme	Identifies the overarching theme that the option aligns with.
ID	A unique action ID assigned to each option using the format: [Strategy ID].[Implementation Plan ID].[Numerical Sequence]
Action Name	A short name or title for the option (typically fewer than 20 words).
Action Description	A more detailed explanation of the option.
Lead	Identifies the organisation with lead responsibility for implementation.
Support	Lists supporting agencies or stakeholders.
CM Manual Approach	Indicates the relevant strategic approach from the Coastal Management Manual (OEH, 2018d)
Option Source	Notes the original source of the option (e.g., stakeholder suggestion, technical recommendation).



Table 4-3 Refined List of CMP Options

CMP Document	Applicable Estuary	Theme	Stage 3 ID	Action Name	Action Description	Lead	Support	CM Manual Approach	Source of Option
CMP Document	Study Area Wide Implementation Plan	Theme 1: Climate Change	T1.01	Identify migration pathways for coastal wetlands and develop a management plan to ensure the preservation of these ecosystems for the future.	Utilise scientific modelling and research to identify migration pathways and develop a management plan to ensure coastal wetlands and littoral rainforests are preserved, taking into account climate change. Why? Ensure coastal wetlands and littoral rainforests are preserved into the future.	MCC	LLS	Planning for change	Manning ECMP
CMP Document	Study Area Wide Implementation Plan	Theme 2: Governance	T2.01	Enhance partnerships for observing estuary processes, centralising data storage and standardising data collection	Network with relevant stakeholders and data managers to prioritise data collection, efficiently maintain and service in-situ equipment and maximise industry participation and end-user understanding of the data being collected. Why? To enhance collaboration between organisations to reduce double-ups and increase efficiency and working relations.	LLS	Fisheries DCCEEW Oyster Growers Researchers	Alert	Workshop
CMP Document	Study Area Wide Implementation Plan	Theme 2: Governance	T2.02	Develop an Estuary Processes stakeholder forum	Build partnerships between industry, recreational and cultural fishers, natural resource managers and researchers to improve understanding of estuary processes and inform management decisions. This will be achieved through the facilitation of effective collaboration with estuary stakeholders through tailored engagement activities. Why? To build partnerships to improve understanding of estuary processes and inform management decisions.	LLS	Fisheries, MCC	Alert	Workshop
CMP Document	Study Area Wide Implementation Plan	Theme 3: Community Stewardship	T3.01	Integrate information about the Southern Estuaries into the education package for tourists promoting understanding, connection and stewardship.	Integrate information about the Southern Estuaries into an education package for tourists to raise awareness about the unique local ecosystems of the Southern Estuaries to foster stewardship. The program will provide essential information on the importance of these ecosystems and practical ways for visitors to contribute to their protection and sustainability. Why? To connect with new residents to increase information and knowledge about the estuaries, the need to protect them, providing them with ways to do so.	MCC		Avoid Future Impact	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 3: Community Stewardship	T3.02	Integrate information about the Southern Estuaries into the education package for new residents promoting understanding, connection and stewardship.	Integrate information about the Southern Estuaries into an education package for new residents to raise awareness about the unique local ecosystems of the Southern Estuaries to foster stewardship. The program will provide essential information on the importance of these ecosystems and practical ways for residents to contribute to their protection and sustainability. Why? To connect with new residents to increase information and knowledge about the estuaries, the need to protect them, providing them with ways to do so.	MCC	LLS	Avoid Future Impact	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 3: Community Stewardship	T3.03	Design and implement a whole of community engagement and education program to promote an understanding of the future threats and risks on the Southern Estuaries	Design and implement a Community Engagement and Education Program regarding the keys threats and risks facing the estuary systems from climate change, and how they can actively contribute to mitigating these risks and improving the resilience of the coastal zone. Why? To ensure community understanding of the issues facing the Southern Estuaries in relation to climate change	MCC		Avoid Future Impact	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 3: Community Stewardship	T3.04	Develop and implement a community engagement and education program to promote understanding, create connection and improve stewardship of the Southern Estuaries	Engage estuary users and the whole community in an engagement program to promote understanding of ecosystem values, current and future threats and risks, create connection with and improve stewardship of the Southern Estuaries. Why? To connect our community with the Southern Estuaries, increase their knowledge about water quality, ecosystem health, local flora and fauna and how they can mitigate their impact.	MCC		Avoid Future Impact	Workshop
CMP Document	Study Area Wide Implementation Plan	Theme 3: Community Stewardship	T3.05	Develop and implement a litter and stormwater pollution source control plan to mitigate the impact of litter in the Southern Estuaries, supported by the development of a marine debris engagement program.	Develop and implement a litter and stormwater pollution source control plan to mitigate the impact of litter in the Southern Estuaries. The following components will be incorporated: a) Development of source control plans for two identified hot spot locations b) Support for community and industry clean up events c) Development and implementation of a marine debris engagement campaign. Why? To reduce the impact of litter and pollution in our estuaries to support ecosystem health and visual amenity.	MCC		Active Intervention	Workshop
CMP Document	Smiths Lake	Theme 3: Community Stewardship	T3.06	Develop and implement community engagement and education program regarding the health and function of Smiths Lake.	Develop and implement a community engagement and education program for the Smiths Lake Catchment, promoting environmental awareness, responsible use and the dynamic and fragile nature of the system. Why? To inform the community about the Smiths Lake system, why and when openings will occur and help protect this important ecosystem, particularly in times of low water levels.	MCC		Active Intervention	Workshop
Supporting Catchment	Supporting Catchment	Theme 4: Agricultural Impacts	T4.01	Work with intensive agriculture farmers to improve estuary and catchment health by implementing a co-ordinated sustainable agriculture program	Continue to work with the intensive agriculture industry to reduce nutrient run-off. This will improve the quality and volume of nutrient-rich stormwater runoff from farms into the Southern Estuaries, improving waterway health. Why? Support estuary health outcomes at the source	MCC	LLS, Landcare	Active Intervention	Workshop
CMP Document	Study Area Wide Implementation Plan	Theme 6: Coastal Wetlands	T6.01	Manage threats to coastal wetlands in the National Park estate and adjacent lands, in collaboration with Aboriginal Traditional Owners.	Collaboratively manage threats to coastal wetlands within the National Park estate and adjacent lands by working in partnership with Aboriginal Traditional Owners. This will involve applying traditional knowledge to support the protection, restoration, and sustainable management of these culturally and ecologically significant wetland ecosystems.	NPWS		Active Intervention	Agency Engagement



CMP Document	Applicable Estuary	Theme	Stage 3 ID	Action Name	Action Description	Lead	Support	CM Manual Approach	Source of Option
CMP Document	Myall Lakes	Theme 6: Coastal Wetlands	T6.02	Undertake submerged aquatic vegetation mapping for the Myall Lakes.	Undertake submerged aquatic vegetation mapping for Myall Lakes to provide NPWS with strategic information for ongoing best management. Why? To understand the distribution of aquatic vegetation and enhance ongoing management.	NPWS		Alert	Agency Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 6: Coastal Wetlands	T6.03	Address the impacts of encroachment on sensitive foreshore habitats.	Address the impacts of encroachment into foreshore habitats and wetlands on public land at identified priority locations through community engagement, restrictions to access, habitat restoration and compliance as required. Identified sites are: 1. Green Point Swamp at Booti Booti - Green Point 2. Limekilns Reserve, Tea Gardens 3. High priority locations, Southern Wallis Lake foreshore Why? To protect foreshore and wetland ecosystems, support waterway health and ecosystem services these foreshore habitats provide.	MCC	Crown Lands	Active Intervention	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 6: Coastal Wetlands	T6.04	Advocate for purchase and restoration of priority coastal wetlands.	Advocate for purchase and protection of priority coastal wetlands through agreement with landholders, utilising funding mechanisms such as the NSW Coastal Acquisition Fund. Focus on the following priority areas : a. Khappinghat Creek (in the vicinity of Khappinghat National Park and Saltwater National Park) b. Big Island (Wallis Lake) c. Minimbah Sand beds – western areas d. Minimbah Creek wetlands e. Shallow Bay wetlands (near the Wallingat River and at Teatree Creek) f. Tea Gardens foreshore estuarine wetlands g. Lower Karuah River / Boogie Woogie Island wetlands h. Viney Creek Sand beds wetlands Why? Protect coastal wetlands and restore their ecological function	MCC		Planning for change	Council Engagement
CMP Document	Wallis Lake	Theme 6: Coastal Wetlands	T6.05	Investigate and implement the preferred option to reinstate a natural hydrology in the lagoon on Wallis Island Nature Reserve.	Investigate and implement the preferred option to reinstate a natural hydrology in the lagoon on Wallis Island Nature Reserve. Why? Enhance ecological outcomes for Wallis Lake	NPWS		Active Intervention	Agency Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 6: Coastal Wetlands	T6.06	Identify locations and projects for vegetation offsets within the coastal zone.	Identify opportunities for local coastal and marine vegetation offsets to ensure that any loss of vegetation resulting from development can be offset within the same locality or catchment. This action would support the implementation of the DPI Fisheries Intertidal and Marine Vegetation Offset Strategy and policy. Why? To identify local marine and terrestrial vegetation offsets to ensure no net loss of marine vegetation from development within the Southern Estuaries.	MCC	Fisheries	Active Intervention	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 6: Coastal Wetlands	T6.07	Regenerate the natural asset values of priority coastal wetlands.	Implement a schedule of works to regenerate the natural asset values of Council-managed and private coastal wetlands, including weed controls, erosion mitigation, habitat enhancement and pest animal control in priority locations, including : a. Darawakh Creek and Frogalla Swamp Wetlands b. Tea Gardens foreshore estuarine wetlands and Kore Kore Creek Reserve c. Pacific Palms reserves d. Bulahdelah Plain wetlands e. Minimbah Sandbeds wetlands f. Myall Lakes wetlands g. Duckhole Creek wetlands Why? To ensure wetlands are regenerated and prioritised as key assets to estuary health.	MCC		Active Intervention	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 7: Entrance Modification	T7.01	Advocate for State Government commitment to fund ongoing, long-term maintenance of safe navigation in designated navigation channels in Wallis Lake and Lower Myall River.	Advocate for State Government commitment to fund ongoing, long-term maintenance of safe navigation in designated navigation channels in Wallis Lake and Lower Myall River. Recommend these sites be included in the NSW Coastal Dredging Strategy. Why? Maintain safe navigation within Wallis Lake and the Lower Myall River.	MCC		Active Intervention	Workshop
CMP Document	Smiths Lake	Theme 7: Entrance Modification	T7.02	Increase understanding of entrance dynamics at Smiths Lake to inform future entrance management policy	Increase understanding of entrance dynamics to inform ongoing management at Smiths Lake through: - historical analysis of past entrance opening conditions, including berm heights and water levels. - a record management system of weather and conditions preceding opening, and impacts of opening. - an analysis of how climate change may impact entrance dynamics. Why? Understand the historical opening regime and how openings will be impacted by changing climatic conditions to inform ongoing management.	MCC		Alert	Workshop
CMP Document	Wallis Lake	Theme 7: Entrance Modification	T7.03	Monitor ongoing impacts of the entrance training in Wallis Lake on sand movement and shoaling in the entrance delta	Undertake periodic hydro surveys of the entrance delta of Wallis Lake to understand the change within the entrance delta and channels to inform the need for any viable future dredging interventions.	TfNSW		Alert	Workshop



CMP Document	Applicable Estuary	Theme	Stage 3 ID	Action Name	Action Description	Lead	Support	CM Manual Approach	Source of Option
					Why? Monitor ongoing impacts of entrance training walls on sand shoaling to inform future dredging.				
CMP Document	Wallis Lake	Theme 8: Human Health	T8.01	Maintain the boating effluent management engagement, education and compliance program	<p>Continue the proactive, face to face boating effluent management engagement and education program to deliver additional provisions in the NSW Marine Pollution Act 2012. This action will address human health risks and estuary health by reducing holding tank leaks or dumping of effluent by private and commercial vessels in Wallis Lake.</p> <p>It will include the provision of signage and dump point information at boat ramps for visitors to understand how and where to dispose of their vessel's wastewater correctly, and the implications if it is done incorrectly.</p> <p>This action links to Action 131, with the provision of additional vessel pump-out facilities.</p> <p>Why? To improve management of boating effluent management systems and reduce the risk to human health.</p>	TfNSW	MCC	Avoid Future Impact	Agency Engagement
CMP Document	Wallis Lake	Theme 8: Human Health	T8.02	Maintain the Wallis Lake island toilets and rationalise and upgrade these facilities as required	<p>Develop a formal agreement (e.g. MOU) between MCC and NPWS for the cleaning and asset maintenance for the toilets on the Wallis Lake islands that are on NPWS land. Undertake a condition assessment, determine usage and identify if any of the toilets can be decommissioned or need renewal. Upgrade toilet facilities as required.</p> <p>Why? To reduce the chance of system failure and consequent risk to human health and ecosystem health.</p>	MCC	NPWS	Active Intervention	Wallis Lake ECMP
CMP Document	Wallis Lake	Theme 8: Human Health	T8.03	Advocate for a State Government commitment to ensure that all recreational and commercial houseboats in Wallis Lake have grey and black water holding tanks installed and for dye to be added to holding tanks.	<p>Advocate for a State Government commitment to require all recreational and commercial houseboats in Wallis Lake to install grey and black water holding tanks to prevent wastewater discharge into the lake. Push for the inclusion of dye in the holding tanks to aid in detecting improper discharges and ensuring compliance with regulations. This will help protect water quality, promote responsible waste management, and support ongoing environmental monitoring and enforcement efforts.</p> <p>Why? Reduce the risk of boats causing effluent pollution and human health risk.</p>	TfNSW		Avoid Future Impact	Wallis Lake ECMP
CMP Document	Study Area Wide Implementation Plan	Theme 8: Human Health	T8.04	Monitoring and reporting on water quality in relation to human health	<p>Develop a human health monitoring program aligned with the BeachWatch methodology at key high public use areas, and communicate outcomes with the community. Follow up with investigations into the source of pathogens where ongoing issues are identified.</p> <p>Why? To understand the risks to human health in key swimming locations and inform community about swimmability.</p>	MCC		Alert	Workshop
CMP Document	Wallis Lake	Theme 8: Human Health	T8.05	Provide additional vessel pump-out facilities	<p>Install additional vessel pump-out facilities on Wallis Lake foreshore to make them more accessible and increase compliance with the disposal of effluent.</p> <p>Why? Reduce the risk of boats causing effluent pollution and human health impacts.</p>	MCC	TfNSW	Active Intervention	Workshop
CMP Document	Study Area Wide Implementation Plan	Theme 9: Inundation	T9.01	Protect retreat areas for saltmarsh and mangrove habitats on public reserves	<p>Protect retreat areas for saltmarsh and mangrove habitats on public reserves through:</p> <ul style="list-style-type: none"> - The identification of areas of public foreshore for landward migration of saltmarsh and mangrove habitats. - Update the natural areas Plan of Management for Crown foreshore land to include the protection of these areas. - Engage with Council staff and volunteers to stop mowing areas identified for habitat retreat. <p>Why? To allow saltmarsh and mangroves to migrate landward on public reserves in response to tidal inundation.</p>	MCC		Planning for change	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 9: Inundation	T9.02	Asset Resilience Program to address tidal inundation	<p>Develop an inter-departmental strategic direction to identify risks and opportunities for asset management in response to tidal inundation. Develop integrated visual tools to develop risk thresholds at a range of scales. Ground truth assets identified as 'at risk' in the tidal inundation study and verify the tidal inundation model. Develop an understanding of how often and for how long assets will be inundated. Identify how assets can be made more resilient for continued servicing during tidal inundation.</p> <p>Why? To develop a detailed understanding of when assets across MCC will be impacted by SLR and establish thresholds for servicing and to identify when to start adaptation planning. Use this information to inform land use planning controls.</p>	MCC		Avoid Future Impact	Stage 2 Study
CMP Document	Study Area Wide Implementation Plan	Theme 9: Inundation	T9.03	Develop an education program and co-design an adaptation plan for tidal inundation for vulnerable settlements / localities.	<p>Develop a community education and engagement program for communities at high risk of tidal inundation. Using this consultation, develop an adaptation plan for tidal inundation and sea level rise with the community.</p> <p>Why? To understand the communities' appetite for risk in relation to tidal inundation and develop adaptation options for future SLR scenarios.</p>	MCC		Avoid Future Impact	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 9: Inundation	T9.04	Construct improvements to the walking track in Myall Lakes National Park and Khappinghat National Park impacted by tidal inundation	<p>Upgrade affected walking tracks to reduce the risk of erosion and sedimentation to local wetland habitats</p> <p>Why? Reduce sedimentation from tidal inundation.</p>	NPWS		Active Intervention	Agency Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 9: Inundation	T9.05	Advocate for research into the impact of sea level rise on groundwater levels and consequences for built assets.	<p>Develop partnerships with universities to undertake a comprehensive investigation into the future impact of sea level rise on groundwater levels for built assets at high risk locations, with consideration to the compounding effects of sea level rise at high risk locations identified in the tidal inundation study.</p> <p>Why? Develop a better understanding of how groundwater will respond to sea level rise and in turn how built assets will be impacted e.g. roads</p>	MCC		Alert	Workshop
CMP Document	Wallis Lake	Theme 9: Inundation	T9.06	Install three (3) new tidal level gauges in Wallis Lake	<p>Collect baseline information on estuary water levels to inform future modelling on tidal inundation and understanding of sea level rise trends and impacts. Install three (3) new tidal level gauges in Wallis Lake:</p>	MCC		Alert	Workshop



CMP Document	Applicable Estuary	Theme	Stage 3 ID	Action Name	Action Description	Lead	Support	CM Manual Approach	Source of Option
					<ul style="list-style-type: none"> - Nabitac on the Pacific Highway Bridge - Coomba Park or Coomba Bay - the junction of the Coolongolook River and the Wang Wauk River. <p>Why? To inform future management of Wallis Lake</p>				
CMP Document	Wallis Lake	Theme 11: Recreation	T11.01	Boat ramp and boat access upgrades at Wallingat – Ferny Creek and Cockatoo Island Nature Reserve.	<p>Undertake boat ramp and boat access upgrades at Wallingat – Ferny Creek and Cockatoo Island Nature Reserve.</p> <p>Why? To ensure recreational impacts are minimised and provide safe public access</p>	NPWS		Active Intervention	Agency Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 11: Recreation	T11.02	Develop and install educational signage to highlight the impact of fishing rubbish on ecosystem health. Install fishing line collection bins along foreshore areas with high recreational fishing numbers.	<p>Develop and install educational signs and fishing line collection points along key foreshore areas with high recreational fishing numbers.</p> <p>Why? To reduce the impact of fishing litter in our estuaries.</p>	MCC		Active Intervention	Workshop
CMP Document	Study Area Wide Implementation Plan	Theme 11: Recreation	T11.03	Assess the impact of tourism at high use locations, identify future risks to estuary health.	<p>Develop partnerships with researchers to assess emerging impacts of tourism in high use locations.</p> <p>Why? To identify emerging impacts of tourism on estuary health to identify future management actions.</p>	MCC		Avoid Future Impact	Workshop
CMP Document	Wallis Lake	Theme 12: Biodiversity Conservation	T12.01	Implement the Wallis Lake seascape adaptation plan in partnership with key stakeholders	<p>Implement the Wallis Lake seascape adaptation plan that identifies and prioritises sub-tidal, inter-tidal and supra-tidal areas for habitat creation, restoration and adaptation. This will integrate and synthesise the existing knowledge base with holistic, collaborative and innovative approaches, including through the development of partnerships between research bodies, and recreational and commercial groups that use Wallis Lake.</p> <p>This adaptation plan will concentrate on fish nursery and habitat restoration in key locations such as Wallis Lake, and include habitats such as seagrass meadows, mangroves, and oyster reefs.</p> <p>Why? Increase biodiversity and estuary health</p>	LLS	MCC Crown Fisheries NPWS Researchers	Active Intervention	Workshop
CMP Document	Study Area Wide Implementation Plan	Theme 12: Biodiversity Conservation	T12.02	Implement a coordinated approach to pest management through a cross-tenure integrated pest and weed control program to protect natural assets within the coastal zone.	<p>Deliver a program of coordinated cross-tenure pest and weed management, incorporating key actions from the Hunter Regional Weeds Action Plan, Hunter Regional Strategic Pest Animal Plan and identified local priorities including:</p> <ul style="list-style-type: none"> - Wallis Lake Foreshore and islands - Smiths Lake Foreshore - Kore Kore Creek - Wallamba River Estuary - Coomba Park <p>Why? To reduce the impact of introduced species on coastal wetlands, littoral rainforest and other coastal zone habitats</p>	MCC	LLS NPWS Forestry Crown Lands	Active Intervention	Workshop
Supporting Catchment	Supporting Catchment	Theme 12: Biodiversity Conservation	T12.03	Identify, protect and restore freshwater refuge pools.	<p>Identify, protect and restore freshwater refuge pools in collaboration with community to protect local biodiversity, improve riparian habitat, connectivity and water quality throughout the catchment and for the benefit of the lower estuaries.</p> <p>Why? To ensure that refuge areas are available for freshwater species to utilise during drought conditions.</p>	MCC		Active Intervention	Workshop
CMP Document	Study Area Wide Implementation Plan	Theme 12: Biodiversity Conservation	T12.04	Implement a roadside environmental program including a roadside marker system to better protect key natural assets	<p>Identify the locations of sensitive roadside environments and identify these via a roadside marker system. Ensure road maintenance does not impact high conservation roadsides at identified key locations, where impacts will be felt within creeks, wetlands and Endangered Ecological Communities.</p> <p>This will also involve reducing impacts of roads on these key assets, including through sensitive roadside management, weed controls, and awareness and training.</p> <p>Why? Ensure road maintenance does not impact high conservation roadsides.</p>	MCC		Active Intervention	Workshop
Supporting Catchment	Supporting Catchment	Theme 12: Biodiversity Conservation	T12.05	Work collaboratively with Landcare, Land for Wildlife and the Biodiversity Conservation Trust to promote conservation and restoration of key estuarine habitats.	<p>Promote and facilitate establishment of 30 private conservation agreements covering 1500 ha in the study area by 2036, through Land for Wildlife and the Biodiversity Conservation Trust.</p> <p>Why? - To build on and enhance the existing partnership between Council and these programs, and enhance biodiversity within the coastal zone.</p>	MCC		Active Intervention	Prior Plan
CMP Document	Wallis Lake	Theme 12: Biodiversity Conservation	T12.06	Develop a seascape adaptation plan for Wallis Lake	<p>Develop an adaptation plan to integrate and synthesise current knowledge of Wallis Lake, including science, stakeholder experience and observations, traditional knowledge, values and water quality. This will be used to identify and prioritise sub-tidal, inter-tidal and supra-tidal areas for habitat creation, restoration and adaptation.</p> <p>Why? To ensure the Wallis Lake ecosystem is maintained into the future regarding climate change impacts.</p>	LLS	MCC	Avoid Future Impact	Agency Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 12: Biodiversity Conservation	T12.07	Advocate for State Government commitment to fund priority fish passage works.	<p>Advocate for removal or upgrade of barriers to fish migration at priority locations by physical removal; installation of fishways where removal is not feasible; or upgrading of existing fishways.</p> <p>Why? To improve fish habitat and biodiversity of the ecosystem.</p>	MCC		Active Intervention	Manning ECMP



CMP Document	Applicable Estuary	Theme	Stage 3 ID	Action Name	Action Description	Lead	Support	CM Manual Approach	Source of Option
CMP Document	Wallis Lake	Theme 12: Biodiversity Conservation	T12.08	Manage threat to Snake Island Pelican Rookery	Identify, monitor and address threats to the Pelican Island and Snake Island rookery of the Coastal Pelican. Monitoring of threats over time will enable NPWS to respond and support ongoing breeding on the islands. Why? Protect the pelican rookery from threats to ensure ongoing longevity of the population	NPWS		Active Intervention	Agency Engagement
CMP Document	Wallis Lake	Theme 12: Biodiversity Conservation	T12.09	Undertake Assisted Natural Regeneration and manage encroachment at priority locations along the foreshore reserve in Southern Wallis Lake	Undertake Assisted Natural Regeneration at priority locations along the foreshore reserve in southern Wallis Lake to support the recovery of native vegetation communities. This involves the strategic removal of invasive species, suppression of weed growth, and planting of native species to enhance ecological resilience. In conjunction, actively manage encroachment from adjacent land uses, such as informal tracks, dumping, vegetation clearing, and unapproved structures, to ensure the long-term protection and functionality of the foreshore's ecological and hydrological values. Why? Ensure local biodiversity is maintained	Crown Land		Avoid Future Impact	Agency Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 12: Biodiversity Conservation	T12.10	Protect and recover priority estuarine and near-estuarine plant and animal species and ecological communities in the Southern Estuaries through habitat restoration.	Identify threats and ecosystem needs for priority estuarine and near-estuarine plant and animal species in the Southern Estuaries. Undertake research and monitoring, deliver habitat restoration, enhancement and manage threats. Why? To ensure that ongoing conservation projects are effective and have the greatest impact possible.	MCC		Active Intervention	Workshop
CMP Document	Wallis Lake	Theme 12: Biodiversity Conservation	T12.11	Prepare a habitat restoration plan for Minimbah and Darawank Nature Reserves	Undertake a preliminary investigation of ecosystem and hydraulic function, water quality management issues and scope further work needed to enable site and wetland management. Why? Restore these vital habitats for greater biodiversity and ecosystem health	NPWS		Planning for change	Agency Engagement
CMP Document	Wallis Lake	Theme 12: Biodiversity Conservation	T12.12	Restore oyster reefs	Design and implement living shorelines and restoration of oyster reefs in high priority locations within Wallis Lake to enhance coastal resilience, improve water quality, and support local ecosystems. Why? Improve local biodiversity, amenity, shoreline protection and water quality in the Southern Estuaries.	LLS MCC		Active Intervention	Workshop
CMP Document	Myall Lakes	Theme 12: Biodiversity Conservation	T12.13	Investigate options for bird viewing facilities in the Hawks Nest / Tea Gardens area	Investigate options for bird viewing facilities in the Hawks Nest / Tea Gardens area to encourage community interaction in nature and promote shorebird / habitat engagement and education. Why? To encourage community interaction in nature and promote shorebird / habitat engagement and education.	MCC		Active Intervention	Prior Plan
CMP Document	Study Area Wide Implementation Plan	Theme 12: Biodiversity Conservation	T12.14	Develop a conservation management plan for the endangered Giant Dragonfly (Petalura gigantea) for the Minimbah National Park and surrounds and the Myall Lakes National Park populations.	Develop a conservation management plan, including details of regular population monitoring and community engagement strategies, for the endangered Giant Dragonfly (Petalura gigantea) for the Minimbah National Park and surrounds and the Myall Lakes National Park populations. Why? Promote continued protection of endangered species	NPWS	MCC	Alert	Agency Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 13: Land Use Planning	T13.01	Update SEPP Resilience and Hazards Mapping for coastal wetlands	Develop a planning proposal to update boundaries and extent of coastal wetlands based on Stage 2 wetland mapping. Why? Ensure accuracy of SEPP R&H mapping to protect coastal wetlands with planning controls	MCC		Avoid Future Impact	Council Engagement
CMP Document	Wallis Lake	Theme 13: Land Use Planning	T13.02	Prepare a planning proposal to amend the SEPP Resilience and Hazards Coastal Environment Area to include additional areas of the Forster and Tuncurry towns.	Prepare a planning proposal to amend the SEPP Resilience and Hazards Coastal Environment Area to include additional areas of the Forster and Tuncurry towns as Coastal Environment Area so that there is a consistent, catchment based regulatory framework ensuring planning controls are in place for urban catchments draining to Wallis Lake. Why? To provide a consistent, catchment -based regulatory framework for development in the existing urban areas of Forster and Tuncurry.	MCC		Avoid Future Impact	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 14: Erosion and Sedimentation	T14.01	Maintain roads and trails to address erosion, flooding and inundation risks.	Address risks from flooding and inundation at priority roads including but not limited to: - Bombah Point Road - Mungo Brush Road - Follies Road Why? Reduce sediment inputs into the estuaries to protect estuary health	NPWS		Active Intervention	Agency Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 14: Erosion and Sedimentation	T14.02	Address erosion and sedimentation from unsealed roads and creek crossings.	Address identified priority unsealed roads, creek crossings and boat ramps delivering sediments to waterways within or immediately impacting the coastal zone. The identified sites are: a) Myall Way Reserve b) Shearwater Reserves c) Coomba Park Rec Reserve d) Macwood Road Reserve e) Paradise Drive Reserve f) Karnang Complex g) Bungwahl Reserve h) Minimbah Wetland i) Cedar Park boat ramp j) Bullocky Wharf carpark. Wallis Lake Advocate to State Government for ongoing funding to address sedimentation impacts. Why? Reduce sediment inputs into the estuaries to protect estuary health	MCC	LLS	Active Intervention	Workshop



CMP Document	Applicable Estuary	Theme	Stage 3 ID	Action Name	Action Description	Lead	Support	CM Manual Approach	Source of Option
CMP Document	Study Area Wide Implementation Plan	Theme 14: Erosion and Sedimentation	T14.03	Address foreshore erosion at priority locations	Address identified priority foreshore erosion delivering sediments to waterways impacting the coastal zone. Design the protection works to optimise habitat opportunities and apply nature based controls. The identified sites are: 1. Wallis Lake foreshore between Little Street Baths and Waterline boat shed on Little Street; 2. Elizabeth Parade, Forster Keys; 3. Pindimar foreshore Curlew Street; 4. Point Road adjacent to the swimming area and boating facilities. Why? To protect foreshore assets from erosion and reduce sediment input into the coastal zone to protect estuary health.	MCC		Avoid Future Impact	Prior Plan and Council Engagement
CMP Document	Wallis Lake	Theme 14: Erosion and Sedimentation	T14.04	Monitor and remediate boat access and picnic areas for erosion In Minimbah Nature Reserve and Wallingat National Park.	1. Monitor erosion risk areas including boat wash risks and erosion risks in proximity to estuary access points including day use and campgrounds. 2. Apply "soft" erosion mitigations measures to priority erosion sites. Why? Reduce sediment inputs into the estuaries to protect estuary health	NPWS		Active Intervention	Agency Engagement
CMP Document	Wallis Lake	Theme 14: Erosion and Sedimentation	T14.05	Address river bank erosion and improve the condition of the riparian zone at high priority sites along the Wallamba River and foreshores of Tuncurry.	Address river bank erosion and improve the condition of the riparian zone at high priority sites along the Wallamba River and foreshores of Tuncurry. Why? To improve riparian condition and reduce sedimentation to protect water quality and ecosystem health.	MCC		Active Intervention	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 14: Erosion and Sedimentation	T14.06	Support ongoing improvements in Erosion and Sediment Control practices across the public and private sector	Maintain a high profile for good Erosion and Sediment Control (ESC) practices within the public and private sector. Build on current improvement programs to minimise sediment runoff and protect estuary health. Maintain relationships with industry, develop clear guidance for stakeholders, encourage good ESC practices through training, compliance blitzes, ESC audits, enforcement and promotion of enforcement action. Why? To minimise sediment runoff and protect estuary health	MCC		Active Intervention	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 15: Urban Stormwater and Litter	T15.01	Relocate and upgrade stormwater assets to mitigate tidal inundation impacts within the Southern Estuaries	Retrofit stormwater outlet pipes to manage immediate tidal inundation impacts as informed by the Stage 2 Tidal Inundation study as high risk locations. Why? Ensure assets will remain functional and mitigate impacts from tidal inundation and sea level rise.	MCC		Planning for change	Stage 2 Study
CMP Document	Study Area Wide Implementation Plan	Theme 15: Urban Stormwater and Litter	T15.02	Water quality asset management and maintenance program	Ensure that Council owned and priority privately owned water quality improvement assets are maintained from asset handover to ongoing maintenance to effectively remove nutrients and sediments from urban stormwater. The action includes: • Improving the process for the handover of water quality assets from developers • Program of compliance for privately owned water quality assets at high risk locations • Reporting to the community on maintenance and condition of water quality assets • Refurbishing 20 assets within the coastal zone and 8 assets outside of the coastal zone • Maintaining existing public assets Why? Ensure public and private water quality assets are in functioning effectively to maintain estuary health.	MCC		Active Intervention	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 15: Urban Stormwater and Litter	T15.03	Develop partnerships to deliver community and industry estuary clean up campaigns.	Develop partnerships with the oyster and fishing industries, agencies, community and non profit organisations to deliver community and industry clean up events for Wallis Lake. Encourage proactive removal of derelict tar stick infrastructure during clean up campaigns. Why? Proactive removal of litter to reduce pollution and support ecological health.	MCC	Oyster industry	Active Intervention	Workshop
CMP Document	Study Area Wide Implementation Plan	Theme 15: Urban Stormwater and Litter	T15.04	Develop Stormwater Management Plans (SMP) for priority townships	Develop stormwater management plans for each identified catchment taking into consideration climate change and tidal inundation, as well as projected changes in development with the aim to conserve and protect estuarine habitats as well as meeting stormwater quality and quantity targets. The identified townships are: Forster, Tuncurry, Smiths Lake, Black Head, Hawks Nest and Tea Gardens, Bulahdealah (WQ only). Why? To identify and prioritise actions that will improve stormwater quality and quantity management to support estuary health	MCC		Avoid Future Impact	Workshop
CMP Document	Wallis Lake	Theme 15: Urban Stormwater and Litter	T15.05	Renaturalise Pennington Creek	Restore and monitor the ecological health of Pennington Creek, support biodiversity, water quality and improve community connection to the waterway through integrated Water Sensitive Urban Design (WSUD), nature-based creek stabilisation, restoration of riparian habitats and citizen science. Community and Aboriginal engagement will form a key component, ensuring the project reflects local values and builds stewardship for ongoing management. Why? To restore the ecological and hydrological condition of Pennington Creek while improving water quality, riparian biodiversity, and community engagement.	MCC		Active Intervention	Council Engagement
CMP Document	Wallis Lake	Theme 15: Urban	T15.06	Investigate contamination and develop a feasibility study to rehabilitate Talanbar Dump, Wallis Lake.	Undertake a contamination assessment at Talanbar Dump (Wallis Lake Foreshore Reserve - 1032168), and develop a rehabilitation feasibility study.	MCC		Active Intervention	Council Engagement



CMP Document	Applicable Estuary	Theme	Stage 3 ID	Action Name	Action Description	Lead	Support	CM Manual Approach	Source of Option
		Stormwater and Litter			Once clean up and rehabilitation actions are identified, this action will be updated to include the implementation of preferred options. This will require the CMP to be amended and re-submitted for certification. Why? Reduce the risk of water contamination from historical dump site.				
CMP Document	Study Area Wide Implementation Plan	Theme 15: Urban Stormwater and Litter	T15.07	Stormwater Discharge Remediation to reduce erosion and sediment impacts	Reduce scour impacts from stormwater discharge locations, and remediate erosion caused by these discharge outlets at the following locations: > Pleasant View Parade, Bundabah > Between First and Second Ridge Road, Smiths Lake > Kiora Street, Pindimar > Wood Street, Pindimar > Binalong Crescent, Coomba Park > Moorrooba Road, Coomba Park > Coonabarabran, Road Coomba Park > Kooyong Place, Coomba Park > Coomba Road, Coomba Park. Why? Reduce sediment inputs into the estuaries to protect estuary health	MCC		Active Intervention	Council Engagement
Supporting Catchment	Supporting Catchment	Theme 15: Urban Stormwater and Litter	T15.08	Undertake a Water Sensitive Urban Design demonstration project in Forster / Tuncurry.	Design and construct a Water Sensitive Urban Design demonstration project in Forster / Tuncurry to manage the impacts of infill and intensification on water quality (WQ). This approach will address challenges in achieving effective onsite WQ outcomes while maintaining appropriate built form. Additionally, the project will support broader planning objectives, such as increasing density in existing urban areas, reducing pressure on greenfield sites, enhancing street tree planting, promoting urban greening, mitigating heat island effects, improving amenity, and fostering active living through streets-for-people initiatives. Why? Showcase the potential of WSUD, reduce water quality impacts and improve ecosystem health	MCC		Active Intervention	Workshop
CMP Document	Study Area Wide Implementation Plan	Theme 16: Aboriginal Custodianship	T16.01	Raise awareness of tidal inundation risks in relation to cultural heritage and cultural values.	Build understanding of tidal inundation risks with Aboriginal and Torres Strait Islander groups to inform decision making regarding adaptation planning for cultural heritage sites, intangible assets and impacts on the natural environment. Why? Raise awareness with Aboriginal and Torres Strait Island people about tidal inundation risks to cultural heritage and cultural values.	MCC	First Nation Groups	Avoid Future Impact	Indigenous Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 16: Aboriginal Custodianship	T16.02	Engage with Aboriginal and Torres Strait Islander land owners to identify opportunities for funding conservation and land management activities in the coastal zone.	Identify high conservation value land owned by Aboriginal and Torres Strait Islanders and engage with them to identify opportunities for funding conservation and land management activities such as Indigenous Protected Areas, bio banking and grant funding to maintain the ecological values and ecosystem services. Why? Support Indigenous Groups to maintain ecological values of high conservation lands.	MCC	First Nation Groups	Avoid Future Impact	Biodiversity Framework
CMP Document	Study Area Wide Implementation Plan	Theme 16: Aboriginal Custodianship	T16.03	Build relationships and work closely with the Aboriginal and Torres Strait Islander community to increase involvement and knowledge sharing in catchment and estuary management.	Build relationships with the Aboriginal and Torres Strait Islander community to develop an understanding of cultural values and how these relate to estuary processes, increase participation in the management of the land within the coastal zone. Building on Local Land Services 'Sea Country' program this action will enable a two way sharing of information and co- design of an awareness and engagement program including cultural education activities that are designed to enable local Aboriginal and Torres Strait Islander community to further their understanding and awareness of cultural values, key estuary management issues and associated management approaches. Through this, relationships and opportunities for Aboriginal and Torres Strait Island people to be involved in the management and stewardship of the Southern Estuaries will be identified. Why? Build partnerships with the Aboriginal and Torres Strait Islander community to increase participation, knowledge sharing and opportunities for involvement in catchment and estuary management to ensure culturally sensitive management of the Southern Estuaries.	MCC	LLS, NPWS, First Nation Groups	Alert	Indigenous Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 16: Aboriginal Custodianship	T16.04	Work closely with the Aboriginal and Torres Strait Islander community to implement community education programs promoting awareness and appreciation of Aboriginal and Torres Strait Island cultural heritage	Develop and implement a program of Indigenous cultural education in partnership with Aboriginal and Torres Strait Island people. Demonstrate the link between cultural values and estuary health using a range of methods. Why? Increase community awareness and appreciation of the Aboriginal and Torres Strait Island cultural heritage values of the Southern Estuaries and build partnerships	MCC	First Nation Groups	Active Intervention	Indigenous Engagement
Supporting Catchment	Study Area Wide Implementation Plan	Theme 16: Aboriginal Custodianship	T16.05	Undertake cultural land management practices, including cultural burning	Partner with the Aboriginal and Torres Strait Islander community to identify opportunities for, and to undertake cultural practices (including cultural burning) across the estuary catchments. This would involve land managers (Council, NPWS, LLS) working closely with Aboriginal and Torres Strait Islander communities to develop and implement a program of works. Why? Support ecosystem health through cultural burns and connect with Aboriginal and Torres Strait Islander community to build relationships and ongoing partnerships.	MCC, LLS, NPWS	First Nation Groups	Active Intervention	Indigenous Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 17: Monitoring and Research	T17.01	Develop partnerships for sharing monitoring data and resources	Build on existing systems or develop a database to track the types of data being collected, the locations, and the responsible parties within the Southern Estuaries. Use this database as a foundation for discussions aimed at improving the efficiency of data collection processes and establishing data-sharing agreements between industry and government entities. Why? Raise awareness on what data is being collected within the Southern Estuaries, develop partnerships for sharing data and resources for estuary monitoring.	MCC	DECCW	Alert	Workshop



CMP Document	Applicable Estuary	Theme	Stage 3 ID	Action Name	Action Description	Lead	Support	CM Manual Approach	Source of Option
CMP Document	Study Area Wide Implementation Plan	Theme 17: Monitoring and Research	T17.02	Monitor, evaluate and report on ecosystem health to guide adaptive management	Undertake monitoring, evaluation and reporting of ecosystem health to guide adaptive management of the coastal zone, engage with the community on the ecological value of the coastal zone through waterway health report cards. Why? To ensure management decisions are based on best available science and community understand the importance of ecological health of our waterways.	MCC		Alert	Council Engagement
CMP Document	Study Area Wide Implementation Plan	Theme 17: Monitoring and Research	T17.03	Undertake research projects with universities, research organisations and volunteer groups in order to support the delivery of the coastal management program.	Partner with universities, research organisations and volunteer groups to understand species, ecosystems, estuary processes and monitor threats to community values to inform future management of the Southern estuaries, and support two PhD stipends over the 10-year CMP. Why? Receive greater research information about the Southern Estuaries and which will assist with better management of the systems.	MCC		Alert	Workshop



4.4 Feasibility Assessment

4.4.1 Overview

As per the NSW Coastal Management Manual (OEH, 2018d), feasible coastal management options are those which are:

- Consistent with the objects of the relevant legislation (including the *Coastal Management Act 2016*, the *Marine Estate Management Act 2014*).
- Consistent with statutory and policy requirements at local, state and Commonwealth levels.
- Environmentally acceptable and consistent with Ecologically Sustainable Development (ESD) principles.
- Feasible in engineering / management terms, i.e., can the option(s) be realistically implemented, given the local social and environmental context.
- Able to address the identified issues, mitigating risks or enhancing opportunities, based on previous experience.
- Adaptive and can transition to alternative approaches when circumstances change.
- Broadly able to be implemented, in terms of available capacity and capability.
- Able to contribute new knowledge about effective management; for instance, a response that is structured as a carefully controlled trial of new technology.

The development of the list of options was thereby undertaken with regards to the above. The feasibility assessment investigated how each option met the above requirements, and the ability for each option to address the various risks and opportunities across the study area.

4.4.2 Multi Criteria Analysis Methodology

The feasibility assessment was designed to provide an indicative measure of each potential management option's ability to address the identified risks and capitalise on opportunities across the study area (as outlined in Stage 2 of the CMP). This included both direct and indirect contributions to risk reduction and broader management objectives. To ensure a consistent, transparent, and easily understood approach for comparing diverse options, a high-level, semi-quantitative multi-criteria analysis (MCA) framework was applied.

Under this framework, each option was assessed against a defined set of criteria and assigned a numerical score, allowing for a semi-quantified comparison across all options. The outcome of this process was the calculation of a Total Feasibility Score (TFS), which enabled a ranking of options based on their overall merit and feasibility for implementation.

A summary of this methodology is provided in Figure 4-2. Each option was evaluated against the following key criteria:

- **The Degree of Risk Mitigation:** This criterion assessed how effectively each option reduces risks identified in Stages 1 and 2 of the CMP. It considered:
 - The level of risk being addressed – for example, does the option mitigate an extreme risk to public safety or a moderate risk to estuary health?
 - The effectiveness of the option – assessing whether the option provides a long-term or short-term solution, and the degree to which it mitigates the target risk.
- **Potential Impacts on Environmental, Social, and Cultural Values:** This considered the broader implications of each option, recognising that effective coastal management must balance risk reduction with the protection and enhancement of key community values. Options were scored based on potential positive



or negative impacts in the following areas (which were adopted to broadly align with the “Key Estuary Threats” identified in the Stage 1 Scoping Study (Water Technology, 2022) and the Issue Papers developed for Stage 3:

- Water Quality – including stormwater runoff, estuarine water quality, and potential for pollution reduction.
- Biodiversity – including habitat protection and enhancement for native species and ecological communities.
- Physical coastal & estuary processes – including impacts on sediment transport, erosion, and natural geomorphic function.
- Social & recreational amenity – including accessibility, usability, and enhancement of public open space and foreshore areas.
- Public safety – including reduction in exposure to hazards such as erosion, inundation, shoreline instability, or water quality.
- Cultural heritage values – considering both tangible heritage (e.g. sites or artefacts) and intangible cultural connections, including those identified through consultation with First Nations Groups stakeholders.

Each criterion was scored on a scale from **+4 (strongly positive)** to **0 (neutral or no impact)** to **-4 (strongly negative)**. A strongly negative score (e.g. -3 or lower) in any criterion may render an option unfeasible for inclusion due to significant adverse impacts.

Using the formula provided in Figure 4-2 below, a Feasibility Score was calculated for each option. To further refine the assessment, a geographic scale factor - ranging from 1 to 3 - was applied to each option to reflect the spatial extent of its potential benefits and impacts. This approach acknowledges that options with broader application across the study area may deliver more widespread value and efficiency, and greater benefits across the whole study area. The scale factor was applied to the Feasibility Score to determine the Total Feasibility Score.

The Feasibility Assessment scores for each option are provided in Appendix D.

Table 4-4 Scale factor criteria

Option range of application	Scale Factor
Option generates benefit/impacts to a localised area	1
Option generates benefit/impacts an entire estuary functional zone or multiple zones.	2
Benefit/impacts realised across the entire Southern Estuaries study area	3

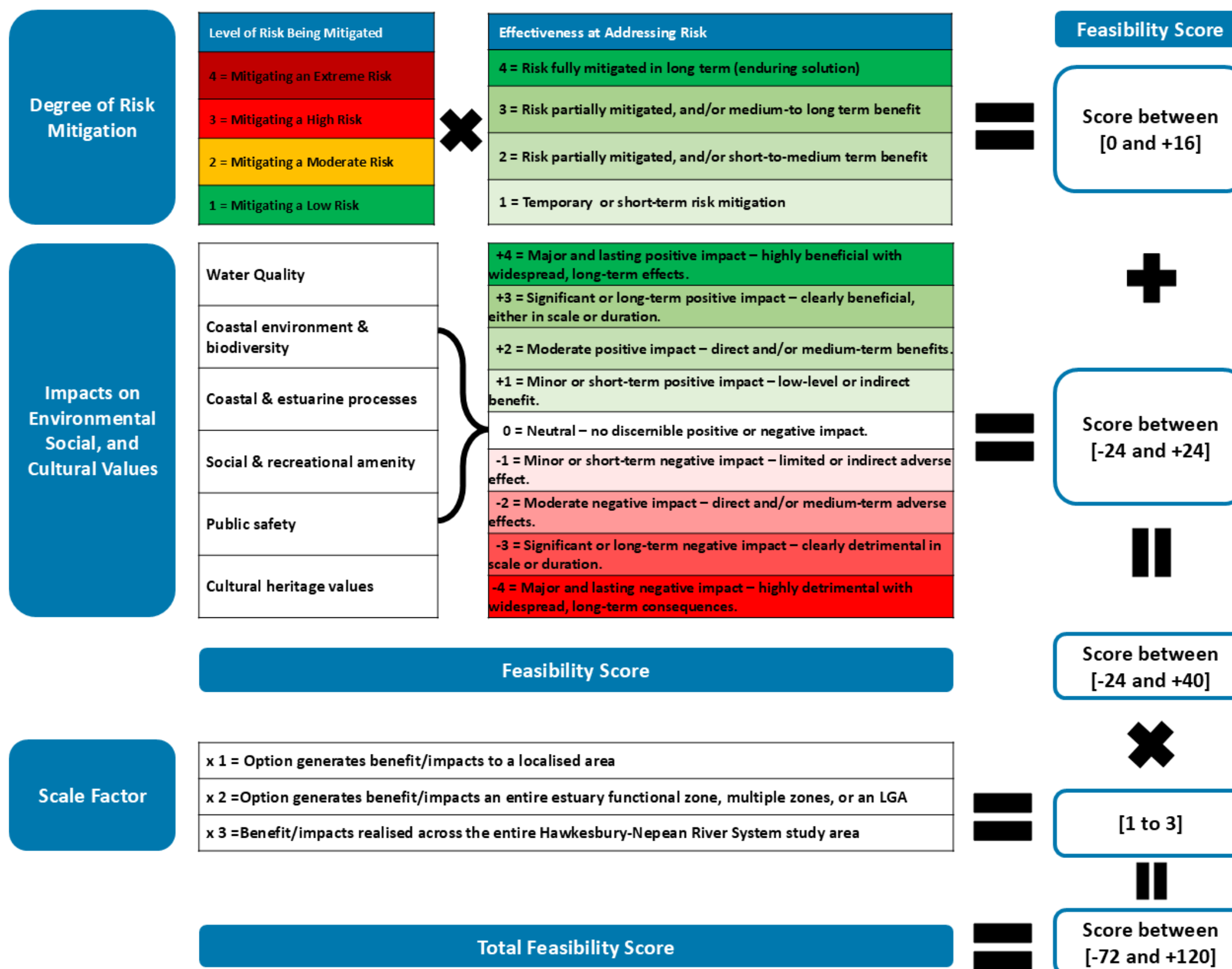


Figure 4-2 Calculation of feasibility score



4.5 Acceptability Assessment

A key factor in the evaluation of options involved determining the acceptability of those options to three distinct stakeholder groups:

- Local communities across the Southern Estuaries.
- Local First Nations stakeholders, including those identified in the Community & Stakeholder Engagement Plan
- Relevant stakeholders, including public authorities and State Government agencies, and industry groups – e.g. agricultural industry, boating industry.

To inform this assessment, a robust community and stakeholder engagement process was carried out during Stage 3. The engagement methods and outcomes are detailed in Appendix A. This process provided an opportunity for stakeholders to offer feedback on the potential management options and propose additional actions for consideration. This engagement project took place from Friday 11 April to Thursday 22 May 2025, and included:

- Survey of potential management options (both online and a paper version), with 209 responses. Each management option received at least 75% support.
- Face-to-face engagement opportunities, with engagement directly with at least 239 people:
 - Seven pop-ups across the catchment areas, including Smiths Lake, Tuncurry, Forster, Tea Gardens and Hallidays Point (Figure 4-3).
 - Four events, including Riverfest in Tea Gardens, a Twilight Tour in Smiths Lake, the Southern Estuaries Photography Competition Awards Night in Forster and Changing Nature of Wallis Lake in Forster.
- Stakeholder meetings with five groups, including Indigenous engagement (see Appendix A for further detail):
 - Several Indigenous groups and individuals
 - Wallis Lake Oyster Growers
 - Wallis Lake Fisherman's Co-op
 - Myall River Action Group
 - Wallamba Landcare Group
 - Aboriginal Reference Group.
- One submission.



Figure 4-3 Engagement at NAIDOC week

The following graph (Figure 4-4) combines all the option survey results into 11 themes. This demonstrates that overall, the management option themes have at least 82% support from the community.



Figure 4-4 Survey Outcomes based on theme

Feedback from this engagement process was used to calculate an Acceptability Score for each option, using the method outlined in Table 4-5. Equal weighting was applied across the three stakeholder groups to generate a normalised score between 0 and 1 for each option.

Similarly, actions that were still awaiting approval or refinement during the engagement process, or that were led by external parties outside of Council's control, were not included in the community survey and were also given a default score of 1. In these cases, it is noted that further engagement will occur during Stage 4, including through the public exhibition phase. Where no clear indication of community support or opposition was received, a default score of 1 was also applied.

The Acceptability Assessment scores for each option are provided in Appendix C.

Table 4-5 Calculation of acceptability score

Component	Description	Acceptability Score
Community Support	Based on the percentage of community support recorded through the Stage 3 engagement portal. Support was converted into a decimal value (e.g. 75% = 0.75).	0 - 1



Component	Description	Acceptability Score
Indigenous Stakeholder Support	<p>Support from local Indigenous interest groups was obtained through both face to face and online engagement methods. Stakeholder support was provided as a number between 0 and 1:</p> <ul style="list-style-type: none"> ▪ If an Indigenous interest group indicated that it did not support a particular option, then a score of 0 was given. ▪ If partial or conditional support was offered from any group, then a score of 0.5 was applied and conditions of support were noted to modify the option accordingly. ▪ If all groups indicated support of the option, then a score of 1 was applied. <p><i>At this point in the project, the default value for most actions is 1 – as these actions have been developed in consultation with First Nations during Stage 3. However, the next round of engagement with these groups will confirm this.</i></p>	0 - 1
Stakeholder Support	<p>Based on feedback from industry groups and State Government agencies. Scored identically to the approach for First Nations stakeholders.</p> <p><i>At this point in the project, the default value for most actions is 1 – as these actions have been developed in consultation with stakeholders during S3. However, the next round of engagement will confirm this.</i></p> <p>A score of 0 received from any State Agency automatically excludes the option.</p>	0 - 1
Total Acceptability Score	Calculated as the product of the three component scores	0 - 1

4.6 Viability Assessment

4.6.1 Overview

The primary purpose of the viability assessment was to determine, for each potential management option:

- The estimated cost of implementation
- The distribution of costs and benefits among stakeholders
- Proposed cost-sharing arrangements and funding mechanisms
- Whether the option is considered affordable and, therefore, viable for progression to Stage 4 of the CMP.

As part of Stage 3, an economic assessment was undertaken for each option on the long list. The intent of economic assessment is to help decision-makers understand the socioeconomic implications of different management strategies and support the selection of options that deliver net community benefits (OEH, 2018d).

However, the scope and depth of an economic assessment should be proportionate to the:

- Nature and scale of the option – including its cost, complexity, and the number of affected stakeholders; and
- Risk level and significance of the issue being addressed.



Accordingly, the required level of assessment varied between options. This is illustrated in Figure 4-5, which presents guidance from the NSW Coastal Management Manual on matching the level of economic assessment to project risk and complexity. As shown, conducting a detailed cost-benefit analysis (CBA) for options with minor costs and limited stakeholder impacts is generally not an effective use of resources. Instead, economic assessments should be scaled to match the nature and impact of the proposed action.

		Complexity	
		Low	High
Risks and impacts	Low	<ul style="list-style-type: none"> Limited number of stakeholders Little or no quantitative data 	<ul style="list-style-type: none"> Disagreement or conflicting views among stakeholders Difficulty defining beneficiaries or apportioning costs Good quantitative data
	High	<ul style="list-style-type: none"> Limited spatial scale Low risk and low impact 	<ul style="list-style-type: none"> Addressing high or extreme risks An option involves major investment (see Treasury Guideline 2017)
		Simple economic assessment These assessments ask similar questions as the more complex analysis, but use qualitative analysis and expert opinion rather than quantitative data.	Intermediate level assessment These assessments ask the same questions as the more complex analysis, but may use detailed costings.
		Intermediate level assessment Monte Carlo modelling or significant social analysis may not be necessary, but some detailed costing, e.g. for maintenance, is required.	Detailed cost-benefit analysis This may involve a systematic comparison of all foreseeable costs and benefits and the probability that they will arise over the planning period.

Figure 4-5 Matrix of risk and complexity for selecting the level of economic assessment (source: OEH, 2018d)

In line with this guidance, Stage 3 of the CMP considered two levels of economic assessment:

- **Intermediate Level Economic Assessment:** Applied to options identified in Figure 4-5 as requiring either a Simple or Intermediate assessment.
- **Detailed Economic Cost-Benefit Analysis:** Used for high-risk and high-impact options where both costs and benefits could be reasonably estimated, and probabilistic coastal hazard mapping was available to inform such an assessment. As per DCCEEW's advice, this is only necessary for options estimated to be greater than \$5 million. For any project with a total cost greater than \$5 million, it needs to have a CBA performed prior to apply for funding through the Coasts and Estuaries grant (DCCEEW, 2024).

The Simple or Intermediate Level Economic Assessment was used for all the options in the long list. No options met the criteria for the Detailed Economic Cost-Benefit Analysis.

Using the Intermediate assessment method, each option was assigned a Viability Score that incorporated an estimate of its likely cost, recognising that cost is a key factor influencing feasibility and prioritisation. At this stage of the process, not all options had fully defined scopes or detailed costings. To allow for consistent and meaningful comparison across a wide range of potential actions, a tiered cost-rating system was applied. This system grouped options into indicative cost brackets based on estimated implementation effort and resource requirements. The cost categories used were:

- Staff Time



- Less than \$10,000
- \$10,000 - \$50,000
- \$50,000 - \$200,000
- \$200,000 - \$500,000
- \$500,000 - \$1,000,000
- \$1,000,000 - \$2,000,000
- \$2,000,000+.

4.6.2 Viability Score

Following the estimation of each option's approximate cost, a Viability Score was calculated. This score was based on the base-10 logarithm of the approximate cost, allowing for an order-of-magnitude cost weighting to be applied in the overall MCA.

It should be noted that for some options, the primary cost incurred is associated with in kind staff time resourcing of Council or State Agencies, which was assigned a designation of Staff Time in the analysis. For such options, a nominal cost of \$10,000 was applied.

The Viability Assessment scores for each option are provided in Appendix E.

4.7 Total Ranking Score

The output of the three-phase assessment described was the calculation of an *Options Ranking Score*, which was the arithmetic combination of the *Feasibility Score*, the *Viability Score*, and the *Acceptability Score*, as demonstrated in Figure 4-6.

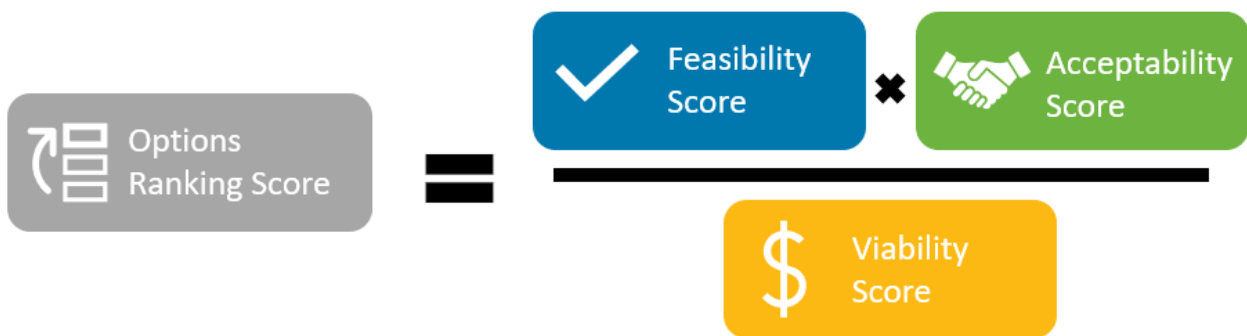


Figure 4-6 Calculation of the options ranking score

Each component of the Options Ranking Score provided a distinct perspective on the performance of an option:

- The **Total Feasibility Score** assessed the extent to which an option addressed the various risks across the study area - either directly or indirectly - and considered its social and environmental impacts.
- The **Acceptability Score** reflected the level of support for each option among local community members and key project stakeholders.
- The **Viability Score** captured the cost of each option and provided an indication of economic viability and value for money.



It is, however, acknowledged that the Options Ranking Score incorporates inherent subjectivity and uncertainty. As such, it should not be interpreted as a definitive or conclusive metric for determining which options proceed to the next stage. Some options may deliver additional qualitative or strategic benefits not easily captured through this assessment framework and may involve organisational, political, or social considerations that affect their overall favourability.

4.8 Options Assessment Outcomes

A summary of the assessment outcomes is presented in Table 4-6.

Ultimately, the number and nature of options progressing to Stage 4 will also be influenced by the budgetary and resource constraints of Council and State Agencies. Accordingly, the Options Ranking Score was considered a starting point for discussion with Council and State Agencies - with the results to be interpreted alongside local knowledge and contextual understanding of environmental, economic, and social priorities.

Subsequently, a preliminary assessment of which options will progress through to the CMP has been undertaken through engagement with Council. Following targeted engagement, a preliminary status has been assigned to each option in Table 4-6:

- Yes Stage 4 – for options that will progress through to Stage 4 of the CMP
- Continued Engagement – for option that require ongoing discussion to determine where or not they will progress through to Stage 4 and refinement of action inclusions.
- No - Drop Out – for options that will not progress through to the CMP.

No options were assigned “Drop-out”, primarily due to the initial rigorous preliminary screening process. Typically, these were not progressed through the Stage 3 process because they:

- Were considered “business as usual” activities already covered by Council operations;
- Fell within the remit of other frameworks, such as the NSW Floodplain Risk Management Framework;
- Not within Council or State Agency priorities; or
- Aligned more closely with alternative strategies, such as Council open space strategies or asset management plans.

Of the 72 long-listed options, all 72 have been assessed as progressing to Stage 4. Several of the actions, in particular those by State Agencies, have been flagged for further discussion through continued engagement following the delivery of the First Draft Stage 3 Report.



Table 4-6 Options Assessment Outcomes

ID	Action Name	Accept. Score	Feasibility Score	Viability Score	Option Ranking Score
T1.01	Identify migration pathways for coastal wetlands, and develop a management plan to ensure the preservation of these ecosystems for the future.	0.94	66	2	27
T2.01	Enhance partnerships for observing estuary processes, centralising data storage and standardising data collection	1.00	21	1	21
T2.02	Develop an Estuary Processes stakeholder forum	0.96	21	1	20
T3.01	Integrate information about the Southern Estuaries into the education package for tourists promoting understanding, connection and stewardship.	0.96	39	1	37
T3.02	Integrate information about the Southern Estuaries into the education package for new residents promoting understanding, connection and stewardship.	0.96	39	1	37
T3.03	Design and implement a whole of community engagement and education program to promote an understanding of the future threats and risks on the Southern Estuaries	0.94	48	2	27
T3.04	Develop and implement a community engagement and education program to promote understanding, create connection and improve stewardship of the Southern Estuaries	0.95	63	2	26
T3.05	Develop and implement a litter and stormwater pollution source control plan to mitigate the impact of litter in the Southern Estuaries, supported by the development of a marine debris engagement program.	0.96	39	2	16
T3.06	Develop and implement community engagement and education program regarding the health and function of Smiths Lake.	0.94	15	1	14
T4.01	Work with intensive agriculture farmers to improve estuary and catchment health by implementing a co-ordinated sustainable agriculture program	0.97	36	2	15
T6.01	Manage threats to coastal wetlands in the National Park estate and adjacent lands, in collaboration with Aboriginal Traditional Owners.	1.00	30	1	30
T6.02	Undertake submerged aquatic vegetation mapping for the Myall Lakes.	1.00	26	1	26
T6.03	Address the impacts of encroachment on sensitive foreshore habitats.	0.96	54	2	23
T6.04	Advocate for purchase and restoration of priority coastal wetlands.	0.93	48	1	22
T6.05	Investigate and implement the preferred option to reinstate a natural hydrology in the lagoon on Wallis Island Nature Reserve.	1.00	17	1	17
T6.06	Identify locations and projects for vegetation offsets within the coastal zone.	1.00	24	2	14
T6.07	Regenerate the natural asset values of priority coastal wetlands.	0.97	68	3	11



ID	Action Name	Accept. Score	Feasibility Score	Viability Score	Option Ranking Score
T7.01	Advocate for State Government commitment to fund ongoing, long-term maintenance of safe navigation in designated navigation channels in Wallis Lake and Lower Myall River.	0.94	34	1	32
T7.02	Increase understanding of entrance dynamics at Smiths Lake to inform future entrance management policy	0.93	15	2	8
T7.03	Monitor ongoing impacts of the entrance training in Wallis Lake on sand movement and shoaling in the entrance delta	1.00	11	2	6
T8.01	Maintain the boating effluent management engagement, education and compliance program	1.00	34	1	34
T8.02	Maintain the Wallis Lake island toilets and rationalise and upgrade these facilities as required	1.00	28	1	28
T8.03	Advocate for a State Government commitment to ensure that all recreational and commercial houseboats in Wallis Lake have grey and black water holding tanks installed and for dye to be added to holding tanks.	0.94	26	1	24
T8.04	Monitoring and reporting on water quality in relation to human health	0.95	66	3	23
T8.05	Provide additional vessel pump-out facilities	0.94	31	3	10
T9.01	Protect retreat areas for saltmarsh and mangrove habitats on public reserves	0.94	42	1	40
T9.02	Asset Resilience Program to address tidal inundation	0.93	99	3	34
T9.03	Develop an education program and co-design an adaptation plan for tidal inundation for vulnerable settlements / localities.	0.93	57	2	31
T9.04	Construct improvements to the walking track in Myall Lakes National Park and Khappinghat National Park impacted by tidal inundation	1.00	17	1	17
T9.05	Advocate for research into the impact of sea level rise on groundwater levels and consequences for built assets.	0.94	18	1	17
T9.06	Install three (3) new tidal level gauges in Wallis Lake	1.00	26	2	11
T11.01	Boat ramp and boat access upgrades at Wallingat – Ferny Creek and Cockatoo Island Nature Reserve.	1.00	48	2	21
T11.02	Develop and install educational signage to highlight the impact of fishing rubbish on ecosystem health. Install fishing line collection bins along foreshore areas with high recreational fishing numbers.	0.96	24	1	23
T11.03	Assess the impact of tourism at high use locations, identify future risks to estuary health.	0.93	16	1	15
T12.01	Implement the Wallis Lake seascape adaptation plan in partnership with key stakeholders	1.00	102	3	38
T12.02	Implement a coordinated approach to pest management through a cross-tenure integrated pest and weed control program to protect natural assets within the coastal zone.	0.97	84	3	27
T12.03	Identify, protect and restore freshwater refuge pools.	0.96	66	3	23
T12.04	Implement a roadside environmental program including a roadside marker system to better protect key natural assets	0.96	22	1	21
T12.05	Work collaboratively with Landcare, Land for Wildlife and the Biodiversity Conservation Trust to promote conservation and restoration of key estuarine habitats.	0.97	48	2	20



ID	Action Name	Accept. Score	Feasibility Score	Viability Score	Option Ranking Score
T12.06	Develop a seascape adaptation plan for Wallis Lake	1.00	19	1	19
T12.07	Advocate for State Government commitment to fund priority fish passage works.	0.95	18	1	17
T12.08	Manage threat to Snake Island Pelican Rookery	1.00	14	1	14
T12.09	Undertake Assisted Natural Regeneration and manage encroachment at priority locations along the foreshore reserve in Southern Wallis Lake	1.00	14	1	14
T12.10	Protect and recover priority estuarine and near-estuarine plant and animal species and ecological communities in the Southern Estuaries through habitat restoration.	0.97	34	3	12
T12.11	Prepare a habitat restoration plan for Minimbah and Darawank Nature Reserves	1.00	12	1	12
T12.12	Restore oyster reefs	0.95	34	3	12
T12.13	Investigate options for bird viewing facilities in the Hawks Nest / Tea Gardens area	0.93	10	2	5
T12.14	Develop a conservation management plan for the endangered Giant Dragonfly (<i>Petalura gigantea</i>) for the Minimbah National Park and surrounds and the Myall Lakes National Park populations.	1.00	9	2	5
T13.01	Update SEPP Resilience and Hazards Mapping for coastal wetlands	1.00	75	1	75
T13.02	Prepare a planning proposal to amend the SEPP Resilience and Hazards Coastal Environment Area to include additional areas of the Forster and Tuncurry towns.	1.00	44	1	44
T14.01	Maintain roads and trails to address erosion, flooding and inundation risks.	1.00	32	1	32
T14.02	Address erosion and sedimentation from unsealed roads and creek crossings.	0.96	87	3	28
T14.03	Address foreshore erosion at priority locations	0.95	66	2	27
T14.04	Monitor and remediate boat access and picnic areas for erosion in Minimbah Nature Reserve and Wallingat National Park.	1.00	34	2	20
T14.05	Address river bank erosion and improve the condition of the riparian zone at high priority sites along the Wallamba River and foreshores of Tuncurry.	0.95	62	3	20
T14.06	Support ongoing improvements in Erosion and Sediment Control practices across the public and private sector	1.00	40	2	17
T15.01	Relocate and upgrade stormwater assets to mitigate tidal inundation impacts within the Southern Estuaries	1.00	105	3	35
T15.02	Water quality asset management and maintenance program	1.00	96	3	29
T15.03	Develop partnerships to deliver community and industry estuary clean up campaigns.	0.96	51	2	21
T15.04	Develop Stormwater Management Plans (SMP) for priority townships	0.95	57	3	20
T15.05	Renaturalise Pennington Creek	0.94	40	3	12
T15.06	Investigate contamination and develop a feasibility study to rehabilitate Talanbar Dump, Wallis Lake.	1.00	12	1	12



ID	Action Name	Accept. Score	Feasibility Score	Viability Score	Option Ranking Score
T15.07	Stormwater Discharge Remediation to reduce erosion and sediment impacts	0.97	64	3	10
T15.08	Undertake a Water Sensitive Urban Design demonstration project in Forster /Tuncurry.	0.90	11	3	3
T16.01	Raise awareness of tidal inundation risks in relation to cultural heritage and cultural values.	0.89	28	1	25
T16.02	Engage with Aboriginal and Torres Strait Islander land owners to identify opportunities for funding conservation and land management activities in the coastal zone.	0.92	26	1	24
T16.03	Build relationships and work closely with the Aboriginal and Torres Strait Islander community to increase involvement and knowledge sharing in catchment and estuary management.	0.93	24	1	22
T16.04	Work closely with the Aboriginal and Torres Strait Islander community to implement community education programs promoting awareness and appreciation of Aboriginal and Torres Strait Island cultural heritage	0.91	26	2	14
T16.05	Undertake cultural land management practices, including cultural burning	0.92	28	2	11
T17.01	Develop partnerships for sharing monitoring data and resources	0.95	30	1	29
T17.02	Monitor, evaluate and report on ecosystem health to guide adaptive management	0.96	63	3	23
T17.03	Undertake research projects with universities, research organisations and volunteer groups in order to support the delivery of the coastal management program.	0.96	20	2	11



5 THE WAY FORWARD

The 72 potential management options assessed in Section 4 of this report will progress as management actions to Stage 4 of the CMP process. Some of these management actions due to their location outside of the coastal zone (see Section 2.2.1) will be included in a catchment compendium document, whilst those within the coastal zone will be included in the draft CMP.

