



central coast
waterways
tuggerah lakes estuary



Central
Coast
Council

Tuggerah Lakes Estuary Management Plan

Summary of Implementation 2008-2020



did you know...

Our key achievements have included



40km
rural stream rehabilitation



374ha
wetland conservation and rehabilitation



32
boat ramps and jetties



13km
urban stream rehabilitation



277
Gross pollutant traps



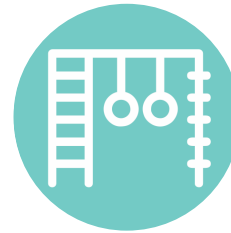
4
foreshore beaches



2.5ha
saltmarsh reconstruction



37
constructed wetlands



33
regional and local playspaces



29ha
saltmarsh rehabilitation



29km
shared pathways



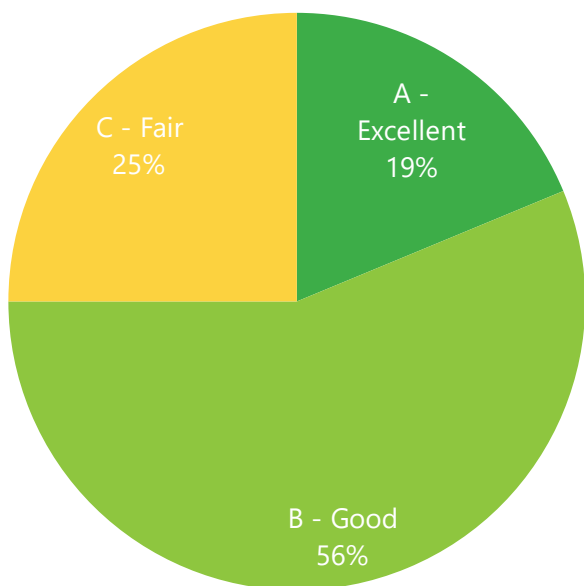
award
winning community programs



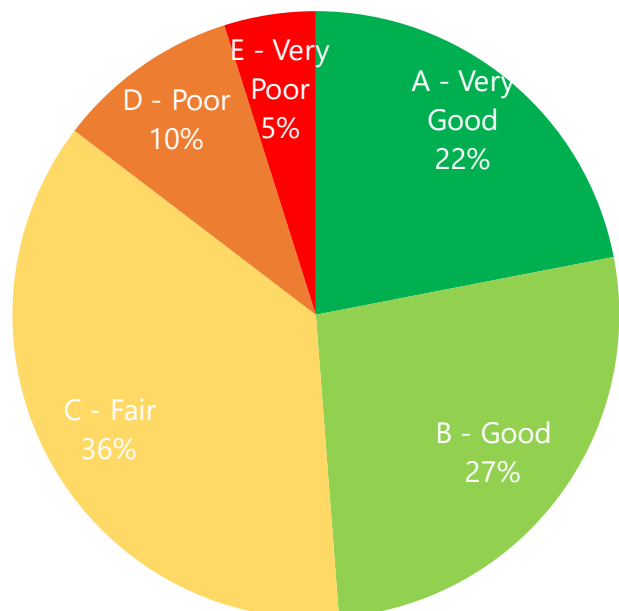
Snapshot of program delivery



Estuary water quality results



Catchment water quality results







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ICOLLs are common on the NSW coast, but are a rare feature in other parts of the world. NSW ICOLLs were formed when sea levels rose around 6,500 years ago at the end of the last ice age.

Catchment characteristics – population, threats and risks

Tuggerah Lakes is an Intermittently Open or Closed Lake or Lagoon (ICOLL) located on the Central Coast of New South Wales, Australia. ICOLLs are rare features worldwide, but are common on the south east coast of Australia. The estuary consists of three interconnected lakes: Lake Munmorah, Budgewoi Lake and Tuggerah Lake and a single narrow ocean entrance.

The 710km² catchment included five major creeks and rivers with an average annual flow of 193,000 million litres per year. The estuary has a typical water surface area of 80km² and an entrance compartment of <0.5km² making it very poorly connected to, and flushed by, the ocean.

The catchment has been heavily modified since European settlement. The greatest impacts occurred through the 1970-1990's as a population boom resulted in expansive clearing of river valleys, riparian corridors and floodplains, broadscale urban

development, poor sewage management and loss of important natural wetlands, saltmarshes and seagrass. It is estimated that 50% of the saltmarsh and 80% of the seagrass has been lost from Tuggerah Lakes. This era brought widespread eutrophication, macroalgal blooms and a raft of water and sediment quality, ecology and amenity impacts. The poorly conceived "1990 Lakes Restoration Project" dredged large areas of organic sediment and seagrass from the lakebed and used the spoil to reclaim and widen many foreshore reserves by up to 30m. This presents ongoing groundwater quality issues to this day.

The population of the catchment is now over 140,000. Catchment and ecological response modelling shows that the major catchment derived pollutants (nitrogen, phosphorus and sediment) are key drivers of ecological decline.

Ongoing pressures include urban stormwater pollution, catchment development and other anthropogenic impacts along with climate change.



Environmental, social and economic values of the Tuggerah Lakes estuary

Tuggerah Lakes is a central feature of the Central Coast region and a hub for tourism, with the regional value estimated at \$900,000,000*.

The estuary provides a key visual and recreational resource, with towns dotted around its perimeter. Natural and built foreshore assets including boat ramps, jetties, foreshore parks, playgrounds, fitness stations, barbeques and sandy beaches are connected by a high-quality shared pathway that loops the waterway. These keep our community active and connected, and paired with raised boardwalks and interpretive signage, provide opportunities for passive engagement and education.

Many protected areas remain in the Tuggerah Lakes catchment including National Parks, State Conservation Areas and local reserves. These are protected for their ecological value and ecosystem services. Council and our program partners have invested heavily in the protection and restoration

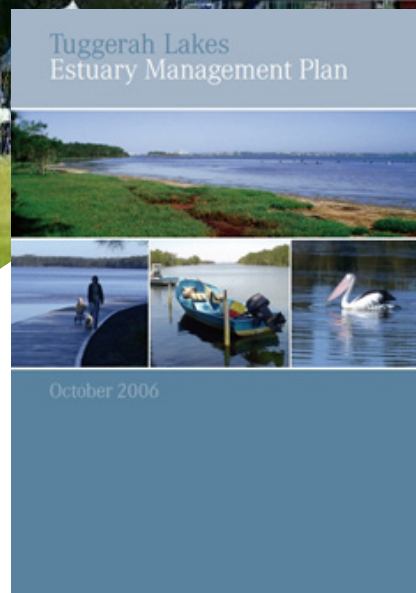
of these areas over the past 12 years. The estuary and catchment are home to endangered White's Seahorse, Platypus, Koala, threatened Squirrel Glider and recently discovered Mahoney's Toadlet among others.

Notably, Tuggerah Lakes is recognised as a globally "Important Bird Area", providing habitat to a range of protected migratory shorebirds including the Little Tern and Bar-tailed Godwit. During the recent inland drought, over 6,000 Black Swans were recorded at one time on Tuggerah Lakes.

The estuary is a commercial fishing hotspot, one of few remaining nearby, with an average annual haul of 351 tonnes (DPI, 2020).

The value the community places on local waterways was demonstrated through the Community Strategic Plan (2018- 2028). Maintaining environmental resources for the future and cherishing and protecting the natural beauty of the Central Coast were highlighted as key focus areas.

*Central Coast Destination Management Plan (2017)



Management and governance framework

In NSW, the responsibility for overarching management of coasts and estuaries resides primarily with Local Government, historically through Estuary and Coastal Zone Management Plans.

More recently, the Coastal Management Act and Marine Estate Management Act establish the framework for coastal management, with councils preparing and implementing Coastal Management Programs.

Objectives: Tuggerah Lakes Estuary Management Study

In 2001 the Tuggerah Lakes Estuary Process Study was completed and following this, in 2005 the Tuggerah Lakes Estuary Management Study was finalised. The Estuary Management Study identified six primary objectives for managing Tuggerah Lakes. These were to:

1. Ensure that the quality and quantity of water meet the needs of the community and lakes and rivers.
2. Ensure that the plants along the banks of rivers, lakes and in wetlands are protected because these are essential to a healthy ecosystem.

3. Ensure that biodiversity and ecological integrity of the lakes ecosystem are maintained or enhanced.
4. Ensure that human activities can take place while protecting cultural heritage and enhancing soil, water and ecosystem health.
5. Ensure that the social and economic needs of the community are met while protecting the environment of the coastal zone.
6. Ensure that we continue to improve our understanding of how the estuary works and incorporate this knowledge into management.

Through extensive community and stakeholder consultation, in 2006 Wyong Shire Council (now Central Coast Council) prepared and adopted the Tuggerah Lakes Estuary Management Plan (EMP). The EMP assimilated these objectives, and set the direction for management of the estuary over the coming years. The EMP was certified in 2007 and over the past 12 years, has been implemented by a series of dedicated Estuary Management groups/teams within Council, in partnership with a range of stakeholders and program partners.



Vision: Tuggerah Lakes Estuary Management Plan

The Estuary Management Plan was designed around multiple agreed vision statements which related to key estuary attributes. These included:

Water quality: Current water quality does not deteriorate in the face of new development. Recreational water quality is improved at lake and creek swimming areas.

Foreshores: Healthy foreshore that promote saltmarsh growth which in turn aid the natural breakdown of seagrass wrack.

Public facilities: Excellent recreational facilities and access points.

Rivers and creeks: Healthy rivers and creeks that connect well with the estuary and provide good habitat for estuarine animals.

Ocean entrances: Existing exchange with the ocean is maintained. A permanent entrance is not a cost-effective solution and will have unknown ecological impacts.

Seagrass wrack: Seagrass wrack will be harvested from locations where it accumulates too frequently to be broken down naturally. Wherever possible, saltmarsh will be used to encourage natural odourless decomposition of wrack on the foreshores.

Fish and prawns: Sustainable fish and prawn populations and habitat that provide long-term recreational and commercial fishing.

Implementation of the Estuary Management Plan was overseen in part by the Tuggerah Lakes Estuary, Coastal and Floodplain Management Committee and more recently, the Catchments and Coast Committee Tuggerah Lakes which includes multiple stakeholder agency and community representatives.



Funding

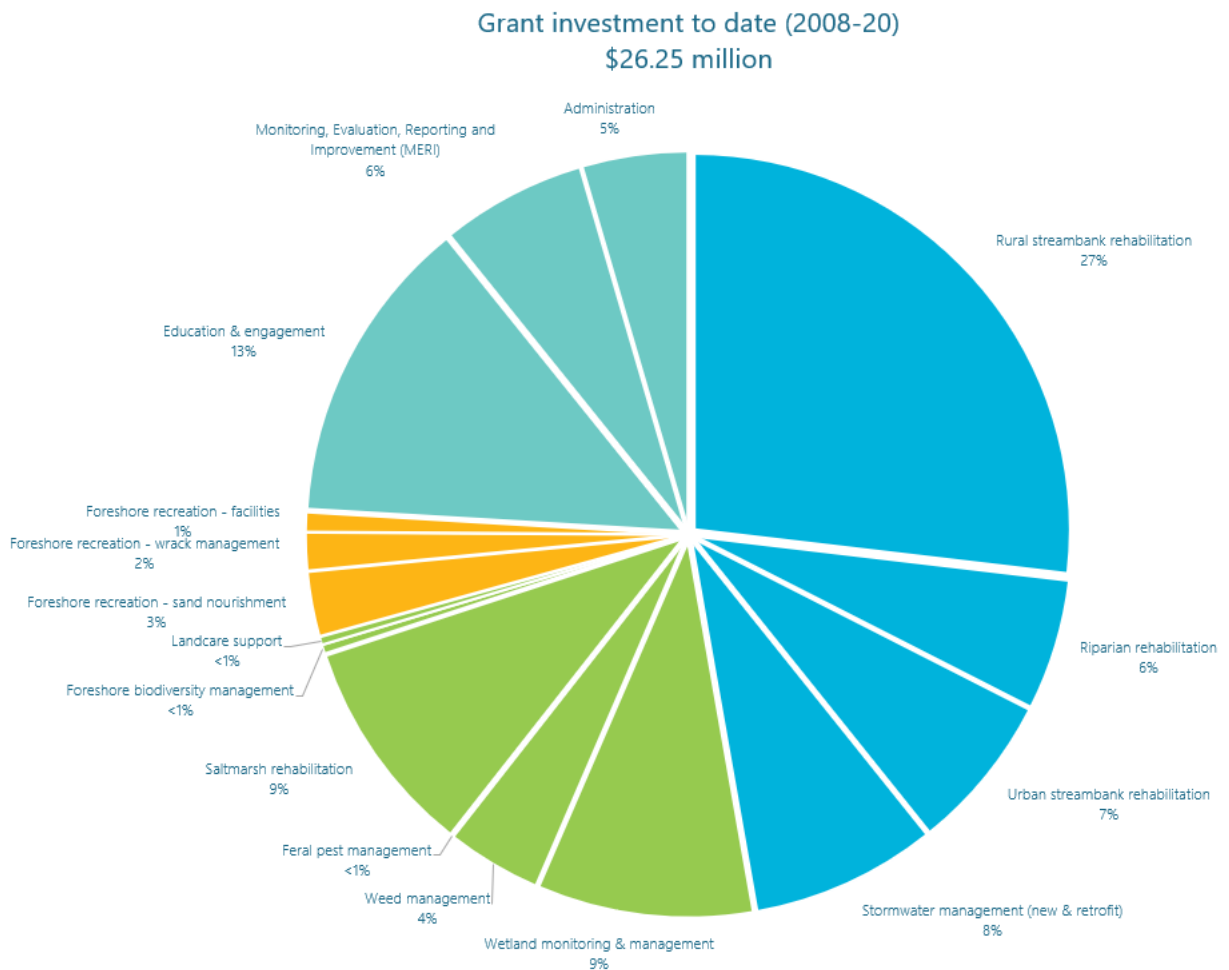
Since the Tuggerah Lakes Estuary Management Plan was completed in 2006, Council has received \$30.95 million in federal funding to implement aspects of the EMP that aligned with the objectives of the respective grant programs. Between 2008 and 2017, these were restricted to the electoral seat of Dobell. The current Environment Restoration Fund, which was executed in March 2020, does not have these same restrictions, allowing us to expanded work into the catchments of Budgewoi Lake and Lake Munmorah. A breakdown of the funding per grant category is as follows:

