MIDCOAST council

WATERWAY AND CATCHMENT REPORT

Reporting on data
November 2019 to March 2020

2020

This project is funded by MidCoast Council's Environmental Rate and supported by the New South Wales Government through its Coast and Estuary Program, and Department of Planning, Industry and Environment.

NSW GOVERNMENT

MidCoast Council 2020 Waterway and Catchment Report
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Introduction

The MidCoast Council region depends heavily on the health of our catchments and waterways. The waterways form the basis of the region's economy (supporting tourism and primary production), contribute to our way of life and provide habitat for extraordinary biological systems. The region's catchments are under continued pressure from pollution and impacts associated with catchment land use, development and tourism. If unmanaged this has the potential to result in a decline in the health of our waterways.

All our local waterways are critically susceptible to environmental pressures; a Hepatitis A event in oysters in Wallis Lake in 1997, reoccurring blue-green algae in Myall Lakes, acid sulfate soil runoff in the Manning and Wallamba Rivers and episodic fish kills throughout our catchments are all examples of what can go wrong.

This report has been presented to accompany the 2020 Waterway and Catchment Report Card. It provides the technical information on how the Report Card scores were calculated as well as providing more detail on the results, and the impacts of the extreme climatic conditions including drought, bushfires and flooding during the sampling period.

Water quality - ecological health

Good management of our lakes, rivers and estuaries requires understanding of how they work, predictions about future conditions and informed choice about actions to get the outcome the community wants. MidCoast Council and the Department of Planning, Industry and Environment - Environment Science (DPIE-ES) have worked together to put these principles into action. International best practice suggests that research, modelling, management and monitoring should all use the measures of condition and success. DPIE-ES research allowed the development of a solid understanding of the impacts of catchment activities on estuary health. It also concluded this abundance of algae and water clarity would be good indicators for the future. Council used the scientific understanding to form the Water Quality Improvement Plan in 2009, which was designed to achieve a number of specific outcomes, expressed in terms of water clarity and algal abundance. Progress towards these outcomes has been measured using the same measures in the annual report cards.

The MidCoast Council community value the health of our waterways and the Waterway and Catchment Report Card is a tool that Council use to monitor how we are tracking. DPIE-ES have undertaken an ecological health monitoring program in Wallis Lake and Khappinghat as part of the state-wide Monitoring, Evaluation and Reporting Strategy (MER). As part of the strategy, these estuaries were selected as two of seven across the state to be sampled each year to track inter-annual variability in two ecological health indicators; chlorophyll a (the amount of algae) and turbidity (the amount of sediment).

Since 2011 the monitoring program has been expanded to cover other key sites across the MidCoast Council area. DPIE-ES have provided an independent scientific evaluation on the ecological health of Wallis Lake, Smiths Lake, Karuah River Estuary, Myall Lakes, Khappinghat Estuary and the Manning River Estuary.

Ecological health does not refer to environmental health issues such as drinking water quality, safety for swimming, heavy metal contamination, disease, bacteria, viruses or our ability to harvest shellfish or fish.

Figure 1: Coastal Floodplain at Minimbah

Healthy waterways support our local towns and communities, they keep them thriving. They put food on our tables, support our outdoor lifestyle, local economy and provide homes for wildlife, trees and plants of every sort. With healthy waterways our communities have a healthy vibrant future

Introduction

Ecological health results presented in easy to understand Report Card

The results of ecological health monitoring have been presented in a Waterway and Catchment Report Card (see Appendix 1) which grades the health of the waterways in a similar way to school Report Cards, with a grade ranging from A (excellent) to F (very poor).

The information provided below includes the background details for the Report Card including the objectives, methods and a detailed description of the results.

Report Card objectives

The objectives for the Report Card are:

1. To report on ecological health.
2. To track progress on management actions.

These objectives are specifically achieved by providing information to:

- Assist in the current and ongoing protection of “high conservation” areas that provide substantial water quality and biodiversity benefits to the rivers and estuaries.
- Guide and report on the remediation of areas that have high pollutant loads and highlight areas that may require further action.
- Help protect all waterways against further declines in water quality.

Environmental values

The environmental values that management actions in the catchment are aiming to achieve are:

1. Minimal algal growth.
2. Minimal sediment inputs and maximum clarity.
3. Intact aquatic habitats like seagrass, macrophyte and riparian vegetation.

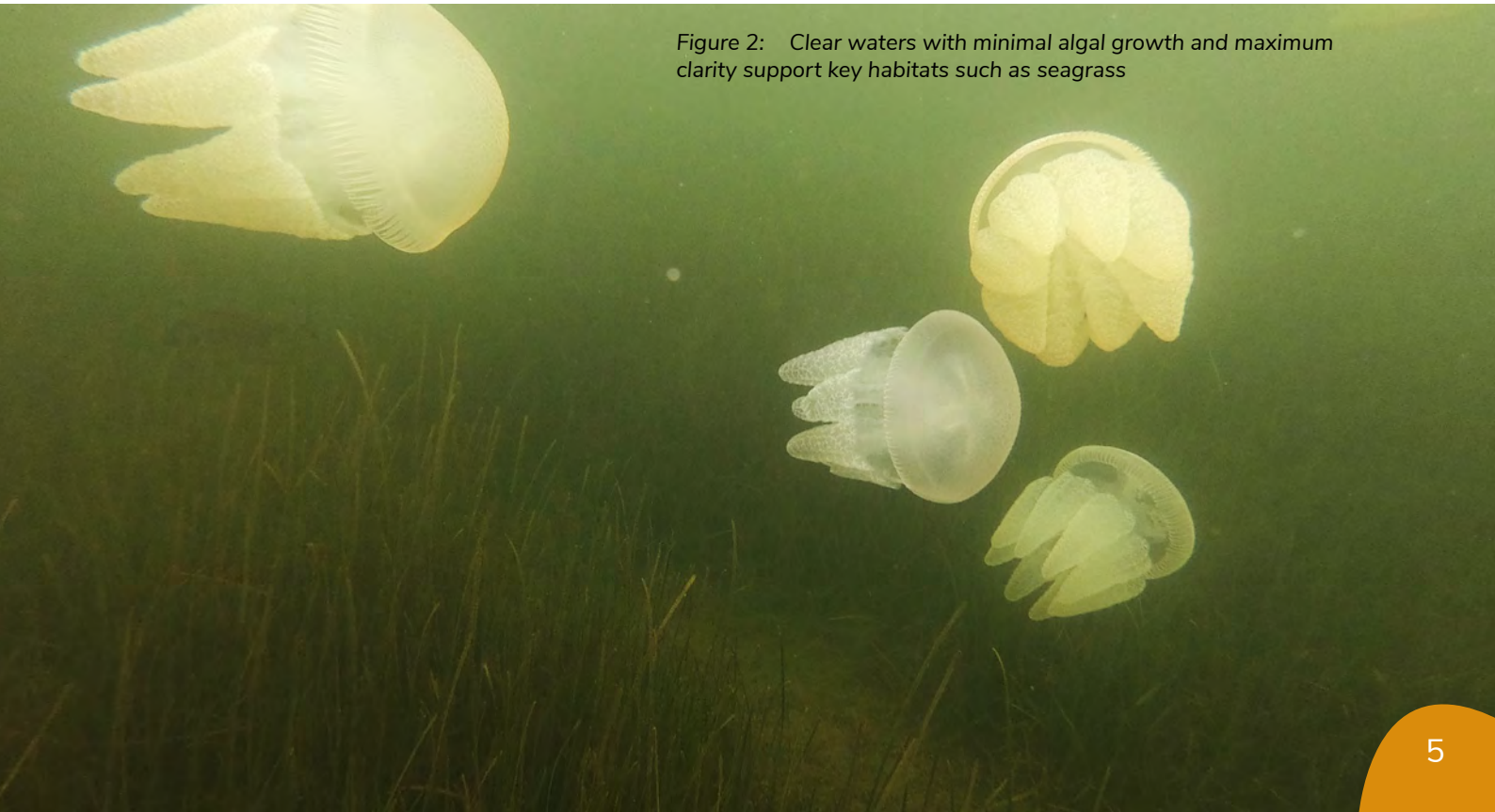


Figure 2: Clear waters with minimal algal growth and maximum clarity support key habitats such as seagrass

Methods

Development of Report Card grades

The monitoring program has assessed the Ecological health of Wallis, Smiths and Myall Lakes, Manning and Karuah River Estuaries and the Khappinghat Estuary. There are a number of steps taken to determine the score for each zone and subsequent Report Card grade:

1. Selecting the indicators.
2. Identifying the trigger levels.
3. Collecting the data.
4. Calculating the zone score.
5. Allocating the Report Card grade.

Selecting the indicators

In order to meet the objectives of the Report Card, indicators must report on ecological health but also be able to report on the outcomes of management actions. The management actions are linked to the environmental values set for the region (listed above), and the indicators selected have been shown to be responsive to catchment management actions.

There are many different estuary reporting programs world-wide, with indicators specifically chosen to suit local conditions or issues.

Chlorophyll and turbidity are commonly used as they are proven to be very informative and responsive indicators, see Table 1.

Why a Report Card?

Report Cards are an effective way to check on the health of our waterways. They help us compare current conditions with the condition we would like them to be. Scientists use indicators to 'health check' our waterways. Just as your body temperature is used as an indicator that something may be wrong with your own health, indicators are used to show if something is out of balance or unhealthy in the system. The indicators are selected to assess the overall health or ecological condition. The results of the Report Card are used to guide future management actions and ensure long-term ecological health of our catchments.

Activity

What we do on the land impacts on the quality of water that runs off. If the quality of the runoff is poor it puts stress on the environment.