The next stage of the CMP process, Stage 4, involves the preparation, public exhibition (and updating if required), and submission of a draft CMP to the Minister for certification (OEH, 2018e). The draft CMP should include the various components laid out in the NSW Coastal Management Manual (OEH, 2018e), including:

- Snapshot of issues (coastal processes, coastal hazards, threats to biodiversity, resilience and integrity of coastal ecosystems and ecological values etc).
- Actions to be implemented by Council and other public authorities.
- A business plan identifying the full capital, operational and maintenance costs, and timings of management actions.
- Mapping of coastal management areas (including any proposed changes to current coastal management areas, or mapping of new coastal vulnerability areas).

The Draft CMP document should, in essence, provide a clear and succinct *statement of proposed coastal management actions* undertaken to meet State, Regional and Local coastal management objectives. It will outline how actions will be implemented through Council's Integrated Planning and Reporting (IP&R) framework and the land-use planning systems. Following the completion of a draft CMP, DCCEEW will review the draft CMP prior to public exhibition to ensure it meets all mandatory requirements for ministerial certification.

Council will then place the CMP on *public exhibition* to seek feedback from all stakeholders in the form of written submissions. It is a mandatory requirement of the NSW Coastal Management Manual that the draft CMP be exhibited for a period of not less than 28 calendar days (OEH, 2018e).

All submissions will be reviewed, considered, and if applicable, incorporated into the finalised version of the CMP, along with a *Submissions Report* documenting all outcomes.



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APPENDIX A COMMUNITY AND STAKEHOLDER ENGAGEMENT SUMMARY REPORT





APPENDIX B

ELECTRONIC APPENDIX STAGE 3 CMP OPTIONS LONG LIST AND OPTION ASSESSMENT





APPENDIX C ACCEPTABILITY ASSESSMENT OUTCOMES





Table C-1 Acceptability Assessment Outcomes

Stage 3 ID	Action Name	Corresponding Community Survey Question (If Applicable)	Community	State Agencies	Traditional Owner Groups	Acceptability Score
T1.01	Identify migration pathways for coastal wetlands, and develop a management plan to ensure the preservation of these ecosystems for the future.	Identify where coastal wetlands and littoral rainforests might move as the water levels rise and develop a management plan to protect these ecosystems, ensuring they can adapt and survive in the future.	0.83	1	1	0.94
T2.01	Enhance partnerships for observing estuary processes, centralising data storage and standardising data collection		1.00	1	1	1.00
T2.02	Develop an Estuary Processes stakeholder forum	Bring together industry, fishers, resource managers, and researchers to better understand estuary processes and support better management decisions.	0.87	1	1	0.96
T3.01	Integrate information about the Southern Estuaries into the education package for tourists promoting understanding, connection and stewardship.	Connect with visitors and tourists to increase information and knowledge about the estuaries and how they can mitigate their impact while visiting.	0.88	1	1	0.96
T3.02	Integrate information about the Southern Estuaries into the education package for new residents promoting understanding, connection and stewardship.	Connect with new residents to increase information and knowledge about the estuaries, the need to protect them, providing them with ways to do so.	0.87	1	1	0.96
T3.03	Design and implement a whole of community engagement and education program to promote an understanding of the future threats and risks on the Southern Estuaries	Design and implement a whole of community engagement and education program to promote an understanding of the future threats and risks to the Southern Estuaries in relation to climate change.	0.83	1	1	0.94
T3.04	Develop and implement a community engagement and education program to promote understanding, create connection and improve stewardship of the Southern Estuaries	Connect our community with the Southern Estuaries by increasing their knowledge about water quality, ecosystem health, local flora and fauna and how they can mitigate their impact.	0.86	1	1	0.95
T3.05	Develop and implement a litter and stormwater pollution source control plan to mitigate the impact of litter in the Southern Estuaries, supported by the development of a marine debris engagement program.	Develop and implement a community litter and stormwater pollution engagement program to reduce litter at its source.	0.89	1	1	0.96
T3.06	Develop and implement community engagement and education program regarding the health and function of Smiths Lake.	Develop and implement community engagement and education regarding the health and function of Smiths Lake, an intermittently closed and open coastal Lagoon.	0.82	1	1	0.94
T4.01	Work with intensive agriculture farmers to improve estuary and catchment health by	Work with Local Land Services and Landcare to share best practices with landholders and support them in	0.91	1	1	0.97



Stage 3 ID	Action Name	Corresponding Community Survey Question (If Applicable)	Community	State Agencies	Traditional Owner Groups	Acceptability Score
	implementing a co-ordinated sustainable agriculture program	reducing their impact on estuary and catchment health.				
T6.01	Manage threats to coastal wetlands in the National Park estate and adjacent lands, in collaboration with Aboriginal Traditional Owners.		1.00	1	1	1.00
T6.02	Undertake submerged aquatic vegetation mapping for the Myall Lakes.		1.00	1	1	1.00
T6.03	Address the impacts of encroachment on sensitive foreshore habitats.	Address the impacts of encroachment on sensitive foreshore habitats.	0.88	1	1	0.96
T6.04	Advocate for purchase and restoration of priority coastal wetlands.	Advocate for purchase and restoration of priority coastal wetlands to restore their ecological function	0.80	1	1	0.93
T6.05	Investigate and implement the preferred option to reinstate a natural hydrology in the lagoon on Wallis Island Nature Reserve.		1.00	1	1	1.00
T6.06	Identify locations and projects for vegetation offsets within the coastal zone.		1.00	1	1	1.00
T6.07	Regenerate the natural asset values of priority coastal wetlands.	Protect and restore priority coastal wetlands	0.92	1	1	0.97
T7.01	Advocate for State Government commitment to fund ongoing, long-term maintenance of safe navigation in designated navigation channels in Wallis Lake and Lower Myall River.	Advocate for State Government commitment to fund ongoing, long-term maintenance of safe navigation in designated navigation channels in Wallis Lake and Lower Myall River.	0.81	1	1	0.94
T7.02	Increase understanding of entrance dynamics at Smiths Lake to inform future entrance management policy	Improve understanding of Smiths Lake entrance dynamics, including past opening patterns and how climate change may affect future openings, to guide management.	0.80	1	1	0.93
T7.03	Monitor ongoing impacts of the entrance training in Wallis Lake on sand movement and shoaling in the entrance delta		1.00	1	1	1.00
T8.01	Maintain the boating effluent management engagement, education and compliance program		1.00	1	1	1.00
T8.02	Maintain the Wallis Lake island toilets and rationalise and upgrade these facilities as required		1.00	1	1	1.00
T8.03	Advocate for a State Government commitment to ensure that all recreational and commercial houseboats in Wallis Lake have grey and	Advocate for a State Government commitment to ensure that all recreational and commercial houseboats in Wallis Lake have grey and black water	0.81	1	1	0.94



Stage 3 ID	Action Name	Corresponding Community Survey Question (If Applicable)	Community	State Agencies	Traditional Owner Groups	Acceptability Score
	black water holding tanks installed and for dye to be added to holding tanks.	holding tanks installed and for dye to be added to holding tanks.				
T8.04	Monitoring and reporting on water quality in relation to human health	Develop a human health monitoring program at key high public use areas, and communicate outcomes with the community. Follow up with investigations into the source of pathogens where ongoing issues are identified.	0.86	1	1	0.95
T8.05	Provide additional vessel pump-out facilities	Provide additional vessel sewage pump-out facilities around Wallis Lake	0.82	1	1	0.94
T9.01	Protect retreat areas for saltmarsh and mangrove habitats on public reserves	Protect saltmarsh and mangrove habitats on public reserves by identifying retreat areas, updating management plans and reducing mowing, allowing them to migrate landward in response to tidal inundation.	0.83	1	1	0.94
T9.02	Asset Resilience Program to address tidal inundation	Develop a clear understanding of when MidCoast Council community assets will be affected by sea level rise, set thresholds for service impacts, and determine when to begin adaptation planning.	0.78	1	1	0.93
T9.03	Develop an education program and co-design an adaptation plan for tidal inundation for vulnerable settlements / localities.	Create a community education program for areas at high risk of tidal flooding, and work with the community to develop an adaptation plan for inundation and sea level rise.	0.79	1	1	0.93
T9.04	Construct improvements to the walking track in Myall Lakes National Park and Khappinghat National Park impacted by tidal inundation		1.00	1	1	1.00
T9.05	Advocate for research into the impact of sea level rise on groundwater levels and consequences for built assets.	Advocate for research into the impact of sea level rise on groundwater levels and consequences for built assets,	0.81	1	1	0.94
T9.06	Install three (3) new tidal level gauges in Wallis Lake		1.00	1	1	1.00
T11.01	Boat ramp and boat access upgrades at Wallingat – Ferry Creek and Cockatoo Island Nature Reserve.		1.00	1	1	1.00
T11.02	Develop and install educational signage to highlight the impact of fishing rubbish on ecosystem health. Install fishing line collection bins along foreshore areas with high recreational fishing numbers.	Install signs about fishing waste impacts and place fishing line collection bins in busy foreshore fishing areas.	0.90	0.99	1	0.96
T11.03	Assess the impact of tourism at high use locations, identify future risks to estuary health.	Evaluate tourism impacts at busy spots and identify future risks to estuary health.	0.79	1	1	0.93
T12.01	Implement the Wallis Lake seascape adaptation plan in partnership with key stakeholders		1.00	1	1	1.00



Stage 3 ID	Action Name	Corresponding Community Survey Question (If Applicable)	Community	State Agencies	Traditional Owner Groups	Acceptability Score
T12.02	Implement a coordinated approach to pest management through a cross-tenure integrated pest and weed control program to protect natural assets within the coastal zone.	Create a coordinated pest and weed management program to reduce the impact of introduced species	0.92	1	1	0.97
T12.03	Identify, protect and restore freshwater refuge pools.	Identify, protect, and restore freshwater refuge pools to provide safe areas for freshwater species during droughts.	0.88	1	1	0.96
T12.04	Implement a roadside environmental program including a roadside marker system to better protect key natural assets	Identify and mark sensitive roadside areas. Make sure road maintenance doesn't harm important sites, like creeks and wetlands.	0.88	1	1	0.96
T12.05	Work collaboratively with Landcare, Land for Wildlife and the Biodiversity Conservation Trust to promote conservation and restoration of key estuarine habitats.	Work collaboratively with Landcare, Land for Wildlife and the Biodiversity Conservation Trust to promote conservation and restoration of key estuarine habitats.	0.91	1	1	0.97
T12.06	Develop a seascape adaptation plan for Wallis Lake		1.00	1	1	1.00
T12.07	Advocate for State Government commitment to fund priority fish passage works.	Advocate for removing or upgrading barriers to fish migration by eliminating obstacles, adding fishways, or improving existing ones at key locations.	0.86	1	1	0.95
T12.08	Manage threat to Snake Island Pelican Rookery		1.00	1	1	1.00
T12.09	Undertake Assisted Natural Regeneration and manage encroachment at priority locations along the foreshore reserve in Southern Wallis Lake		1.00	1	1	1.00
T12.10	Protect and recover priority estuarine and near-estuarine plant and animal species and ecological communities in the Southern Estuaries through habitat restoration.	Ongoing monitoring and restoration of the habitats of identified threatened plant and animal species	0.91	1	1	0.97
T12.11	Prepare a habitat restoration plan for Minimbah and Darawank Nature Reserves		1.00	1	1	1.00
T12.12	Restore oyster reefs	Create living shorelines and restore oyster reefs in key areas of Wallis Lake to boost coastal resilience, improve water quality, and support local ecosystems.	0.86	1	1	0.95
T12.13	Investigate options for bird viewing facilities in the Hawks Nest / Tea Gardens area	Investigate options for bird viewing facilities in the Hawks Nest / Tea Gardens area to encourage community interaction in nature and promote shorebird / habitat engagement and education.	0.79	1	1	0.93
T12.14	Develop a conservation management plan for the endangered Giant Dragonfly (Petalura gigantea) for the Minimbah National Park and surrounds and the Myall		1.00	1	1	1.00



Stage 3 ID	Action Name	Corresponding Community Survey Question (If Applicable)	Community	State Agencies	Traditional Owner Groups	Acceptability Score
	Lakes National Park populations.					
T13.01	Update SEPP Resilience and Hazards Mapping for coastal wetlands		1.00	1	1	1.00
T13.02	Prepare a planning proposal to amend the SEPP Resilience and Hazards Coastal Environment Area to include additional areas of the Forster and Tuncurry towns.		1.00	1	1	1.00
T14.01	Maintain roads and trails to address erosion, flooding and inundation risks.		1.00	1	1	1.00
T14.02	Address erosion and sedimentation from unsealed roads and creek crossings.	Address priority unsealed roads, creek crossings, and boat ramps that send sediment into waterways.	0.87	1	1	0.96
T14.03	Address foreshore erosion at priority locations	Address foreshore erosion at priority locations.	0.86	1	1	0.95
T14.04	Monitor and remediate boat access and picnic areas for erosion in Minimbah Nature Reserve and Wallingat National Park.		1.00	1	1	1.00
T14.05	Address river bank erosion and improve the condition of the riparian zone at high priority sites along the Wallamba River and foreshores of Tuncurry.	Address riverbank erosion and improve riparian areas along the Wallamba River and Tuncurry foreshores to reduce sediment and protect water quality and ecosystems.	0.84	1	1	0.95
T14.06	Support ongoing improvements in Erosion and Sediment Control practices across the public and private sector		1.00	1	1	1.00
T15.01	Relocate and upgrade stormwater assets to mitigate tidal inundation impacts within the Southern Estuaries		1.00	1	1	1.00
T15.02	Water quality asset management and maintenance program		1.00	1	1	1.00
T15.03	Develop partnerships to deliver community and industry estuary clean up campaigns.	Deliver community and industry clean up events for Wallis Lake by developing partnerships with the oyster and fishing industries, agencies, community and non profit organisations.	0.88	1	1	0.96
T15.04	Develop Stormwater Management Plans (SMP) for priority townships	Create stormwater management plans for townships around Smiths, Myall and Wallis Lake to improve the quality and quantity of stormwater management.	0.85	1	1	0.95
T15.05	Renaturalise Pennington Creek	Restore and protect the ecological health of Penenton Creek, Forster (near old Forster Information Centre site), by improving water quality, supporting biodiversity, and strengthening community connections.	0.81	1	1	0.94
T15.06	Investigate contamination and develop a feasibility		1.00	1	1	1.00



Stage 3 ID	Action Name	Corresponding Community Survey Question (If Applicable)	Community	State Agencies	Traditional Owner Groups	Acceptability Score
	study to rehabilitate Talanbar Dump, Wallis Lake.					
T15.07	Stormwater Discharge Remediation to reduce erosion and sediment impacts	Reduce the erosion of soil and sediment at stormwater discharge locations	0.92	1	1	0.97
T15.08	Undertake a Water Sensitive Urban Design demonstration project in Forster /Tuncurry.	The design and construction of a Water Sensitive Urban Design demonstration project in Forster /Tuncurry to showcase how this urban planning approach can reduce from pollutants entering Wallis Lake and surrounding waterways.	0.71	1	1	0.90
T16.01	Raise awareness of tidal inundation risks in relation to cultural heritage and cultural values.	Raise awareness within the Aboriginal community about tidal flooding risks and how they could affect cultural heritage and the environment.	0.68	1	1	0.89
T16.02	Engage with Aboriginal and Torres Strait Islander land owners to identify opportunities for funding conservation and land management activities in the coastal zone.	Support Local Aboriginal land owners to maintain ecological values of high conservation lands.	0.76	1	1	0.92
T16.03	Build relationships and work closely with the Aboriginal and Torres Strait Islander community to increase involvement and knowledge sharing in catchment and estuary management.	Build partnerships with the Aboriginal community to strengthen knowledge sharing, increase participation in estuary and coastal management, and ensure culturally sensitive stewardship.	0.79	1	1	0.93
T16.04	Work closely with the Aboriginal and Torres Strait Islander community to implement community education programs promoting awareness and appreciation of Aboriginal and Torres Strait Island cultural heritage	Collaboratively develop and implement an Indigenous cultural education program that highlights the deep connections between Aboriginal cultural values and estuary health, fostering meaningful partnerships between Aboriginal communities, environmental groups, and the wider public.	0.73	1	1	0.91
T16.05	Undertake cultural land management practices, including cultural burning	Work with the Aboriginal community to support cultural practices, like cultural burning, to help care for the estuary catchments. This means local land managers (Council, National Parks, Local Land Services) will partner with Aboriginal people to improve ecosystem health and build strong, lasting relationships.	0.75	1	1	0.92
T17.01	Develop partnerships for sharing monitoring data and resources	Strengthen partnerships to improve estuary monitoring, streamline data collection, and enhance collaboration for better efficiency.	0.86	1	1	0.95
T17.02	Monitor, evaluate and report on ecosystem health to guide adaptive management	Monitor and report on ecosystem health to guide management decisions and help the community understand the importance of healthy waterways.	0.89	1	1	0.96
T17.03	Undertake research projects with universities, research organisations and volunteer groups in order to support the delivery of the coastal management program.	Work with universities to research species, ecosystems, and estuary processes, helping to identify threats and improve future management of the Southern Estuaries.	0.88	1	1	0.96



APPENDIX D FEASIBILITY ASSESSMENT OUTCOMES





Table D-1 Feasibility Assessment Outcomes

ID	Action Name	Feasibility Assessment												Feasibility Score		
		Level of Risk Mitigation					Associated Environmental, Social, and Cultural Impacts							Total Score		
		What Risk?	Level of Risk Being Mitigated	Risk Rating Score	Effectiveness at Risk Mitigation	Risk Mitigation Score	Water Quality	Biodiversity	Physical Processes & Hazards	Social/ Recreational Amenity	Public Safety	Cultural Heritage Values	Impact Score	Total Benefit Score	Scale Factor	Total Feasibility Score
T1.01	Identify migration pathways for coastal wetlands, and develop a management plan to ensure the preservation of these ecosystems for the future.	Loss of Coastal Wetlands	Extreme	4	2	8	3	3	4	2	1	1	14	22	3	66
T2.01	Enhance partnerships for observing estuary processes, centralising data storage and standardising data collection	Ineffective estuary management	Low	1	1	1	1	1	1	1	1	1	6	7	3	21
T2.02	Develop an Estuary Processes stakeholder forum	Unengaged community	Low	1	1	1	1	1	1	1	1	1	6	7	3	21
T3.01	Integrate information about the Southern Estuaries into the education package for tourists promoting understanding, connection and stewardship.	Estuary health	Moderate	2	1	2	2	2	2	2	2	1	11	13	3	39
T3.02	Integrate information about the Southern Estuaries into the education package for new residents promoting understanding, connection and stewardship.	Uninformed community	Moderate	2	2	4	2	2	1	2	1	1	9	13	3	39
T3.03	Design and implement a whole of community engagement and education program to promote an understanding of the future threats and risks on the Southern Estuaries	Uninformed community	High	3	2	6	2	2	2	2	1	1	10	16	3	48
T3.04	Develop and implement a community engagement and education program to promote understanding, create connection and improve stewardship of the Southern Estuaries	Uninformed community	High	3	4	12	2	2	1	2	1	1	9	21	3	63
T3.05	Develop and implement a litter and stormwater pollution source control plan to mitigate the impact of litter in the Southern Estuaries, supported by the development of a marine debris engagement program.	Estuary health	Moderate	2	2	4	2	2	1	2	1	1	9	13	3	39
T3.06	Develop and implement community engagement and education program regarding the health and function of Smiths Lake.	Uninformed community	Moderate	2	2	4	2	2	2	2	2	1	11	15	1	15
T4.01	Work with intensive agriculture farmers to improve estuary and catchment health by implementing a co-ordinated sustainable agriculture program	WQ	High	3	3	9	3	3	1	1	1	0	9	18	2	36
T6.01	Manage threats to coastal wetlands in the National Park estate and adjacent lands, in collaboration with Aboriginal Traditional Owners.	Biodiversity Loss	Moderate	2	2	4	1	3	2	2	0	3	11	15	2	30
T6.02	Undertake submerged aquatic vegetation mapping for the Myall Lakes.	Ineffective management	Moderate	2	3	6	1	2	2	1	0	1	7	13	2	26
T6.03	Address the impacts of encroachment on sensitive foreshore habitats.	Biodiversity	High	3	3	9	3	3	1	0	1	1	9	18	3	54
T6.04	Advocate for purchase and restoration of priority coastal wetlands.	Loss of biodiversity	High	3	4	12	3	3	3	1	1	1	12	24	2	48
T6.05	Investigate and implement the preferred option to reinstate a natural hydrology in the lagoon on Wallis Island Nature Reserve.	WQ	Moderate	2	3	6	2	3	3	2	0	1	11	17	1	17
T6.06	Identify locations and projects for vegetation offsets within the coastal zone.	Biodiversity	Moderate	2	2	4	1	2	2	2	0	1	8	12	2	24
T6.07	Regenerate the natural asset values of priority coastal wetlands.	Biodiversity	Extreme	4	4	16	4	4	3	3	2	2	18	34	2	68
T7.01	Advocate for State Government commitment to fund ongoing, long-term maintenance of safe navigation in designated navigation channels in Wallis Lake and Lower Myall River.	Public safety	High	3	1	3	2	1	3	4	4	0	14	17	2	34
T7.02	Increase understanding of entrance dynamics at Smiths Lake to inform future entrance management policy	Estuary health	High	3	2	6	0	0	3	2	3	1	9	15	1	15
T7.03	Monitor ongoing impacts of the entrance training in Wallis Lake on sand movement and shoaling in the entrance delta	Estuary health	Low	1	1	1	0	1	3	2	3	1	10	11	1	11
T8.01	Maintain the boating effluent management engagement, education and compliance program	WQ - human health	Extreme	4	2	8	2	1	1	2	2	1	9	17	2	34
T8.02	Maintain the Wallis Lake island toilets and rationalise and upgrade these facilities as required	WQ - human health	Moderate	2	3	6	0	0	0	4	4	0	8	14	2	28
T8.03	Advocate for a State Government commitment to ensure that all recreational and commercial houseboats in Wallis Lake have grey and black water holding tanks installed and for dye to be added to holding tanks.	WQ - human health	High	3	1	3	3	0	0	3	3	1	10	13	2	26
T8.04	Monitoring and reporting on water quality in relation to human health	WQ	Extreme	4	1	4	3	3	3	4	4	1	18	22	3	66
T8.05	Provide additional vessel pump-out facilities	WQ - human health	Extreme	4	4	16	4	1	1	4	4	1	15	31	1	31
T9.01	Protect retreat areas for saltmarsh and mangrove habitats on public reserves	Loss of biodiversity and WQ	Extreme	4	3	12	2	3	2	1	0	1	9	21	2	42
T9.02	Asset Resilience Program to address tidal inundation	Inundation	Extreme	4	4	16	2	2	4	4	4	1	17	33	3	99



ID	Action Name	Feasibility Assessment												Feasibility Score		
		Level of Risk Mitigation					Associated Environmental, Social, and Cultural Impacts							Total Score		
		What Risk?	Level of Risk Being Mitigated	Risk Rating Score	Effectiveness at Risk Mitigation	Risk Mitigation Score	Water Quality	Biodiversity	Physical Processes & Hazards	Social/ Recreational Amenity	Public Safety	Cultural Heritage Values	Impact Score	Total Benefit Score	Scale Factor	Total Feasibility Score
T9.03	Develop an education program and co-design an adaptation plan for tidal inundation for vulnerable settlements / localities.	Inundation	Extreme	4	2	8	0	1	3	3	3	1	11	19	3	57
T9.04	Construct improvements to the walking track in Myall Lakes National Park and Khappinghat National Park impacted by tidal inundation	WQ	Moderate	2	4	8	2	2	1	2	1	1	9	17	1	17
T9.05	Advocate for research into the impact of sea level rise on groundwater levels and consequences for built assets.	Inundation	Low	1	1	1	0	1	4	1	1	1	8	9	2	18
T9.06	Install three (3) new tidal level gauges in Wallis Lake	Ineffective estuary management	High	3	1	3	0	1	4	1	3	1	10	13	2	26
T11.0 1	Boat ramp and boat access upgrades at Wallingat – Ferny Creek and Cockatoo Island Nature Reserve.	Access	High	3	3	9	3	1	3	4	3	1	15	24	2	48
T11.0 2	Develop and install educational signage to highlight the impact of fishing rubbish on ecosystem health. Install fishing line collection bins along foreshore areas with high recreational fishing numbers.	Ecosystem health	Moderate	2	1	2	1	3	0	3	2	1	10	12	2	24
T11.0 3	Assess the impact of tourism at high use locations, identify future risks to estuary health.	Estuary health	Moderate	2	1	2	1	1	1	1	1	1	6	8	2	16
T12.0 1	Implement the Wallis Lake seascape adaptation plan in partnership with key stakeholders	Estuary health	Extreme	4	4	16	4	4	4	3	1	2	18	34	3	102
T12.0 2	Implement a coordinated approach to pest management through a cross-tenure integrated pest and weed control program to protect natural assets within the coastal zone.	Biodiversity	Extreme	4	4	16	2	3	2	3	1	1	12	28	3	84
T12.0 3	Identify, protect and restore freshwater refuge pools.	Biodiversity Loss	Extreme	4	4	16	4	4	4	3	1	1	17	33	2	66
T12.0 4	Implement a roadside environmental program including a roadside marker system to better protect key natural assets	Biodiversity	Low	1	2	2	2	4	1	1	0	1	9	11	2	22
T12.0 5	Work collaboratively with Landcare, Land for Wildlife and the Biodiversity Conservation Trust to promote conservation and restoration of key estuarine habitats.	Loss of biodiversity	Moderate	2	4	8	2	3	1	1	0	1	8	16	3	48
T12.0 6	Develop a seascape adaptation plan for Wallis Lake	Estuary health	Extreme	4	2	8	3	3	3	1	0	1	11	19	1	19
T12.0 7	Advocate for State Government commitment to fund priority fish passage works.	Biodiversity	Moderate	2	1	2	1	3	2	0	0	1	7	9	2	18
T12.0 8	Manage threat to Snake Island Pelican Rookery	Biodiversity Loss	High	3	3	9	0	3	0	1	0	1	5	14	1	14
T12.0 9	Undertake Assisted Natural Regeneration and manage encroachment at priority locations along the foreshore reserve in Southern Wallis Lake	Biodiversity Loss	Moderate	2	3	6	3	3	1	0	0	1	8	14	1	14
T12.1 0	Protect and recover priority estuarine and near-estuarine plant and animal species and ecological communities in the Southern Estuaries through habitat restoration.	Biodiversity Loss	High	3	3	9	1	4	1	1	0	1	8	17	2	34
T12.1 1	Prepare a habitat restoration plan for Minimbah and Darawank Nature Reserves	Biodiversity	High	3	2	6	1	2	1	1	1	0	6	12	1	12
T12.1 2	Restore oyster reefs	Biodiversity	Extreme	4	4	16	4	4	4	3	1	2	18	34	1	34
T12.1 3	Investigate options for bird viewing facilities in the Hawks Nest / Tea Gardens area	Unengaged community	Low	1	2	2	0	2	0	3	2	1	8	10	1	10
T12.1 4	Develop a conservation management plan for the endangered Giant Dragonfly (Petalura gigantea) for the Minimbah National Park and surrounds and the Myall Lakes National Park populations.	Biodiversity Loss	Moderate	2	2	4	0	3	0	1	0	1	5	9	1	9
T13.0 1	Update SEPP Resilience and Hazards Mapping for coastal wetlands	Ineffective estuary management	Extreme	4	4	16	2	2	2	2	0	1	9	25	3	75
T13.0 2	Prepare a planning proposal to amend the SEPP Resilience and Hazards Coastal Environment Area to include additional areas of the Forster and Tuncurry towns.	Ineffective estuary management	Extreme	4	4	16	2	1	1	1	0	1	6	22	2	44
T14.0 1	Maintain roads and trails to address erosion, flooding and inundation risks.	WQ	Moderate	2	3	6	2	1	2	2	2	1	10	16	2	32
T14.0 2	Address erosion and sedimentation from unsealed roads and creek crossings.	WQ	Extreme	4	4	16	4	2	3	2	1	1	13	29	3	87
T14.0 3	Address foreshore erosion at priority locations	WQ	Extreme	4	4	16	4	3	4	3	2	1	17	33	2	66
T14.0 4	Monitor and remediate boat access and picnic areas for erosion In Minimbah Nature Reserve and Wallingat National Park.	WQ	Moderate	2	3	6	2	1	2	4	1	1	11	17	2	34
T14.0 5	Address river bank erosion and improve the condition of the riparian zone at high priority sites along the Wallamba River and foreshores of Tuncurry.	WQ	High	3	4	12	4	4	4	2	4	1	19	31	2	62
T14.0 6	Support ongoing improvements in Erosion and Sediment Control practices across the public and private sector	WQ	High	3	3	9	4	3	1	2	0	1	11	20	2	40



ID	Action Name	Feasibility Assessment												Feasibility Score		
		Level of Risk Mitigation					Associated Environmental, Social, and Cultural Impacts							Total Score		
		What Risk?	Level of Risk Being Mitigated	Risk Rating Score	Effectiveness at Risk Mitigation	Risk Mitigation Score	Water Quality	Biodiversity	Physical Processes & Hazards	Social/ Recreational Amenity	Public Safety	Cultural Heritage Values	Impact Score	Total Benefit Score	Scale Factor	Total Feasibility Score
T15.0 1	Relocate and upgrade stormwater assets to mitigate tidal inundation impacts within the Southern Estuaries	Inundation	Extreme	4	4	16	3	3	4	4	4	1	19	35	3	105
T15.0 2	Water quality asset management and maintenance program	WQ	Extreme	4	4	16	4	3	3	2	3	1	16	32	3	96
T15.0 3	Develop partnerships to deliver community and industry estuary clean up campaigns.	WQ	High	3	4	0	4	3	3	3	3	1	17	17	3	51
T15.0 4	Develop Stormwater Management Plans (SMP) for priority townships	SW	Extreme	4	1	4	3	3	3	2	3	1	15	19	3	57
T15.0 5	Renaturalise Pennington Creek	Biodiversity Loss	Extreme	4	4	16	4	4	4	4	4	4	24	40	1	40
T15.0 6	Investigate contamination and develop a feasibility study to rehabilitate Talanbar Dump, Wallis Lake.	WQ	High	3	1	3	2	2	2	1	1	1	9	12	1	12
T15.0 7	Stormwater Discharge Remediation to reduce erosion and sediment impacts	WQ	Extreme	4	4	16	4	2	4	3	2	1	16	32	2	64
T15.0 8	Undertake a Water Sensitive Urban Design demonstration project in Forster /Tuncurry.	WQ	Moderate	2	2	4	2	1	1	1	1	1	7	11	1	11
T16.0 1	Raise awareness of tidal inundation risks in relation to cultural heritage and cultural values.	Loss of Indigenous heritage	High	3	2	6	0	1	2	1	0	4	8	14	2	28
T16.0 2	Engage with Aboriginal and Torres Strait Islander land owners to identify opportunities for funding conservation and land management activities in the coastal zone.	Biodiversity Loss	Moderate	2	2	4	2	2	1	1	0	3	9	13	2	26
T16.0 3	Build relationships and work closely with the Aboriginal and Torres Strait Islander community to increase involvement and knowledge sharing in catchment and estuary management.	Ineffective estuary management	Moderate	2	2	4	1	1	1	1	0	4	8	12	2	24
T16.0 4	Work closely with the Aboriginal and Torres Strait Islander community to implement community education programs promoting awareness and appreciation of Aboriginal and Torres Strait Island cultural heritage	Cultural heritage	Moderate	2	2	4	1	1	0	2	1	4	9	13	2	26
T16.0 5	Undertake cultural land management practices, including cultural burning	Ineffective estuary management	Low	1	1	1	1	3	3	1	1	4	13	14	2	28
T17.0 1	Develop partnerships for sharing monitoring data and resources	Ineffective management	Low	1	2	2	2	2	1	1	1	1	8	10	3	30
T17.0 2	Monitor, evaluate and report on ecosystem health to guide adaptive management	WQ	High	3	3	9	3	2	2	2	2	1	12	21	3	63
T17.0 3	Undertake research projects with universities, research organisations and volunteer groups in order to support the delivery of the coastal management program.	Ineffective estuary management	Low	1	4	4	1	1	1	1	1	1	6	10	2	20



APPENDIX E VIABILITY ASSESSMENT OUTCOMES





ID	Action Name	Upper Estimate of Cost (\$,000)	Viability Score
T1.01	Identify migration pathways for coastal wetlands, and develop a management plan to ensure the preservation of these ecosystems for the future.	200	2.3
T2.01	Enhance partnerships for observing estuary processes, centralising data storage and standardising data collection	10	1.0
T2.02	Develop an Estuary Processes stakeholder forum	10	1.0
T3.01	Integrate information about the Southern Estuaries into the education package for tourists promoting understanding, connection and stewardship.	10	1.0
T3.02	Integrate information about the Southern Estuaries into the education package for new residents promoting understanding, connection and stewardship.	10	1.0
T3.03	Design and implement a whole of community engagement and education program to promote an understanding of the future threats and risks on the Southern Estuaries	50	1.7
T3.04	Develop and implement a community engagement and education program to promote understanding, create connection and improve stewardship of the Southern Estuaries	200	2.3
T3.05	Develop and implement a litter and stormwater pollution source control plan to mitigate the impact of litter in the Southern Estuaries, supported by the development of a marine debris engagement program.	200	2.3
T3.06	Develop and implement community engagement and education program regarding the health and function of Smiths Lake.	10	1.0
T4.01	Work with intensive agriculture farmers to improve estuary and catchment health by implementing a co-ordinated sustainable agriculture program	200	2.3
T6.01	Manage threats to coastal wetlands in the National Park estate and adjacent lands, in collaboration with Aboriginal Traditional Owners.	10	1.0
T6.02	Undertake submerged aquatic vegetation mapping for the Myall Lakes.	10	1.0
T6.03	Address the impacts of encroachment on sensitive foreshore habitats.	200	2.3
T6.04	Advocate for purchase and restoration of priority coastal wetlands.	10	1.0
T6.05	Investigate and implement the preferred option to reinstate a natural hydrology in the lagoon on Wallis Island Nature Reserve.	10	1.0
T6.06	Identify locations and projects for vegetation offsets within the coastal zone.	50	1.7
T6.07	Regenerate the natural asset values of priority coastal wetlands.	1000	3.0
T7.01	Advocate for State Government commitment to fund ongoing, long-term maintenance of safe navigation in designated navigation channels in Wallis Lake and Lower Myall River.	10	1.0
T7.02	Increase understanding of entrance dynamics at Smiths Lake to inform future entrance management policy	50	1.7
T7.03	Monitor ongoing impacts of the entrance training in Wallis Lake on sand movement and shoaling in the entrance delta	50	1.7
T8.01	Maintain the boating effluent management engagement, education and compliance program	10	1.0
T8.02	Maintain the Wallis Lake island toilets and rationalise and upgrade these facilities as required	10	1.0
T8.03	Advocate for a State Government commitment to ensure that all recreational and commercial houseboats in Wallis Lake have grey and black water holding tanks installed and for dye to be added to holding tanks.	10	1.0
T8.04	Monitoring and reporting on water quality in relation to human health	500	2.7
T8.05	Provide additional vessel pump-out facilities	1000	3.0
T9.01	Protect retreat areas for saltmarsh and mangrove habitats on public reserves	10	1.0
T9.02	Asset Resilience Program to address tidal inundation	500	2.7
T9.03	Develop an education program and co-design an adaptation plan for tidal inundation for vulnerable settlements / localities.	50	1.7
T9.04	Construct improvements to the walking track in Myall Lakes National Park and Khappinghat National Park impacted by tidal inundation	10	1.0
T9.05	Advocate for research into the impact of sea level rise on groundwater levels and consequences for built assets.	10	1.0
T9.06	Install three (3) new tidal level gauges in Wallis Lake	200	2.3



ID	Action Name	Upper Estimate of Cost (\$,000)	Viability Score
T11.01	Boat ramp and boat access upgrades at Wallingat – Ferny Creek and Cockatoo Island Nature Reserve.	200	2.3
T11.02	Develop and install educational signage to highlight the impact of fishing rubbish on ecosystem health. Install fishing line collection bins along foreshore areas with high recreational fishing numbers.	10	1.0
T11.03	Assess the impact of tourism at high use locations, identify future risks to estuary health.	10	1.0
T12.01	Implement the Wallis Lake seascape adaptation plan in partnership with key stakeholders	500	2.7
T12.02	Implement a coordinated approach to pest management through a cross-tenure integrated pest and weed control program to protect natural assets within the coastal zone.	1000	3.0
T12.03	Identify, protect and restore freshwater refuge pools.	500	2.7
T12.04	Implement a roadside environmental program including a roadside marker system to better protect key natural assets	10	1.0
T12.05	Work collaboratively with Landcare, Land for Wildlife and the Biodiversity Conservation Trust to promote conservation and restoration of key estuarine habitats.	200	2.3
T12.06	Develop a seascape adaptation plan for Wallis Lake	10	1.0
T12.07	Advocate for State Government commitment to fund priority fish passage works.	10	1.0
T12.08	Manage threat to Snake Island Pelican Rookery	10	1.0
T12.09	Undertake Assisted Natural Regeneration and manage encroachment at priority locations along the foreshore reserve in Southern Wallis Lake	10	1.0
T12.10	Protect and recover priority estuarine and near-estuarine plant and animal species and ecological communities in the Southern Estuaries through habitat restoration.	500	2.7
T12.11	Prepare a habitat restoration plan for Minimbah and Darawank Nature Reserves	10	1.0
T12.12	Restore oyster reefs	500	2.7
T12.13	Investigate options for bird viewing facilities in the Hawks Nest / Tea Gardens area	50	1.7
T12.14	Develop a conservation management plan for the endangered Giant Dragonfly (<i>Petalura gigantea</i>) for the Minimbah National Park and surrounds and the Myall Lakes National Park populations.	50	1.7
T13.01	Update SEPP Resilience and Hazards Mapping for coastal wetlands	10	1.0
T13.02	Prepare a planning proposal to amend the SEPP Resilience and Hazards Coastal Environment Area to include additional areas of the Forster and Tuncurry towns.	10	1.0
T14.01	Maintain roads and trails to address erosion, flooding and inundation risks.	10	1.0
T14.02	Address erosion and sedimentation from unsealed roads and creek crossings.	1000	3.0
T14.03	Address foreshore erosion at priority locations	200	2.3
T14.04	Monitor and remediate boat access and picnic areas for erosion in Minimbah Nature Reserve and Wallingat National Park.	50	1.7
T14.05	Address river bank erosion and improve the condition of the riparian zone at high priority sites along the Wallamba River and foreshores of Tuncurry.	1000	3.0
T14.06	Support ongoing improvements in Erosion and Sediment Control practices across the public and private sector	200	2.3
T15.01	Relocate and upgrade stormwater assets to mitigate tidal inundation impacts within the Southern Estuaries	1000	3.0
T15.02	Water quality asset management and maintenance program	2000	3.3
T15.03	Develop partnerships to deliver community and industry estuary clean up campaigns.	200	2.3
T15.04	Develop Stormwater Management Plans (SMP) for priority townships	500	2.7
T15.05	Renaturalise Pennington Creek	1000	3.0
T15.06	Investigate contamination and develop a feasibility study to rehabilitate Talanbar Dump, Wallis Lake.	10	1.0
T15.07	Stormwater Discharge Remediation to reduce erosion and sediment impacts	1000	3.0
T15.08	Undertake a Water Sensitive Urban Design demonstration project in Forster /Tuncurry.	1000	3.0
T16.01	Raise awareness of tidal inundation risks in relation to cultural heritage and cultural values.	10	1.0
T16.02	Engage with Aboriginal and Torres Strait Islander land owners to identify opportunities for funding conservation and land management activities in the coastal zone.	10	1.0
T16.03	Build relationships and work closely with the Aboriginal and Torres Strait Islander community to increase involvement and knowledge sharing in catchment and estuary management.	10	1.0



ID	Action Name	Upper Estimate of Cost (\$,000)	Viability Score
T16.04	Work closely with the Aboriginal and Torres Strait Islander community to implement community education programs promoting awareness and appreciation of Aboriginal and Torres Strait Island cultural heritage	50	1.7
T16.05	Undertake cultural land management practices, including cultural burning	200	2.3
T17.01	Develop partnerships for sharing monitoring data and resources	10	1.0
T17.02	Monitor, evaluate and report on ecosystem health to guide adaptive management	500	2.7
T17.03	Undertake research projects with universities, research organisations and volunteer groups in order to support the delivery of the coastal management program.	50	1.7



APPENDIX F ISSUES PAPERS





ISSUE ANALYSIS CLIMATE CHANGE

2024

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1. Climate Change

The increase in greenhouse gases within the atmosphere, largely caused by the activities of humans, is causing long term impacts to global climate systems. As a result, mean sea levels along the Earth's coastlines are rising - along with the water levels inside estuaries. Ocean and estuarine water temperatures are also warming, which will have flow-on impacts to water chemistry and ecology. Rainfall patterns are changing and any altered hydrology across the Southern Estuaries catchments will change the prevailing mix of fresh and salt water in the estuary. Similarly, changes to the hydrology of the catchment will affect the productivity and viability of agricultural and the tendency for rainfall to cause erosion.

Two broad groups of management actions can be considered to address climate change: mitigation, the reduction of greenhouse gases to reduce the amount of global warming, and adaptation, which includes options to live with the results of warming. In the context of a local CMP for the Southern Estuaries, the authorities responsible for management only have agency to implement effective adaptive management options. These options are difficult to formulate, as there is substantial uncertainty surrounding the rate by which the earth will continue to warm, and how the local environments will respond to that warming.

Authors: *Courtney Smith, Chris Beadle*

Contributors: *Gerard Tuckerman, Ainslie Downes, Will Glamore, Tracey Hamer, Rob Corken, Brad Henderson, Zac Aliberti, Bec Swanson, Tanya Mason, Mat Bell, Michael Millang, Erin Masters, Evan Vale, Brian Hughes, Prue Tucker, Neil Duffy, Kirti Lal, Sue Calvin, Michael Griffith, Rob Henderson*

1.1 Situation Analysis

1.1.1 Climate Change Background

Key Points
<ul style="list-style-type: none">• The Earth has warmed over the past century.
<ul style="list-style-type: none">• Global warming has been enhanced by the burning of fossil fuels and generation of greenhouse gases such as carbon dioxide.
<ul style="list-style-type: none">• The increase in atmospheric greenhouse gases warms the Earth by trapping more heat in the atmosphere.
<ul style="list-style-type: none">• A CMP is largely concerned with actions that will allow us to adapt effectively to the changing climate.

The Intergovernmental Panel on Climate Change (IPCC) is a scientific body established by the United Nations in 1988 to provide objective information relating to climate change. In its most recent set of reports (IPCC Sixth Assessment Report, or AR6), the IPCC (International Panel on Climate Change, 2023) noted that:

“Widespread and rapid changes in the atmosphere, ocean, cryosphere and biosphere have occurred. Human-caused climate change is already affecting many weather and climate extremes in every region across the globe”.

The Earth has warmed and cooled over geological time scales in the past. Current warming would not be remarkable if it were not for the influence of human beings. AR6 states:

“The likely range of total human-caused global surface temperature increase from 1850–1900 to 2010–2019 is 0.8°C to 1.3°C, with a best estimate of 1.07°C.”

“Policies and laws addressing mitigation have consistently expanded since AR5. Global GHG emissions in 2030 implied by nationally determined contributions (NDCs) announced by October 2021 make it likely that warming will exceed 1.5°C during the 21st century and make it harder to limit warming below 2°C.”

The basis of climate change theory is that human generated emissions of greenhouse gases, particularly over the past several decades, are affecting the dynamics of energy exchange between the Earth and its atmosphere. The various processes which contribute to the overall energy budget are relatively complex, as illustrated in Figure 1.

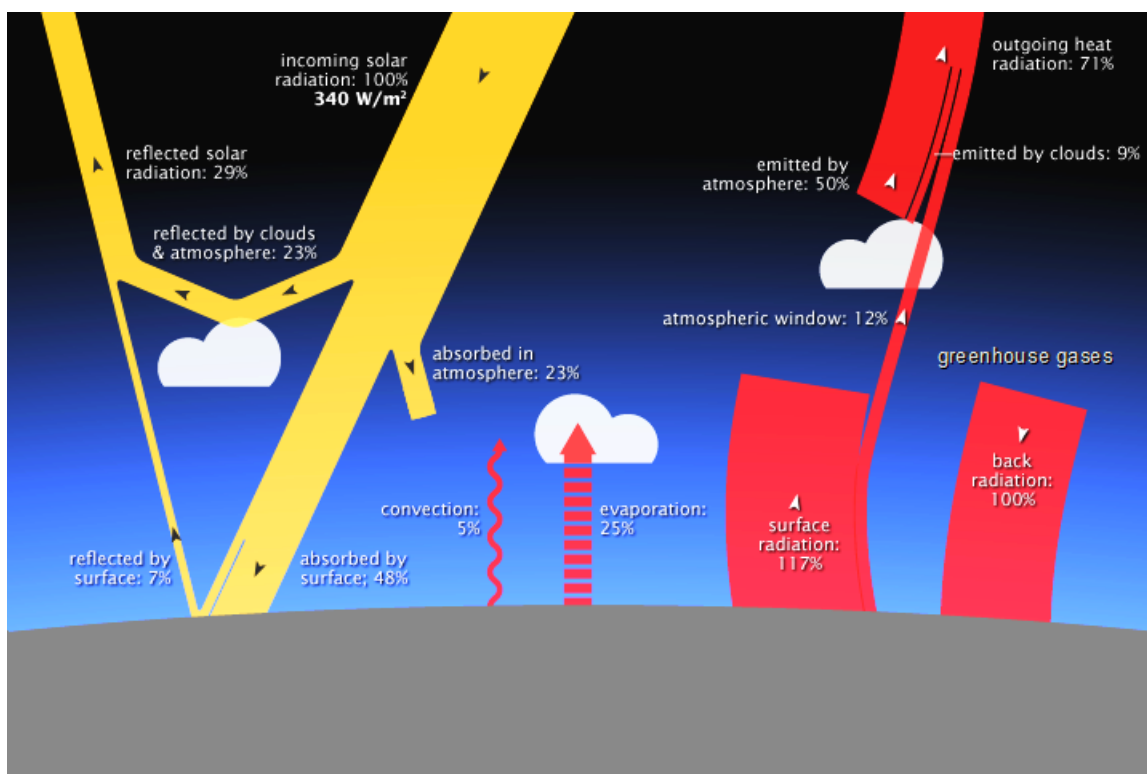


Figure 1 Sample Energy Budget and Its Components (source: Wikipedia, NASA)

When the energy budget of the earth is in balance, the amount of solar energy entering the atmosphere matches the energy radiating back out into space. However, higher concentrations of greenhouse gases have caused an imbalance in the global energy budget, by increasing the capacity of the atmosphere to retain heat. The effect is somewhat like adding blankets to a bed. More, thicker, or heavier blankets tend to make a bed warmer by reducing the rate at which heat can be lost and thus increasing the temperature underneath the blankets. Greenhouse gases have a similar effect on the Earth's atmosphere. Increasing concentrations of greenhouse gases reduce the efficiency with which energy is radiated back out into space from the atmosphere and therefore additional energy is “trapped”, and, on average, the atmosphere, surface of the Earth and its oceans heat up over time.

Therefore, the underpinning cause of human induced climate change is global scale increases in the concentrations of greenhouse gases. Continuous CO₂ monitoring occurs around the world; Mauna Loa in Hawaii has the longest continuous CO₂ monitoring station. An up-to-date chart of

carbon dioxide concentrations over the last 60 years at the NOAA Mauna Loa Observatory is shown in **Error! Reference source not found.**.

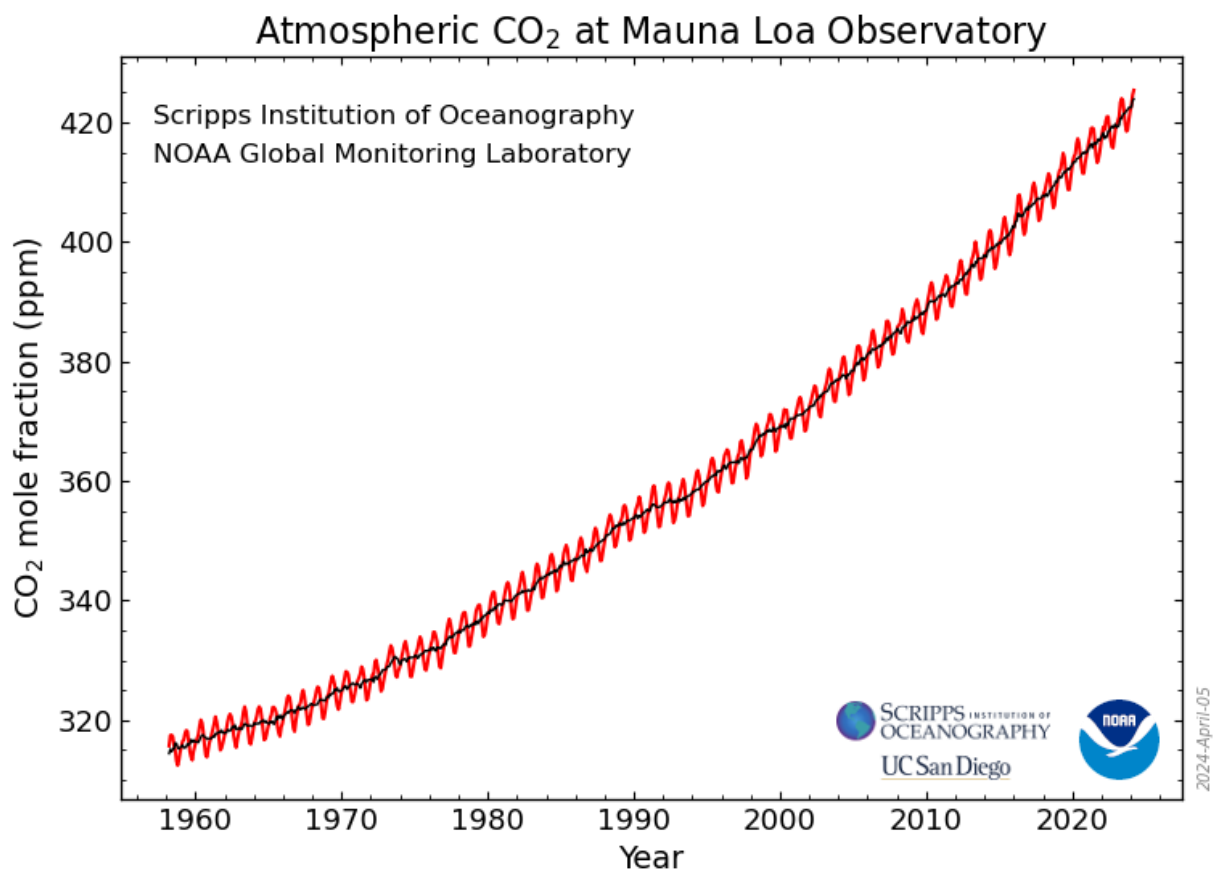


Figure 2 Atmospheric CO₂ at Mauna Loa Observatory from 1958-2024

Interestingly, **Error! Reference source not found.** does not yet reflect a slowing in the rate of carbon dioxide increase over time, even though there have been international agreements to reduce greenhouse gas emissions for the past 30 years. According to the World Meteorological Organisation (WMO) ¹, a number of climate records were observed in 2023, including:

- Greenhouse gas levels continuing to increase – and reached record high levels in 2023;
- 2023 was the warmest year in the 174-year observational record;
- 2023 set record sea surface temperatures, with widespread marine heatwaves;
- In 2023, global mean sea level reached a record high in the 150-year observational record; and
- Antarctic sea-ice extent reached an absolute record low for the satellite era.

Clearly, a wide range of uncertain future scenarios are possible, depending on the highly uncertain future behaviour of the global population and future economic growth. With this in mind, it is useful

¹ <https://wmo.int/news/media-centre/2023-shatters-climate-records-major-impacts>

to recognise the two broad groups of management actions which can be considered to address climate change (Pittock, 2009):

- Mitigation, or the reduction of greenhouse gas emissions to reduce the amount of global warming. Local authorities possess limited capacity to effect measurable impact on global greenhouse gas emissions. Regardless, MCC has declared a Climate Emergency and has developed a *Climate Change Mitigation Plan* as part of MCC's Climate Change Strategy Phase 1 (2021).
- Adaptation, which includes options to live with the results of warming. The actions within the CMP are limited to address adaptation. To plan for adaptation, it is necessary to have an idea of what the future under a climate change scenario might look like. This is fraught with substantial uncertainty, and the accepted way of exploring potential futures is to examine several plausible scenarios.

Shared Socioeconomic Pathways (SSPs)

In order to aid decision makers in planning for future climate change impacts – The IPCCs AR6 outlines a range of potential future global emissions scenarios – and their associated environmental impacts. These are referred to as Shared Socioeconomic Pathways (SSPs). The SSPs serve as frameworks for characterising potential future development pathways for human societies, and incorporates assumptions about population dynamics, education, energy consumption, technological advancements, and mitigation efforts for climate change over the coming century. By combining socio-economic factors with varying levels of ambition for climate mitigation, these scenarios generate greenhouse gas emissions projections and associated atmospheric concentrations. The resulting climate change projections encompass a spectrum of plausible future climates, ranging from business-as-usual high-carbon scenarios, to low-carbon scenarios aligned with the goals of the 2015 Paris Agreement. These comprehensive tools enable policymakers and researchers to explore diverse socio-economic and environmental trajectories, aiding in strategic planning and decision-making to address the challenges of climate change effectively.

The SSPs are described below in Table 1. The first number in the SSP name is the particular set of socioeconomic assumptions driving the emissions and other climate forcing inputs taken up by climate models and the second number is the radiative forcing level reached in 2100. As seen in Table 1, each SSP will result in a different level of global temperature increase over the coming century. It shows that for even the most optimistic future emission scenarios, that global temperature will continue to rise - resulting in a range of local impacts to the Southern Estuaries identified below.

Table 1: Shared Socioeconomic Pathways

SSP	Scenario	Estimated warming (2041–2060)	Estimated warming (2081–2100)	Very likely range in °C (2081–2100)
SSP1-1.9	Very low GHG emissions: CO ₂ emissions cut to net zero around 2050	1.6 °C	1.4 °C	1.0 – 1.8
SSP1-2.6	Low GHG emissions: CO ₂ emissions cut to net zero around 2075	1.7 °C	1.8 °C	1.3 – 2.4
SSP2-4.5	Intermediate GHG emissions: CO ₂ emissions around current levels until 2050, then falling but not reaching net zero by 2100	2.0 °C	2.7 °C	2.1 – 3.5
SSP3-7.0	High GHG emissions: CO ₂ emissions double by 2100	2.1 °C	3.6 °C	2.8 – 4.6
SSP5-8.5	Very high GHG emissions: CO ₂ emissions triple by 2075	2.4 °C	4.4 °C	3.3 – 5.7

1.1.2 Sea Level Rise

Key Points
<ul style="list-style-type: none"> Increasing global temperatures are causing sea levels around the world to rise. This is due to both the expansion of seawater as it warms, and the melting of ice from glaciers and ice sheets.
<ul style="list-style-type: none"> Sea level rise has been recorded around the world over the last century by a combination of satellite and tide gauges. The global rate of sea level rise is estimated to be 3.4 mm/yr over the last 30 years. However, this rate of rise is increasing over time and over the last decades has exceeded 4 mm/yr.
<ul style="list-style-type: none"> SLR projections have been made by the IPCC for the next 100 years based on future SSP scenarios.
<ul style="list-style-type: none"> SLR will generate a range of local impacts on the Southern Estuaries, including increased frequency and severity of tidal inundation and coastal storm inundation, and as well as impacts on local coastal wetland ecosystems.

Sea level rise (SLR) refers to the long-term increase in the average level of the ocean's surface. As our climate warms, sea levels rise primarily from two factors: the expansion of seawater as it

warms, and the melting of ice from glaciers and ice sheets (IPCC, 2023). The impacts of SLR on the estuaries of Australia's east coast has been the subject of much study in recent decades, managing the social, environmental, and economic impact of future SLR is a key objective of the CMP.

Included in the technical assessment of AR6, is an updated assessment of the historical rates of global MSLR. A summary of those findings is provided below. Note that the numbers referred to in brackets represent the [5% and 95%] likelihood range respectively:

- *“Global mean sea level (GMSL) increased by 0.20 [0.15 to 0.25] m over the period 1901 to 2018, with a rate of rise that has accelerated since the 1960s to 3.7 [3.2 to 4.2] mm yr⁻¹ for the period 2006–2018 (high confidence). Human activities were very likely the main driver of observed GMSL rise since 1971, and new observational evidence leads to an assessed sea level rise over the period 1901 to 2018 that is consistent with the sum of individual components contributing to sea level rise, including expansion due to ocean warming and melting of glaciers and ice sheets (high confidence). It is virtually certain that GMSL will continue to rise over the 21st century in response to continued warming of the climate system”.*

The 2023 WMO State of the Global Climate Report indicated that GMSL continued to rise in 2022 (see Figure 3 below). The global rate of MSLR is estimated to be 3.4 ± 0.3 mm/yr over the 30 years of the satellite altimeter record (1993–2022). However, of note is that the report states that the rate of global mean SLR has doubled between the first decade of the record (1993–2002) and the last (2013–2022), during which the rate has exceeded 4 mm/yr. The report also notes that MSLR is not uniform geographically, and that notable geographic variations can and do occur due in part to local variations in oceanographic process and ocean heat content.

The drop in sea level between 2010 and 2011 (Figure 3) is discussed by Fasullo et al (2013). It was caused by an interplay between the IOD, SAM and a strong La Nina - sea temperatures did not fall, but there was less water in the ocean and more on the Australian continent.

In general, the rates of global mean SLR measured by satellites is similar to the rates measured by coastal tide gauges around the Australian coastline (Glamore, Rahman, Cox, Church, & Monselesan, 2015). For the period of high-quality satellite-altimeter data (since 1993), sea levels around Australia have been rising at close to the global average rate in the south and south-east (the NSW coast) and above the global average in the north and north-west (Deng, et al., 2011; Haigh, Eliot, & Pattiaratchi, 2011).

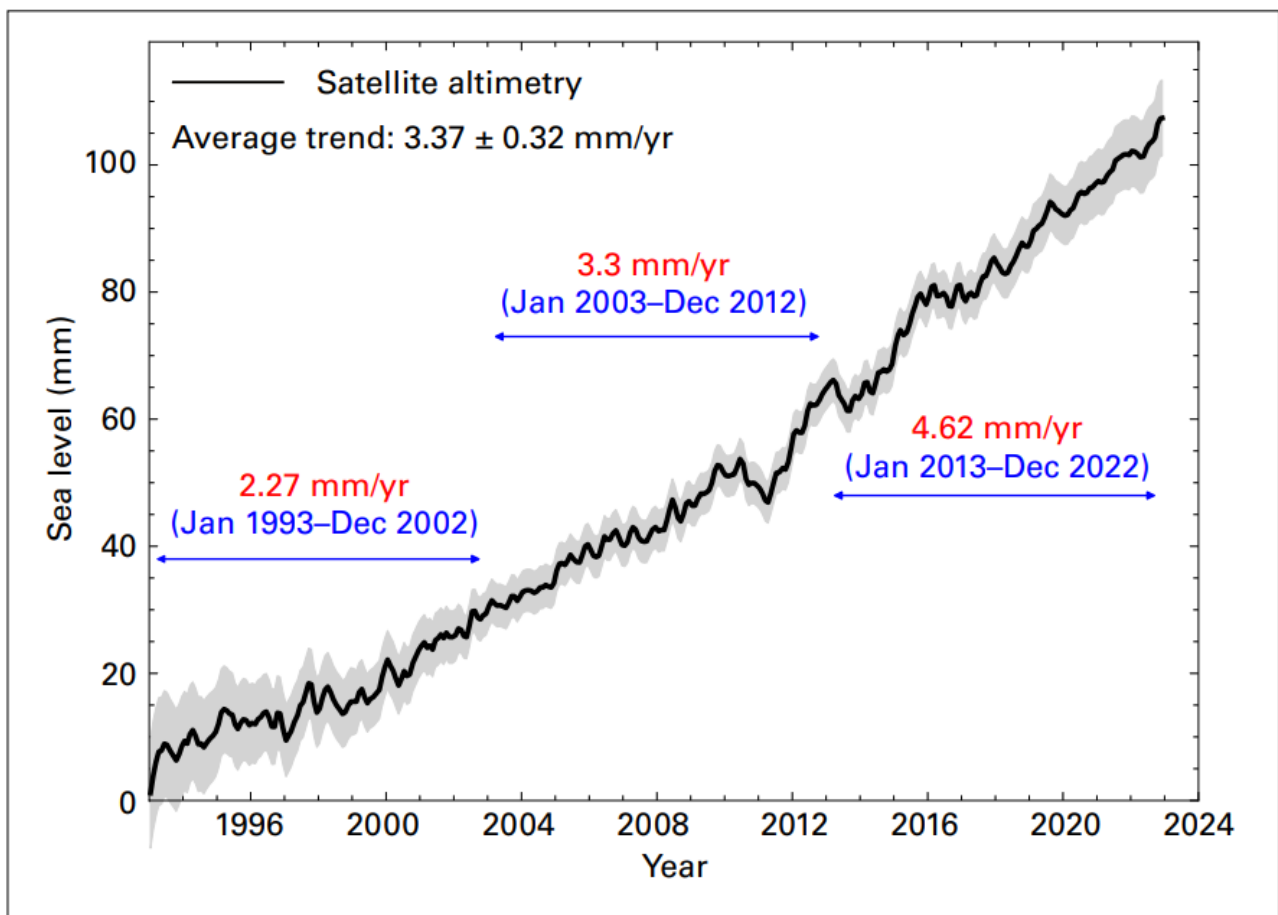


Figure 3 GMSL evolution from January 1993 to December 2022 (black curve) with associated uncertainty (shaded area) based on satellite altimetry. The horizontal, coloured lines represent the average linear trends over three successive time spans (WMO, 2023)

AR6 makes future mean SLR projections for a number of different SSPs – as shown in Figure 4 below.

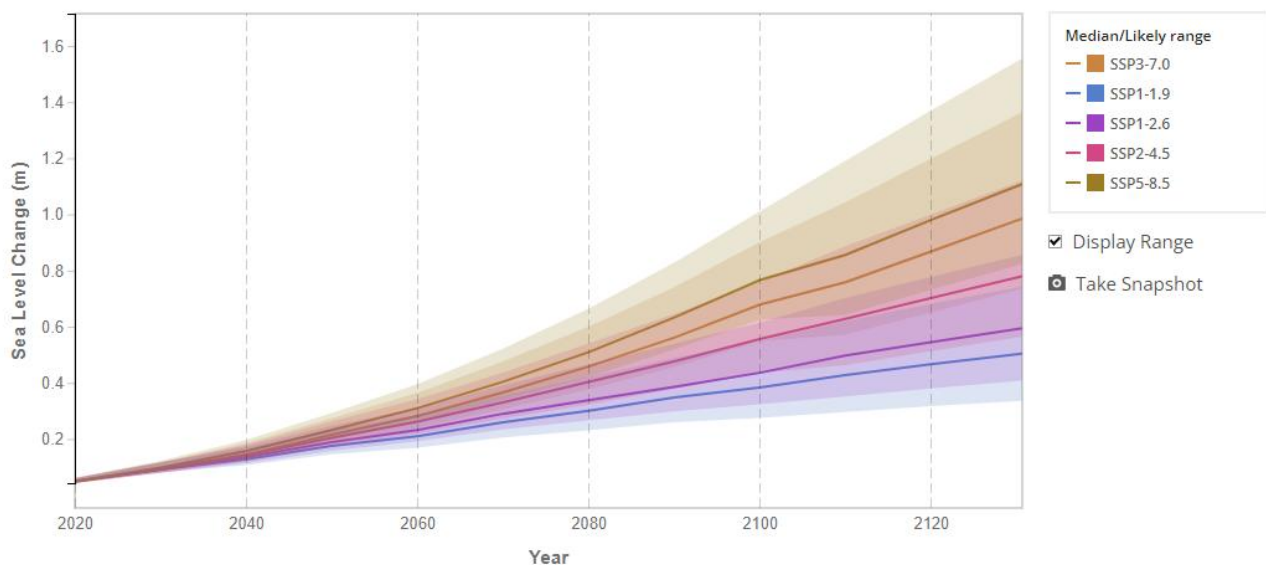


Figure 4 A summary of Global Mean SLR Projection from AR6 for five of the SSPs

This projected SLR will have a number of critical impacts on the Southern Estuaries, including:

- An increase in the frequency and severity of tidal inundation (sometimes referred to as “sunny day flooding” or “king tide flooding”) – this will be summarised in the “Tidal Inundation” Issue Paper, following the completion of the Stage 2 Tidal Inundation Assessment.
- An increased frequency and severity of severe coastal inundation - this will be summarised in the “Tidal Inundation” Issue Paper, following the completion of the Stage 2 Tidal Inundation Assessment.
- The resultant changes to tidal hydrodynamics from sea-level rise are likely to influence the water quality and mixing processes of estuaries. Sea-level rise will likely propagate tides and saline water further upstream when the entrance is open, resulting in an increase in the extent of saltwater intrusion.
- Sea-level rise may also lead to a number of changes to coastal ecosystems, causing permanent submergence in some areas, changes to the tidal prism, and the landward displacement of shorelines and estuarine habitats – see Figure 5.