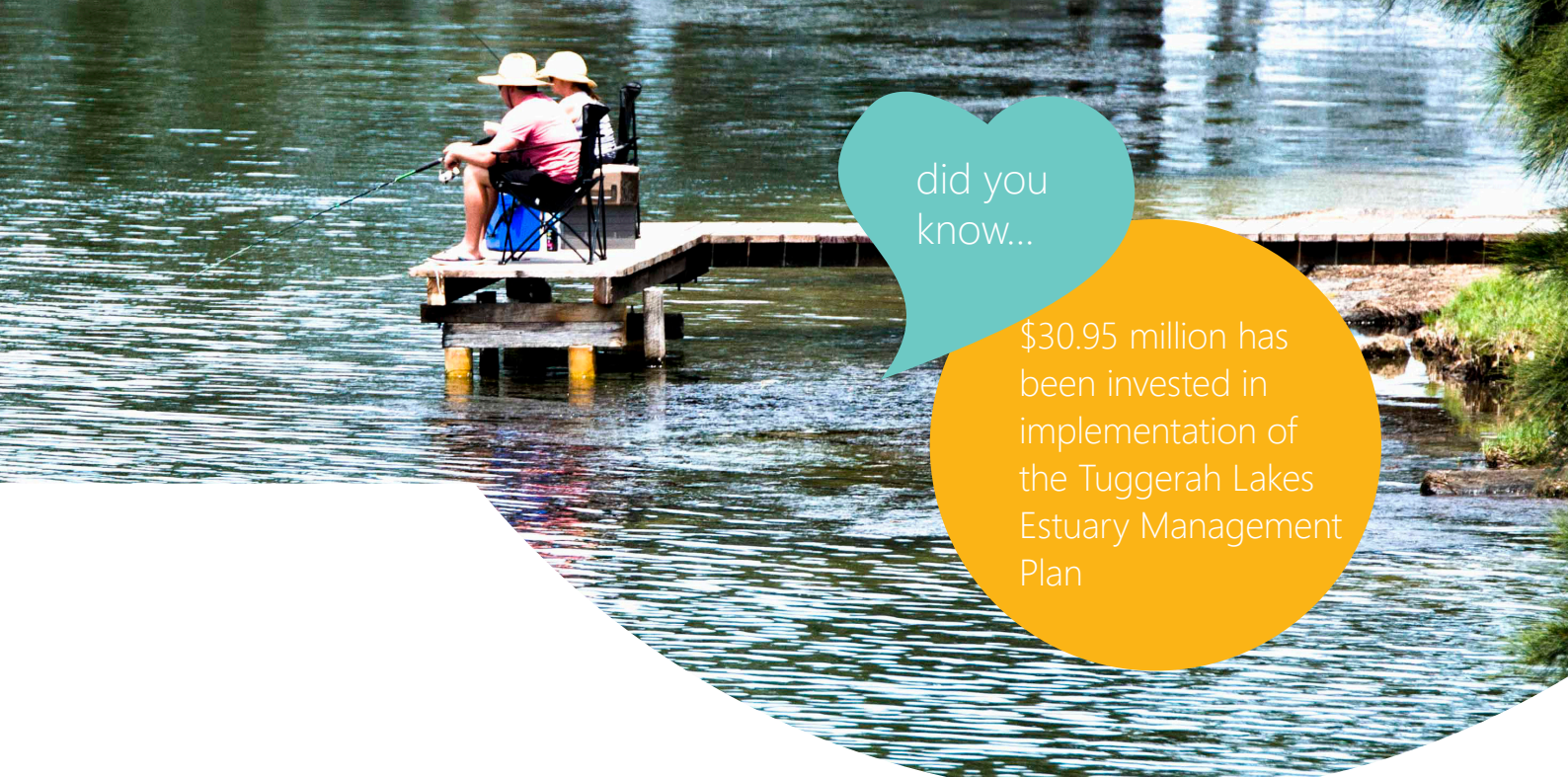
2008-13: \$20 million – Caring for our Country

2014-17: \$3.25 million – National Landcare Programme

2017-20: \$3 million – Improving your Local Parks and Environment

2020-23: \$4.7 million - Environment Restoration Fund

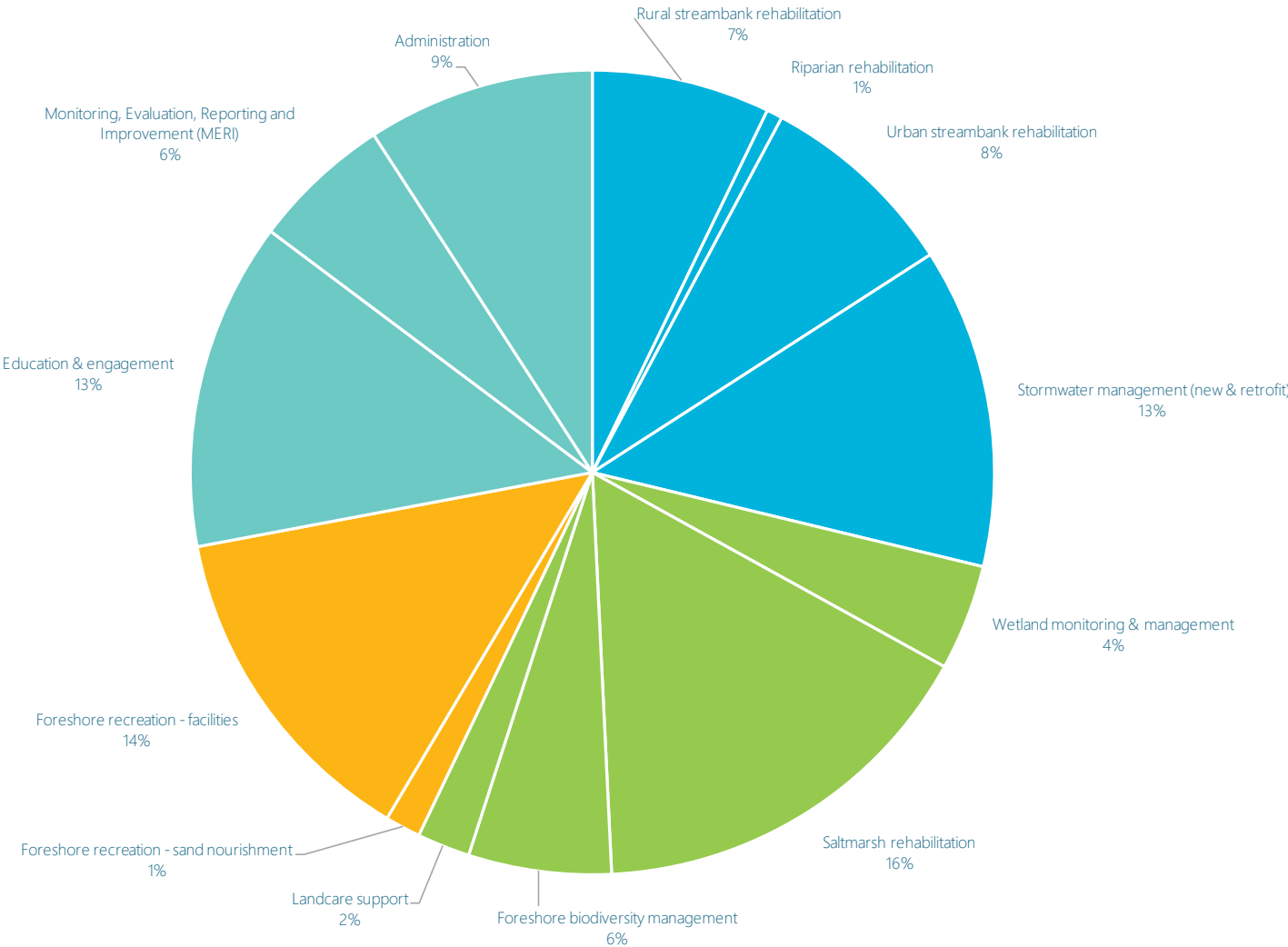




did you know...

\$30.95 million has been invested in implementation of the Tuggerah Lakes Estuary Management Plan

Environment Restoration Fund 2020-23 \$4.7 million



In addition, Council contributes approximately \$5 million per year on estuary improvement projects across the Local Government Area.



Collaboration and partnerships

Central Coast Council has been fortunate to establish and maintain strong partnerships and collaborations throughout the development and implementation of the EMP. The initial plan preparation included engagement with technical experts, a wide range of community and business stakeholder groups and residents of the Tuggerah Lakes catchment. A few examples of government agencies include Local Land Services, Department of Planning, Industry and Environment (Biodiversity and Conservation; Environment, Energy and Science), National Parks and Wildlife Service, NSW Roads and Maritime Services, Department of Primary Industries (Fisheries) and Crown Lands. Ongoing community consultation and engagement has been part of the works delivery and education programs in specific locations.

The Catchments and Coast Committee Tuggerah Lakes brings together a range of stakeholders and community representatives to help advise on management, and channel information to Councillors and community. In addition to government agencies, representatives from Waterwatch, community interest groups and the local community participate in the bimonthly meetings.

An effective collaboration model during the implementation phase has been devolved grant arrangements, whereby Council as the lead agency provided funding to other organisations to assist in delivering priority actions. These arrangements have been formalised through individual grant agreements which allowed for more streamlined project management and reporting. Collectively, these projects drew on the expertise and networks of these other organisations including Local Land Services, National Parks and Wildlife Service, Central Coast Wetlands and the Local Aboriginal Land Council to broaden the range of possible outcomes.

Expert scientists from the NSW Government have been pivotal in successfully filling knowledge gaps, prioritising management actions and establishing a long-term, comprehensive estuary and catchment monitoring program. This information drives our current management and will be embedded in the new Coastal Management Program which is currently under development.

Finally, the NSW Government Expert Panel and Working Group that commenced in 2020, will foster these positive relationships and provide a unique opportunity for recognised experts in estuary and coastal management to review management to date, and advise on matters relating to ongoing improved water quality for the Tuggerah Lakes estuary.

EMP Action Plans and Priority Programs

The Tuggerah Lakes Estuary Management Plan included 27 priority programs which were drawn from the management studies and stakeholder engagement programs and were intended to sustainably manage this locally iconic waterway. The priority programs were split across four interrelated Action Plans which aimed to achieve the objectives of the Estuary Management Study and Vision of the Estuary Management Plan. These include a – Water Quality Action Plan, Ecology Action Plan, Socio-Economic Action Plan and Knowledge and Management Action Plan.

The EMP identified a total of 100 actions. Around 86% of the individual actions have been completed or are ongoing. The implementation program has been delivered in partnership with a variety of state government agencies, non-government organisations, community groups and technical experts in a range of fields. Our success is a testament to these strong, long-term collaborations. Those actions that have not been commenced, or need revisiting, will be reviewed as part of the Coastal Management Program Scoping Study.





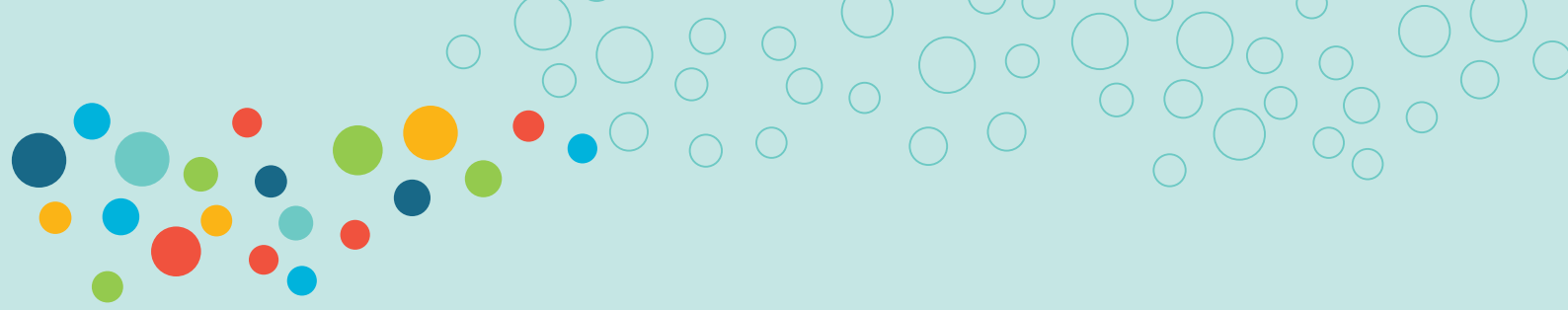
Water Quality Action Plan

The Water Quality Action Plan included the largest number or priority programs, with water quality being a surrogate for a range of actions that relate to broader ecological health and recreational health outcomes. These were considered important to maintain or improve water quality which is fundamental to the long-term health and sustainability of the estuary.

The map below highlights the proposed locations of various water quality actions (from the EMP in 2006):



The priority programs and actions related to water quality, along with their progress, either complete (✓), ongoing (→) or needing further work (!), are shown in the following table:



Priority Program	Water Quality Action Plan											
	1 Action		2 Action		3 Action		4 Action		5 Action		6 Action	
PP1 Streambank rehabilitation	Prepare creek management plans and identify areas experiencing poor creek condition or streambank erosion (including urban streams)	✓	Develop a programme of prioritised remediation measures	✓	Implement rehabilitation works including bank stabilisation, bush regeneration and limit stock access/ boat wash - \$500K p.a.	→	Assess effectiveness of rehabilitation, collate data, present to stakeholders and inform management	→				
PP2 Stormwater management - new urban areas	Review Stormwater Management Plan to improve strategy for new urban areas including DCP's, guidelines and any supporting works	→	Develop and apply an assessment protocol to determine appropriate stormwater interventions (in terms of flow and WQ) for new developments	→	Design and cost stormwater harvesting and stormwater pollution control infrastructure (including ongoing maintenance costs)	→	Manage the installation of infrastructure (funding through S. 94)	→	Assess effectiveness of stormwater management programmes in achieving objectives and adjust management plans accordingly	→		
PP3 Stormwater management - existing areas	Prepare a 5 year plan for stormwater remediation upgrades focussing on priority catchment first rather than available space	✓	Undertake design and construction on a 5 year plan as part of the drainage infrastructure upgrade programme	→	Assess the performance of the devices and link back to design and management plans	→						
PP8 Audit for compliance in catchments	Develop a rationale and criteria for conducting audits	✓	Undertake the audits and provide constructive advice	→	Link results for the audits to management planning	→						
pp9 Develop a sub-catchment prioritisation tool	Develop a process/ system for assessing which catchments are a high priority, and what type of intervention is required	✓	Collect catchment data and device performance data to improve understanding of priorities and responses	→	Undertake the assessments on an annual basis for prioritising works	→	Use the information for refining planning (Stmw Mgt Plan) and doing drainage upgrades (PP3)	→				

	1		2		3		4		5		6	
	Action		Action		Action		Action		Action		Action	
PP20 Maintenance of stormwater devices	Continue existing maintenance programme	→	Review adequacy of existing devices and retrofit devices where necessary to improve performance and maintainability	→	Develop a system for handling, processing and disposing of collected material	✓	Record data on collected material	→	Review data and feed into catchment management decisions and design of future devices	→	Review adequacy of maintenance programmes	→
PP26 Educate people about stormwater pollution	Identify key groups that need to be targeted	✓	Devise and implement the education programme	→	Assess attitudinal and behavioural change through time to determine effectiveness	→						
PP27 Sustainable use of water	Review of innovative schemes and current best practice	→	Conduct trial of incentive schemes	→	Implementation of successful trial	→	Review community acceptance, cost impacts and demand changes	→				





Ecology Action Plan

The Ecology Action Plan relates to the natural and ecosystem values of the estuary and catchment, along with the ecosystem services these areas provide which are fundamental to our way of life. In simple terms, ecology describes the interactions of the physical environment with the plants and animals that reside there, including us. Maintaining and improving the ecological integrity of the estuary and catchment is good for us all.