Stressors

Stressors are changes to the environment that result from the activity, these can lead to ecological harm. Stressors can include nutrients, acid leachate and sediment in the water (turbidity).

Ecological impacts

Ecological condition grades are a combination of turbidity (water clarity) and algae (measured as chlorophyll) scores.

Methods

Algal growth can be measured by assessing chlorophyll a levels in the water and sediment inputs are assessed by measuring the turbidity (see feature box). These indicators are easy to measure and directly relate to the environmental values. The extent of seagrass beds is also an excellent ecological indicator of a healthy functioning ecosystem (see feature box).

Seagrass is the basis of the food web in healthy estuaries. Seagrass provides essential habitat and food for marine life. Where seagrass is abundant so is aquatic life and as such, it is an excellent indicator of ecological health. Seagrass growth is affected by a number of factors including nutrient levels, algal growth, physical removal and water clarity. Water clarity (turbidity) is directly linked to seagrass growth and can be used as a surrogate for ecological health. When water clarity is high, seagrass is abundant as there is plenty of light for it to thrive.

While macrophytes and riparian vegetation are not currently measured, low chlorophyll and turbidity levels are necessary to ensure healthy habitats. Expansion of the program in the future is likely to include assessment of these habitats.

Table 1: Indicators used in various estuarine monitoring programs

Monitoring Program	Chlorophyll a	Turbidity	Dissolved Oxygen	Nutrients	Riparian vegetation	Seagrass	Other critical habitats (e.g coral)
South East Queensland Ecosystem Health Monitoring Program	✓	✓	✓	✓	✓	✓	✓
Chesapeake Bay EcoCheck program	✓	✓	✓			✓	✓
Northern Rivers CMA Ecohealth	✓	✓	✓		✓		
New South Wales Monitoring, Evaluation and Reporting Program *	✓	✓	F		F	✓	
MidCoast Council Report Card (this program)	✓	✓	F		F	F	

F - future
* New South Wales Monitoring, Evaluation and Reporting Program also samples fish in a limited number of sites

The New South Wales Monitoring, Evaluation and Reporting Program, concluded that measurement of chlorophyll a and turbidity provides an effective measure of the short-term response of estuary health to management actions. Seagrass and other macrophytes provide a long-term integration of estuary health.

Dissolved oxygen has been widely used as an indicator of the amount of oxygen in the water column with many critical aquatic processes dependent on a healthy level and minimal variability. MidCoast Council and the New South Wales Monitoring, Evaluation and Reporting Program both acknowledge that dissolved oxygen is an important variable to measure but have not done so to date, due to logistical reasons. There are plans to include this indicator in future monitoring activities.

Methods

Identifying the trigger levels

A healthy ecosystem refers to a system which has normal ranges of diversity and function. These 'normal' ranges have been established from extensive monitoring of estuaries across New South Wales. To establish these ranges, sites that represent a variety of ecological conditions from pristine (reference) sites to highly degraded have been sampled over a number of years. The data for pristine (reference) sites have been used to establish the trigger values which are fundamental for ranking the ecological health of a site.

A trigger value is the value which indicates that a variable is outside the 'normal range' and could trigger further investigation. In our context, we have used the trigger value to indicate conditions which are not desirable for continued waterway health.

A trigger value is specific to different types of estuary. In this study, Wallis Lake, Pipers Creek, Charlotte Bay, Bombah Broadwater and Myall Lake Estuary were all classified as 'Lakes', Mid Wallamba Estuary, Karuah Estuary, Wallamba Cove, Dawson River, Farquhar Inlet, The Branch Estuary, Lower Myall Estuary and Upper, Mid and Lower Manning Estuary River were classified as a 'River estuary' and Khappinghat was classified as a 'Creek estuary' (Roper et al. 2011).

Table 2: Trigger Values for NSW Estuaries (from Roper et al. 2011)

	Turbidity (NTU)	Chlorophyll (µg/L)	pH
Lake	6.7	2.5	
River estuary (mid)	1.9	2.2	

Figure 3: Algal growth in the Pipers Creek Catchment.

Algae

Algae or microscopic plants are always present in waterways but if conditions change and are suited to algal growth, blooms can occur. Blooms may occur if there is a lot of nutrients in the water which can come from urban stormwater, fertiliser runoff from farms and gardens and seepage from septic tanks. Algal blooms can reduce the amount of light reaching seagrass beds limiting their growth. When blooms of algae die and start to decay, the resulting bacterial activity can reduce oxygen concentrations in the water column, possibly leading to fish kills.

Chlorophyll a

Chlorophyll a is a pigment found in plants and is an essential molecule for the process of photosynthesis (the conversion of light energy to chemical energy resulting in the consumption of carbon dioxide and the production of oxygen and sugars). In estuarine and marine waterways, chlorophyll a is present in phytoplankton such as cyanobacteria, diatoms and dinoflagellates. Because chlorophyll a occurs in all phytoplankton it is commonly used as a measure of phytoplankton biomass (EHMP 2008).

Methods

Collecting the data

The MidCoast Council region has been divided up into reporting zones. A zone is actually a broad area within the estuary rather than a discrete point (see maps in Results Section) and may be represented by a single sample or by multiple samples. Six zones were sampled in Wallis Lake Estuary (Mid Wallamba Estuary, Coolongolook Estuary, Wallamba Cove, Pipers Creek, Wallis Lake and Charlotte Bay). There are five zones in the Manning River Estuary (Middle, Upper, Lower and Dawson River Estuaries and Farquhar Inlet), three zones in the Myall Lakes (Myall Lake, Bombah Broadwater and Lower Myall Estuary), two zones in Karuah (Karuah Estuary and The Branch Estuary) and one zone in the Khappinghat Estuary and one zone in Smiths Lake.

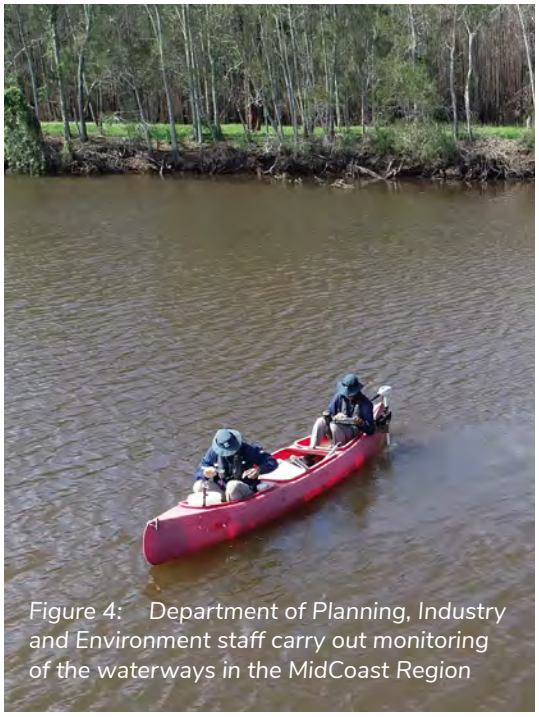


Figure 4: Department of Planning, Industry and Environment staff carry out monitoring of the waterways in the MidCoast Region

Samples were collected on six occasions between summer and autumn from November 2019 to March 2020. This represents the part of the year when the highest chlorophyll concentrations are expected.

At each of the selected sites, samples were taken in accordance with the New South Wales Monitoring, Evaluation and Reporting protocols which are described in full in Roper et al. (2011). At each of the 'Lake' sites, turbidity was measured using a calibrated probe suspended at a depth of 0.5 metres for five minutes as the boat drifted or was motored (generally covering a distance of at least 300 metres), logging data every 15 seconds. The final value for the 'site' sampled was the average of all the logged data. During the drift, at least five samples of the top 1 metre of the water column were collected and combined in a bucket. At the end of the drift, a single 200 millilitre sample for chlorophyll a analysis was taken from the composite in the bucket.

For the river estuary sites, an 'underway sampler' is used to pass water past the probe whilst the boat travels at a regulated speed along a transect upstream from the middle to the upper part of the estuary. The turbidity is calculated as the mean of logged values for the transect. At two sites along the transect, composite water samples are collected for chlorophyll a analysis.

Chlorophyll a samples are immediately filtered (within one hour) under mild vacuum and the filter frozen until analysis. Chlorophyll a is extracted into acetone and chlorophyll a concentration is determined by spectrometry.

Figure 5: Department of Planning, Industry and Environment staff carry out monitoring of the waterways in the MidCoast Region

Methods

Seagrass depth range is calculated by measuring water depth at the shallow limit and deep limit of seagrass cover across three transects at a sampling site. One transect is a routine transect used in the survey each year. The remaining two transects are randomly located within 50 m each side of the routine transect. The mean shallow limit is subtracted from the mean deep limit to give the depth range for that site. All depths are standardised to a number of standard height markers in proximity to the sampling sites within the lake to remove potential errors from changing water levels.

A report card grade is calculated following the analysis method outlined in the New South Wales sampling and reporting protocols (OEH, 2016). Briefly, the seagrass depth range scores are based on not only the recorded depth range for a specific year, but also how that compares to the previous year, meaning how seagrass has progressed, recovered or regressed over time since the previous survey. The seagrass score is presented separately in the report card and does not affect the overall ecological health grade.