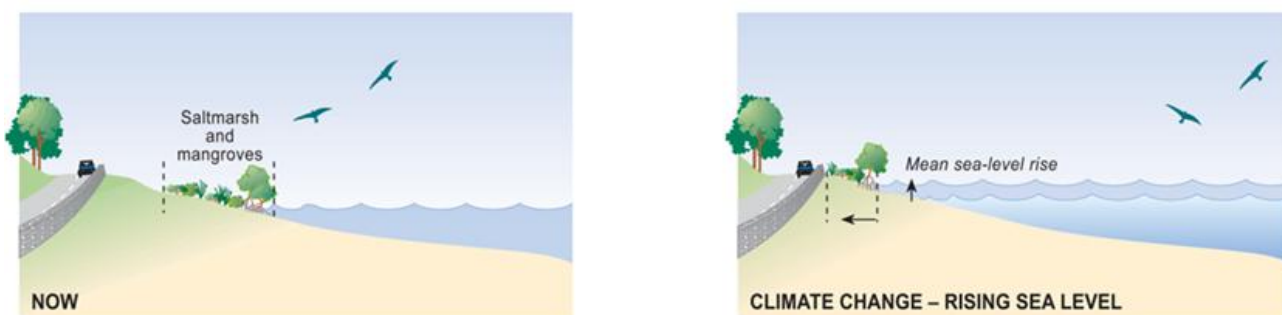


Figure 5 Sea level rise and habitat creep (Source: AGDCC, 2009)

1.1.3 Increases in Extreme Rainfall

Key Points
<ul style="list-style-type: none"> • As the atmosphere warms, it can hold more moisture. This means that short duration rainstorms (~1 day or less) are becoming more intense. The behaviour for longer storms is less clear.
<ul style="list-style-type: none"> • Planning to manage the risks associated with extreme flooding is undertaken in NSW under the state government’s Floodplain Risk Management Process, and studies have recently been prepared. The CMP has only a minor role in managing the risks from extreme flooding
<ul style="list-style-type: none"> • Current Australian guidance recommends that the increase in short duration rainfall intensity can be neglected when planning over a 20-year time frame.
<ul style="list-style-type: none"> • Using current Australian guidance, an increase of between 10% and 20% in rainfall intensities was calculated as being appropriate for a facility or structure with a 60-year design life.

The 2019 (most recent) update to Australian Rainfall and Runoff (Ball et al., 2019; hereafter ARR) includes guidance on allowing for an increase in rainfall intensities as the climate warms.

There are several factors which impact on extreme rainfall intensities. At a very basic level, the amount of moisture which the atmosphere can hold increases as temperature increases. ARR recommends an increase in rainfall intensity of 5% per °C increase in temperature, although more recent research is indicating a value of around 7% per °C would be more appropriate.

ARR argues that, if the planning horizon being considered is relatively short (<20 years), then climate change will have negligible impact on design rainfall intensities.

1.1.4 Increased Drying of Catchments

Key Points
<ul style="list-style-type: none">• The Southern Estuaries catchments are expected to dry as the climate warms.
<ul style="list-style-type: none">• This drying will not be felt uniformly, and it is expected to be at least 20 years before the change in dryness is definitive.
<ul style="list-style-type: none">• The effects of drying will likely be expected as an average increase in the intensity of droughts over time.

Overall, the Australian continent is expected to become drier as the global climate warms. This may seem counterintuitive considering the expected increase in extreme rainfall intensities, but there are multiple interacting factors which are expected to cause this. For example, under higher temperatures the base of the clouds tends to be higher, and the likelihood of rain is reduced. Higher clouds are particularly prevalent during dry periods and dry periods are generally expected to become longer across the Australian continent as it warms.

However, the patterns are not uniform. For example, changes in atmospheric circulations are expected to result in a general poleward shift of the locations of mid-latitude rain generating weather patterns. At a more local scale, changed weather patterns will interact with topography to determine the magnitude and direction of change ultimately experienced.

An increased tendency for the catchment to be dry may, at least partly, counteract the tendency for more intense rainfall to cause larger floods. A dry catchment at the onset of rainfall will tend to have drier soil profiles that can absorb more water, resulting in greater “initial losses” and less runoff at the start of a potential flood event. However, during extended drought conditions, land degradation including the loss of vegetation the trampling and compaction of soil by stock and the erosion of upper layers of soil, can also encourage water to runoff exposed surfaces more rapidly. The balance of these effects will vary over space and time. It is clear however, that a warmer climate is expected to result in a drier catchment overall as we progress further into the future.

It is also expected that increased drying of catchments could have a significant impact on local habitats and ecosystems, including the distribution of coastal wetlands and littoral rainforests around the study area.

1.1.5 Increased Water Temperature

With increasing global temperatures, it follows that the water inside estuaries and rivers will gradually also warm over time. Furthermore, it follows that areas closest to the ocean entrance will be more influenced by temperatures in the adjacent ocean temperatures and upper reaches more influenced by adjacent land and air temperatures. The area where the two mix in the estuary is likely to reflect a combination of both.

The factors which will affect temperature at any given location and time are complex, relating to the degree of shading, depth, overriding climate (e.g., drought), recent weather, state of the entrance and flushing efficiency with the ocean. These factors combine to make it very difficult to predict

exactly how much temperature will increase. However, two broad preliminary assumptions seem reasonable:

- Water temperatures in the Southern Estuaries will tend to increase if air and ocean temperatures increase.
- The temperature increase magnitude will be of similar magnitude to the increase in ocean and air temperature increase.

Of particular concern is that the extreme temperature conditions experienced from time to time, which could, for example cause death of species which use the estuaries, will also increase. Accordingly, temperature related mortality events could be expected to increase in frequency over time.

1.2 Stakeholders

Climate change will have broad impacts on many facets of estuary and catchment management. There are many stakeholders which will have interest, although for some risks issues may not arise for several decades.

Stakeholders include MCC; LLS; DPI-Fisheries; Commercial fishery and aquaculture businesses; DCCEE (E&H); Floodplain land holders; NPWS; TfNSW-Maritime (navigation and waterway access); DPIH-Crown Lands; Local Aboriginal Land Councils, the Aboriginal community (e.g., impact on heritage sites); research institutions; DPIH-Planning; Federal government departments including the Department of Agriculture, Fisheries and Forestry; DCCEE; Tourism (e.g., recreational fishing, ecotourism, boating).

Community and stakeholder engagement

A community survey and other stakeholder engagement activities conducted in Stage 1 of the Southern Estuaries CMP identified 'sea level rise' and 'climate change' as key issues in the study area.

1.3 Existing Management Approach

Management of climate change impacts is multi-faceted, and permeates into numerous areas of council operations, with varied impacts on the Southern Estuaries. This section outlines some existing management approaches, strategies and actions that address climate change.

Sea Level Rise Benchmarks: The NSW Government Sea Level Rise Benchmarks have been adopted as part of MCC's flood and stormwater management practices to allow decision making to consider the future impacts of sea level rise. In the Great Lakes region, the benchmark for sea level rise is 0.5m by 2060 and 0.9 m by 2100. MCC has a Sea Level Rise Policy that has been utilised in the Stage 2 Tidal Inundation Assessment. These benchmarks guide all hazard assessments of tidal and coastal inundation, subsequently governing land use and development within the coastal zone.

MidCoast Council Climate Change Policy: This policy has been developed to articulate MCC's position and response to climate change. It defines MCC's role in reducing its carbon emissions and adapting to the projected impacts of climate change and supporting the community to do the same. The policy states that MCC recognises a state of climate emergency exists, declaring a climate emergency in October 2019. The policy was adopted by Council in June 2021 and provides a framework that brings together plans for sustained action to both manage and reduce greenhouse emissions and to adapt practices to become more resilient to the unavoidable impacts

of climate change. A key objective of this policy is to demonstrate leadership by setting emission reduction and renewable energy targets for Council's operations.

MCC will also incorporate risk-based assessment of climate change impacts in its decision-making, processes and operations, and will develop partnerships and engage with local communities and industry bodies to adapt to these risks and manage these impacts collaboratively.

MidCoast Council Climate Change Strategy: This strategy implements the Climate Change Policy and affirms that urgent action is required by MCC to avert a climate crisis by reducing carbon emissions and helping communities adapt to the impacts of climate change. This Phase 1 Strategy is focused on MCC's assets and operations so it can lead by example. The second phase will focus on working with the MCC community to develop a plan to help reduce the region's emissions and increase resilience to climate change.

MCC will achieve net zero greenhouse gas emissions from its operations, including its facilities, transport fleet and landfills, and 100% renewable electricity for its operations by 2040. MCC has also adopted a target to divert 75% of the region's waste from landfill by 2030.

Over 150 actions are proposed in the Strategy to meet these targets and MCC will offset those emissions that can't be mitigated by purchasing renewable energy and investing in local carbon sequestration initiatives such as tree planting programs and the restoration of coastal wetlands.

The Strategy also identifies a range of measures to increase the resilience of MCC's operations to the impacts of climate change, including the increased risk of flooding and bushfire, accelerated coastal erosion, and a reduction in annual rainfall, river flow and water supply.

The Strategy is organised into three categories:

- Leadership and Governance
- Climate Change Mitigation
- Climate Change Resilience

Several of the risks associated with climate change and related management actions relevant to the Southern Estuaries CMP are listed below:

- **R001. Changes in the annual rainfall level may cause a change in the ecosystem that may result in the loss of trees, plant and animal species within the physical and natural environment**

The strategy proposed that short-term actions include studies and plans such as preparing a greening strategy, adopting a Biodiversity Framework and development of Catchment Management Plans, and finalising an asset management plan. A medium-term action was the creation of corridors, refugia and pathways.

- **R003 Changes in the annual rainfall level may cause variations in the environmental flows negatively impacting water-dependent ecosystems**

Herein, current controls including projects with DPI-Fisheries and the cease-to-pump controls for drought conditions were to be continued in the short term.

- **R004 Changes in the average annual rainfall level may result in an increased success of weed and pest species resulting in the threat to or loss of plant and animal species within the natural environment, placing higher demand on Council resources to manage the impact**

Existing controls and participation in a regional weed committee were put forward as actions and this could be carried forward into the SE CMP. Additionally, plant surveys and monitoring

of threatened species was identified as a short term action.

- **F008 Increased Forest Fire Danger Index days will cause an increase in water pollution due to sediment and fire debris entering waterways which may threaten ecosystems**

Short term actions include riparian revegetation programs for private land holders.

- **SLR001 An increase in sea level may cause loss/changes to key ecosystems, negatively impacting on tree, plant and animal species, which could reduce ecosystem services such as nutrient and sediment removal from wetland, salt marsh and littoral rainforest areas**

The plan included the implementation of a CMP and identifying areas for retreat of wetlands and rainforest, and a bush regeneration program. We note that retreat options for littoral rainforest may be limited. Consideration for beach and dune habitat movement have not been considered herein from a habitat perspective, but the loss of useable beach space is considered in SLR002 below.

- **SLR002 An increase in sea level rise could cause loss/damage to coastal nature reserves (conservation spaces incl. foreshore vegetation); beaches; public recreational sites (passive and active); public recreational facilities; scenic amenity and public accesses, resulting in negative impacts on recreational activities, surf lifesaving activities, local economy and tourism**

Actions include implementing the CMP, and review of economic development plans.

- **SLR003 An increase in sea level could cause loss/damage to adjoining Council infrastructure negatively affecting Council's ability to provide services to the community and businesses (relates to transport assets; community and recreation facilities; water and sewer assets, public onsite sewage management systems)**

The Plan suggested that critical assets should be identified as part of an asset management plan, and that future construction should meet appropriate flood level requirements (presumably incorporating sea level rise).

- **SLR004 An increase in sea level may cause changes to private and public land use due to erosion, re-alignment of shores, increased flooding, inundation, wave overtopping events and salinisation, negatively affecting landholders, residents and businesses**

The plan included, in addition to existing planning controls, the development of a Policy providing clear direction as to how coastal recession should be considered during development assessment, and the identification of emergency management measures. Medium-term adaptation actions include identifying relocation areas for people displaced by sea level rise.

A common coastal recession approach identified by the NSW Government should be considered in the planning context to ensure consistency across LGAs.

- **SLR005 An increase in sea level may negatively impact water quality due to the salinisation (salt wedge) and inundation of coastal freshwaters / salt marshes and mangroves resulting in damage/loss to the natural environment**

The Plan suggested that research into this matter could be undertaken with natural resource management agencies, and undertake a review of and update the entrance opening strategy.

- **SLR009 Sea level rise inundation results in failure of private onsite sewage management systems leading to potential pollution and negative impacts on public health, with increased costs to Council**

The plan recommended finalisation and implementation of the assessment framework for onsite wastewater and to consider capping new development approvals within areas that are likely to be affected in future or strategic planning to reticulate presently unsewered areas.

- **RI003 An increase in the number of extreme rainfall/storm events may cause increased rates of erosion resulting in surface runoff and stormwater pollution, affecting the natural and physical environment**

Actions here are of relevance to the CMP including development of appropriate safeguards within development assessments to ensure water quality, detention and erosion is appropriately addressed.

- **RI005 and RI009 An increase in the number of extreme rainfall/storm events may impact the quality of water catchments due to surface runoff and sewer overflows entering the stormwater system and affecting creeks, wildlife and the natural environment**

Relevant actions include reducing sewer overflow, investigate inflow infiltration investigation, asset inspections, smoke testing and ensuring sediment and erosion control at worksites. The medium-term action was to fix identified issues.

- **RI010 An increase in the number of extreme rainfall/storm events may result in stormwater infrastructure having insufficient capacity to cope with the water flows leading to public health and safety issues, environmental issues and damage to private property**

Short term action is to undertake studies of stormwater infrastructure.

- **T006 Increased average annual temperature may increase the occurrence of algal blooms and other waterborne micro-organisms causing a reduction in water quality and a risk to public safety**

Actions include the future development of WSUD guidelines and policy, water quality monitoring across the catchment, the inclusion of WSUD in capital works, management of the riparian zone, update of urban stormwater management plans and community notification and education. Medium term adaptation plans include increased capacity of aquifer extraction.

MidCoast Council Climate Change Risk Assessment

MCC is on track to complete a Climate Change Risk Assessment, which will include an analysis of Council-owned assets and operations at risk of being impacted by climate change. Further information will be provided in due course, and if completed prior to the issuing of Final Issue Papers, will be added.

Hunter and Central Coast Enabling Regional Adaptation

The Hunter and Central Coast Enabling Regional Adaptation (HCC ERA) project builds on local knowledge to understand climate vulnerabilities in the Hunter and Central Coast (HCC) regions and identify opportunities to respond. The project supports regional decision-makers to enhance government service delivery and planning at a regional and subregional scale in the context of climate change. Actions out of this project are high level, and aligns with the objectives of the CMP. However, there are no direct actions for the Southern Estuaries that could be implemented as part of the CMP.

Wallis Lake Wetlands Strategy

In the Wallis Lake catchment, wetlands hold recognised national, state, regional, and local conservation significance. They serve as habitat for listed international migratory bird species and threatened communities, populations, and species protected under Commonwealth and NSW

legislation, as well as regionally significant vegetation community types. The Wallis Lake Wetlands Strategy recognise that most wetland communities are underrepresented in the reserve system and hold high conversational value. Recognizing the threats wetlands face, such as inappropriate clearing and modification, the strategy acknowledges that wetlands continue to be degraded or altered. Moreover, they are vulnerable to the serious impacts of global sea level rise associated with anthropogenic climate change. While some wetlands within the MCC Local Government Area (LGA) remain in good and functioning condition and are conserved in the national reserve system, others are held in private tenure and/or are degraded or modified.

Actions relevant to the Southern Estuaries CMP relate to protecting, restoring and reinstating wetland functions, and managing floodplains and wetland to establish wetland buffers and corridors.

MCC Rural Strategy

The MidCoast Rural Strategy (2022) emphasizes the preservation of natural landscapes, sustainable primary production, enhancement of rural lifestyles and improvement of planning practices. The strategy identifies strategic recommendations and documents local plan recommendations to provide a common understanding for the development and application of planning controls in rural areas of the MidCoast LGA. Relevant actions to the CMP include management of risks of climate change to flooding and sea level rise, review of floodplain risk and coastal management plans, and incorporation of new knowledge on climate change projections.

Biodiversity Framework

MidCoast Council's biodiversity framework emphasizes the significance of the region's natural assets and biodiversity for community well-being, economic development, and quality of life. It acknowledges the community's recognition of environmental protection as a core value and aligns with regional goals set by the NSW government. The framework aims to address biodiversity conservation through an ecosystem approach, considering the interplay of land, water, and living resources while acknowledging the vital role of Aboriginal people in protecting Country and biodiversity. The document highlights the decline of biodiversity both nationally and locally due to pressures such as habitat loss, invasive species, climate change, and extreme weather events like droughts and bushfires. Many actions within the framework relate to climate change and its potential far reaching impacts.

Tops to Lakes Program

The Tops to Lakes Initiative is a strategic program aiming to enhance biodiversity, protect environmental services, and promote sustainable development across the MCC LGA. It seeks to achieve these goals through coordinated decision-making involving the council, community, and partner agencies. The initiative recognizes the importance of conserving natural landscapes, restoring biodiversity, and preserving cultural heritage while addressing challenges such as habitat loss, land degradation, and urban development. By establishing wildlife corridors, enhancing ecosystem resilience, and engaging the community, the initiative aims to create a more sustainable and resilient environment for current and future generations. Through strategic planning and collaborative efforts, the Tops to Lakes Initiative strives to leave a positive legacy by conserving biodiversity and promoting environmental well-being. There are no direct actions that the CMP could provide an implementation pathway for.

Our Water Our Future 2045

This is MidCoast Water's Integrated Water Cycle Management Strategy and is predominantly concerned with delivery of town water and sewer services. Sections related to climate change and the Southern Estuaries are:

- Raise critical infrastructure at pumping stations out of flood zones to maintain operation through extreme events.
- Review our land planning and development servicing plans for consideration of impact of sea level rise on new assets.

1.4 Knowledge Gaps

Climate change by its nature is uncertain and knowledge gaps will remain as the future unfolds. However, key issues have been identified for attention as follows:

- Current salinity distribution patterns throughout the Southern Estuaries.
- Current and future impacts of climate change on hydrology, although tidal inundation is better understood with the Stage 2 Tidal Inundation Assessment.
- An understanding of the expected change of species behaviour due to climate change.
- Effect of acidification on shellfish.
- Likely impact of temperature change on the distribution of seagrasses.
- Distribution and vulnerability of floodplain rainforests to increased erosion due to sea level rise.
- What areas will ultimately change from pasture to coastal wetlands as use for grazing becomes unfeasible under a sea level rise scenario.
- How far will existing coastal wetlands expand (or contract) considering adaptation pathways across the landscape. A comprehensive study and prioritisation, including landward retreat analyses, are required.
- Estuary entrance instability with increased sea level.
- Quantification of the expected increased export of sediment and nutrients from the catchment under a drying climate with more intense infrequent events.
- Not much knowledge of impacts on climate change on biodiversity, e.g. migration of habitats – not a good idea of how it will change (e.g. how will mangroves migrate?).
- Don't have enough information about the climate change impacts – what are the impacts of e.g. warming of estuaries, acidification, water quality impacts.
- How the freshwater-saltwater interface is changing.
- The extent of potential impacts on groundwater.

1.5 What's working, what's not?

What's working

Workshop input:

- Estuary dependant industries are adapting well to climate change
- Opportunity to work with aboriginal community – proactive

- New developments and the planning controls are working well
- Coordination across Council and agencies is pretty good
- Collaboration and integrated decision making
- MCC uses integration, collaboration, science.
- Flood planning levels are working
- Inflow reduction program – reduces the number of wet weather overflows and volumes
- Eco-morphodynamic wetland modelling – hydrological responses to saltmarsh and mangroves (DCCEEW).
- Greater level of collaboration following fire and floods.

Other input:

- MCC Climate Change Risk Review. This is an internal review of planning and MCC operations and will lead to updated management priorities and actions.
- Ongoing actions on coastal wetland remediation.
- Strong, ongoing locally targeted research involvement in the Southern Estuaries, including consideration of climate change impacts supported by both local and state governments.
- A formal, cross-Council water resilience team was established during the 2019 drought. The capacity gained here can be used to better plan for climate change, considering the expected increased frequency of drought.

What's not working?

Workshop input

- Coordination with data collection to make the best use of existing hardware, partner with the oyster industry, ongoing data collection for monitoring.
- Across the state, planning sea level rise levels are not consistent.
- Haven't planned for the management of existing infrastructure for climate change.
- Processes that add time – bureaucracy e.g. managing grant applications, need to make sure that catchments are included in the CMP for ICOLLs.
- Freshwater-saltwater interface is changing, human and natural assets, how will they shift, how will that step change be managed.
- Huge impact on groundwater, more increases in groundwater and more groundwater leeching into the system, low lying areas will have very poor drainage.
- Don't understand the slow creep of climate change e.g. temperature and water level impacts.
- Emerging contaminants – from where?
- Is there a transition plan – actively transition 10-15yrs.
- Improving asset management plans for each asset in relation to climate change

- Need for education on keeping stormwater out of the sewers.
- Knowledge gaps - don't have enough information about the climate change impacts. What are the impacts of e.g. warming of estuaries, acidification and the impact on estuaries, impacts on habitats, water quality impacts
- Rural landholders not supported.
- Impact on water supply business, not enough storage due to drought, water security is an issue.
- Considering the smaller scale impacts of climate change, adapting to short term solutions to help build towards adaptation solutions that will be helpful in the longer term.

Other input

- Efforts to reduce the rate at which greenhouse gases are being emitted do not seem to be having a noticeable effect. This means that, over the long term, we may be headed to 2.0 °C of warming or more, substantially more than the current aspirational goal of 1.5 °C. This means that adaptation will be required to manage the catchment, estuaries and wetlands.
- Translation of uncertain projections of climate change impacts into flexible and 'agile' adaptation management actions has not yet occurred. This should happen to enable timely adaptive actions, when required, in future.
- Apparent lack of coordination of activities between state scale (e.g., State Govt. through MEMA) and local scale research activities. A general need for better coordination of research and to ensure that targeted research meets the needs of future adaptation planning at the local scale.
- There is no accepted method for deriving "Coastal Vulnerability Area" extents for the "tidal inundation" coastal hazard under the *Coastal Management Act 2016*. There is significant overlap between tidal inundation flooding and the risks addressed by the floodplain risk management process in NSW. The potential for confusion and overlap between that process and coastal vulnerability areas is an issue.
- Need to integrate sea level rise planning into asset management programs.
- Sea level rise will increasingly flood wetlands and saltmarsh.
- Where infrastructure and/or ecological systems have limited resilience, the increasing severity of extreme events will continue to have a deleterious effect.
- Ranges of uncertainty over long time frames (60 years or more) become very wide and projections begin to diverge markedly. This makes planning for these longer time frames difficult.
- It is difficult for planning to keep up with the changing understanding as new research is completed. It is difficult to plan and approve development in affected areas when guidance needs to be regularly updated. The general consensus of the issues paper stakeholder workshops was that leadership is needed from the NSW Government in terms of policy on issues like sea level rise.
- Indigenous consultation/involvement in discussions about climate change and future plans/changes relating to it.

1.6 Opportunities

- Model migration pathways and planning
- Monitoring of pests moving due to climate change
- Prevent shoreline recession
- Identify and monitor the risks
- Planning proposal for ICOLLs – whole of catchment approach to manage the resilience of the catchments
- Increase education on keeping stormwater out of the sewer
- Fast track amendments to SEPP maps – State government
- Protect Saltmarsh through SEPP – State government
- Engaging indigenous communities
- Greater education and psychological wellness of the community around climate change impacts and changing environments
- What are the exit strategies for landholders from agricultural land? Education of landholders planning for moving out of areas that are not viable in the future.
- Plans for managing the disposal of animals following flooding and fire
- Select a place and find out how it will transition with climate change and development, work out if there is anything we need to do now to manage for the future
- Two-way communication between science and community e.g. oyster and fishing process project
- White seahorse, opportunity for seahorse hotels
- Soft corals – refuge for Port Stephens
- Understanding that changes in tidal regime are much more significant than the impact of ocean acidification.
- Understanding that oyster shell forming – salinity gradient in the estuary, is the thing that drives the acidification
- Oyster reef – if there was a QX outbreak, oyster reef restoration within Wallis Lake is really important to maintain these ecological functions
- Identify access issues and decide if we need to continue with the service.
- Fisheries multispecies approach is not supported and there is artificial pressure on particular species
- Integrating asset management with climate change adaptation for older assets – Council
- When are some areas no longer fit for habitation, more modelling, planning.

- Highlight opportunity to partner with LLS to identify markers for enabling adaptation e.g. change from farming to wetlands
- What does the future look like and what do we need to do to prepare. Future thinking and integration. Transition plan. Build an integrated model to consider governance, adaptation.
- Consistency across programs.
- Research into impacts of climate change on biodiversity, habitat.

1.7 Possible Management Options

- Use research data that identifies retreat buffer zones for coastal wetlands and littoral rainforest under sea-level rise scenarios to develop a forward plan to retain suitable buffers in partnership with landholders by 2025.
- Develop forward plans in Council's Asset Management Program for upgrade and replacement of Council assets at risk from sea level rise and extreme storm events.
- Work collaboratively with landholders and other stakeholders to develop an adaptation plan to mitigate the long-term (50-100 years) risk of climate change impacts on the estuaries.
- Choose locations in the estuaries and investigate a transition plan for the next 10, 20, 40 years. Transfer this assessment and learnings to across all estuaries.
- Identify specific requirements of threatened species in climate change scenarios and develop appropriate management techniques e.g. development of seahorse hotels, oyster reefs, multi-species restoration.
- Link entrance modification management options with climate change adaptation planning.
- Conduct research into future habitat migration due to climate change. Incorporate this into strategic planning.
- Conduct a review of long-term planning relating to population growth and development around the estuaries.
- Review the location of tidal level gauges and salinity gauges to help monitor future changes in the estuaries.
- Further educate communities in the potential social, environmental and economic implications climate change.

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ISSUE ANALYSIS GOVERNANCE - FINAL

2024

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1. Governance

This issues paper describes how estuaries, waterways and catchments are managed in NSW, and within the MidCoast Council Local Government Area (LGA). This issues paper provides an overview of the governing legislation and policy framework for Coastal Management in NSW, as well as the local application of this framework for the MidCoast Southern Estuaries. Discussion is also provided regarding potential management options for implementation of the CMP.

Authors: *Courtney Smith, Chris Beadle*

Contributors:

(Full names of author, peer reviewer and participants in discussion group.)

1.1 Situation Analysis

The current governance across the coastal zone is multi-layered, with the beaches, shorelines, waterways, reserves, and headlands of the study area (and associated assets) owned and managed by a number of stakeholders across multiple levels of government. One of the objectives of the CMP is to facilitate the integration of management responsibilities across the study area, including the council, land managers and public authorities. This section provides an overview of the statutory context, plans, and reporting strategies in place within MCC.

The NSW Coastal Management Framework

The NSW coast provides a multitude of values and uses for the community. However, the coastal zone is under increasing pressure from a growing population, urbanisation, natural hazards, and climate change (OEH, 2018b). Planning for coastal communities must carefully balance the need to provide jobs, housing, community facilities and transport for a changing population, while maintaining the unique qualities and managing risks associated with development along the State's coastlines (DPIE, 2019).

Sustainable management of the coastal zone often involves local councils, their communities, and public authorities balancing a diverse range of challenges and opportunities. The context is one of rapid environmental, social, and economic change along with dynamic coastal processes affecting the open coast, estuaries and coastal lakes (OEH, 2018b).

In order to plan for development, protect environmental assets and manage coastal hazards across the state, the NSW Government has implemented the *NSW Coastal Management Framework*, which includes a range of legislation and associated planning policies, and aims to provide an integrated framework for coastal management across the state.

Key components of the framework are discussed below. A schematic of the NSW Coastal Management Framework is provided in Figure 1-1.

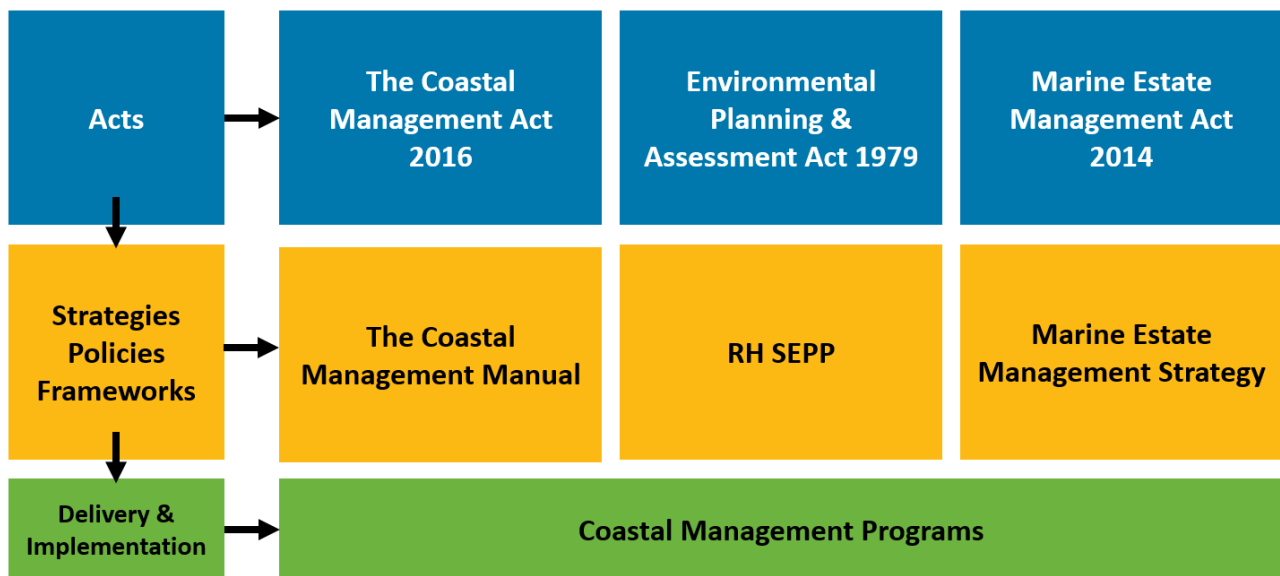


Figure 1-1 The NSW Coastal Management Framework

Legislation

Coastal Management Act 2016 (CM Act)

The CM Act commenced on 3 April 2018, replacing the *Coastal Protection Act 1979*. The CM Act is administered by the Minister for the Environment. It establishes the framework and outlines the overarching objects for coastal management in NSW. Part 3 of the CM Act contains the legislative basis for preparing CMPs.

The overarching object or purpose of the CM Act is:

"to manage the coastal environment of New South Wales in a manner consistent with the principles of ecologically sustainable development for the social, cultural and economic well-being of the people of the State"

The CM Act recognises that the coastal environment is dynamic, with beaches and estuaries changing in form and being affected from time to time by hazards driven by coastal processes. The CM Act specifies 7 coastal hazards, of which 4 are of most relevance to estuaries:

- Coastal lake or watercourse entrance instability;
- Coastal Inundation;
- Tidal inundation; and
- Erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.

Part 2 of the CM Act identifies four "coastal management areas" which, in order of hierarchical importance, are:

- (a) coastal wetlands and littoral rainforests area, comprising land which displays the hydrological and floristic characteristics of coastal wetlands or littoral rainforests and land adjoining those features.
- (b) coastal vulnerability area, comprising land which is defined as being subject to coastal hazards.

(c) coastal environment area, comprising land containing features such as coastal waters, estuaries, coastal lakes, coastal lagoons and adjoining land, including headlands and rock platforms.

(d) coastal use area, comprising land adjacent to coastal waters, estuaries, coastal lakes, and coastal lagoons where development is or may be carried out (at present or in the future).

The hierarchical importance means, for example, that the management objectives outlined for coastal wetlands and littoral rainforests will prevail over those of the coastal vulnerability area, where the mapped areas of these overlap.

The maps defining the four areas are contained in the State Environmental Planning Policy (Resilience and Hazards) 2021 (RH SEPP). The combined, mapped extent of the four coastal management areas is defined as the "coastal zone", which thus defines the legal extent of the CMP. In the Stage 1 Scoping Study, it was also acknowledged that activities in the catchment were also of importance to integrity of the environment in the estuaries. For this reason, the CMP will also consider actions upstream of the estuary, within the broader catchment. However, actions located within the catchment outside the legal coastal zone will be provided in a companion document, separate to the CMP.

Presently, MCC does not have a Coastal Vulnerability Area (CVA) mapped. It is likely that a management action of the CMP will encompass mapping the CVA, and incorporating it into planning documents.

Marine Estate Management Act 2014 (MEM Act)

The objective of the MEM Act is to provide for strategic and integrated management of the NSW marine estate, including the marine waters, coasts and estuaries. The MEM Act promotes a biologically diverse, healthy and productive marine estate, and facilitates the economic cultural, social and recreational use of the marine estate, scientific research, education and management of marine parks. The key legislative instruments under the MEM Act include:

- Marine Estate Management Regulation 2017; and
- Marine Estate Management (Management Rules) Regulation 1999.

As several of the Southern Estuaries are located within the Port Stephens-Great Lakes Marine Park, there are a number of special legislative protections and requirements that apply to the estuaries under the MEM Act and regulations. Under Section 56 of the MEM Act, for any development on land that is in the locality of a marine park, the consent authority must take into consideration the Act and potential impacts on the marine park.

Any development within marine parks, under Section 55 of the MEM Act (any development below the mean high-water mark) requires the Ministers consent. If the consent authority intends to grant consent to the carrying out of the development, it must obtain the concurrence of the relevant Ministers to the carrying out of the activity or the granting of approval

Furthermore, marine park legislative requirements require that certain activities require consent (in the form of a marine park permit), including:

- Any activity that contravenes the protection of animals, plants and habitat within a marine park zone. (Clause 1.11, 1.16, 1.19, 1.22);
- Commercial (Clause 1.32) or research activities (Clause 1.31); and
- Organised sporting, educational or recreational activities (Clause 1.34).

It should be noted that one of the objectives of the CM Act (and of the CMP) is to support the objectives of the MEM Act 2014.

The MEM Act is administered under the auspices of the Marine Estate Management Authority (MEMA), and implemented through the Marine Estate Management Strategy (MEMS).

Environmental Planning and Assessment Act 1979 (EPA Act)

The EP&A Act is a key piece of legislation that governs land use planning and development in NSW, focusing on sustainable development, environmental protection, community participation, and compliance measures. The relationship between the EP&A Act and CMPs is integral to coastal management in NSW. The EP&A Act provides the legal framework for planning and development, while CMPs offer a strategic approach to managing the coastal environment in line with this framework. Together, they ensure that development is sustainable, environmentally responsible, and in accordance with state policies and regulations.

Local Land Services Act 2013 (LLS Act)

Provides agricultural production advice, biosecurity, natural resource management and emergency management functions. LLS also delivers grants and funding programs to support natural resource management and sustainable agriculture activities.

Strategies, Policies and Guidelines

Marine Estate Management Strategy (MEMS)

The MEMS implements the MEM Act, and is a comprehensive approach that includes identifying values and benefits of a marine estate, assessing threats to these benefits and implementing management initiatives to address priority threats. The strategy is based on input from various stakeholders including scientists, the community, Traditional Owner groups, industry, and government organisations. It includes mechanism for monitoring, reporting, and adapting management actions over a ten-year period.

State Environmental Planning Policy (Resilience and Hazards) 2021 (RH SEPP):

One of the key environmental planning instruments for land-use planning in the coastal zone. It gives effect to the objectives of the CM Act 2016 and delivers the statutory management objectives of the Act by specifying how development proposals are to be assessed if they fall within the coastal zone. In particular, it provides mapping of the four coastal management areas that comprise the NSW coastal zone, and uses this mapping to management development in the coastal zone and land use planning.

The NSW Coastal Management Manual

The NSW Coastal Management Manual sets forth mandatory requirements and provides guidance to councils in connection with the preparation, development, adoption, implementation, amendment, and review of CMPs.

Coastal Management Programs

CMPs are a key delivery and implementation method of the NSW Coastal Management Framework. CMPs prepared under the CM Act establish a long-term strategy for a defined area of coastal zone, which focuses on achieving the objects of the CM Act and gives effect to the management objectives of RH SEPP. A CMP may be prepared in relation to part of the coastal management areas included in the coastal zone within an LGA. The Coastal Management Manual outlines how CMPs are to be prepared.

Related Plans and their Linkages to the CMP

The Port Stephens - Great Lakes Marine Park Operational Plan outlines how the Port Stephens- Great Lakes Marine Park will be managed to meet key objectives of conserving marine

biodiversity, maintaining ecological processes, providing opportunities for ecologically sustainable use, and supporting public appreciation, enjoyment and understanding of the marine park. The Operational Plan was developed in consultation with the then Port Stephens – Great Lakes Marine Park Advisory Committee (Marine Parks Authority, 2010). The plan outlines a series of actions that are grouped into eleven management categories. In accordance with the objectives of the Act, there is a strong focus on the management of biological diversity, resource use in, and adjacent to, a multiple use marine park, as well as maritime heritage and cultural issues.

The Marine Park extends from Cape Hawke near Forster south to Birubi Beach at the northern end of Stockton Beach. It is approximately 980 km² in area and includes:

- offshore waters to the three nautical mile limit of NSW waters;
- all of Port Stephens, the Karuah River, the Myall River, Myall and Smiths Lakes, and their creeks and tributaries to the tidal limit.

NSW Draft Mainland Marine Parks Network Management Plan (2021 – 2031)

This is a plan of management for the five mainland marine parks (Cape Byron, Solitary Islands, Port Stephens-Great Lakes, Jervis Bay and Batemans), and outlines priority actions for the mainland marine park network over the next decade. A range of actions regarding research, education, rehabilitation, infrastructure, compliance, planning, policy, rules and partnership activities have been developed based on the best available evidence and engagement with communities and stakeholder groups. It provides a new approach to evidence-based marine park management to conserve not just environmental, but also social, cultural and economic values of marine parks, while reducing threats to those values.

Hunter Regional Plan 2036

This Plan sets regional planning priorities and provides guidance and direction for regional and local planning decisions over a 20-year period to 2036. It provides an overarching framework to guide subsequent and more detailed land use plans, development proposals and infrastructure funding decisions (DPE, 2017).

The Hunter Local Land Services Strategic Plan sets the vision, priorities and overarching strategy for LLS in the Hunter region, with a focus on appropriate economic, social and environmental outcomes. The plan focuses on achieving the objects of the LLS Act, through community engagement, setting and delivering local priorities, and determining how the priorities for Local Land Services are best achieved at local level (LLS, 2021). The plan outlines a series of strategies through which the goals are to be achieved, through the improved management of biosecurity, natural resources, agricultural productivity and emergency management (LLS, 2021). The Strategic Plan is intended to maintain and improve the resilience of the natural systems of the catchment and has a general focus on communities of the catchment and the ecosystem services provided to them by natural resources such as soils and land, native vegetation and aquatic ecosystems.

MCC has a Memorandum of Understanding (MoU) with Hunter LLS, which provides a platform for partnership projects that produce results for both estuary/catchment improvement and farm management.

National Parks and Wildlife Service (NPWS) Plans of Management

Several national parks are located within the Southern Estuaries study area. Each park has a Plan of Management (PoM) which has been developed to establish guidelines for conserving natural and cultural values, managing resources, and providing sustainable visitor access and recreation. Parks include:

- Khappinghat National Park

- Booti Booti National Park
- Wallingat National Park
- Myall Lakes National Park
- Karuah National Park



Figure 1-2 Booti Booti National Park (Left) and Myall Lakes National Park (Right) (Source: NPWS).

MidCoast Council IP&R Framework

As per the requirements of the *Local Government Act 1993*, all NSW local governments are required to prepare a series of strategic plans that conform to the structure of the state Integrated Planning and Reporting (IP&R) Framework. The structure of this framework is depicted in Figure 1-4 and a brief overview of the components is provided below.

The *Draft MidCoast 2032: Shared Vision, Shared Responsibility: Community Strategic Plan* (CSP) is the overarching, visionary document that translates the community's key priorities and aspirations into long-term strategic goals that guide the future direction of the LGA. The Plan represents the highest level of strategic planning undertaken by a local council. As per NSW OLG, 2019, the Plan essentially addresses four key questions for the community:

- *Where are we now?*
- *Where do we want to be in ten years' time?*
- *How will we get there?*
- *How will we know when we have arrived?*

All other plans developed by Council (such as CMPs) must reflect and support implementation of the Community Strategic Plan. In fact, under the CM Act, the objectives and management actions developed as part of CMPs are required to be strategically aligned with the objectives and strategies outlined in the Community Strategic Plan.

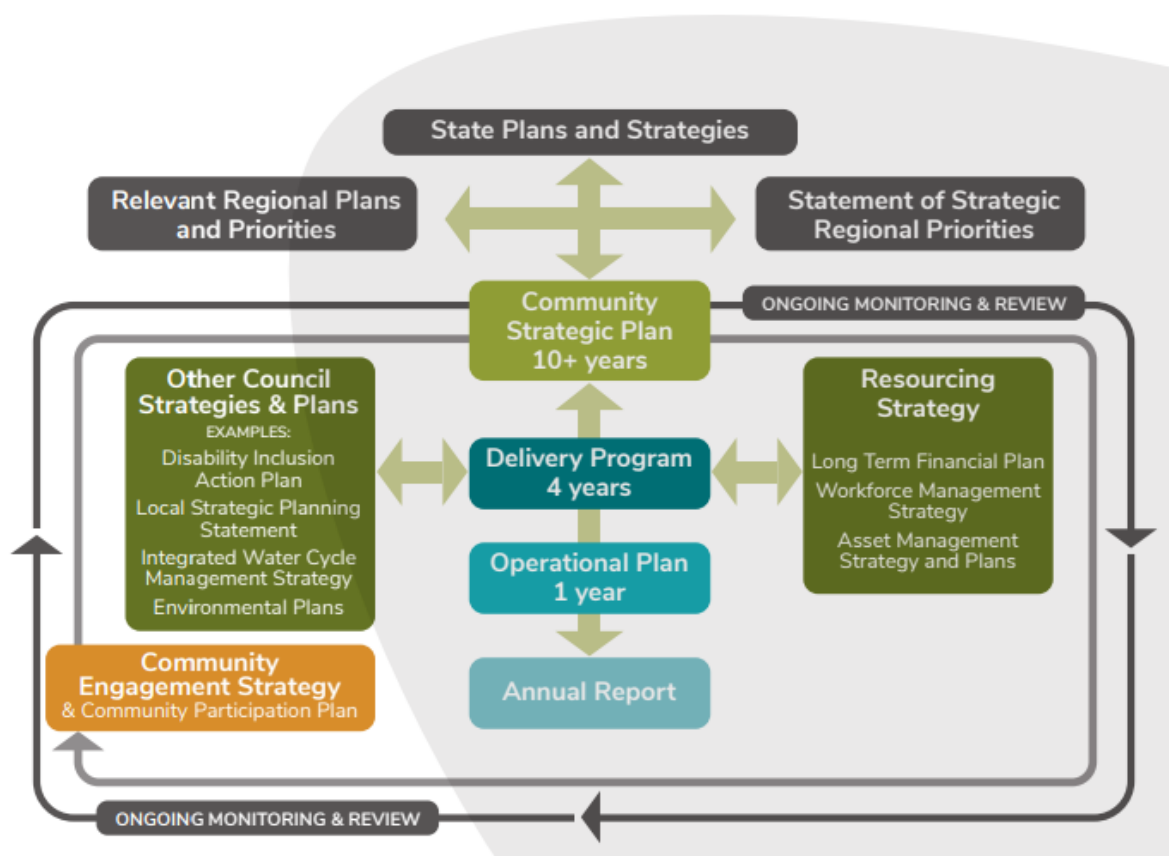


Figure 1-3 Integrated Planning and Reporting Framework (Source: NSW OLG, 2018)

The implementation of the CSP is supported by a suite of integrated plans that include actions to support the strategies identified in the CSP.

The MidCoast CSP brings insights to their shared community values, which are *“Our diverse communities offer active and social opportunities, are safe and are places where we work together with a creative focus acknowledging our rich history and culture. We are socially and physically connected with each other, by ensuring we have activities, facilities, roads, footpaths and technology that are upgraded and well maintained. Our natural environment is protected and enhanced, while we maintain our growing urban centres and manage our resources wisely. We are a place where people want to live, work and play, business is resilient and adaptable to change by utilising knowledge and expertise that supports innovation. We work in partnerships towards a shared vision, that provides value for money and is community focused”*.

The Delivery Program is a four (4) year program that translates the strategic objectives of the Community Strategic Plan into actions. It identifies all key activities a council has committed to undertake over its four-year life cycle. The Resourcing Strategy supports the delivery program and outlines the resources required to implement it. It is therefore a critical link when translating strategic objectives into actions. The Resourcing Strategy generally consists of three inter-related elements: Long-Term Financial Planning, Asset Management Planning and Workforce Planning (NSW OLG, 2020).

The Operational Plan is generated over shorter, one-year planning timeframes and provides the detail of the Delivery Program, identifying the individual projects and activities that will be undertaken in a specific year to achieve the commitments of the program.

Reporting is a key element of the IP&R framework. Councils must prepare an Annual Report that provides information regarding progress and success in implementation of the Operational Plan and Delivery Program.

Other strategic planning activities may be undertaken by a council to support the achievement of outcomes in specific areas identified in the Community Strategic Plan (NSW OLG, 2020). These may include, for instance, a Cultural Plan, an Economic and Tourism Strategy, Emergency Risk Management Planning, Climate Change Planning, or even a Heritage Plan.

MidCoast Community Strategic Plan

MidCoast 2025-2035: Shared Vision, Shared Responsibility sets out the vision and values for the MidCoast LGA. The plan includes five key values:

- We value our unique, diverse and culturally rich communities
- We value a connected community
- We value our environment
- We value our thriving and growing economy
- We value strong leadership and shared vision

MidCoast Council was formed on 12 May 2016 through a merger of the Gloucester Shire, Great Lakes and City of Greater Taree Councils. Subsequently, MCC is presently functioning under:

- Three Local Environment Plans (LEPs) – Gloucester LEP 2010, Great Lakes LEP 2014 and Greater Taree LEP 2010;
- Three Development Control Plans: Gloucester, Great Lakes and Greater Taree; and
- Multiple development policies.

The Land Use Issue Paper will provide greater detail about the various land use legislation and associated plans.

MidCoast Council strategies

Our Water Our Future

Our Water Our Future is the Integrated Water Cycle Management (IWCM) Strategy for the MidCoast. It outlines how sustainable and affordable water and sewerage services will be provided to the community for the next 30 years. It integrates the continued provision of water services and conservation with building resilience into water sources.

Recreational Boating Infrastructure Plan

The Plan seeks to establish a sustainable and future focused infrastructure plan for public land in the MidCoast area of NSW. It incorporates the review of existing facilities, identifying future needs, prioritisation of infrastructure requirements, and consultation with boat users and the community.

Open Space and Recreational Strategy

The MidCoast Open Space and Recreation Strategy outlines how outdoor spaces in the region will be planned, maintained, and delivered to 2035. It presents the guiding principles to managing open spaces that promote social inclusion and sets a framework for future management plans. It will consider the sustainable management of public open space and the development and upgrade of sport and recreation facilities.

1.2 Stakeholders

State Government Agencies

There are numerous state government agencies with management roles and responsibilities across the study area that are relevant to the CMP. These agencies are spread across five (5) separate state government departments (or clusters). These agencies and their position within the

wider NSW state government organisational structure are depicted in Figure XXX. Some of these agencies have a land and asset management role, whilst others are issues based.

Stakeholders include: MCC; DCCEEW (E&H); NPWS, DPHI (Planning and Assessment); DPHI (Crown Lands); Regional NSW (DPI-Fisheries); Port Stephens-Great Lakes Marine Park; LLS North Coast; Transport for NSW (Maritime); Transport for NSW (MIDO); NSW State Emergency Service; First Nations groups; Community Groups.

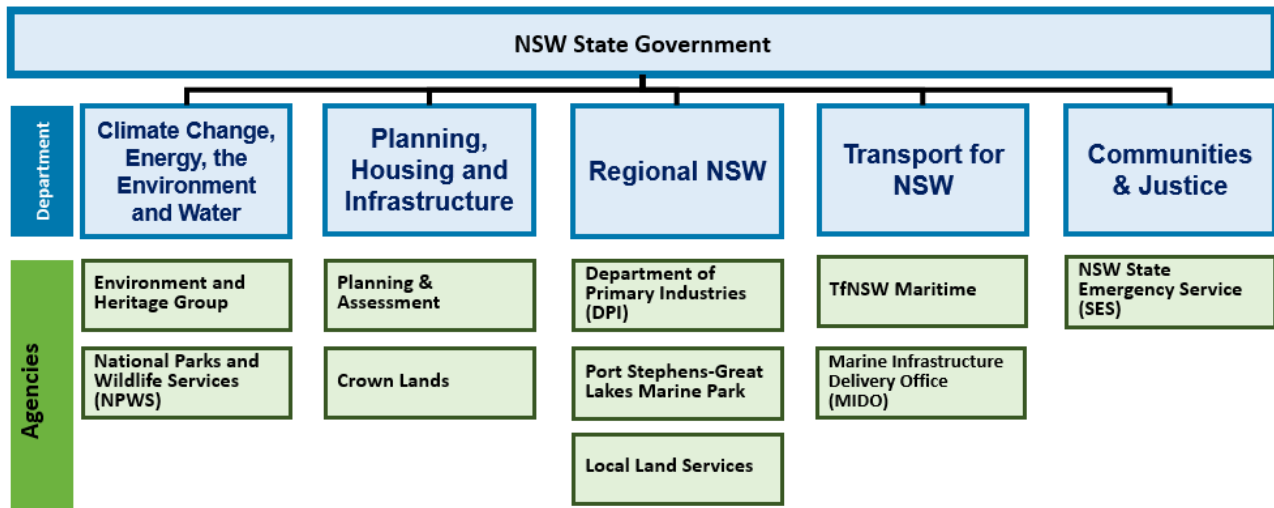


Figure 1-4 Framework NSW State Government agencies with coastal management roles

Community Groups

There are a number of other non-governmental organisations (NGOs) that operate across the study area. These organisations include educational institutions, industry groups, and community and resident groups and businesses. There are a number of active community consultative bodies (CCBs) and community groups across the study area, who can be liaised with to implement management actions, for example dune restoration or citizen science projects.

First Nations Groups

The Local Aboriginal Land Councils (LALCs) acting across the study area have a degree of governance and interface with council, as well as the various State and Federal Government bodies. LALCs have a right to be informed and involved in the planning, protection and preservation of cultural sites and areas under the NSW Aboriginal Land Rights Act 1983 on land within their boundaries. The LALCs aim to achieve long term economic and social solutions for the indigenous communities, and to conserve and maintain cultural and heritage land management. The four active LALCs across the study area, which include:

- The Purfleet/Taree LALC covers the area north from Khappinghat Creek
- The Forster LALC covers a geographical area between the coast and the Central Highlands, from Seal Rocks in the south to Hallidays Point in the north, and
- The Karuah LALC covers much of the Karuah catchment, between the Forster LALC to the north to Port Stephens in the south.
- The Worimi LALC is south of Karuah and covers Port Stephens.

1.3 Existing Management Approach

Council has established a number of groups involved in coast and estuary management, including reference groups, technical working groups and committees. For example, there is the Manning River Estuary Coastal Management Program Reference Group and the Old Bar - Manning Point Coastal Management Program Reference Group. These groups focus on specific coastal and estuary risks including asset protection, water quality and floodplain drainage.

Subsequently, the Southern Estuaries CMP Reference Group has been established to provide input throughout the development of stages 3 and 4 of the CMP. The group is comprised of community members, state government stakeholders, delivery partners and representatives from special interest groups. It is highly recommended that a reference group of key stakeholders is maintained throughout the CMP process, including the Stage 5 Implementation Phase, that provides assistance and feedback to MCC on the development and implementation of the CMP.

1.3 Knowledge Gaps

There is a lack of data transfer and Southern Estuaries-wide collaboration between agencies and stakeholders – this results in a large knowledge gap and potential duplication of efforts, and inefficient estuary management.

1.5 What's working, what's not?

What's working

- Development and implementation of the CMP reference group
- Stakeholder involvement and existing partnerships

What's not working?

- Data sharing and knowledge of what other agencies and stakeholders are doing with the Southern Estuaries.
- Cross-agency collaboration

1.6 Opportunities

There is a high level of opportunity for increased data sharing, and cross-agency and cross-tenure management of the Southern Estuaries.

1.7 Management Options

Actions adapted from the Manning River ECMP:

- 8.01 Establish a CMP Working Group to coordinate operational implementation of the Southern Estuaries CMP, with representation from all government agencies involved in project delivery.
- 8.02 Implement a holistic, interagency approach to compliance and regulation focussing on identified CMP risks and issues.

Other potential management options include developing data sharing agreements, estuary working groups, including with input from stakeholders such as oyster growers, and establishing MOUs between State Agencies.

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ISSUE ANALYSIS COMMUNITY STEWARDSHIP

2024

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1. Community Stewardship

This Issue Paper discusses community stewardship within the Southern Estuaries, and provides a synthesis of potential management options identified from other Issue Papers and prior management plans.

Stewardship is the act of taking responsibility for the well-being of the environment and doing something to restore or protect that well-being.

Community engagement is an essential component to a Coastal Management Program (CMP) as it fosters a sense of ownership and responsibility among community members for the management and preservation of their local environment. It also facilitates collaboration, knowledge exchange, and collective action, leading to more effective solutions and increased resilience to environmental challenges.

This issue paper provides an insight into the Southern Estuaries communities, community engagement strategies, and management options to bolster community stewardship and foster stronger connections to the Southern Estuaries. It identifies key principles, methodologies, and communication tools essential for environmental education, outreach, and community engagement. Through collaboration with the Stakeholder Reference Group and other Issue Paper workshops, community stewardship actions have been identified and are presented below.

Authors: *Courtney Smith, Neil Dufty*

Contributors:

(Full names of author, peer reviewer and participants in discussion group.)

1.1 Situation Analysis

The need for engagement

CMP Engagement Requirements and Guidelines

The *Coastal Management Act 2016* (CM Act) requires local councils to consult with the community and stakeholders before adopting a CMP. Section 16 of the CM Act requires that:

1. Before adopting a coastal management program, a local council must consult on the draft program with:
 - a) the community, and
 - b) if the local council's local government area contains: (i) land within the coastal vulnerability area, any local council whose local government area contains land within the same coastal sediment compartment, and (ii) an estuary that is within 2 or more local government areas, the other local councils, and
 - c) other public authorities if the coastal management program: (i) proposes actions or activities to be carried out by that public authority, or (ii) proposes specific emergency actions or activities to be carried out by a public authority under the coastal zone emergency action subplan, or (iii) relates to, affects or impacts on any land or assets owned or managed by that public authority.

2. Consultation under this section is to be undertaken in accordance with the relevant provisions of the coastal management manual.
3. A failure to comply with this section does not invalidate a coastal management program.
4. The regulations may amend Schedule 1.

Part A of the Coastal Management Manual includes statutory provisions and mandatory requirements relating to community and stakeholder engagement. These provisions and requirements include:

A draft CMP must be exhibited for public inspection at the main offices of the councils of all local government areas within the area to which the CMP applies, during the ordinary hours of those offices, for a period of not less than 28 calendar days before it is adopted. This mandatory requirement does not prevent community consultation, or other consultation, in other ways.

The NSW Government has issued guidelines for community and stakeholder engagement related to the CMP process titled '*Guidelines for community and stakeholder engagement in coastal management*' (NSW OEH, 2018). These guidelines provide engagement approaches to help meet the above requirements and recommended approaches to enable community and stakeholder feedback to enhance the development of the CMP.

The guidelines recommend the use of the International Association for Public Participation (IAP2) spectrum, which is a widely accepted model to design engagement strategies and plans. As shown in Figure 1, the spectrum identifies five levels of engagement, the goal of each level and the community's role in decision-making and implementation.

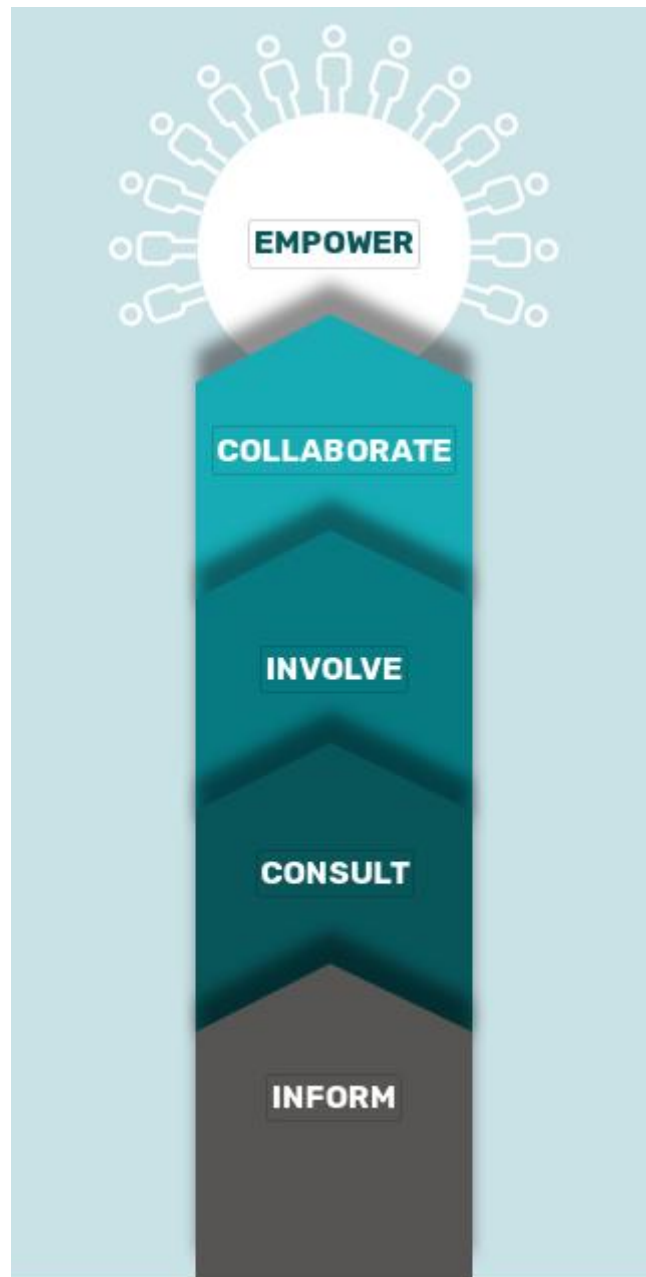


Figure 1 *IAP2 Spectrum (Source: Southern Estuaries CMP Community and Stakeholder Engagement Strategy)*

NSW Marine Estate Management Strategy

Community engagement to promote stewardship is also a strong feature of the NSW Marine Estate Management Strategy (MEMS). Identified threats to social, cultural and economic benefits statewide include:

- Lack of community awareness of the marine estate and associated benefits and threats
- Lack of, or ineffective community engagement in governance

- Antisocial behaviour and unsafe practices

Management Action 8.1 in the MEMS calls for increasing stakeholder and community awareness of the marine estate and promoting safe and ecologically sustainable use by:

- *Building on existing school and community education programs to encourage environmental stewardship, enhance self-compliance and promote the physical and mental health benefits associated with nature;*
- *Developing and promoting best practice guidance and codes of practice to reduce resource use conflicts;*
- *Developing online information resources and digital technologies*

Southern Estuaries CMP

Engagement and stewardship are key themes for the Southern Estuaries CMP. The call to focus on community stewardship is reflected in the vision and several objectives for the CMP:

Vision: *“The Southern Estuaries CMP will guide the integrated management of our estuaries and respond to present, evolving and future challenges. It will protect and enhance the social, economic and environmental values supporting the exceptional biodiversity, and resources that connect our community.”*

Objective C: *“To promote community understanding, a sense of connection and stewardship of estuary values”*

Objective I: *“To maintain meaningful engagement with the community, and to support public participation in coastal management and planning, and to foster greater public awareness, education and understanding of coastal processes and management actions”.*

Further information about the MidCoast communities and stakeholders can be found in the Stage 1 Scoping Study (Water Technology, 2022), which provides detail on the social and cultural context of the region, existing community groups, prior engagement activities and citizen science programs.

The Southern Estuaries CMP Engagement Strategy

The engagement strategy developed for the CMP is a strategic tool that contains principles and methods that can be applied to ongoing engagement in the implementation of the program.

The engagement strategy notes that social capital (people, networks, relationships) and natural capital (ecosystems, environment, nature) are intrinsically linked, as shown in Figure 2. Changes in ecosystems can impact trust, involvement, and cohesion within communities by altering human-environment relationships. For example, the economic and public health costs associated with damage to ecosystem services can be substantial. Conversely, strong social bonds at the community level can enhance ecosystem services and the success of environmental management programs (Barnes-Mauthe, et al., 2015; Nichols, 2014).

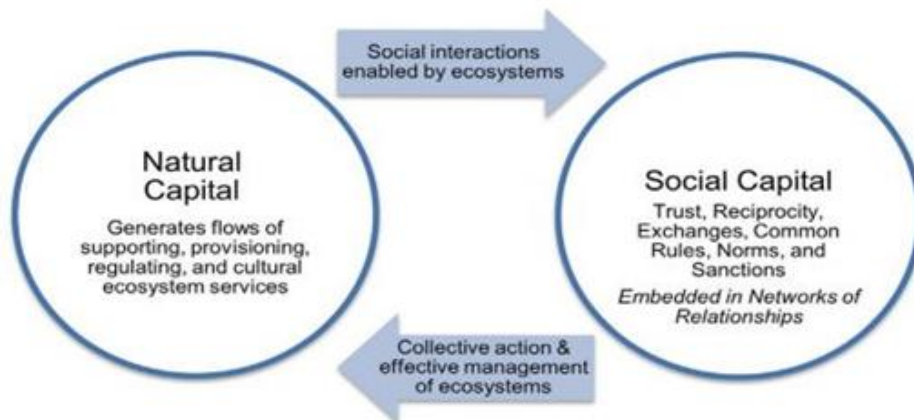


Figure 2: Relationship between Natural and Social Capital

When people are well connected and their knowledge is sought, incorporated and built upon during planning and implementation, they are more likely to sustain stewardship and protection of natural resources over the long-term (Pretty & Smith, 2004).

The engagement components of the Southern Estuaries CMP will help develop the relationship between social and natural capital in order to foster sustainable catchment and estuary management.

The CMP engagement strategy brings attention to the diversity of the communities of the Southern Estuaries and how the strategy needs to be inclusive of the different groups to be effective.

The engagement will be assessed, monitored and reflected upon to ensure a continuous improvement of the engagement practice.

Methods

There are numerous methods and frameworks for community engagement. Some of these that are most familiar with the MidCoast Council (MCC) project team are shown below.

Action Learning involves establishing a small group to work on real, complex problems. Taking action, reflecting and learning as individuals and a group. The group uses a process of asking open questions (appreciative inquiry or strategic questioning) to clarify the exact nature of the problem and identifying possible solutions. Action is taken, evaluated and reviewed or scaled up. Action Learning solves problems and develops leaders simultaneously by encouraging participants to think critically and creatively, and to work collaboratively.

Changeology is an approach to designing programs to generate behaviour change developed by Les Robinson, whose training workshops are widely attended by both MCC and HLLS engagement officers. It is based on five principles:

- Create familiarity - through hands-on experiences linked to existing knowledge and experience.
- Be visible – make the correct behaviours highly visible close to the point where they are made.

- Redesign for ease – reduce the number of steps or decisions, matching best practice with existing activities.
- Establish best practice as the norm – provide evidence others are doing it.
- Passionate champions – connect and support people who will model and promote the practice change.

ADKAR is an acronym which stands for Awareness, Desire, Knowledge, Ability, Reinforcement. It is a change management model for business, government and community and is used by MCC across a range of programs. The ADKAR models define five basic building blocks for social change. ADKAR programs commence with an assessment of where target groups are situated with regards to the five building blocks, then implement change activities targeted at each of the five elements. Change activities include communications, coaching, training. Factors influencing the success of each element are shown in Table 1 below.

Table 1: ADKAR success elements

Element	Factors influencing success
Awareness Of the need for change	<ul style="list-style-type: none"> • A person (or group's) perception of the current state or problem • Credibility of the sender of awareness messages • Misinformation, rumours, contestability of the reasons for change
Desire To support and participate in the change	<ul style="list-style-type: none"> • The nature of the change, how much it will impact on the person (or group) • Their personal situation and motivations
Knowledge Of how to change	<ul style="list-style-type: none"> • The current knowledge base of the individual or target group • Their capability to gain additional knowledge • Resources available for training and education • Access to or existence of the required knowledge
Ability To implement required skills and behaviours	<ul style="list-style-type: none"> • Psychological blocks, physical abilities, intellectual capacity • Time available to master new skills • Availability of resources
Reinforcement To sustain the change	<ul style="list-style-type: none"> • Meaningful and specific reinforcement for the person or target group impacted by the change • Association between reinforcement and demonstrated results aligned to program targets • Absence of negative consequences • Accountability system to monitor and report on change

Asset Based Community Development (ABCD) is an approach to sustainable community-driven development. In this approach, instead of focussing on deficiencies, facilitators work within their community to identify strengths and mobilise them to solve the identified problem. Agencies lead by providing facilitation, support and resources while stepping back to create opportunities for grass root community- led initiatives

Asset Based Community Development facilitators work with community groups to identify assets in five categories: Individuals, Associations, Institutions, Facilities and Connections. Building relationships between actors is the key to success in ABCD programs. Principles of are shown in Table 2 below. There are many tools available to help facilitate ABCD. Graeme Stuart from the University of Newcastle's Family Action Centre is a local leader in the field and his blog is a good place to start.

Table 2: Asset Based Community development

EVERYONE HAS GIFTS
With rare exception, people can contribute and want to contribute. Everyone in a community has something to offer.
PEOPLE CARE AND ARE MOTIVATED TO ACT
Facilitators work with individuals and groups to uncover what they care about and their motivations to act in ways that will address the issue.
RELATIONSHIPS BUILD A COMMUNITY
An intentional effort to nurture relationships and build effective networks is the core of ABCD.
CITIZENS AT THE CENTRE
Community participants are engaged as leaders and actors, not just as recipients of a program: "Join us, we need you."

Environmental Interpretation is an environmental education process involving first-hand experience with a resource such as an estuary or wetland. It uses communication tools such as guided tours and interpretive signage to foster emotional and intellectual connections between the interests of the audience and the values of the resource. Technical language is translated into terms and ideas that people with no prior knowledge can understand. Information conveys relationships and meanings centred around a theme. The goal is to build understanding, a desire to conserve the resource, and commitment to a set of sustainable behaviours required for asset protection

Community Based Social Marketing

This is a method that uses community resources and partnerships to promote healthy behaviours. Community-based social marketing borrows from the success of face-to-face community organising to build online engagement around shared issues and causes. Using this approach can:

- Target unsustainable behaviours, and identify the barriers to change;
- Understand various commitment strategies;
- Communicate effective messages; and
- Enhance motivation and invite participation.