The map below highlights the proposed locations of various ecology actions (from the EMP in 2006):



The priority programs and actions related to water quality, along with their progress, either complete (✓), ongoing (→) or needing further work (!), are shown in the following table:



Love our living lakes

The Central Coast's catchments and coast are unique and abundant in native plants and animals.

Our freshwater streams support healthy populations of platypus and crayfish, who make their homes in the soft sandy banks of the rivers and creeks. Australian Bass feed throughout the year on the crustaceans and invertebrates they find amongst rocks and snags, then in late autumn travel downstream to the estuaries to breed.

Our diverse estuaries support abundant meadows of seagrass and macroalgae, which are home to the elusive White's Seahorse who gently winds its tail around the seagrass leaves and eats tiny amphipods as they pass by. A record six thousand black swans visited Tuggerah Lakes in recent years to find refuge from inland drought conditions. Prawns, worms, molluscs and small crustaceans gather tiny food particles from the sediment or filter them from the flowing water. They in turn becoming dinner for flathead, whiting and yellowfin bream.

The fringing riparian and estuary vegetation provide roosting and breeding habitat for osprey and sea eagles, while spoonbills and stilts wade at the water's edge. Migratory birds travel from Asia and North America to visit, rest and feed. Small-mouth hardyhead, sea mullet and flathead gudgeon graze amongst estuary plants, tolerating the extremes of fresh and salt water.

Our beaches, sand dunes and bluffs provide the link between the surf zone, intertidal zone and nearby temperate rocky reefs which are teeming with life. Gutters, gullies and rockpools carved in the rock shelves are home to anemones, molluscs, seastars and octopus. Deeper still, the stunning Port Jackson Shark takes shelter in caves and rocky outcrops during the day and by night forages for sea urchins, crustaceans and fish.

Our waterways are a world of their own, and they are ours to protect.

Priority Program	Ecology Action Plan										
	1		2		3		4		5		6
	Action		Action		Action		Action		Action		Action
PP4 Restore degraded catchment habitat	Identify catchment habitats important to the estuary that require active rehabilitation and management	✓	Assess rehabilitation requirements and plan the approach to habitat management	✓	Implement the rehabilitation/bush regenerators programme	→	Assess effectiveness of habitat rehabilitation	→			
PP5 Foreshore rehabilitation	Identify location of important foreshore habitat	✓	Assess threats and future uses to determine if rehabilitation is required and set objectives for rehabilitation	✓	Develop and implement rehabilitation programmes and designate protective zones	→	Assess effectiveness of rehabilitation in meeting objectives	→			
PP7 Limit access to sensitive parts of the estuary	Identify points of public access to sensitive habitats and assess appropriate controls	→	Implement access controls and educate the community and key stakeholders	→	Assess recovery/protection of the sensitive habitats and feed back into management decisions	→					
PP11 Monitor key wetlands	Identify key natural wetlands important for the estuary and investigate appropriate monitoring programmes (qualitative and quantitative)	✓	Provide an ongoing monitoring programme and develop a series of triggers that indicate when urgent action is required	✓	Review wetland conditions and revise management accordingly	→					
PP17 Protect important catchment habitats	Identify sensitive threatened habitats in the catchment that are important to the estuary and require strategic protection	✓	Develop strategic policies and plans that protect these habitats	→	Implement the programmes	→	Assess the effectiveness of strategies and plan future programs	→			

Priority Program	Ecology Action Plan											
	1		2		3		4		5		6	
	Action		Action		Action		Action		Action		Action	
PP22 Maintenance of foreshore rehabilitation areas	Develop a maintenance schedule for rehabilitation sites	→	Implement the maintenance schedule	→	Review the effectiveness and longevity of the rehabilitation programmes	→						
PP24 Assess riverine ecology and river flow	Assess the ecology of tributaries to determine how regulation is affecting riverine and estuarine health	✓	Determine the flow requirements for river/estuary health	✓	Examine ways of improving flow without impacting on water supply (e.g. by modelling changes to requirements from water cycle management planning)	→						





Socio-Economic Action Plan

The Socio-economic Action Plan is about how we interact with and use the estuary. Tuggerah Lakes offers significant tourism and recreational opportunities and has a considerable value as a commercial fishery. Facilitating our use of the estuary and catchment, in a manner that is not detrimental, and is perhaps even beneficial to the health of the estuary, is a key outcome of this action plan.

The map below highlights the proposed locations of various socio-economic actions (from the EMP in 2006):



The priority programs and actions related to water quality, along with their progress, either complete (✓), ongoing (→) or needing further work (!), are shown in the following table:



Priority Program	Socio-economic Action Plan											
	1		2		3		4		5		6	
	Action		Action		Action		Action		Action		Action	
PP6 Foreshore recreation facilities	Undertake community consultation to determine interest groups and recreational requirements	✓	Identify and designate recreational locations. Develop prioritised works schedule addressing the interests of the various foreshore users	✓	Implement programmes of works for new foreshore facilities and programme to encourage users back to the lakes (including boating facilities and business opportunities)	✓	Assess community response to the improvements	!				
PP12 Develop a population strategy	Assess the need/ feasibility for determining the limits of impact the lake can sustain before irreversible change	✓	Determine load and flow changes under a range of scenarios and assess estuarine processes to determine "tipping point"	✓	Include as a consideration in population planning	!						
PP14 Develop partnerships with business	Establish a "Friends of the Lake" business forum	!	Devise initiatives/ programmes that solve estuary/ catchment management problems and still integrates business with estuary requirements	!	Assess the initiatives and field test them	!						
PP18 Entrance Management	Provide funding and resources for the continuation of the dredging programme	✓	Assess ocean entrance dredging effects on key estuarine/ physical processes	✓	Develop flood, safety and ecological triggers that aid in determining dredging requirements/ timing	→	Review the dredging program in light of any new information	!				

Priority Program	Socio-economic Action Plan											
	1		2		3		4		5		6	
	Action		Action		Action		Action		Action		Action	
PP19 River mouth dredging	Assess all creek entrances and determine the need for dredging and identify causes of sedimentation	→	Develop remediation plans where sedimentation can be minimised (tie to PP1)	✓	Develop a rolling plan for dredging creeks that need it	!	Implement the dredge programme and the remediation programme and obtain rolling approvals (N.B. remediation is costed in PP1)	!	Review effectiveness of programmes and feed back into management planning	!		
PP21 Maintain foreshore recreation facilities	Assess the maintenance required at each site to improve the visitor experience (clean beaches, wrack harvesting, beach nourishment)	→	Develop and implement a maintenance programme	→	Review the effectiveness	!						



Knowledge & Management Action Plan

The Knowledge and Management Action Plan brings together our understanding of the system at the time the EMP was prepared, highlights knowledge gaps worthy of investment and seeks to establish a management model with continuous improvement at its core. This Action Plan identifies pathways and a management framework to oversee delivery of the EMP.

The map below highlights the proposed locations of various knowledge and management actions (from the EMP in 2006):



The priority programs and actions related to water quality, along with their progress, either complete (✓), ongoing (→) or needing further work (!), are shown in the following table:



did you
know...

Seagrass is 40-50
times more efficient
at storing carbon
than rainforests?

Priority Program	Knowledge & Management Action Plan											
	1 Action		2 Action		3 Action		4 Action		5 Action		6 Action	
PP13 Develop partnerships with universities	Identify academic institutions and researchers with expertise to review existing catchment management practices	✓	Develop memoranda of understanding between Council and the universities	✓	Sponsor research programmes that answer management questions (see PP23)	→	Feed this information back into management plans (PP23)	→				
PP15 Develop and estuary management body	Develop an organisational model for implementing the EMP, educating staff and the public, liaising with users etc.	✓	Establish the estuary management body based on the management model	→	Review the effectiveness of the team	→	Consult with the community to determine satisfaction with the administration of estuarine programmes. Revise administration if required	!				
PP16 Prepare and implement a funding strategy	Review spending and effectiveness of any environmental levy	→	Evaluate additional funding strategies (grant funding)	→	Link to management reporting (especially Council's Management Plan)	→						
PP23 Address key estuary management questions	Resolve outstanding high priority management questions	✓	Develop a process for identifying new management questions	→	Develop a protocol for undertaking the research including QA/QC procedures such as peer review	→	Undertake data collection and assessment	→	Develop a process for incorporating new knowledge into management planning and programmes	→		

Priority Program	Knowledge & Management Action Plan											
	1 Action		2 Action		3 Action		4 Action		5 Action		6 Action	
PP25 Educate community and stakeholders about the estuary	Preparation and implementation of community education program focussing on residents, tourists and school students (as future estuarine managers)	✓	Preparation and implementation of capacity building program for staff.	→	Review effectiveness of programmes and revise approach	!						

did you know...

An online portal was created to provide details on the physical projects completed through this program

Overview of achievements



The 12-year implementation program has been able to meet and exceed multiple objectives by applying a sound, scientific framework which has guided a huge range of priority on-ground actions, including:

Stormwater quality improvements to address the major drivers of ecological decline by reducing pollutant loads from urban catchments.

Streambank rehabilitation, in urban and rural streams to reinstate natural processes, reconnect riparian corridors, stabilise creek banks, reduce erosion and improve water quality.



Saltmarsh and foreshore rehabilitation to undo the damage of the past and support the critical ecological and water quality functions of this intertidal community. Shallow sloped shorelines and saltmarshes have been proven to significantly improve nearshore water quality, which has flow on effects for the whole estuary.

Bush regeneration at key locations including foreshore bushland, natural wetlands and riparian corridors to reconnect these natural systems, improve their biodiversity and hydrology and enhance their capacity to provide fundamental ecosystem services for the catchment and estuary.



Recreational upgrades to support the socio-economic value of the estuary, providing unique places for people to gather and use, whilst limiting damaging use of other ecologically important areas.

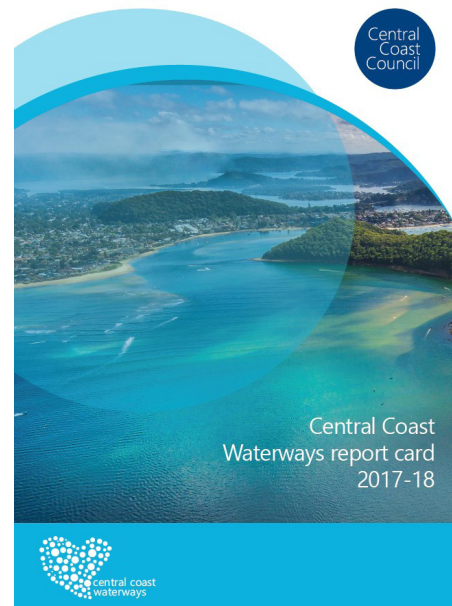


A range of complimentary initiatives have included:

Water quality monitoring to establish trends through time, provide transparent, factual information about estuary and catchment health to the community and inform future management. Through this program we have measured long-term improvements at multiple locations.

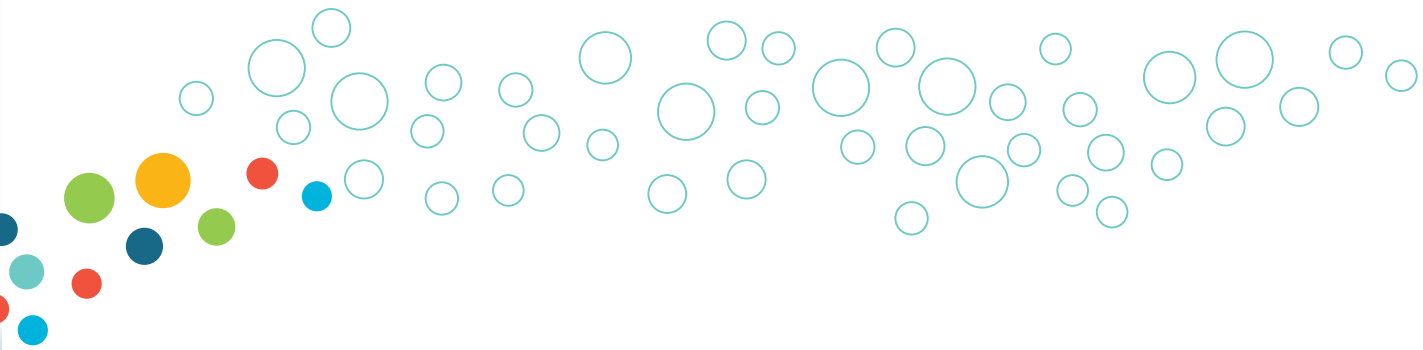


Development and publication of the Tuggerah Lakes Estuary Report Cards, and more recently, the Central Coast Waterways Report Card (centralcoast.nsw.gov.au/waterwayhealth) as a tool to communicate ecological health results through time.