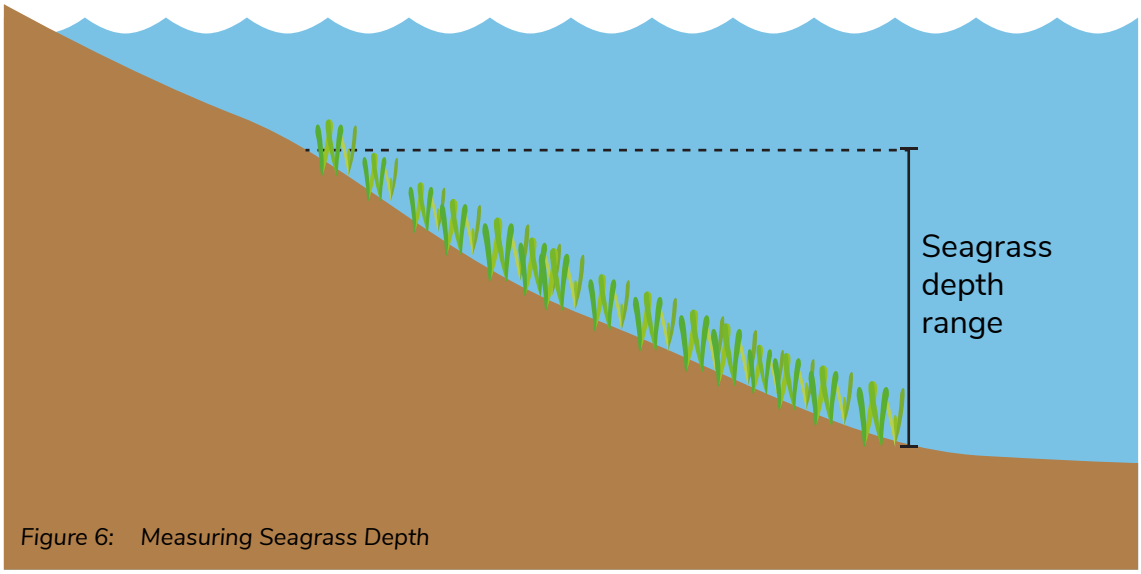


Figure 6: Measuring Seagrass Depth

Figure 7: Roadside sediment runoff

Sediment

Sediment from the land can be washed into waterways when it rains. If land is poorly managed, large amounts of sediment can wash into our waterways. Sediment also comes from roads and pathways washing directly into the stormwater and then the estuaries.

Too much sediment in the water reduces the amount of light reaching the bottom and is detrimental to seagrass which require light for growth. Seagrass is critical for the health of estuaries as it provides essential habitat for fish and invertebrates which support bird life and the local tourism and aquaculture industries. Excess amounts of suspended particles can also smother benthic organisms like sponges, irritate the gills of fish and transport contaminants.

Turbidity

Turbidity provides a measure of sediment in the water. It is the measure of light scattering by suspended particles in the water column, providing an indication of the amount of light penetration through the water column (EHMP 2008).

Methods

Calculating the zone score

The measured values of all indicators are summarised into one value which can then be compared between different reporting zones.

Two basic calculations have been performed for each zone:

- Non-compliance score – are the indicator values non-compliant with the trigger value?
- Distance from the benchmark score – how far from the trigger value are the indicator values?

The distance measure is a recognition that the trigger values only allow for two possible states, compliant and non-compliant. The distance measure provides for more sensitivity for ecological condition along the gradient from good to poor.

Calculating the non-compliance score

The non-compliance score is simply calculated by taking the number of samples that are above the trigger value as a proportion of the total number of samples taken in the sampling period. The non-compliance score is then expressed as a value between 0 and 1, with 0 equal to none of the values being non-compliant (i.e. all compliant) and 1 equal to all values being non-compliant.

Non-compliance score equals the number of samples non-compliant with trigger value divided by the total number of samples.

Calculating the distance from benchmark score

The distance score has been expressed as a proportion between 0 and 1 to be standardised with the non-compliance score. To do that, the distance score is expressed as a proportion of the worst expected value (WEV) with a score of 0 equal to the benchmark value, and 1 equal to the worst expected value for each of the indicators.

The worst expected value has been determined by examination of a data set for all of New South Wales. The 98th percentile value was selected as the worst expected value Table 3. In the small number (2%) of circumstances where measured values were greater than worst expected value, the distance measure became 1 (which is the highest possible value).

Table 3: Worst expected value for Condition Calculations

	Turbidity WEV (NTU)	Chlorophyll WEV (µg/L)
Lake	20	30
River (mid)	60	30
Lagoon	20	30

Distance of each non-compliant value equals: (measured value - trigger value) / (worst expected value - trigger value).

The distance score is calculated as the mean distance from the trigger of those values that are non-compliant for the reporting period.

Once the non-compliance and distance score have been calculated, the geometric mean of both scores is calculated to arrive at a single score that can be used to assess the condition of each indicator in that zone.

$$\text{Final score for indicator} = \sqrt{(\text{non-compliance} \times \text{distance score})}$$

The final 'zone score' for each reporting zone is then the simple average of the indicator scores.

Methods

Allocating the Report Card Grade

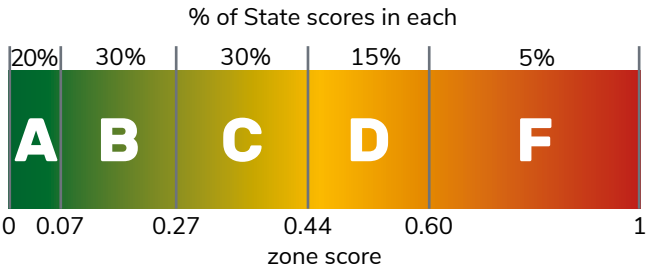
Defining the Report Card grade is an important step in the development of the Report Card. The grade definitions below are linked to the environmental values outlined above and are structured to allow easy comparison between each system and over time.

It is important that the cut-off values for each grade reflect the condition of each zone in comparison to a broader scale of condition across all New South Wales estuaries (i.e. an 'Excellent' grade represents an excellent condition for a New South Wales estuary). To assist with the derivation of cut-offs, scores were calculated for 130 zones across a wide range of New South Wales estuaries using the same triggers and worst expected values as the MidCoast analyses. Cut-offs were then defined as representing a percentage of the scores for the state (Table 4). For example, a zone score less than 0.07 defined the 20% of best zone scores in the state and this became our 'Excellent' grade (see Table 4 for other cut-offs). We did not use a score of 0 as 'Excellent' because, as a consequence of how the trigger values are calculated, we expect that even pristine reference sites will exceed trigger values 20% of the time. The definition of the grades and description are shown in Table 4.

Table 4: Report Card results, definitions, descriptions and cut-off

Grade	Result	Definition	Description
A	Excellent	All environmental values met (The indicators measured meet all of trigger values for almost all of the year)	The best 20% of scores in the State
B	Good	Most environmental values met (The indicators measured meet all of the trigger values for most of the year)	Next 30% of good scores
C	Fair	Some of the environmental values met (The indicators measured meet some of the trigger values for some of the year)	Middle 30% of scores
D	Poor	Few of the environmental values met (The indicators measured meet few of the trigger values for some of the year)	Next 15% of poorer scores
F	Very Poor	None of the environmental values met (The indicators measured meet none of the trigger values for almost all of the year)	The worst 5% of scores in the State

Figure 8: Relationships between grades, zone scores and state percentiles



Summary of the process for calculating the zone score

In summary, the process for calculating the zone involved:

- Calculating the proportion of time that the measured values of the indicator are above the adopted guideline limits or Trigger Values.
- Calculating the distance/departure from the guidelines for that indicator - the extent the data extends past the trigger value and approaches the worst expected value (WEV) for that indicator.

Methods

- Calculating the geometric mean of the non- compliance and distance scores to get a final score for that indicator for each zone.
- Averaging the scores for the two indicators at each site – this gives the 'zone score'.
- Grade the zone based on the zone score as A, B, C, D, F.

Rainfall results

The amount of rainfall that occurs around the period of sampling for the Report Card (September – March each year) influences the Report Card results. If there is more rain, there is more runoff in the catchment resulting in greater quantities of sediment and nutrients entering our waterways.

The sampling period for 2019/20 saw a variety of climatic conditions with drought conditions and little rainfall during the first three months followed by moderate rains and then flooding conditions in January, February and March.

The rainfall data is taken from the Forster Bureau of Meteorology rainfall station (Tuncurry Marine Rescue) (www.bom.gov. au/climate/data). Similar trends were seen in data throughout the MidCoast Area.