Tools

Education tools need to be carefully selected and designed to meet the needs of the target audience. This is best done in consultation with the audience themselves. Tools include:

Farm Field Days	Best practice frameworks
Sustainable farming or Landcare groups	Networks
Workshops	Presentations
Public meetings	Forums and seminars
Webinars	Community action days e.g. clean-ups
Guided tours	Interpretive signage
Brochures and fact sheets	On-line content
Social media posts	Training manuals
One-on-one field visits and advisory services	Stories
Videos	Media release
Advertising campaigns	Competitions
Flagship species	Exhibitions
Postcards, bumper stickers, posters	Competitions
Citizen science activities	Outdoor classrooms
Drain stencilling	Gutter talks/kitchen table talks

Existing Programs

MCC has several existing community stewardship programs and outreach activities. These include those from the Water Quality Improvement Plan, prior coastal zone management plans, the Catchment and Marine Discovery Program, and community engagement surrounding the Wallis Lake Sponge. Some programs which have community stewardship strategies relevant to the CMP are discussed below.

Water Quality Annual Report Card and Technical Report

Each year, MCC and DCCEEW develop a water quality annual report card and associated technical report, which reports on water quality and ecosystem health across MCC estuaries. The information is used to track ecosystem health over time, and to track progress on management actions.

The technical report also outlines all the numerous community projects and programs available for community members to get involved in regarding water quality and ecosystem health across the Southern Estuaries.

Backyards for Biodiversity

The Backyards for Biodiversity program is coordinated by the MidCoast Council in partnership with National Parks and Wildlife. It aims to increase habitat for native species across backyards in Smiths Lake. Through the iNaturalist program, observers can track species in their backyards assisting in identifying which species are present and the patterns of population as native habitat is restored. The program seeks to encourage whole-of-community action by protecting bushland from invasive species and providing habitat for local fauna. The program focuses on the Smiths Lake region as an area of spectacular bushland home to a variety of native species including threatened plants and animals.

River Revival

River Revival is a three-year program, whose activities include assessing and prioritising refugia and on-ground riparian restoration (stock exclusion, bank stabilisation, bush regeneration, pest and weed control), Riverwatch sampling and community engagement workshops.

To date, riparian restoration includes 13 landholders actively involved in the program protecting 9.8km of river reach including on-ground works across 34.7ha of riparian land, with Council contributing over 3000 native riparian plants. The restored network of refuge pools and riparian habitat will enhance the resilience of aquatic fauna to climate change stressors.

Additionally, each year of the project, 2 community engagement workshops and quarterly citizen science monitoring events across the Barnard and Dingo catchments help grow understanding, stewardship, and participation in the project. Whilst this project is within the Manning River catchment, a similar project could be developed for the Southern Estuaries CMP.

Waterwatch

Waterwatch Australia is an initiative to help understand, monitor, care for and sustainably manage waterways. It is a network of citizen scientists that monitor local waterways – it could be a creek, pond, lake, dam, wetland, lagoon or estuary.

Waterwatch programs support communities to monitor the health of waterways; to learn through environmental education, and to participate in projects to protect, rehabilitate or restore the health of our waterways. Council (through MidCoast Water) manages the local Waterwatch group.

Share the Science – Marine and Catchment Discovery Series

These community events are run as educational programs about a wide variety of scientific topics related to estuaries, the marine ecosystem and wider catchments. This provides an accessible event where community members can become involved with local programs, learn about and feel connected to their local environment.

1.2 Stakeholders

Stakeholders include: MidCoast Council; Hunter Local Land Services; Midcoast-to-Tops Landcare; Karuah Great Lakes Landcare; National Parks and Wildlife Service; BirdLife Australia, local schools; community groups (OzFish, Manning Great Lakes Birdwatchers, Hunter Bird Observers Club, Pacific Palms Art Network (investigate), recreational/commercial fishers), real estate agents, and the Landholder Network.

In the Community and Stakeholder Engagement Strategy (MCC, 2022), stakeholders were grouped into four categories: Community, Special Interest Groups, Key Stakeholders and Delivery Partners. These groupings were based on broadly shared values and interests among the stakeholders in each category. These are listed below.

Community

- Residents, in particular those that utilise the estuarine areas
- Recreational fishers
- Rural and urban landholders
- Indigenous community members
- Schools and other educational institutions

Special Interest Groups

- Environmental Interest Groups
- Beef, Dairy and Oyster Farmers
- Professional fishers
- Recreation Clubs
- Business & Tourism networks
- MidCoast 2 Tops Landcare network
- Karuah Great Lakes Landcare network

Key Stakeholders

- MCC Councillors
- MCC GM and Directors (EMANEX)
- MCC Leadership Group and Management (MANEX)
- MCC Staff
- DCCEEW
- Scientists
- Forster and Karuah Local Aboriginal Land Councils
- Port Stephens Council
- Emergency Services

Delivery Partners

- Hunter Local Land Services
- DPHI (Crown Lands)
- National Parks and Wildlife Services
- Forests NSW
- Office of Water
- DPI – Fisheries
- DPI – Marine Parks
- Transport NSW
- Indigenous Service Providers

1.3 Existing Management Approach

Partnerships between local organisations are key to developing and implementing community projects. MidCoast Council, Hunter Local Land Services (HLLC) and Midcoast 2 Tops Landcare work both individually and in partnership on a range of landholder and community engagement programs to promote catchment management. Memorandums of Understanding are in place between HLLS and MCC, HLLS and Landcare, and Landcare and MCC.

1.4 Knowledge Gaps

There are limited knowledge gaps that would be solved through additional studies or engagement.

1.5 What's working, what's not?

What's working

- Engagement with community groups and different communities
- Ongoing funding from Council and by other state agencies
- Collaboration between Council and state agencies to deliver programs
- Share the Science is a fantastic opportunity the CMP could harness.

What's not working?

- Engagement with youth remains difficult
- Ongoing repeated engagement is needed, especially to increase education regarding complex coastal processes – e.g. ICOLL management.

1.6 Opportunities

- Lots of opportunities to co-design and develop engagement programs with industry groups and other stakeholders
- Lots of existing partnerships and programs to continue to deliver

- Potential to engage people early in their visit to the Southern Estuaries – e.g. tourists, new residents and home owners.

1.7 Management Options

Prior Management Options

This section presents management options from prior management plans, and the Manning ECMP that could be considered for the Southern Estuaries CMP.

Manning ECMP

- Engage river users and the whole community in an engagement program to promote understanding of ecosystem values and stewardship of the river
- Promote whole-farm planning and natural resource management for catchment outcomes
- Support landholders to develop whole farm planning approaches to decision making based on best management practices.
- Implement a litter and stormwater pollution source control program
 - Monitor and report annually on the volume, type and location of litter collected during GPT maintenance and clean-up days
 - Utilise this data for targeted education and engagement campaigns
 - Develop source control plans for identified hot spot locations.
 - Support community and industry groups to complete a minimum of one litter clean up event each year in identified hot spots.
- Improve erosion and sediment control (ESC)
 - Develop a comprehensive erosion and sediment control management system within MCC. Identify improvements required; set benchmarks; undertake audits and share results to build capacity.
 - Develop and implement an ESC capacity building program for designers, builders, engineering consultants and developers. Follow up with a proactive, targeted compliance program by 2028.

Wallis Lake ECMP

- Work with landholders to build their capacity to undertake sustainable farming activities that improve groundcover and reduce direct cattle impacts on waterways
- Develop a building & construction education program that increases the capacity of architects, designers and builders to implement best practice SEC
- Develop a WSD education and capacity building program for key urban stakeholders within the community including: developers; building designers and architects; real estate agents; businesses; and residents.

- Continue to educate and engage with boat owners to monitor the effectiveness and efficiency of holding tanks, and minimise potential sewage dumping from vessels
- Run regular clean-ups (involving volunteers, where possible) of waterways and the Lake utilising or mooring in Wallis Lake
- Engage the general community regarding both the sources of litter and the impacts it has on waterways, native flora and fauna
- Engage commercial and recreational fishers regarding the impacts of fishing debris on the Estuarine and Lake environment
- Develop programs targeting engagement of visitors (and local tourism businesses) to the region during peak times to reduce their concentrated impact on waterways
- Continue to promote and provide support to local volunteer environmental groups
- Continue to educate and inform the community regarding the importance of biodiversity, including protecting and restoring habitat for threatened species, populations and communities. Engage with the community on the benefits of natural areas
- Include water quality, water sharing legislation and environmental flow information in rural landholder extension and education programs
- Continue to work with local landholders to strategically control and reduce weed impacts on farming land and the natural environment
- Continue to educate businesses, government agencies and the community regarding the impacts of invasive plant and animal species and their role in control and surveillance
- Coordinate and deliver education and awareness programs with regards to the importance of riparian areas
- Promote the importance of seagrass and other aquatic habitats, and their protection to stakeholders and the general community
- Continue to educate and engage the community regarding general and local wetland values and issues
- Support a broad communication and education program addressing sustainable management of the Wallis Lake fishery.
- Incorporate information regarding local Aboriginal cultural history and connection to land in educational material for the community and visitors

Smiths Lake CZMP

- Educate the community on existing waterway zoning
- Encourage the community to utilise existing boat ramps, through education
- Develop and implement education program on the dangers and legalities associated with opening events
- Develop and implement education program on pollutant sources to Lake

- Develop and implement public awareness program on ecological values and important habitat.

Karuah River Catchment Management Plan

- Continue to engage and inform the community about the value of local wetlands and associated issues
- Improve community knowledge and management of acid sulfate soils in the estuary zone of the catchment
- Improve community knowledge of the methods available to both prevent and mitigate soil erosion, including the value of riparian vegetation
- In collaboration with landholders build understanding and capacity to increase the adoption of best management practices which address catchment degradation and encourage profitable farms. Opportunities for focused action may include focus farms, group mentoring programs, on farm trials, farm sector advisory groups, demonstration sites, landholder champion programs, and property management planning activities
- Targeting sediment and nutrient hotspots, work in collaboration with landholders to improve grazing/groundcover management, soil health (including organic carbon) and water use efficiency
- Continue catchment management education programs, such as WaterWatch, with local primary schools and community groups
- Continue to use communication and social marketing tools such as newsletters, extension, field days and websites to promote an understanding and awareness of catchment management within the community
- Explore and implement opportunities to build the capacity of rural lifestyle and absentee landholders to protect, maintain and restore catchment health. Opportunities could include:
 - the introduction of mentoring programs, the promotion of local champions and the development of focus groups
 - development of NRM information packages for rural lifestyle properties
 - encouragement of real estate agents to provide a package of 'Small Property Management' to potential buyers of rural lifestyle land
 - provision of information to new property owners through the Council's rating system
- Engage with local Aboriginal communities to identify key water and landscape related environmental, social, cultural and economic values and priorities for protection
- Engage with local Aboriginal communities to incorporate, where appropriate, traditional land management knowledge into NRM programs
- In collaboration with private landholders, utilise incentive and engagement mechanisms to protect and rehabilitate threatened species, ecological communities, areas of high biodiversity values, and to create vegetation corridors

From other Issue Papers

Agriculture Paper

- Continue to deliver behaviour change engagement programs across the catchment.
- Locally relevant demonstration projects in each catchment.
- Run an outreach program with property visits. Maintain extension staff/catchment officers to resource this approach.
 - Link engagement to current issues e.g. drought and water security to encourage off stream watering, fence off dams and include watering points from dams.
 - Provide technical advice on installation of dams to reduce their potential impact.
 - Education about options for management of land identify and promote triggers for management e.g. ground cover triggers for allowing cattle into fenced riparian areas.
 - Support the sustainable farming program long term. Use the CMP as a way of sourcing funds for land management, technical and engagement advice for landholders.
 - Talk about, educate and inform people about ecosystem services, what the river gives to us and what we need to do to protect it.
 - Work more with farmers, Landcare to promote a transition to regenerative farming.
 - Educate new arrivals, targeting property buyers in high priority areas.
- Offer stewardship payments for landholders for best practice management of farming land.
- Continue Beyond the Shed. Target other industries as well, and mentoring for landholders
 - vineyards,
 - cottage industries (environmental outcomes and benefits are often core to the niche product that you're buying);
 - dairy specific
 - Private Native Forestry
- Citizen Science – waterwatch, eDNA and macroinvertebrate training for landholders

Climate Change Paper

- Increase education on keeping stormwater out of the sewer
- Engagement with Traditional Owners
- Greater education and psychological wellness of the community around climate change impacts and changing environments
- What are the exit strategies for landholders from agricultural land? Education of landholders planning for moving out of areas that are not viable in the future e.g. will be tidally inundated.
- Two-way communication between science and community e.g. oyster and fishing process project

- Further educate communities in the potential social, environmental and economic implications climate change.

Aquaculture and Commercial Fishing Paper

- Collaboration between government, recreational fishers and Traditional Owners to develop fishing regulations. Incorporate best practice fishing guidelines into regulations for commercial fishing to win support from government and protect the future of commercial operations.
- Collaborate with water management authorities, local farming groups and landholders to improve the quality of run-off and restore the health of seagrass beds, improving fish nurseries and local fish stocks.
- Educating the public about how best to look after our marine environment should be a priority. Particularly landholders on the shores of waterways.
- Estuary processes and seafood production group – forum to link science and fishers and managers together to share experience
- Education and compliance program for new owners on the foreshore to build their understanding and establish custodianship / stewardship for foreshore landholders
- Communication with general public living on the water edge, removal of habitats and the impacts

Entrance Modification Paper

- Develop and implement community engagement and education regarding entrance modification including an understanding of estuaries being dynamic and fragile systems.

Biodiversity and Habitat Conservation Paper

- Connect with universities to find the sweet spot between Council and universities – list of projects want research on. Opportunities: Work integrated uni students, honours students, PhD studies.
- Research questions that students could assist with
- Community engagement with species like GG bell frog
- Educate landowners about the true cost of clearing for capital gains.
- Improve knowledge and skills for drought management.
- Share the science with the community – expand program for Southern Estuaries
- Working with indigenous community to repair habitats and create oyster reefs
- Work with fishers to record their observations and promote stewardship with rec and pro fishers
- Use EDNA to engage with community and expand research
- Look for opportunities to engage community in foreshore areas particularly

- Management questions: reconsider how community interact with decision making. Work with community to see each other as partners in coming up with solutions. Need to find a solution to the challenge of monitoring
- Citizen science and schools program to make sure that the 'right' information is getting to schools eg mangrove die back project from the pacific. Easier access to correct scientific information and making sure that they are aware of MEMs for example
- Adopt a set of significant flagship and indicator species, with Aboriginal and community input, to use for monitoring and community engagement programs.
- Develop an interagency, multi-media suite of communication, education and training material to promote biodiversity awareness, appreciation, understanding and skills for best management practice in urban and rural settings.
- Establish an annual citizen science BioBlitz through the Australian Living Atlas.
- Develop nature-based tourism experiences e.g. birding routes, hides, boardwalks, river walks. Identify and undertake a needs assessment of key target audiences for engagement to promote protection, natural regeneration and revegetation.
- Deliver outreach and incentive programs to improve the condition, extent and connectivity of terrestrial and riparian vegetation in priority areas.

Coastal Wetlands

- Develop a coordinated education and awareness program including case studies and field events to promote wetland values, best management practice and sustainable use.
- Deliver a coordinated, proactive, strategic community wetland education and engagement program, including a schools program, interpretive signage at wetland sites, flyers, and social media. Improve the level of awareness in the community of the importance of wetlands. Address myths, misconceptions and misinformation about wetlands. Target new residents and new rural property owners. Use social marketing to drive behaviour change to protect wetlands from damaging activities. Develop a curriculum based education for schools.

Coastal and Tidal Inundation:

- Educate communities in the potential social, economic and environmental impacts of tidal inundation.
- Develop community education regarding impacts on cars in relation to tidal inundation. Could develop a tidal calendar, and a king tide photo program.

Freshwater Flows:

- Develop an education program regarding the use of bores and their impact on aquifers and groundwater dependant ecosystems, especially during droughts, particularly for locations like Tuncurry and Tea Gardens
- Continue MCC programs with residents and other land users to promote water efficiency, e.g. water restrictions, ongoing education, pricing mechanisms.

Recreation:

- Additional initiatives for educating users / recreational fishers, boat users, visitors, on protecting the environment
- The potential for regular waterway clean up events in collaboration with multiple stakeholders and government organisations
- Interactive foreshore walks
- Support community engagement opportunities regarding environmental protection. Eg Coastal Warriors, One Tide.
- Connect with visitors and tourists to increase information and knowledge about the estuaries and how they can mitigate their impact. Connect with tourism operators, and investigate ecotourism accreditation.
- Additional signage on 4WD – specifically Dark Point (Mungo Brush so in the NP)
- Education on fishing rubbish in areas that have high recreational fishing
- Increase education on seagrasses and how they impact fishing and other activities
- Education and engagement directly with residents and tourists at the recreation sites
 - Discovery Rangers
 - Council Engagement
 - 4wd sites
 - Shorebirds
 - Seagrasses and Sponges
 - Wetlands
 - Littoral Rainforest
 - Dolphins
- Greater education for tourists eg FAQ, Fact Sheets, promotion of businesses
- Greater promotion of recycling
- Education and engagement and enforcement on boating rules boating education officer visibility

Erosion and Sedimentation:

- Promote understanding and commitment to erosion and sediment control through the construction industry, forestry, landholders and recreational boat users.
- Education for boaters on the impact of their wake on bank erosion

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ISSUE ANALYSIS

AGRICULTURAL

IMPACTS

2024

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1. Agricultural Impacts

This issue analysis paper covers a range of risks to the environment within the coastal zone resulting from agriculture including water quality issues from diffuse source runoff of nutrients and pollutants, degradation of riparian and marine vegetation by stock, and soil degradation/disturbance and associated consequences such as exposure of acid sulphate soils.

Associated issues papers include the *Aquaculture and Commercial Fisheries Issues Paper* and the *Climate Change Issues Paper*.

Authors: *Petra Arola*

Contributors: *Full names of author, peer reviewer and participants in discussion group.*

1.1 Situation Analysis

1.1.1 Agriculture background

The history of intensive agricultural practices within the study area dates back to early European settlement in the mid-1800s. Drawn by agricultural and timber prospects, the early farmers and graziers initiated extensive clearing and draining of wetlands to create farmlands. Poultry, dairy, and beef cattle production have been prominent over time, leading to continued agricultural land use in both commercial and small-scale farming operations.

Agriculture in the MidCoast LGA is a significant employer and regional specialisation forming part of the LGA's economic competitive advantage (Saphere Group, 2018). The value-add from agriculture to the MidCoast LGA in 2022 was nearly \$290 million (Community ID, 2024). Combined with aquaculture, forestry and mining, the agriculture industry accounts for approximately \$478 million in exports from the MidCoast LGA, which is over 55% of the LGA's total exports (MidCoast Council, 2020).

Cattle grazing

Cattle and calves are the most important agricultural commodity within the region based on the gross value of agricultural production (GVP). The economic contribution of this sector was valued at \$153 million in 2018-19, making up about a third of the region's agricultural production value (MidCoast Council, 2021). The Karuah River catchment has the highest intensity of cattle grazing within the study area (Figure 1).

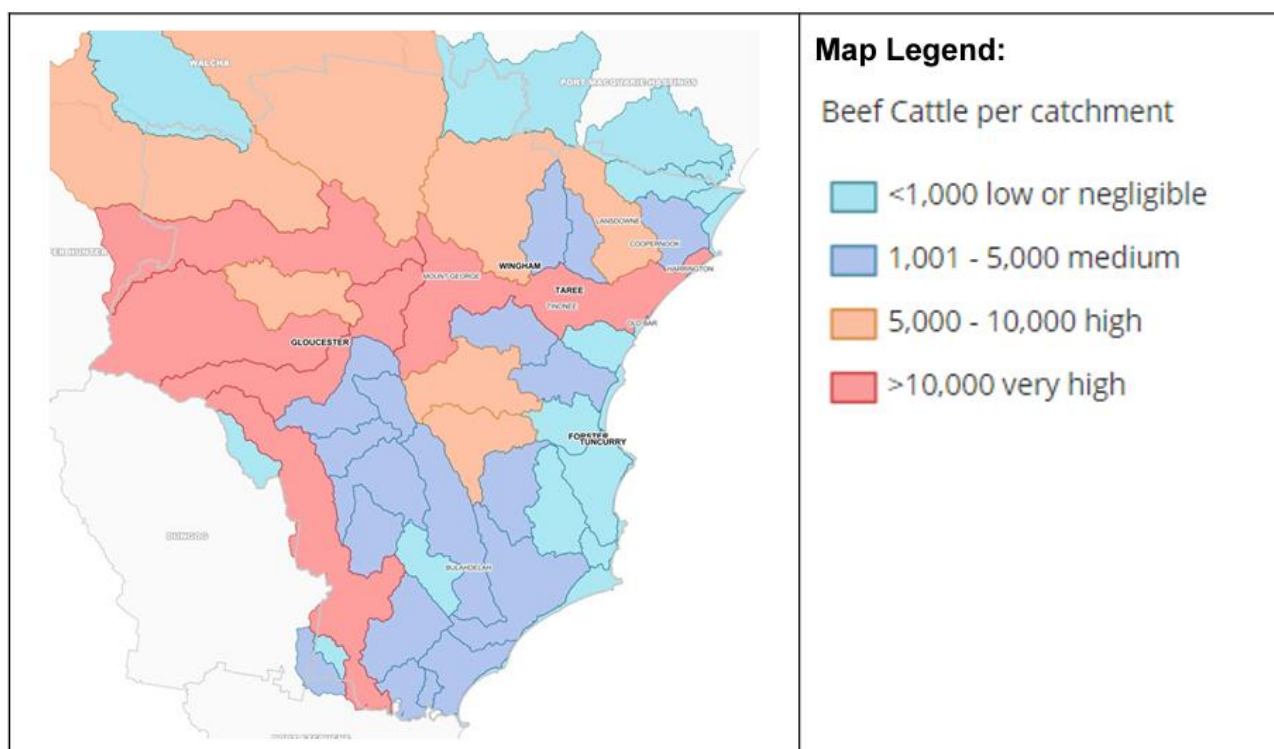


Figure 1: Beef cattle stocking densities in MidCoast Council. Figure courtesy of MidCoast Council 2021, mapping based on LLS data from 2018.

Dairying

The dairy industry has great historical significance to the MidCoast LGA and it remains a major economic contributor, with milk production identified as the second most important agricultural commodity in the Mid North Coast region. Approximately 25% of NSW's milk is produced in the MidCoast LGA (MidCoast Council, 2021). Dairy farming intensity is very high in Wallamba River catchment and moderate in the Karuah River catchment (Figure 2).

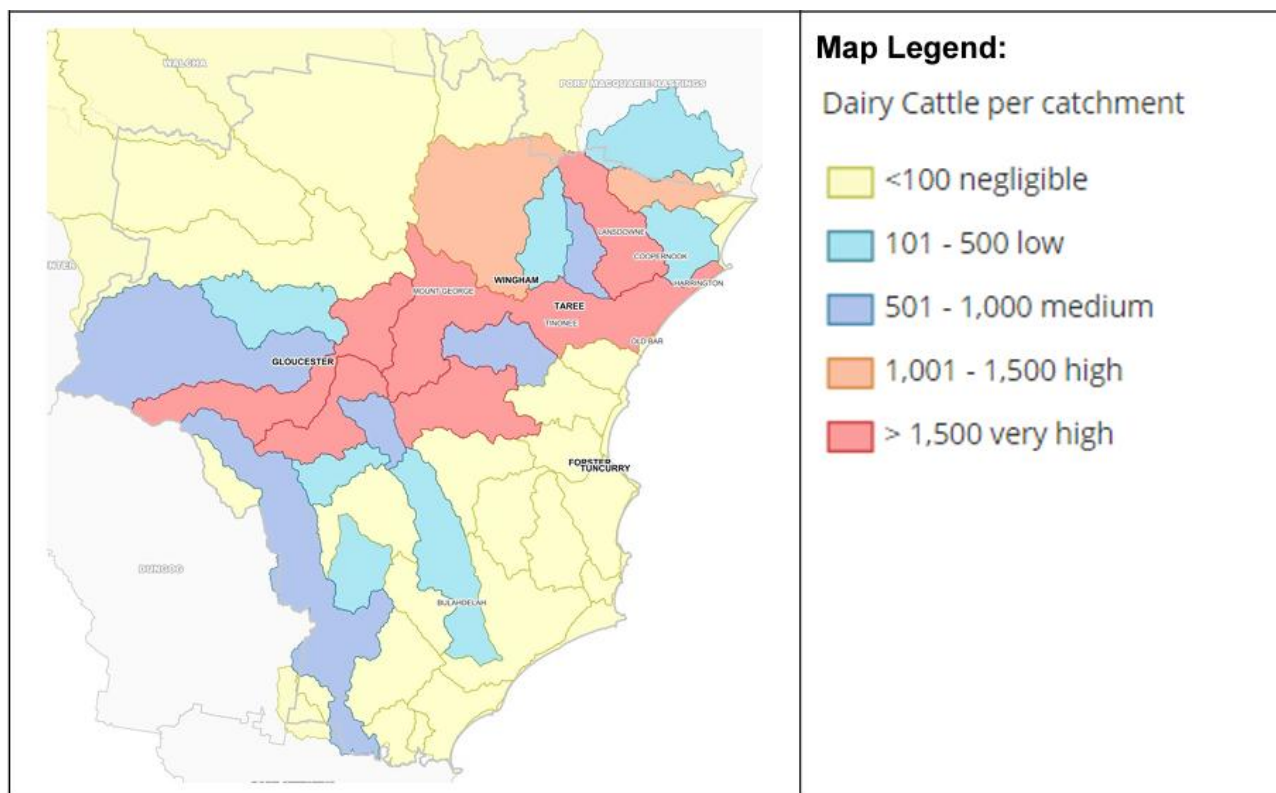


Figure 2: Dairy cattle stocking densities in MidCoast Council. Figure courtesy of MidCoast Council 2021, mapping based on LLS data from 2018.

Poultry

Poultry stock intensity rates are highest in the Karuah River catchment (Figure 3), and around Buladelah, which flows into Myall River and Myall Lakes. About 30 high intensity poultry farms exist in the catchment and are crucial to the local economy (MidCoast Council, 2021). In 2018-19 the Gross Value of Production (GVP) for the poultry industry was \$41 million, contributing nearly 9% to the total value of agricultural production in the region.

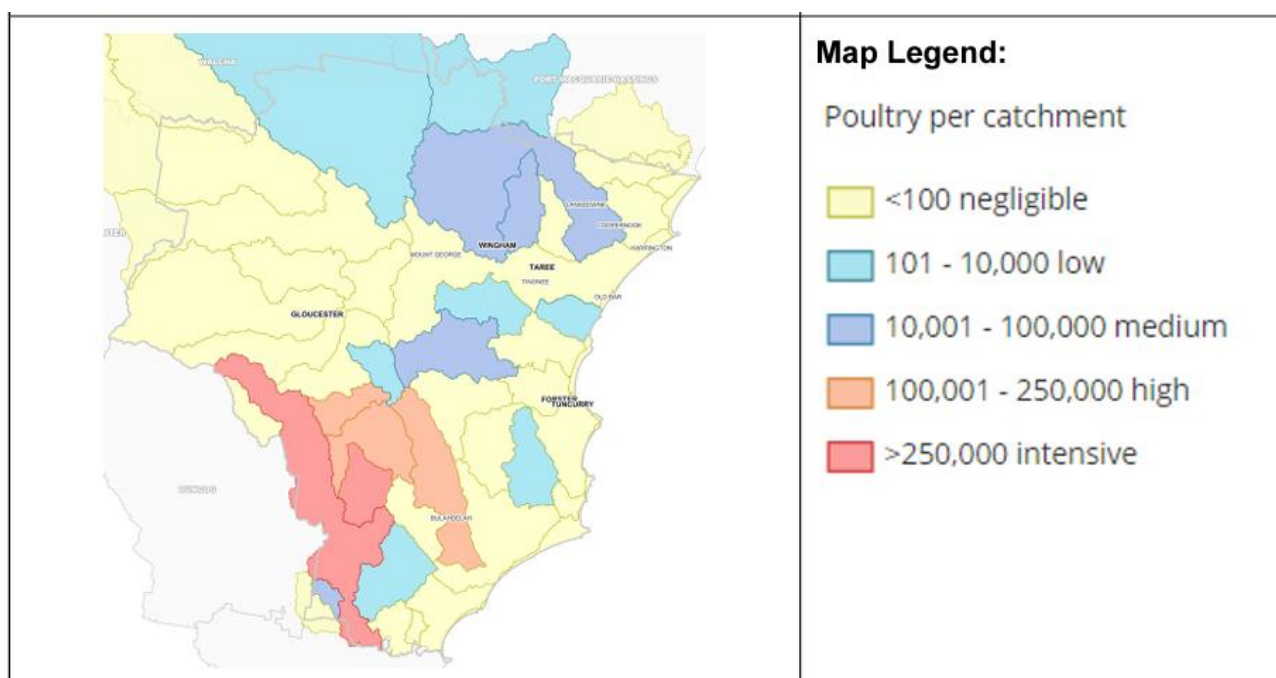


Figure 3: Poultry stocking densities in MidCoast Council. Figure courtesy of MidCoast Council 2021, mapping based on LLS data from 2018.

Horticulture

Horticulture is a relatively small industry in the MidCoast LGA when compared to other agricultural industries. Horticultural commodities that contribute the most to the economy of the MidCoast LGA are cut flowers (\$1.3 million), avocados (\$0.6 million), berries (\$0.2 million), macadamias (\$0.2 million) and beans (\$0.1 million) (MidCoast Council, 2021). There are a small number of vineyards across the Southern Estuaries catchments, predominantly in the Karuah, Myall and Wallis Lake catchments.

Forestry

Forestry Corporation of NSW has been managing environmental sustainability, tourism and renewable timber production in NSW's State-owned commercial native and plantation State forests for more than a century.

The NSW Forest Management Framework outlines the key legislation, policy, regulatory instruments and programs that regulate and support forest management in NSW across all public and private land tenures and Forestry Corporation's Annual Report and Sustainability Reports report key outcomes in each of these areas annually.

Relevant to the MidCoast LGA is the Forestry Management Plan (FMP) for the Softwood Plantations and Coastal and Tablelands Hardwood Forests (Forestry Corporation, 2022). This FMP describes the key activities undertaken and facilitated as part of the forest management including timber harvesting, native forest regeneration, plantation establishment, weed and pest control, fire management, road maintenance, and community partnerships, recreation and public access.

Figure 4 provides a map of State Forests across the catchments related to the study area. Logging and other forestry operations only take place at times in these catchments.

Soil compaction resulting from logging decreases water infiltration rates, increases runoff rates and therefore increases erosion. Because the 'duplex soils' (those with contrasting textures in the soil profile) of south-eastern Australia are particularly prone to sealing (becoming impermeable) when vegetation is removed and they are exposed to rain, the risk of erosion is greater in south-east Australia than for other areas. Logged areas may contribute up to five times more sediment to water bodies than undisturbed catchments. Road building associated with logging practices can also increase turbidity in streams in certain circumstances. (Webb et al., 2012).

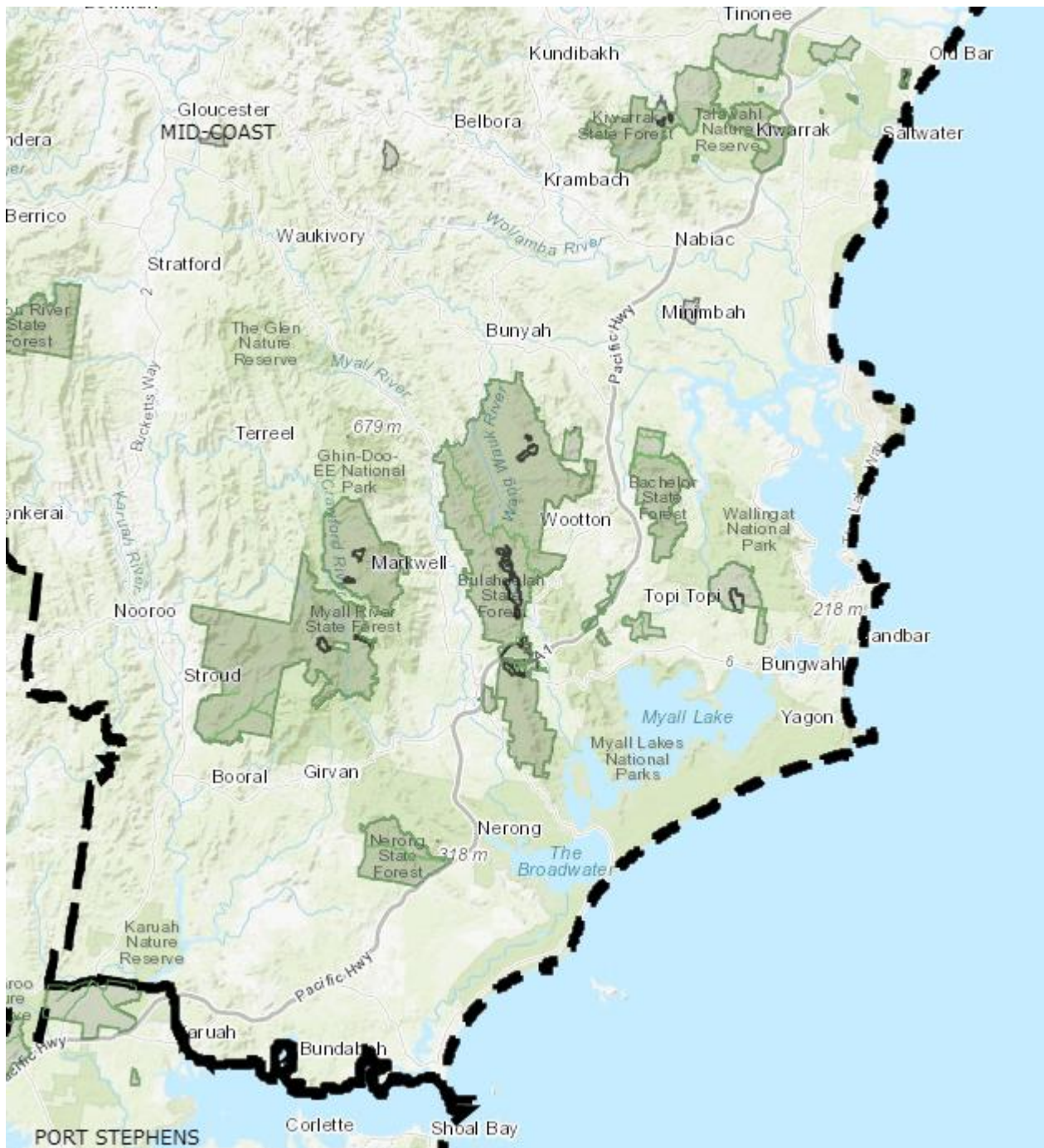


Figure 4: State Forests across the catchments related to the study area.

General

The MidCoast Regional Economic Development Strategy (2018) identified the economic importance of rural industries as the top specialised industries in the MidCoast LGA when compared to NSW. While these industries do not generally employ a large number of people, they have a competitive advantage as specialised industries for the region.

The rural industry in MidCoast Council is sometimes subject to land use conflicts. Conflict can be from expanding urban development, impacts on water quality or from people seeking a rural lifestyle (MidCoast Council, 2022). Ensuring that these activities are protected, while promoting sustainable practices, is essential.

Community consultation undertaken when developing the Manning River Estuary and Catchment Management Program (CMP) revealed the cultural significance of farming in the area. Farming is a way of life for many in the region, with multi-generational family connections to the land. This is expected to be the case in the Southern Estuaries catchment too. Rural scenery associated with agricultural landscapes is also part of the regional identity. Farming contributes to employment, food security and export earnings. Rural produce is supplied to the local community through farmers' markets and retailers and distributed to export markets.

1.1.2 Water Quality Issues Within the Study Area

Water and sediment quality in estuaries are affected by complex interactions of catchment inputs and tidal exchange processes. Monitoring programs, such as the Waterways and Catchment Report Card, provide insight into estuarine health, with water quality scores ranging from moderate to excellent. Increased nutrients and turbidity directly impact on some ecosystems in the study area.

Water quality within the study area is managed under the *Great Lakes Water Quality Improvement Plan* (GLC, 2009) and monitored and reported on annually (*Waterway and Catchment Technical Report, Catchment Report Card*). While management actions, along with conservation efforts in national parks and state forests, have helped mitigate some impacts, challenges remain.

According to the 2023 *Waterway and Catchment Report*, an improvement in water quality has occurred in Khappinghat Creek estuary, whereas the conditions in Karuah River and Bombah Broadwater have declined. The best rating estuary over time has been Myall Lakes. The conditions within most estuaries fluctuate between moderate and good.

The Myall Lakes system, despite its protected catchment areas, remains sensitive to pollutant loads. Downstream areas, like Bombah Broadwater, experienced elevated nutrient levels from agricultural runoff, leading to increased algal concentrations. Similarly, the Karuah Estuary, and Port Stephens exhibit good water quality overall, though concerns regarding nutrient loads and turbidity persist, particularly in the Karuah River.

The Branch Estuary (which leads into the Karuah River) has a primary land use of cattle grazing land with some forest and woodland in the upper catchment. It received a poor grade for algal growth in 2023, which exceeded desired levels all season. However, water clarity remained good. Overall, the Branch and Karuah Estuaries range between C and B water quality ratings, with algal growth receiving a grade of poor in 2023. Rain events can cause increased turbidity and algal growth from excessive nutrients resulting from agricultural uses. For example, the Waterway and Catchment Technical Report Card (MidCoast, 2023) reported that "*High algal abundance on January 16, 2023 was probably fuelled by nutrients in catchment runoff from a moderate rain event of 40mm, 7-10 days prior*".

1.1.3 Stressors and Impacts

Agricultural activities have historically and continue to exert a significant influence on the catchment and estuaries within the study area. Activities associated with agriculture such as land-clearing, groundcover loss and soil degradation accelerate the rate of rainwater runoff and erosion, carrying sediments, nutrients, pathogens and agricultural chemicals into waterways of the catchment and estuary (NSW Department of Environment and Climate Change NSW, 2009).

Potential direct impacts from agriculture on water quality include increased nutrient loading, sediment, and acid leachate into the water, issues that commonly occur in some of the study area estuaries (GLC, 2009).

Land Clearing

Coastal wetlands in the study area catchments and estuaries have historically been extensively cleared and drained for farming. The clearing reduced both the extent and condition of many wetlands and this still affects the wetlands in the study area today (Ecological 2024). A relatively high exotic plant cover is a feature of these degraded/transformed areas, particularly in non-urban areas where the native understorey and groundcover has been removed and replaced by pasture.

Low condition or cleared wetlands within the study area are frequently subjected to agricultural practises, with related impacts including grazing and trampling of wetland plant species, increased irrigation, and increased nutrients and eutrophication (Ecological 2024). Stock impact on the riparian zone is a widespread threat to estuary health and the impact of land-clearing and agricultural run-off is influencing health in estuarine catchments. Cattle grazing is a dominant land use as detailed in the *Agriculture Issues Analysis Paper*, and stock frequently have access to riverbanks and wetlands, leading to soil degradation, erosion, reduced vegetation and poor water quality.

Additionally, land cleared for agricultural purposes can also have higher levels of Acid Sulfate Soils. In their natural state, these soils are submerged but when exposed or drained, they become oxidised and sulphuric acid is produced. This reduces soil fertility, kills vegetation and reduces fish populations.

Nutrient runoff and water pollution

Nutrients used for fertilising cropped field and pastures can end up in waterways through runoff water. Increased nutrient loads can cause algal blooms and imbalances in the ecosystems. Algal blooms are detrimental both to human and ecosystem health.

Much of the chicken manure from the poultry farms in Karuah River catchment is used to fertilise grazing areas around the farms, creating potential increases in nutrient runoff into the waterways. The Karuah River flows into Port Stephens-Great Lakes Marine Park, containing a range of valuable aquatic habitats (MidCoast Council, 2021b).

Stock manure on streambanks and in adjacent pastures is a potential source of pathogens to waterways, risking the health of both humans and the ecosystem.

Agricultural activities significantly impact water quality in the estuaries of the study area, with ongoing efforts needed to mitigate these impacts and ensure the long-term health of estuarine ecosystems. Areas with intense agricultural land use face heightened ecological risks, emphasizing the importance of targeted management strategies to safeguard water quality and ecosystem health. Healthy in-stream condition contributes to the conservation of aquatic fauna. More detailed information can be found in Appendix 6 of the Great Lakes Water Quality Improvement Plan, which investigated subcatchments and their relative contribution of nutrients to the estuaries resulting from different land uses.

Water quality testing as per the Waterway and Catchment Report Card (MidCoast Council, 2023) shows an overall trend in improvement of algal concentrations and water clarity within the estuaries over recent years. However, water quality issues still persist. Parts of the study area where the dominant land use is agriculture and where water quality issues can be seen include Wallamba catchment and the Karuah River catchment (MidCoast Council, 2023). Myall River catchment is also largely agricultural, however, the protected vegetation surrounding the lake (national parks) prevents much of the negative impacts on water quality (increased sediment runoff, nutrients) entering the Lake.

These findings are largely reflected in the 2016 Catchment Health Report (Miller, 2016) by MidCoast Council for Wallis Lake, Myall and Karuah Catchments. The report also highlights the connection between land use intensity within the catchments and water quality in the estuaries.

MidCoast Council has worked together with Hunter Local Land Services (HLLS) and local farmers to increase awareness of potential problems arising from overuse of chicken manure as fertiliser to decrease impacts on waterways. The work has proven effective and has given rise to improved farming practices with lower negative environmental impact. (MidCoast Council, 2021b)

Erosion, turbidity and degradation of riparian vegetation

Grazing and poor pasture management cause soil degradation including compaction, erosion and loss of soil structure and organics, which contribute to runoff by reducing the rate at which rainwater infiltrates into the soil.

Riparian vegetation plays a key role in reducing diffuse-source water pollution by slowing the rate of runoff, taking up nutrients and stabilising riverbanks. Livestock graze on riparian vegetation and seek shade along the creeks, trampling soft banks and drinking from streams. This results in degradation of the riparian zone by disturbing the vegetation and soil, introducing weeds, and increasing nutrients through defecation. Reductions in the extent, condition and connectivity of riparian vegetation increase the rate and impact of diffuse-source water pollution through increased runoff (NSW DPI, 2005).

Riverbank erosion also exposes acid sulphate soils that can cause acid leaching into the waterways. Drainage channels dug across the floodplain to allow cropping of areas has also changed the local hydrology, impacting on the local vegetation communities. These channels also require maintenance, and excavations to clear them can expose acid sulphate soils (Hughes, 2024).

Seagrasses are sensitive to light changes and an increase in turbidity will negatively impact on seagrass growth and may in severe cases cause seagrass die-off. Turbidity can be caused by sedimentation of the waterway due to erosion or an increase in phytoplankton due to high nutrient availability. Seagrasses are important aquatic habitats and act as fish nurseries. A loss of seagrass meadows could therefore have detrimental effects on the local ecosystems and fish stocks (MidCoast Council, 2023).

Riverbank restoration and rehabilitation projects within the riparian zones are supported by Council and HLLS. The project focus has been on improving farm management, protecting coastal wetlands and enhancing biodiversity in the Karuah River Catchment. Riparian vegetation was fenced off and rehabilitated on 8 neighbouring properties in The Branch catchment, resulting in protection of 270 ha of wetlands and 50 ha of riparian vegetation (MidCoast Council, 2021b).

A recent 2021 study has determined that only 117 ha of woody vegetation is required for all riparian and littoral zones in the Manning, Great Lakes and Karuah catchments to exceed 70% cover by 2040 (Pietsch et. al, 2021). This 117 ha is in addition to the natural regeneration rate of woody vegetation, which is estimated to be increase to 3000 ha by 2040. The study notes that all but 10 of streams or lakes within these catchments will have a woody vegetation cover greater than 70% by 2040, requiring only 6 ha/year revegetation efforts per year for the remaining streams and lakes (Pietsch et. al, 2021).

Climate change

Climate-change modelling for the NSW North Coast region predicts hotter summers, rainier springs and autumns, and drier winters. More severe drought conditions, as well as increased severity of storms and floods, is anticipated (Adapt NSW, 2024). More frequent and prolonged drought has potential to exacerbate soil degradation through loss of pasture cover and soil carbon. More

extreme weather events will accelerate the rate of runoff and diffuse-source water pollution during high rainfall events.

Resulting sea level rise can create habitat squeeze in areas where vegetation cannot recede landwards and could lead to accelerate rates of riparian vegetation loss. Where agricultural practices occur close to a waterway riparian, vegetation may not be able to migrate further up on the bank.

Community

Behaviour change from community members is a key step to improving the health of the Southern Estuaries. Water quality impacts arising from agriculture and rural land use is a key issue. As part of the Manning Estuary CMP, MidCoast Council commissioned a report that investigated the motivations and challenges for beef and dairy farmers in implementing measures to improve the ecology of the Manning River Basin, and to report on its findings, with recommendations to support those farmers to change (MidCoast, 2019). Key findings from this could be implemented for the Southern Estuaries CMP, as similar challenges exist for both study areas. These findings include:

- Increased education on the Southern Estuaries health – need to acknowledge there is a problem before fixing it.
- Need long term solutions, not immediate fixes that then cause further problems/financial implications down the line.
- Providing incentives, training and extension advice to develop new concepts and skills
- Supporting peer-to-peer learning;
- Negotiating win-win management actions.

1.2 Stakeholders

Management agencies

Hunter Local Land Services; MidCoast Council; DPI Department of Agriculture

Community stakeholders and groups

Karuah & Great Lakes Landcare (Bulahdelah Sustainable Farming Group; Wang Wauk Wallamba Sustainable Farming Group; Wootton-Topi Topi Sustainable Farming Group); Women in Dairy; Young Farmers Network; Biodynamic farmers; Economic Development Council; Growers Markets; NSW Farmers; Great Lakes Food Trail

Community and stakeholder engagement

A community survey and other stakeholder engagement activities conducted in Stage 1 of the Southern Estuaries CMP identified water quality and agriculture runoff as key issues in the study area.

1.3 Existing Management Approach

Legislative controls are in place to manage agricultural pathogens, pesticides and chemicals, but compliance and monitoring are weak. The current scale of actions to mitigate agricultural impact does not correspond with the large scale of diffuse source runoff.

Great Lakes Water Quality Improvement Plan

The Great Lakes Water Quality Improvement Plan (WQIP) was developed by MidCoast Council as a framework for practitioners and catchment/estuary management groups to improve water quality in Wallis Lake, Smiths Lake and Myall Lakes. This plan covers the lakes and surrounding catchments. It was developed in partnership with agencies, industry groups and the community.

The WQIP focuses primarily on algae concentration and water clarity as indicators of estuarine ecological condition due to the impact increased algal biomass and decreased water clarity can have on estuarine function and used microalgae (chlorophyll-a), water clarity (turbidity) and extent of seagrass as the primary indicators of estuarine condition.

A variety of water quality data for across the study area has been collected in past and present monitoring programs. This includes water quality sampling undertaken as part of the Waterways and Catchment Report Card Program. Based on both new and existing research, modelling and community engagement, a range of management support actions to protect, support and, where required, restore the ecological health of these systems were identified. Proposed remediation actions related to agriculture include:

- Groundcover management
- Nutrient (fertiliser) management
- Infrastructure (dam) management
- Riparian zone protection
- Future investigation relating to the Farm Scale Action Plan

Karuah River Catchment Management Plan

The Karuah River Catchment Management Plan was developed in 2015 by MidCoast Council in response to the ecological health assessment undertaken in 2011/12 by the NSW Office of Environment and Heritage that determined the Karuah River and its estuary were in moderate ecological condition with indicators of poor and degrading ecological condition. It was established to provide a framework that guides future management actions to ensure the long-term health of the catchment through the restoration and preservation of the catchment's ecosystems.

Management actions related to agriculture in the Karuah Coastal Management Plan include riparian zone rehabilitation, stock exclusion fencing, grazing management, rural landholder education and capacity building, and improvements for the poultry industry in relation to nutrient runoff.

Wallis Lake Estuary and Catchment Management Plan

The Wallis Lake Estuary and Catchment Management Plan, prepared by Great Lakes Council, was finalised in 2014 and outlines recommendations for management actions to provide a unique and sustainable environment balanced with lifestyle opportunities through development, infrastructure and services. The scientific information underpinning this new Management Plan was adopted from the Great Lakes WQIP and the subsequent research and management projects that followed. The Plan was also developed through extensive review of the existing Wallis Lake Estuary Management Plan and Wallis Lake Catchment Management Plan in conjunction with internal and external stakeholder engagement.

Management actions within the plan that directly relate to agricultural impacts include collaboration with landholders, development of weed management strategies and riparian vegetation and wetland protection.

Coastal Zone Management Plan for Smiths Lake Estuary

The Smiths Lake Coastal Zone Management Plan (CZMP) was finalised in 2018 with the primary purpose of acting as a guide for future Council actions. It provides strategic direction and specific focus for the short and long-term sustainable management of the Smiths Lake Estuary, its tributaries, its surrounding foreshore lands, and its catchment insofar as catchment activities impact on the condition of the Lake. The Plan has a particular focus on maintaining or improving the environmental qualities and attributes of Smiths Lake Estuary.

There is a number of management actions within the Smiths Lake CZMP that more generally relate to pollution and water quality impacts, bank erosion and vegetation management.

MidCoast Rural Strategy

The Rural Strategy provides a 20-year vision for planning for the rural and natural landscapes in MidCoast LGA. The purpose of the strategy is to meet the changing circumstances around rural land uses and pressures from growth while ensuring the planning framework meets the communities needs and vision for the future. A review of existing planning frameworks for rural lands was undertaken, including all rural and natural landscape zones ranging from waterways zones to rural zones.

Key planning controls include land use zones, minimum lot sizes for subdivision and maximum height of buildings, as well as issues such as paper subdivisions, urban release areas, drinking water catchments and areas of high velocity flooding. The information from the Rural Strategy feeds into the new draft Local Environmental Plan and Development Control Plan for the MidCoast LGA.

Koala Conservation Strategy

MidCoast Council has developed a strategy to guide the conservation and management of koalas and their habitat across the LGA for the next five years. The Koala Conservation Strategy forms part of the broad koala conservation program in the MidCoast, called the Koala Safe Spaces Program, documenting management actions for koala recovery and conservation. The strategy has been informed by koala sightings data, habitat mapping, applied scientific knowledge and the ideas and perspectives of stakeholders and the community.

Based on the modelled koala habitat maps, the study area has significant areas of koala habitat and recorded sightings, particularly around Tea Gardens and northern Port Stephens, as well as around Smiths Lake, but with records throughout most of the LGA.

Riparian zones are important koala habitat as well as acting as corridors for movement between populations. The forestry industry also has the potential to significantly impact on local koala populations due to clearing and degrading their habitat.

Hunter Local Land Services Catchment Management Funding

HLLS operates an agricultural extension program including incentive grants when funds allow. Projects to reduce diffuse-source water pollution include stock-exclusion fencing to protect riparian vegetation and providing off-stream water-points and alternative shade, as well as introducing rotational grazing to improve pasture cover.

The Hunter-Central Rivers Catchment Management Plan 2013-2023 was established under the *Catchment Management Authorities Act 2003* which has now been repealed by Section 210 (b) of the *Local Land Services Act 2013*. The plan has not been updated to current management plan for the catchment by HLLS.

MidCoast Council catchment management programs

MidCoast Council run a number of programs aimed at improving catchment management with private land holders. One such example is Beyond the Shed, a partnership with LLS to engage with over 30 poultry farmers to improve overall farm management and reduce impacts on downstream water quality. The project focused on nutrient management (such as from litter stock piles or high nutrient paddocks) while improving the farm's business – specifically the ancillary grazing business that most poultry farms operate on the side.

1.4 Knowledge Gaps

- Nutrient runoff from land under different management regimes
- Impact of climate change on catchment hydrology and therefore diffuse pollutant transport into the estuaries
- How to tackle private vs public benefit
- Future water security
- What are the opportunities to link financial return with catchment benefits (eg 100% groundcover 100% of the time), what are the other opportunities? Productivity benefits of sub-dividing paddocks, riparian fencing, etc.
- The Manning ECMP investigated motivations and challenges for beef and dairy farmers implementing measures to improve the ecology of the Manning River Basin (MCC, 2019). Key findings from that could be applied for the Southern Estuaries CMP. This includes:
 - Increased education on the Southern Estuaries health – need to acknowledge there is a problem before fixing it.
 - Need long term solutions, not immediate fixes that then cause further problems/financial implications down the line.
 - Providing incentives, training and extension advice to develop new concepts and skills
 - Supporting peer-to-peer learning;
 - Negotiating win-win management actions

1.5 What's working, what's not?

What's working

- Increasing demand for information and training in Regenerative Agriculture and Rehydrating the Landscape, across Australia and locally.
- Private conservation agreements on environmentally sensitive land.
- Council acquisition and remediation of agricultural land for conservation.

- Environmental field officers and incentive programs (e.g. through Hunter Local Land Services, Landcare, former MidCoast Water).
- Whole-of-farm and holistic management training offered by Landcare.
- Landcare and Sustainable Farming Groups appeal to new farmers/landholders that want to feel part of a community.
- Stock exclusion
- Beyond the Shed
- River Revival

What's not working?

- Farmers within the study area don't have the cultural experience or knowledge about how to manage during drought conditions due to experience in a milder climate. Farms were overstocked during the drought. Farmers didn't look ahead and know when to de-stock.
- What happens on the land has the biggest impact on the river and estuary. Improving land management is the key rather than focusing on the river.
- Erosion and sediment loss from farm paddocks remains an issue, demonstrated by the sediment build-up in farm dams being cleaned out during the drought.
- Landscape is drying out.
- Rate of run-off is increasing (more cleared areas, hard surfaces, less groundcover).
- Engagement with horse owners is a gap. Horses can be intensive and have a large impact.
- Public land – Crown, road reserves – allowing cattle into riparian zone.
- Absence of regulation relating to nutrient discharges from farms, use of fertilisers etc. NZ has introduced reforms with controls on nitrogen pollution and farm practices.
- Modification of the riparian areas is impacting significantly on potable water supply due to loss of banks and sedimentation. Flood peaks are higher and ongoing sediment load is higher.
- There is significant potential to improve pastures using regenerative farming methods.
- There is community pressure on Council to reduce rural lot sizes – needs to be managed carefully.
- Potential impact of land-clearing on local water cycle and microclimate.
- Hotspots - concentrating investment in the worse spot - ignoring protection and improvement of the ok- good areas.
- Seagrass loss – why?

1.6 Opportunities

- Regenerative farming and rehydrating the landscape, noting the considerable interest in amongst cohorts in the district including young farmers, hobby farmers and agribusiness. Early adopters are reporting success with these practices. This has seen a considerable uptake in recent years, in particular with more young farmers in the region and new landholders post-covid.
- Government bodies and academics are beginning to support practice change by documenting credible scientific evidence on the impact and repeatability of regenerative agriculture practices on the physical, chemical and biological health of the soils and the associated long-term economic, environmental and social benefits.
- New farm practices being introduced by young graduates:
- Continue to deliver incentive and engagement programs to promote the benefits of the actions that will improve catchment health and farm productivity (e.g. fencing river banks to keep cattle within property boundaries)
 - Share a vision but don't be too prescriptive. Encourage people to engage individual and innovative ways then share knowledge and experience
 - Encourage and support young farmers who have had high levels of training, encourage peer on peer learning - authorities are the last step.
 - Council promote property planning via website.
 - Landholder booklet with contact lists, legislation, farm planning.
 - Farmers markets opportunity to provide information to farmers and reach new farmers
 - Maintain continuity of catchment management efforts to bridge the knowledge gap when funding cycles impact on engagement opportunities.
 - Use local media for stories showcasing good agricultural practice. Maintain agricultural extension promoting sustainable farming as a field of expertise through face to face, sustainable farming groups etc.
 - Promote holistic farm management, whole farm planning and management through extension, support, demonstration farms.
 - Build expertise in regenerative methods to improve soil health: healthy soils can improve water infiltration, erosion. Building the soil sponge will also buffer or mitigate the impacts of climate change.
 - Promote the role of trees and native vegetation in the agricultural landscape. Trees create rain. Whatever we can do to encourage trees would be good - even crop trees, fodder trees or timber trees within farming systems, not just natives.
 - The CMP team could join meetings at the fire sheds to discuss fixing estuary issues.
- Work with the large commercial more traditional farmers to maintain productivity while managing environmental impacts.
- Support more sustainable technologies on productive farms e.g. Smiths Farm in the Myall should be supported.

- Advocate to improve management of public land (Crown land, RMS) for conservation e.g. impose licence conditions on farmers using their land.
- MCC is working on a new Local Environment Plan (LEP) and reviewing zoning and development controls. Opportunity to improve environmental outcomes.
- Offer rate relief to encourage people to achieve environmental outcomes identified through the Rural Strategy being developed by MCC.
- As estuarine farmland becomes less viable, convert to natural areas (e.g. wetlands). Demonstrates how the results yield increased estuarine productivity for aquaculture, fish etc.
- Carbon farming – investigate opportunities of increasing carbon sequestration, for example Living Carbon funding. This could involve financial return for property holders, with significant catchment benefits. Could be targeted to areas in the catchment that would get the best environmental return, for example steep slopes, or low grazing/productivity return.
- Build the link between premium produce, a healthy environment and sustainable farming practices (e.g. Tasmania, King Island). We can strengthen the region's brand and bring our farming practices into line with the values we hold for our spectacular natural environment.
 - Integrate economic development with environmental outcomes particularly with high intensity farms: value-add to products with clean environment branding.
 - Farmers practicing good environmental stewardship can get a premium price on their produce, for example through organic or biodynamic certification or the new Land to Market system. Investigate opportunities to build a local brand (e.g. Farm to Fridge) or co-op with best practice guidelines to develop a reputation for good land stewardship and premium produce.
- High nutrient pastures from prolonged chicken litter application – managed as grazing enterprise / lease/ agist to make most benefit out of it. Also remove nutrients (phosphorus) through intensive grazing.
- Focus on water quality impacts from agricultural industries within the drinking water catchment of the Crawford River.
- The River Styles recovery potential and prioritisation framework has been used on the NSW River Styles database to develop a workflow for identifying and prioritising where corridors of river recovery can be built in all coastal catchments of NSW. Could use this as a tool to prioritise where to invest.
- Expand Beyond the Shed
- Use of Council's greenwaste near chooksheds
- Greater monitoring of nutrient loads
- Hold an event for hobby farmers
- Potential for rate rewards for compliance and improvements
- Undertake workshops on weekends for maximum landholder attendance

1.7 Management Options

Governance

- Develop a sustainable agriculture vision for MidCoast; similar programs are being operated by Council, LLS and Landcare, however if unified could result in a better outcome.
- Develop a catchment plan for the Myall River. The Ramsar character description is strongly linked to the amount of algae in the system and the water quality so it is really important to have good catchment management

Planning

- Use the Rural Strategy, Local Environment Plan (LEP) and DCP to encourage appropriate land use, reduce agricultural impacts and improve environmental outcomes.
- Put planning controls in place in the Myall River Catchment to protect Ramsar site.

Capacity Building

- Continue to deliver behaviour change engagement programs across the catchment.
- Locally relevant demonstration projects in each catchment.
- Use flexible approaches relevant to the demographic, farm type, size, level of risk for the location or type of farm (e.g. tailor whole farm management to meet responsive to farmer needs; productivity plus environmental outcomes).
- Support farmer-to-farmer learning
- Package communication for different target audiences.
- Run an outreach program with property visits. Maintain extension staff/catchment officers to resource this approach.
 - Link engagement to current issues e.g. drought and water security to encourage off stream watering, fence off dams and include watering points from dams.
 - Provide technical advice on installation of dams to reduce their potential impact.
 - Education about options for management of land identify and promote triggers for management e.g. ground cover triggers for allowing cattle into fenced riparian areas.
 - Support the sustainable farming program long term. Use the CMP as a way of sourcing funds for land management, technical and engagement advice for landholders.
 - Talk about, educate and inform people about ecosystem services, what the river gives to us and what we need to do to protect it.
 - Work more with farmers, Landcare to promote a transition to regenerative farming.
 - Educate new arrivals, targeting property buyers in high priority areas.
- Offer incentive programs for riparian management, especially in high value areas (e.g. in the tidal zone). Maintain finance to support this approach.

- Design projects to meet their individual needs for management. Highlighting benefits for the farmer.
- Focus on 'whole reach' fencing by working with connected properties.
- Offer stewardship payments for landholders for best practice management of farming land.
- Improve clarity on what 'best practice' looks like including a range of options for different types of farms.
 - Define and promote best practice targets for nutrients, buffer zones, management of weeds on river banks, ground cover levels – especially when the farms have river frontage.
 - Provide credible regenerative farming advice, info on benefits and methods and where to get it.
- Continue Beyond the Shed. Target other industries as well, and mentoring for landholders
 - vineyards,
 - cottage industries (environmental outcomes and benefits are often core to the niche product that you're buying);
 - dairy specific
 - Private Native Forestry
- Birds on Farm pilot currently operating - how to link this to on-ground actions > delivering water quality outcomes. (Frogs on farms?)

Regulatory Compliance

- Best practice behaviour programs
- Incentives for stock exclusion and improvement of riparian areas

Science and research

- Pasture trials - mitigation of Phosphorous impacts from poultry farms and farms with historic use of phosphorous
- What can we learn from the blueberry industry?
- Lidar analysis of banks in regards to sediment loads
- Currently got a project in Manning estuary- could you extend to upper catchment? Where? (SEC workshop to expand to Southern Estuaries)
- Nutrient monitoring programs
- Implement waterwatch program with landholders

Operations

- Develop a program to build the link between premium produce, a healthy environment and sustainable farming practices
- Do a demonstration project rationalising the number of drainage channels in the floodplain and changing the profile. Replace many small, deep channels with a few wide, shallow, laser-levelled drains that can be grassed with pasture cover. It could reduce acid leachate and improve productivity of the farms on lower reaches of the estuaries.
- Facilitated multi-species plantings (ground-cover, understory and canopy planting)
- Retrieve floating oyster racks
- Citizen Science – waterwatch, eDNA and macroinvertebrate training for landholders
- Pest management control including deer culling and other ferals
- Expansion of the River Revival program into the Southern Estuaries
- Increased education and capacity building around the importance of protecting the river
- Facilitate landholder to landholder engagement
- Incentives for stock exclusion and improvement of riparian areas
- Investigate alternative options for soil improvement
- Cull of introduced species like deer, fox, rabbit etc
- Deposit Council Greenwaste near chooksheds

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ISSUE ANALYSIS

AQUACULTURE AND

COMMERCIAL

FISHING

2024

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1. Aquaculture and Commercial Fishing

The Southern Estuaries of the MidCoast Council LGA provide a stunning natural environment, a multitude of recreational opportunities, and are also a key contributor to the “blue” economy that supports the local communities. Aquaculture and commercial fishing are both important industries in the area, and recreational fishing is widespread throughout the region. Fishing and aquaculture activities have far reaching cultural and economic values in the region, and represent a major drawcard for the region’s tourism industry.

This issue paper focuses on the risk of aquaculture and commercial fishing to the Southern Estuaries, as well as impacts from environmental factors on aquaculture and fisheries. This includes, but is not limited to unsustainable fishing limits, fisheries productivity, and aquaculture diseases. Related CMP Issue Papers include Agricultural Impacts, Biodiversity Loss and Habitat Loss and Degradation.

Authors: Petra Arola

Contributors:

Kate De Roover (NSW DPI fisheries policy), Ainslie, Downes, Megan Huggett (UNI Newcastle, microbial interactions, oysters sewage and near shore systems), Margaret Platell (UNI Newcastle, bio fouling on fisheries, food webs), Jonathan Pini, Cherie Clolyer-Morris, Andrew Hampstead, Anthony Zammit, Shane McGrath, Helmut Panhuber, Kath Cheers, Brian Hughes, Mat Taylor (Principle researcher, rec fishing monitoring), Erin Masters, Prue Tucker, Neil Duffy, Ross Fidden, Shane McGrath (NSW DPI, MEMS lead), Brent Carey (DPI Fisheries officer), Troy Gaston (UNI Newcastle), Kris Cooling (extension officer).

1.1 Situation Analysis

1.1.1 Aquaculture and Commercial Fishing Background

Oyster Aquaculture

The MidCoast region is one of Australia’s oldest and most significant producers of oysters. In 2018-2019 the NSW oyster industry produced about 76 million oysters worth \$59 million at the farm gate – and about one third of those were produced in the MidCoast LGA.

Oysters are an important regional export, as well as a draw for food-based or gastronomic tourism in the area. In general, productivity of the oyster industry is highly seasonal and dependent on weather conditions and water quality.

The coastal estuarine areas are the most important locations for aquaculture production. These estuarine areas provide ideal ecological conditions to produce a range of habitats and aquatic communities. In part, these suitable estuarine conditions are a result of the semi-tropical climate and intricate river, coastal and wetland systems.

Oyster growing within the study area is most prevalent in Wallis Lake around Forster and Wallis Island, along the northern and inner shores of Port Stephens estuary, in the Karuah estuary, and at the mouth of the Myall River. Oyster harvesting in Wallis Lake and Port Stephens dates back to the early 1880s and is an important driver for the local economy and major employer in the region.

Commercial Fishing

Commercial fishing occurs in most parts of the study area, including the Port Stephens estuary, Karuah River, Smiths Lake, Wallis Lake and Myall Lake. Prawning also occurs in Myall River.

Commonly targeted fish species include the sea mullet, tarwhine, sand mullet and yellowfin bream. Key target species also include crustaceans such as blue swimmer crabs and mud crabs.

The lakes themselves serve as important fish breeding and nursery grounds. Wallis Lake has well over 100 species of fish, and Smiths Lake alone hosts up to 78 fish species, including commercial fishing targeting species. Spawning and recruitment of fish species in Smiths Lake is dependent on the status of the lakes entrance which may limit the distribution and abundance of fish population.

Fishing within the Port Stephens – Great Lakes Marine Park is permitted according to the marine park's zoning map and user guide. While recreational fishing is allowed for permit holders in the general use zone and habitat zone, subject to some restrictions, commercial fishing is more strictly regulated. Commercial submersible nets, purse seine nets, hauling nets and prawn nets are only permitted in some locations (NSW DPI, 2021b). Seasonal closures to commercial fishing are also in place in certain locations.

Economic and Cultural Context

Oyster farming and fishing are important economic activities along the coast and in the estuaries, and the MidCoast Regional Economic Development Strategy identified the economic importance of these rural industries, particularly the oyster industry, as some of the top specialised industries in the MidCoast when compared to elsewhere in NSW. While these industries do not generally employ a large number of people, they have a competitive advantage as specialised industries for the region.

The Sydney Rock Oyster is the main aquaculture species grown in NSW and accounts for approximately 58% of all aquaculture species grown in NSW. The MidCoast Region is renowned as one of Australia's oldest and most significant producers of Sydney Rock Oysters. According to CommunityID, in 2023 the aquaculture industry across the MidCoast LGA reported \$30 million of economic output, and directly employed over 150 people (as well as indirect employment and economic opportunities to the wider community). This output has grown from around \$19 million in 2018, indicating that the industry remains a key economic growth sector for the LGA.