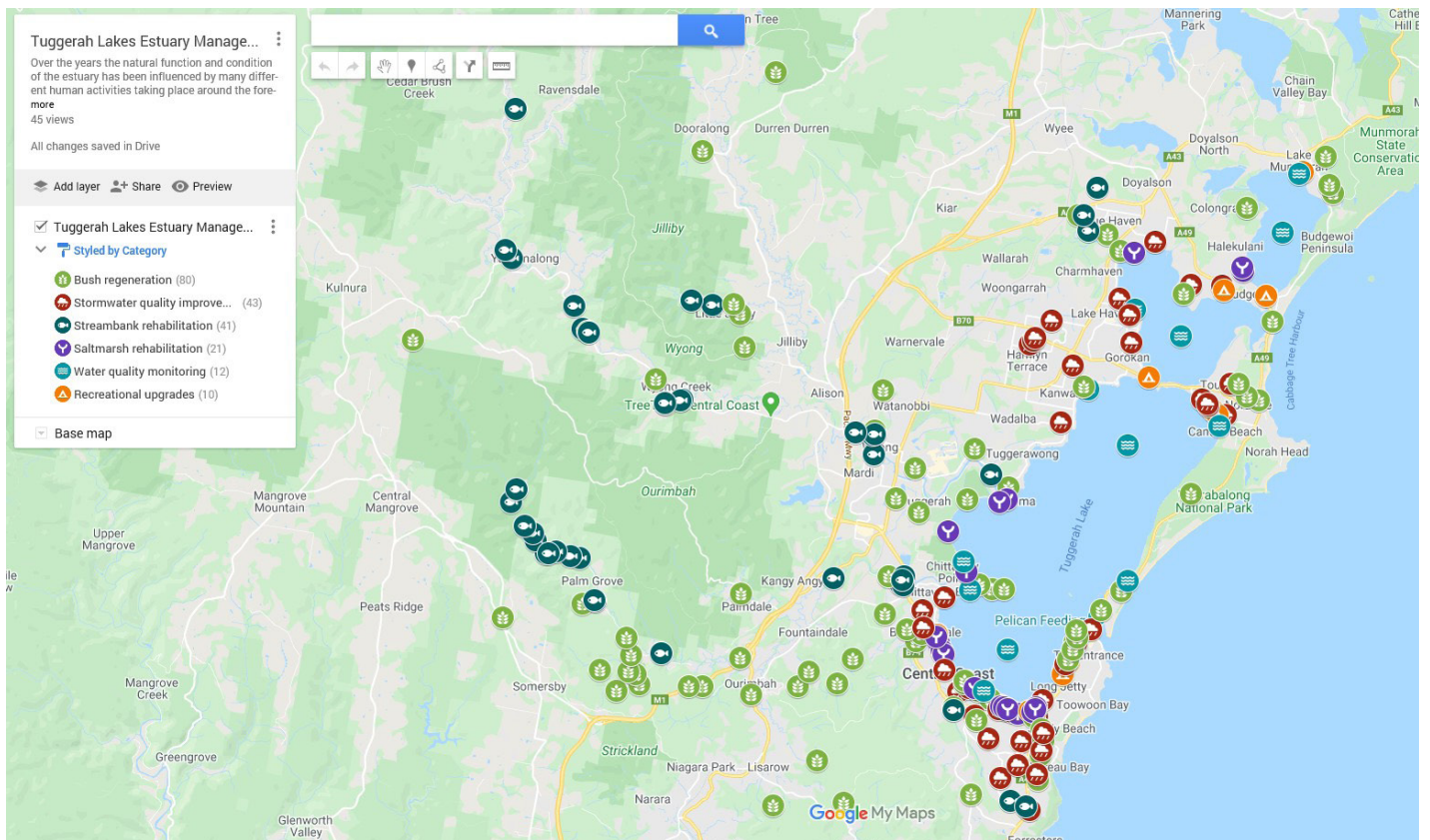
Broad community education and engagement including online and printed content, workshops, ecotours, community, school and business-based programs and a range of complimentary education programs aimed at broadscale awareness raising and behaviour change (centralcoast.nsw.gov.au/LoveOurWaterways).





Interactive map of projects

An online portal was created to provide details on the physical projects completed through this program. The projects are grouped by category, and viewers can click on an individual icon to bring up the details of the work completed at the site. The map is updated as new projects are completed. Visit centralcoast.nsw.gov.au/tuggerahlakesestuary and follow the link through to the map of projects to explore our broad range of projects.





Major achievements

Publication of the Tuggerah Lakes Estuary Management Plan

In 2006, the former Wyong Shire Council finalised and published the Tuggerah Lakes Estuary Management Plan (EMP). This was preceded by over nine years of dedicated research and investigation to understand catchment and estuary ecological processes and the drivers of ecological decline throughout the system. An Estuary Process Study (2001) and an Estuary Management Study (2005) summarised these findings and included a detailed options analysis which led into priority programs, individual management actions and cost estimates. The final plan was adopted by Council in 2006. In December 2007, the EMP was adopted and gazetted by the NSW Government as a Coastal Zone Management Plan (CZMP) in accordance with Section 55 of the Coastal Protection Act 1979, making it legally binding. The Tuggerah Lakes EMP was the first CZMP gazetted in NSW.

The Estuary Management Plan provided a holistic, scientifically validated guide to future management of the estuary. The plan established a framework to support the development of a suite of sub-plans which further guided specific on-ground works and allocation of funding. These included Streambank Rehabilitation Plans, Wetland Management Plans, Saltmarsh Rehabilitation Plans, Stormwater Management Plan and a Foreshore Recreation Strategy.

This was an important milestone in the management of Tuggerah Lakes because it assimilated the current knowledge, determined community and stakeholder priorities and importantly, ensured we invested funding in the right places to address the key issues that are affecting estuary health.

Ensuring a sound management plan was in place meant that the goals and objectives did not continually shift, and we could stay the course to achieve positive long-term outcomes. There are 184 estuaries in NSW and Tuggerah Lakes led the way as the first to have an EMP adopted and gazetted in the state. This provided a tool which has stood the test of time to sustainably manage our estuary, guide good decision making and lead us towards a positive future for Tuggerah Lakes.

The next step for management of Tuggerah Lakes will be to review the Estuary Management Plan as guided by the NSW Government's Coastal Management Framework, and develop a new Coastal Management Program for the estuary.

More information: centralcoast.nsw.gov.au/environment/coastlines/estuaries-lagoons-and-wetlands/tuggerah-lakes-estuary
environment.nsw.gov.au/topics/water/coasts/coastal-management/programs

Catchment, hydrodynamic and ecological response modelling



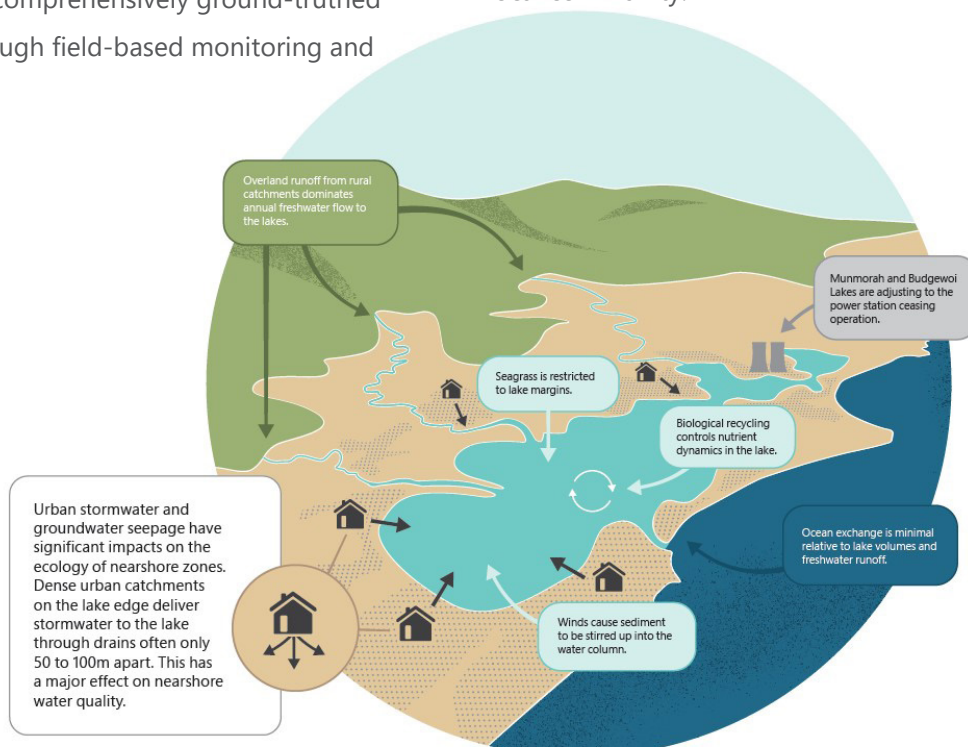
In 2010-13, Central Coast Council collaborated with expert estuary scientists and modellers from the NSW Government's Department of Planning Industry and Environment to address some knowledge gaps. This project developed a series of interconnected catchment, hydrodynamic and ecological response models to represent Tuggerah Lakes and its catchment. The models simulate the processes occurring within the system to predict nutrient and sediment loads entering the estuary and the likely effects these have on the ecological function.

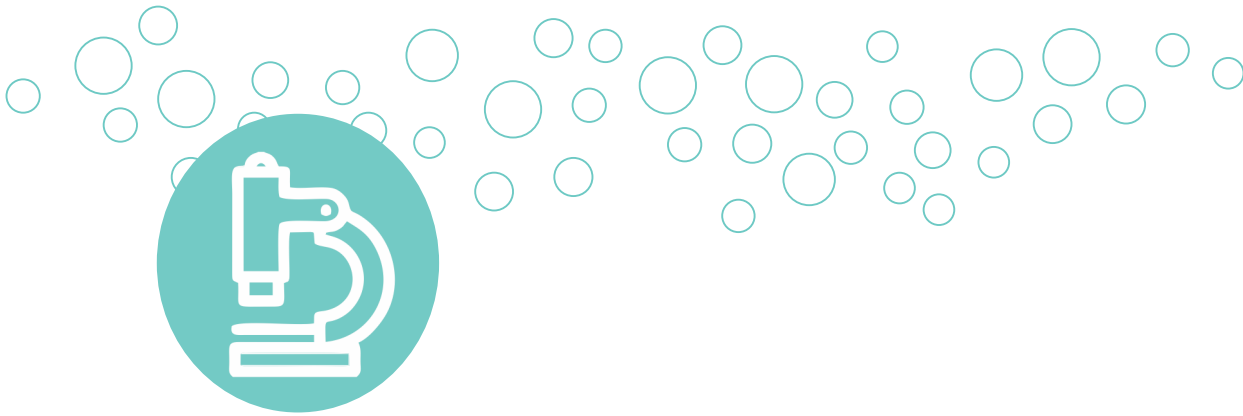
This information allows us to benchmark current condition, measure and evaluate change through time, and establish thresholds for acceptable levels of impact with robust consideration of ecological, social and economic risks and values.

The project was undertaken as a series of grant-funded contracts, which would not have been possible without access to the federally-funded grant. The models were comprehensively ground-truthed and calibrated through field-based monitoring and

a series of specific cause-effect studies. The key outputs included a series of robust numerical models which provide a detailed understanding of hydrology, catchment inputs and ecological function. The models describe how the catchment and estuary interact, mixing and flushing processes, the source and type of major pollutants, how they impact the system, how resilient the system is, and where efforts should be focussed to address ongoing ecological health issues. This enabled sound investment of funding into high priority actions and guided other business as usual programs to achieve better outcomes for the estuary.

This innovative project changed the way we managed Tuggerah Lakes and was the catalyst to comprehensive investment in on-ground works (see subsequent sections). The project also resulted in a series of digital animations and conceptual models of the estuary which show mixing and flushing processes along with the limited oceanic exchange. This has been an incredibly useful communication and education tool to engage with our local community.





Ongoing ecological health and water quality monitoring and reporting

Following on from the research that underpinned the numerical models, in 2011-12 Council established an innovative water quality monitoring program focused on ecological health of the estuary. This program was again designed in partnership with the NSW Environment, Energy and Science Team (DPIE) and built on the NSW Estuary Ecosystem Health Protocols (DPIE, 2016). The program has been an ongoing collaboration for the past 10 years, with the department's scientists collecting monthly data from 16 fixed estuary locations every month since 2011. The sites are linked to hydrologically discrete sub-catchments and trend data can be used to identify problematic areas for further investigation/ remediation work. The sampling program collects a range of water quality and biological data including nitrogen and phosphorus compound concentrations, suspended sediment, chlorophyll-a (as a measure of phytoplankton abundance) and seagrass depth range at fixed transects. The comprehensive data collected as part of the program is used to track environmental condition through time, and assess the overall effectiveness of waterway management activities.

A subset of the results is used to calculate annual

water quality grades by comparing each site to a statewide dataset. The grades range from A (excellent) to F (very poor) and are published for the community to view in an annual Waterways Report Card (formerly Tuggerah Lakes Estuary Report Card 2012-2017). By building on the NSW protocols, we are able to compare our sites to any other estuary in NSW at a glance. This innovative program began in the Tuggerah Lakes estuary and due to its success, has recently expanded into all eight estuaries on the Central Coast as well as the freshwater catchments. The Waterways Report Card is an exemplary science communication and education tool, which helps us raise awareness, foster behaviour change and prioritise management actions. The program integrates with existing waterway management programs and will be an integral reporting mechanism for future Coastal Management Programs.

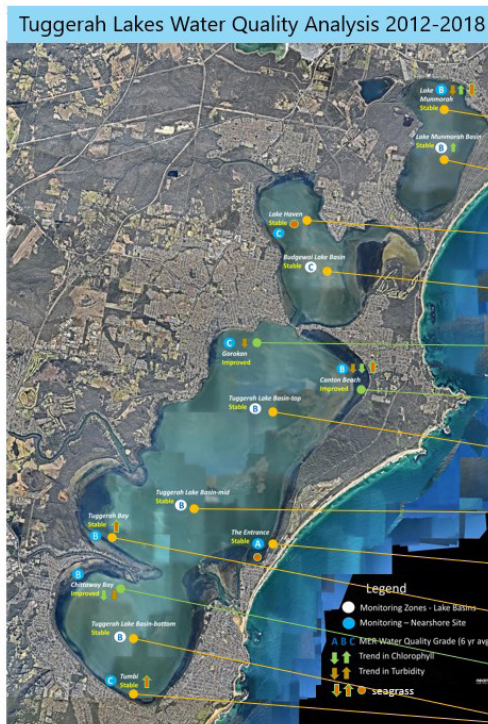
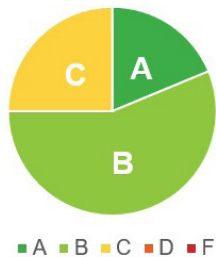
Most importantly, this program has been able to measure long-term water quality improvements at multiple locations (Gorokan, Canton Beach and Chittaway Bay) and seagrass improvements at (Canton Beach, Tuggerah Bay and Tumbi). Of the 16 sites sampled in 2017-18, 19% of sites ranked A (excellent), 56% of sites ranked B (good) and 25% of sites ranked C (fair). No sites ranked D (poor) or F (very poor).