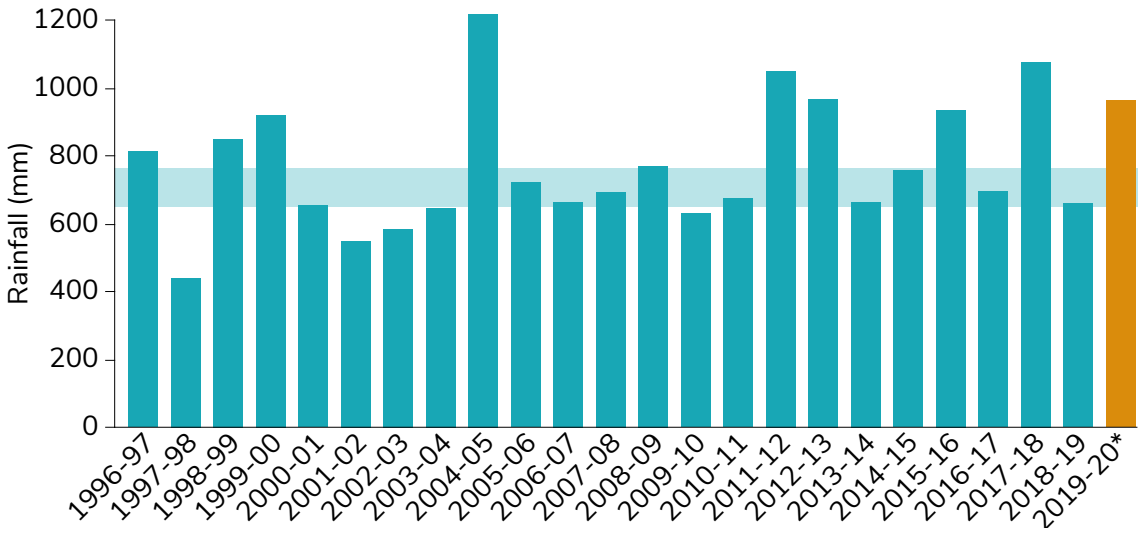


*Figure 9: Data presented includes total rainfall. * data collected from Whoota Station.*

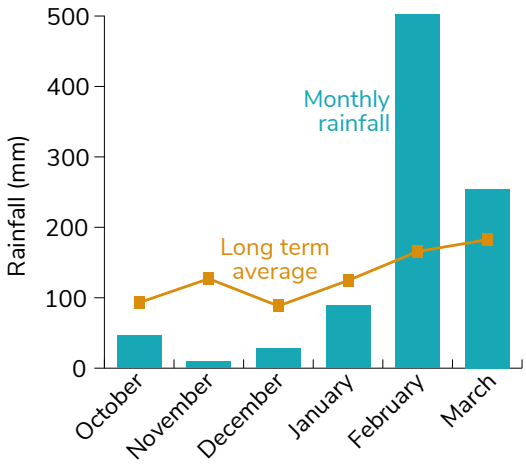


Figure 10: Monthly observed and long term average rainfall during the 2019-20 monitoring program at Whoota (bom.gov.au)

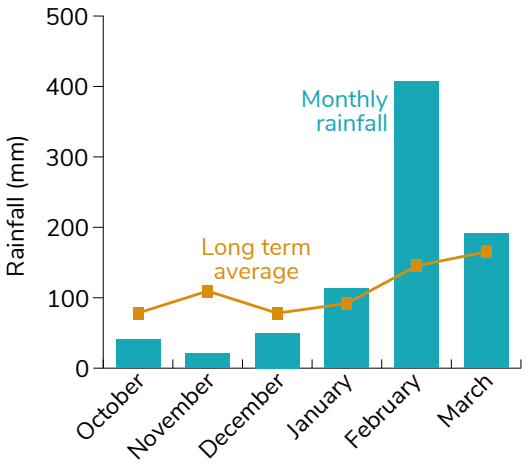


Figure 11: Monthly observed and long term average rainfall during the 2019-20 monitoring program at Taree Airport (bom.gov.au)

Methods

References

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Acknowledgements

The methodology presented here was developed by the Department of Planning, Industry and Environment - Environment Science (DPIE-ES)with input from Hodge Environmental and the International Water Centre.

Figure 12: Community members enjoying the waterway at Pipers Creek.

Manning River Estuary

Catchment description

The Manning River has a catchment area of 8,420 square kilometers, which makes it the sixth largest on the coast of NSW. The Manning River is unique on the NSW coast because it is a double delta with two river entrances at Harrington and Old Bar. The main land uses within the catchment are urban development, beef cattle grazing, dairying, oyster growing and forestry. Significant areas of the catchment are also conserved within National Parks and Nature Reserves. The majority of the catchment's population live in the estuarine zone around the town centres of Taree, Wingham, Cundletown, Harrington and Old Bar.

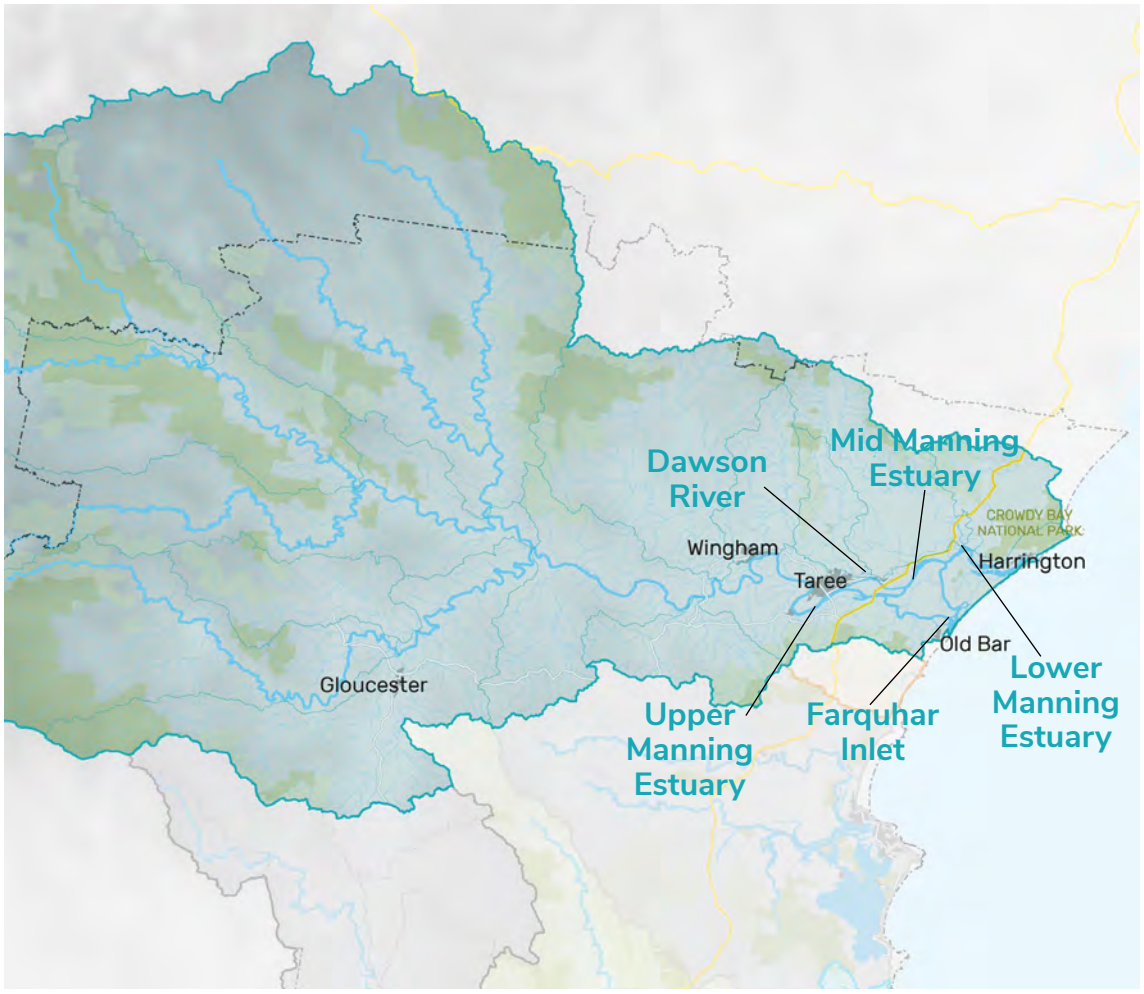
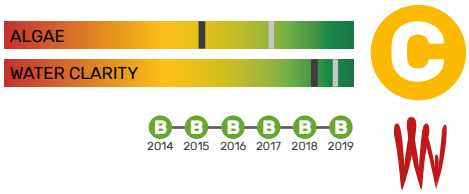


Figure 13: Manning River

Manning River Estuary



Upper Manning Estuary

The Upper Manning decreased from good in the 2018/19 period to fair during 2019/20. Elevated algal concentrations are an ongoing issue in this part of the estuary.

The chlorophyll trigger value was exceeded by small to moderate amounts in just over half of the samples. The water clarity trigger value was exceeded around half of the time by a very small amount during the sampling period.

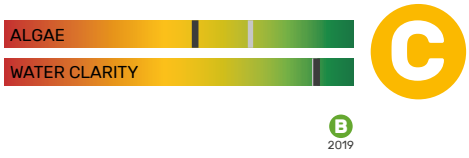
The extended dry period in the first part of sampling would have maintained the water clarity due to the minimal amount of catchment runoff entering the estuary, but the higher algae levels can also result in decreased water clarity. Elevated chlorophyll was evident immediately after the January rains and reduced water clarity occurred after February floods. The elevated chlorophyll did not occur after February floods due to low salinity and high flow in the river.

See the special section (p30) for more detail on how weather and fires affected the results of this year's sampling.

Seagrass has not recolonised the upper river for unknown reasons.

Estuary description

The Upper Manning Estuary includes the section of river from Tinonee to the western end of Dumaresq Island.



Dawson River Estuary

The overall grade for the Dawson River Estuary was fair, which represents a decrease from the previous year. This result was mainly driven by a poor chlorophyll grade with 80% of samples exceeding the trigger level by a moderate amount.

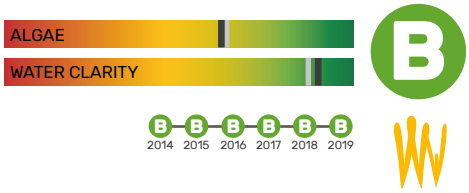
Water clarity exceeded triggers in half the samples by a small amount. It is clear from the results that there is a need for nutrient and sediment management in this catchment.

The influence of runoff after rain is less clear in the Dawson River; chlorophyll was high before rain and remained high after January rain and immediately after February floods. Turbidity was higher prior to the floods than after; even though the low post flood salinity shows there was displacement of estuary water by runoff.

Estuary description

Dawson River is a tributary of the Manning River. It enters downstream of Taree and receives runoff from Taree's industrial areas as well as a sewage discharge.