Generally, productivity and employment in the oyster industry is highly seasonal and is dependent on environmental and weather conditions. The oyster industry is expected to be reasonably stable in terms of output for the foreseeable future. However, the recent devastating impact of QX disease on oyster production in Port Stephens highlights the ever present risks that disease and adverse environmental conditions pose for the industry.

Not only does the aquaculture and fisheries within the region bring significant economic benefit, it also has important cultural values. Aboriginal harvesting of oyster reefs and fish populations is an important practice, and fishing and access to water resources has always been a critical element of the relationship between Aboriginal people and their traditional country (DPI 2024a). In NSW, the Aboriginal Cultural Fishing Interim Access Arrangement (ACFIA) (s 21AA) under the *Fisheries Management Act 1994* provides for the Aboriginal cultural fishing. The ACFIA has not yet been fully commenced.

Protecting and promoting cultural fishing activities of Aboriginal communities is recognised in managing the NSW fisheries resources with measures that provide for continued access to and involvement of Aboriginal people in management of the NSW fisheries resource (DPI 2024a). The Aboriginal community in MidCoast Council are included in the development of aquaculture and fishing industries and have ongoing involvement in both.

1.1.2 Stressors and Future Productivity of Commercial Fishing

The commercial fishing and aquaculture within the study area is suffering from a range of stressors outlined below.

Habitat Degradation

The lake habitats, including seagrasses, mangroves, and oyster reefs, provide important fish nurseries for commercial fish species. The seagrass meadows in Wallis Lake are particularly pivotal to supporting the lake's extensive recreational and commercial fishing industry.

The connection to healthy seagrass meadows and sustainable fisheries is recognised in the *Fisheries Management Act 1994* (FM Act) and the NSW Department of Primary Industry's (DPI) Policy and Guidelines for fish habitat conservation and management (NSW DPI, 2013). Loss of these habitats and marine vegetation in general is a big driver of declines in fish stocks.

Human activities can cause a range of stressors that result in habitat degradation, and the reported extents of key habitat areas are contracting. Turbidity, nutrient and pollutant runoff, boating and some fishing practices are among the current stressors causing habitat degradation, and climate change is anticipated to aggravate the issues. If left unchecked, the habitat degradation could have serious impacts on the fish stocks of the area if fish species are left without breeding and nursery habitats.

Contamination issues related to tar use in oyster industry also occur, polluting the environment and the habitat in oyster growing locations. Tar use is being phased out, however issues both with leakage and how to deal with disused equipment, drums of tar and tar pits persist.

Obstruction to fish passage also occurs in some waterways. Historical weirs and causeways, as well as dams, block access to passages that certain species need for their life cycles. DPI Fisheries has funding available for removal of primary obstructions and Council is notified of any obstructions that require removal.

Disease

Disease within aquaculture systems can put a significant pressure on both the natural species populations, as well as commercial species.

QX disease is caused by the protozoan parasite *Marteilia sydneyi*. The protozoan affects the native Sydney Rock Oyster (*Saccostrea glomerata*) and has occurred in a number of NSW estuaries. This disease poses a significant threat to the oyster aquaculture industry in the region, causing mortality in affected oysters. The disease has not been shown to cause harm to humans. Efforts to manage QX disease include implementing biosecurity measures to prevent its spread, such as controlling movement of infected oysters and implementing hygiene protocols. QX was first detected in southeast Queensland. In the Port Stephens estuary it was first detected in 2021, and this remains the only affected oyster farms within the study area to date. (DPI 2024b)

Other disease outbreaks in the area include the Hepatitis-A outbreak in Wallis Lake oysters in 1997. Pacific Oyster Mortality Syndrome (POMS) has also occurred in nearby areas. There has also been at least one event in 2023 where gastric disease, probably *e-Coli*, was spread from boat effluent via oysters in the lake to consumers (source personal comment). This resulted in a closure of Wallis Lake harvest areas for a limited period of time in the leadup to Christmas.

The disease outbreaks highlight the need for strict water quality controls and healthy environmental water flows in aquaculture areas. New diseases, such as white spot disease which affects prawns and crustaceans, are also likely to spread as the sea temperatures warm with climate change.

Pressure on Fish Stocks

The increasing human population in the catchments of the study area and increased seafood consumption adds stress to the fish stocks. Sustainable fishing methods, as well as monitoring of fish stocks, is essential to ensure fishing limits reflect the fish stock.

Fish population sizes are often more difficult to calculate due to a number of reasons. There is in general less information available about aquatic ecosystems, species' distributions and their interactions and movements. Changes in population estimates may be detected through changes in catches, however when a decrease in catch for a species is detected it may already have suffered a significant decline. If stocks are overfished, it is unlikely that they will recover until the quotas are lowered. Overfishing also causes imbalances in the marine food chain with potential widespread effects.

Some species are also indirectly impacted by fishing. Non-targeted species may end up being caught in nets or on lines and classified as 'bycatch'. Fish and crustaceans can end up as bycatch when targeting other species, but also many larger animals such as turtles, dolphins and birds can get entangled in nets and drown or starve to death. The degree of bycatch and entanglement within the area is not known at the writing of this issues paper.

The use of particular fishing methods can also result in unsustainable impacts on local fish stocks. Some methods are less harmful than others, e.g. in that they limit the amount of catch, they target the species and size groups correctly, or they limit the amount of bycatch. These are the fishing methods that should be favoured in a sustainable fishery. As an example, a crab trap has been developed by the fishing industry in collaboration with DPI and LLS that lets undersized crabs escape, reducing damage and mortality associated with handling and reducing the impacts of ghost fishing if traps are lost. This trap will be helpful in recovering local crab populations within the lakes.

Another issue is the loss of fishing gear and equipment within the waterways and the ocean. So called 'ghost fishing', when derelict fishing equipment in the water cause fish or other animal mortality, is a persisting issue which extent is largely unknown. Based on conversations with stakeholders, the issue occurs within the study area, and further research would be required to detect which areas are affected and to what degree.

Other Stressors

Water pollution is a major factor that directly impact fish species and their habitats and can, in worst cases, cause widespread fish kills. This issue is discussed in detail in the Agriculture and the Habitat Degradation issues papers. Oil spills, anti-fouling paints and littering from commercial and recreational boating can pollute the waterways and cause further habitat degradation. Furthermore, land use planning and infrastructure, dredging, introduced flora species, marine pests, shoaling of oyster lease areas and waste management, all impact on fisheries and aquaculture. Similarly, the future impacts of climate change can potentially be very significant. The details around these issues are discussed within separate issues papers.

1.1.3 Industry Research

Not only are oysters of economic importance within the LGA, but both naturally occurring and farmed oysters are of ecological importance too. Oyster leases are shown to provide habitat for fish and invertebrate species, particularly near seagrass beds (Smith et al. 2023), and may significantly increase fish biodiversity and abundance (Gilby et al. 2021).

Also, disused equipment provides habitat. Commercially important species such as Eastern King Prawn, Luderick and Yellowfin Bream juveniles use these habitats, and they help in supporting a healthy natural ecosystem.

Natural oyster reefs are generally on the decline across the study area, potentially contributing to diminishing fish stocks in some areas. Oyster reefs create a three-dimensional structure on flat areas, creating habitat for small species in areas that may otherwise be barren. Oyster reef restoration projects are underway in the Port Stephens-Great Lakes Marine Park and Wallamba River. These projects are subject to research initiatives including studies on restoration location planning (Gilby et al. 2021) and synergies with simultaneous restoration of other habitats such as mangroves (Esquivel-Muelbert & Bishop 2022).

Different methods of oyster farming also impact on fish habitat, especially seagrasses that are abundant in Wallis Lake. Floating bags have been shown to impact less on sensitive *Posidonia australis* seagrass meadows and could be used as a preferred oyster farming method in sensitive areas (Ferretto et al. 2022).

A push for transition to climate ready aquaculture is occurring and Hunter Local Land Services (HLLS) has been working with oyster growers since 2015 to develop adaptation responses to climate change. Small grants are given to oyster farmers to fund projects, e.g. to reduce the use of tar-treated timber, waste generation and help protect seagrass habitat. Some of the oyster reef restoration projects are also included in this scheme.

1.2 Stakeholders

Management agencies

Department of Primary Industries - Fisheries; Department of Climate Change Environment Energy and Water; Hunter Local Land Services; Marine Parks (DPI); MidCoast Council; Food Authority (DPI), NSW Crown Lands

Industry associations

Oyster growers; Professional fishers; OzFish; Ocean Watch; Wallis Lake Fishermen's Co-op; Commercial Fishermen's Co-Operative; Wallis Lake Shellfish Program

Community stakeholders and groups

Recreational fishers; Community Club Forster Fishing Club; Tea Gardens Country Club/ Fishing Club; Pacific Palms Recreation Club/ Fishing Club; Coomba Park Fishing Club; Shellfish quality assurance program

Research

Oyster reef restoration projects; Water Research Laboratory

Community and stakeholder engagement

A community survey and other stakeholder engagement activities conducted in Stage 1 of the Southern Estuaries CMP identified 'water quality' and 'diseases in the oyster industry' as key issues in the study area.

1.3 Existing Management Approach

Management of commercial fisheries and aquaculture within MidCoast LGA falls under NSW DPI Fisheries' jurisdiction, with the *Fisheries Management Act 1994* (FM Act) as the main legislative tool. Below is a brief description of those management plans and contexts that are relevant to fisheries within the study area.

NSW Fisheries Management Act 1994

The FM Act is the statewide legislation under which all fisheries and aquaculture practices, as well as fisheries resources fall. The Department of Primary Industries - Fisheries (DPI-Fisheries) is responsible for administering the FM Act and ensure decisions made about land management and development avoids and minimises impacts on fisheries resources. Its responsibilities also include the licensing of recreational fishers, enforcement of bag limits, and permits for commercial fishing activities. It is responsible for threatened species conservation and marine vegetation protection (including mangroves, saltmarsh and seagrass) across the waterways of the study area.

Fisheries also administer the *Marine Estate Management Act 2014* in coordination with the NSW Marine Estate Management Authority (MEMA), including the management of the Port Stephens-Great Lakes Marine Park. The FM Act identifies key fish habitat, threatened aquatic species, populations and ecological communities.

On a federal level, the *Fisheries Management Act 1991* defines the Australian Fishing Zone (AFZ) and provides for the majority of Commonwealth fisheries offences. It underpins both domestic and foreign compliance work and provides enforcement powers to protect Australia's valuable fishery resources.

NSW Oyster Industry Sustainable Aquaculture Strategy

The NSW Oyster Industry Sustainable Aquaculture Strategy (OISAS) is a statewide strategy that aims to pinpoint suitable areas in NSW estuaries for oyster farming, secure resource access rights for current and future farmers, and promote best practices integrating ecological sustainability, community expectations, and the needs of other user groups. It also formalises the industry's commitment to environmental care, provides a clear framework for industry operation and development, and establishes water quality parameters for sustainable production, influencing state land and water management.

Rather than providing management actions, the strategy contains guidelines for the NSW oyster industry including water quality aspects, environmental sustainability practices, best practices for maintenance of premises and leases, as well as planning, approval and permitting processes.

Australian Shellfish Quality Assurance Program

The Australian Shellfish Quality Assurance Program (ASQAP) is a government-industry co-operative program designed to assure the food safety of shellfish managed in accordance with its operational guidelines. The ASQAP is part of the Commonwealth legislations for food safety for shellfish together with the Australia New Zealand Food Standards Code and export controls. The implementation of pre-harvest and some post-harvest export standards are principally a responsibility of appropriate state government agencies. By contrast, post-harvest export standards, such as those relating to depuration, storage, handling and labelling, are largely the responsibility of shellfish producers.

NSW Shellfish Program

The NSW Shellfish Program is a program under the NSW Food Authority as the regulatory body for harvesting of shellfish in NSW. The purpose of the program is to minimise the risks of foodborne illness associated with consumption of raw shellfish. Shellfish regulated under this program include farm-produced oysters and mussels, and wild harvested pipis, cockles and clams. All NSW shellfish producers have to be licensed with the Food Authority as a mandatory condition of operation.

The NSW Marine Estate Management Strategy (MEMS)

The NSW Marine Estate Management Strategy (MEMS) sets the overarching framework for the coordination of the management of all NSW marine estate, in accordance with the objectives of the

Marine Estate Management Act 2014. The strategy is based on a threat and risk assessment undertaken in 2016-17 which then informed the priority management actions. Ultimately, the strategy outlines how to manage threats to the environmental assets, as well as to the social, cultural and economic benefits the community derives from the marine estate.

MEMS Management Initiative 6 *Ensuring sustainable fishing and aquaculture* identifies the benefits and highlights the importance of locally sourced seafood for industry, personal and Aboriginal cultural use. It also identifies threats from fishing and aquaculture operations, including risks for threatened species, habitats and fish assemblages. The strategy then lists nine management actions based on the threats and stressors.

Great Lakes Water Quality Improvement Plan

The Great Lakes Water Quality Improvement Plan (WQIP) was developed by MidCoast Council as a framework for practitioners and catchment and estuary management groups to improve water quality in Wallis Lake, Smiths Lake and Myall Lakes. This plan covers the lakes and surrounding catchments.

The WQIP focuses primarily on algae concentration and water clarity as indicators of estuarine ecological condition due to the impact increased algal biomass and decreased water clarity can have on estuarine function and used microalgae (chlorophyll-a), water clarity (turbidity) and extent of seagrass as the primary indicators of estuarine condition.

Based on both new and existing research, modelling and community engagement, a range of management actions to protect, support and, where required, restore the ecological health of these systems were identified. None of the actions directly relate to fisheries, however the supporting actions include sampling of fish stocks as an indicator for water quality monitoring.

Karuah River Catchment Management Plan

The Karuah River Catchment Management Plan was developed in 2015 by MidCoast Council in response to the ecological health assessment undertaken in 2011/12 by the NSW Office of Environment and Heritage that determined the Karuah River and its estuary were in moderate ecological condition with indicators of poor and degrading ecological condition. It was established to provide a framework that guides future management actions to ensure the long-term health of the catchment through the restoration and preservation of the catchment's ecosystems.

The plan is underpinned by four guiding principles, including community participation in managing the catchment, the value of healthy rivers and riverbanks, catchment health influence on the local economy, and ecosystem resilience.

Management actions directly related to fisheries and aquaculture in the Karuah Coastal Management Plan relate to management of and knowledge sharing within the oyster industry, fishways and monitoring of recreational fishing.

Wallis Lake Estuary and Catchment Management Plan

The Wallis Lake Estuary and Catchment Management Plan, prepared by Great Lakes Council, was finalised in 2014 and outlines recommendations for management actions to provide a unique and sustainable environment balanced with lifestyle opportunities through development, infrastructure and services. The scientific information underpinning this new Management Plan was adopted from that developed in the Great Lakes WQIP and the subsequent research and management projects that followed. The Plan was also developed through extensive review of the existing Wallis Lake Estuary Management Plan and Wallis Lake Catchment Management Plan in conjunction with internal and external stakeholder engagement.

Management actions within the Plan that directly relate to fisheries and aquaculture include reducing impacts on fish passages, biosecurity programs, sustainability goals for fishing and aquaculture, dredging, debris and the indigenous fishing strategy.

Coastal Zone Management Plan for Smiths Lake Estuary

The Smiths Lake Coastal Zone Management Plan (CZMP) was finalised in 2018 with the primary purpose of acting as a guide for future Council actions. It provides strategic direction and specific focus for the short and long-term sustainable management of the Smiths Lake Estuary, its tributaries, its surrounding foreshore lands, and its catchment insofar as catchment activities impact on the condition of the Lake. The Plan has a particular focus on maintaining or improving the environmental qualities and attributes of Smiths Lake Estuary.

The CZMP represents an update and revision of the previous Smiths Lake Estuary Management Plan which outlines actions that should be followed in order to maintain Smiths Lake as a healthy and productive estuarine ecosystem. Following the review process, the revised CZMP plan was designed to assist to achieve improved environmental conditions balancing human and ecological demands on the Lake.

Management action within the CZMP directly relates to fisheries and their management include investigation of fish health and increased enforcement of fishing zones and regulations.

MidCoast Rural Strategy

The purpose of the MidCoast Rural Strategy is to review the rural lands and their uses, looking at the existing situation, NSW Government and industry trends and how to maintain and ensure the rural lands remain productive and relevant into the future. Commercial fishing and aquaculture also fall within the rural uses category and are therefore included in the review.

The strategy applies zones to waterbodies depending on their level of sensitivity and use. Smiths Lake is zoned Natural Waterway due to being environmentally sensitive, while Crowdy Head Harbour and Cape Hawke Harbour are zoned Working Waterways to reflect their commercial activities. Based on this zoning, land use decisions can be made allowing industries operations while maintaining a balance with the environmental values of each area.

1.4 Knowledge Gaps

- Emerging diseases and impacts from climate change and other stressors.
- The future of fish stocks: impacts from stressors that cause declines or imbalances, affecting what would be considered sustainable fishing quotas.
- What sustainable fishing quotas look like going forward.
- The extent of impacts from ghost fishing on marine fauna.
- The potential to expand land-based aquaculture in the area.
- Impacts of foreshore development on fish stocks.
- Don't really understand the benthic communities – gap in understanding.

1.5 What's working, what's not?

What's working

Workshop output

- MidCoast LGA output of \$229 million last Financial Year for production, very economically productive region within NSW.
- Cooperation and collaboration between universities, agencies and local government.
- Do phone surveys with recreation fishers 1200 household surveys who diary fish catches for 6 months.
- Knowledge and monitoring of fish stocks. Stock assessments, species by species, harvest strategies being developed to manage the fisheries for all stakeholders.
- Region 4, stocks have been relatively stable except for the blue swimmer crabs. Constant monitoring at the statewide scale.
- Crab trap exchange program, removing traps that are less environmentally friendly and providing more environmentally friendly traps.

Other thoughts

- Legislative context under FM Act
- Management of fisheries and aquaculture under DPI Fisheries
- Research and actions for oyster reef restoration
- General knowledge of areas for improvement/management actions.

What's not working?

Workshop output

- Lack of land base for aquaculture opportunities
- Responsiveness of novel applications and approaches, lag in permits for doing research
- Oyster growing can impact on *Posidonia australis* seagrass meadows (listed as endangered under the EPBC Act)
- Marine debris from fishing and oyster growing
- Communicating to the community about how we are improving the estuary values (e.g. recreational)
- Prawn farm pollutants from around Pindimar
- Cleared mangroves along the creek in Kore Kore Creek, lack of clarity
- Marine Park zoning condenses effort of fishing professional in other areas
- Urban stormwater drainage systems in low lying areas, increasing the capacity of pipes, short term fix to move water into the estuary

- Discussions with fishers across the state show that there are periods of poor conditions (water quality) and this impacts on the fishery.
- Crabs in Wallis Lake are depleting. The cause is unknown, could be due to catchment inputs but this is unknown
- Lack of understanding of benthic communities
- Improve monitoring of what is coming into the systems, continuous logging to better understand the system
- Making sure that (recreational) infrastructure keeps up with waterway use (eg sanitation, more vessels on the lake, make sure there is enough effluent pump out and toilet facilities)
- Smiths Lake opening, needs to be opened lower than 2.1m and 1.8m due to the cold fresh water
- Western side of Wallis Lake foreshore used to be a good greasy back prawn haul – near Duck Creek, loss of seagrass due to Acid Sulphate Soil (ASS) and development too close to the foreshore
- Rapid response if there is a problem within the lake – need to be out there finding out what is causing the issue.
- Recreation fishers should be held accountable for their fish take
- Fisheries are rebuilding their local team and there has been a change of staff followed by low responsiveness to issues
- Lack of clarity within the community about who to contact if there is an issue
- Sand mining in Kore Kore Creek – developer takes sand into teagardens, concern about ASS
- The difficulty with finding the appropriate agency to deal with a problem. There is a need for an overriding point of contact eg., like My Gov.

Other thoughts/comments

- Waste left by oyster growers.
- Surveillance of compliance with bag limits and marine parks zoning.
- Natural resource management of fish stocks as a sustainable food source, and the balance between recruitment and fish mortality due to multiple factors causing declines in fish stocks.
- Fish habitat management (habitat degradation, loss of seagrasses and oyster reefs, etc).
- Disease management in aquaculture.
- Stormwater management and associated pollutant and contamination runoff.
- Free passage for fish in all waterways.
- Sustainable fishing limits which reflect accurate estimated of fish stocks, taking into account future changes to the stocks.
- Derelict fishing gear in the waterways, both from recreational fishing and commercial fishing.

1.6 Opportunities

- More cohesive industry, academia and industry working together
- Collaboration and incorporation of novel tools (eg artificial intelligence, eDNA breeding programs, incorporation of citizen science)
- Marine Park Plan review – meant to be after 10 years but it has now been 17 years
- Strategic direction for stormwater maintenance and management with a focus on WSUD especially with changing climate. Less reactive approach to stormwater management,
- Nature conservancy identified regenerative aquaculture where there are environmentally friendly aquaculture, mitigate nutrient uptake (<https://www.nature.org/en-us/what-we-do/our-insights/perspectives/restorative-aquaculture-for-nature-and-communities/>). Investigate how restorative aquaculture can be set up in the study area.
- Responsiveness of agencies is really important for areas around parks (eg cattle at the edge of national parks)
- Additional restrictions for use of crab traps in Port Stephens. Use of witches hat traps should be banned in NSW.
- Mandated crab trap escape hatches
- Tar treated timber use in Oyster industry – while there is an intent to phase this out there should be support for the industry
- Legacy waste – whole of government approach to fixing the waste (orphan waste). Proactive approach with partnering with industry
- Use of sensors to predict harvest area closures by NSW Food Authorities following heavy rainfall, harmful algal blooms, or shellfish disease outbreaks in the estuary (UTS and DPI Aquaculture Research project)
- Adapt new fishing/aquaculture methods to reduce bycatch
- Collaboration between government, recreational fishers and Traditional Owners to develop fishing regulations. Incorporate best practice fishing guidelines into regulations for commercial fishing to win support from government and protect the future of commercial operations.
- Collaborate with water management authorities, local farming groups and landholders to improve the quality of run-off and restore the health of seagrass beds, improving fish nurseries and local fish stocks.
- Utilise data sharing options e.g. Australian Agricultural Data Exchange (AADX)
- Investigate circular economy options for reducing oyster industry waste by reusing/adding value across other industries (circular economy principles, <https://www.frdc.com.au/frdcs-circular-economy-program>)
- Research into past commercial activity in the estuaries to provide a baseline to compare with current production. This would give us a better understanding of where we are now.
- Seaweed aquaculture could be a good fit for some areas. Certainly, better than the cold water shellfish, Abalone. Existing commercial seaweed operations in other regions could be used as an example.

- Educating the public about how best to look after our marine environment should be a priority. Particularly landholders on the shores of waterways.

1.7 Management Options

Workshop input

- Oyster reef habitats to be established – focus on how we will do ecosystem restoration
- Consider rate reduction for allowing oyster reefs within existing – fisheries moving to a partnership approach to achieve stewardship outcomes
- ChIA and recruitment of blue swimmer crabs – partnership within report card and fisheries
- Compliance about livestock access along the banks of the river – fisheries, build compliance to compliment the restoration activities
- Estuary processes and seafood production group – forum to link science and fishers and managers together to share experience
- Need to work out what is driving the impacts on the fishery
- Benthic habitat mapping – understand other reefs and habitats
- Education and compliance program for new owners on the foreshore to build their understanding and establish custodianship / stewardship for foreshore landholders
- Climate change resilient farms program to benefit farmers and downstream habitats
- Communication with general public living on the water edge, removal of habitats and the impacts
- Coordinated monitoring program
- Partnership to enhance habitat mosaics within the systems (agencies, community, aboriginal community)
- Develop a long term strategic stormwater management plan for each catchment taking into consideration climate change and projected changes in development with the aim to conserve and protect estuarine habitats as well as meeting stormwater quality targets (WSUD)
- Better understanding of estuarine function, students to contribute to develop leaders for the future
- Knowledge of what has been done in other catchments in terms of research to determine if there are gaps in knowledge
- Removal of oyster lease tar sticks in a cost effective way
- Incorporate Traditional knowledge into fisheries and aquaculture management practices

Other input

- Include foreshore structures in the MidCoast Development Control Plan.
- More awareness of, consideration to and stricter regulations around marine and aquatic environments for new developments and in land use planning.

- More community/public jetties and shared boating/waterway infrastructure, to stop people from building unauthorised structures and in general fewer structures. This would benefit recreational fishers and area users as well as the marine environment as a whole.
- Improve water sensitive urban design/stormwater management (stormwater runoff into sensitive areas e.g. marine parks) by taking a more holistic approach. WQ issues, habitat destruction when clearing drains (outlets built behind mangroves which needs to be dug out), sediment fans pluming out of drains over seagrass beds (possibly a problem in Wallis Lake) area some of the problems related to stormwater management causing unmanaged ongoing impact on Key Fish Habitat, and there is clear potential for improvement.
- Better collaboration between Council and oyster growers for water quality monitoring (e.g. use salinity as indicator for viruses). There is existing WRL modelling of hydrology for sewer breakages/spills etc.
- Better data/hardware sharing between stakeholders.
- Develop living seawalls e.g. in Forster area foreshore and Tea Gardens, to improve habitat and biodiversity in otherwise relatively barren locations.
- Focused research on disease spread in aquaculture and fisheries.
- Work with industry to deal to remove waste, including old tar treated equipment. Current legacy issues and waste management issues are making it difficult to dispose of disused materials.
- Set aside grant funding for oyster cleanup efforts.
- Focus on fish nursery and habitat restoration in key locations such as Wallis Lake seagrass meadows, mangroves, and oyster reefs.

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ISSUE ANALYSIS LOSS OF COASTAL WETLANDS

2024

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1. Loss of Coastal Wetlands

This issue analysis paper provides an overview of coastal wetlands in the estuary, key stressors, impacts and management options. It considers climate change, land use change and resulting impacts on ongoing wetland health and viability into the future. Related issues analysis papers include *Biodiversity and Habitat Conservation*, *Climate Change* and *Tidal Inundation*.

Coastal forested wetlands, freshwater wetlands and estuarine wetlands are amongst the most sensitive and significant habitats in the MidCoast Local Government Area (LGA) coastal zone. They occupy transitional ecotones that could be susceptible to sea level rise, erosion, inundation, salinity change and also to developmental and land use changes in their surroundings. All such activities can impact on these habitats, and in some cases, restrict the ability for wetlands to naturally migrate.

Coastal wetlands also form one of the four coastal management areas under the *Coastal Management Act 2016* (CM Act) and are protected under the *State Environmental Planning Policy (Resilience and Hazards) 2021* (RH SEPP), which aims to protect coastal wetlands in the environmental and economic interests of NSW.

Authors: *Petra Arola*

Contributors: *Tanya Mason, Tanya Cross, Mat, Erin, Sal, Prue, Troy Gaston, Megan Huggett, Michael Millang, April McKay, David Wainwright, Josh Chivers, James Duval, Sue Calvin, Sophie Powrie, Liam, Prue Tucker, Erin Masters, Neil Dufty*

1.1 Situation Analysis

1.1.1 Background

Coastal wetlands are amongst the most significant habitats on the NSW coast as they perform critical ecosystem services and have high economic, social and cultural values (Tait, 2024). Environmental functions that coastal wetlands perform include (DPIE, 2018):

- mitigating storm damage and flood impacts;
- recharging groundwater;
- storing carbon;
- helping to stabilise climatic conditions;
- purifying water quality (including denitrification);
- retaining and exporting nutrients and sediments;
- providing highly biodiverse foraging, roosting and breeding habitats for flora and fauna including migratory shore birds;
- seagrass beds provide food, shelter and oxygen for organisms in the estuary, and reduce turbidity by stabilising the riverbed and trapping suspended sediments.

Coastal wetlands also provide significant economic, social and cultural benefits by:

- providing foraging and nursery habitat for many fish, crustaceans and molluscs, including species of commercial and recreational value;

- providing opportunities for tourism and recreational activities such as nature photography, fishing, camping and birdwatching; and
- having Aboriginal cultural significance, historical significance and importance for science and education.

Coastal wetlands have high economic value for their ecosystem services (Kirkpatrick 2011, Janes et al. 2020). Despite making up only 15% of wetlands globally, coastal wetlands make the most significant financial contribution of all wetland types (Davidson et al., 2019). The *Coastal Management Act 2016* (CM Act) recognises coastal saltmarsh, mangroves and seagrass as the highest priority coastal wetland types. Studies confirm that saltmarsh and seagrass are the most significant contributors to the productivity of commercial fisheries (Baker et al., 2020).

Mangroves, saltmarshes and seagrasses also help mitigate climate change by sequestering carbon. “Blue carbon” is the carbon stored in mangroves, salt tidal marshes, and seagrass meadows, ordered highest to lowest in carbon stocks per hectare (IUCN, 2017). Blue carbon is an increasing area of policy and research, with methodologies being developed to quantify carbon credits for coastal wetland restoration.

Coastal wetlands provide a home to a rich mix of biodiversity, including many threatened plants and animals. Many species of migratory shorebirds rely on coastal wetland habitats for foraging and roosting. Some threatened plants (like *Phaius australis*) are confined to coastal wetland environments and these habitats provide for threatened animals such as White’s seahorse, green and golden bell frog, wallum froglet, as well as micro-bats, coastal raptors and ground-dwelling mammals (such as eastern chestnut-mouse). As wetlands are lost or degraded, the biodiversity within them is also depleted. Many coastal wetlands are listed as threatened ecological communities in NSW and Australia, including:

- Coastal Saltmarsh
- Freshwater Wetlands on Coastal Floodplains
- Swamp Oak Floodplain Forest
- Swamp Sclerophyll Forest on Coastal Floodplains

The listing advice for each of the above threatened ecological communities issued by the NSW Scientific Committee provides a synthesis of the values, pressures and threats of these different systems.

Wetland restoration

Due to their high ecological and economical value, as well as the high level of threat, it is vital to maintain the health of wetland ecosystems. Wetland restoration can help improve water quality, habitat and biodiversity (NSW Marine Estate 2024).

One of the best examples of successful wetland restoration within the study area is the Darawakh Creek and Frogalla Swamp restoration project. The *Darawakh Creek and Frogalla Swamp Wetland Management Plan* (WetlandCare Australia, 2004) was prepared to solve the problems relating to acid leaching from disturbed wetland areas. The entire wetland was underlain by acid sulphate soils that were exposed when drainage works were undertaken in the 1960s. Through the development of a wetland management plan (WetlandCare Australia, 2004) and implementation of a restoration management plan (Great Lakes Council 2014a), the wetland has been restored to a more natural state. This included acquisition of 23 private properties, reinstating the area’s natural hydrology by infilling, excluding cattle, and undertaking vegetation management.

Restoration of habitats can also create synergies where adjacent habitats are restored simultaneously. Naturally co-occurring foundation species may mutually benefit each other in

restoration efforts, e.g. mangroves and oysters. Mangroves provide habitat for oysters, while oysters shells can provide protection for mangrove seedlings by reducing wave energy. Studies are underway in Wallis Lake to investigate the feasibility of co-restoring oyster reefs and mangroves (Esquivel-Muelbert & Bishop 2022).

1.1.2 Stage 2 Study: Coastal wetland mapping

During the stakeholder workshop for the Stage 1 report for the CMP, it was indicated that the RH SEPP mapping of coastal wetlands in the Wallis and Smiths Lake estuaries was not considered accurate enough use as a decision base for the CMP. The mapping, description, and condition of wetland communities had recently been completed for Karuah & Myall River catchments. Preliminary analysis of vegetation mapping provided by MidCoast Council and inspection of aerial imagery have also confirmed that a formal technical review and accuracy of the mapping was warranted. A study in Stage 2 was undertaken by EcoLogical (2024) to address this data gap.

The purpose of the Stage 2 study was to provide a better understanding of the distribution and condition of wetland systems, which was needed to inform the development of strategies to mitigate future negative impacts on wetlands and their values. This was achieved by collating existing wetland vegetation mapping and identifying and mapping any unmapped coastal wetlands in the study area. This study also included a broad assessment of wetland condition for all wetland patches within the study area.

At the time of writing this issues paper, the coastal wetlands Stage 2 study was still in a draft stage, and so the mapping and conclusions within the report may change pending review.

The area of interest covers more than 2,064 km². Mapping of wetlands was done using existing vegetation mapping and surveys, as well as field surveys. A condition assessment was undertaken based on both desktop and field-based methods. Indicators used included presence of weeds, hydrology, land-use, adaptive capacity and resilience, and pest species. Newly mapped wetland areas were also attributed to a fine scale vegetation community.

A total of 19,312 ha of wetlands were mapped, including 6,763 ha of previously unmapped wetland areas. The vegetation classes with the highest area of wetlands were Coastal Swamp Forests at 9,359 ha and Coastal Floodplain Wetlands at 5,376 ha. Mangrove and saltmarshes (saline wetlands) had a total area of 1,742 ha and 1,022 ha respectively. Freshwater habitats were least common in the study area, with Coastal Heath Swamps and Coastal Freshwater Lagoons covering less than 1,000 ha each.

The largest patch of continuously connected wetland vegetation was identified at Nerong which was approximately 2,350 ha. The second largest area of wetland vegetation is at Wallis Island Nature Reserve at 605 ha.

Most of the wetland areas were mapped as being in high condition, with saltmarshes and mangroves having the largest area of high condition vegetation in proportion to their total area. 29% of coastal freshwater lagoons were mapped as low condition, principally due to having legacy cleared areas. Weed occurrence ranged from nil to very high throughout the study area.

1.1.3 Stressors and Impacts

Coastal wetlands are under significant threat from historic clearing, reclamation for development, construction of seawalls, modified hydrology and drainage, uncontrolled stock access and grazing, offroad vehicles, pollution, weeds and pests, and the impacts of climate change (DEE 2016).

It is estimated that more than 60% of the coastal wetlands in southern Australia have been cleared since European settlement (MidCoast Council 2021). Wetlands in the riparian zones are often among the most fertile parts of the landscape and have been extensively cleared and developed for agriculture. Historically, the values of wetlands were not recognised, which led to substantial

degradation, reclamation and clearing.

Key stressors causing wetland loss, disturbance and degradation are described below.

Land use, developments and clearing of wetlands

Coastal wetlands in the study area catchments and estuaries have historically been extensively cleared and drained for farming. The clearing reduced both the extent and condition of many wetlands and this still affects the wetlands in the study area today (EcoLogical 2024). A relatively high exotic plant cover is a feature of many of these degraded/transformed areas, particularly in non-urban areas where the native understorey and groundcover has been removed and replaced by pasture.

Today, encroachment of properties, development in wetlands, mowing of foreshores and waterway access e.g. at Green Point and Smiths Lake, present some of the biggest current land use related threats facing wetlands. Major impacts from this includes ongoing land clearing, reduce groundwater recharge through increased hard stand areas and accelerated overland flows (EcoLogical 2024). Based on anecdotal evidence, waterway access occurs both on foot and by vehicles, e.g. for boat launching, in some areas of saltmarsh.

Activities such as four-wheel driving can negatively affect saltmarsh in a range of ways, including habitat (physical) disturbance, compaction and reduction in plant diversity. It can also disturb wildlife, particularly threatened beach-nesting and migratory shorebirds.

Low condition or cleared wetlands within the study area are frequently subjected to agricultural practises, with related impacts including grazing and trampling of wetland plant species, increased irrigation, and increased nutrients and eutrophication (EcoLogical 2024). Stock impact on the riparian zone is a widespread threat to estuary health and the impact of land-clearing and agricultural run-off is influencing health in estuarine catchments. Cattle grazing is a dominant land use as detailed in the *Agriculture Issues Analysis Paper*, and stock frequently have access to riverbanks and wetlands, leading to soil degradation, erosion, reduced vegetation and poor water quality.

As the rate of sea-level rise is expected to accelerate over the coming century, as detailed below, planning for ecosystem protection in the future including appropriate zoning needs to start now.

Changes in hydrology, drainage and stormwater runoff

Changes in hydrology of wetlands have historically occurred as a result of e.g. draining wetlands for agricultural uses or grazing, and other land use alterations. Altered hydrological regimes can also stem from activities such as water harvesting, channelisation and infilling (Glamore et al. 2021). Changes in water regimes from stormwater runoff can also have significant impacts by changing both volumes and water quality of water entering the wetlands.

Modified hydrology through drainage, levees and floodgates, and the prevalence of Acid Sulfate Soils (ASS) also present significant threats to the ecosystem health and productivity of coastal wetlands in the study area floodplains.

ASS are sediments deposited under estuarine conditions that contain the sulfidic mineral pyrite. Generally speaking, ASS materials do not pose a problem if left undisturbed in the subsurface. However, they pose a risk if exposed to air by excavation or the lowering of the water table, as the iron sulphides they contain react with oxygen to create and release sulfuric acid and acid leachates in toxic amounts (DPIE, 2021). Acid runoff from disturbed ASS in agricultural, urban and general drainage works on lands adjacent to the estuary can have potentially harmful impacts on ecology, aquaculture and recreational amenity.

As previously mentioned, draining of the wetland for land use purposes caused significant issues

with acid sulphate soil exposure and leakage in Darawakh Creek and Frogalla Swamp. These issues were largely resolved by restoring the natural drainage in the wetland.

Other drained ASS wetlands elsewhere within the study area are located in the Wallis Lake catchment, with the potential for them to also have been drained in parts of Khappinghat and Myall Lakes / Port Stephens systems.

Pests and weeds

Based on the wetland mapping study by EcoLogical (2024), with the exclusion of partially cleared and highly degraded areas of wetland, exotic plant species mostly appeared to be confined to the edges of wetland patches. Exotic plant species observed frequently occurring within or on edges of wetlands included Buffalo Grass, Coastal Morning Glory, Lantana and Bitou Bush, it was noted that Alligator Weed also is present within the MidCoast Council area.

An exotic species of *Juncus* is present in local areas, e.g. Port Stephens, and Longleaf Willow Primrose is a problematic weed in Darawakh Nature Reserve.

Pest species that degrade wetland habitat include Rusa deer around Forster, and European red fox. Deer impact through trampling, damage trees and grazing. Foxes prey on native species, particularly impacting threatened and migratory shorebirds in wetlands near north and south entrances, and around parts of the Port Stephens estuary.

Climate change: Habitat migration and squeeze caused by inundation

Climate change, particularly sea-level rise (SLR), presents a major threat to coastal wetlands in Australia and globally. In NSW, the MEMS identified sea level rise as a significant threat to coastal wetlands and the threatened species that rely on these habitats. Salt marsh is particularly at risk from climate change, which is reflected in its Endangered Ecological Community status under State and Commonwealth legislation. Rising sea level will increase flooding and inundation resulting in loss of saltmarsh and other intertidal habitat including foraging areas for shorebirds.

The loss of intertidal wetlands is of particular concern as it would have detrimental consequences for both human and ecological communities. On the south-east Australian coast, case studies suggest that the future of intertidal wetlands will greatly depend on landward migration as surface accretion may not keep up with the predicted SLR in many estuaries. However, due to differences in geomorphological settings and land-use, estuaries vary in their capacity to accommodate lateral migration (Wen et al. 2023).

A study by Wen et al. (2023) investigated the potential for wetlands to migrate laterally within 110 NSW estuaries. The result showed that larger estuaries tended to have more potential for wetland habitats to migrate, while saline wetlands were at risk of disappearing from most intermittently closed-open estuaries with insufficient space for habitat movement. The study suggested implementing low intensity land uses when doing land use planning as a buffer on the landward side of wetland habitats. This may promote landward migration of the habitat and provide sufficient space without creating a squeeze between existing development.

Mapping of current coastal wetland distribution and modelling of future habitat migration in relation to SLR and existing development are essential for guiding planning for potential wetland migration pathways, as well as land use planning (Hughes et al. 2022).

Climate change: Other impacts

Climate change is also expected to result in increased and more severe bushfires. The Black Summer bushfires of 2019/2020 resulted in the burning of large areas of habitats such as intertidal estuarine wetlands. Across New South Wales, these bushfires affected 183 ha of saltmarshes and 23 ha of mangroves in 19 estuaries. In the worst affected estuaries up to 81% of the saltmarsh area was impacted. The impacts on mangroves were smaller but still significant. Many species of

saltmarsh plants had re-sprouted or germinated after 6–24 months, but the extent of any recovery or changes in species composition were not quantified. The majority of fire affected mangrove trees appeared to be dead 24 months after the fires. Strategic hazard reduction burns may need to be considered in the future to avoid fire impact on wetland habitats. (Glasby et al. 2023)

While areas of saltmarsh may establish elsewhere if space is left for migration, extreme drought may reduce wetland productivity and carbon sequestration potential. Severe drought in 2019 severely impacted aquatic systems in many local waterways and contributed to fish-kills and the death of many platypus, turtles and other aquatic species (MidCoast Council 2021). Other potential stressors associated with climate change include changed sedimentation rates, changed fire regimes, changes to groundwater flow and biological productivity (Santilan & Rogers 2009).

There are opportunities for climate change impact mitigation through wetland management. By sequestering significant amounts of carbon dioxide from the atmosphere, wetlands play a crucial role in climate action efforts. Maintaining coastal vegetation, such as wetlands, can also provide transitional/migration impact protection from the effects of sea level rise and increased storm events (MidCoast Council 2021).

Flood Impacts

Flooding events can have significant implications for wetlands, including sediment accumulation and excessive inundation. For example, dead mangroves have been observed in the lower Myall River in late 2021 following extreme flood events, mainly along the eastern shoreline in Swan Bay. Similar dieback was observed in many other estuaries (e.g. Hawkesbury River, Hasting River, Richmond River) within a year of these floods and it is only mangroves at a particular surface elevation that have died. Furthermore, only the grey mangrove (*Avicennia marina*) has been affected, while the other common mangrove (*Aegiceras corniculatum*, or river mangrove) has generally survived in flood-affected estuaries. Elevated water levels for long periods due to flood waters appear to have resulted in the peg roots of the grey mangroves being inundated for too long and effectively drowning the plants. In some cases, large movements of sand from the flood water may also have caused water to pond in low-lying areas or smothered peg roots (C. Colyer-Morris, personal communication, 10/07/2024).

The extent of this dieback has remained largely unchanged since 2022. Aerial images show areas of dead mangroves on both shorelines of the lower Myall between the singing bridge at Tea Gardens and Monkey Jacket Creek. Specifically, there are clear patches of dead mangroves on the island opposite marine Drive in late 2022. However, between Dec 2022 and Sept 2023, there appears to have been some increase in the extent of dead mangroves in the section of the island that is closest to Marine Drive (C. Colyer-Morris, personal communication, 10/07/2024).

1.2 Stakeholders

Management agencies

MidCoast Council; Hunter Local Land Services; NSW Department of Climate Change, Environment, Energy and Water; Department of Planning Infrastructure and Housing – Crown Lands; Department of Primary Industries – Fisheries; National Parks and Wildlife Service; Department of Primary Industries – Marine Parks. Universities - Southern Cross, Griffith, Macquarie, UNSW, Sydney.

Who's affected?

Private landholders; MidCoast Council; Department of Planning Housing and Infrastructure - Crown Lands; Recreational and Commercial Fishers; Community.

1.3 Existing Management Approach

Legislation and Policy Framework

Management of coastal wetlands in NSW is guided by the *NSW Wetlands Policy* (2010). The policy aims to protect and sustainably manage the statewide network of wetlands. Federally wetlands are managed through conservation advice that includes condition thresholds, priority research and conservation actions, as well as through international agreements such as the Ramsar Convention.

The majority of NSW coastal wetlands are listed as Threatened Ecological Communities under state biodiversity conservation legislation. Saltmarsh, swamp oak forests and coastal swamp sclerophyll forests are also all federally listed ecological communities under the EPBC Act. Each of these communities has declared listing advice or determination advice, which provides information on their values, a

Coastal wetlands along with littoral rainforest form one of the four coastal management areas under the *Coastal Management (CM) Act 2016*. Objectives for management under the CM Act are:

- a) to protect coastal wetlands and littoral rainforests in their natural state, including their biological diversity and ecosystem integrity;
- b) to promote the rehabilitation and restoration of degraded coastal wetlands and littoral rainforests;
- c) to improve the resilience of coastal wetlands and littoral rainforests to the impacts of climate change, including opportunities for migration;
- d) to support the social and cultural values of coastal wetlands and littoral rainforests;
- e) to promote the objectives of State policies and programs for wetlands or littoral rainforest management.

Previously protected by the State Environmental Planning Policy (Coastal Management) 2018, coastal wetlands are now integrated into the State Environmental Planning Policy (Resilience and Hazards) 2021 (RH SEPP). The aim of this policy is to ensure that the coastal wetlands are preserved and protected in the environmental and economic interests of NSW.

Under the CM Act, a coastal wetland is defined as “land which displays the hydrological and floristic characteristics of coastal wetlands or littoral rainforests and land adjoining those features.” These include the broad community types of mangroves, sedgeland, saltmarsh, melaleuca forests, casuarina forests, brackish and freshwater swamps, and wet meadows. Spatial maps and development controls are provided within the RH SEPP.

Ramsar Convention

Myall Lakes is designated as a Wetland of International Importance under the Ramsar Convention. The area is also protected by the NSW Government through Myall Lakes National Park, as well as the Port Stephens – Great Lakes Marine Park. The convention requires that the site is managed to maintain or improve its ecological character.

The Myall Lakes Ramsar site covers 44,612 ha and consists of a mosaic of near-natural wetlands ranging from fresh to brackish and estuarine waters within a relatively unmodified coastal lake system. The site's wetlands include brackish waters, fringing swamps, freshwater swamps, mangroves, saltmarshes, riverine ecosystems and rocky marine shores and beaches. The site supports a rich biodiversity, containing a range of undisturbed terrestrial and wetland vegetation communities with a large number of plant and animal species. (NSW OEH 2012).

Wallis Lake Wetland Strategy

The Strategy was developed based on a need to protect the ecosystem services and functions, biodiversity, aesthetics and threatened communities within the Wallis Lake wetlands. Wetland protection was also included as management actions in a number of now updated management plans.

The Strategy recognises that despite some legislative protection, wetlands continue to be subject to clearing, modification, degradation, inappropriate land uses and other activities. Furthermore, wetland habitats are likely to be seriously impacted by global sea level rise associated with anthropogenic climate change. Consequently, knowledge of wetland location, status and condition and research into management needs and priorities needs to be gathered.

In relation to the Wetland Strategy, a condition assessment for future management considerations for saltmarshes in Wallis Lake was undertaken (Umwelt 2012). The study found fragmentation and habitat conversion to be the biggest threats. Mangroves were also found to have expanded on the expense of saltmarshes. Small patches of saltmarsh did not function like larger patches and were considered likely to die out. Opportunities for maintaining saltmarshes exist through adequate management and conservation actions, including active rehabilitation.

MidCoast Council Biodiversity Framework 2021-2030

The MidCoast Council's biodiversity framework provides the main management approach for biodiversity within the LGA, including wetlands. It emphasises the significance of the region's natural assets and biodiversity for community well-being, economic development, and quality of life. It acknowledges the community's recognition of environmental protection as a core value and aligns with regional goals set by the NSW and Commonwealth governments. The document highlights the decline of biodiversity both nationally and locally due to pressures such as habitat loss, invasive species, climate change, and extreme weather events like droughts and bushfires.

The MidCoast biodiversity framework identifies management actions relating to education around wetland importance and values, priority wetlands for reserve purposes (e.g. Darawakh Creek/Frogalla Swamp and Wallis Lake wetlands), restoration of degraded wetlands e.g. for fish habitat enhancement, wetland mapping, and research opportunities.

Existing Estuary and Catchment Management Plans

All of the existing management plans for the estuaries and catchments within the study area bring up wetland management. The plans include the Karuah River Catchment Management Plan (2015), the Wallis Lake Estuary and Catchment Management Plan (2014) and the Coastal Zone Management Plan for Smiths Lake Estuary (2018). Myall Lakes is mainly managed under NPWS as well as the Ramsar Convention. The Great Lakes Water Quality Improvement Plan: Wallis, Smiths and Myall (2009) also involves wetland management. Management actions largely relate to wetland mapping, protection and rehabilitation. For Wallis Lake most actions relate to the Wallis Lake Wetland Strategy.

Council Wetland Management Projects

Wetland protection and restoration, including riparian and foreshore areas, is part of MidCoast Council's ongoing management activities for wetland management through state funding. Two examples include the restoration of the Bulahdelah Plain Wetlands and Lower Wallamba River. A 366 ha area in the Bulahdelah wetlands was improved through revegetation of cleared areas, weed and pest control and stock exclusion, improving the water quality in the Myall Lakes and Myall Lakes Ramsar site. Weed and pest removal on riparian banks of the Wallamba River have had similar effects, as well as a significant positive impact on the local native species. (MidCoast Council 2024)

Another successful and awarded wetland restoration project is the Darawakh Creek and Frogalla

Swamp Wetland, discussed above. The Frogalla Swamp Wetland is underlain by highly reactive acid sulfate soils (ASS) from as little as 0.5 meters below the surface. In the 1950s, the construction of floodgates, main drains, and secondary drains led to extensive drainage of the wetland, significantly altering its hydrology and biodiversity. These actions, combined with lift pumps, dried out the wetland, lowering the groundwater and releasing severely acidic groundwater. Additional changes included farm crossings, levees, loss of native plants, grazing by hard-hoofed stock, and burning, all exacerbating the acid problem, making the outflows highly toxic.

In response, Council commissioned WetlandCare Australia to prepare a management plan, which identified that doing nothing was not an option due to the presence of an estimated 1,000 years' worth of acid-generating material. The plan recommended reinstating the natural hydrology of the landscape by infilling and decommissioning the drainage network and removing levees was required. This approach, combined with fostering native vegetation, was predicted to reduce acid sulfate outflows by 80%.

Implementation of the strategy began in 2004, involving the acquisition of 23 private properties and active management of the area. With the support of various stakeholders and external grants, significant progress has been made: most private properties have been acquired, over 80% of artificial drains have been infilled or decommissioned, and major levees have been removed. Additionally, grazing cattle have been removed, invasive weeds controlled, and native plants restored. As a result, water quality in Darawakh Creek has stabilized with a pH of approximately 6.0. This is an exemplary example of wetland restoration efforts within the study area.

MidCoast Council has also collaborated with the NSW Government to secure the protection of several coastal wetlands in the Minimbah area of the Wallis Lake catchment.

National Park Plans of Management

In addition to areas covered by the Myall Lakes National Park and Port Stephens – Great Lakes Marine Park, there are coastal wetlands within other gazetted National Parks reserves, including Khappinghat National Park, Booti Booti National Park, Wallingat National Park and Karuah National Park.

The catchments have a large proportion of national parks which are managed by NSW National Parks and Wildlife Service. A plan of management has been developed for each park, covering all relevant aspects for each park, such as protection and management of flora and fauna, hydrology, geology, Aboriginal heritage and visitor areas. The specific threats within each park are also listed. Many of the large and significant wetland areas within the study area are within protected National Parks estate.

Other Projects

DPI-Fisheries has funding for a small project to track changes in mangroves over time in the Lower Myall using high resolution satellite imagery. This will enable an assessment of when the dieback occurred, whether it is expanding, or whether there is any detectable changes over time.

1.4 Knowledge Gaps

- Comprehensive climate change risk assessment and prioritisation. Model the anticipated effects and develop strategies to avoid, mitigate or offset the predicted negative impacts.
- Valuation of environmental services versus agricultural production, when to transition, best mix of land-uses as sea-level rises.
- Given the likely negative impacts of climate change and sea level rise, a landward retreat analysis should be undertaken. Use modelling (Stage 2 tidal inundation assessment, flood

studies) to identify areas of land suitable for retreat (“retreat zones” on a landscape scale) and those that should be prioritised for protection.

- Social science research: Need to understand landholder willingness more broadly, what are key motivators (e.g. financial) or barriers to land-use change.
- Prioritise wetlands for conservation based on their size, perimeter to area ratio, condition and threats (pressures), extent within the catchment and more broadly in NSW, as well as listing status.
- Risk from blackwater events
- Impacts of modified freshwater flows and declining water quality on system functions and aquatic communities. Does current Water Sharing Plan sufficiently protect/ benefit coastal wetlands?
- Habitat valuation for commercial and recreational fisheries, aquaculture and shorebirds.
- Research into dieback in Broad-leaved Paperbark (including mapping) to ensure this functional, structurally important and dominant species is not lost from these wetlands.

1.5 What’s working, what’s not?

What’s working

- Strong scientific evidence-base for coastal wetlands and floodplain management in partnership with UNSW Water Research Lab (WRL).
- Collaborative approach between agencies, research institutes, landholders and industry representatives is working well.
- Council acquisition and remediation of coastal wetlands for environmental services, recreation and community benefit, e.g. Cattai, Big Swamp, Dawson Wetlands. Unprecedented level of Council involvement in wetland restoration and acquisition – Bulahdealah, Cattai, Big Swamp, Darawank Wetland. Active restoration and conservation management by Council.
- Feral deer program (pilot) has reduced the impact of deers in saltmarsh
- Collaboration with Aboriginal groups for wetland restoration (particularly at Darawank National Park and parts of Myall Lakes National Park). NPWS placed emphasis on cultural heritage and engaging with Aboriginal community.
- Case studies on restoration are good education tools describing what has been done to provide best practice management information for landholders.
- Council environmental education discovery program of webinars, wetland walks helps inform wider community on environmental values, ecosystem services and sustainable management.
- Data and mapping provides a good baseline to evaluate changes.
- There is a level of appreciation in the community of the values of wetlands, including aesthetic and ecosystem services values.
- Achievements:

- Council and NPWS have a strong history of interest and action in wetland conservation; including Darawank and Minimbah.
- There have been lots of wetland success stories, including public acquisition of wetlands, restoration of degraded wetlands and private wetland conservation projects (such as The Branch).
- Public investment in private wetlands has led to public good outcomes.
- We have large areas of well-managed wetland systems, which contribute to the social, biological and economic fabric of our area. We need to protect this.
- Wetlands are important to commercial fisheries as nursery grounds and for water quality protection.

What's not working?

- Habitat degradation, land clearing, and wetland drainage are common throughout the system.
- Failure to enforce compliance with fisheries regulation to prohibit grazing of foreshore areas. Need a systematic compliance program for this, including on Crown land, where there are cases of swamp oaks being illegally cleared for views.
- Poor community understanding and awareness of what wetlands are and the ecosystem services they provide. Saltmarsh is seen as “most expendable” of wetlands.
- Impacts on wetlands by the community – e.g. camping in wetland areas.
- Detrimental activities on private land have a public cost for remediation (for example diffuse source pollution of water quality). Lack of regulation and accountability.
- Council roads and culverts blocking tidal flow in coastal wetlands.
- We cannot stop the trajectory of substantial wetland loss and change associated with sea level rise caused by anthropogenic climate change; we can only adapt. We need to make room for wetlands to adjust.
- The rate of planning for wetland change adaptation associated with sea level rise is not adequate.
- The current planning rules don't properly safeguard wetlands and wetland buffers / transition areas; they don't prevent the clearing and development of important wetland environments. This needs strong State leadership.
- Land use and development decisions on wetlands and in low-lying areas have continued the trajectory of wetland loss and have removed the ability for wetland migration in some areas eg. Follyfoot Farm
- There are a range of both legacy and contemporary pressures on wetlands and these have depleted the extent, condition and function of wetland systems.
- Infrastructure assets in wetlands including elevated roads alter hydrology and impact the condition and function of wetland systems.
- The planning system doesn't address or consider the cumulative impacts to wetlands from developments and activities.

- It is not clear what “good” saltmarsh is.
- Wetland acquisition funding is difficult to source
- Monitoring of restoration strategies, long term, should be included in the MER framework.
- Understanding of how groundwater will be impacted by SLR and flow on impacts to groundwater systems and links to wetland
- Fire – inappropriate fire regimes are a threat to freshwater wetlands

Governance:

- There isn’t a collective vision in relation to wetlands – recognition, management, conservation.
- There isn’t a tenure-blind approach to wetland conservation / restoration and there is inconsistencies in the way wetlands are managed across the project area.

1.6 Opportunities

- Blue carbon: Potential investment and offset opportunities for coastal wetlands and fringing vegetation. Will carbon credits and offsets be a driver or a distraction? Worth pursuing. Need to talk with WRL.
- Partnering opportunities on blue carbon with The Nature Conservancy.
- Continue using best available science to prioritise coastal wetlands for acquisition and/or remediation.
- Seagrass restoration in the estuaries
- BCT Voluntary Conservation Agreements in the estuary in perpetuity.
- Incorporate Aboriginal traditional knowledge and Aboriginal Rangers for coastal wetland monitoring and management.

1.7 Management Options

Planning

- Use Council’s strategic planning framework to implement planning controls to protect wetlands (Rural Strategy, SEPP, LEP, and DCPs). Amend to prohibit development in wetlands and wetland buffers and in strategic wetland transition areas. Also amend the LEP / DCP / policies to better protect wetlands from the effects of altered quality and quantity of flows from development sites.
- Introduce best-practice, prescriptive and clear wetland protection considerations in the LEP and DCP – including prevention of all direct and related impacts of development.
- Provide evidence and propose amendments to the Coastal Management SEPP to support acquisition, rezoning and remediation of coastal wetlands to improve ecosystem services.
- Develop a whole-community long-term, landscape-scale plan for the floodplain under future sea-level rise scenarios. Build agreement and map an appropriate mix of land-uses that will be sustainable in the longer term.

- Develop agreed interagency principles and priorities for coastal wetland management.
- Prioritise wetlands for conservation based on their size, perimeter to area ratio, condition and threats (pressures), extent within the catchment and more broadly in NSW, as well as listing status.
- Develop an adaptation pathway and strategy for SLR impacts, in particular for salt marsh.
- Review SEPP mapping
- Include conditions on developments in regards to wetlands.
- Identify areas of acquisition / conservation, with care on how this is written up
- Standardise permissible activities to facilitate action on private wetlands.

Advocacy

- Advocate for investment in coastal wetland acquisition and/or remediation by the NSW Government.

Capacity Building

- Develop a coordinated education and awareness program including case studies and field events to promote wetland values, best management practice and sustainable use.
- Prepare a wetland adaptation plan inclusive of wetland migration under global sea level rise; implement its findings. Allow room for wetland migration / adjustment. Prevent development in areas of wetland migration.
- Incentivise the de-stocking of wetland areas on private rural properties.
- Incentivise the protection and restoration of privately-owned floodplain freshwater wetlands (billabongs) on the Myall River. Reverse the patterns of degradation of these important systems.
- Deliver a coordinated, proactive, strategic community wetland education and engagement program, including a schools program, interpretive signage at wetland sites, flyers, and social media. Improve the level of awareness in the community of the importance of wetlands. Address myths, misconceptions and misinformation about wetlands. Target new residents and new rural property owners. Use social marketing to drive behaviour change to protect wetlands from damaging activities. Develop a curriculum based education for schools.
- Find ways to recognise, describe and better respect the biological, cultural and social values of wetlands.
- Develop guidance on how to do planning /assessment and hydrology impacts on wetlands.
- Develop a targeted program with landholders who have wetlands on their farms – link to key species like the black neck stork or other hero species

Regulatory Compliance

- Establish a systematic compliance program to address illegal clearing on public and private land and compliance with conditions on Crown Land grazing permits.

Science and research

- Complete modelling and identify retreat buffer zones to retain coastal wetland ecosystem services under sea-level rise scenarios.
- Data / mapping:
 - Complete the standardised, accurate maps of wetland type and condition across the project area. Need fine scale condition mapping.
 - Collate all available historical wetland mapping and description data into a centralised knowledge hub. Use this knowledge hub to help describe patterns of wetland loss and change over time.
 - Track changes to wetland systems over time – what percentage of wetlands is protected, actively-managed, destroyed, etc.
- Research and address visitor impacts to wetland systems, with sensitive walks, interpretive signage, no-go areas, etc.
- Look into a scheme for transferring development rights from within wetlands to other suitable areas. Take away the development pressure on wetlands.
- Investigate metrics to determine saltmarsh health – e.g need different metrics for different plants and ecosystems.
- Mangrove monitoring – community monitoring program, looking at the ecology of the tree. Investigate University of Newcastle's program in Samoa. Opportunity for 'seagrass rangers' program in Lake Macquarie. Could investigate collaboration with traditional owners.
- Utilise Red map – log species of fish, University of Newcastle and NSW Government program.
- Application of model by WRL on Southern Estuaries – understanding of how saltmarsh and mangroves will respond to SLR.
- Finer understanding of wetland management units – Spatially define wetland units and determine if more information is needed about the pressures – prioritisation and identify the best interventions for each one.
- Investigate Blue Carbon initiatives. Blue carbon as a tool for landholders, Nature positive bill / nature repair.

On-ground

- Acquire and remediate coastal wetlands prioritised for community benefit, including retreat zones to mitigate impact of sea level rise.
- Manage threats to coastal wetlands in the National Park estate and adjacent lands, in collaboration with Aboriginal Traditional Owners.
- Manage coastal wetlands on public land for ecosystem services and/or as demonstration sites for agricultural best management practice (Crown lands, TfNSW). Review agricultural permits before renewing.
- Remediate and restore intertidal hydrology on priority public and private land, (in partnership with TIDE, commercial fishermen, OzFish, Landcare, LLS, oyster industry).

- Implement an integrated weed and pest management program in partnership between land management agencies and private landholders. Weeds include Chinese violet alligator weed. Select a species for an eradication plan for a single species.
- Incorporate Aboriginal traditional knowledge and Aboriginal Rangers for coastal wetland monitoring and management.
- Coordinate with universities and partner agencies to develop Blue Carbon opportunities.
- Control feral deer to protect coastal wetlands.
- Identify key wetland restoration/protection projects.

Governance

- Establish a floodplain management group following on from CMP Reference and Technical Working Groups to implement CMP and coordinate ongoing management and planning.
- Incorporate Traditional Owner perspectives and practices into wetland conservation and management. Provide opportunities for Traditional Owner groups to be involved in wetland management actions (leading to employment opportunities, social outcomes).

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ISSUE ANALYSIS

ENTRANCE

MODIFICATION

2024

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1. Entrance Modification and Modified Hydrology

This Issue Paper provides an overview of historical modification of estuary entrances for the MidCoast Southern Estuaries CMP study area and the complex impacts on estuary hydrodynamic, morphological, and ecological processes.

Each of the study area estuaries possesses a unique hydrologic regime resulting from the complex balance between coastal and catchment processes as well as the impact of human intervention such as entrance training, dredging, and artificial openings. This Issue Paper provides a summary of each of the Southern Estuaries and includes a discussion on the various processes that impact estuary entrances and hydrological regimes. This includes delta migration, entrance opening frequency and timing, sand migration, and dredging requirements to retain safe navigable waterways.

It is important to note that coastal lake or watercourse entrance instability - discussed herein - is one of the seven hazards named in the *Coastal Management Act 2016* (CM Act).

Authors: *Courtney Smith, Chris Beadle*

Contributors: *Gerard Tuckerman, Ainslie Downes, Danny Bucher (Crown Lands, involved in developing entrance opening policy), Andrew Hampstead, Bethany Alexander (DECCW), Chris Beadle, Bec Swanson, Chris Drummond, Michael Millang, Evan Vale, Erin Maters, Prue Tucker, Neil Duffy (facilitator), Peter Goonan, David Hopper.*

1.1 Situation Analysis

This section provides a brief overview of each estuary. More detail can be found in the Stage 1 Scoping Study (Water Technology, 2022), and prior coastal process investigations and management plans for each estuary.

Khappinghat Creek

Khappinghat Creek is located within Saltwater National Park, with the entrance to the Tasman Sea just south of the Wallabi Point township. Khappinghat Creek is one of only a few naturally opening and closing estuarine systems (an ICOLL) on the mid north coast of NSW. Numerous creeks make up the tributaries to the Khappinghat Creek estuary, and together form a system of waterways supporting areas of RH SEPP mapped littoral rainforest and coastal wetlands (including mangroves, salt flats, sedge and rush-dominated wetlands).

The estuary is classified as an ICOLL, with an entrance that meanders behind Saltwater Beach, and is semi-frequently open to the ocean. It has a fairly large catchment of 91 km², relative to the size of its waterway (an area of 1.2 km²). A high proportion of the estuary catchment area (as well as the estuary entrance) is located within National Park land tenure and comprises undeveloped coastal reserve. Consequently, there has historically been a limited need to manage this entrance from a flood mitigation perspective.

Discussion with DCCEEW - National Parks and Wildlife Service (NPWS) in regard to management of Khappinghat Creek will be required throughout Stage 3 of the CMP. In 2019, a Plan of Management (PoM) was developed for Saltwater National Park (National Parks and Wildlife Service, 2019). Entrance management was not identified as a key management issue in that PoM.

Black Head Lagoon

Black Head Lagoon is located between Red Head and Pebbly Beaches. It is classified as an ICOLL and has a small (2 km²) catchment area, with a waterbody area of 1 ha, and an average depth of around 0.2 m. Historically, it has experienced poor water quality, and has been rated very poor for algae abundance, and poor overall estuary health. The clarity of the water is often poor mainly due to the overflows from the urbanised areas around its catchment. Occasional incidents of sewage overflows have been reported making it temporarily unfit for primary contact recreation. (NSW DCCEEW, 2024).

The catchment of Black Head Lagoon is highly disturbed by the two main urban centres of Black Head and Hallidays Point. The catchment has amenities such as the Surf Life Saving Club, Big4 Holiday Park, and the Bowling Club. An area of bushland remains adjacent to the estuary, but most bushland has been cleared.

The entrance is relatively natural; there are only minor rock protection works at the southern end of the beach protecting Black Head Surf Life Saving Club, which also provides protection against ocean swell events. The creek typically hugs the southern shoreline, travelling behind the beach under a permanent footbridge installed that crosses the creek. It typically breaks out near the southern entrance of the beach near the breakwall.

Historically, entrance management has not been required for flood mitigation purposes. However, the increasing urbanisation of Black Head has resulted in increased annual surface runoff, altering the flow and creek condition. This has led to an alteration of the entrance opening regime over time, with an increased percentage of time where the lagoon is open.

The Stage 2 Risk Based Framework Assessment will provide greater detail and management options for Black Head Lagoon.

Wallis Lake

Covering over 1,400 km², the Wallis Lake system (See Figure 1) comprises the biggest catchment within the study area, and houses unique and varied ecosystems that support agriculture, commercial and recreational fishing, aquaculture and tourism industry.

The catchment is primarily made up of seven sub-catchments:

- Wallamba River
- Lower Wallamba River
- Wang Wauk River
- Minimbah Sandbed
- Coolongolook River
- Wallingat River and
- Wallis Lake Body

Wallis Lake is large trained, permanently open estuary that flows into the sea between the township of Forster and Tuncurry. The water body is just over 85 km² in area and has a relatively shallow depth averaging 1.8m. Being permanently open, there is considerable tidal exchange between the ocean and the estuary. These training walls, which commenced construction over 110 years ago (WorleyParsons, 2011), have significantly impacted the natural estuarine processes and tidal regime of the lake. Especially the construction works undertaken in 1966 have triggered an increased in the tidal range, resulting in increased amounts of tidal exchange, including sediment transport, between the lake and ocean (Great Lakes Council, 2014).



Figure 1 Wallis Lakes (source: NSW Gov)

The northern sections of the lake are more heavily influenced by tides and saltwater influence than the southern end (Great Lakes Council, 2014).