Estuary results and trends

- Monitoring estuary since 2011
- Consistent with the NSW MER
- 16 locations (nearshore & basin)

2017-18 results

- A = 19%
- B = 56%
- C = 25%



Water quality	Seagrass	Grade
Stable	decline	B
Stable		B
Stable	Stable	C
Stable		C
improve		C
improve	improve	B
Stable		B
Stable		B
Stable	Stable	A
Stable	improve	B
improve		B
Stable	improve	B

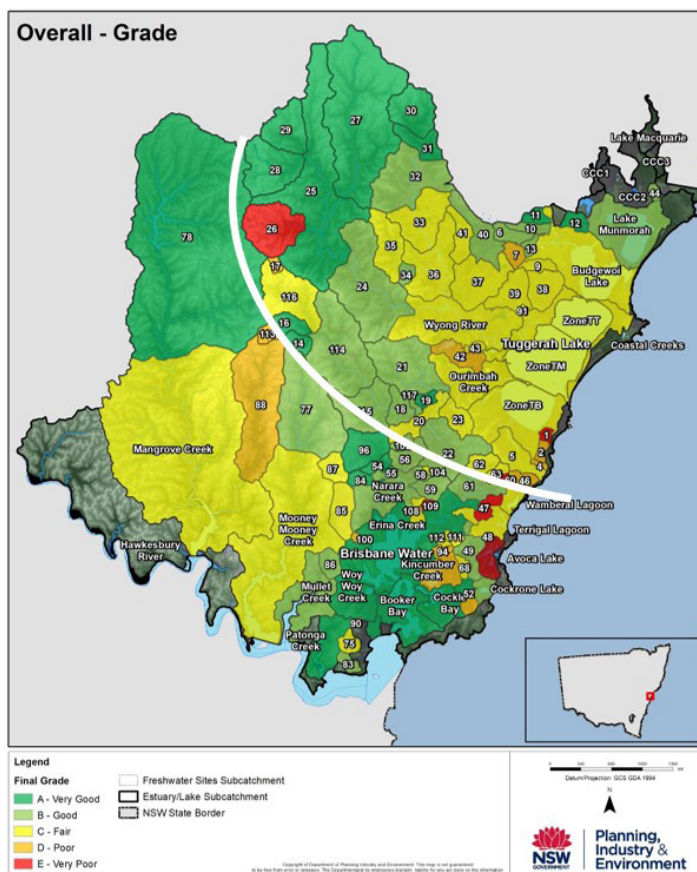
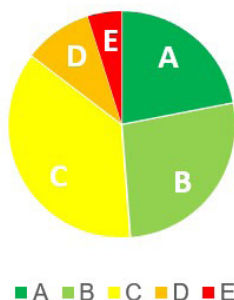
Recently, the program has expanded into the freshwater catchments and includes 41 spatially discrete sites representing a suite of sub-catchments throughout the broader estuary catchment. The program integrates water quality, riparian and reach condition and macroinvertebrates observed vs expected scores (as per AusRivAS protocols) to derive an ecological condition score for each freshwater sub-catchment. This riverine monitoring program is the first of its kind in NSW. The results included 22% of sub-catchments ranked A (very good), 27% of sub-catchments ranked B (good), 37% of sub-catchments ranked C (fair), 10% of sub-catchments ranked D (poor) and 5% of sub-catchments ranked E (very poor).

Riverine results and trends

- Monitoring since 2016
- Adapted from NSW MER
- 41 spatially discrete locations

2017-18 results

- A = 22%
- B = 27%
- C = 37%
- D = 10%
- E = 5%





Recreational Water Quality Monitoring

Since 2002, Council has worked in partnership with the NSW Department of Planning, Industry and Environment to undertake the Beachwatch water quality monitoring program for the Central Coast. The program provides regular and reliable information to enable local residents and visitors of the Central Coast to make informed decisions about where and when to swim.

Council monitors and reports on the water quality of 32 swimming sites, including 15 ocean beaches, three ocean baths/rock pools, four coastal lagoons, four estuarine netted baths and six lake netted baths. Samples are collected and tested for Enterococci, which are a group of bacteria common to the faecal matter of warm-blooded animals. These bacteria indicate stormwater and/or sewage contamination. The results of the Enterococci test are used to determine if the site is suitable for swimming.

In Tuggerah Lakes, Beachwatch sampling is undertaken at Canton Beach and Lake Munmorah. The results are translated to a weekly star rating which is published on Council's website: centralcoast.nsw.gov.au/beaches with annual summary information published in the NSW State of the Beaches Report. In 2018-19, all estuary beaches on the Central Coast, including Canton Beach and Lake Munmorah were graded poor.

Like most estuaries and poorly flushed locations, the local estuarine swim sites generally perform more poorly than ocean beaches. Swimming at estuarine beaches is not recommended during and for up to three days following rainfall or if there are any signs of stormwater such as discoloured water or floating debris.

Council and the University of Newcastle have commenced a series of investigations at designated estuary sites to profile microbial contamination, understand contamination pathways and the effect of anthropogenic stress in Lake Macquarie, Tuggerah Lakes and Brisbane Water. The microbial profiling will assess nutrients, enterococci and bacterial DNA to assist in identifying whether microbial contamination is from human or non-human sources (such as wildlife and domestic animals). The molecular data will be assessed to determine if enterococci are a good indicator of health risks in estuaries, and enable council to evaluate whether to include molecular-based monitoring techniques in environmental monitoring programs. This will assist Council to refine management actions and to improve water quality.

Council has invested approximately \$110 million in sewage capital works in the last five years to improve the performance, reliability and capacity of the sewerage reticulation system, sewage pumping stations and sewage treatment plants (STPs) throughout the Central Coast local government area.

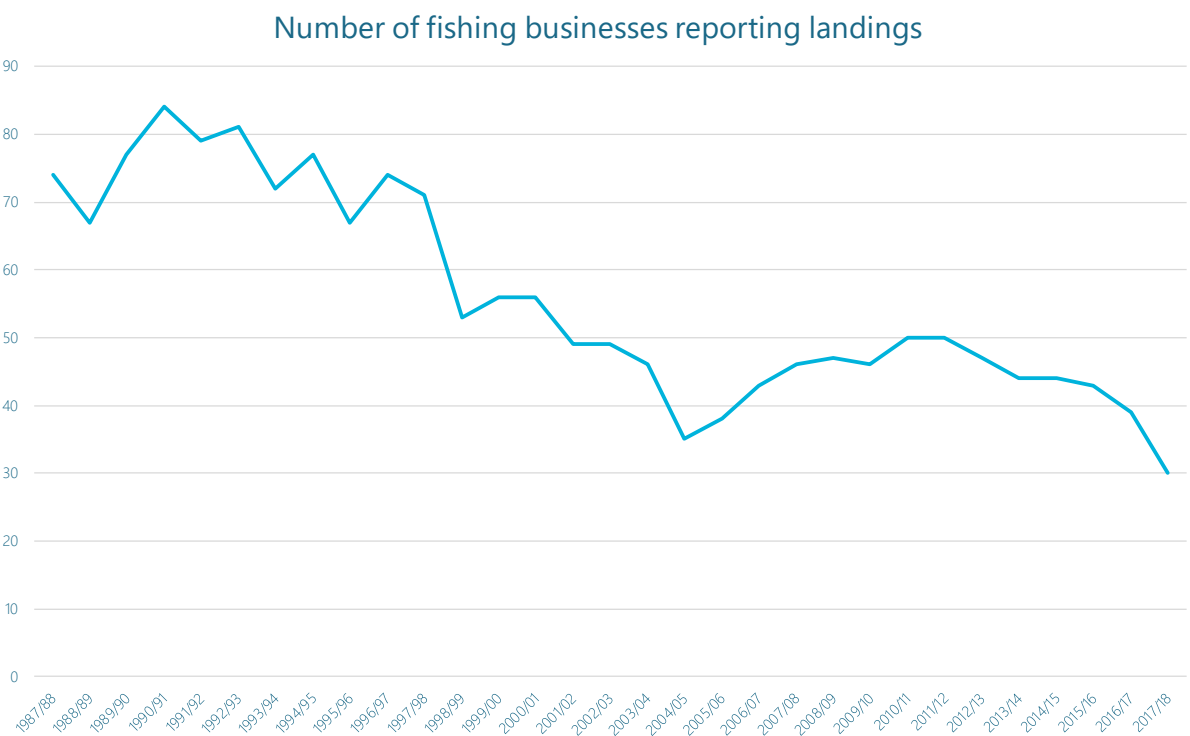
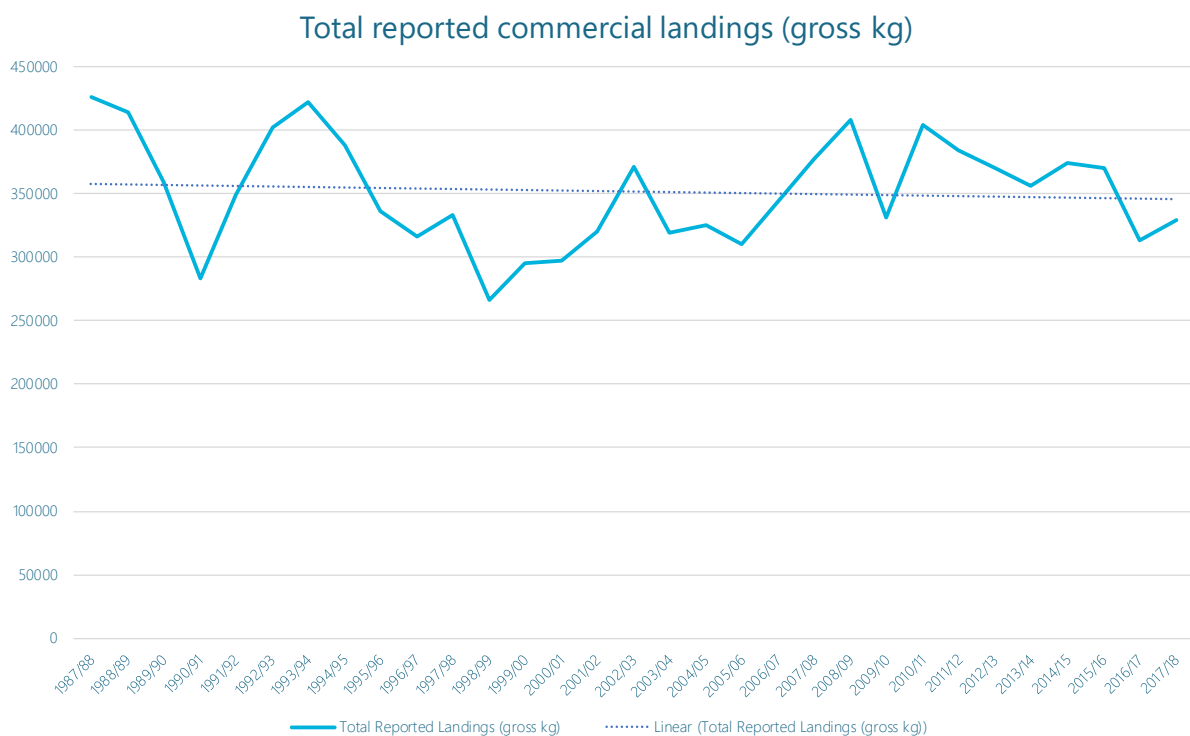


Commercial fish catch data

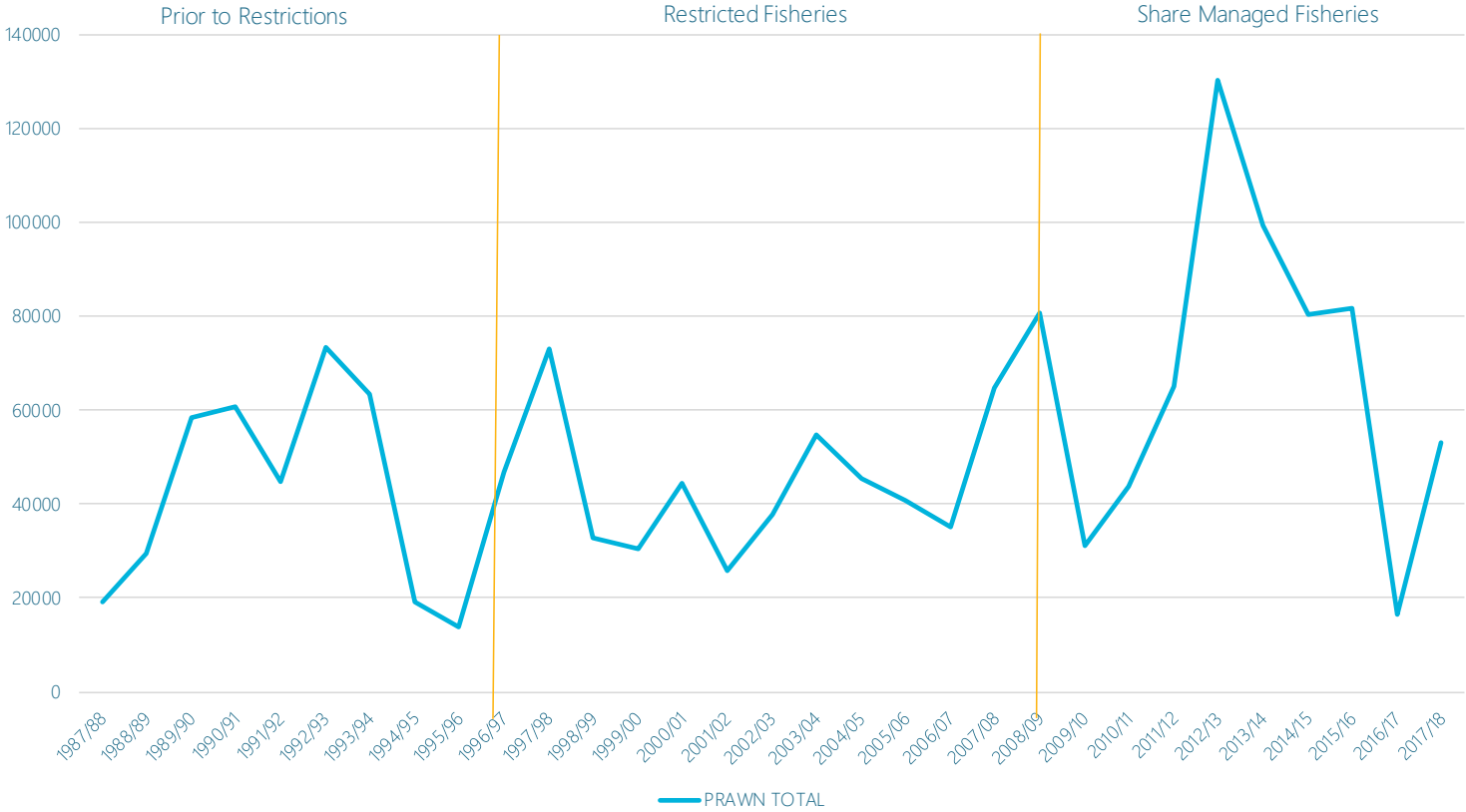
Recreational and commercial fishing are managed in Tuggerah Lakes by the NSW Department of Primary Industries. The Estuary Management Plan set out to ensure that sustainable fish and prawn populations and habitat were maintained to provide for long-term recreational and commercial fishing.