Manning River Estuary



Mid Manning Estuary

Algae concentrations in the Mid Manning Estuary were slightly worse than last year for most of the sampling period but water clarity was better.

The water clarity trigger value was exceeded for less than half of the sampling period by a small amount, whereas the chlorophyll-a trigger value was exceeded in two thirds of the sampling period. Generally, these exceedances were small, but exceedances were greater after moderate rain in January.

The high river flow and low salinity after February floods kept chlorophyll levels low, despite the runoff carrying nutrients from fire and drought affected land into the river. Seagrass depth range increased slightly, but the grade is still fair, indicating that turbidity is limiting the area that seagrass can survive in.

Estuary description

The Mid Manning Estuary is the river from the western end of Dumaresq Island to the confluence with the Lansdowne River in the north channel, and to the confluence with Warwiba Creek in the south channel of the river. The Mid Manning Estuary also extends into Scotts Creek to the confluence with Bukkan Bukkan Creek.

Lower Manning Estuary

There was a slight improvement in the water clarity and algae concentrations throughout the sampling period compared to last year's results. This would be mostly due to low rainfall in the early part of sampling and limited impacts of flood flows in February and March.

The water clarity trigger value was only exceeded by a very small amount in only one sample during the sampling period, and that was following the February floods. The algae trigger value was exceeded by a small amount in over three quarters of the samples, but was not influenced by post-rain runoff like upstream sites. Flood runoff did, however, reduce salinity significantly in February and March.

The depth range where seagrass is able to grow in the lower estuary decreased to fair, the same level as 2017 and 2018. Seagrass coverage in the lower estuary is still less than expected.

Estuary description

The Lower Manning Estuary is from the Lansdowne River confluence to the river mouth at Harrington, and from the Warwiba and Bukkan Bukkan Creek confluences to the river mouth at Farquhar Inlet.

Manning River Estuary

Farquhar Inlet

Ecological condition in Farquhar Inlet continued its good grade. Water clarity was high, exceeding triggers by a very small amount in half of the samples.

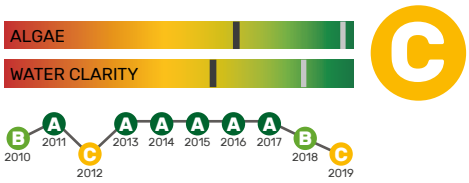
Algal levels were slightly higher than desired, exceeding desired levels by a small amount in 80% of samples, particularly after rain in January and February. Salinity typically hovered just below seawater for most of the summer (30 to 34) but dropped significantly after the rain and the opening in February.

The effect of opening the entrance on 9 February 2020 is hard to discern from the consequences of flood flow from rain at the same time, but it is clear that chlorophyll levels remained high 2 weeks after opening and turbidity after opening was higher than before opening.

Estuary description

Farquhar Inlet is a secondary entrance to the Manning River system that is intermittently open. It is a broad, shallow sand delta at the junction of the Manning River South Arm and Scotts Creek. It is surrounded by agricultural lands and receives runoff from the town of Old Bar.

Khappinghat Estuary



The Khappinghat Estuary, located in Saltwater National Park is surrounded by Khappinghat Nature Reserve and is expected to be in excellent ecological condition. In the 2019/20 summer, moderate algal growth and poorer than expected water clarity resulted in a fair grade overall. The sampling period was one of the driest on record followed by very heavy rain; the quality of runoff would have also been strongly influenced by extensive fires within the Kappinghat area which covered approximately 93% of the catchment.

Additionally, extreme temperatures and low rainfall during the period the first 4 samples were taken led to warm waters and the highest salinity seen since 2007 when sampling commenced. The dry conditions were followed by heavy rain in February 2020 which washed soil and nutrients into the waterway and as a result, algal growth was moderate, with all but one of the samples exceeding trigger values. These higher than desirable algal levels were accompanied by poorer than expected water clarity and resulted in a fair grade rather than the expected excellent grade.

Wallis Lake

Catchment description

The Wallis Lake catchment extends over 1400 square kilometers and this catchment includes the region's major urban centre of Forster-Tuncurry.

Wallis Lake is one of the most significant producers of Sydney Rock Oysters in Australia and is also central to the local tourism industry, valued at over $315m per year. The lake is one of New South Wales' top three producing estuarine fisheries, it produces 80% of the states commercial crabs and is utilised extensively for recreation including boating, fishing and swimming.

The Wallis Lake catchment contains habitat for threatened and international migratory species and contains 35% of the seagrass beds of New South Wales, as well as the second largest representation of saltmarsh in the State.

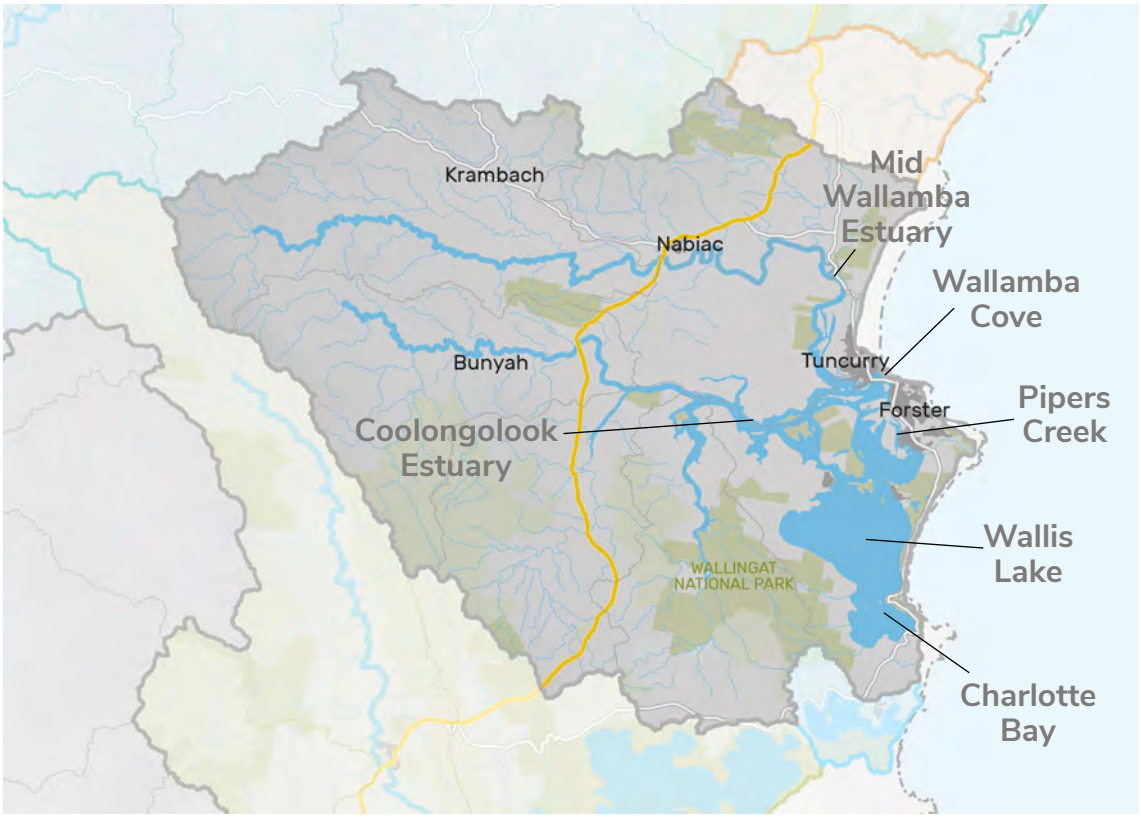
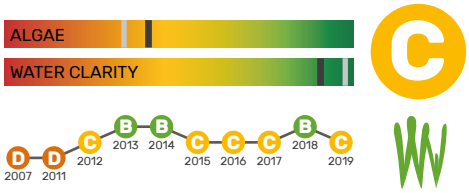


Figure 14: Fishing in Pipers Creek

Wallis Lake



Mid Wallamba Estuary

In the Mid Wallamba Estuary water clarity was good but excess nutrient runoff resulted in much higher than desired algal growth resulting in a continuation of the fair grade this year.

As has been seen in past years, the water clarity has remained good with just over half of the samples below trigger values. Since sampling commenced in 2007 seagrass has re-established in the mid-estuary, particularly near the rock fillets. Despite this, it appears that the water clarity is still restricting its growth in deeper waters.

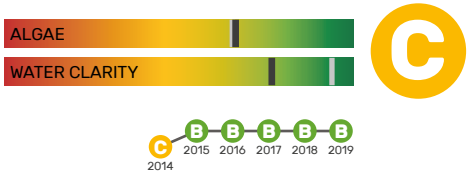
The algal abundances continue to be much greater than desired with all samples exceeding trigger values by a large amount. The results from the sample taken after the February rain was particularly poor showing that there remains a need for better nutrient management in the catchment.

Seagrass depth improved and is now rated as good.

Estuary description

The Mid Wallamba Estuary sub catchment covers almost one third of the Wallis Lake catchment (550 km²). The catchment is one of the most modified sub catchments in Wallis Lake. Agriculture is the dominant land use with a small urban centre at Nabiac. The Mid Wallamba Estuary faces additional localised pressures from the erosion and collapse of stream banks due to its popularity for water sports over the summer period.

The water quality sampling occurs in the estuarine reaches of the river from Wallamba Island to Failford.

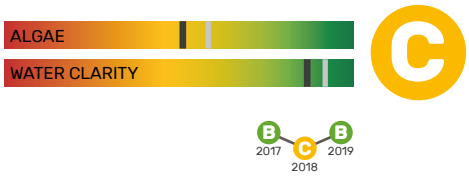


Wallamba Cove

A drop in grade from good to fair in Wallamba Cove was the result of greater than desired algal growth and shows that this site continues to be affected by stormwater runoff from Tuncurry.