With a permanent entrance, the source of marine sediment entering the estuary is the beach and surf zone immediately adjacent to the entrance, with waves playing an important role in the delivery of that sediment. Wave stirring of sediments at the seaward end of the entrance channel and in the adjacent surf zone acts to suspend sediment that can be transported into the estuary by tidal currents. The result is a net transport of sediment into the lagoon entrance, which has resulted in the formation of a pronounced flood tide delta in the downstream region of the estuary. The tide delta in Wallis Lake is continually growing as more sand is transported in and it is estimated that it could take another 300-400 years or more to reach a new equilibrium (Nielsen & Gordon 2017).

Key issues presently include:

- The hydrodynamic regime of the estuary entrance and associated scour undermining the Forster Tuncurry Bridge pylons in certain locations (currently being investigated by Transport for NSW (TfNSW));
- Entrance shoaling and flood tide delta migration- resulting in loss of safe navigable draft for commercial and recreational boating in the downstream reaches of the estuary (see Figure 2).

The historical impediments for navigational access have led to the implementation of an ongoing dredging program, the most recent iteration of which occurred in late 2023, when 19,120 cubic metres of sand was dredged from the Tuncurry channel adjacent the Tuncurry boat ramp in the lower estuary. However dredging investigations in recent times have encountered Acid Sulfate Soils (ASS) which have required careful management to avoid adverse environmental and social impacts.

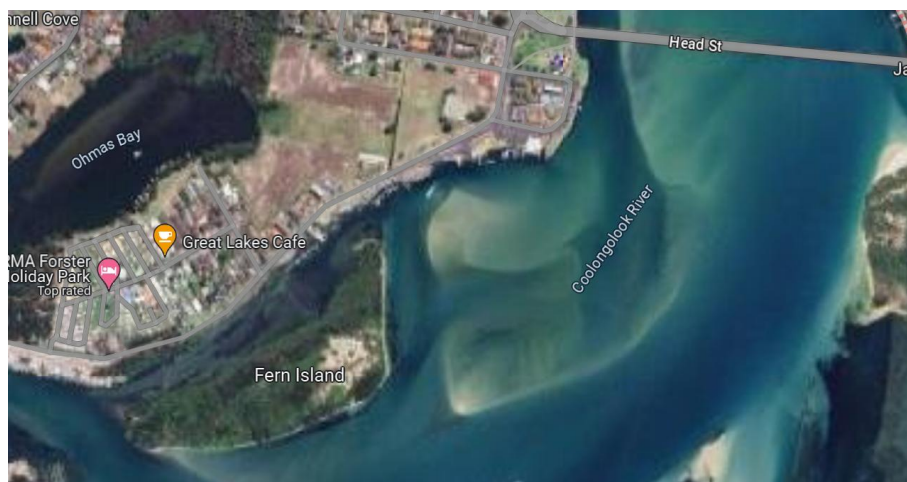


Figure 2 Sand aprons impacting navigational safety at Fern Island

Studies currently underway include:

- TfNSW investigation into Forster Tuncurry Bridge pylons
- Modelling of Wallis Lake (Salients) - consultants to undertake hydrodynamic assessment to guide future dredging management options.

Historical assessments that provide greater detail into entrance modification and estuary dynamics include:

- Wallis Lake: Dredging and Disposal Options Assessment (2011);
- Coastal Process Report: Hydrodynamic and Sediment Transport Assessment of Wallis

Lake Dredging (2011);

- Wallis Lake Estuary and Catchment Management Plan. This included a Navigation Dredging Program, with key sites identified as shown in Figure 3.



Figure 3 Wallis Lake Northern Section Dredging and Spoil Disposal Locations (Wallis Lake ECMP, 2015)

Smiths Lake

Smiths Lake is a large coastal lake, located on the lower-north coast of NSW between Wallis and Myall Lake – see Figure 4. The lake is classified as an ICOLL.

The lake's catchment is approximately 34 km², with surface waters of about 11 km² and has a maximum fetch of around 3 km. There are no major rivers that flow into the lake, and the tributaries feeding into the lake are Wamwarra Creek, Tarbuck Creek and Bramble's Creek. The lake has three islands within its main



Figure 4 Smiths Lake (Source: MidCoast Council)

water body - Big Island, Little Island and Bull Island. The bordering catchment is largely undeveloped and has only small townships of Smiths Lake and Tarbuck Bay on the northern shore, and Bungwahl on the west. The northern and southern sections of the lake are surrounded by open forest, forested wetlands and open freshwater wetlands. Smiths Lake, and its creeks and tributaries to the tidal limit, are part of the Port Stephens-Great Lakes Marine Park.

The estuary is a “barrier lagoon system” with a coastal sand dune barrier on the eastern foreshore impounding the lake waters within a drowned valley (See Figure 4). The entrance region forms a sand barrier between main channel and Symes Bay. The ocean entrance or the opening of the estuary is across a sandy beach called Sandbar Beach. The lake’s entrance is mechanically opened by MCC on an as-needed basis for flood mitigation purposes – in accordance with Councils entrance opening policy. The entrance has been artificially opened since 1932, with Council coordinating the activity since 1960 (WMA 2009). The trigger Lake water level, to initiate opening was initially set at a 1.7m AHD, and since 2002, the level has been raised to 2.1m AHD.

The entrance opening policy is based on mitigation of estuarine flood risk for The Lakes Way, the major access road for the region. However, this lake level can result in inundation of Frothy Coffee Boatshed, a café built over the water on the northern side of the lake, and Sandbar Caravan Park on the north-east side of Smiths Lake. It should be noted that 2.1m AHD has the level of the lake at the floorboards of Frothy Coffee. Water pumps and sewage treatment pumps may also be inundated over the coming 20-year planning period due to sea level rise, as well as other minor assets. These pumps are already inundated at 2.1m. Council’s Water Services have stated that these are sealed and not a problem for inundation. However, this will need to be checked with them in the Human Health issues paper.

In addition to this pressure to open the lake prior to reaching 2.1 m AHD, the fishing community has expressed desire for an increased exchange with the ocean, specifically to allow greater numbers of larvae and juvenile prawns to enter the Lake. MCC has specifically stated that a review of the Smiths Lake Entrance Policy will not be conducted as part of the CMP process as there is the possibility that the CMP will include an action to review the Policy. It was recently reviewed as part of the CZMP (BMT, 2018), which included an assessment of the opening procedure with respect to the Marine Parks Act.

However, a review may be required over the 10-year timeframe of the CMP. Therefore, a management option may be to investigate and update the entrance opening policy as required.

A further key concern is sediment infill, which was explored in detail in the Smiths Lake CZMP (BMT, 2018). It identified that as a wave dominated estuary with no major river inflows, the largest source of sediment is likely the landward extension of the flood tide delta resulting from coastal processes pushing marine sand into the estuary. This has resulted in a large sand barrier that separates Symes Bay from the main lake, and a flood tide delta that has grown in size since at least 1953. The lateral growth of the delta indicates an increase in sediment deposition within the region and may be due to an increase in entrance openings since 1961 due to the tidal asymmetry promoting flood tide deposition (BMT, 2018). Additionally, breaches below their natural range are weaker, flushing far less sand out of the mouth than might occur naturally. The main channel west of the flood tide delta has shown little movement since 1953. Overall, the assessment determined sand infilling resulted in a minimal impact on navigation, ecology or water quality since 1953, however the southward shift of the entrance opening has resulted in dune erosion and recession south of the entrance (BMT, 2018).

The assessment also investigated two management options that would reduce further infilling; initiate changes to the entrance opening regime, and site specific dredging. Changes to the entrance opening regime include having a higher trigger water level, that may promote increased scouring during an entrance opening event, and artificially closing the lake to limit landwards transport of sand back into the entrance region. However, the trigger water level is set based on flood mitigation

requirements, and so at the present-day cannot be altered. Dredging could be a viable alternative to maintain tidal flows or between Symes Bay and the main entrance channel, however would need Crown Lands and Port Stephens – Great Lakes Marine Park approval.

It is also important to consider the impacts of changing climate on the opening regime of Smiths Lake. For example, as discussed in the Climate Change issues paper, more intense bursts of rain are projected for the study area including Smiths Lake, leading to the need for more frequent opening particularly in La Nina episodes. Also, sea level rise plus storm events will possibly also lift the berm meaning there could be more closures of the lake during more frequent protracted drought periods included El Nino events. Wave run-up during non-erosive conditions sets the berm level, and therefore sea level rise will result in a commensurate rise in typical barrier levels. If the breach level of 2.1 is maintained - artificial opening will be required more frequently as sea levels rise.

Myall Lake

The Myall Lakes system is a coastal barrier lake system comprising four linearly connected brackish to freshwater waterways, with a total catchment area of 780 km². The waterbody itself is also significant comprising 102 km², 11.2% of the total catchment area (See Figure 5). The four basins are the Myall Lake, Boolambayte Lake, Two Mile Lake and Bombah Broadwater. The average depth of the lake is 2.7 m, with the deepest point at about 13 m within the connecting channels. The Myall Lakes catchment is divided into six sub catchments:

- Upper Myall River;
- Lower Myall River;
- Crawford River;
- Bombah Broadwater;
- Boolambayte Creek; and
- The Myall Lake catchment area (Great Lakes Council, 2009).



Figure 5 Myall Lakes. (Source: NSW Gov)

In 1999, Myall Lakes was designated as a Wetland of International Importance under the Ramsar Convention and are protected by conservation reserves managed by the NSW Government. The area consists of Myall Lakes National Park, Little Broughton Island Nature Reserve, Corrie Island Nature Reserve, and part of Gir-um-bit National Park. The estuarine and brackish waters and the beaches and intertidal areas in the site are within Port Stephens – Great Lakes Marine Park

The Myall Lakes system connect to the ocean via the Lower Myall River, through channels both north and east of Corrie Island. Historically, sand build up has resulted in navigation issues in between the eastern side of Corrie Island and the mainland ("The Shortcut"), with larger boats having to navigate a longer distance around the western side of Corrie Island which is the formal navigation channel to reach the northern passage. The Shortcut has been dredged since 2015, however quickly infills. Sand from the dredging operations at the Shortcut is stockpiled for renourishment of Jimmy's Beach.



Figure 6 Sand accumulation at the Navigation Channel. Source: Myall River Action Group

Sand accumulation near Hawks Nest and Tea Gardens has also historically resulted in navigation issues, with ferries that service Tea Gardens touching the bottom in multiple places.

Dredging has historically occurred over the past decades to maintain access to Myall Lakes, with 120,000 m³ of sand removed from The Shortcut at Hawks Nest in 2020.

In early 2024, funding to dredge a number of areas of the channel within the Lower Myall River was allocated with the aim to improve navigational safety and support local economies. This project is funded by the Marine Infrastructure Development Office (MIDO), with MCC managing the dredging which is expected to occur in 2024/2025. Further assessment of dredging in the Lower Myall River will occur when the MCC Dredging Strategy is written in latter stages of this CMP.

Karuah River Estuary

Port Stephens and the Karuah River collectively make up 300 km² of waterways, which makes them one of the largest estuarine waterways in NSW. The estuary includes the northern foreshore of Inner Port Stephens, from Yallimbah Creek to Pindimar (including Tea Gardens and Hawks Nest) and including North Arm Cove and the Karuah River up to the limit of tidal influence, one kilometre south of the village of Booral.

Port Stephens has an extensive shallow flood tide delta that extends across the estuary entrance and is continuously modified by the complex interaction of tides, waves, and minor flows from the Lower Myall River along the northern shore (BMT WBM, 2011). Generally, sediment erodes from the estuarine beaches and is trapped and deposited in the flood-tide delta, which occupies most of the outer estuary. The delta dynamics are related to the dynamics of the Myall River mouth and Winda Woppa spit. There has been a noted net loss of sand in the flood-tide delta from 1851 up until around the early 1960s and it has been speculated that this erosion and subsequent deepening of the estuary allowed the breaching of the Winda Woppa spit by a storm in 1927 (Thom, et al., 1992). However, Vila-Concejo et al. (2007) found that the flood-tide delta has increased in its extent since 1963.

The Pindimar area within the estuary has sandy and mangrove lined shoreline. The adjacent land to the shoreline is low-lying, and flood prone land. This area is impacted by erosion of the sandy beaches and has mobile sediments in the nearshore, which has been a cause of concern for the local community (Umwelt, 2000). Entrance modification is mostly concerned with sedimentation around Corrie Island, which has been addressed under the section of Myall Lakes.

The Lower Pindimar, Pindimar, Upper Pindimar and Bundabah Foreshore Erosion Study (BMT WBM, 2011) investigated foreshore erosion issues along these shorelines, including: the extent of erosion in residential areas, including both private and public lands; the potential causes of any observed erosion (e.g. waves, tidal currents, boat wake, stormwater discharges, mangrove dieback); and protection options to manage identified erosion). A suite of strategies to enhance

and improve foreshore protection and habitats in the study area is detailed in the plan – along with a suite of sub-actions to implement these strategies.

Climate Change

Climate change will impact all estuaries, altering their physical, chemical, and biological characteristics. A primary impact will be sea level rise, which will influence entrance opening frequency and duration, and increase estuary water levels. Sedimentation and infill rates will also be altered, in addition to changes to rainfall levels and flood events, that will together result in morphological changes to each estuary. SLR will also increase the extent of saltwater intrusion into estuarine ecosystems, potentially disrupting the balance of freshwater and saltwater habitats and their extents. This will be explored in greater detail in the Coastal Wetlands and the Coastal and Tidal Inundation Issue Paper.

Climate change impacts are likely to be gradual and it is unknown exactly how each estuary will respond and adapt. Thus, management actions will have to be dynamic and allow for modification as impacts are realised. Some issues, such as sea level rise, have clear impacts such as inundation of the foreshore and assets; these can be predicted and actioned in the short-term. Others, such as increasing salinity or water temperature, may be a gradual change with limited practical action that MCC can take to mitigate effects.

1.2 Stakeholders

MCC; DCCEE – Environment and Heritage; DPHI - Crown Lands; TfNSW - Maritime Infrastructure Development Organisation (MIDO); DPI – Fisheries; Port Stephens – Great Lakes Marine Park; recreational and commercial fishers; Port Stephens Council; MidCoast Water; asset owners (e.g. Frothy Coffee Boatshed).

Community and stakeholder engagement

A community survey and other stakeholder engagement activities conducted in Stage 1 of the Southern Estuaries CMP identified 'waterway access e.g. Karuah River' as a key issue in the study area.

1.3 Existing Management Approach

Management of estuary entrances across the Southern Estuaries study area has historically been based on the unique requirements and environmental constraints for each unique system; what applies to a permanently open estuary may not be relevant to an ICOLL. As such, the following management plans have been developed:

- Khappinghat National Park, Khappinghat Nature Reserve and Saltwater National Park Plan of Management;
- Coastal Zone Management Plan for Smiths Lake Estuary;
- Karuah River Catchment Management Plan;
- Wallis Lake Estuary and Catchment Management Plan;
- Port Stephens Foreshore Management Plan; and
- Myall Lakes National Park and Myall Coast Reserves Plan of Management.

1.4 Knowledge Gaps

- Unknown tidal regime in Black Head Lagoon – installation of a water level gauge

1.5 What's working, what's not?

What's working

- Communications between agencies
- Wallis Lake – different agencies come together to address shoaling.
- Having a Crown land licence for Smiths Lake opening is 'working'. Aim for minimal intervention – what are the strategies for raising levels?
- Opening procedure for opening for Smiths Lake working well.
- Trained walls are an advantage from a flooding perspective and flooding of Smiths Lake is also working well, sand to Jimmy's Beach is a bonus.

What's not working?

- Need for more strategy around the timing for proactive dredging rather than being caught off guard.
- Big processes involved in Myall Lakes and the amount of funding available will not suffice,
- Limited information about the management of the Khappinghat Creek, Black Head Lagoon.
- More education around the dredging issue so that there is a better understanding.
- Embed the ongoing impact of entrance modification on the estuary and responsibilities around this – community understanding and education needs to increase for ongoing management.
- Understanding how entrances will be managed into the future. Plan to indicate when this happens, need to be more interventionalist.
- No opening regime for Black Head Lagoon.
- No triggers for dredging, dynamic area, some sites have been removed from the sites identified in the CZMP. Focus on navigation. Economically losing high value leases in the entrance to Wallis Lake (\$2M loss per year)
- Currently doing hydrodynamic modelling to identify the sustainable dredging options.
- Tuncurry Channel monitored 50% full plan the next campaign – 6-7years.
- Expect to see the issues with Tuncurry Channel increasing over time.
- MIDO Coastal dredging strategy and infrastructure plan are due to be updated this year. 9 priority sites from strategy having REF approved (with monitoring). Current strategy, Wallis Lake, Tuncurry Channel to Point Road moorings.
- Required to open for any other reason than water level management – need to have an EIS.
- Opening more frequently, barrier heights will get higher = more effort to open & more.

1.6 Opportunities

- Check policy to ensure flexibility in its link to the Crown land licence.

- Consider the option of dredging to nearshore areas, reworking into the beach profile.
- Consider what the entrance opening regime might change with climate change and what this means for infrastructure and impacts on the estuaries.
- Engagement around options – when Council says ‘no’ – State government set a policy, setting the clear direction.
- Consider private sources for funding the dredging to support oyster leases.
- Monitoring is the key to identifying triggers.
- Model for funding from federal government for dredge at Swansea channel, MIDO to get the dredge and share across councils 2026.
- CoastSnap for Khappinghat Creek.
- Consider when and if we should open Blackhead Lagoon for water quality issues, consider impacts of climate change
- Formalise action to remove sand from the Eastern Channel (The Shortcut) to renourish Jimmy’s beach as an action.
- Document the information after dredging or opening, how has it impacted levels of the estuary, weather conditions.
- Sharing of data and identify gaps in knowledge.
- Include research projects.
- Community engagement and education program to include tourists, indicate that these are dynamic systems.
- Maintain good relationship with MIDO - some budget available to assist with dredging.
- Community of practice on ICOLL management, southern estuaries in NSW have progressed their CMPs.
- Bathymetry monitoring seawalls to know whether they are going to be undermined.
- Wallis Lake – advocacy, understanding the link between breakwall management, good asset management = need to consider all impacts.
- Consider sale for dredged spoil to fund the projects (pending EPA changing their classification).
- More data around the tidal prism – and the cost benefit analysis for different stakeholders.
- Impact on fringing habitats to be monitored, what happens to the ecology – modelling future impacts with climate change and communicate this with the community so that they can see what the projections are.
- Talk to DPI Fisheries about streamlining processes for moving leases.
- Ecosystem health monitoring program – evolve the current report card approach to build in more ecosystem monitoring ideas. Snapshot about what extra information to tell a response story after the estuaries are opened – answer a specific question

1.7 Management Options

Management options from prior management plans that could be incorporated into the CMP are listed below:

Wallis Lake ECMP

- Identify and prioritize foreshore areas in need of protection from erosion
- Develop and implement Best Management Practice for riparian stabilisation in highwash areas according to priority and opportunity
- Dredge the sand bar encroaching on Posidonia australis beds between Wallis and Tonys Point Islands
- Implement the Wallis Lake Dredging Maintenance Program in consultation with relevant authorities for navigation channels. Support sustainable dredging of oyster leases in 'protocol' area. The Wallis Lake Navigation Dredging Program identified ten sites that were high priority to maintain safe access and navigation.

Smiths Lake CZMP

- Commence monitoring and recording of entrance conditions and opening impacts
- Survey southern foreshore dune (including wetland edge) near entrance following opening events
- Investigate success of existing dune stabilisation works and implement maintenance / upgrade program
- Investigate and implement options to enhance safety during opening procedure

Lower Pindimar, Pindimar, Upper Pindimar and Bundabah Foreshore Erosion Study (BMT WBM, 2011)

- Implement protection works to remediate erosion at the Norfolk Island Pine, boat ramp and adjacent foreshores;
- Promote growth and enhancement of native foreshore vegetation such as mangroves;
- Remove illegal revetments and seawalls; and
- Reduce scour impacts from stormwater discharge locations, and remediate erosion caused by these discharge outlets.

From workshop

- Formalise harvesting of sand for replenishment of Jimmys Beach
- Ensure that there is follow up data of entrance management and dredging across estuaries.
- Develop and implement community engagement and education regarding entrance modification including an understanding of them being dynamic and fragile systems.
- Use InletTracker and other platforms to monitor entrance changes and impacts of entrance modification practices.
- Ensure strategic planning is related to future entrance changes particularly related to climate change.
- Have no impact policy for Knappinghat Creek entrance,

- Have low intervention policy and monitoring of berm height at Black Head Lagoon to manage community expectations.
- Monitor bathymetry around seawalls and revetments for undermining issues.
- Further develop the ecosystem monitoring program.

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ISSUE ANALYSIS FLOOD, COASTAL INUNDATION, AND TIDAL INUNDATION

2024

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1. Coastal and Tidal Inundation and Flooding

This Southern Estuaries Coastal Management Program (CMP) paper investigates the extent and impact of coastal and tidal inundation and flooding on the Southern Estuaries, including impacts on environmental, physical and social assets. Coastal and tidal inundation will significantly impact numerous areas of the Southern Estuaries, with the frequency, depth and extent of inundation increasing with sea level rise. The Stage 2 Tidal Inundation Study (JBP, 2024) provides an assessment of inundation levels and associated risk, and identifies assets and infrastructure that could be impacted in the present-day or in future planning horizons.

Authors: *Courtney Smith, Chris Beadle*

Contributors: *Michael M, Mat Bell, Evan, Amanda, Danny Butcher, James Duval, Ainslie, Courtney, Neil, Andrew Fielding, Peter Brennan (NPWS), Erin, Prue, Sue Calvin, Tracy Hamer, Christeen Matta*

1.1 Situation Analysis

The primary aim of the CMP is to document practical actions to be carried out by MCC and other stakeholders to mitigate risks from coastal hazards and risks to the health of the estuary. Under the *Coastal Management Act 2016* (CM Act), the coastal zone is comprised of the following coastal management areas, as mapped in the Resilience and Hazards State Environmental Planning Policy (RH SEPP):

- (a) the coastal wetlands and littoral rainforests area,
- (b) the coastal vulnerability area,
- (c) the coastal environment area,
- (d) the coastal use area.

Under the CM Act, Coastal Vulnerability Areas are defined as land subject to current and future coastal hazards. There are seven types of coastal hazards defined by the CM Act. Of those seven, three hazards are discussed in this issue paper:

- tidal inundation
- coastal inundation
- erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.

These three hazards are discussed in the below sections. However, CMPs under the CM Act are not intended to take precedence over other council plans, but rather provide information to support the more effective consideration of coastal hazards and estuary health in other statutory and operational plans.

In the case of flood, coastal inundation and tidal inundation, the primary planning documents are the Floodplain Risk Management Plans (Port Stephens Foreshore (Floodplain), Wallamba River, Nahiack, Myall River, Smiths Lake, Wallis Lake Foreshore (Floodplain), Karuah River).

1.1.1 Tidal Inundation

Tides are the regular rise and fall of sea levels caused primarily by the gravitational forces exerted by the Moon and the Sun on the Earth's oceans. The tides along the NSW coastline are semi-diurnal in nature, i.e. high water and low water occur about twice daily (the actual period of a tidal cycle is about 12.5 hours).

Additionally, the alignment of the Sun, Moon, and Earth can lead to variations such as spring tides, which are higher than average and occur during full and new moons, and neap tides, which are lower than average and occur during the first and third quarters of the moon. King tides are the highest tides of the year, occurring when the Earth is closest to the Sun (perihelion) and the Moon is closest to the Earth (perigee). These extreme tides typically happen once or twice a year, may inundate low lying foreshores, particularly in estuarine settings (JBP, 2024). This typically affects low-lying communities for a short period of time (~0-2 hours) and is sometimes referred to as 'nuisance inundation' or 'sunny day flooding' (Hanslow et al, 2019).

The impacts of sea level rise are expected to gradually affect coastal communities over the coming decades through higher, more frequent and longer duration tidal inundation events. Higher sea levels mean that high tides reach further inland, flooding areas that were previously dry. This is particularly problematic in low-lying coastal regions, where even minor increases in sea level can significantly exacerbate flooding impacts.

The broader impacts of climate change have been presented in the Climate Change Issue Paper.

Currently, tidal inundation can result in significant impacts on infrastructure such as roads, homes, and businesses - which can be damaged or rendered temporarily unsafe/unusable during these high tide events. Such impacts can be exacerbated by meteorological conditions (including storm events) to generate storm tide conditions, and this is discussed more in Section 1.1.3..

Increased severity and frequency of tidal inundation due to rising sea levels can lead to significant economic damages related to repair and maintenance of public and private infrastructure, disruption of services, and declining property values. Additionally, sea level rise poses significant threats to essential infrastructure. For example, tidal inundation can overwhelm stormwater systems, leading to sewage overflows and contamination of local water supplies, posing public health risks. These risks are particularly prevalent in the more densely populated regions of the Southern Estuaries such as Tuncurry, Forster, Tea Gardens and Hawks Nest.

The latest projections from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (AR6) indicate that sea levels will keep rising, increasing the frequency and severity of tidal inundation (see Figure 1).

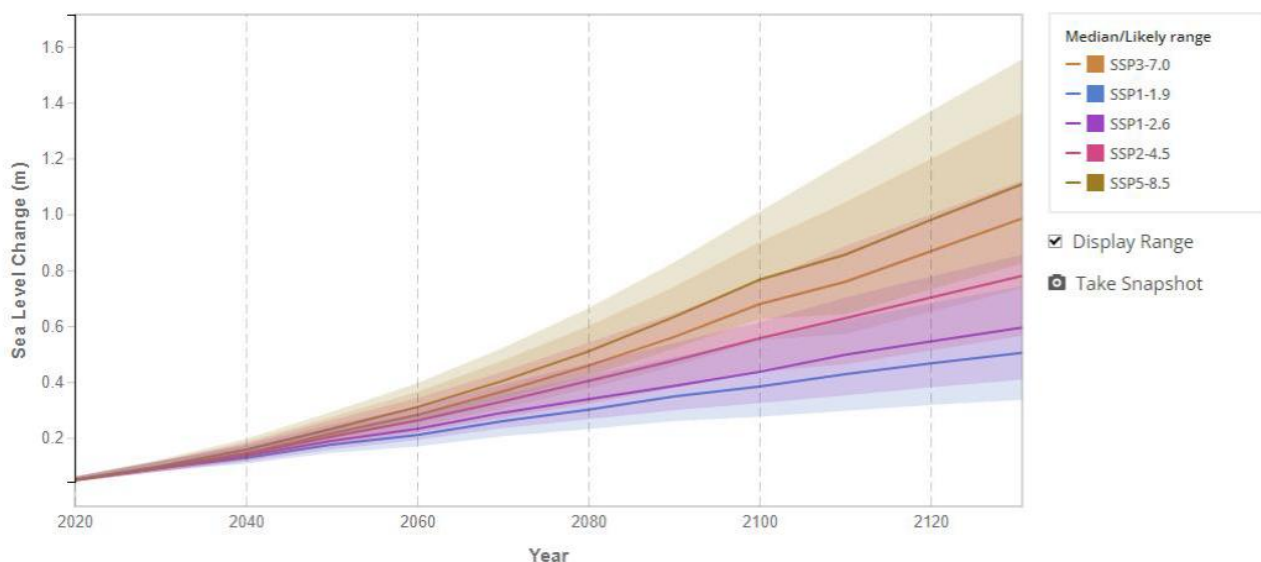


Figure 1 A summary of Global Mean SLR Projections from AR6 for five of the Shared Socioeconomic Pathways.

By 2075, many coastal areas could experience tidal flooding on a nearly daily basis in comparison to the present day. Predictions with the Southern Estuaries range from +0.1m to +0.7m sea level rise during this period. This chronic flooding could render some areas uninhabitable, forcing relocations and significantly altering the demographics and economies of coastal regions.

Furthermore, sea level rise is expected to have significant environmental impacts. Coastal ecosystems, including wetlands, mangroves, and estuaries are particularly vulnerable. The encroaching saltwater disrupts the delicate balance of these habitats, leading to loss of biodiversity. Increased erosion and flooding threaten natural landscapes, causing habitat destruction and the displacement of various species. Additionally, the inundation of freshwater sources by seawater can compromise the quality of aquatic habitats, affecting both plant and animal life. The overall impact is a cascading effect on ecosystems, necessitating urgent adaptive and mitigative measures to safeguard these environments and the services they provide.

1.1.2 Tidal Inundation Report Summary

The Southern Estuaries CMP Stage 2 Tidal Inundation Study (JBP, 2024) developed new tidal inundation mapping for the MidCoast Council Southern Estuaries. Mapping was prepared in accordance with the NSW Coastal Management Manual, which allows for a probabilistic framework to assess future tidal inundation hazards. A risk assessment was subsequently undertaken using this data to evaluate the regions susceptibility to sea level rise. This was prepared for present day and future scenarios of +15 years (2040), +50 years (2075), and +100 years (2125).

The assessment considered the increasing tidal exposure of property, essential infrastructure, open space assets, and the environment. Under present day conditions it was identified that 75 residential properties and 20 non-residential properties face high or extreme risk of inundation, with numbers set to increase significantly by 2040 and even more so by 2075 and 2125. Essential infrastructure, including stormwater, water and sewerage networks, bridges, culverts, and energy systems, will experience decreased performance due to increased inundation. Roads and remote tracks/trails will see a dramatic rise in exposure, extending from 13 km today to over 200 km by 2125. Open space features, such as benches, signs, shelters, and picnic settings, along with boat facilities, will also face heightened risk, with affected assets increasing from 203 today, to 963 by 2125. Furthermore, environmental areas will undergo substantial land system changes, particularly in coastal swamp forests and floodplain wetlands, with up to 42.1% of these areas projected to be affected by 2125.

The comprehensive risk assessment detailed within the study report and the accompanying mapping offer crucial insights that will guide the development of strategies to deal with future sea level rise. By leveraging these findings, stakeholders can make informed decisions to enhance resilience and improve land management across the region.

This Stage 2 study has identified potential management options that will be evaluated through the Stage 3 option assessment process.

1.1.3 Coastal Inundation

Coastal water levels in the study area are dominated by the astronomical tide. However, significant short-term variations from the predicted tide level can occur due to meteorological conditions (such as storm events) – and these variations are referred to as storm surge. The total water level resulting from astronomical tides and storm surge is referred to as a storm tide. Figure 2 illustrates the primary water level components of a storm tide event. Inundation of coastal areas due to storm tides is referred to as Coastal Inundation (which is related to, but distinct from Tidal Inundation, which occurs outside of storm events).

Coastal inundation due to severe storm events is a relatively infrequent event and, normally, is of short duration. However, it can result in significant damage to both public and private property and represent a public safety risk.

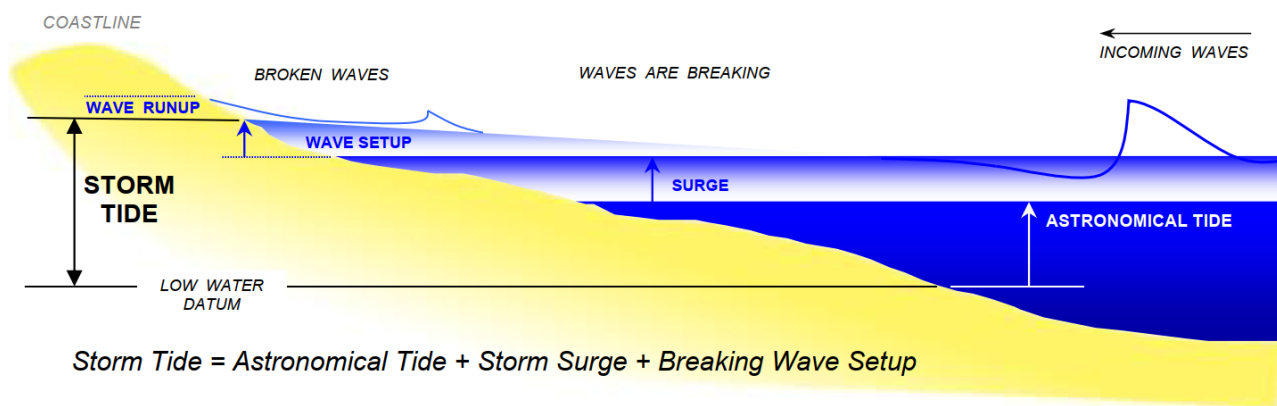


Figure 2 Components of a Storm Tide Event

The majority of the study area is protected from extreme coastal inundation due to being in constrained estuaries, which limits the exposure to large coastal waves. However, water levels in Port Stephens are influenced by both water levels within the estuary and offshore wave climate (Water Technology, 2022). Foreshore inundation around Port Stephens will depend on a combination of water levels in the estuary, wind waves, ocean wave activity, inshore bathymetry and the presence of foreshore structures (Umwelt, 2009). As waves reach the shoreline, they break and the remaining energy dissipation results in wave run up, which can cause inundation of foreshore areas.

Manly Hydraulics Laboratory (Manly Hydraulics Laboratory, 1997) examined the wave runup and flood levels around the Port Stephens foreshore. The study found that ocean waves tend to primarily impact the eastern embayments of Port Stephens, and that the highest waves were caused by easterly winds pushing waters directly into Port Stephens. The Draft Port Stephens FRMSP Review modelled the design flood events accounting for 0.55 m of sea-level rise by 2050 and 0.91 m of sea-level rise by 2100. It identified the following areas as being subject to wave runup flooding based on design wave runup depth maps under current and future planning horizons:

- Tahlee
- Carrington
- North Arm Cove
- Bundabah
- Pindimar

In particular, Carrington and Tahlee are subject to extensive foreshore flooding under a range of design SLR conditions. Under the design 1% AEP scenario, the towns become inundated by depths greater than 1.0 m. By 2100, flood extents and depths increase for the increase to depths greater than 1.5 m.

The Stage 2 Tidal Inundation Study (JBP, 2024) assessed tidal inundation at a range of sea level rise scenarios and planning periods. Approximate coastal inundation depths and extents can therefore be inferred through assessing the various sea level rise scenarios modelled in the Tidal Inundation Study. The Study provided mapping of the High High Water Solstice Springs (HHWSS) tidal plane for a range of current and future scenarios:

- HHWSS at 1.00mAHD (Present Day)
- HHWSS at 1.50mAHD (+0.5 m SLR)
- HHWSS at 2.00mAHD (+1.0 m SLR)
- HHWSS at 2.50mAHD (+1.5 m SLR)
- HHWSS at 2.90mAHD (Largest modelled SLR event).

The 100-year ARI coastal storm tide level is approximately 1.5 mAHD for Port Stephens region (OEH, 2015). Therefore, this level has been modelled in the Stage 2 Tidal Inundation Study and can be used as an approximate indication of coastal inundation for areas in the Southern Estuaries study area that are not constrained within an estuary.

1.1.4 Erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters

Riverine flooding is not considered under the CMP planning process, and instead is covered under the NSW floodplain risk management framework. However, the interaction of catchment floodwaters and tidal/coastal inundation and their effects on the erosion and inundation of foreshores is a coastal hazard defined by the CM Act.

Flooding in tidal waterways can be caused by catchment flooding, elevated ocean conditions, or a combination of the two. The influence of flooding from each of the two sources and the coincidence of the two impacts overall flood risk and varies with distance upstream from the ocean and other estuarine characteristics. While there are complex interactions between catchment and coastal flooding throughout the waterways, coastal conditions have a particularly strong impact on flooding in the lower reaches of the tidal waterways due to their influence on water levels. The joint occurrence of coastal and catchment flooding can have significant impacts on the MidCoast estuaries.

There is a long history of flooding in the MidCoast LGA, with both cyclones and east coast lows having the potential to bring flood-generating weather to the region. It is known that a flood exceeding the 1% Annual Exceedance Probability (AEP) flood occurred in 1927 impacting the areas around Wallis Lake and the Myall Lakes.

1.1.4 Adaptation and Management

Adaptation strategies, including coastal protection works (such as sea walls), improving drainage systems, and implementing managed retreat in some areas, are essential to mitigate the impacts. However, these solutions are often expensive and logistically challenging, particularly for densely populated urban areas. Addressing the root causes of climate change, such as reducing greenhouse gas emissions, is also crucial in managing the long-term risks associated with tidal inundation. Without significant intervention, both in terms of adaptation and mitigation, the challenges posed by tidal inundation will only become more severe.

Stakeholder engagement is fundamental to successful adaptation to sea level rise because it ensures that the diverse perspectives, needs, and knowledge of all affected parties are considered in the planning and implementation process. Engaging stakeholders, including local communities, businesses, government agencies, and environmental organizations, fosters collaboration and builds a sense of shared ownership and responsibility. This inclusive approach helps to develop more effective and equitable solutions, and increase public support for adaptation measures. By incorporating the insights and expertise of those directly impacted, adaptation strategies can be better tailored to address specific vulnerabilities and priorities, ultimately leading to more resilient and sustainable outcomes.

1.2 Stakeholders

Management agencies

MidCoast Council; NSW State Emergency Service, Department of Climate Change, Energy, the Environment and Water

1.3 Existing Management Approach

Riverine flooding, tidal inundation and coastal inundation are managed through the various Floodplain Risk Management Studies and Plans across the study area, listed above.

Emergency planning and response is covered by the Floodplain Risk Management Plans, the MidCoast Council Local Emergency Management Plan (SES, 2017), and the MidCoast Council Flood Emergency Sub Plan (SES, 2023).

Infrastructure management: Council has developed a Climate Change Adaptation Framework to manage climate risks on Council infrastructure assets. This is discussed in the Climate Change Issue Paper, and outlines key infrastructure that may be at risk over the next 100 years, and methods to improve resilience.

1.4 Knowledge Gaps

- Should determine coastal inundation extents, particularly for open foreshore e.g. Pindimar foreshore. Can utilise tidal inundation mapping.

1.5 What's working, what's not?

What's working

- Cumulative areas are lost to wetlands, allow for retreat wherever possible.

What's not working?

- Pump out sewer at places like Pindimar etc could potentially have a major impact
- Operations could be impacted by saltwater intrusion

1.6 Opportunities

- Strategic approach to coastal wetland managed retreat.
- Asset management to manage the design life of the asset.
- Planning for the water & sewer assets and work out the triggers for acting.
- Opportunity to increase community readiness in response to coastal and tidal inundation.
- Include planning controls for areas that will be inundated and give consideration to those locations that are high risk and may have developments approved.
- Engagement with the communities that are within the high risk areas, determine the appetite for risk within specific communities
- Tidal inundation calendars as a tool for engaging with community to assist with managing the controls. Send out warnings / alert for when particular council assets are under water
- Key areas for adaptation planning - Pindimar, consider the whole system in adaptation planning e.g no point sealing the sewer if you cant access the roads
- Research into the impact of changes in tide on the groundwater, and target areas with built assets. Use this data to work out the levels that assets will go under.
- Need to work out the tolerance and thresholds to work out when to start adaptation planning
- Need more detailed data for specific locations focus on the areas that are identified as high risk. Be more specific about the impact at these locations with the changing water levels and how and if these locations can be serviced.
- Public engineering works case studies

1.7 Management Options

Transport

- Make transport and stormwater assets more resilient for continued servicing e.g. installing duckbill outlets.
- Relocating of assets and/or relocation of buried assets above groundwater
- Removal of assets, modifying the asset e.g. remove the pipe and have it opened
- Funding for a ground truthing exercise to verify at risk assets found from the tidal inundation risk assessment.
- Study to analyse how often Transport Assets are inundated.
- Have robust planning policies in place to stop people from building in certain places/areas.
- Adopt strategies where we are not creating (or making worse) problems for future generations.
- Revisions of the Business Continuity Plan

- Review and revise current stormwater policies, procedures and guidance in order to create opportunities to incorporate Water Sensitive Urban Design into Council's new and upgraded capital infrastructure.
- Development of Stormwater Management Plans (SMP) for the following townships: Forster, Tuncurry, Smiths Lake, Black Head, Hawks Nest and Tea Gardens. Incorporate resulting Actions into a subsequent revision of the CMP.
- Communicate information to new people moving into the area about the risks and effects of tidal inundation.
- Develop forward plans in Council's Asset Management Program(s) for upgrade and replacement of Council assets at risk from sea level rise such as roads, stormwater systems, water & sewerage infrastructure and community spaces facilities.
- Need to start acknowledging the problem and moving out of these areas.
- Need to set policies that recognise it is not a static issue.
- Update asset management plans that consider the effects of sea level rise. Reference the tidal inundation study and following work...
- Undertake comprehensive studies of groundwater and its effects with sea level rise.
- Adopt innovative policies and strategies from overseas places to tackle sea level rise e.g. Florida USA, Netherlands
- Policy needs to catch up, for example: how are you going to demolish/adapt/retreat from areas which are at risk to sea level rise?

Water Services

- Make water and sewer assets more resilient for continued servicing e.g. sealing manhole lids.
- Relocating assets
- Funding for a ground truthing exercise to verify at risk assets found from the tidal inundation risk assessment.
- Develop forward plans in Council's Asset Management Program(s) for upgrade and replacement of Council assets at risk from sea level rise such as roads, stormwater systems, water & sewerage infrastructure and community spaces facilities.
- Have robust planning policies in place to stop people from building in certain places/areas.
- Adopt strategies where we are not creating (or making worse) problems for future generations.
- Communicate information to new people moving into the area about the risks and effects of sea level rise.
- Need to start acknowledging the problem and moving out of these areas.
- Need to set policies that recognise it is not a static issue.

- Prepare plans for public infrastructure, buildings and ecological areas.
- Update asset management plans that consider the effects of sea level rise.
- Removal of assets from non-serviceable locations
- Implement Council's Onsite Sewerage Management System (OSSM) Audit and Compliance Strategy with a proactive inspection program at identified high-risk locations within the Coastal Zone.
- Relocation of buried assets above groundwater
- Undertake comprehensive studies of groundwater and its effects with sea level rise.
- Adopt innovative policies and strategies from overseas places to tackle sea level rise e.g. Florida USA
- Policy needs to catch up, for example - how are you going to demolish/adapt/retreat from areas which are at risk to sea level rise?

Community Assets

- Be aware of tidal inundation and don't build things in areas where we will later need to move them.
- Community Assets understanding of tidal inundation needs to improve – potential further workshops and education programs.
- Understanding how tidal movement impacts community assets prior to giving letters of consent for community groups delivered projects.
- Council wide planning policies including developer contributions for community land and community assets.
- Asset planning needs greater consideration of climate risk factors – make them more resilient.
- Consideration of relocation of assets, including considering how to manage Indigenous tangible assets.
- Asset Management Plans need to further acknowledge and address sea level rise.
- Develop forward plans in Council's Asset Management Program(s) for upgrade and replacement of Council assets at risk from sea level rise such as community spaces facilities.
- Have robust planning policies in place to stop people from building in certain places/areas.
- Map and implement SEPP Resilience and Hazards mapping to put controls on future development in high risk areas.
- Rezone sensitive wetland areas to a conservation zone to provide a buffer for wetlands to migrate with SL rise

- Investigate how the SLR predictions will impact on the ecological character description for the Myall Lakes Ramsar site. Determine how inundation will impact on the species and wetlands within the Ramsar site
- Adopt strategies where we are not creating (or making worse) problems for future generations.
- Need to start acknowledging the problem and moving out of these areas.
- Removal of assets from non-serviceable locations
- Undertake comprehensive studies of groundwater and its effects with sea level rise.
- Asset based assessment, work out the hot spots and get more detailed information, modelling, have biological experts, work on building resilience within the natural systems that will be impacted. Will need to take into consideration changes in WQ for example salinity in Darawank. Reduce stressors in hot spot locations, avoid degrading processes such as changes to hydrology.
- Identify resilient systems as a first priority and protect those.
- Include natural assets in asset register.
- Conversion of habitats to natural habitats. Map to identify where these key areas are, also note that the places that are natural don't get converted to grass (e.g Coomba Park).
- Require more data at black head lagoon on water levels, water level data within the tidal reaches of the Karuah River, Khaphinghat, Coolongolook. Include loggers for future modelling.

Impacts on Community Assets:

- loss/damage to coastal reserves, beaches; public recreational sites, public recreational facilities
- Asset deterioration – components become unusable / brittle
- Reduction in useful life
- Negatively impacts the functionality of recreation assets
- Increase in renewal costs
- Increase in maintenance costs
- Increased demand for other facilities
- Impact on community usage and level of service
- Impact on tourism
- Impact on local economy

Other

- Working collaboratively with landowners and other stakeholders to develop an adaptation plan to mitigate the long-term risks of tidal inundation impacts.
- Conduct research into future habitat migration of wetlands and other ecologically sensitive communities due to tidal inundation.
- Choose locations in the estuaries and investigate a transition plan for the next 10, 20, 50 years or beyond.
- Conduct a review of long-term planning relating to population growth and development around the estuaries/study area.
- Review the location of tidal level gauges to help monitor future tidal inundation changes in the estuaries. Possibly install new tidal level gauges where required.
- Educate communities in the potential social, economic and environmental impacts of tidal inundation.
- Develop community education regarding impacts on cars in relation to tidal inundation. Could develop a tidal calendar, and a king tide photo program.
- Share information with the LALC, so that they can do their own adaptation planning for cultural heritage sites and intangible assets and impacts on natural environmental assets (habitats and species).
- Incorporate cultural knowledge about tides and song lines.

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ISSUE ANALYSIS

MODIFIED FRESHWATER FLOWS

2024

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1. Modified Freshwater flows

Ensuring that sufficient and high-quality surface and groundwater water is provided for environmental purposes is essential for the health of the Southern Estuaries, and central to the National Water Initiative and NSW Water Sharing Plans. This paper considers the impacts of extraction, drought, climate change and increased peak run-off on flow rates and ecosystem health in the Southern Estuaries catchments and coastal zones. In addition, it considers the impact and management of waterway modification, including weirs and dams.

It is noted that the management of freshwater flows is the focus of the Our Water Our Future 2050 Integrated Water Cycle Management (IWCM) Strategy (MidCoast Council, 2023). Therefore, this Issue Paper provides an overview of the Strategy, other relevant plans, and potential methods for the Southern Estuaries CMP to assist in the delivery of the Our Water Our Future 2050 strategy for positive estuary health benefits.

Authors: *Advaita Nitturkar, Courtney Smith*

Contributors: *David B, Erin Masters, Jarrod, Craig Evans (University of Newcastle), Danny Bucher, Prue Tucker.*

(Full names of author, peer reviewer and participants in discussion group.)

1.1 Situation Analysis

Overview

The Southern Estuaries includes Wallis, Smiths and Myall Lakes, Karuah River, Khappinghat and Kore Kore Creeks, North Arm Cove and Blackhead Lagoon. These estuaries are fed through a combination of catchments draining directly into the water body, creeks, rivers and groundwater. The water budget for the estuaries is a balance between inflows from direct rainfall, surface runoff, tidal flow, groundwater inflows and outflows associated with discharges to the ocean, evaporation, groundwater discharges and extraction.

The provision and maintenance of freshwater flows is critical to ensure healthy estuaries, and make a crucial contribution to the environmental, social and economic values of the region. From an environmental perspective, the full range of flows are necessary to maintain healthy estuaries. These include flood flows to scour channels, rework sediments, and inundate floodplains; medium flows to oxygenate water and allow fish passage; and low flows to maintain connectivity and assist the survival of aquatic and riparian flora and fauna.

The timing and volume of freshwater inflows is important to ecosystem health in the estuaries, which in turn provides significant environmental, commercial, tourism and aesthetic values. Salt and fresh water mixing in the estuary contribute to the high levels of habitat diversity and biological productivity.

Freshwater inflows also influence the dynamics of estuary entrances and the characteristics of tidal flushing (Betteridge & Rabbidge, 2016).

MidCoast Integrated Water Cycle Management (IWCM) Strategy

The MidCoast Integrated Water Cycle Management (IWCM) Strategy is a plan developed by MidCoast Council that balances the need for water security and water conservation with environmental requirements across the MidCoast Local Government Area (LGA).

Council currently provides around 9 billion litres of drinking water to residents and businesses each year, servicing 90% of the permanent residents of the LGA with water and sewer systems. The

population serviced by water and sewer systems is expected to grow by around 48% by 2051, putting increasing pressure on water supply. In turn, this puts pressure on the waterways and catchments that provide this water supply (MidCoast Council, 2023).

The availability of water from the Southern Estuaries catchments for potable town water supply, stock and domestic water, irrigation and industry underpin the viability of regional communities located throughout the catchment. Commercial and recreational fishing also depends on maintaining ecologically sustainable flow regimes.

Six water supply schemes are located across the LGA, consisting of 1,200 km of pipeline, six water treatment plants, two borefields, 45 reservoirs and 25 water pump stations. Raw water for different supply catchments is conveyed to the local water treatment plant where it is then treated to meet the Australian Drinking Water Guidelines. Extraction points within the CMP study area and catchment are:

- Myall Lakes:
 - o Tea Gardens aquifer bore field: services 3,000 connected properties. In the 2019 drought, water was carted from Tea Gardens to Gloucester to service the population with water. The recharge area of the aquifer is currently rural. If this land is developed, the aquifer and water supply could be impacted.
 - o Bulahdelah Scheme: Water is drawn from a weir on the Crawford River (which flows into the Myall River) and treated at the nearby Bulahdelah Water Treatment Plant, which can treat up to 2 million litres of water per day. This scheme services 600 connected properties.
- Karuah River
 - o Stroud Scheme: Water is drawn from a weir on the Karuah River and pumped to a 50 million litre off-stream storage dam. This services approximately 500 connected properties.
- Wallis Lake
 - o Nabiac aquifer – currently not used as a primary water source, however, is kept operational and may be used infrequently. The borefield consists of 28 production bores and a series of raw water mains. The aquifer is recharged by a combination of direct rainfall infiltration and storm water runoff from Bundacree Creek, located to the west of the catchment. Currently, MidCoast Council is licensed to extract 10ML/day. The scheme has an emergency production capacity of 18ML/day for temporary implementation only during extended drought conditions.

As well as the provision of drinking water, Council is responsible for sewage and stormwater services. Sewage is collected and treated at 14 treatment plants across the LGA. Ten recycled water plants treat wastewater, which is used for both irrigation of public open spaces, and for agricultural purposes. Re-use utilises 10% - 25% of recycled water (MidCoast Council, 2023). The use of recycled water is likely to increase over the CMP planning period; this will result in a reduction of freshwater extraction, however may be offset by increased freshwater requirements from urban growth.

Stormwater infrastructure managed by Council includes pipes, pits, basins and open channels. Stormwater management directly impacts water quality of the estuaries. To ensure water quality is maintained, frequent water samples are taken from six major catchments. Stormwater management has been discussed in detail in the Urban Stormwater and Litter Issues Paper.

In addition to the MidCoast Integrated Water Cycle Management program, numerous private properties at Forster/Tuncurry have licenced and unlicensed bores. The number and extraction rates of these bores are not known, and thus their impact on the aquifer is also not quantified. The licencing and regulation of bores is managed through the Natural Resources Access Regulator

(NRAR). However, there is an action (Action 9.5) in the Wallis Lake Estuary Catchment Management Plan regarding the monitoring of groundwater quality and extraction from aquifers, including Forster/Tuncurry.

Stressors

Key stressors on modification of freshwater flows in the Southern Estuaries include extraction, drought, climate change and associated changes in rainfall, increased peak run-off due to land-clearing and urban development, and obstructions such as weirs and dams.

Extraction of surface water, whilst a significant stressor for other rivers in the LGA such as the Manning River, has a lesser impact on the Southern Estuaries due to the substantially smaller volume of water extracted and properties serviced. There is a minimal amount of extraction licenses for agricultural purposes. However, basic landholder rights for stock and domestic use allows for private extraction. All properties with river/creek frontage have unregulated access for stock and domestic supplies and can store runoff in surface dams up to a volume of 10% of the rainfall falling on the property as part of their Harvestable rights (in a coastal-draining catchment).

Groundwater extraction via bores can impact on both river base flows and Groundwater Dependent Ecosystems (GDEs). An increase in demand of water from aquifers is likely as a result of increasing insecurity in surface water supply. However, the Integrated Water Cycle Management Strategy has identified several infrastructure projects to increase storage to reduce pressure on surface water and groundwater extraction during droughts, and methods to reduce water consumption across the LGA (MidCoast Council, 2023). Improved infrastructure and efficient water use will be necessary during periods of drought when the base flow through much of the estuarine ecosystems are made up of groundwater.

In addition to extraction, drought can be a significant stressor on flow. The Adapt NSW climate change data provides an overview of modelling results for the North Coast Region. Key trends include a warming climate and increased extent of dry periods by 2050, resulting in major periods of low flow. Natural flow regimes will also be impacted by more frequent severe weather events (AdaptNSW, 2024).

In 2017-19, the MidCoast LGA experienced the worst drought since instrumental records began in 1880. This resulted in substantial decreases in river flow and surface water reaching the Southern Estuaries and led to the Tea Gardens Aquifer supplying drinking water to additional properties at Gloucester (MidCoast Council, 2021). The drought put significant pressure on the Southern Estuaries ecosystems, with reduced flow impacting salinity, algal blooms, hydrodynamics and morphodynamics.

Water restrictions were in place across the MidCoast LGA for a period of five months and 20 days, exceeding the previous record by more than three months. It was also the first time Level 4 restrictions had been implemented in the region (MidCoast Council, 2021). The extreme lack of rainfall throughout 2019 and early 2020 saw all four of the region's supply rivers severely impacted by the drought. Flow levels in the Karuah River, which supplies the communities of Stroud and Stroud Road, became too low to continue pumping in October. The river stopped flowing altogether on 10 November (MidCoast Council, 2021). In late December, the Barrington River ceased to flow for the first time in 75 years of records. Previously, it had proven a reliable water source for the towns of Gloucester and Barrington and had not been known to flow at a level lower than six million litres per day. The Crawford River, which supplies the township of Bulahdelah, also experienced a significant drop in flow levels. Under ordinary circumstances, water is drawn from a pool created by a small weir across the river. However, an emergency water supply pump had to be installed in January 2020 after the pool became too low to continue extracting water (MidCoast Council, 2021).

As a result of this drought and the resulting impacts on freshwater flow and sustainable extraction, Council employed a Water Resilience Officer to help businesses and other large users across the region identify cost-effective measures to save water. This is considered a highly effective and mutually beneficial way to reduce the demand on water supply in the short term, as large commercial users account for a significant proportion of the MidCoast LGA's daily water use. A Water Education and Communication Officer was also employed to promote more efficient water use inside residential houses. A range of education programs and behavioural change initiatives were developed as a part of this role to target the individual behaviours of current and future water users in the region. Although this measure is unlikely to significantly reduce demand on water supply in the short term, it will result in more sustainable use in the long term and promote a greater sense of community stewardship towards our water resources (MidCoast Council, 2021).

Additionally, there is a study currently being prepared that investigates the impact of surface water extraction from the Wallamba River during drought. Findings from this report may assist in developing management actions, however, may not be completed by the time of management option development for this CMP.

In addition to drought and water extraction, land-clearing for agriculture and increased impervious surfaces in urban areas result in increased run-off volume and velocity during high rainfall events. This leads to increased sediment and turbidity; nutrient loading; pollution from pathogens, litter and urban stormwater; acid leachate from exposed Acid Sulfate Soils, and blackwater (deoxygenated water) from decomposition of organic matter washed into waterways.

In contrast to drought, floods can also have significant impacts on freshwater flows. Flooding can scour out entrance channels, increase tidal exchange for estuaries, movement of sediment and change morphodynamics of tributary rivers and estuaries. Natural flood management (e.g. increasing riparian vegetation) can play a role in decreasing the negative impacts from flooding and on freshwater flows.

Obstructions, such as weirs and dams, have significantly modified freshwater flow as well as blocking native fish passage. Notable weirs are located at Buladelah on the Crawford River (leading into the Myall River), and far upstream at Stroud on the Karuah River.

Impacts

During the 2019 drought, many reaches of rivers within the MidCoast LGA were reduced to scattered pools providing crucial drought refuge for native fauna. Low flow obstructed species' passage (e.g. fish, turtles) and increased fauna exposure to predation (e.g. platypus). These impacts and management actions are covered in the CMP Issue Paper for Biodiversity Conservation.

Potential impacts caused by reduced freshwater inflows from water allocations and drought include upstream saline intrusion and hyper-salinity in upstream aquatic habitats, coastal wetlands, riparian zones and groundwater dependent ecosystems. Other potential impacts on the estuary include reduced nutrient and organic inputs for primary production and alterations to the physical features of the estuary mouth. These impacts are different for each estuary type. For example, those with trained entrances (e.g. Wallis Lake) will likely still have an open entrance, maintaining tidal exchange, however with limited freshwater flow. ICOLLS (e.g. Khappinghat, Smiths Lake) will likely have a closed entrance, resulting in a closed entrance often for months at a time and a larger dry lake area.

These impacts may:

- Reduce the abundance, distribution, breeding success and diversity of fish and prawns;
- Negatively impact on water quality and fish habitats and increase algal blooms.

- Negatively impact on lake ecosystems, for example by increased use of the dry bed area (driving on lake bed).

During the 2019 drought, there was higher than usual salinity in closed ICOLLS and rivers and salt extended much further upstream (David Bowland, pers. Comm. Feb 2020). Saltwater intrusion into the upper estuary can result in plant deaths (e.g. water ribbon) and changes in biological structure and function. Further information about climate change and freshwater flows can be found in the Climate Change Issue Paper.

Obstructions, including weirs, impact the health of waterways by restricting fish passage and the natural movement of water and sediment. To reduce this impact, Council has installed fish passages at Bulahdelah and Stroud weirs. These are aging structures, and upgrading the passages could be a management option for the CMP, with potential liaison with NSW Department of Primary Industries - Fisheries.

The impacts of surface and ground water extraction are presently managed by extraction licences, which regulate who, where and when water can be extracted. This is administered by NRAR, with Council also playing a key role as the major extractor of surface water across the Southern Estuaries.

1.2 Stakeholders

MidCoast Council (MCC); NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) – Environment and Heritage; DCCEEW – Water; Natural Resources Access Regulator (NRAR); WaterNSW; NSW Department of Primary Industries – Fisheries.

Community and stakeholder engagement

A community survey and other stakeholder engagement activities conducted in Stage 1 of the Southern Estuaries CMP identified flooding and inundation as key issues in the study area.

1.3 Existing Management Approach

Legislation

In NSW, the key legislation to manage flow and extraction is the *New South Wales Water Management Act 2000* (WM Act 2000). It is administered by WaterNSW (rural landholders, rural industries) and NRAR (most users including water utilities). Under the WM Act, Water Sharing Plans provide a legal basis for sharing water between the environment and consumptive water users.

The sharing of water must protect the water source and its dependent ecosystems and as well as basic landholder rights. Sharing water to licensed water users is effectively the next priority for water sharing. Among licensed water users, priority is given to water utilities and licensed stock and domestic use, ahead of commercial purposes such as irrigation and other industries.

Implementation

The NSW Government's Water Sharing Plan (WSP) for the Lower North Coast Unregulated and Alluvial Water Sources (2022) regulates license allocations for town use, farms, irrigators and industry, and reserves environmental water for the overall health of the Southern Estuaries catchments, rivers, aquifers, and the estuaries themselves. It also covers the unregulated rivers and groundwater in the upriver alluvial aquifers and coastal sands.

DCCEEW is responsible for managing and allocating groundwater resources as set out in the WSP. To ensure local impacts are monitored and managed, all applications for new bores and trades are individually assessed. If there are excessive groundwater level declines in an area,

management controls may include restricting extraction by license holders. Bores for basic landholder rights (stock and domestic use) are exempt. During low flow periods, cease-to-pump rules protect environmental flows, excluding licences held by local water utilities, licensed stock and domestic users, and licences used for food safety and essential dairy care.

The WSP for the Great Lakes Coastal Sands Groundwater Source (covering the MidCoast LGA) is part of WSP for the North Coast Coastal Sands Groundwater Source (NSW Department of Primary Industries, 2016).

The Great Lakes Coastal Sands Groundwater Source covers an area of 419 km². It is bounded by the towns of Old Bar to the north and Tea Gardens to the south with 50% of the groundwater source of high environmental value. Yields within this groundwater source are typically moderate to high, with thick sand sequences giving rise to yields of up to 30 L/s. Groundwater is used predominantly for domestic purposes accessed through basic spear point extraction systems. This groundwater source has been developed by Mid Coast Council to augment a town water supply at Tea Gardens and a new borefield is proposed at Nabiac to supplement the Forster–Tuncurry town water supply.

Water management in the MidCoast Council LGA is through the Integrated Water Cycle Management Strategy (MidCoast Council, 2023), which sets out a series of management actions from present day to 2050. The CMP may provide an additional pathway to implement certain actions, if they provide positive benefits to the Southern Estuaries. For example, upgrades to stormwater treatment plants that discharge directly into the coastal zone, upgrades to weirs and storage dams, or connections of villages to the sewage network.

Additional present-day management includes the work of Hunter Local Land Services, MidCoast Council and Midcoast-to-Tops Landcare, who work with farmers to improve land management practices including measures to rehydrate the landscape and conserve water.

1.4 Knowledge Gaps

- Current and future impact of climate change (altered flows) on hydrology.
- Understanding of the capacity of rivers in the MidCoast region to resist and recover from drought.
- Importance of different flow regimes to ecosystem health. Impact of extraction on ecosystem health during low flow events.
- Scientific evidence to demonstrate sufficient environmental water has been allocated.
- The ecology of the groundwater-dependent ecosystems and karsts is not well understood.
- Better understanding of hydrodynamics and impacts of extraction on freshwater inflows to the estuaries.
- Minimum flow requirements to maintain hydrologic refuge pools.
- Impacts from mining related water extraction (eg Duralie Mine, no longer operating)
- Impacts of instream sediment load on flow and ecosystem health. It would be useful to assess instream depths and volumes of sediment accumulation over time.
- There are current gaps/patchy data in coastal catchments on water quality compared to inland systems. Inland systems tend to be monitored more for water quality, particularly for dissolved oxygen related to fish kills.

- The knowledge base upon which decisions are made could be improved (e.g. ecological impacts of allocation). Climate change predictions and estuary studies should be included in the revised Water Sharing Plan and cease-to-pump rules.
- Socio-impact assessment of cease-to-pump options.
- Economic valuation of tourism and recreational use of the Southern Estuaries.
- Future modified flow projects – for example, pumped hydro schemes. Yancoal is currently investigating the feasibility of a pumped hydro energy storage scheme near Gloucester.

1.5 What's working, what's not?

What's working

- MCC Water restriction program in the 2019 drought worked well with excellent communication and strong uptake and ownership in the community, including behaviour change and reporting of breaches.
- Substitution of treated recycled water for dairy wash-down and dust suppression helped save potable water.
- MCC established a formal, cross-Council water resilience team to manage water security during the 2019 drought, with some representation from NSW agencies. The team continues to drive water management improvements. A debrief of performance and learning during the 2019 drought was developed and reported through the A Drought Like No Other report (MidCoast Council, 2021).
- The MidCoast community is pretty environmentally aware, with average water use of 170L pp per day, which is the lowest water use across the state

What's not working?

- Compliance and enforcement of regulations could be improved. During the 2019, drought there was an increase in reports about illegal pumping to Council's Water Services and Natural Systems teams, some of which were passed on to NRAR for investigation.
- There are limited resources for monitoring generally. More comprehensive water quality data is required to undertake robust risk assessments for the WSP. More monitoring gauges are required to monitor flow at key locations. The Southern catchments don't have basic flow data, and water quality data is only grab samples.
- Does the Water Sharing Plan achieve the right balance between consumptive and environmental needs during drought and non-drought periods?
- Environmental flows should have at least the same degree of security as water access entitlements.
- Drought management strategies currently in place involve user-driven pumping restrictions which may be ineffective.
- The natural environment at the top of the catchment could be better managed to slow water movement, improve water quality and infiltration rates by addressing the effects of vegetation clearing, degradation from wild horses and cattle.

- Potential impact of sediment accretion on flow volumes: Flow has a key role in flushing sediment. Some sedimentation is a natural part of the system, but it is exacerbated through land-clearing.

1.6 Opportunities

- Improve monitoring of extraction, reporting, accounting and compliance of water use through the WSP.
- Utilise Riverstyles data to prioritise works that are beneficial to maintaining or improving natural flows (flattening hydrograph).
- De-coupling / Natural Flood management – relevant for target area? Eg reducing flood risk at Stroud and Bulahdelah?
- The WSP could be improved by specifying the environmental flows for specific areas. Salinity triggers for cease-to-pump could be written into the WSP as a control.
- Groundwater sources throughout the catchments should be protected through no net increase in allocation.
- Improve collaboration, integration, data sharing and cost-sharing for water monitoring programs.
- Standardised, transferable, cost-effective methods for water quality and bio-indicator monitoring.
- Water quality monitoring could include opportunities for citizen science or grant-funded projects. Investigate new techniques such as remote sensing or event based surveying, rather than intensive regular macroinvertebrate sampling.
- Use strategic planning (e.g. Rural Strategy, Local Environment Plan, Development Control Plans, Development Assessment) to protect flow. Strategies could include regulating lot size and reducing the number of lots with direct river frontage and harvestable rights for stock and domestic water; retaining or creating public reserves in riparian zones; regulating high intensity water use.
- There are opportunities for land use change through zoning and ceasing certain landuse activities.
- Improve management of Crown land with water frontage, much of which is agisted for grazing.
- Audit of grazing licenses to ensure they are not granted in Resilience and Hazards SEPP Coastal Wetland areas.
- Purchase and retire unused “sleeper” water access licences to reduce the impact of extraction, improve environmental flows and water security for farmers and irrigators. Prioritise purchase from subcatchments at risk of hydrologic stress/over extraction. Purchase licences in a flood year to get best market price. This could be linked with support for improved on-farm water storage and off-stream watering.
- Provide education, training and support for irrigators to promote landscape rehydration, sustainable extraction, sustainable on-farm practices and onsite farm water storage.
- Investigate drought refuge pools:
 - Identify fish and habitat requirements

- Where is refugia lacking? Do more areas need to be developed?
- Include this in the catchment program, and encourage landholders to protect riparian habitats
- Investigate high-flow conversions through appropriate on-farm and other storage to help alleviate the severe competition for water during extended dry periods, while acknowledging regular high flow flushing events contribute to ecological health.
- Recycled water – reduce extraction
 - Are there significant benefits from recycling water to reduce extraction totals? Likely more relevant at Stroud, Myall and Bulahdelah.
 - Improving quality of or reducing total amount of discharge to river. Stroud and Bulahdelah WTP discharge to river. Are their measurable benefits (eg human health) to reducing this via recycling?
- Support incentives for including rainwater tanks and retrofitting homes, environmental outcome over water saving outcomes
- Communication and engagement about bore water and the impacts of drawing bore water on the environment
- Barriers to fish migration
- To create community available water from community tanks from community facilities.

1.7 Management Options

Planning

- Collaborate within internal Council teams to implement the Integrated Water Cycle Management Strategy (MidCoast Council, 2023).
- Use development controls and land use zoning through the MCC Rural Strategy to improve drought resilience and mitigate impact of future development on extraction and water use.