The following data was provided by DPI Fisheries in relation to gross landing volumes and number of fishing businesses. Tuggerah Lakes produces an annual total haul of 351 tonnes.

DPI Fisheries note that reported commercial landings are not a robust indicator of abundance due to environmental, economic, social and legislative factors.



Annual commercial prawn catch (gross kg)





Improved understanding of ecological processes and anthropogenic impacts

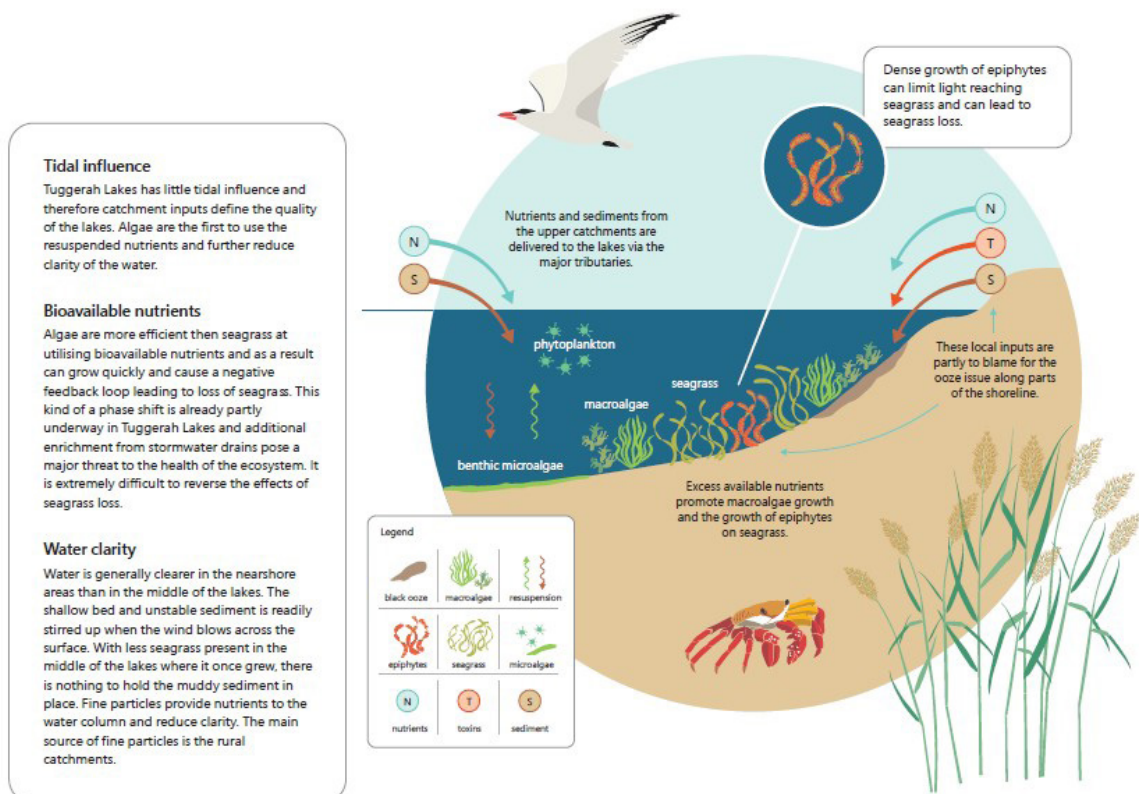
A range of studies have been completed to help expand our understanding of key processes affecting ecological health. These have included:

- nearshore processes and nearshore sediment dynamics
- seagrass distribution, abundance and patterns of migration
- seagrass wrack modelling and seasonal patterns of accumulation
- entrance dynamics and ecological impact of management practices
- site specific investigation of surface and groundwater and how these affect water and sediment chemistry.

These studies inform our current management programs and will be embedded into future management programs through the new Coastal Management Program.

A series of concept models, such as the example below, have been developed for educational purposes to help shed some light in the complex ecological processes within the estuary, and the impacts of human activity.

Nearshore Pollution

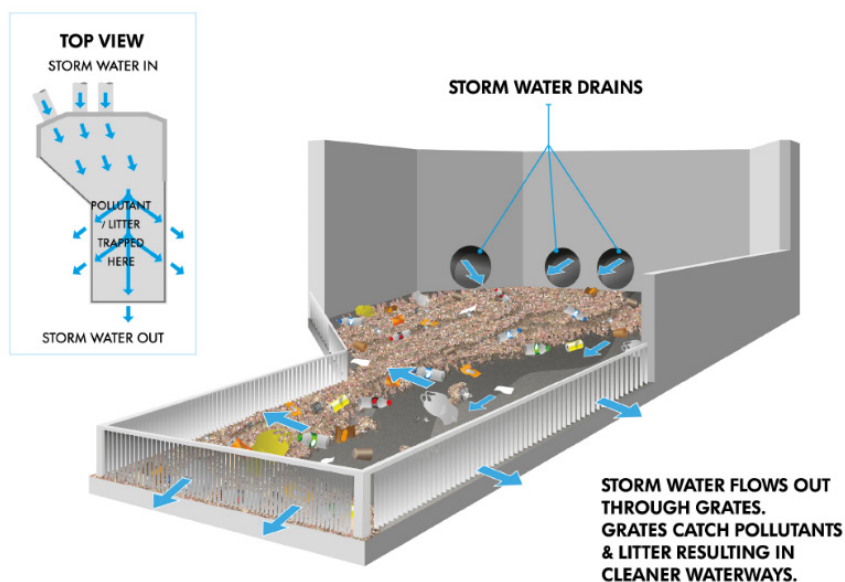


Improved stormwater management



Recognising that stormwater pollution was a key contributor to water quality decline, the EMP identified “reducing nutrient and sediment loads from existing development”, “maintaining natural nutrient and sediment loads and water flows after new development” and “maintaining stormwater traps and collecting information on material removed” as some of its highest priorities. Since 2008, Council has been working to improve stormwater management and reduce stormwater derived pollutant loads from the catchment. This has involved working with water sensitive urban design practitioners and stormwater engineers whilst building internal capacity to design and deliver better systems. The Tuggerah Lakes

catchment now has a total of 277 gross pollutant traps and 37 constructed wetlands which are designed to reduce stormwater pollution from urban areas. Each year since 2014, our stormwater engineers have coordinated and delivered approximately ten new or upgraded stormwater treatment devices in priority locations with the support of grant funding. We have established two dedicated catchment maintenance crews who are tasked with maintaining these assets and undertaking regular clean outs, with around 1000T of gross pollutants (organic material, coarse sediment, litter, debris) being removed from the devices per annum.



did you know...

The Tuggerah Lakes catchment now has a total of 277 gross pollutant traps

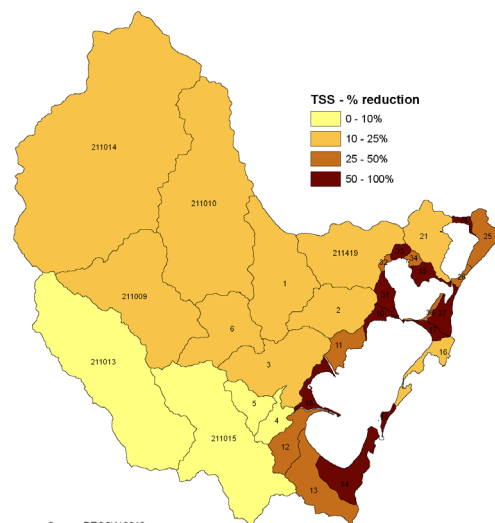


Stormwater treatment devices reduce pollutant loads and improve water quality from the catchment. As part of our ongoing evaluation and improvement program, we will soon be undertaking a detailed review of stormwater device performance to help guide ongoing management and maintenance. Stormwater management has historically focussed on quantity rather than quality – that is, moving water away from urban areas with little regard for downstream impacts. This program addresses both aspects and has included the development of new and innovative treatment devices, including specialised “saltmarsh swales” on the intertidal foreshores which use salt-tolerant species instead of traditional freshwater macrophytes to remove nutrients and filter runoff. Furthermore, the location of the first saltmarsh swale that was constructed at Long Jetty was identified as a priority through both Council’s long-term monitoring program and an ongoing local citizen science water quality program (Waterwatch). This project is located along a popular shared pathway and interpretive signage has been installed to help educate the community about the function of the device, and the importance of improving catchment water quality throughout the system. With urban stormwater a major ongoing challenge for coastal environments, particularly those like Tuggerah Lakes which are naturally poorly flushed, ongoing attention to stormwater management, through retrofit and comprehensive integration of stormwater quality and quantity control into new developments, presents the most significant risk and opportunity in protecting our estuary in the long-term. A renewed focus on stormwater and wastewater system management, will be a key action of the new Coastal Management Program.

Information derived from the catchment models, demonstrates that the degree of pollutant load reduction that can be generated by comprehensive retrofit of the stormwater system is significant. We must continue to work towards and invest in this outcome, if we want to continue to see improvements in water quality in the face of new development.

More information: centralcoastcouncil.mysocialpinpoint.com/tuggerah-lakes-estuary-management#/

100% RETROFIT WITH WSUD



% reduction from future scenario



Strategic collection of seagrass wrack

Seagrass wrack is a natural by-product which is generated as seagrass plants shed their leaves. Wrack can gather and float in rafts near the surface and be blown ashore by the prevailing wind. Floating wrack provides a habitat and nursery ground for Eastern Garfish, and for this reason, collection is not permitted in the middle of the lakes between October and March. Wrack is also an important part of the estuary's ecology, providing food and habitat for invertebrates, fish and bird species.

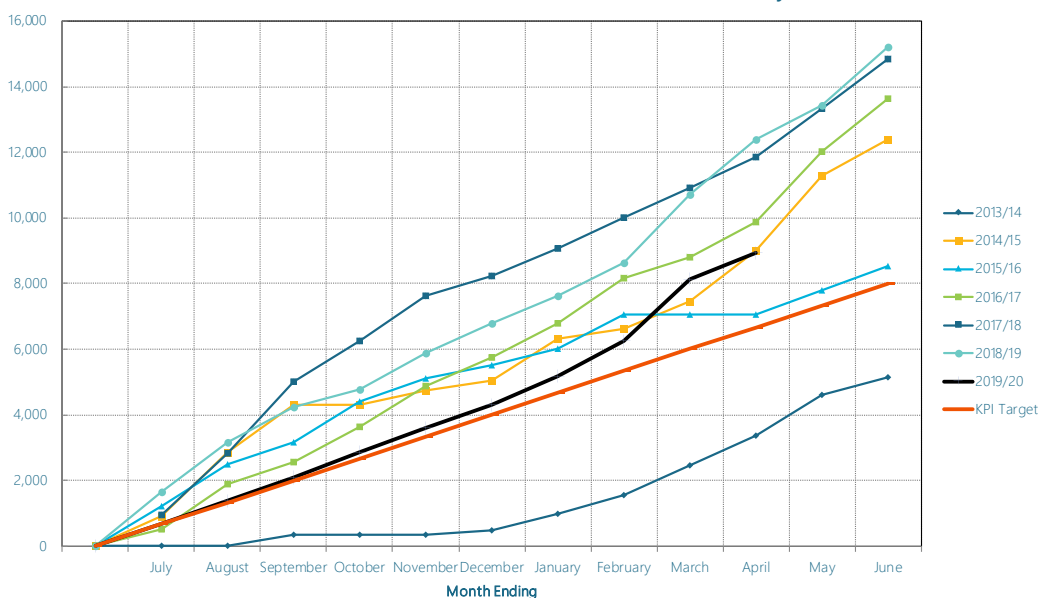
The Estuary Management Plan supports collection of seagrass wrack from locations where it accumulates too frequently to be broken down naturally. Alongside this objective, the EMP seeks to wherever possible, use saltmarsh to encourage natural odourless decomposition of wrack on the foreshores.

Council has a program of wrack and macroalgae collection which includes a range of plant and equipment including a large purpose-built wrack collector which works in tandem with supplementary equipment operated by a contractor. Equipment access is affected by wave conditions, water depth, physical barriers such as very shallow and/or rocky shorelines and the presence of ecologically endangered communities such as saltmarsh. Wrack collection is undertaken under licence from NSW Department of Primary Industries and includes temporary stockpiling of collected wrack on purpose built drying pads to allow for dewatering, followed by transport of the wrack to a green waste processing facility for recycling.

Since 2013-14, in response to community requests, there has been an increase in wrack collection effort with increasing cumulative volumes of wrack and macroalgae removed from the estuary per annum. This program has been managed in partnership with Fisheries Officers to ensure an effective and sustainable outcome.

The cumulative volumes of wrack removed per month between 2013-14 and 2019-20 are shown below:

Annual cumulative volume of wrack removed (m³) by month





The collection locations, frequency and timing are guided by a range of objectives including public amenity and water quality objectives.

The clearing of public shorelines for amenity is undertaken in concert with routine seasonal collection.

The strategic seasonal collection program aims to maximise the exposure of the nearshore zone to prevailing wind, wave and current energy by clearing away seasonal build-ups of wrack at key locations.

Research has shown that this aids the flushing of the nearshore zone (which is naturally poorly mixed), as well as minimising the progressive build-up of wrack throughout the season. Seasonal wind patterns can be summarised as:

- Summer: dominated by alternate northeast and southeast wind events
- Autumn: increase in the occurrence of westerly to north westerly winds
- Winter: dominated by westerly to north westerly winds
- Spring: characterised by wind events from the northeast, southeast and northwest

By taking advantage of these typical wind patterns, wrack collection can boost the natural shoreline cleansing mechanisms, and improve nearshore water and sediment quality in the medium to long-term. A summary of the aims of the seasonal collection program are shown below:

Season	Wind	Collection locations	Aims
Spring	NNW, NE, SE	Northern regions including: Long Jetty, Canton Beach, Toukley, Budgewoi, Gorokan.	Reduce winter accumulations, improve wave penetration in areas exposed to NE and SE directions, improve circulation.
Summer	NE, SSE	Southern regions including: Killarney Vale, Berkeley Vale, Chittaway Bay.	Reduce large accumulations due to NE wind events in spring and summer, improve wave penetration in areas exposed to NE direction, better circulation in nearshore zones prone to ooze formation during summer.
Autumn	NE, S, SSE, NW	Multiple regions including: Tuggerawong, Gorokan (south), San Remo, Budgewoi, Munmorah (north).	Clear large seasonal accumulations in areas less prone to ooze formation, better circulation in areas with low energy during winter.