The impact of urban runoff from Tuncurry is particularly evident at the upstream site where all samples exceed algal trigger values by a small to moderate amount and just over half the samples exceed turbidity trigger values by a small to moderate amount. The impacts at the downstream sites are less, due to either dilution by the river or distance from input locations near the town centre.

Wallis Lake



Coolongolook Estuary

In the Coolongolook Estuary, water clarity was good but excess nutrient runoff resulted in much higher than desired algal growth resulting in a drop from good to fair this year.

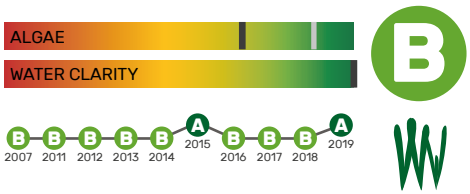
The Mid Coolongolook Estuary continued to show a large amount of algal growth but generally acceptable water clarity. All samples exceeded trigger values for algae by a moderate amount, samples after the February rain exceeded by a high amount. Just over 50% of the samples taken exceeded turbidity trigger values by a small amount.

These results show that there is a need for ongoing improvements in nutrient management within the Coolongolook catchment.

Estuary description

The Coolongolook Estuary receives water from the Coolongolook and Wang Wauk Catchments which contains modified landscapes predominantly used for agriculture. All lands within the Coolongolook catchment are on erodible soils. The catchment contains a small urban service centre with a population of around 417.

The water sampling occurs in the estuarine reaches of the river.



Pipers Creek

This year Pipers Creek dropped from excellent to good ecological condition, mainly as a result the fair algal grades after the heavy rain in February. Whist the grade dropped this year from an A to a B this continues to be a good result given it receives runoff from a heavily urbanised catchment.

There is still a need for ongoing control of nutrients, with one third of samples exceeding algae trigger values by a moderate to large amount. All samples were below turbidity trigger values.

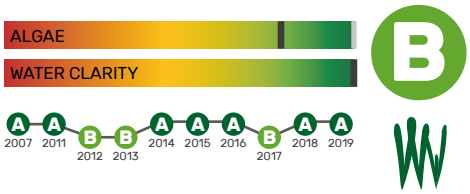
Seagrass depth is excellent and near the maximum that can be expected in this part of the lake system.

Estuary description

The majority of the Forster township is located in Pipers Creek Catchment. The rainfall that once infiltrated into the ground through native vegetation now meets impervious surfaces (roofs, roads and footpaths) and runs directly into stormwater drains and Pipers Creek. This stormwater runoff carries with it pollutants such as sediments and nutrients from houses, lawns, roads and pathways. In the past, Pipers Creek and Pipers Bay have experienced large algal blooms and shown signs of poor ecological health. Following large rainfall events, the water from Pipers Creek and Pipers Bay can reach Wallis Lake and Charlotte Bay areas. Reducing the impacts of stormwater from the Pipers Bay Catchment therefore has benefits across the whole of Wallis Lake.

The samples for this Report Card are taken next to Big Island adjacent to Forster Keys.

Wallis Lake



Wallis Lake

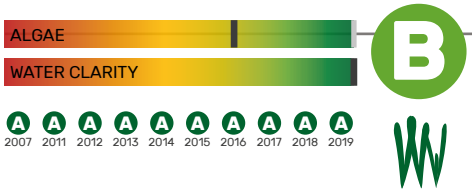
The grade for Wallis Lake shifted from excellent to good ecological condition in 2020. This overall change in grade was a consequence of moderate algal growth in the two samples that followed the heavy rain in February. The rain brought nutrients into very warm lake waters, which presented perfect conditions for algal growth.

Turbidity samples were all below trigger values during the sampling period. Seagrass depth is excellent and near the maximum that can be expected in this part of the lake system.

Estuary description

Wallis Lake is in the centre of the estuary and receives runoff from a narrow catchment immediately surrounding the lake. Adjoining areas directly influencing Wallis Lake include Coomba Park, Green Point and the rural residential land on the western side of Wallis Lake. During large rainfall events, water from the major rivers and the Pipers Creek catchment flow into this area carrying pollutants with it.

Sampling in Wallis Lake takes place in the centre of the estuary between Yahoo Island in the north and Earps Island in the south.



Charlotte Bay

Charlotte Bay dropped from excellent to a good grade for the first time since sampling began. In the extreme dry conditions in early to mid-summer salinity levels rose to 18% greater than seawater and the waters became very warm. This, combined with nutrient runoff triggered excess algal growth for the first time and as a result half the samples exceeding trigger values by a small to moderate amount. Water clarity however, continues to be excellent with no exceedances for turbidity.

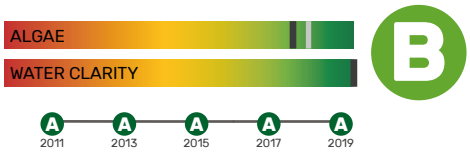
Seagrass depth is the best in the lake system and seagrass extends from one shore to the other across the lake floor.

Estuary description

Charlotte Bay covers the southern most part of the Wallis Lake estuary. There is limited mixing between the northern and southern parts of Wallis Lake, therefore the condition of this area is influenced mainly by the surrounding catchment. The catchment is largely vegetated with a small amount of residential, commercial and rural residential land.

Sample collection in Charlotte Bay occurs in the middle of the water body south of Earps Island.

Smiths Lake



The grade for Smiths Lake dropped this year from excellent to good. The summer presented challenging conditions including one of the driest summers on record followed by very heavy rain. Heavy rain in February resulted in nutrient runoff which led to algae exceeding trigger levels by a small amount in just under half the samples. Water clarity was excellent with no exceedances of trigger values.

The three locations that make up the grade for Smiths Lake include Wamwarra Bay, central Smiths Lake and Symes Bay. Waters in Wamwarra Bay, central Smiths Lake and Symes Bay were all slightly saltier than seawater, water clarity was excellent at all locations. There was a slight amount of excess algal growth at all three sites, half the samples in Wamawarra Bay and central Smiths exceeded triggers by a very small amount resulting in a good grade, in Symes Bay only a third of samples exceeded by a very small amount resulting in an excellent grade.

Estuary description

Smiths Lake has a catchment area of 35.89 square kilometers. It is an intermittently closed and open coastal lagoon and the lake entrance is artificially opened when levels approach 2.1 meters above sea level to prevent flooding of low-lying areas. The catchment of Smiths Lake has a good cover of native vegetation with a significant proportion of the catchment under conservation within the Wallingat and Myall Lakes National Parks. The Smiths Lake township and tourism facilities are situated near the lake's mouth, with impervious surfaces (roofs, roads and footpaths) increasing stormwater runoff into the lake. This stormwater runoff can carry with it pollutants such as sediments and nutrients from houses, lawns, unsealed roads and pets.

Samples for Smiths Lake were taken from three locations: Wamwarra Bay, Central Smiths Lake and Symes Bay. These data have been averaged to provide an overall score for Smiths Lake.

Figure 15: Smiths Lake

Myall Lakes

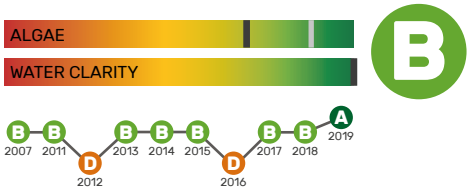
Catchment description

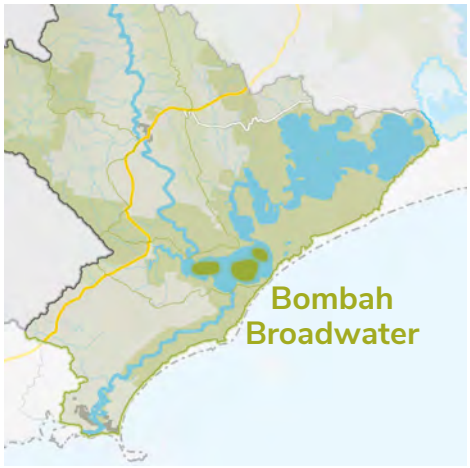
The Myall Lakes catchment covers 440 square kilometres. Its major tributary is the Myall River, whose headwaters extend to Craven Nature Reserve and the Kyle Range. The catchment is largely occupied by agricultural land, with forestry and protected vegetation in the steeper areas and a small amount of urban land in the townships of Bulahdelah and the well-known tourist destinations of Tea Gardens-Hawks Nest.

The Myall Lakes and Myall River in particular are part of a large tourism and recreation industry which includes Myall Lakes National Park, one of New South Wales' most visited National Parks with estimated annual visitor numbers of 250,000.

Major issues for the Myall Lakes system include the impacts of rural runoff on water quality including nutrients, noxious weeds and other pathogens. Urban runoff and the impacts from tourism and recreation uses of the lakes and estuaries are more prevalent in the lower reaches of the catchment.

Myall Lakes





Bombah Broadwater

Excess algal growth after the February rains meant that the grade for Bombah Broadwater dropped from excellent to good this year. The condition of Bombah Broadwater is strongly influenced by runoff from the Myall River catchment and this year the drop in grade in the Broadwater was due to increased algal levels. The marked variability in condition between reporting years emphasises the need to continue to reduce nutrient runoff from land use activities in the catchment.

Half of the samples taken in Bombah Broadwater exceeded triggers by a small to moderate amount. This shows that the Bombah Broadwater is under continual pressure from nutrients. All samples were less than trigger levels for turbidity.

The marked variability in condition, swinging from good to poor and back again to excellent emphasises the strong response to catchment inflows and highlights the need to continue to control nutrients from the catchment of the upper Myall River.