Advocacy

Capacity Building

- Promote uptake of best management practice to conserve water and improve drought resilience on farms.
- Develop best management practice for water conservation on Council open space and use as demonstration projects.
- Incentives for landholders to undertake actions on farms

Regulatory Compliance

- Liaise with NRAR to identify and report illegal extraction. Develop a MOU with NRAR.
- Sediment control and increased compliance for development
- Nutrient management for the poultry industry

Science and research

- Establish a Memorandum of Understanding between key stakeholders to improve integration, knowledge-sharing and water management. The MOU could cover water monitoring, data-sharing, project updates, share-the-science webinars etc.
- Risk assessment of where to invest in water quality
- Investigate natural capital markets
- Collaborate with universities and DPI-Fisheries to understand what fish are in the estuary ecosystems, and what need to be protected with the refuge pool.

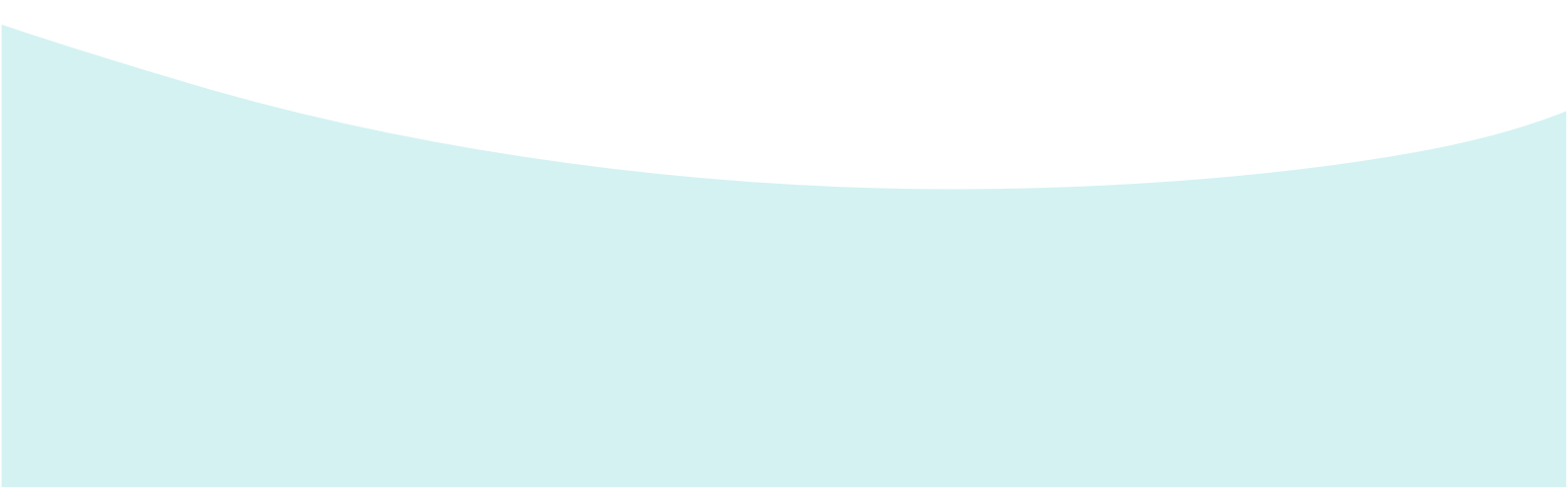
On-ground and operations

- Upgrade MCC water infrastructure to reduce leakage and maximise water efficiency.
- Continue MCC programs to support implementation of the Smart Water Advice Audit for large water users, e.g. caravan parks, abattoir, dairy industry, hospital. Tools include pricing mechanisms, audits to identify leakage and savings, on-site water capture and storage, demonstration projects, use of recycled water. Should prioritise the implementation of this Audit.
- Identify, map, prioritise and protect/rehabilitate drought refuge pools and upland wetlands.
- Maintain / reinstate fish passage in modified waterways, through liaison with DPI-Fisheries.
- Ongoing WSUD programs
- Protect riparian areas
- Utilise the Mobile Recycling Trailer as an engagement opportunity.

Community Education

- Develop an education program regarding the use of bores and their impact on aquifers and groundwater dependant ecosystems, especially during droughts, particularly for locations like Tuncurry and Tea Gardens.
- Continue MCC programs with residents and other land users to promote water efficiency, e.g. water restrictions, ongoing education, pricing mechanisms.

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ISSUE ANALYSIS RECREATION

2024

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1. Recreation

This issues analysis paper discusses the recreational use of the estuaries, waterways and foreshores within the study area. It predominantly focuses on the impacts and requirements of waterway and foreshore use, equitable access between user groups, and ecologic impacts resulting from recreational activities. Related issues papers include the *Community Stewardship Issues Paper*, the *Biodiversity and Habitat Conservation Issues Paper* and the *Climate Change Issues Paper*.

The Southern Estuaries (study area) in the MidCoast Local Government Area (LGA) support a range of highly valued community uses and recreational opportunities, such as nature observation, exercise, relaxation, swimming, watercraft activities, and recreational fishing. The local communities place significant value on safe and sustainable access to the estuaries.

Authors: *Petra Arola*

Contributors: *Neil Aimes, Liam (Acting manager open space), Amanda, Linda Hannah, Lauren McBriarty, Erin, Prue, Neil*

1.1 Situation Analysis

1.1.1 Background

The MidCoast LGA coastline has long provided an attractive natural setting for a range of outdoor recreational activities, to both the local community and a regional population that extends beyond the boundaries of the LGA. The coastal waters, foreshore and estuaries of the LGA are highly valued by the local community for the social and recreational amenity that they provide.

These estuaries are popular sites for tourists due to their proximity to Newcastle and extensive National Parks that surround the estuaries. The foreshore of both Wallis Lake and Karuah River/Port Stephens has considerably more infrastructure and waterway access than Smiths Lake or Myall Lakes as they are contained within a broad corridor of public land that is within easy reach of the surrounding road network and the presence of local townships.

There is a diverse range of recreational usage of the estuaries including water-based and on-shore activities which utilise the range of settings and opportunities that the estuary environs offer. Foreshore activities include camping, walking and four-wheel driving. Water-based activities include boating (a range of types), fishing, swimming, and various watersports.

The study area extends as far as the Coastal Use Area in the estuaries as mapped in the *State Environmental Planning Policy (Resilience and Hazards) 2021*. One of the management objectives for the Coastal Use Area under the *Coastal Management Act 2016* is to ensure that adequate public open space is provided, including for recreational activities and associated infrastructure. As the Southern Estuaries are significantly impacted by their catchments, recreational use in the catchment should also be considered.

The recreational uses within the study area face challenges as outlined in Section 1.1.3. Over time, the pressures of a growing population will increase demand for recreational use of the waterways (particularly across the Wallis Lake system), leading to recreational use conflicts. These pressures are also exacerbated by the increasing role of the MidCoast LGA as a tourism destination, particularly due to major urban centres within relatively close driving proximity such as Sydney and Newcastle. These pressures currently manifest during peak holidays periods, however, this issue will place additional strain on the area over the CMP planning timeframes.

High tourism use can also result in conflicts in values, use, priorities, and understanding of coastal management issues between permanent residents and more transient recreational users of the

coastal zone. This is further detailed in the section below.

The content of this issues paper is partly based on discussions with MidCoast Council and much of the background information is from Council's internal projects, conversations had with the community and stakeholder workshops for various projects.

Recreational uses

Boating is one of the main water-based recreational activities. Recreational boating, including motorised and non-motorised boats and jet skis, is the main form of boating in the region. Sport boating such as fishing, rowing, sailing, canoeing and dragon boating is often provided through sporting clubs. Tourism boating, including hire boats and boat tours, is also prevalent in the area, allowing people from other areas to enjoy the waterways. (MidCoast, 2023).

The provision of contemporary boating infrastructure was identified as a key action from the MidCoast Open Space and Recreation Strategy 2023-2035. The MidCoast Recreational Boating Infrastructure Plan 2024 – 2035 (RBIP) is the strategic planning document for the provision of recreational boating infrastructure for the MidCoast region. It provides a plan of management for boating facilities that Council oversees and guides their management until 2035. This is a key strategic planning document, and is discussed further in this Issue Paper below.

There are 39 Council-managed boat ramps within the LGA, of which the majority are within the study area (MidCoast, 2023). The boat ramps allow for extensive boating access across the Southern Estuaries. Water-based recreation in the estuaries includes boating, fishing, and swimming and the use of non-powered watercraft such as canoeing, kayaking, and paddle boarding (Great Lakes Council, 2014).

Ecosystem health is pivotal for the recreational enjoyment of the area, but also for supporting the estuaries' extensive recreational and commercial fishing industry, e.g. through seagrass meadows acting as fish nurseries. The connection to healthy seagrass meadows and sustainable fisheries is recognised in the *Fisheries Management Act 1994* (FM Act) and the NSW DPI – Fisheries' *Policy and Guidelines for fish habitat conservation and management* (2013).

1.1.2 Community Consultation

A contemporary assessment of community values was undertaken for the Stage 1 CMP study for the study area to identify a range of environmental, social and economic values provided by the coastal zone. A summary of responses from the survey: "What words or phrases would you use to describe what you value about these estuaries?" yielded responses such as "beauty", "natural", and "biodiversity" - indicating the high importance that the local community places on the natural environment of the area. Furthermore, words such as "places", "family" and "swimming" and "activities" were also common, indicating the high recreational and social values that the Southern Estuaries provide to the MidCoast community.

'Scenic amenity' ranked as the third most important value and recreational amenity ranked as the fourth most important value. This indicates that the foreshore areas and waterways of the Southern Estuaries are highly valued by locals and visitors alike for the social and recreational amenity values that they provide. At Wallis, Smiths and Myall Lakes this was equally important. The most popular activities include:

- Nature observation and relaxation (enjoying the scenery, bird watching);
- Walking, running or other exercise;
- Picnics/barbecues;
- Recreation on the water (kayaking, canoeing, sailing, recreational fishing from a boat); and

- Recreation in the water (swimming, snorkelling, stand up paddleboard (SUP), wind surfing).

During 2022 and 2023, the MidCoast Open Space and Recreation Strategy 2023 – 2035 was developed, which is a twelve-year plan to manage both the public open space in MidCoast along with the activities that take place on that space. This included engagement with the community to obtain community perspectives and use of current open space and needs for the future.

The provision of contemporary boating infrastructure was identified as a key action from the MidCoast Open Space and Recreation Strategy 2023-2035. The MidCoast Recreational Boating Infrastructure Plan 2024 – 2035 is the strategic planning document for the provision of recreational boating infrastructure for the MidCoast region. The Plan responds directly to issues raised by industry and the community over several years of consultation, including through the Regional Boating Plans, Draft Regional Ports Strategy and specific consultation with industry in 2017 and 2018.

1.1.3 Stressors and Impacts

Based on a stressor analysis within the CMP Scoping Study (Water Technology 2022), the threats to recreation within the study area include inundation, shoreline recession, coastal erosion from storm events, bushfire, droughts, climate change, habitat degradation, and water quality issues (sedimentation, turbidity, modified flows).

Risks arising from recreation include unsustainable fishing practices/limits, unrestricted access to foreshore areas (vehicle and pedestrian), anti-social behaviours, physical disturbance to nature (e.g. seagrass damage from outboards and shading from boat moorings), overcrowding, congestion, heritage impacts, safety, wildlife interactions and vessel strikes (Water Technology 2022). These impacts result in deteriorating natural values and reduced amenity.

Coastal Hazards

Coastal hazards, including coastal inundation, foreshore erosion, combined coastal and catchment flooding, can cause damage to recreation infrastructure and reserves. This needs to be accounted for in future planning, including moving assets out of at-risk areas if possible. In particular, coastal erosion and foreshore erosion can cause significant loss of foreshore areas and impacts beach access.

Boating

There are a number of issues related to recreational boating, many of which are addressed through the MidCoast Recreational Boating Infrastructure Plan. Safe and equitable access to the estuaries are required, including for power and non-power boats. This is managed through the RBIP, where the upkeep and management of boating infrastructure, such as boat ramps, fish cleaning, access to foreshores is prescribed up to 2035. Major infrastructure upgrades are planned e.g. at Tea Gardens boat ramp on Marine Drive, which is almost complete. Infrastructure upgrades and new construction projects are also proposed in the estuaries, for example in Allworth on the Karuah River, in Nerong on Nerong Creek and in Nabiab on Wallamba River.

Boat access to water and boat storage also presents some problems throughout the study area. There are a number of illegal boat ramps on Wallis Lake and in Smiths Lake, and in parts of Wallis Lake some boats are left for use and eventually abandoned. The boat storage and abandonment issues are covered in the *MidCoast Recreational Boating Infrastructure Plan*. The lack of boat ramps, particularly in areas of new development, creates issues where people access the water through sensitive vegetation like saltmarshes.

Some members of community have also indicated that there is a need for more pump out stations for recreational boats. This would act as a prevention for outbreak of disease like the norovirus

outbreak in Wallis Lake.

Much of the Southern Estuaries study area, including parts of each of the estuaries, are very shallow. However, in many instances navigation channels are not clearly marked. The navigation within the waterways is also made more challenging by tides, fluctuating water levels and changes to sand shoals. An analysis of boating safety over the period 2009-2013 revealed that the most common incident type in the region was grounding, accounting for 19 incidents. This is more than double the State-wide average (6%). Additionally, boating in shallow waters can harm the aquatic habitats through physical disturbance, i.e. scarring from outboards and vessels, as well as disturbing other benthic (bottom-dwelling) communities.

Ecological aspects

One of the most significant issues is the impact of recreational boating on sea grass beds. Wallis Lake has 20% of the NSW sea grass beds which drive the productivity of the Lake. These beds occur in shallow areas not suitable for powerboats. Propellor damage to seagrass is readily apparent. Damage resulting from tourism boating (hire boats, people visiting from other locations) unfamiliar with the shallow sea grass beds is an increasing concern.

An additional key recreational pursuit is bird watching, and the extensive wetlands in the area provide for excellent bird watching opportunities for both native and migratory species. The bird watching community has expressed wishes to update the bird watching platform at Winda Woppa and are seeking funding for it.

Concerns were also raised about the pelican rookeries in the shallow areas of Wallis Lake. During busy times of the year there are a large number of boats on the water, and due to some poorly marked navigational channels, it is easy to accidentally drive close to or even over some of these locations.

The increasing popularity of dragon boats, and other forms of non-motorised boating, has the potential to harm seagrass meadows. The boats can go in shallow waters where the substantial drag from them can create strong local currents that may impact on seagrass growth. Parasailing and windsurfing in shallow lake areas also cause damage to the aquatic habitats, e.g. when wind surfers stand in the water or walk out.

Tracks for 4WD and hiking

The use of four wheel drive (4WD) vehicles has been noted as an issue in certain parts of the study area. Notably areas around Smiths Lake are affected through beach access and through direct lake access during low water levels, causing detrimental track formation and erosion. There is a lot of interest from the local community to build new walking tracks to reduce 4WD activity in the affected areas. Other areas within the LGA (outside the Southern Estuaries study area) provide for 4WD activity, for example on Sandbar Beach is permitted with a permit with access via Bushlands and Sandbar Caravan Park.

The popularity of hiking in the area has given rise to demand for new hiking and walking tracks. There is a push to build walking trails through Endangered Ecologic Communities in Smiths Lake, including fringing saltmarshes and wetlands that may be impacted by development and associated increased visitors. For example, the development of the Great Lakes Walk and Aquatic Trail has been underway for some time and plans are being prepared for where it should be located. However, contentions also arise when considering financial sustainability, Aboriginal cultural impacts, land tenure issues, in addition to ecological constraints.

Recreational fishing

Currently, commercial fishing is permitted at Port Stephens, Smiths Lake and Wallis Lake and is a significant industry in these areas that supports livelihoods and the local economy (Water Technology, 2022).

Efforts in Wallis Lake to improve water quality and maintain compliance with the previous ECMP has aided in providing a sustainable commercial and recreational fishing industry (Great Lakes Council, 2014). However, given the increasing population and increased interest in fresh seafood it is important these sustainable practices are maintained or improved to ensure that meeting any increase in demand is not prioritised over a healthy and sustainable fishery for all to enjoy.

Recreational fishing is also a stressor on the local flora and fauna through the growing amount of derelict fishing gear in the lakes and estuaries. The fishing gear may be left behind on purpose or unintentionally if it gets lost or gets stuck on something. Entanglement of fauna in fishing gear has been noted as a problem particularly in Wallis Lake (personal comment). Crab pots, oyster grower debris (PVC pipes, polystyrene floats etc.) and ghost traps of various kinds cause a range of environmental issues, including on the numerous islands within Wallis Lake. The surveillance of bag limits for recreational fishermen is also a topic that has been raised.

Health and safety impacts

Maintaining good water quality of estuarine and coastal waters is essential to human health, the environment, agriculture-based industries and the recreational value of waterways, wetlands and coastal waters. Poor water quality affects recreational users both directly (in-water activities) and indirectly. Water pollution/contamination can arise from several sources, including urban stormwater discharge, agricultural runoff, and sewage effluent and septic runoff across the catchment. These pollutants can affect human health and safety for those coming into contact with water, particularly following periods of heavy rainfall.

Wallis Lake is an important location for both recreational and commercial vessels. It provides safe mooring for vessels traveling up and down the NSW coast, particularly when marine conditions are poor. Despite the presence of training walls, the Wallis Lake entrance is strongly influenced by ocean conditions and navigation can be dangerous under certain conditions. This is partly due to dynamic and shallow entrance bars. According to the *Taree – Great Lakes Regional Boating Plan* (Transport for NSW, 2015), incidents in the bar are uncommon, only accounting for 1 of the 22 severe marine incidents that occurred between 2009 and 2013, however, they can have severe consequences.

Public toilets were installed at various locations around the Wallis Lake islands and lower estuary following the Hep C outbreak in the late 1990's. The toilets cater for recreational tourism demand and local waterway use and help manage a key threat to water quality conditions for oyster farming. It is critical that these are maintained and modernised to meet current and future demand.

Traveling boats moored in Wallis Lake and the Lower Myall pose a risk to water quality and oyster farming. It is important that oyster farming areas are categorized as no discharge zones for effluent.

It has also been a requirement that all new houseboats on Wallis Lake have both grey water and black water holding tanks to manage the threat to the oyster industry and public health.

1.1.4 Overcrowding/congestion of waterways and user group conflict

The townships of the MidCoast LGA are popular tourist and homeowner destinations. The rate of increase in tourism is expected to continue or increase further into the future causing issues of congestion and overcrowding of waterways due to the increased number of vessels these visitors bring with them. Additionally, there is expected to be an increase in permanent population in these areas that will further increase the stress on these waterways.

The number of boats in the study area is expected to increase with the population increase (Water Technology, 2022). According to Transport for NSW (2022) there were approximately 5,600 registered vessels in the townships adjacent to the study lakes. These estimates of vessels do not take into account unregistered and unpowered recreational vessels, including kayaks, paddleboards, small sailing boats etc., which account for a significant portion of the waterway use.

The summer months, particularly the Christmas/New Year holidays, are expected to be the times when overcrowding and congestion of water ways are experienced the most. This is likely to put more pressure on the estuaries with regard to overcrowding when the increase in population and number of vessels is compounded by more tourists.

In certain areas, recreational activities on the waterways have been restricted to address user conflicts. As an example, wakeboarding and wake enhancing activities has been voluntarily prohibited from the Wallamba River through the Wallamba River MOU developed and signed by key stakeholders using the Wallamba River. The Wallamba River MOU was first developed collaboratively by stakeholders in 2003 and identified suitable and unsuitable areas for waterskiing. As a result, waterskiing in the area was agreed to be restricted to defined and managed areas that minimise impacts on the riverbank. The MOU has largely achieved the desired results by reducing conflict, ensuring a suitable area for continuing water skiing, protecting vulnerable riverbanks and ensuring water quality was improved through reduced turbidity.

Conflicting area uses during peak tourism times may arise with concerns both for safety, the natural environment and the general amenity. Actions to resolve this are being taken e.g. by closing boat ramps in heavy use areas during the busiest times of the year, such as the closure of Little Street boat ramp in Forster in December and January (MidCoast Council, 2024). This also solves any associated parking issue in the relevant locations.

There is also strong evidence to suggest that both the quality of the recreational experience and the environmental values of the waterways will decline with increased visitation and more facilities. The point at which irreparable damage is done, caused by increased unmanaged visitation and more facilities is known as the “environmental threshold”. All recreational facilities and activities in natural areas should be managed short of that threshold. (MidCoast Council, 2023)

Areas can be negatively affected by congestion and high usage. However, if additional access infrastructure, e.g. boat ramps, are introduced, additional people are likely to be attracted wishing to use the new facilities. This increase in visitation then impacts those that are attracted by the pristine natural conditions. These additional persons may not be as attached to the natural qualities of the environment, and people without an attachment to the waterways may not be as inclined as other people to protect these qualities. This can create conflicts between users. During seasonal visitor periods, high levels of motorised water-based vessels are often in conflict with those who desire to enjoy the natural environment. Of particular note in this context are jet-skis, which the area sees extremely high use during some periods (MidCoast Council, 2023).

1.1.5 Internal Management

There are several internal management issues relating to recreation and providing access to recreation opportunities within the study area.

This includes management of the interface between land and water at the edge of reserves, for both formed edges (e.g. rock walls, revetments, beach access structures), and non-formed edges (e.g. vegetated edges). The management of this interface is difficult, and often requires inter-department and inter-agency collaboration.

Asset ownership and responsibility is sometimes unclear, with structures or management of areas potentially belonging to multiple teams or agencies. This can result in a lack of upkeep, reduction of future planning opportunities, in addition to public safety concerns. Failing or dilapidated infrastructure is another issue, which if asset ownership is unclear, may not be accounted for. Collaboration and communication between agencies and departments within Council is essential.

1.2 Stakeholders

Management authorities

MidCoast Council; DPI – Crown Land; National Parks and Wildlife Service; Transport for NSW – Maritime; Department of Primary Industries & Regional Development (DPIRD) – Fisheries.

Other stakeholders

Recreational fishers; Tourism operators; Local residents;

Recreational clubs

Great Lakes Sailing Club; Forster Tuncurry Golf Club; Club Forster Fishing Club; Tea Gardens Country Club/ Fishing Club; Hawks Nest Golf Club; Forster Croquet Club; Pacific Palms Recreation Club/ Fishing Club; Coomba Aquatic Club; Little Street Baths; The Y NSW Tea Gardens; The Y NSW Great Lakes Aquatic and Leisure Centre; The Great Aussie Bush Camp; Sporties Tuncurry; Karuah & District RSL Club; Forster RSL Club; Forster Park Run; Karuah Motor Yacht Club

Community and stakeholder engagement

The community survey and other stakeholder engagement activities conducted in Stage 1 of the Southern Estuaries CMP identified the following as key issues in the study area:

- Growing population and tourism;
- Increasing demand for recreational uses;
- Overcrowding/congestion of waterways;
- Limited or lack of foreshore and waterway access;
- Habitat disturbance from boat wash; and
- Lack of compliance with regulations, particularly relating to driving on the lakebed of Smiths Lake and anti-social behaviour on the waterways from recreational boating.

The most popular comments from participants regarding recreation were concerning 4WD access around the Southern Estuaries causing environmental damage. Other comments related to the need to manage tourism to maintain natural areas as well as small towns, safety issues around conflicting area uses (snorkeling and boating), jetty structures, limited public boat ramps in certain areas, moorings, and wastewater pump facilities.

1.3 Existing Management Approach

MidCoast Open Space and Recreation Strategy 2023-2035

The MidCoast Open Space Recreation Strategy provides for and encourages equity of access to the LGA's beautiful natural environment for all community members. It lays out the guiding principles and framework for future management of open spaces and natural environments, and also highlights the challenges faced by Council, in particular with climate change. Sub-plans will also be developed for the various areas within the open space and recreation strategy, e.g. boating infrastructure plan, walking and cycling plan and aquatics plan. Some of these are still in a draft stage and many have now been adopted.

Community consultation for the strategy indicate that people spend time outdoors for fun and

enjoyment, to get fresh air, to spend time with family, and to be in nature, in falling order of importance. The most popular activities are walking, picnics, bush walking, sitting/relaxing, walking the dog, and fishing. The coastal and foreshore areas are noted as significant areas of recreation for natural enjoyment, surfing, fishing, walking, and many other activities.

MidCoast Recreation Boating Infrastructure Plan 2024-2035

The MidCoast Recreational Boating Infrastructure Plan 2024-2035 is a sub-plan under the Open Space and Recreation Strategy as part of the strategy's action plan, and is a key strategic planning document. The purpose of the plan is the identification of all existing boating infrastructure, what infrastructure needs upgrading, and the identification of where new boating infrastructure will be needed in the future.

Most of the boating infrastructure within the study area is located on Crown land managed by Council or community land owned by Council; however some infrastructure is under Maritime NSW or NPWS tenure. Boating infrastructure include boat ramps, canoe slides, jetties, pontoon and wharves.

The plan contains a detailed list of all boating infrastructure assets within the LGA, as well as a recreational boating infrastructure action plan outlining where infrastructure upgrades, repairs, and investigations are needed.

MidCoast Walking, Cycling and Trail-based Activity Strategy 2024-2035 – Draft (2 July 2024)

The MidCoast Walking, Cycling and Trail-based Activity Strategy 2024-2035 is another sub-plan under the Open Space and Recreation Strategy as part of the strategy's action plan. The strategy has been divided into two parts, the first is the walking and cycling section, and the second being a separate section that deals with bushwalking and trail-based activities. The strategy includes multiple plans for coastal walks and multiuse pathways.

Smiths Lake Boating Plan of Management 2005-2010

Smiths Lake Boating Plan of Management was developed by the NSW Maritime Authority in line with commitments to promoting the sustainable and equitable use of NSW waterways for all users. The boating plan of management seeks to ensure that boating procedures and practices maximise user safety, responsibility and enjoyment; identify and protect the recreational and environmental values of the waterway; and provide a consistent approach to existing and anticipated future issues. The plan is now outdated as the program was discontinued by the government.

Regional Boating Plan: Port Stephens – Hunter Region

The Port Stephens – Hunter Regional Boating Plan was a 5-year plan that identified boating safety, access and infrastructure actions, to be implemented over the 2015-2020 period. It explored key issues, including safety, access, storage of boats and riverbank erosion. \$3.68 million in NSW Boating Now funding was allocated to support the 22 infrastructure projects determined through the prioritisation process. It is possible that the CMP could be an alternative delivery platform to provide funding for remaining projects.

Port Stephens Great Lakes Marine Park – User Guide

The Port Stephens Great Lakes Marine Park User Guide guides the permitted uses of the various zones within the marine park. The basis for the guide is the *Marine Estate Management (Management Rules) Regulation 1999*. The permitting requirement for various activities is also outlined.

The recreational uses of the marine park included in the guide cover fishing and collection of aquatic fauna, vehicle and boat use, boat speed limits, anchoring, domestic animal permissions, and certain area restrictions.

NPWS Plans of Management

The catchments have a large proportion of national parks which are managed by NSW National Parks and Wildlife Service. A plan of management has been developed for each national park, covering all relevant aspects for each park, such as protection and management of flora and fauna, hydrology, geology, Aboriginal heritage and visitor areas. Common recreational uses in the national park are also outlined within each plan of management. The specific threats within each park are also listed.

While nature reserves and national parks include a reasonably comprehensive selection of estuarine areas, this selection tends to be biased towards the terrestrial and freshwater fringes of the estuaries.

Transport for NSW (TfNSW) – Maritime

TfNSW is NSW's maritime safety regulator for commercial and recreational vessels and their operators. Maritime's role within TfNSW is to promote safe, responsible and sustainable use of waterways, including but not limited to the enforcement of safe on-water vessel practices, the administration of recreational vessel licenses and vessel registrations, and provision of guidance for safe navigation.

TfNSW is also responsible for the direct delivery of a number of maritime infrastructure projects as well as investment in many others across the state. Other responsibilities include property administration, policy development, strategic planning and infrastructure management related to commercial and recreational boating – including some of the boat ramps and public jetties, wharves and pontoons across the study area (noting that most boat ramps are generally owned and managed by councils).

State-wide planning strategies that impact on recreational boating within NSW include the *NSW Maritime Infrastructure Plan 2019-2024* and the *NSW Coastal Dredging Strategy 2019-2024*.

1.4 Knowledge Gaps

- Investigate free camping areas, ascertain if these are legal/illegal or causing issues.

1.5 What's working, what's not?

What's working

- Community consultation by MCC to get baseline data regarding community recreational values and behaviours is very important and allows for better planning approach.
- Procedure for pump out and twice yearly with procedures
- Maintenance of foreshore assets are to a high standard
- Not creating opportunities for motorised transport along Pelican board walk
- Regional dispersal program to encourage people away from the coastal region
- Tourism team will be working with operators to get feedback

What's not working?

- Methods to address increasing recreational users, conflicting uses, and the impacts on marine environment / fauna and flora

- Despite numerous government initiatives regarding responsible fishing practices, some recreational fishers are still not taking care to minimise environmental impacts
- Public toilets in parks strategy is in draft review, toilets on island will be covered as a 'maintain action'. The CMP can cross reference to this.
- Overuse of certain areas for events, eg damage to grounds at John White Park
- Closing boat ramp in Little St to motorised boats, 2 year trial
- High tide action for Smiths Lake – assess impacts ecologically endangered communities.
- Top recreation area for caravanning and camping in NSW – how to best manage this?
- Cars on Smiths Lake
- Clearing vegetation in front of homes – signs and compliance work.
- Increased rubbish from tourism
- Illegal camping
- Increased recreational boating
- Tourism impacts on wildlife
- Congestion
- Non-compliance of jetskis
- Increased number of boats from outside of the LGA
- Large motorboat sizes on Smiths Lake

1.6 Opportunities

- Recreational boating infrastructure strategy
- Walking and cycling strategy – has many actions within the coastal zone – e.g. coastal walk – all ability action for Jimmies beach
- Information – visitor etiquette to hand to visitors.
- Birding guide – activities to direct visitors to hinterland and spread the tourism load.
- Policy being developed to manage jet skis
- Education being ramped up for Jet ski users
- Connecting people to the waterway, but need to encourage sensible use.
- Regulatory team planning policy to manage dogs and vehicles on the beaches.

1.7 Management Options

Planning

- Look at the possibility of removing 4WDs from more areas
- Investigate better management of Forster islands and potential of only being accessible by kayak

Education

- Additional initiatives for educating users, recreational fishers, boat users, visitors, on protecting the environment
- The potential for regular waterway clean up events in collaboration with multiple stakeholders and government organisations
- Interactive foreshore walks
- Support community engagement opportunities regarding environmental protection. Eg Coastal Warriors, One Tide.
- Connect with visitors and tourists to increase information and knowledge about the estuaries and how they can mitigate their impact. Connect with tourism operators, and investigate ecotourism accreditation.
- Additional signage on 4WD – specifically Dark Point (Mungo Brush so in the NP)
- Education on fishing rubbish in areas that have high recreational fishing
- Increase education on seagrasses and how they impact fishing and other activities
- Education and engagement directly with residents and tourists at the recreation sites
 - Discovery Rangers
 - Council Engagement
 - 4wd sites
 - Shorebirds
 - Seagrasses and Sponges
 - Wetlands
 - Littoral Rainforest
 - Dolphins

Capacity Building

- Greater education for tourists eg FAQ, Fact Sheets, promotion of businesses
- Greater promotion of recycling
- Communication and engagement with Tourism Operators
- Increase communications with fisheries

Regulatory Compliance

- Education and engagement and enforcement on boating rules boating education officer visibility.
- Investigate if estuary foreshores can be included in compliance (David).
- Additional compliance of 4WDs.
- Increased compliance for illegal clearing for pathways and walking trails.
- Compliance of clearing in bushland for bike jumps.

Science and research

- Investigate toilets in areas where they may be necessary due to increased usage.

On-ground

- Better boat facilities not more boat ramps. Most boat owners are happy to travel to an area to launch their boat but would like better facilities and parking.
- 4 knot zone within Wallis Lake – mainly used for conflicting user zones, would also need to have a safety aspect.
- Marking seagrass areas within Wallis Lake – MCC can assist but DPI will need to assist in the identification of areas.
- Investigate if boat engine sizes or types (e.g. petrol engines) can be limited in certain waterways to restrict speed. Linda will investigate.
- Introduce rubbish bins for fishing line in Forster, bins in Forster on foreshore and near dump points.
- Investigate who owns dump point assets.
- Increase the number of bins and the collection times at key recreation areas, e.g. Lions Club Park in Tea Gardens, Pindimar Foreshore.
- Increased cleaning of stormwater drains during high visitor periods.

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ISSUE ANALYSIS BIODIVERSITY AND HABITAT CONSERVATION

2024

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Biodiversity Conservation

This Southern Estuaries Coastal Management Program (CMP) issues analysis paper focuses on biodiversity within the estuaries, riparian and coastal zones, and catchments of the southern estuaries of the MidCoast Council LGA (study area). The paper is divided into sections covering aquatic and terrestrial aspects separately.

Biodiversity loss is a global issue that is driven by a multitude of factors including land clearing, habitat degradation and fragmentation, invasive weeds and introduced pests, altered fire and hydrological regimes, pollution and nutrient runoff, climate change, fishing and aquaculture practices, tourism impacts (overuse, wildlife disturbance, poor recreational fishing habits), disease, and more. Large scale historical clearing for agriculture and development still has far reaching impacts on biodiversity today (MidCoast Council, 2021).

Many of the processes behind the abovementioned issues are covered in separate Southern Estuaries CMP issues papers, and the purpose of this paper is to discuss their impacts on biodiversity and habitats, how biodiversity has changed within the study area over time, and future risks to biodiversity and how to manage them. Related issues papers include *Coastal wetlands*, *Climate change*, and *Aquaculture and Commercial Fishing*

The MidCoast Council's Biodiversity Framework has been developed to guide Council's overall biodiversity management within the LGA, and the Framework covers the entire study area. The management actions developed within this issues paper may overlap with those of the framework, however the aim is to focus on managing issues specific to the study area and relevant for the CMP.

Authors: *Petra Arola*

Contributors: Terrestrial biodiversity - *Daniel Trudgeon, Nick Coleman, Erin Masters, Peter Goonan, Alex Callen (UNI Newcastle), Kate Tunstill (UNI Newcastle), Michael Griffith, Mat Bell, Andrew Morris, Anthony Marchmont, Matt Hayward (UNI Newcastle), Neil Dufty. Aquatic biodiversity: Hayden Schilling, Margaret Platell, Sam Marwood (odanata), Cherie Clolyer-Morris, Troy Gaston (UNI Newcastle), Ray Nice (Tieramar), Hayden Schilling (stock assessment DPI, NSW UNI), Neil Dufty, Erin Masters.*

Biodiversity Within the Study Area

The study area is renowned for its biodiversity, created by a range of factors including its location, relatively high degree of natural intactness, and diverse landform, habitat and geological features.

The study area is located within the NSW North Coast Terrestrial Bioregion and the Manning Shelf Marine Bioregion and covers landscapes from beaches to mountain ranges, providing habitats for a diverse array of species including many protected under State and Commonwealth legislation. Notably, the region hosts internationally significant sites such as World Heritage-listed rainforests, Ramsar wetlands and marine parks, all of which highlight the area's ecological importance.

Iconic species that are land based within the area include green and golden bell frog, dingo and the multitude of shorebirds present. Aquatic species that are of special value within the study area include bream, mullet, green turtle, loggerhead turtle, white seahorse and dolphins.

Community engagement and surveys, including the community survey undertaken in Stage 1 of the Southern Estuaries CMP, have shown that the healthy and diverse ecosystems within the study area are also highly valued by the community for the natural resources, cultural values and beauty they contain.

Biodiversity Loss

In recent times, Australia has experienced one of the highest rates of biodiversity loss globally (Waldron et al. 2017), and this is evident also within the study area. Despite the intactness of the ecosystems it still does not contribute to ecological functionality. Seagrass meadows are declining (West & Glasby 2021), oyster reefs are under increasing pressures (Gilby et al. 2021) and threatened species, such as the koala, are losing habitat and declining in numbers (MidCoast Council, 2024). The threats to biodiversity are further exacerbated by anthropogenic climate change in the form of sea level rise and other impacts including floods and more severe bush fires (Glasby et al. 2023, Hughes et al. 2022).

Not only are the local ecosystems heavily affected by this loss of biodiversity, but there are negative impacts on the community and economy due to, for example, reduced fish stocks, higher water treatment costs, damage to the tourism industry, and loss of lifestyle and cultural values (MidCoast Council, 2021).

Protection of Species and Ecological Communities

The region contains a high number of threatened species and ecological communities that, despite legal protection, have experienced a decline in population numbers and extent. The number of listed species and threatening processes is increasing, and no threatened species or ecological communities have been de-listed because of conservation interventions or recovery actions to date. Special concerns have been raised by Council for the local populations of green and golden bell frog, white's seahorse and black rock-cod. Non-listed species of special value in the area include, but is not limited to, estuarine sponges, shorebird populations and dingoes.

Council has within the Biodiversity Framework prioritised conservation actions focusing on flagship species, i.e. those species that have broadscale environmental reach that benefit a range of other species, and those impacted by recent bushfires, as well as vegetation communities of regional significance, underscoring the importance of comprehensive conservation strategies to preserve its ecological heritage for future generations (MidCoast Council, 2021),

Littoral Rainforest and Coastal Wetlands, as mapped under the *State Environmental Planning Policy (Resilience and Hazards) 2021*, are found within the study area. Littoral rainforests occur mainly in the coastal zone from Seal Rocks north, while coastal wetlands are common throughout the study area. These ecological communities are listed as endangered or critically endangered due to threats from clearing, fragmentation, disturbance, invasive weeds, and impacts livestock and feral animals. To preserve the remaining patches, the communities have been protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and BC Act as well as the *Coastal Management Act 2016* (CM Act). Many threatened species are also associated with these communities, such as the Grey-headed Flying-fox (Australian Government Department of the Environment, Water, Heritage and the Arts, 2009).

Also, there are protected aquatic areas (Port Stephens – Great Lakes Marine Park, Myall Lakes Ramsar wetland) and terrestrial areas (National Parks estate, nature reserves etc.) which are further discussed in the sections below.

1.1 Situation Analysis

1.1.1 Aquatic Biodiversity

Background

Rivers and creeks, riparian zones and estuaries form a transition zone between marine and terrestrial ecosystems and contain a diverse range of ecological communities. Rivers and their margins act as connecting corridors for biodiversity within otherwise often fragmented landscapes.

Their aquatic corridors connect areas of habitat, providing ecological linkages for migration and dispersal of wildlife.

Estuaries, where fresh and saltwater meet, are important fish nurseries. Their sheltered waters, often with seagrass, mangrove or reef habitats, provide vital nesting, breeding and feeding habitats for many species of fish, shellfish, aquatic plants and birds. Most commercially valuable fish species depend on estuaries at some point during their development (NSW DCCEEWW, 2024).

Although it is difficult to estimate the value of specific estuarine habitats for commercially harvested species, attempts have been made for prioritising management, conservation, and restoration activities. A study by Raoult et al. (2022) indicates that saltmarsh is of highest value, followed by mangroves and seagrasses. However, it is noted that the habitat's economical value in a bigger context also depends on their habitat value to exploited species as well as their areal cover.

Despite their geographical proximity, the ecosystems in the lakes within the study area are somewhat different. The aquatic flora and fauna communities within the estuaries are strongly influenced by the long-term hydrological regimes (including salinity), as well as the nature of the biophysical environment. This influence is particularly notable in Myall Lakes which ranges from brackish to fresh water, while Wallis and Smiths Lakes are predominantly marine habitats. Due to the variability in salinity, the species abundance in Myall Lakes system is high while the diversity is low. (Atkinson et al, 1981)

The Port Stephens-Great Lakes Marine Park established in 2005 covers the entire coast and all tidal areas between Stockton Beach and Forster, including much of the study area for this issues paper. The estuaries north of Forster, including Wallis Lake, are not within the marine park. A study undertaken by Breen et al. in 2004 to identify ecologically suitable options for establishment of a marine protected area (MPA) suggested the marine park should also include Wallis Lake and Khappinghat Creek in the MPA due to their ecological values.

The entire aquatic section of the study area has been designated as Key Fish Habitat as per the *Fisheries Management Act 1994* (FM Act), recognising its importance to the sustainability of recreational and commercial fishing industries, the maintenance of fish populations generally and the survival and recovery of threatened aquatic species (NSW DPI, 2024).

All seagrasses in NSW are protected under the FM Act and *Posidonia australis* in Wallis Lake, Port Stephens and seven other estuaries is a protected ecological community under the EPBC Act.

Existing Biodiversity

This section provides a brief description of the aquatic biodiversity features within each major estuary of the study area.

Khappinghat Creek

Khappinghat Creek estuary is a large, relatively undeveloped wetland and an intermittently closed and open lake and lagoon (ICOLL), supporting saltmarsh habitats including salt flats, soft sediment, seagrass and oyster reefs, sedge and rush-dominated wetlands. Mangroves have only recently colonised the area. Khappinghat Creek estuary also has freshwater wetlands listed as threatened ecological communities under the *Biodiversity Conservation Act 2016* (BC Act). Much of the Khappinghat Creek estuary is within Khappinghat National Park and Saltwater National Park, with the upper catchment of the estuary containing State Forest, National Parks as well as private rural and rural-residential areas.

Estuarine and freshwater habitats provide foraging, shelter, and nesting sites for wading birds and habitat for amphibians, reptiles, and mammals, including the platypus (in the upper, freshwater sections). Due to their sheltered nature and abundance of invertebrates (crustaceans, molluscs, insect larvae) the estuarine wetlands sustain fish nurseries and support waterbirds. Khappinghat Creek estuary at Saltwater is also recognised for its Aboriginal cultural significance.

Wallis Lake

Wallis Lake is a coastal estuarine lake with prominent habitats such as seagrass and macrophyte beds, intertidal sand and mud flats, rocky reef habitat, sponge gardens, oyster reefs, islands and coffee rock. Mangroves and saltmarsh border a large part of the lake. The vast seagrass meadows cover over 30 km², which is the largest area of seagrass in NSW and comprises 35% of the state's seagrass habitat. These seagrass meadows are pivotal to supporting Wallis Lake's biodiversity, and also the extensive recreational and commercial fishing and aquaculture industry in the lake. (Great Lakes Council 2014)

Wallis Lake houses both freshwater and marine fish species; the freshwater species occur occasionally at the southern end of the lake (Fiebig, 2010), as well as the inflowing rivers. Several turtle species are found in the lake periodically, such as the green turtle, hawksbill turtle and loggerhead turtle, all listed as threatened species under state and/or federal legislation. Threatened fish species such as black rock-cod, white shark, grey nurse shark and white's seahorse have also been reported in the estuary. Marine mammals including bottlenose dolphins are known to use the lake, there are occasional visits from humpback and southern right whales.

The lake is listed as a wetland of national importance and is inhabited by over 30 JAMBA and CAMBA listed migratory and threatened bird species. The catchment has two national parks located within its boundary – the Wallingat National Park and the Booti Booti National Park – and nature reserves including Darawank Nature Reserve, Minimbah Nature Reserve which support a diverse range of vegetation communities including littoral rainforest, coastal heath, coastal forests, saltmarshes, cabbage palm forests and moist eucalypt forests. (GLC, 2009).

Unique sponge and ascidian communities also contribute to the biodiversity in Wallis Lake. A survey by Barnes (2017) reported 12 sponge species, which is twice the number of species recorded in any other lake or lagoon in NSW. Most species have their specific niches restricted to within the Wallis Lake catchment, while others are more widespread. Many of the sponge populations are small with limited or no information available about them; many of them are not even named. They are susceptible to extinction and should therefore be protected from harmful human disturbances (Barnes et al. 2022). Potential threats to sponges in Wallis Lake include increased sediment loads and loss of habitat (seagrass and algal meadows).

A 20 year long study by Barnes et al. (2022) showed that the sponge diversity in Wallis Lake had remained similar over twenty years with six out of ten species re-recorded between 2002 and 2022. Declines were observed in certain areas such as at Pacific Palms where a decrease in *Suberites* species correlated with a decline in charophyte cover. The ascidian communities declined during the study, and only one species, an introduced species, was recorded since 2009. Boom and bust patterns could also be observed for certain species, however the driving factors for these could not be confirmed.

Threats to biodiversity within the lake include habitat degradation, invasive marine species, and entanglement of marine fauna. Significant frog bit infestations occur around Green Point and Forster, and climate change may facilitate the introduction of new pest species. A new seastar species, a species known to occur in tropical Queensland, has been encountered in Wallis Lake (*Pentaceraster regulus* or *Pentaceraster gracilis*). The species was first encountered in Wallis Lake in 2008, and a study indicates that there is an established population in the estuary (Keable ^ Mah 2021). Monitoring and/or community science will be required to determine if this species becomes an ecosystem altering threat.

A review compiling recent information about macrophytes, invertebrates and fish in Wallis Lake was prepared in 2010 (Glasby & van den Broek). The purpose was to map sponges and macrophytes, provide an assessment of fishes and macroinvertebrates, and compare the sponges in Wallis Lake to other NSW estuaries. Fish and macroinvertebrate communities were found to be similar to other NSW estuaries. There is a moderate commercial catch of finfish while the catch of crustaceans, mainly blue swimmer crab, and oyster farming is one of the greatest compared to

other NSW estuaries. In addition to the large seagrass meadows, Wallis Lake also has the second largest area of saltmarsh in NSW after Port Stephens estuary. The sponge communities are discussed above (studies by Barnes et al. 2022).

Smiths Lake

Smiths Lake is an Intermittently Closing and Opening Lake or Lagoon (ICOLL) and is therefore not permanently connected to the ocean. This creates a dynamic system with significantly different conditions for flora and fauna at open and closed stages. (BMT, 2018)

The lake's vegetated marine habitats primarily consist of seagrass, saltmarshes, and mangroves. Seagrass, covering approximately 2.23 km², thrives mainly in shallow areas like Wamwarra Bay and is dominated by *Zostera* species. Saltmarsh communities fringe the lake's edges, dominated by sea rush, with large areas occurring in Symes Bay and west of Horse Point. The overall vegetation within the lake is in good condition, with a significant portion of the catchment located within the Wallingat and Myall Lakes National Parks.

The lake itself serves as an important fish breeding and nursery ground. Spawning and recruitment of fish species is dependent on the status of the lakes entrance which may limit the distribution and abundance of fish population. Another unique feature of Smiths Lake includes several sections of rocky shoreline. These habitats are mostly colonised by molluscs such as oysters and are highly influenced by the lake's entrance condition. Sponges and jelly fish also inhabit the lake.

University of NSW (UNSW) runs a field station for marine biology at Smiths Lake and has collected valuable data series locally over the years, e.g. as part of course work. Multi-year studies include surveys of biomass (g/m²) over the years. The yearly variations appear to fluctuate, however a declining trend is observable for many groups including seabirds, fish, and macroalgae and seagrass. Other groups are increasing, such as phytoplankton, zoobenthos, benthic crustaceans, and a very large increase in jellyfish (Suthers and van der Lay, 2021).

Myall Lakes

The Myall Lakes belong to a series of coastal lagoons along the eastern Australian coast which range from fully saline to freshwater. Myall Lake is one of the few freshwater lagoons which is in a relatively pristine condition compared to other estuaries and lakes within the study area, yet there is little information on the aquatic ecology of the lake. Historically the biodiversity may have been more complex. The lake system is also listed as a Ramsar wetland under the Ramsar convention, providing habitat for a range of aquatic dependant species, including fauna like fish, crabs and birds (NSW OHE, 2012).

An ecological health assessment of the lower Myall River (Scanes et al. 2010) was undertaken to address community concerns about the river's ecological health due to changes in water clarity in the river channel. Both water quality (salinity, turbidity) and physical parameters (water depth, flow regimes) were measured, as well as ecological indicators (biodiversity abundance, algal growth, bacterial breakdown of seagrass leaves, energy consumption by fish and invertebrates, herbivory on mangrove leaves). The results indicate that the river is in excellent ecological health, despite it changing from a strong to a slight dominance of ebb tide flows, causing changes in water clarity. No negative impact on the river's ecosystem was detected.

The macrophyte and algal species found in the freshwater sections in Bombah Broadwater are dominated by *Ruppia* species and charophytes, while the lower reaches with more marine influence have dense beds of *Zostera capricorni* and *Ruppia spiralis* (Atkinson et al, 1981).

Myall Lakes face challenges with threats to mangroves and saltmarshes (NSW OEH, 2012), and seagrass fragmentation (Swadling et al, 2022). Studies suggest that the seagrass areas in the lower Myall River apparently decreased from 273 ha in 1985 to 150 ha in 2004, and the area of seagrass in the Myall lakes declined from 7.9 ha in 1985 to 2.6 ha in 2005 (Williams et al. 2006). However, other observations indicate that the seagrass populations are naturally highly dynamic

with periods of stability and at other times periods of rapid change when the sandbanks in the riverbed change (Scanes et al. 2010). In recent years there have also been mangrove dieback events in the Lower Myall River.

Myall Lakes support the only known occurrence in Australia of gyttja, a green–brown sediment rich in organic matter derived from the decomposition of charophytes, macrophytes and cyanobacterial algae. Gytja commonly occurs in other parts of the world, e.g. Sweden where the word derives from. The gyttja found in the Myall lakes is believed to be important in structuring and maintaining the characteristic submerged aquatic vegetation of the lakes. (NSW OEH, 2012)

Northern Foreshore of Port Stephens and the Karuah River

Wetlands are an important feature of the Karuah River Catchment, and a large proportion of the estuary is mapped as Coastal Wetlands under the CM Act. Wetlands play a vital role in nutrient cycling, nutrient uptake and trapping sediments by slowing the flow of water. They also contain a biodiverse range of species and provide a nursery for fish, crabs and prawns and a habitat for a wide range of plants and animals (Great Lakes Council, 2015).

While seagrass habitats occur within the Port Stephens estuary, they are almost non-existent within the Karuah River, with few seagrass habitat patches recorded. An 80% decline in seagrass habitats was reported in the Karuah River Catchment Management Plan (2015).

Monitoring of fish populations in the Karuah River since 1983 has shown a progressive increase in the number of fish species within the river. A number of activities aimed at improving fish passage in the Karuah River have been undertaken (Great Lakes Council, 2015).

State Forests are the largest land use managed by a single land manager within the catchment. The Forestry Corporation is required to implement many permanent harvest exclusions based on ecological values such as rainforest, ridge and headwater habitat, old growth forest and threatened species habitats. (Great Lakes Council, 2015)

An ecological condition assessment undertaken in Karuah River estuary in 2011 (Haines et al. 2011) indicated that the estuary and catchment were in moderate ecological condition, with some significant issues like seagrass and saltmarsh loss, riparian habitat degradation, algae, runoff nutrients and turbidity to manage. Macroinvertebrate, fish and shorebird assemblages were in good condition.

Stressors and Impacts

At the national level, key threats to biodiversity in aquatic ecosystems and marine receiving waters include diffuse-source water pollution, degraded riparian habitats and climate change, including the impacts of changed frequency, magnitude and intensity of floods and droughts (UNSW, 2020).

These threats are reflected in the CMP study area, where major stressors include:

- Land clearing, habitat degradation and fragmentation
- Water pollution from sediments and nutrients
- Aquaculture and fishing
- Changing climate including extreme weather events such as drought and widespread and intense fires
- Invasive plants: alligator weed (WoNS), Amazonian frogbit and Senegal tea plant
- Pest animals: foxes, cats, rabbits/hares, deer, pigs, carp

- Diseases of concern include Phytophthora (causing dieback of trees), Chytrid fungus (killing frogs) and myrtle rust (causing dieback of species of myrtaceous plants)
- Altered hydrological regimes (e.g. weirs and causeways blocking fish passage)
- Land-uses such as forestry (private and public)

With the exception of diffuse-source water pollution, all of these pressures are listed as key threatening processes under state and commonwealth legislation.

Some of the more significant stressors and impacts are discussed below.

Stressor: Water Pollution

Healthy in-stream condition contributes to the conservation of aquatic fauna. Water quality testing as per the Waterway and Catchment Report Card (MidCoast Council, 2023) shows an overall trend in improvement of algal concentrations and water clarity within the estuaries. However, while improvement has occurred in Khappinghat Creek estuary, the conditions in Karuah River and Bombah Broadwater have declined. The best rating estuary over time has been Myall Lakes. The conditions within most estuaries fluctuate between moderate and good.

The above findings are largely reflected in the 2016 Catchment Health Report (Miller, 2016) by MidCoast Council for Wallis Lake, Myall and Karuah Catchments. The report also highlights the connection between land use intensity within the catchments and water quality in the estuaries.

Stressor: Aquaculture and Fishing

Fishing and aquaculture can impact on biodiversity loss and habitat degradation both directly and indirectly. Fishing directly reduces fish biomass and can have direct impact on habitat from e.g. bottom trawling. Oyster leases and other aquatic structures have been shown to alter the natural environment and cause loss and fragmentation of key species such as seagrasses (Halpern et al. 2014), however oyster infrastructure can also provide habitat value and protection for shorelines and refuges for fish and other marine life as described below. By opting for less impactful fishing and aquaculture practices the negative effects can be minimised. A study by Ferretto et al. (2022) in oyster aquaculture showed that using floating bags rather than trays or longline baskets for oyster farming causes less impact on seagrasses due to lower shading.

At the same time, the infrastructure of oyster farms also provides habitats that support fish and invertebrate communities. While seagrass meadows tend to have the highest species richness and abundance of the estuarine habitats, the oyster leases have a higher species richness and abundance than in control locations (Smith et al. 2023). Additionally, oysters purify the water through their filter feeding. Therefore, oyster leases should be considered as part of the estuarine seascape when making decisions about habitat restoration and biodiversity conservation.

Mud crab and blue swimmer crab are commonly targeted species within the study area, however problems with catching undersized crabs and fish (yellow fin bream) exist. Alternative traps have been developed and tested, including traps with larger mesh size and traps with species-specific escape hatches. A study (Broadhurst et al 2018) showed that increasing the mesh size did not significantly decrease the amount of undersized blue swimmer crabs retained, but it did for yellowfin bream. Escape gaps had a positive impact on the escape rate for undersized individuals of both species. Another study showed that while there were no significant cumulative benefits of escape gaps in larger meshed traps, there was a trend of fewer unwanted catches overall (Broadhurst et al. 2020). Smaller meshed traps retrofitted with an escape gap would have a more significant positive effect.

Stressor: Climate Change

Climate change and expected future increases in fire severity may impact on estuarine ecosystems such as mangroves and saltmarshes. The 2019-2020 bushfires, with at least some attribution to anthropogenic climate change, affected 183 ha of saltmarshes (12 ha in Wallis Lake and 9 ha in Khappinghat Creek) and 23 ha of mangroves (0.6 ha in Wallis Lake) across NSW as quantified in a study by Glasby et al. (2023). While the saltmarsh plants had resprouted, the majority of burnt mangroves appeared to be dead 24 months after the fires. The study noted that species assemblages may have changed, and that protection of these habitats may need to be considered when planning for hazard reduction burns. Fires also affect water quality by increasing sedimentation due to vegetation loss, ash in water lowering sunlight, and deoxygenating the water.

Sea level rise is also threatening these ecosystems by creating habitat squeeze and decrease in their extents where the habitat cannot migrate landwards or the change in sea level is too rapid. Mapping methods have been developed (Hughes et al. 2022) and can be used to predict potential losses and gains to assess the habitat's level of vulnerability. This can then be used to inform land use planning to accommodate for future changes in estuarine habitats, e.g. by providing a low intensity land use zones as a buffer within the estuaries, incentivising the protection of wetland migration areas. However, there may not be enough space to accommodate this habitat migration. While some large estuaries have space to accommodate this migration, saltmarshes especially may disappear from more intermittently closed-open estuaries unless they can expand vertically at the same pace as sea level rise. This discussion will be further developed in the Coastal Wetlands Issues Paper.

Impacts: Seagrass Meadows

A study by West and Galsby (2021) examined the spatial and temporal variability of seagrasses in estuaries across NSW, including Wallis Lake and Port Stephens. A general decline in seagrasses was observed across NSW, mostly contributed to declines in *Ruppia*. Over the 40 years, Wallis Lake experienced a decline in seagrasses of 0.7% while Port Stephens had an increase in seagrasses of 2.2%. No relationships were found between catchment disturbances, measured as land use or population density, and seagrass change or temporal variability at the estuary scale. Identifying the causes of seagrass degradation is often difficult due to a multitude of factors operating at the same time, or because physical variables and seagrass areas are not measured concomitantly (Ralph et al. 2007).

Swadling et al (2022) investigated the impacts of human activities on seagrass fragmentation. It was found that seagrass meadows are more fragmented in highly populated areas, and in estuaries the most important predictor for habitat seagrass fragmentation within estuaries was the density of boat moorings. Increased numbers of jetties and oyster aquaculture leases were also shown to increase fragmentation. If not mitigated, the fragmentation is likely to increase as human population and estuarine development increases.

Impacts: Oyster Reef Restoration

Shellfish reefs are one of the coastal ecosystems most threatened by human activities, and have globally experienced declines of up to 85%, affecting habitat availability for local fish assemblages (Gilby et al. 2021). Oyster reefs occur in the study area at Wallis Lake and are dominated by Sydney rock oysters.

Reef restoration projects are being carried out in some of the estuaries and funding is available for future projects. Projects are also being undertaken in Wallis Lake where the simultaneous restoration of mangroves and oyster reefs is being trialled with the goal that the restoration of multiple key species at once would mutually benefit them and enhance and strengthen ecosystem functions (Esquivel-Muelbert & Bishop 2022).

In a study by Gilby et al. (2021) mapping suitable oyster reef restoration locations based on fish assemblages, it was found that location planning for these projects should be done carefully to maximise the benefits, e.g. by locating the site close to existing habitat such as seagrass meadows, remnant oyster reefs or mangroves.

1.1.2 Terrestrial Biodiversity

Background

It is widely accepted that riparian vegetation plays a central role in stabilising waterways, reducing channel boundary erosion, filtering diffuse-source run-off and providing habitat. Riparian vegetation helps maintain water quality by reducing the amount of pollutants entering the waterway and serves as a physical buffer, slowing down overland flow and mitigating the negative impacts of flooding (Swanson, 2020).

Vegetated riparian areas are also very important for biological connectivity. Intact and connected riparian vegetation is critical for building resilience to climate change impacts and has an important role in carbon sequestration (MidCoast Council, 2021).

Managing riparian vegetation is a primary tool to effect catchment-scale improvements in the river environment, both in terms of its intrinsic values, and its impacts on social and economic values (Pietsch et al. 2019). The importance of riparian vegetation in maintaining water quality and ecosystem health was noted throughout consultation for the Manning River CMP.

Terrestrial vegetation, including ground cover, also has an important role to play in soil organics, erosion control, providing shade for livestock away from watercourses, driving microclimates and the local water cycle, and hydrating the landscape. However, the condition of the riparian vegetation in the catchments varies greatly. Myall Lakes and much of the lower reaches of the Myall River is protected by National Park and has undisturbed riparian zones, while for example, Karuah River is subject to relatively high agricultural pressures with resulting issues such as riparian zone grazing, nutrient and pollution runoff, bank erosion, turbidity and sedimentation, cleared lands and more (Great Lakes Council, 2015).

A large area of the catchment study area is protected in national parks, nature reserves and state conservation areas (303,000 in the whole LGA). The largest national park is Myall Lake National Park which surrounds the entire Myall Lakes system and parts of the estuary, also listed under the Ramsar Convention. Wallis Lake is also listed in NIWA by the Australian Government. Other protected areas in the study area include Wallingat National Park, Booti Booti National Park and Khappinghat National Park and Nature Reserve, Talawahl Nature Reserve, Darawank Nature Reserve, Minimbah nature Reserve and Wallis Island Nature Reserve. The catchment with the highest level of protection is the Myall Lakes system.

Existing Biodiversity

This section provides a brief description of the terrestrial biodiversity features within each major catchment of the study area.

Khappinghat Creek Estuary

Above the estuarine / aquatic environment, Khappinghat Creek and its tributaries are characterized by diverse forested wetlands, including swamp sclerophyll forests, and wallum heathlands. Some of these ecological communities are listed as threatened ecological communities under the *Biodiversity Conservation Act 2016* (BC Act).

Threatened species like koalas, brush-tailed phascogales and squirrel gliders have been recorded in the area. Other notable threatened species in this catchment include:

- *Allocasuarina defungens* – a genetically distinct population of this species was known from Khappinghat NP, but the population has been significantly impacted by bushfire events, including the 2019 black summer bushfires.
- Eastern blossom-bat – this species is nearing its southern limit of natural distribution and has been recorded within Khappinghat National Park.

- Coastal threatened raptors – species like the osprey, white-bellied sea-eagle and square-tailed kite utilise the habitats of the Khappinghat estuary.
- Common planigale – there are records of this threatened small mammal from the Khappinghat area.
- Wallum froglet – the wallum heaths of the Khappinghat Creek estuary support breeding populations of this species.

Part of the Khappinghat Creek estuary is within the Khappinghat National Park and Saltwater National Park.

Pest species like Rusa deer and European red fox are present in the estuary.

Wallis Lake Estuary Catchment

Wallis Lake has diverse landscapes and vegetation, including cabbage tree palm forests and littoral rainforests. The Wallis Lake catchment is also home to nearly 50 threatened fauna species, including koalas, squirrel gliders, and black-necked storks. (Great Lakes Council, 2014)

Approximately 44% of the catchment has been cleared for agriculture, urban development and infrastructure (Great Lakes Council, 2014). A 2012 LGA wide survey by Great Lakes Council (Landscape Report Card) reported that nearly 69% of the Wallis Lake catchment had native vegetation cover. The Wallamba River catchment had less than 40% cover.

Introduced pests like Rusa deer, European red fox and domestic cats, pose significant threats to native flora and fauna in the Wallis Lake catchment. Herbivory and environmental degradation by deer are a key threatening process in NSW. Rusa Deer are causing substantial grazing and trampling impacts to coastal wetlands and littoral rainforest, particularly around Wallis Lake. Controlling and containing the MidCoast Rusa deer population in the area between Smiths Lake, Old Bar and the Pacific Highway has been identified as an Action in the Hunter Regional Strategic Pest Animal Management Plan 2024-2028 (Draft).

The lake is also impacted by past and future urban development. Forster is the largest town in the area (Great Lakes Council, 2014).

Smiths Lake Catchment

Smiths Lake, nestled within the Wallingat and Myall Lakes National Parks, has a broad diversity of flora and fauna. Foreshore vegetation, dominated by species such as blackbutt, grey ironbark and grey gum, is mostly intact around the Lake, which combined with extensive seagrass meadows and good water quality gives Smiths Lake a high ecological value (BMT, 2018). Wetlands include herbaceous marshes and tree-dominated swamps surrounding the lake, and there are sand dunes with dune vegetation communities on the eastern side of the lake. The dune vegetation around the entrance channel supports numerous endangered plants species, such as sand spurge. Smiths Lake is home to a diverse array of fauna, including the endangered green and golden bell frog and vulnerable wallum froglet.

Despite its ecological richness, Smiths Lake faces challenges from pest animals like foxes and invasive flora species such as asparagus, bitou bush, and lantana (BMT, 2018). Efforts to address these issues are underway through the Council's Backyards for Biodiversity Program.

Myall Lakes Catchment

Freshwater fringing vegetation dominated by swamp oak and broad-leaved paperbark, line the Lower Myall River. The freshwater swamp community is associated with an ecological community listed under the EPBC Act. The Myall Lakes Ramsar site supports a large array of fauna, among them 12 nationally or internationally threatened species including wetland-dependent species like the Australasian bittern and the green and golden bell frog (NSW OHE, 2012). The terrestrial

biodiversity values of the Myall Lakes National Park have been described in the Myall Lakes Ramsar Site Ecological Character Description report.

Northern Foreshore of Port Stephens and the Karuah River

The Karuah River catchment covers an area of over 500 km². Most of the lower to mid-slopes and floodplains are cleared, and riparian zones often consist of narrow strips of vegetation along the waterways, although there are some exceptions to this. The proportion of private land covered by remnant native vegetation, approximately 34%, is high compared to other catchments.

The catchment also has a comparatively large proportion of land held in public reserves, also covered by intact remnant vegetation. (Great lakes Council, 2015). Much of this public reserve land is on the higher, steeper lands of the mid to upper river catchment, although Karuah National Park preserves wetland and riparian habitats.

Most of the large areas of intact native vegetation occur in the less developed and more inaccessible steep slopes of the catchment. Although significant sections of intact riparian vegetation are present in the Karuah River part of the estuary, their characteristics are less well documented compared to the other three large estuaries. The connections between habitat and habitat types are also in some cases lacking (Great lakes Council, 2015).

The majority of the Karuah River foreshore is mapped as coastal wetlands under the CM Act and these wetlands play a vital role in supporting the local biodiversity (DPHI, 2024).

State Forests are the largest land use managed by a single land manager within the catchment. The landscape has significant ecological values which are managed through the Integrated Forest Operations Approval, which must comply with the NSW *Threatened Species Conservation Act 1995*. The Forestry Corporation is required to implement many permanent harvest exclusions based on ecological values such as rainforest, ridge and headwater habitat, old growth forest and threatened species habitats.

Stressors

In NSW, land clearing is currently the main threat to the extent and condition of native vegetation and habitat for terrestrial fauna (Bishop, 2016). Clearing, degradation and fragmentation of vegetation due to land uses such as agriculture and urban development, can result in loss of diversity and degradation of natural terrestrial and aquatic environments, erosion, spread of invasive species, and species extinction (Commonwealth of Australia, 2021).

Human activities impacting on riparian and terrestrial vegetation within the study area and other threats include:

- Clearing riparian vegetation for land uses including urban development, foreshore development, agriculture, roads and river access.
- Catchment-wide vegetation clearing, including public and private native and plantation forestry.
- Cattle and livestock over-grazing of pastures and access to the riparian zone for shade and water in both fresh and estuarine waterways degrades native vegetation.
- Weeds and feral pests degrade riparian and terrestrial vegetation.

Some of the more significant stressors and impacts are discussed below.

Development and Vegetation Clearing

Issues with land uses and developments resulting in vegetation clearing are far reaching and results in a range of issues discussed within this paper as well as in other papers, e.g. the *Land Use*

Planning issues paper. Development controls are in place to avoid ecological impact where possible. However, development applications that have been approved in the past (zombie DAs) were assessed under different planning and biodiversity requirements. This will result in loss of habitat and biodiversity in some locations.

Livestock Grazing in Riparian Zone

Streambank erosion is a widespread pressure in NSW in areas where livestock grazing occurs in the riparian zone, including in the upper catchment areas of the study area. This leads to loss of structure in the riparian zone and loss of vegetation. Hillslope erosion contributes large amounts of sediment to waterways in the catchment following rainfall. An intact riparian vegetation zone would capture some of the sediment, so riparian zone vegetation maintenance, including groundcover species, is highly beneficial for decreasing both nutrient runoff and turbidity (NSW DPIE 2020).

Weed and Pest Species

Weeds are a widespread problem in all the catchments and includes weeds of National Significance (WoNS) such as include Madeira Vine, Lantana, Cats Claw Creeper and Blackberry. Other priority weeds in the catchment are Giant Parramatta Grass, Privet (small and broad leaf varieties), Camphor Laurel, Green Cestrum, St John's Wort, Fireweed, Coolatai Grass (giant & dwarf), Noogoora Burr, Crofton Weed, Bathurst Burr and Willow. *Juncus acutus* has been found in Khappinghat Creek but NPWS has worked with LLS and other partners to control the spread within the extensive saltmarsh areas of the estuary. No cane toad populations are known or expected at the present time, but the region supports a climate that is suitable to this invading species.