The program also includes a series of wrack reserves, where wrack is allowed to accumulate without intervention to support ecological processes. These areas typically align with existing natural areas.



did you know...

During 2010-11, with the support of federal grant funding, Council completed 13km of urban stream restoration



Urban stream restoration

With urban development concentrated on the estuary floodplain, several creeks have historically been reclaimed, straightened and/or concreted to expand the available development footprint. These changes have impacted two main creeks in the estuary catchment, Saltwater Creek and Tumbi Creek. These catchments continue to deliver significant pollutant loads to the estuary, as a result of their highly modified hydrology and landscape. In 2008, Central Coast Council engaged a consultant specialising in urban stream restoration to develop "Streambank Rehabilitation Plans" for these two systems. The process included an assessment of geomorphology, review of vegetation condition, identification of erosion and water quality hotspots and preparation of concept designs for remediation with a view to reinstating natural creek alignment and conditions where possible.

The project identified numerous sites where rehabilitation would be of benefit, and would not exacerbate localised flooding. Following this, Council

engaged water sensitive urban design consultants to develop detailed designs and seek the necessary approvals to undertake the work. During 2010-11, with the support of federal grant funding, Council successfully completed 13km of urban stream restoration which included reintroducing natural planform (creek shape) where possible, installation of multiple pool and riffle sequences in the lower reaches of Tumbi Creek, stabilisation of banks and beds, revegetation of riparian corridors and installing stormwater treatment devices upstream of the creek to improve incoming water quality. Some of this work was completed by upskilling our own operational staff, and other sites were delivered by contractors.

The project has successfully controlled erosion hotspots with the sites remaining stable through numerous subsequent flood events. Future opportunities to build on this work, with integration of stormwater improvements, bush regeneration and engagement with the community through mechanisms such as Landcare should be encouraged.

[More information: centralcoastcouncil.mysocialpinpoint.com/tuggerah-lakes-estuary-management#/](http://centralcoastcouncil.mysocialpinpoint.com/tuggerah-lakes-estuary-management#/)



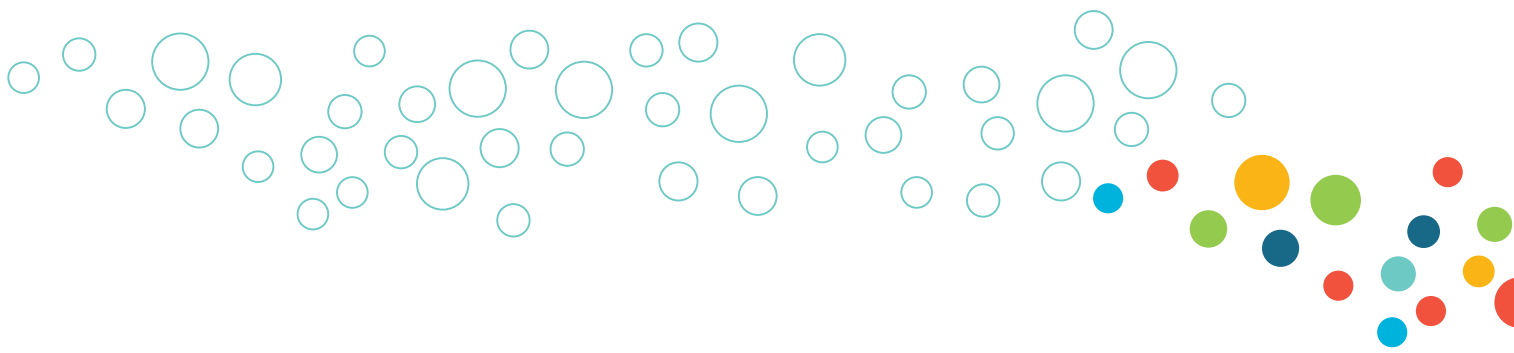
Rural streambank rehabilitation

Rural catchments are recognised as a major contributor to ongoing sediment and nutrient loads to the estuary. Local research reported that 10% of the eroded material from Wyong River was less than 0.15mm diameter and that streambank erosion had the potential to double Total Suspended Solid (TSS) loads discharging to the estuary (OEH, 2011). Fine sediment is known to smother aquatic vegetation, increase turbidity and significantly affect the distribution and abundance of seagrass in Tuggerah Lakes (OEH, 2012). Similarly, excess macronutrients can be bound to sediment which is carried to the estuary and can exacerbate algal blooms and symptoms of eutrophication. As such, “stabilising foreshore and streambank erosion” was identified as another priority program in the Tuggerah Lakes EMP. The two largest tributaries in the Tuggerah Lakes catchment are Wyong River (447km²) and Ourimbah Creek (160km²). These contribute the most significant loads as a result of their size, whilst Wallarah Creek and Spring Creek have smaller, but still significant contributions.

The nature of sediment from certain catchments is an important consideration. Soils in parts of Jilliby Jilliby

Creek and Wallarah Creek are finer clays, which are dispersible and can be very easily liberated and carried in suspension for a long time, increasing downstream turbidity and impacts on aquatic plants such as seagrass.

In 2009, Council engaged a consultant to develop Streambank Management Plans for each of these systems which included geomorphic and riparian condition assessment, identification of hotspots for remediation and through a comprehensive multi-criteria analysis, prioritisation of on-ground works. The works were to be sympathetic to the local environment with a focus on natural solutions and soft-engineering techniques wherever possible. Through this program, we worked with local landholders to establish non-binding agreements to undertake work on private land in accordance with the priorities listed in the Streambank Management Plans. This program achieved over 40km of rural streambank rehabilitation by employing a wide range of individually designed treatments including fencing and revegetation, bank toe protection, brushing, establishment of pile fields on vulnerable sections, rock revetment, and in most cases, revegetation of the surrounding area with local provenance native species. Our crews maintained the sites for 12-18 months after the initial works to improve the success rate of replanting and physical works.



Further to this work, we collaborated with Local Land Services (LLS) to establish a devolved grant arrangement, whereby incentive grants were offered to local landholders to undertake smaller scale projects on their own land. This included revegetation, fencing provision of off-stream watering points for livestock. Through this program, LLS were able to achieve 526ha of improved riparian management on private land. To complement this work, LLS also ran a series of landholder workshops which raised awareness and educated rural landholders on how to manage their land in a more environmentally sustainable way.

An investigation into the benefits of sealing unsealed roads in rural areas was undertaken in 2013 and demonstrated substantial reductions in sediment generation but very little reduction in nutrient generation (DPIE, 2013).

Individual project sites are mapped on our website: centralcoastcouncil.mysocialpinpoint.com/tuggerah-lakes-estuary-management#/





Saltmarsh reconstruction

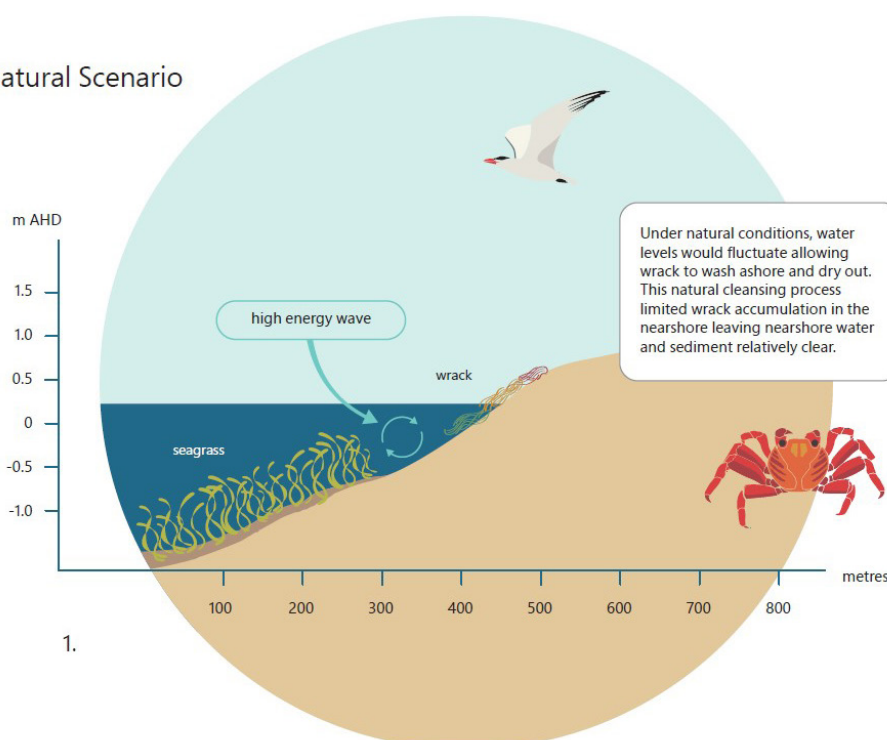


In Tuggerah Lakes, foreshore degradation and reduced nearshore water quality is a key concern. In addition to their habitat value, saltmarshes and gently graded foreshores have been shown to improve intertidal connectivity, allow seagrass wrack to wash ashore and dry aerobically and reduce the rate of organic enrichment of nearshore sediments. Collectively, these changes reduce the rate of nearshore eutrophication and anaerobic sediment metabolism reducing the very strong hydrogen sulphate (rotten egg gas) smells that are common along degraded shorelines but less so in natural areas.

In the early stages of EMP implementation, it was recognised that poor foreshore management practices of the past had created a step change in elevation along many shorelines which affected these important ecological functions. In 2009, ecological consultants were engaged to identify locations where foreshore regrading and saltmarsh reconstruction was feasible.

This was followed by detailed site survey and the development of site remediation plans for multiple locations. By again upskilling operational staff, Council began a program of “active” saltmarsh rehabilitation. This included regrading the shoreline, management of acid sulphate soil issues, revegetation with local provenance saltmarsh plants and local transplants and mulching with seagrass wrack. Through trial and error these were grown in a local nursery and “hardened off” with salt water prior to planting, with significantly better success rates. The program included up to 18 months of careful maintenance by Council bush regeneration crews to ensure success. Through this program, 2.5ha of new saltmarsh was established with more on the way. This program was initially met with public scepticism and concern, but through considered community engagement along the way, is now an accepted method of restoration which has seen multiple local Landcare groups form to maintain sites and establish their own saltmarsh regeneration sites.

Natural Scenario



1.

In terms of innovation, whilst this type of restoration work had been undertaken in tidal estuaries where saline inundation assisted with seed supply, weed suppression and other key processes, Tuggerah Lakes is non-tidal, and this type of work was unprecedented in Australia, leaving us a very steep learning curve to overcome. We continue to roll out saltmarsh restoration projects today, with several planned for the next three years.

Monitoring of sites for several years post construction indicated that in time, they rehabilitate to a level consistent with reference sites and in some case but not all, result in reduced formation of black ooze nearby, e.g. Lake Munmorah and Long Jetty (Umwelt, 2011, DPIE, 2013). In extreme case, such as the Berkeley Vale shoreline, saltmarsh regeneration alone

cannot overcome the extent of nearshore degradation and additional strategies are required (e.g. seasonal wrack collection, extensive stormwater management and source control, and ideally greater water level fluctuation). This was the catalyst to a detailed research program which is ongoing at Berkeley Vale to investigate surface and groundwater pollution pathways and impacts.

The saltmarsh reconstruction program will continue to roll out as part of the Environment Restoration Fund Program.



Passive saltmarsh and foreshore bushland rehabilitation



Protection, conservation and rehabilitation of important catchment habitats is part of the ongoing management program for Tuggerah Lakes. This activity integrates multiple priority programs identified in the EMP. Some of these areas are protected as National Park or State Conservation Area, but many are in public ownership zoned as recreational reserves. In 2010, a Passive Saltmarsh Rehabilitation and Management Plan was developed for Tuggerah Lakes. This defined “key saltmarsh areas” and “foreshore saltmarsh areas”. Key saltmarsh areas were typically aligned with protected areas and low-lying creek deltas where development had not encroached. Foreshore saltmarsh areas were typically long-narrow bands of remnant saltmarsh along recreational foreshores.

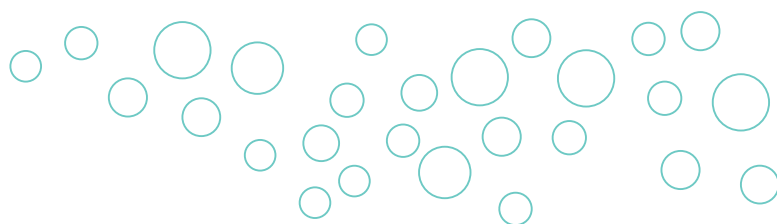
Again, with the support of grant funding, we excluded damaging activities (such as illegal vehicle access to sensitive areas) and engaged professional bush regeneration contractors to control weeds and use seagrass wrack as a mulch to assist with saltmarsh recovery in key saltmarsh areas (Roberts & Chapman, 2003). We also engaged with local indigenous and youth groups to deliver these projects at specific sites. Through this program, 29ha of saltmarsh was rehabilitated with work continuing today. In addition, we have

worked with local regeneration contractors to manage a further 32ha of important foreshore bushland.

This program was paired with localised educational programs to address ongoing impacts including mowing, trampling and vegetation clearing to retain water views. As we continue to roll out this program, we are connecting discrete patches of saltmarsh and foreshore bushland and improving local biodiversity. We have recently embarked upon a project to connect 5km of foreshore along the Entrance-Long Jetty-Killarney Vale foreshore. This particular site integrates with a raised boardwalk that we constructed at a heavily used location, to provide a recreation and education space whilst simultaneously removing pressures. This site includes a suite of interpretive signage that connects the local community with the estuary and provides a hub for education tours run by Council and other local environmental groups.

More information:

centralcoast.nsw.gov.au/council/news/media-releases/council-to-unveil-new-boardwalk-on-tuggerah-lakes
centralcoastcouncil.mysocialpinpoint.com/tuggerah-lakes-estuary-management#/



did you
know...