Dry conditions in early and mid-summer saw the lakes become more saline, with the Bombah Broadwater approaching three quarters of the salinity of seawater.

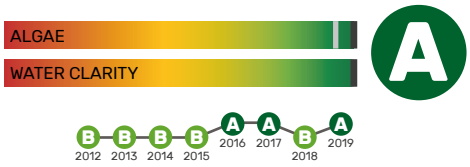
Estuary description

The Bombah Broadwater and Myall Lake are part of the Myall Lakes system which is comprised of four linearly connected brackish to freshwater basins: Myall Lake, Two Mile Lake, Boolambayte Lake and the Bombah Broadwater. The Myall Lakes National Park surrounds the lakes and is listed as a Ramsar wetland of international importance.

While the Bombah Broadwater itself is surrounded by National Park, it receives the majority of its inflow from the upper Myall River and Crawford River catchments which together drain an area of approximately 440 square kilometres. These catchments are largely occupied by agricultural land with forestry and protected vegetation in the steeper areas and a small amount of urban land in the township of Bulahdelah.

Samples were taken from three sites in the Bombah Broadwater and were combined to give an overall score for the health of the system.

Myall Lakes



Myall Lake

The grade for Myall Lake remained excellent this year with no samples exceeding algal or turbidity trigger levels. Dry conditions in early and mid-summer saw the lakes become more saline, with Myall Lake results showing half the salinity of seawater.

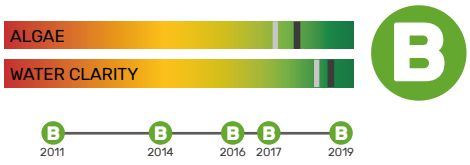
Estuary description

Myall Lake along with the Bombah Broadwater is part of the Myall Lakes system which is comprised of four linearly connected brackish to freshwater basins: Myall Lake, Two Mile Lake, Boolambayte Lake and the Bombah Broadwater.

The Myall Lakes National Park surrounds the lakes and is listed as a Ramsar wetland of international importance.

Myall Lake is directly influenced by a small fringing catchment which is contained within the Myall Lakes National Park. During times of high rainfall however, water from the Broadwater (and therefore the Upper Myall River and Crawford River catchments) influences Myall Lake by carrying with it nutrients and algae.

Samples were taken from two sites in Myall Lake and were combined to give an overall score for the health of the system.



Lower Myall Estuary

The Myall River Estuary upstream of Tea Gardens maintained its good grade this year. This area is usually strongly influenced by the condition of the outflow from the Bombah Broadwater however, when there is little catchment runoff, as was the case this year, the waters moved by the tides are the main influence.

Salinities varied from half seawater on run-out tides to near seawater on incoming tides.

Algae levels varied from moderate to good and exceeded triggers by a small amount in half of the samples. Water clarity was good, also exceeding triggers by a very small amount in one quarter of the samples.

Estuary description

The Lower Myall Estuary near Tea Gardens is the mouth of the Lower Myall River and is situated in an area of highly mobile sand features. The river discharges into the moderately sheltered waters of Port Stephens but the river entrance is exposed to swell from the south-east coming through the entrance of the Port. The Lower Myall Estuary receives water from the urban area of Tea Gardens and Hawks Nest and is strongly influenced by the waters of the Bombah Broadwater following rainfall.

Karuah River

Catchment description

The Karuah River Catchment is approximately 1460 square kilometres, largely comprised of grazing land, forest and woodland and is sparsely populated, the largest settlements being Karuah (pop.~1000), located at the mouth of the river, and Stroud (pop.~700), located in the centre of the catchment.

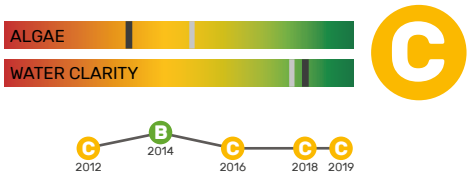
Land use in the Karuah River Catchment has undergone continuous change since European settlement beginning with land clearing for forestry and agriculture from the late 19th century. The landscape today is a mosaic of rural landuse, including forestry, grazing industries, poultry production, mining, aquaculture and rural residential areas.

Trends from past water quality monitoring shows periods of high sediment and nutrient loads within the Karuah River; whilst at the same time displaying a range of in-stream biological diversity. In 2011 the Karuah River estuary and Catchment was assessed as being in a moderate ecological condition, but with some significant threats to the system.

The Branch is a subcatchment of the wider Karuah River Catchment and is approximately 211 square kilometres. The Branch subcatchment is a mosaic of floodplain environments, with steep ridgelines traversing from the upper catchment through to the tidal zone of the river. The subcatchment is sparsely populated, without any settlements. Landuse is primarily grazing land with some forest and woodland in the upper catchment.

Figure 16: Karuah is the largest settlement within the Karuah River Catchment.

Karuah River Estuary



Karuah River Estuary

The Karuah River Estuary maintained its fair grade this year continuing to show signs of significantly impaired estuary health. The site had much higher than desired algal growth and chlorophyll exceeded trigger values in every sample but one, by a large to moderate amount leading to an extremely poor grade. Unlike some other estuaries, excess nutrients from catchment runoff were not linked to the rainfall from late summer indicating that there is a chronic flow of nutrients into the estuary.

Water clarity in the Karuah River Estuary was good with half to two-thirds of samples exceeding triggers values but only by a small amount. As has been the case for many years, there was no seagrass in the Karuah River estuary which is thought to be a consequence of past conditions.

Estuary description

The Karuah River Estuary is a priority oyster production area which has suffered periodic water quality issues associated with catchment runoff. The Karuah River Estuary discharges into the north western part of Port Stephens, and is the only significant source of sediment to this system.

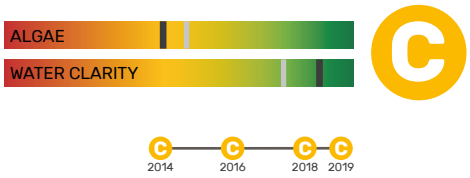
There are substantial areas of mangrove and saltmarsh habitats in the Karuah River Estuary, which provide food sources and nursery areas to fish, but only very small areas of seagrass (seagrass extent has decreased by almost 80% between 1985 and 2009). Low light availability, due to high turbidity is the most likely reason for the lack of seagrass in the Karuah River Estuary.

The extent of saltmarsh over this time has also reduced, while mangrove has increased. Similar to many estuaries in New South Wales it is suggested that mangrove assemblages have increased at the expense of saltmarsh.

The samples for this Report Card have been obtained from three sites within the estuary. They are:

- Above Allworth (1 site)
- The Karuah River Estuary upstream of the Karuah Bridge between Branch River junction and Allworth (1 site)
- The Branch River (1 site)

Karuah River



The Branch Estuary

The Branch Estuary maintained its fair grade this year continuing to show signs of significantly impaired estuary health. It had much higher than desired algal growth and all samples but one exceeded triggers by a moderate amount, leading to a poor grade. Unlike some other estuaries, excess nutrients from catchment runoff were not linked to the rainfall from late summer indicating that there is a chronic flow of nutrients into the estuary. Water clarity in The Brach Estuary was good with one third of samples exceeding the trigger levels by a small amount.

Estuary description

The tidal zone of The Branch River extends to slightly south of the Branch Lane, and discharges into the wider Karuah Estuary and ultimately into the north western corner of Port Stephens Estuary. The estuary is bounded by substantial areas of mangrove and saltmarsh habitats. The Branch is used as a nursery for juvenile oyster production, whilst landuse within The Branch Estuary is largely grazing lands for beef production and rural lifestyle living.

Figure 17: Boats on the Branch

How do our indicators respond to weather and fire?

The indicators that we use for the Waterway and Catchment Report Card monitoring were carefully chosen to respond to changes in inputs of nutrients (algae indicator) and sediments/soil (water clarity indicator) from catchments to our estuaries. However, the response of the indicator is influenced by both a change in the inputs and the context that the change occurs within. By "context" we mean the water residence time and, for algae, the amount of light available. This means that we cannot just look at inputs, we have to integrate other factors into our analysis.

For example, if runoff from rain carries nutrients and sediments from a catchment to a river estuary, then the impacts of rain on algae will be different based on intensity. If the rain is too light, it soaks in and doesn't result in runoff, so has little effect on our indicators. If it is too heavy (a flood) then it carries lots of nutrients, but the water moves through the system so fast that algae are swept away and do not have time to grow and most of the nutrients don't remain in the system. But, if the rain is moderate then sufficient nutrient to stimulate algal growth are moved in and the water residence time is long enough for algae to multiply and grow. The story is, however, different for sediments. Turbidity doesn't rely on a secondary response (like algal growth) and so it is able to impact waterways irrespective of flow.

If, however, the catchment that is affected drains to a coastal lake (like Wallis, Smiths or Myall) then the nutrients are more likely to be retained in the system for long enough to stimulate algal growth.

The past summer's sampling provides an excellent opportunity to see these patterns in action. We has an extended period of dry weather, some light rain and then some huge storms. This weather has provided an opportunity to see the processes described above in action in the data.