Fallow deer, Rusa deer, European red fox, cats, and rabbits are all common pest animals within the study area. Many of these species are listed key threatening process under the BC Act and EPBC Act. Feral pigs are at low density in the southern catchments, notably Karuah and Myall Lakes. Feral deer populations appear to be increasing, but there has been an active control program since about 2022 in the Wallis Lake area.

Impacts from invasive/feral species on native flora and fauna populations is notably through competition for resources and habitat, and predation, causing disruptions in the local ecosystem. They can significantly impact on the local ecosystems by modifying food webs and trophic cascades. Species loss can occur when native species are outcompeted by weeds or predated by pest species. Major events such as floods, droughts or fires that causes drastic short or long term changes the local ecosystem can facilitate the spread of invasive weeds and pest species as the native populations are weakened or out of balance.

1.2 Stakeholders

Management agencies

Hunter Local Land Services; MidCoast Council; Local Land Councils; Department of Climate Change, Environment, Energy and Water; Department of Planning, Housing and Industry - Crown Lands; National Parks and Wildlife Services; Forestry Corporation; Department of Primary Industries - Fisheries

Community stakeholders and groups

MidCoast2Tops Landcare; Manning-Great Lakes Birdwatchers; Hunter Bird Observers Club; Myall Koala and Environment Group, Koalas in Care; For Australian Wildlife Needing Aid; Wildlife in Need of Care; Port Stephens Koala Hospital; Birdlife Australia; Ozfish

Community and stakeholder engagement

A community survey and other stakeholder engagement activities conducted in Stage 1 of the Southern Estuaries CMP identified the following as key issues in the study area:

- Clearing/disturbance of coastal wetlands;
- Vegetation clearing;
- Habitat migration/squeeze;
- Habitat disturbance from boat wash; and
- Lack of environmental data.

Aboriginal groups are an important stakeholder and there are multiple Local Land Councils across the study area. Culturally there are strong ties between indigenous cultures and water. Many land councils and TIDE have been working on Country on shorebird and coastal projects.

1.3 Existing Management Approach

Management of biodiversity within MidCoast LGA is broadly covered and is included in a wide range of management plans. Below is a brief description of those most relevant to this issues paper. Biodiversity is also managed through both state and federal legislation, particularly in relation to threatened entities, development regulation, vegetation clearing and biodiversity offsetting.

MidCoast Council Biodiversity Framework

The MidCoast Council's biodiversity framework provides the main management approach for biodiversity within the LGA. It emphasises the significance of the region's natural assets and biodiversity for community well-being, economic development, and quality of life. It acknowledges the community's recognition of environmental protection as a core value and aligns with regional goals set by the NSW and Commonwealth governments.

The framework aims to address biodiversity conservation through an ecosystem approach, considering the interplay of land, water, and living resources while acknowledging the vital role of indigenous peoples in protecting Country and biodiversity. The document highlights the decline of biodiversity both nationally and locally due to pressures such as habitat loss, invasive species, climate change, and extreme weather events like droughts and bushfires.

The MidCoast biodiversity framework identifies management actions to enhance and maintain biodiversity across the LGA, and these actions should be considered during development of the management options. The CMP should not only consider habitats and species that are known to occur but also identify opportunities to support both aquatic and terrestrial species that could potentially utilise the study area.

Priority ecological communities for protection under the framework include littoral rainforest, coastal saltmarsh, *Themeda* grassy headlands on coastal sea-cliffs, lowland rainforest and coastal and floodplain forests and wetlands. Priority threatened species in the study area include threatened shorebirds (nesting sites), squirrel gliders (Forster), yellow-bellied gliders (Smiths Lake), *Grevillea guthrieana*, threatened terrestrial orchids, giant dragonfly, the koala, and the grey-headed flying fox.

Karuah River Catchment Management Plan

The Karuah River Catchment Management Plan was developed in 2015 by MidCoast Council in response to the ecological health assessment undertaken in 2011/12 by the NSW Office of Environment and Heritage that determined the Karuah River and its estuary were in moderate

ecological condition with indicators of poor and degrading ecological condition. It was established to provide a framework that guides future management actions to ensure the long-term health of the catchment through the restoration and preservation of the catchment's ecosystems.

The plan is underpinned by four guiding principles: community participation in managing the catchment, the value of healthy rivers and riverbanks, catchment health influence on the local economy, and ecosystem resilience.

Wallis Lake Estuary and Catchment Management Plan

The Wallis Lake Estuary and Catchment Management Plan, prepared by Great Lakes Council, was finalised in 2014 and outlines recommendations for management actions to provide a unique and sustainable environment balanced with lifestyle opportunities through development, infrastructure and services. The scientific information underpinning this Management Plan was adopted from that developed in the Great Lakes WQIP and the subsequent research and management projects that followed. The Plan was also developed through extensive review of the existing Wallis Lake Estuary Management Plan and Wallis Lake Catchment Management Plan in conjunction with internal and external stakeholder engagement.

Coastal Zone Management Plan for Smiths Lake Estuary

The Smiths Lake Coastal Zone Management Plan (CZMP) was finalised in 2018 with the primary purpose of acting as a guide for future Council actions. It provides strategic direction and specific focus for the short and long-term sustainable management of the Smiths Lake Estuary, its tributaries, its surrounding foreshore lands, and its catchment insofar as catchment activities impact on the condition of the Lake. The Plan has a particular focus on maintaining or improving the environmental qualities and attributes of Smiths Lake Estuary.

The CZMP represents an update and revision of the previous Smiths Lake Estuary Management Plan (Great Lakes Council, 2001) which outlines actions that should be followed in order to maintain Smiths Lake as a healthy and productive estuarine ecosystem. Following the review process, the revised CZMP plan was designed to assist to achieve improved environmental conditions balancing human and ecological demands on the Lake.

The Backyards for Biodiversity program is an effort to create a holistic community approach to providing suitable habitat for native wildlife, starting from the grassroots, i.e. people's backyards. The focus is on planting the right plants for native species and removing invasive ones. The program is coordinated by Council in partnership with NPWS and supported by NSW Government.

Great Lakes Water Quality Improvement Plan

The Great Lakes Water Quality Improvement Plan (WQIP) was developed by MidCoast Council as a framework for practitioners and catchment/ estuary management groups to improve water quality in Wallis Lake, Smiths Lake and Myall Lakes. This plan covered the lakes and surrounding catchments. It was developed in partnership with agencies, industry groups and the community.

The WQIP focuses primarily on algae concentration and water clarity as indicators of estuarine ecological condition due to the impact increased algal biomass and decreased water clarity can have on estuarine function and used microalgae (chlorophyll-a), water clarity (turbidity) and extent of seagrass as the primary indicators of estuarine condition.

Based on both new and existing research, modelling and community engagement, a range of protection and management support actions to protect, support and, where required, restore the ecological health of these systems were identified. Many of the remedial and protection actions are related to biodiversity (protection of sponge beds, ecological monitoring programs, riparian zone remediation and wetland protection), however none of them are in relation to invasive species.

Hunter Regional Weed and Pest Management Plans

Hunter Local Land Services have developed a Weed Management Plan (WMP) and a Pest Management Plan (PMP) for the areas under its jurisdiction. The plans align with the NSW *Biosecurity Act 2015* as well as other state and federal legislation and policies. Together, these strategies and plans at all levels provide a clear framework for safeguarding primary industries, natural environments and communities from a vast range of pests, diseases and weeds.

The plans details priorities of weed and pest management to protect the Hunter region's environment, economy, and community from the negative impacts of weeds and pests, strengthening the sustainability of the region's natural environment, primary industries, and local communities. Both the WMP and PMP plan outlines a management approach through prevention (exclusion), eradication, containment and asset protection (effective management), using species dependent methods.

MidCoast Biodiversity Priority Weed Management Plan

The Local Priority Weed Management Plan is a guide for land managers to assist in contributing to a better social, environmental and economic future for the MidCoast region. The Plan supports local implementation of the NSW *Biosecurity Act 2015* by articulating community expectations and Council's capacity in relation to effective weed management and facilitating a coordinated approach to weed management in the area.

The plan outlines a management approach through prevention (exclusion), eradication, containment and asset protection (effective management). Council carries out priority weed management using a range of programs and strategies, including inspection programs, weed control programs, compliance actions, mapping and data collection, reporting and community engagement.

On Council's website some weed projects and treatment focus areas are highlighted:

- Myall Lakes catchment: aquatic weeds along 46 km of streambank; alligator weed, salvinia and longleaf willow primrose treatment in Tea Gardens
- Karuah and The Branch Estuary: Ongoing large scale water hyacinth management in cooperation with landholders
- Wallis Lake: Emergency response weed control for first NSW occurrence of Amazon frogbit near Forster

MidCoast Council Weed Biosecurity Policy

Council developed the policy with the objective to effectively manage weeds biosecurity as allowed and required by outlined in the *Biosecurity Act 2015* and the *Biosecurity Regulation 2017*. The weed biosecurity and its management approach aligns with that of the MidCoast Biodiversity Priority Weed Management Plan outlined above.

Port Stephens and Great Lakes Marine Park Operational Plan

The Port Stephens – Great Lakes Marine Park (PSGLMP) includes all coastal waters south from the Cape Hawke Surf Life Saving Club near Forster to Birubi Beach Surf Life Saving Club at the northern end of Stockton Beach, and includes all of Port Stephens, the Karuah River, the Myall River, Myall Lake, Smiths Lake and all of their creeks and tributaries to the limit of tidal influence. While the area is managed by the Marine Parks Authority (MPA), the marine environment is heavily impacted by and related to actions proposed within this CMP.

The Operational Plan details management actions being undertaken by the MPA. These actions focus on meeting key objectives related to the conservation of marine biodiversity, maintenance of ecological processes and the provision of opportunities for ecologically sustainable use, public appreciation, enjoyment and understanding of the marine park.

An update of the PSGLMP management plan is underway and consultation with stakeholders, community and government agencies was undertaken in 2020 as part of the process to identify opportunities, challenges and values.

Myall Lakes Ramsar site Ecological character description

Myall Lakes Ramsar site lies within the Myall Lakes National Park and includes the Corrie Island and Little Broughton Island Nature Reserves. It is one of the few coastal brackish lake systems in NSW which has not been greatly modified by human activities. The area is renowned for the diversity of its plant species and its complex variety of habitats, which is largely due to differences in substrate. It is home to a number of threatened species, such as the endangered Australasian bittern (*Botaurus poiclotilus*) and the endangered green-thighed frog (*Litoria brevipalmata*), as well as the vulnerable Freycinet's frog (*Litoria freycineti*) and stuttering frog (*Mixophyes balbus*).

The ecological characteristics description of the Ramsar site identifies knowledge gaps, provides actions and prioritises them. Mapping of invasive weeds within the Myall Lake catchment is noted as a high priority action. Monitoring programs are also noted to address the knowledge gaps, including a weed monitoring program for the catchment.

Koala Conservation Strategy (draft as at June 2024)

MidCoast Council has developed a strategy to guide the conservation and management of koalas and their habitat across the LGA for the next five years. The Koala Conservation Strategy forms part of the broad koala conservation program in the MidCoast, called the Koala Safe Spaces Program, documenting management actions for koala recovery and conservation. The strategy has been informed by koala sightings data, habitat mapping, applied scientific knowledge and the ideas and perspectives of stakeholders and the community.

Based on the modelled koala habitat maps, the study area appear to have significant areas of koala habitat and recorded sightings, particularly around Tea Gardens and northern Port Stephens, as well as around Smiths Lake, but with records throughout most of the LGA.

Invasive species are not listed as a major threat to koala populations and the management actions within the strategy mainly focus on habitat protection, threat mitigation and education.

Tops to Lakes Program

The Tops to Lakes Initiative is a strategic program aiming to enhance biodiversity, protect environmental services, and promote sustainable development across the MCC LGA. It seeks to achieve these goals through coordinated decision-making involving the council, community, and partner agencies. The initiative recognizes the importance of conserving natural landscapes, restoring biodiversity, and preserving cultural heritage while addressing challenges such as habitat loss, land degradation, and urban development. By establishing wildlife corridors, enhancing ecosystem resilience, and engaging the community, the initiative aims to create a more sustainable and resilient environment for current and future generations. Through strategic planning and collaborative efforts, the Tops to Lakes Initiative strives to leave a positive legacy by conserving biodiversity and promoting environmental well-being. There are no direct actions that the CMP could provide an implementation pathway for.

MidCoast Council's Vegetation Management Policy

Council's Vegetation Management Policy outlines the management of tree removal approvals, vegetation trimming and pruning, weed management, vegetation protection, and maintenance of ecological values of vegetation across the LGA.

MidCoast Council Greening Strategy

The Greening Strategy aims to manage and enhance tree canopy cover and green spaces across our region, with a particular focus on our urban areas. The focus of the strategy is mostly on amenity and urban areas, however any greening activities directly impact wildlife by providing habitat. The strategy also focuses on mitigating heat impacts from climate change through providing vegetation cover.

Wallis Lake Wetland Strategy

The strategy was developed under the based on a need to protect the ecosystem services and functions, biodiversity, aesthetics and threatened communities within the Wallis Lake wetlands. Wetland protection was also included as management actions in a number of now updated management plans.

The strategy recognises that despite some legislative protection, wetlands continue to be subject to clearing, modification, degradation, inappropriate land uses and other activities. Furthermore, wetland habitats are likely to be seriously impacted by global sea level rise associated with anthropogenic climate change. Consequently, knowledge of wetland location, status and condition and research into management needs and priorities needs to be gathered.

National Park Plans of Management

The catchments have a large proportion of national parks which are managed by NSW National Parks and Wildlife Service. A plan of management has been developed for each park, covering all relevant aspects for each park, such as protection and management of flora and fauna, hydrology, geology, Aboriginal heritage and visitor areas. The specific threats within each park are also listed.

While nature reserves and national parks include a reasonably comprehensive selection of estuarine areas, this selection tends to be biased towards the terrestrial and freshwater fringes of the estuaries.

1.4 Knowledge Gaps

Ecology and biodiversity are areas of ongoing research as changes occur and new threats or opportunities emerge. However, due to the complexity of the natural systems knowledge gaps persist, particularly in marine and aquatic environments. Overall, the incomplete ecological information underscores knowledge gaps and hinders effective management of coastal areas moving forward.

The following key issues have been identified for attention:

General

- Identification and mapping of biodiversity hotspots
- Fauna prioritisation, auditing, monitoring, indicators, stressors and thresholds
- Distribution and prioritisation of invasive species including riparian and aquatic weeds.
- Emerging threats in the form of weed and pest species and how to foresee and prevent outbreaks, e.g. the current increase in deer populations (in particular *Rusa*), cane toad population migration.
- Indigenous peoples' knowledge to guide conservation.

Aquatic

- Identification and prioritisation of freshwater hydrological (drought) refugia

- Impact of fish ways and causeways on fish and other aquatic fauna during drought.
- Impact of invasive deer on threatened wetland species (wallum frog)
- Giant dragonfly ecology

Terrestrial

- Role of dingoes as apex predators and mesopredator suppression: interaction of foxes, turtles and dingos; role in feral herbivore control; introduced predator (i.e. fox) control
- Current extent of vegetation extent and condition outside of riparian areas, changes over time including high value areas of native vegetation regrowth over the past thirty years.
- Identification of riparian protection priority sites.
- Finer scale vegetation connectivity mapping.
- How to best restore vegetation and reduce impacts of climate change, with increased predicted drought (long periods of low or no flow) and warming climate. How to incorporate hydrological extremes into the management and restoration of ecosystems and landscapes
- Abundance/distribution of invasive deer in the region. Identify hotspots for management and factors driving their abundance/occupancy. Identify corridor use.
- Threatened orchids in the study area
- Mapping biodiversity hotspots using BioMON: Prioritisation etc., riparian protection priority areas
- Emerging threats from deer
- Roadside fencing impacts: Highway to Coffs Harbour is virtually all fenced – must be fragmenting landscape

1.5 What's working, what's not?

What's working

Workshops: Terrestrial

- Effective collaborations
- History of recognising ecological value of wetlands
- Good onground work for wetland rehabilitation and remediation eg Darawank wetland rehabilitation and mininbar acquisition
- Community education and awareness
- Regulated development well in some areas
- Dingo collaboration between NPWS and UNI NSW, Taronga, MCC
- Lots of marine park and NP estate
- Successful catchment management programs in the past – good planning and implementation

- Council assets are well managed
- Vegetation and habitat are well represented in this study area including threatened species
- Working towards asset management system
- Biodiversity framework
- Rusa deer pilot study working well as a partnership project
- Community strategic plan and interest from community about environment
- Private conservation officer – support landholders in private conservation, landcare, private conservation agreements

Workshop: Aquatic

- Effective collaborative action on ground of estuary plans and WQIP
- Substantial research base, key research gaps but good investment in knowledge and research
- Marine Park
- Regulation of development – WSUD
- Acquisition of habitats and protection actions
- Environmental sensor networks, temporarily funded
- Good collaboration between agencies and Council
- Share the science program

Other thoughts

- The level of community interest and engagement in wildlife conservation is a real asset for any activities wanting to be undertaken in the riparian zone and instream.
- There is good communication and collaboration between agencies. Council staff - have been good to work with, putting effort into biodiversity planning.
- There has been improvement in the last few decades on private land conservation projects, uptake in Land For Wildlife Program and landowners taking agreements to the next levels (i.e. Voluntary Conservation Agreements). There are a lot of keen and open landholders.
- Representatives of the Biodiversity Conservation Trust (BCT) are active in the area. BCT have many agreements in development, but there are a lot of opportunities here as well.
- There has been funding for wildlife conservation at State level (SOS program) and threatened species funding at federal level (National Landcare Program and Bushfire tranches)
- Oyster reef restorations funded by HLLS and Council being carried out within the estuaries
- Aboriginal Rangers working on Country have been available to do a range of activities.
- The NSW biodiversity reforms have benefitted private conservation instruments and associated funding.

- There are good provisions for retaining vegetation in riparian zones and drainage lines as an outcome of land management reforms for the Local Land Services Act.
- Council's environmental special rate secured in perpetuity enables programs and actions for native vegetation including support for private land conservation, a nursery to propagate plants for landholders, and management of Council's bushland reserves.
- Council has good relationships with regulatory bodies (e.g. DPI Fisheries) over native vegetation controls particularly compliance with marine vegetation (mangroves).
- Well established management methods and best practices for handling of certain invasive species that have been developed over long periods of time, which have allowed certain areas to be returned to a natural state, and some invasive species to be sufficiently managed to not pose a threat.
- Weed and pest management issues are well covered in management plans for various agencies. This means that the issue is of higher priority and receives attention to remedy.
- Wallis Lake Feral Deer Partnership trial between MCC, HLLS and National Parks trialling control of Ruse deer in peri-urban areas.

What's not working?

Workshop: Terrestrial

- In general, biodiversity is in decline, resources don't match the needs
- Not responding to climate change
- Biodiversity legislation not delivering what is needed, regulations are not serving well
- Unlawful clearing in reserves – education and resourcing around compliance and enforcement in the urban interface
- Feral impacts widespread – foxes and deer
- Future population pressures
- People don't understand biodiversity as a whole, more engagement about ecosystems
- Strategic alignment of research needs and university research needs
- Do great projects then funding drops off – loss of continuity and change of priorities, how do these programs get maintained

Workshop: Aquatic

- Legacy pressures on our estuaries, declining ecological condition despite the value
- Responding to changing climate – key knowledge gaps
- Impacts of developmental pressures in the catchment – unlawful clearing
- Resourcing doesn't match the scale of the work we need to do, focus on short term projects due to funding
- Future escalation of development pressures

- Adaptation responses due to tidal dynamics / climate change
- State Government programs seem to leave off key tributaries for funding (eg flooding)
- Regulation – fisheries and livestock access to foreshores, impacts of boating with increased pressure and visitation
- Change in habitats within Wallis Lake – do further trials on seagrass restoration
- No standards or specifications for jettys and foreshore structures in our DCP. ACTION
- Unauthorized boat ramps within North Arm cove, maybe because there are not a strategic community facility
- Stormwater management and outdated stormwater systems which don't take into account WSUD – ongoing maintenance = destruction of habitats ACTION strategic approach
- Coordinated monitoring program ecological and flood modelling, improved data management and collection and sharing
- Communication with researchers and decision makers improve decision making
- See the studies put together in with a meta data – long term study
- Include additional indicators within the report card

Other thoughts

- There is a lack of biodiversity data and a sporadic approach to data collection as funding allows. We don't know what we are losing.
- Could do better at incorporating Aboriginal knowledge in programs (e.g. traditional fire management); supporting Aboriginal communities to increase traditional knowledge, building capacity for Aboriginal land management and engaging existing service providers (TIDE, LALCs).
- Invasive species are widespread, especially post drought and fires.
- Landholder engagement in getting stock out of riparian areas and waterways is difficult. There are challenges working with both larger stations and smaller rural landholdings but some are open to changing practices.
- We don't know the rate of biodiversity loss with major recent events (drought and fire) on top of cumulative impacts from land-clearing and degradation, pest species. Are funding and regional actions such as monitoring, on-ground works and engagement commensurate to address the rate of decline?
- Ongoing degradation and loss of riparian vegetation is critical issue, especially post fire.
- Modified floodplain drainage and coastal wetland degradation is a concern for these systems and the wildlife that relies on them.
- The public reserve estate is biased to "residual" reservation (conservation of leftover lands not valuable for other "productive" purposes). We need to enhance the comprehensiveness of the reserve system, and include adequate integrated freshwater / terrestrial conservation scheme across the study area.

- Native timber harvesting has negative impacts on biodiversity and waterways. This includes both public and private native forestry operations.
- Better assess the threat of pest species including pigs, foxes, deer given that feral species are a major threatening process.
- There is a legacy of clearing on high fertility areas like riparian zones and floodplains
- Landowners are clearing land for capital gains in the future.
- Areas of bank erosion are correlated with an absence of riparian vegetation, posing a high risk during extreme weather events.
- Cumulative impacts of clearing are not being considered.
- Need to clarify jurisdiction over vegetation management in the foreshore area.
- Challenges in locations where river frontages are fragmented in privately owned holdings, and good riparian management depends on views and management of each landholder.
- Weeds cross landholder boundaries, so we need tailored solutions to work collectively. Previously Rivercare Plans could influence a group of landholders on a reach.
- Lack of funding for on-ground incentive programs.
- Cattle and livestock access to riverfront. There isn't legislation/regulation to prevent cattle impacts adequately. Need to expand conversation to not just 'exclusion' which is likely unpalatable to many landholders, but to include 'management' or 'temporary exclusion'.
- Landholders are reluctant to protect and restore riparian vegetation. Farmers in the Manning River CMP Reference group noted the complexity and expense of stock exclusion from the riparian zone. Issues include the need for alternate water and shade, weed control and flood damage to fences.
- Native vegetation legislation reforms which reduced clearing regulations while introducing funding and incentives for BCT private conservation agreements hasn't worked effectively. BCT is focussed on preserving land in hills/inland areas while there is clearing elsewhere.
- The BC Act provides for a biodiversity values map however few riparian zones are included. This doesn't adequately limit an ability to develop these lands through the development application process.
- For good catchment management, we should work with landholders to explore models where biodiversity is in balance with production, rather than separately. However, BCT has a more narrow, single-issue focus on biodiversity.
- Control of some significant weeds and pests due to fast spread and high invasiveness (would require fast action and/or development of new/innovative methods for treatment).
- Weeds/pests becoming immune to certain treatment methods due to wrongly used or overused product.
- Lack of funding and resources for weed and pest eradication. The work is time consuming and required ongoing input over a long period of time to be effective.

1.6 Opportunities

Workshop: Terrestrial

- Connect with university to find the sweet spot between Council and UNIs – list of projects want research on. Opportunities: Work integrated UNI students, honours students, PhD studies.
- Research questions that students could assist with
- Community engagement with species like GG bell frog
- Consolidate and extend what is working well, work together
- There are also the government's industry PhD schemes that could support Council's biodiversity projects for limited Council cost. Industry pay for the travel and consumables. <https://www.education.gov.au/national-industry-phd-program>
- Sustainable farming practices that take into account productivity and biodiversity
- Flying foxes as climate change expands
- Build research station – they will come
- Corridor mapping within the planning framework
- Why biodiversity is important
- Look for opportunities to expand clause 4.1b private conservation – review if is working.
- Corridors for resilience for Climate change could be a research project
- Control deer as a threatening process on wetlands
- Coordinate research so that it can be shared and used across programs
- Habitat creation not tree planting
- Expand EDNA work from the Manning
- Establish hero species for the CMP eg green and golden bell frog
- Need to think differently about how we address biodiversity issues. Innovation is required – include “innovation” as a principle within the program can't fix the existing problems with existing approaches.
- Baseline monitoring of birds and frogs and bats using BIOMON (automated call detection sensors powered by solar panels and sending data directly to desktops).
- Squirrel glider/yellow-bellied/greater glider research: Abundance, distribution, population structure, etc.
- Little terns research
- Research into threatened/uncommon species: *Grevillea guthreiana*, Frogs – *brevipalmata*, *freycineti*, *Mixophes balbus*, Platypus
- Sustainable agriculture and monitoring benefits of this

- Research into why flying foxes is expanding into urban areas
- Corridor mapping at a fine scale to inform LEP, and testing whether all species actually use the corridor
- Innovation e.g. safe havens, automated monitoring
- Using research to initiate discussion, e.g. cat movements and diet in urban-bushland fringe
- Fragmentation: if that's an issue, it would be interesting to look at the extinction debt and how long areas need to be fragmented before species drop out of the system

Workshop: Aquatic

- Fish passage e.g. culvert on Khappinghat Creek at half-chain Road
- Incorporate **Indigenous traditional knowledge** in programs.
 - Traditional fire management and fire recovery.
 - Include significant species for Aboriginal custodians as indicators in monitoring and education programs.
 - Develop an Aboriginal seasonal calendar for the river and estuary.
 - Establish Indigenous Protected Areas.
- Develop a suite of **flagship and indicator species** (e.g. platypus, turtles, fish such as bass, shorebird, crayfish, freshwater mussel, dolphin) from key groups, that link to the CMP vision and represent a healthy ecosystem. Use these species in monitoring and community engagement programs.
- Include monitoring results for bio-indicator species in an annual Report Card linked to Biodiversity Framework to produce a ***Health of the Catchment snapshot***.
- Build **research partnerships** with universities.
- **Environmental DNA** is a rapidly evolving technique for detecting species and getting information on assemblages.
- Use of **innovative technology** – for example use of drones with LIDAR for depth measurements. TIDE has qualified drone pilots.
- Manage **rivers and riparian zones as wildlife corridors** by building connectivity of fragmented ecosystems.
- Sustainable Farming resources developed by ANU as well as the growth in regenerative farming interest from landholders, researchers and agencies has potential benefits for Biodiversity and water quality within the upper catchment and estuary.
- Create **multi-tenure riparian reserves** on priority reaches. Use public land as a starting point (Crown, TfNSW) along with conservation agreements on private land.
- **Nature based tourism and wildlife experiences** e.g. birding routes, hides, boardwalks, river walks.
- **Conservation partnerships with NGOs** e.g. Australian Wildlife Conservancy, Bush Heritage Trust to establish fenced or unfenced reserves, animal protection, reintroduction.

- **Crowd funding, social media, donations for threatened species** e.g. captive breeding of MRHT. Best run by community sector.
- **Identify and protect high biodiversity value areas**: map, prioritise and protect freshwater refugia.
- **Develop effective natural disaster responses** to mitigate and reduce impacts of major events, particularly those associated with climate change.
- Improve understanding of **best management practice for vegetation management**, using evidence-based science
- Support **peer-to-peer learning**.
- **Demonstration sites** for vegetation management for education and training.
- Educate landowners about the **true cost of clearing for capital gains**.
- Use **iconic species to promote increase in vegetation cover** e.g. koalas as a surrogate for vegetation particularly for riparian zones, white's seahorse for aquatic habitats.
- Use **property planning to manage vegetation** within a productive landscape.
- Improve knowledge and skills for **drought management**.
- Identify and prioritise **vegetation regrowth areas**.
- Council is in the process of consolidating the **Local Environmental Plan (LEP) and Development Control Plan (DCP)** (draft LEP on review). Identify important biodiversity hotspots and use zoning changes to protect them.
- Create riparian reserves on public land and expand through strategic acquisitions.
- Consider fast growing non-invasive clumping bamboo in paddock corners, to shade cattle away from riparian zone. North south rows planting give good shade.
- Partnership projects to attract investment including NGOs.

1.7 Management Options

Workshop: Terrestrial

- Connect with university to find the sweet spot between Council and UNIs – list of projects want research on. Opportunities: Work integrated UNI students, honours students, PhD studies.
- Research questions that students could assist with
- Community engagement with species like GG bell frog
- Consolidate and extend what is working well, work together
- There are also the government's industry PhD schemes that could support Council's biodiversity projects for limited Council cost. Industry pay for the travel and consumables. <https://www.education.gov.au/national-industry-phd-program>
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Workshop: Aquatic

- Share the science with the community – expand program for Southern Estuaries
- Priority areas should be protected in Marine Park eg Khaphinghat
- Controls for ecotourism – monitoring to check their impacts
- Extent of Posidonia in the area needs to be monitored
- Sediment studies (Margaret)

- Collated Smiths Lake data to see how the system functions, look at all information available for all estuaries to describe function of the systems
- Policy position is communicated to the community to in still stewardship
- Seagrass transplantation trials
- Integrated environmental monitoring program
- Use EDNA to engage with community and expand research
- DCP for jetty construction
- Multi species habitat restoration programs based on Ben Gilbys work.
- Work with fisheries to protect soft coral on
- White seahorse habitat creation – maximise opportunities to improve habitat suitability (see example Manly).
- Urban infrastructure can be beneficial for habitat, work with oyster growers to maximise benefit of the habitat their infrastructure creates
- Incentivize / stewardship program to offset habitats and move infrastructure to
- Research to work out if harvesting oyster reefs would be beneficial to their growth and expansion.
- Working with indigenous community to repair habitats and create oyster reefs
- Work with fishers to record their observations and promote stewardship with rec and pro fishers
- Promote escape hatches in crab traps
- Look for opportunities to engage community in foreshore areas particularly
- Link science to policy / research
- Stormwater management and outdated stormwater systems which don't take into account WSUD – ongoing maintenance = destruction of habitats ACTON strategic approach for all stormwater and other flooding areas to avoid the sensitive areas
- Impacts from boating – navigational hazard marking for seagrass habitats
- Moorings need to be environmentally friendly
- Check each MEMS initiative and see which ones align with our issues
- Management questions: reconsider how community interact with decision making. Work with community to see each other as partners in coming up with solutions. Need to find a solution to the challenge of monitoring
- Citizen science and schools program to make sure that the 'right' information is getting to schools eg mangrove die back project from the pacific. Easier access to correct scientific information and making sure that they are aware of MEMs for example
- Circular economy for bank stabilisation and maximise ecological benefits

- Find out what the estuary looks like? What are the values and are these achievable? Eg Central Coast
- Key information for the community eg signage about the biodiversity of the estuary
- Marine ranger program – eg Woolgolga, Sydney
- Actions need to consolidate what is working well and the significance of those actions from the previous plans. Effective, coordinated long term resources need to be established for this program.
- Focus species for engagement – wildlife we love eg yellow fin bream
- Collaborative on line partner discussions – regular discussions
- QR codes and links to information about the – geo activated walks for interpretive walks
- Collect robust and replicable estuarine monitoring data that can be used to identify an optimal state of functioning for each of the ecosystems of interest, and thus trigger values can be set that can elicit a management response, using approaches that tie into the way that the data for that trigger value was obtained. This could be biotic distributions of anything (water quality is often too changeable).

Other thoughts:

Planning

- Implement development controls to protect terrestrial and riparian native vegetation in Councils DCP and LEP
- Develop (species-specific?) Conservation Action Plans for aquatic fauna and riparian specialists in priority subcatchments.
- Develop a Natural Disaster Response Plan to mitigate and reduce impacts of major disasters, particularly those associated with climate change (e.g. drought, fire).
- Develop a Best Management Practice Framework to integrate biodiversity, catchment and productivity outcomes on public and private land.
- Include resident and migratory shorebirds in planning for coastal wetland retreat.
- Review and update subdivision controls to avoid fragmentation of riparian vegetation and reduce stock access and domestic extraction.
- Look into options for how to deal with zombie DAs
- DAs for river restoration works (revetment walls) in the catchments must have an ecological component

Advocacy

- Identify and advocate for additions to the conservation reserve system to integrate terrestrial and aquatic conservation and improve representativeness, especially in floodplain, depositional, and fertile landscapes.
- Add riparian zones to the Biodiversity Values map under the BC Act.

Capacity Building and Community Stewardship

- Adopt a set of significant flagship and indicator species, with Aboriginal and community input, to use for monitoring and community engagement programs.
- Develop an interagency, multi-media suite of communication, education and training material to promote biodiversity awareness, appreciation, understanding and skills for best management practice in urban and rural settings.
- Build capacity for Aboriginal involvement in NRM by supporting content development, delivery and recruitment of Aboriginal participants for accredited Conservation and Land Management training, and issuing field work contracts.
- Promote and facilitate private conservation agreements through Land for Wildlife and Biodiversity Conservation Trust.
- Establish an annual citizen science BioBlitz through the Australian Living Atlas.
- Develop nature-based tourism experiences e.g. birding routes, hides, boardwalks, river walks. Identify and undertake a needs assessment of key target audiences for engagement to promote protection, natural regeneration and revegetation.
- Deliver outreach and incentive programs to improve the condition, extent and connectivity of terrestrial and riparian vegetation in priority areas.
- Use public land to demonstrate best practice.

Regulatory Compliance

- Adopt, monitor and enforce a standard native vegetation buffer width of 1-metre into the public road verge for the erection and maintenance of fences to preserve roadside.
- Prioritise and enforce regulatory compliance to protect riparian vegetation.

Science and research

- Complete a refugia modelling study to identify, map and prioritise freshwater refuge pools.
- Sponsor an e-DNA research project to characterise aquatic fauna abundance and diversity.
- Use existing research and mapping to identify and prioritise target areas for protection, natural regeneration and revegetation.

On-ground work/private land conservation

- Develop and implement Local Integrated Weed Control Plans to protect priority assets.
- Develop and implement a cross-tenure Feral Pest Control Plan to protect priority assets.
- Reframe feral deer management (particularly *Rusa*) as a specific threat to the Coastal Environment area, and manage them as such.

- Engage Aboriginal Rangers in an ongoing conservation and land management program, incorporating both accredited technical training (e.g. TAFE CLM) and traditional Aboriginal knowledge. (e.g. cultural burning).
- Develop and implement a targeted landholder outreach and incentive program guided by the prioritisation tool and Best Management Practice framework.
- Restore fish passage at barriers identified as Medium-High and High priority.
- Improve condition, extent, connectivity and conservation status of riparian vegetation for wildlife habitat on public and private land.
- Protect and restore refuge pools, both for immediate local biodiversity returns, but to improve riparian habitat, connectivity and water quality throughout the catchment and for the benefit of the lower estuary.
- Implement the Shorebird Conservation Action Plan.

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ISSUE ANALYSIS

LAND-USE

PLANNING

2024

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1. Land-Use Planning

This Issue Paper discusses how land-use planning for the Southern Estuaries can facilitate future planning, protect built and natural assets and ensure that coastal land development is managed responsively to the risks.

Land-use planning along the New South Wales (NSW) coast involves managing how land is developed and used to balance environmental protection, economic development, and community needs. With the State's extensive and diverse coastline, effective planning is essential to address coastal hazards, environmental needs and habitat preservation, whilst also balancing population growth, community access and use of coastal areas.

Authors: Courtney Smith

1.1 Situation Analysis

The NSW coast provides a multitude of values and uses for the community. However, the coastal zone is under increasing pressure from a growing population, urbanisation, natural hazards, and climate change (OEH, 2018b). Planning for coastal communities must carefully balance the need to provide jobs, housing, community facilities and transport for communities, while maintaining the unique qualities and managing risks associated with development along the State's coastlines (DPIE, 2019).

The land-use planning system is one of the most important methods to address coastal hazard risk. Fundamental to this is to discourage further investment in properties i.e. renovation, alterations and extension relative to the risk proposed and the lifecycle of the property. However, land-use planning is not limited to considering only physical assets; land-use planning is an important tool to protect vulnerable habitats and provide a buffer for the dynamic coastal zone.

1.1.1 NSW Coastal Management Framework

In order to plan for development, protect environmental assets and manage coastal hazards across the state, the NSW Government has implemented the *NSW Coastal Management Framework*, which includes new legislation and planning policy, and aims to provide an integrated framework for coastal management across the state.

Key components of the framework include:

Coastal Management Act 2016 (CM Act): An act that provides for the integrated management of the coastal environment of NSW, consistent with the principles of ecologically sustainable development, for the social, cultural, and economic wellbeing of the people of the state.

Marine Estate Management Act 2014 (MEM Act): An act that provides for the management of the marine estate of NSW in a manner that promotes a biologically diverse, healthy and productive marine estate and which facilitates the economic cultural, social and recreational use of the marine estate, scientific research, education and management of marine parks.

Environmental Planning and Assessment Act 1979 (EP&A Act): An act that governs land-use planning and development in NSW, focusing on sustainable development, environmental protection, community participation, and compliance measures.

State Environmental Planning Policy (Resilience and Hazards) 2021 (RH SEPP): One of the key environmental planning instruments for land-use planning in the coastal zone. It gives effect to the objectives of the CM Act 2016 and delivers the statutory management objectives of the act by specifying how development proposals are to be assessed if they fall within the coastal zone.

Coastal Management Programs (CMPs): A 5-stage coastal management process intended to set the long-term strategy for the coordinated management of the coastal zone for a given region.

The NSW Coastal Management Manual (The CM Manual): A manual that sets forth mandatory requirements and provides guidance to coastal councils in connection with the preparation, development, adoption, implementation, amendment, and review of CMPs.

The NSW Coastal Council: It is responsible for providing independent and expert advice on matters relating to the Minister's functions under the CM Act, and in relation to the development and implementation of CMPs by local councils.

The NSW Coastal and Estuary Grants Program: It provides technical and financial support to local government to help manage the coastal zone.

A schematic of the NSW Coastal Management Framework (and linkages to the relevant legislation and policies for the management of the NSW marine estate) is provided in Figure 1-1.

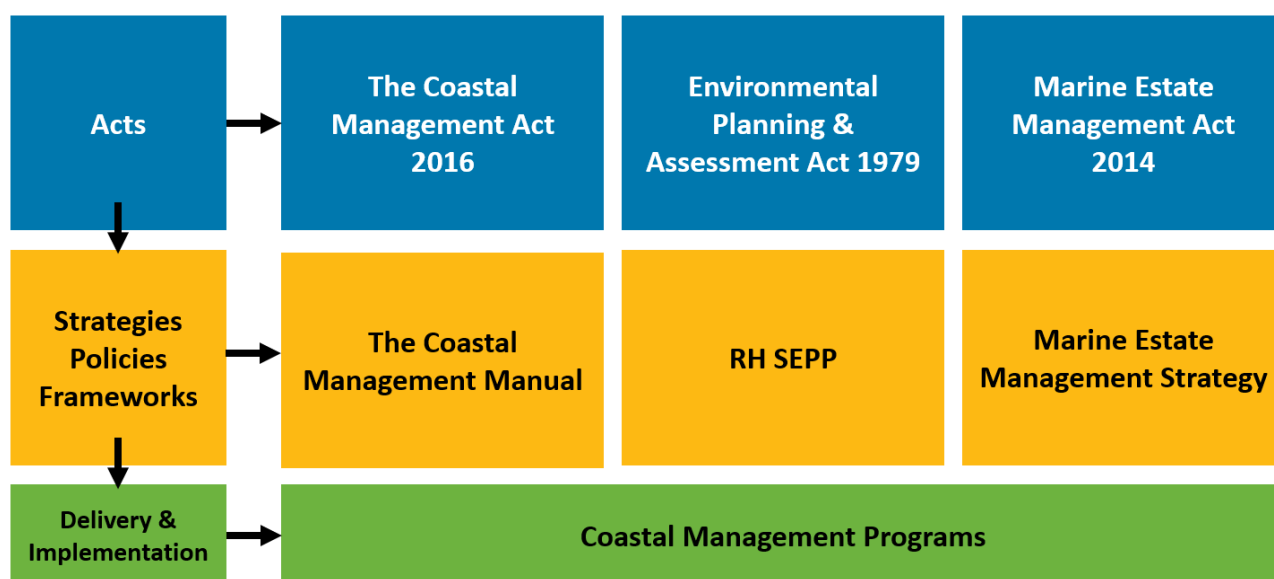


Figure 1-1 The NSW coastal management and marine estate management framework

1.1.2 Coastal Management Areas

In accordance with the CM Act, this CMP gives effect to the management objectives for the 4 coastal management areas (CMAs) that define the coastal zone of the study area. Each CMA has different characteristics and objectives, and the areas may overlap. The CM Act provides the definition and objectives for each of the management areas. The State Environmental Planning Policy (Resilience and Hazards) 2021 (RH SEPP) provides development controls for each of the management areas, and state-wide mapping of 3 of the 4 areas. The 4 coastal management areas as defined by the CM Act are:

Coastal environment area (CEA): Land containing coastal features such as the coastal waters of the state, estuaries, coastal lakes, coastal lagoons, and land adjoining those features including headlands and rock platforms. Beaches, dunes, and foreshores are included in this area.

Coastal use area (CUA): Land adjacent to coastal waters, estuaries, coastal lakes and lagoons where development is or may be carried out (at present or in the future) and impacts of development on the scenic and cultural values and use and enjoyment of the beaches, foreshores, dunes, headlands, rock platforms, estuaries, lakes and the ocean need to be considered.

Coastal wetlands and littoral rainforests area (CWLR): Land which displays the hydrological and floristic characteristics of coastal wetlands or littoral rainforests, as well as a surrounding proximity area to manage impacts of adjacent development.

Coastal vulnerability area (CVA): Land which is subject to any of the coastal hazards listed in the CM Act, including beach erosion, shoreline recession, coastal lake or watercourse entrance instability, coastal inundation, tidal inundation, coastal cliff or slope instability.

1.2 Stakeholders

MCC; DCCEEW; NPWS; Crown Lands; TfNSW.

1.3 Existing Management Approach

Planning for the Southern Estuaries CMP

Land-use planning for the Southern Estuaries CMP will primarily consist of changes to land zoning, with consideration of future coastal hazards, environmental needs and human requirements.

RH SEPP: Of particular note is the coastal vulnerability area (CVA). To map this area, an understanding of coastal hazards is required. The Southern Estuaries CMP area (and wider MidCoast LGA) does not currently have a CVA adopted. The Manning Estuary CMP identified the need to rectify this; Action 7.02 of the CMP was to map the CVA, which once complete, a planning proposal would be submitted to incorporate the mapping into the CM SEPP and MidCoast Council planning controls would be amended in accordance with the Act.

Of the seven types of coastal hazards defined by the CM Act, three hazards are considered relevant for the Southern Estuaries CMP:

- tidal inundation;
- coastal inundation; and
- erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.

The Southern Estuaries CMP Stage 2 Tidal Inundation Study (JBP, 2024) developed new tidal inundation mapping for the MidCoast Council Southern Estuaries. Mapping was prepared in accordance with the NSW Coastal Management Manual, which allows for a probabilistic framework to assess future tidal inundation hazards. A risk assessment was subsequently undertaken using this data to evaluate the regions susceptibility to sea level rise. This was prepared for present day and future scenarios of +15 years (2040), +50 years (2075), and +100 years (2125).

It is likely that a key action of the Southern Estuaries CMP will be to utilise the tidal inundation mapping to develop CVA mapping for the study area. The action may include investigating the potential for a planning proposal recommending amendments to the RH SEPP for eventual adoption by Council.

LEP: The Local Environmental Plan (LEP) is a statutory document that provides the rules for uses on private and public land in the MidCoast LGA. The LEP is made up of the legal instrument and a series of accompanying maps. At the time of writing, there are currently three LEPs across the LGA from the former council areas:

- Greater Taree LEP 2010;
- Great Lakes LEP 2014; and

- Gloucester LEP 2010.

However, these each have different approaches resulting in an inconsistent planning framework across the MidCoast LGA. To rectify this and provide a consistent direction of development in the MidCoast LGA, a new LGA-wide LEP is currently being developed. This has been exhibited and is expected to be adopted by the end of 2024.

DCP: The Development Control Plan (DCP) contains detailed planning and design guidelines to support the LEP. It is non-statutory and provides guidance to help the interpretation and implementation of the LEP clauses. At present, MidCoast Council has three DCPs from the former council areas. A new LGA-wide DCP is currently being developed, to complement the new LGA-wide LEP.

1.4 Knowledge Gaps

The main knowledge gap is how best to protect land for future generations to ensure they are not at risk from coastal hazards – is this best through the CVA mapping and R&H SEPP, or through the LEP/DCP Council process?

1.5 What's working, what's not?

1.5.1 What's working

- The approval and control of domestic waterfront structures is now addressed through estuary-wide plans called Domestic Waterfront Structure Strategies. These are new online maps that show the suitability of waterfront areas for building waterfront structures in different parts of an estuary.
 - The Port Stephens Great Lakes Marine Park Strategy is currently underway, which covers a significant portion of the CMP study area.

1.5.2 What's not working?

- Unclear as to what sea level rise scenarios should be utilised in forward planning and implemented through LEP/DCP updates and SEPP mapping.

1.6 Opportunities

Opportunities to re-zone land based on future hazard risk, to start planning for it now.

Opportunities to protect certain areas of land that have high biodiversity value, or high biodiversity potential in the future – e.g. protect areas that may become wetland or saltmarsh in the future.

1.7 Management Options

The below management options have been sourced from the other Issues Papers that have been developed through the initial stages of the Southern Estuaries CMP – Stage 3 process.

Climate Change:

- Use research data that identifies retreat buffer zones for coastal wetlands and littoral rainforest under sea-level rise scenarios to develop a forward plan to retain suitable buffers in partnership with landholders by 2025.
- Incorporate habitat migration into land-use planning

Agricultural Impacts:

- Use the planning framework to encourage appropriate land-use, reduce agricultural impacts and improve environmental outcomes.

Aquaculture and commercial fishing:

- Increase consideration to and stricter regulations around marine and aquatic environments for new developments and in land-use planning, with reference to the SEPP (PP).

Coastal Wetlands:

- Use the planning framework to implement planning controls to protect wetlands.
 - Need policy about mapping coastal wetlands to appropriate conservation zone with appropriate uses.
- Provide evidence and propose amendments to the RH SEPP to support acquisition, rezoning and remediation of coastal wetlands to improve ecosystem services.
- Develop a whole-community long-term, landscape-scale plan for the floodplain under future sea-level rise scenarios. Build agreement and map an appropriate mix of land-uses that will be sustainable in the longer term.
- Develop agreed interagency principles and priorities for coastal wetland management.
- Prioritise wetlands for conservation based on their size, perimeter to area ratio, condition and threats (pressures), extent within the catchment and more broadly in NSW, as well as listing status.

Biodiversity and Habitat Conservation:

- Implement development controls to protect terrestrial and riparian native vegetation in Councils DCP and LEP
- Develop (species-specific?) Conservation Action Plans for aquatic fauna and riparian specialists in priority subcatchments.
- Develop a Natural Disaster Response Plan to mitigate and reduce impacts of major disasters, particularly those associated with climate change (e.g. drought, fire).
- Develop a Best Management Practice Framework to integrate biodiversity, catchment and productivity outcomes on public and private land.
- Include resident and migratory shorebirds in planning for coastal wetland retreat.
- Review and update subdivision controls to avoid fragmentation of riparian vegetation and reduce stock access and domestic extraction.

- DAs for river restoration works (revetment walls) in the catchments must have an ecological component

Freshwater Flows:

- Collaborate within internal Council teams to implement the Integrated Water Cycle Management Strategy (MidCoast Council, 2023).
- Use development controls and land-use zoning through the MCC Rural Strategy to improve drought resilience and mitigate impact of future development on extraction and water use.

Erosion and Sedimentation:

- Reduce erosion and sediment runoff from construction sites through development controls, regulation and enforcement.

Recreation:

- Look at the possibility of removing 4WDs from more areas; prepare a Beach Access Strategy that will consider a range of beach uses, including 4WD access and use. A similar action is in the Old Bar Manning Point CMP, and will be in the Open Coast CMP.
- Investigate better management of Forster islands and potential of only being accessible by kayak

Coastal Inundation:

- Have robust planning policies in place to stop people from building in certain places/areas.
- Investigate opportunities to control development in high risk areas (e.g. through SEPP Resilience and Hazards mapping, in the LEP).

Biodiversity and Habitat Conservation:

- Implement development controls to protect terrestrial and riparian native vegetation in Councils DCP and LEP
- Review and update subdivision controls to avoid fragmentation of riparian vegetation and reduce stock access and domestic extraction.
- Look into options for how to deal with zombie DAs
- DAs for river restoration works (revetment walls) in the catchments must have an ecological component

Urban Stormwater:

- Develop 'Liveable Community' Strategic Plan (blue space/green space/WSUD) for targeted community where urban expansion will occur, and existing public spaces we can retrofit

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ISSUE ANALYSIS EROSION AND SEDIMENTATION

2024

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1. Erosion and Sedimentation

This paper considers sources, impacts and management actions for erosion and sediment in the Southern Estuaries. Related CMP Issue Papers include Agricultural Impacts, Biodiversity Conservation and Urban Stormwater. Erosion and sedimentation sources considered here include unsealed roads, driveways, earthworks, construction, forestry and agriculture, and boat wash.

Authors: *Advaita Nitturkar, Courtney Smith*

Contributors: *Prue, Erin, Neil, Daniel Park, Gerard, Drew, Jamie Condie, Andrew Morris, April McKay, Stuart.*

1.1 Situation Analysis

Activities and stressors

Erosion is the largest contributor to turbidity and nutrient pollution in water bodies. Many tributaries in the Southern Estuaries catchments have narrow, fragmented or missing protective riparian vegetation.

Land-clearing and removal of woody debris leaves the floodplains, stream bed and banks more vulnerable to erosion. Other activities that contribute to erosion and sedimentation include:

- **Unsealed roads, stock crossings and dirt/gravel driveways** throughout the catchment have a localised impact on sediment loads.
- **Stock access** to creek beds decreases local vegetation and increases local turbidity.
- **Agricultural and forestry operations** including dirt roads, vegetation removal and timber harvest contribute sediment to waterways.
- **Infrastructure** such as roads, weirs, bridges and stormwater drains create impermeable surfaces and barriers that redirect water through single points or culverts, leading to channelling of water. This increases the volume and velocity of surface water during rain events and the potential for erosion.
- **Construction sites** disturb soil and create dust and debris.
- **Riverbank erosion from boat wash** is recognised as a significant issue for the future health and stability of river systems.
- **Bushfires** significantly increase the potential for soil erosion due to the destruction of ground cover and the litter layer.

The relative contribution of these sources varies across the catchment and is unknown. The Great Lakes Water Quality Improvement Plan (WQIP) (GLC, 2009) identifies agricultural runoff, unsealed roads and urban stormwater as very significant sources of pollution in Wallis Lake, and similar pollution sources likely impact all Southern Estuaries.

Modelling for the Wallamba and Crawford Rivers in the Great Lakes WQIP found that remediation of unsealed roads would reduce sediment export from roads within the sub catchments but would have little impact on total loads and estuary sedimentation (GLC, 2009).

The Adapt NSW climate change data provides an overview of modelling results for the North Coast Region. Whilst there is significant and complex variability, key trends forecast include increased intensity of rainfall and runoff events by 2050. This will increase the potential for pulse events with significant inputs of sediments to the estuary. More intense storms could lead to enlargement of streams through bed and bank erosion, thus releasing significant volumes of sediment downstream.

Impacts

Erosion and resulting sedimentation of the Southern Estuaries have several consequences that impact on their form and function. These are discussed below:

Increased Turbidity

Turbidity is a measure of the ability of light to penetrate the water. Suspended sediment, plankton, and detritus can contribute to turbidity. It is usual for creeks to become slightly turbid following heavy rainfall, however, when high turbidity is recorded it indicates diffuse source sediment pollution from the sources listed in the previous section. Spatial dispersion, volumes and the impact of sediment plumes on receiving waters vary according to conditions.

High concentrations of suspended sediments in estuaries can:

- cause turbidity and reduce stream clarity
- inhibit respiration and feeding of stream biota
- diminish light needed for photosynthesis, reducing condition and extent of aquatic plants including seagrass at the base of the food chain
- cause eutrophication of rivers and wetlands
- make water unsuitable for irrigation and cattle
- increased the cost of potable water treatment and infrastructure maintenance
- smother the stream bed, macroinvertebrate habitat and seagrass.

Sedimentation is also an important contributor to the nutrient cycle, adding nitrogen and phosphorous associated with organic matter and fine clays. However, excess nutrients are associated with phytoplankton and algae blooms, including toxic blue-green algae.

Morphological changes

Erosion and sedimentation can lead to morphological changes of the Southern Estuaries. Fluctuations (erosion – accretion cycles) on unconsolidated shorelines is a natural process, occurring in response to variability in water flow, wind, waves and currents, and has been ongoing over geological time scales. However, the positioning of developments in close proximity to shorelines has inhibited natural shoreline movement in some regions of the estuaries, presenting an erosion issue. Furthermore, attempts to stabilise the shoreline at such locations frequently results in problems at adjacent locations, as the problem is transferred.

In other parts of the Southern Estuaries, natural vegetation such as mangroves has been removed, which has caused exposure and erosion of unconsolidated sedimentary shorelines. This is evident at erosion 'hotspots' including:

- Pindimar and Bundabah
- Lower Karuah River
- Wallis Creek
- Forster/Tuncurry, e.g. Elizabeth Parade, Taree Street
- Miles Island and Wallis Island

- The Branch

1.2 Stakeholders

MidCoast Council; Hunter Local Land Services; Transport for NSW (Maritime); Department of Primary Industries – Fisheries; DPI – Forestry; Environmental Protection Authority; recreational boating associations.

Community and stakeholder engagement

A community survey and other stakeholder engagement activities conducted in Stage 1 of the Southern Estuaries CMP identified water quality and erosion/sedimentation as key issues in the study area.

1.3 Existing Management Approach

The *Protection of the Environment and Operations Act 1997* is the primary legislation regulating the management of sediment from construction sites. It is an offence to pollute water under Section 120 of the PEO Act.

Erosion and Sediment Control Plans (ESCP) and **Soil and Water Management Plans (SWMP)** are used to manage erosion and sediment on construction sites and subdivision. These plans are submitted to Council at the Development Application (DA) stage. It is the size of works that dictates which of the two kinds of plans will be used. Both plans are principal management tools used during works.

MidCoast Council's construction operations have a range of measures in place to ensure erosion and sediment are managed during roadworks and other infrastructure projects. The aim of all road drainage is to prevent the concentration of flow at any one point. Multiple drainage structures spread the flow and reduce the likelihood of concentrated flows and erosion. A Works Permit is issued for minor projects and a Review of Environmental Factors (REF) is prepared for projects subject to Part 5 of the *Environmental Planning and Assessment Act 1979*. The specific responsibilities of the Operations Works Engineers, Designers, Co-ordinators, Team Leaders and Team Members in relation to erosion and sediment control are documented and included in Position Descriptions and Individual Work and Development Plans. There are work procedures for erosion and sediment control on road construction, reconstruction and maintenance works. A field guide for outdoor staff including standard drawings and photographs of best practice erosion and sediment control was updated in 2019 by the Soil Conservation Service, and all staff involved in construction received training. A review of internal processes for Erosion and Sediment Control practices is currently underway.

Forestry plantations and native forests on public and private land are managed by the NSW Government for economic (wood and forest products), social (jobs and recreation) and environmental benefits (carbon, biodiversity and soil and water conservation), and cultural heritage values. The Environmental Protection Authority is responsible for the regulation of native forestry operations on private and public land in NSW. Following the 2019-20 fires, DPI – Forestry recommended risk controls to reduce sediment loads from fire-affected plantations and appointed an audit team. Controls included improving road and track drainage to ensure that increased overland flow onto roads and tracks is dispersed without undue concentration of flow or increased velocity; regular inspection and stabilisation of mitre drains to prevent scouring, and a recommendation that to the sensitivity of the flow lines, plantations in the riparian zone should be deferred until a reasonable groundcover has re-established within the stream.

Bank erosion caused by boat wash has historically been an issue at several of the Southern Estuaries. At Wallamba River (which feeds into Wallis Lake), a restriction of water skiers to a 9 km designated length of the river has reduced the impact of boat wash. Along this designated length of the Wallamba River, a number of strategies have been put in place to protect the banks from boat wash including moving roads and re-establishing a riparian zone, bank stabilisation using rock fillets, planting mangroves and the use of oyster shells behind natural log stabilisation.

Unsealed roads and road crossings across creeks across the LGA have been identified and prioritised to mitigate the sedimentation impact. Remediation of these roads, including sealing, can now be performed, with higher priority given to those within 10 km of the coastal zone.

1.4 Knowledge Gaps

- Characterisation of sediment contributions from the full range of sources.
- Extent that runoff of sediment into waterways from unsealed roads contributes to sedimentation in waterways, sub catchments, river and ultimately the estuary.
- Extent and impact of boat wash erosion on environmental, social and economic values. Prioritisation for remediation.
 - Consider high impact boat wash e.g. wake boats (intensive, only in certain locations) vs boat wash from daily/regular use.
 - Identify high-use sites, boat movements and trends e.g. traffic counters at boat ramps during peak times.
 - Shape of river and depth needs to be part of identifying high-risk sites re boat wash erosion.
 - Use markers in the river to estimate wake height.

1.5 What's working, what's not?

What's working

- Council sediment and erosion control project in 2020 with road maintenance team embedding best practice into an Environmental Management System
- Current MEMS-funded project to addressing source pollution from roads – e.g. sealing creek approaches, causeways etc. Could improve the prioritisation process, however overall this has been an effective project.
- Sealing of roads near creek crossings and targeting eroding creek lines has been effective.
- Sealing of intensive stock crossings, in particular at The Branch.
- Wallamba River MOU – have successfully reduced the impacts of water skiing on bank erosion.
- Successfully implemented the Lower Wallamba River Rivercare Plan (Lower Mid North Coast Land Management, 2003), increasing riparian vegetation.

What's not working?

- Clearing of roadside vegetation for road maintenance and weed control on verges is causing erosion and sedimentation.
- Forestry operations – anecdotal. Clear felling has downstream impacts.

- Boat wash erosion
 - Bank protection isn't often funded by TfNSW-Maritime.
 - Boat wash erosion issues, with large areas of undercutting of riparian vegetation on private and public land (e.g. TfNSW site).
 - Weak REF process for new or upgraded boat ramps.
- Legacy issues with erosion and sediment from private properties including driveways, dam batters etc. Difficult to prosecute.
- Haven't prioritised where environmental priorities link to operational requirements
- Private developer homes, not doing good ESC practices but many of these are privately certified. Checks and balances are not in place.
- Climate change challenge – infrastructure not designed to cope with intensity of rainfall – acknowledge the limitations of this infrastructure will be important going forward
- Improve the working relationship between TfNSW and LLS to identify and implement high priority projects.
- The MidCoast LGA is large with lots of erodible soils; it also has a large road and track network.
- Compliance is under resourced from Council
- Construction and assessment process – no ownership through the assessment phase. No key team takes responsibility.
- Regulation is difficult because the plans are average and they are still polluting water.
- North Arm Cove has lots of tracks, unsealed driveways and steep land, therefore resulting in significant erosion.
- Sediment from informal quarries is not being managed very well.
- Erosion of the service easements resulting in increased sedimentation.
- Crown roads, paper road network, stock crossings

1.6 Opportunities

- Several projects through the Marine Estate Management Strategy (MEMS), including:
 - Upgrading Blue Book with a focus on urban construction.
 - Initiative 2 of MEMS is a riverbank management strategy.
 - A tool to prioritise banks for stabilisation is available.
 - Initiative 1a of MEMS is a water quality working group to document and identify who is responsible for what
- Rural strategy: Marine use and access audit, waterways zone review

- Use a recreation management plan and strategic development of public infrastructure to encourage people to go where we want them, and not go where we don't, e.g. Carparks, boat ramps, toilets.
- Target works to reduce turbidity at potable water offtakes.
- Research partnerships to assess impacts/benefits of sediment control projects.
- Develop high priority list for road crossings
- Extension of boardwalk network within the coastal zone – constructing in an environmentally sensitive and safe way for people to interact with the environment.
- Capacity building with landholders to provide advice on improving management of tracks
- Training staff and reinforcing ESC
- Managing water around the road to long term, improve the condition of the road and reduce sedimentation.
- Program works so that they are staged in a way that reduces the exposure of soils
- Focus on stormwater management as part of the job and stage it in a way that opens up less of the road, thus minimising sediment movement.
- Staff want to 'do the right thing' just need coaching
- Include ESC in DCP, ensure that the checks are included in the DCP.
- Auditing and engaging with private and public, build relationships
- Assess if Coolongolook estuary is being impacted by erosion / boat wash
- Formalise stockpile sites with good ESC for road works. Investment will make it easy to maintain ongoing. Note that there is a process for establishing and managing stockpiles.
- Collaborate with State Forests (Forestry Corporation); discussion in regards to their actions to mitigate erosion and sedimentation, and plans for areas with easements.

1.7 Management Options

Planning

- Reduce erosion and sediment runoff from construction sites through development controls, regulation and enforcement.

Advocacy

- Advocate for Transport for NSW – Maritime to support and co-fund research and mitigation of boatwash erosion.

Capacity Building

- Promote understanding and commitment to erosion and sediment control through the construction industry, forestry, landholders and recreational boat users.
- Incentives for landholders to undertake action on farms – partial funding to get people across the line
- Develop a Council web page about ESC that includes guidance – set standards to line up with DCP
- Best practice examples to demonstrate to developers Councils approach and best practice.

Regulatory Compliance

- Increased regulation effort for serious offences for illegal land clearing, improved education on impacts as well as a collaboration between agencies including NRAR and the Biodiversity Conservation Trust.
- Consider the use of a bond if ESC practices are not met.
- Develop a compliance program for ESC.
- Compliance buddy for large / high risk development, compliance person to accompany engineer on pre start meeting.
- Improve tender documentation to ensure best practice ESC for construction jobs that Council manages.
- Investigate if there are sufficient controls on illegal vegetation clearing. Particular focus on peri urban and new urban zones.

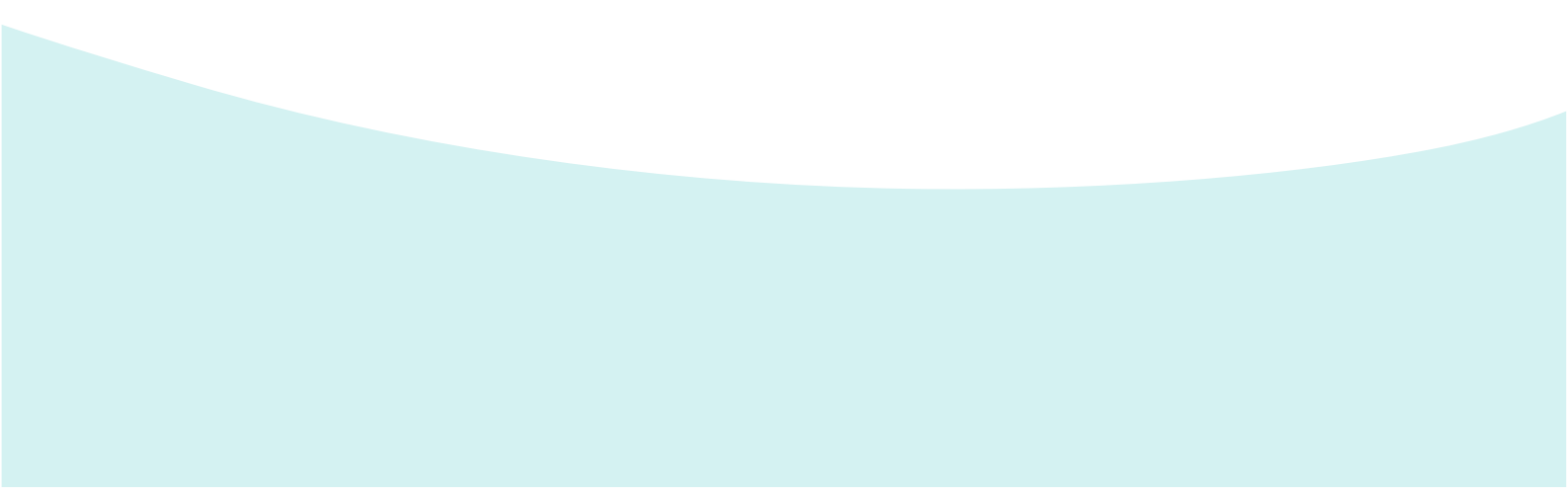
Science and research

- Characterise sediment contributions and impacts on community values from the full range of sources.
- Upgrade the “Blue Book” with a focus on urban construction (*Managing Urban Stormwater*, Landcom 2004).
- Study the impact of sedimentation on mangroves and the impact of floods on these communities
- Monitor ongoing impacts of training walls in Wallis Lake due to marine sand movement
- Include unsealed road maintenance into the handbook and accompany this with training – DECCW have a handbook
- Identify high conservation sections of roads including mapping, signage and controls with ESC practices. Discuss further with Anthony to develop a potential management option.
- Develop guidance for controls for road construction to suit koalas and fauna and also ESC.

On-ground

- Control erosion of unpaved roads and creek crossings in priority areas by sealing or diverting run-off into fringing vegetation. Align creek crossing/unpaved roads near waterways with fish passages.
- Revegetation programs and increasing ground cover.
- Reduce stock access
- Assess bank erosion hot-spots and develop management actions, if required
- Audit and implement any relevant actions from the Lower Pindimar, Pindimar, Upper Pindimar and Bundabah Foreshore Erosion Study (BMT WBM, 2011).
- Install Water Quality Improvement Devices to capture sediment runoff
- Perform a risk assessment of where riparian areas have most ROI in terms of water quality.
- Continue the nutrient management program for the poultry industry eg spreading mulch on free range area
- Install and maintain litter traps in high traffic areas
- Perform bank erosion assessments similar to those done by DPI.
- Education for boaters on the impact of their wake on bank erosion
- Prioritise tracks to be managed that are on public land; need to identify these first.
- Create a specialised role within Council to liaise across all divisions to address ESC.

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Melbourne

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800

Sydney

Suite 3, Level 1, 20 Wentworth Street
Parramatta NSW 2150
Telephone (02) 9354 0300

Brisbane

Level 5, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460

Adelaide

1/198 Greenhill Road
Eastwood SA 5063
Telephone (08) 8378 8000

Perth

Level 1, 21 Adelaide Street
Fremantle WA 6160
Telephone (08) 6555 0105

New Zealand

7/3 Empire Street
Cambridge New Zealand 3434
Telephone +64 27 777 0989

Wangaratta

First Floor, 40 Rowan Street
Wangaratta VIC 3677
Telephone (03) 5721 2650

Geelong

51 Little Fyans Street
Geelong VIC 3220
Telephone (03) 8526 0800

Wimmera

597 Joel South Road
Stawell VIC 3380
Telephone 0438 510 240

Gold Coast

Suite 37, Level 4, 194 Varsity Parade
Varsity Lakes QLD 4227
Telephone (07) 5676 7602

watertech.com.au