We engaged with
local indigenous
and youth groups to
deliver these projects
at specific sites



Wyang
Shire
Council
www.wyang.vic.gov.au

Environmental Protection Area
PROHIBITED ACCESS
Endangered Ecological Community - Coastal Saltmarsh

Authorised vehicles only. Prohibitions Apply Under Local Government Act 1988
Area protected under National Parks & Wildlife Act 1974
Area protected under Interpretation Act 1987 (Vic)

Environmental Protection Area
PROHIBITED ACCESS



Wetland rehabilitation and management

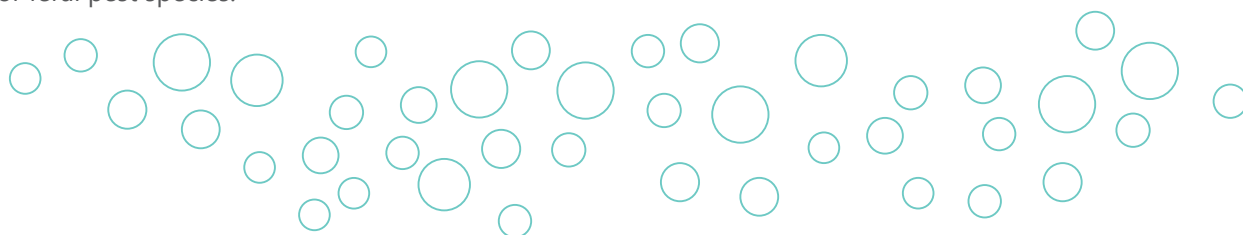


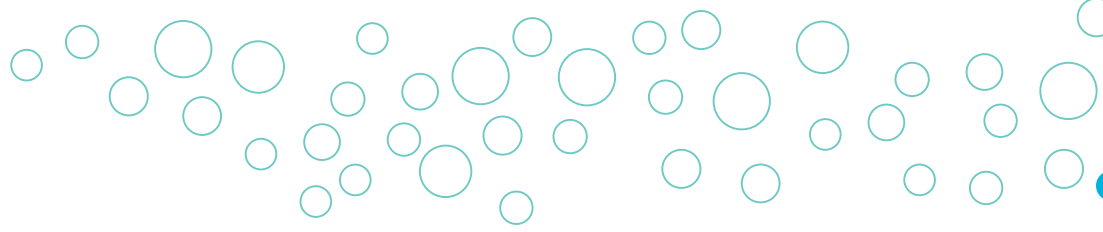
Natural wetlands are recognised as an important natural feature of catchments, providing a range of ecosystem services in addition to their intrinsic value. Monitoring and restoring key wetlands was identified as a high priority in the EMP. In 2009, the Tuggerah Lakes Wetland Management Plan was completed. This plan identified 36 coastal wetlands in the Tuggerah Lakes catchment and undertook a range of detailed and rapid assessments which evaluated hydrology, community composition, eutrophication, sediment accumulation and habitat loss to derive a “recovery potential” score. The report included a priority list of recommended conservation actions. This plan was implemented in partnership with local bush regenerators and NSW National Parks and Wildlife Service resulting in 374ha being protected and regenerated. This partnership has seen regeneration works undertaken in all state and locally owned wetland reserves with work continuing today.

Further to these achievements, this program included 1570ha of local National Park being managed for Weeds of National Significance, and 1290ha for feral pest species.

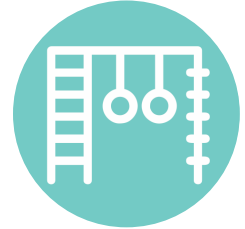
The information gained through this program will go towards remapping of Coastal Wetlands as part of the new Coastal Management Program for Tuggerah Lakes. Individual project sites are mapped on our website: centralcoastcouncil.mysocialpinpoint.com/tuggerah-lakes-estuary-management#/

This program is currently being revisited with the wetland mapping and condition scores being updated and ground-truthed to improve accuracy and align with the State Environmental Planning Policy Coastal Wetlands mapping.





Strategic recreational upgrades



Tuggerah Lakes is a recreational asset for the community. Providing better recreational facilities was a priority of the EMP. A key feature of this program includes a shared pathway “loop” which has been many years in the making and will allow people to circumnavigate the estuary foreshore safely. To date, the shared pathway extends 29km. Many areas are already covered, with recent additions including the highly awaited Budgewoi, Magenta and Tuggerawong pathway extensions. One of the oldest and most popular routes extends along the southern embayment of Tuggerah Lake from the town of the Entrance to Chittaway Point – a 10km section. This pathway connects town centres, fitness stations, BMX track, parks and playground (including the regional all-access playspace at Long Jetty) and includes environmental features and landscaped parklands. It intersects with our first raised boardwalk, which provides an opportunity for pathway users to leave the main track and get close to the water.

The EMP has also delivered four new foreshore beaches at key locations which support local watercraft businesses, alongside other Council projects such as Little Libraries where the community can pick up and drop off books to share and a host of boat ramps, jetties, fish cleaning stations and picnic or barbeque facilities. The Entrance

Town Centre provides a daily opportunity for locals and tourists to witness the historic pelican feeding and we are currently in the process of building a new kayak launching facility at Berkeley Vale.

Collection of excess seagrass wrack from foreshore areas is another key “core business” activity of Council. We have a custom-built wrack collector which skims the surface and removes excess seagrass wrack from popular foreshore locations. Whilst this program began as a purely aesthetic undertaking, research and modelling has proven its value in improving nearshore water quality by clearing wrack build up along managed foreshores, increasing localised wind-driven mixing and flushing. With advice from estuary scientists, the program has shifted from a customer demand-based program, toward a more strategic seasonal collection program aimed at improving nearshore flushing in the longer term. The program takes advantage of seasonal wind patterns to collect at key locations at different times of the year and improve water circulation. This in turn improves nearshore water quality. A series of “wrack pads” have been built around the estuary foreshore to improve the efficiency of the program.



Community education and engagement



Community education and engagement are pivotal in the journey towards a more sustainable estuary. With a population of over 140,000 living in the catchment, everyone has a role in ensuring our great natural area is protected for current and future generations to enjoy. Our message is clear - no matter whether you live here or are just visiting, you can take a range simple actions to ensure our beautiful waterways stay clean and healthy.

With this end goal in mind, a Tuggerah Lakes Estuary Education and Communication Strategy was developed in 2010. This has guided this critical part of our program, with community awareness and behaviour change initiatives constantly under development. These have included wide range of education materials and tools with key outputs including printed and online content (centralcoast.nsw.gov.au/LoveOurWaterways), a community handbook and four dedicated iBooks available free on Apple and Android (Wetlands, Tuggerah Lakes habitats and impacts, Tuggerah Lakes explore and Tuggerah Lakes projects and case studies - books.apple.com/au/book/tuggerah-lakes-estuary/id1404742877), a Waterways Explore App (centralcoast.nsw.gov.au/council/news/media-releases/explore-tuggerah-lakes-estuary-our-new-app-0), school and community based education programs and more recently a series of digital animations and short films

which are available on YouTube and screened at local cinemas. In 2017-18, it is estimated that these short films reached 140,000 viewers. (<https://www.youtube.com/playlist?list=PLXTYWd5hUgYwPeArrtcbBtyOsFd9cKhiZ>)

We have a dedicated Estuary Education Officer who works with local environment centres, organisations, schools and businesses including running a minimum of ten community ecotours each year in the Tuggerah Lakes catchment. These include fun activities like catchment crawls as well as bike and kayak adventures. Council's Estuary Education team recently ran a series of Digital Storytelling workshops where community members could learn filmmaking techniques and produce their own short film themed "speak for our waterways". This was a unique opportunity to engage with our community and was well received. We facilitate a Waterways Weekly social media program to share information and celebrate our waterways each year through the annual Lakes Festival (facebook.com/thelakesfestival/).

In 2017, the Estuary Education Program was highly commended in the NSW Local Government Awards (centralcoast.nsw.gov.au/council/news/media-releases/innovative-council-projects-recognised-local-government-awards)

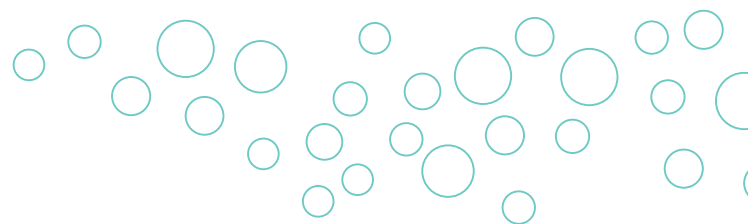


Across our region, we have 80 Landcare groups with more than 600 volunteers who are supported by Council staff to develop site management plans and work to improve our local environment whilst connecting with one another. These volunteers lead by example, and support positive outcomes for our local environment through their commitment and hands on work,

This program is well resourced, with an additional \$30,000 per year since 2014 provided by Estuary Management funding to support the work of these groups to deliver good environmental outcomes in the estuary catchment.

We work with the incredibly successful local group Clean4Shore to fund litter collection from the estuary. This group takes school and community groups out on the water for a day of cleaning up, and learning about the value of waterways. It is a very well recognised program having been acknowledged with the Local Hero Award at the 2019 NSW Coastal Conference and recently secured a \$300,000 federal grant to continue the good work on the Central Coast.

Finally, our Waterways Report Card provides a simple tool to provide water quality information to our community in a simple to understand and accessible form. The project is widely accepted, having received positive coverage in local media for the most recent publication and forming the basis for a range of internal and external reporting mechanisms including the Community Strategic Plan, State of the Environment Report and Coastal Management Program (2016 media release - centralcoast.nsw.gov.au/council/news/media-releases/7-million-towards-making-tuggerah-lakes-cleaner). We are in the process of building a new Waterways Website which will further support dissemination of information to our community in a fun and interactive way.



did you know...

Our Estuary Education Team run a minimum of ten community ecotours each year





Research, innovation and continuous improvement

As part of our continuous improvement program, we are always looking for opportunities to fill knowledge gaps, refine our management programs and find new and innovative ways to achieve positive outcomes for our estuary.

For example, historic poor water quality in the Berkeley Vale area, sparked a comprehensive monitoring program with a focus on surface and groundwater pollution and how these variables were affecting nearshore water quality. The program is a partnership between Council and coastal scientists and incorporates a citizen science component to engage local residents in the process and foster a sense of local ownership. This program will help Council to work towards resolving long-standing eutrophication (very poor water quality) issues at Berkeley Vale, and at other similar sites throughout the estuary.

As a means of supporting future estuary managers, we engage with the local university (University of Newcastle) to support a workplace integrated learning program. The program allows third year students to work with Council scientists for 80-160 hours as part of their approved coursework to get experience in their field of study. Further to this, we have established research partnerships with the university to investigate



recreational swimming safety and microbial contamination, seahorse distribution and abundance and opportunities to improve habitat through these networks.

Recently, we secured a \$4.7 million Australian Government Environment Restoration Fund grant which will include several research projects including a review of the performance of stormwater treatment devices, condition mapping of wetlands and saltmarshes to update the information from 2009, mapping of organic sediments to track improvements in nearshore water quality in response to management actions and include an audit of foreshore drainage lines with a view to retrofitting where possible for better environmental outcomes.

Finally, we have commenced the development of a new Coastal Management Program for Tuggerah Lakes – a five step program guided by the NSW Coastal Management Act (2018) and Coastal Management Framework. This plan will integrate all that we have learned over the past 12 years, and provide the new direction for management of Tuggerah Lakes.

Wondering how you can help?

Demonstrated improvements in estuary condition and water quality are a good sign that we are on the right track. Unfortunately, it is clear that there is no “quick fix” to the water quality conditions in Tuggerah Lakes, and the journey towards a better estuary requires a concerted effort from all of us: Council, the NSW Government, our stakeholder and program partners and most importantly, our community. No matter whether you live here, or are just visiting, you can play a part in positively shaping our ecosystems.

Even small changes can make a difference – we are all in this together. Here are a few tips to help contribute to protecting the Central Coast’s Waterways...

Steady on with the fertiliser. As with everything, moderation is key to success. Use only the amount of fertiliser that your grass needs. Twice as much won’t make it twice as green!

Stop the rubbish tsunami. According to scientists, Australia produces 13,888 tonnes of plastic litter each year, a quarter of which finds its way into our waterways. Let’s keep our lakes alive by collecting and safely disposing all of the rubbish.

Keep on the straight and narrow. Let everyone safely enjoy the pathways around our lakes, which are perfect for cycling and walking. Use the designated paths and stay on the straight and narrow.

Off to greener pastures. Keep your pets and stock away from the streambank vegetation. The cows’ manure can run off with rainfall into local waterways, contributing to algal blooms that turn the water green and toxic, harming our drinking supplies.

Ahoy there! Our coastal lakes are perfect for water leisure, but make sure to keep your boating activities sensible. Always use the boat ramp to launch your vessel into the water, as it is easier and protects the shoreline.

Scoop the poop. Our favourite furry friends’ poo is the most overlooked environmental hazard. It contains harmful organisms which can wash into local waters and pollute them. Be a responsible owner and always pick after your dog.

Dried up and blown away? Dry leaves, which people conveniently remove with leaf blowers, can end up in the stormwater drain and then in the lakes. They are high in organic nutrients and contaminate our waters. Out of sight doesn’t mean out of mind.

Green is good. Green really is the nicest colour! Always make sure to use your green bins to dispose of grass clippings from your lawns and gardens. Never flush them down the drain.



did you
know...

Healthy catchments
mean healthy
waterways. We can all
do our bit to help...

Keep chemicals away. Out-of-date or disused household chemicals from kitchens, bathrooms or garages can do our waters a lot of harm. Take advantage of the Council's Household Chemical Clean-Out days to get rid of unwanted chemicals – it's safe and free.

Take 3. When you visit our local waterways and beaches, take 3 or more pieces of rubbish away with you. Our sealife will thank you.

Become a water hero. Conserve water by using less of it – in your garden & at home. Three minute showers and full-load laundry save a lot of water.

Reusing is thrifty and smart! Install a rainwater tank or rain garden to capture water whenever you can. Later, you may reuse it for watering plants, bathing your pets or washing a car.

Go local. Plant locally native plants who are well-adapted to local conditions, consume less water and are good for the habitat and biodiversity.

Keep wipes out of the pipes! Save our Sewers by flushing responsibly (only 3Ps allowed: pee, poop and toilet paper). Sewer overflows have a very bad impact on waterway health.

Be a good boatie. Adhere to speed limits, and manage fuel, oil and liquid waste appropriately. Go slow to protect seagrass beds and use seagrass-friendly moorings.

Fish responsibly. Always take your fishing gear back with you, stick to catch and size limits, handle the fish with care and only take what you need.

Clean green. As much as possible, switch to eco-friendly cleaning solutions (based on vinegars, essential oils and bicarb), which are gentle on the environment and on your budget.



Passionate about our waterways?

Get involved!

Throughout the Tuggerah Lakes estuary catchment area, there are plenty of amazing organisations, activities and events gathering together people keen to protect our waterways. You can get involved in a group near you and start working on sustainable ways to improve the health of our lakes – for the benefit of the whole community.

Check out our website for more information: centralcoast.nsw.gov.au/LoveOurWaterways





Tuggerah Lakes Estuary Management Plan Summary of Implementation 2008-2020

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