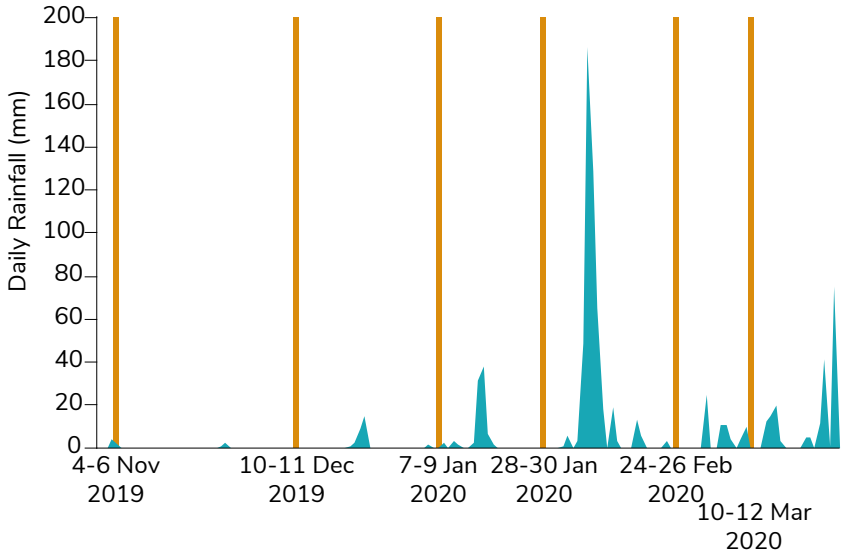
The graph below shows daily rainfall (at the Whoota station) in blue and our sampling dates in orange.

There was very little rain prior to the first three samples, there was a moderate fall (80mm over 5 days) two weeks prior to the fourth sample and a massive rainfall event (453 mm over 6 days) followed up with approximately 20mm on two subsequent days, two weeks before the fifth sample and some minor falls between the fifth and sixth samples.

In the lakes (Figure 20) there was a clear increase in turbidity (orange) and chlorophyll (gray) between sample three and sample four, despite there being insufficient rain to reduce the salinity (blue). This was also evident to a lesser extent in Karuah River, Wallamba River and Upper Manning River Estuaries, but was not evident in Mid and Lower Manning River Estuaries and Farquhar Inlet (Figure 21).

In all the waterways, there was a reduction in salinity following freshwater runoff after February storms. It was much less pronounced in lakes (Figure 20) than rivers (Figure 21).

Figure 19: Daily rainfall at Whoota station in blue, sampling dates in orange



How do our indicators respond to weather and fire?

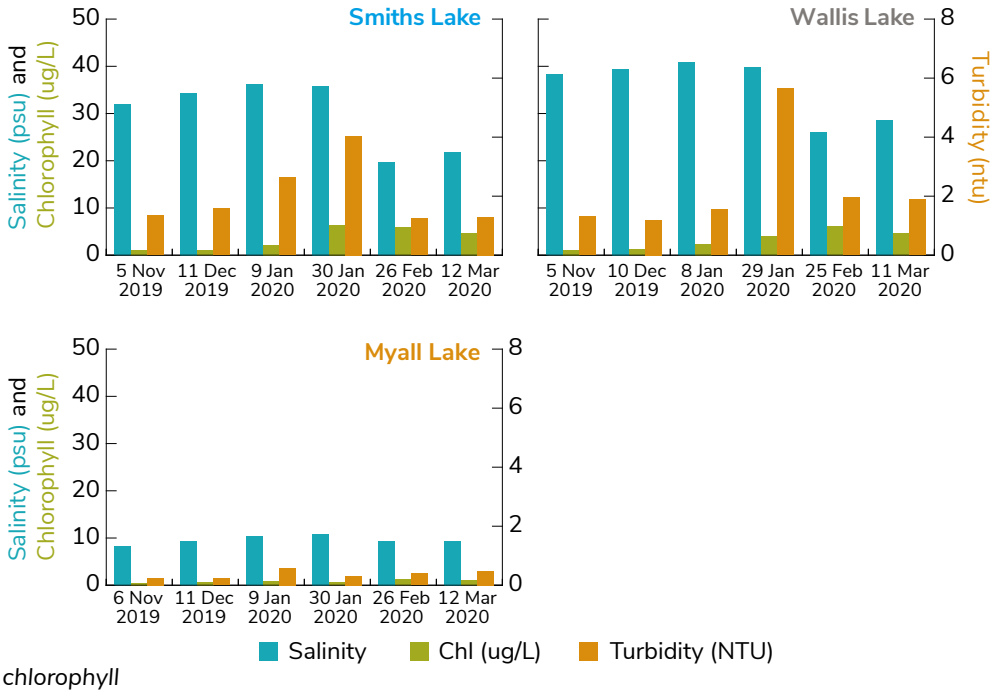


Figure 20: Salinity, chlorophyll and turbidity in the lakes

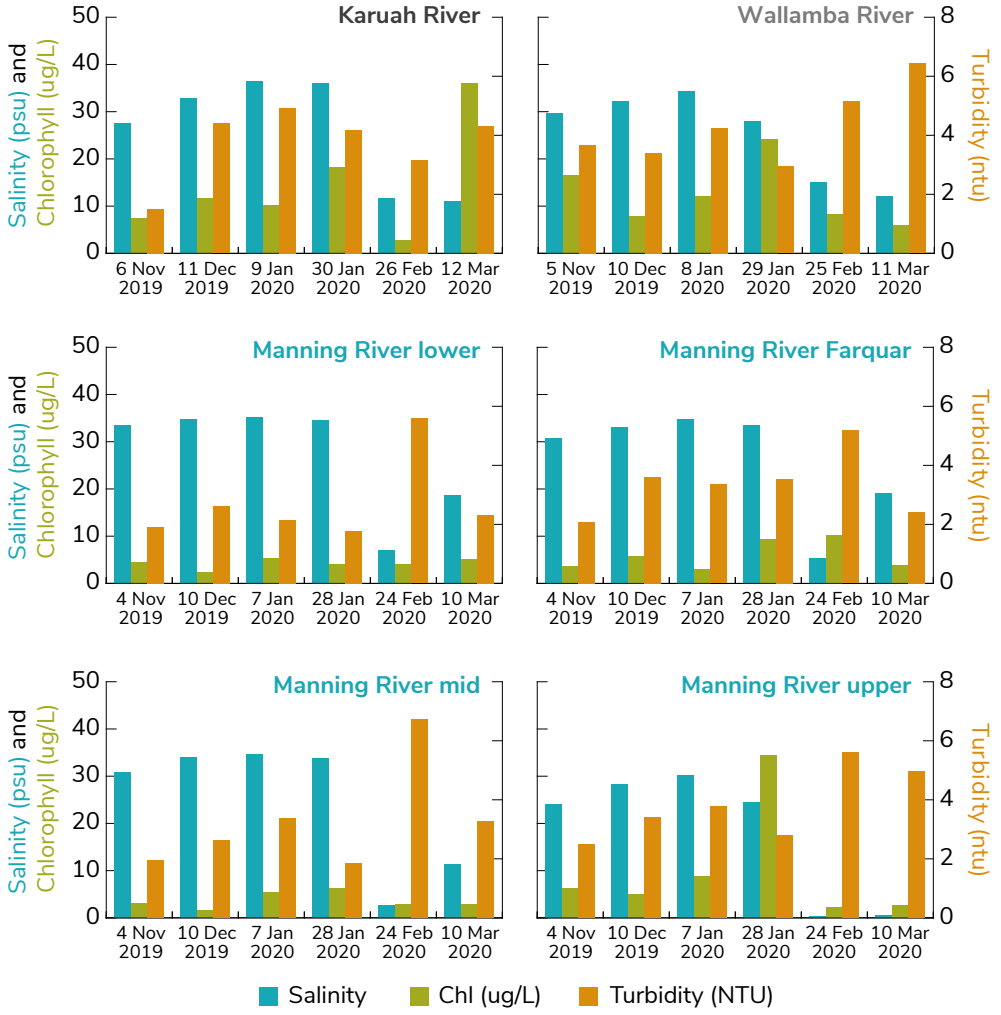


Figure 21: Salinity, chlorophyll and turbidity in the rivers

How do our indicators respond to weather and fire?

In all the rivers impacts on chlorophyll was reduced in sample five when flows were very high and salinity very low, but in the Manning River, the turbidity impacts were greatest in sample five. Chlorophyll impacts in Karuah Estuary were greatest in sample six, and in Mid Wallamba and Manning Estuaries were still suppressed in sample six.

The apparent suppression of algal growth, even though nutrients are available, is due to the high river flows moving nutrients and algae through the system too fast for them to accumulate and grow.

It is not possible to determine the effects of opening Farquhar Inlet on February 9 because of the impacts of the rainfall that were occuring at the same time.

The response of estuaries to fire is also very hard to disentangle from the response to the major floods that followed.

The majority of the bushfires that occurred in the MidCoast region took place in November and December 2019 and mainly affected the Khappinghat, Wallamba River and Manning River catchments.

Intense fires can affect our waterways by removing vegetation cover and thus exposing land to erosion, increasing sediments in our waterways, reducing water clarity and bringing with it nutrients that can cause algal blooms. Fires affect living plant material in many ways, from complete combustion to ash or charcoal, or partially charring leaves and branches. Completely combusted plant material becomes inert, but partially burnt material is readily broken down. If this material enters a waterway following heavy rain in a fire affected area it can reduce oxygen in the waterway as it begins to decompose. Due to the moderate and then heavy rainfall that followed the fires in January and February it is difficult to differentiate the response of the MidCoast estuaries to the bushfires from the response to the flooding.

From the samples that were taken by the Department of Planning, Industry and Environment as part of the Waterway and Catchment Report Card there were no indications of impacts on algae or water clarity in burnt catchments until the period after the floods, when it is likely that nutrients and partially burnt organic matter from the fire debris entered the waterways with rainfall runoff. The breakdown of the partially burnt material likely contributed more nutrients to the waterway, fuelling more algae to grow. The strong post rainfall turbidity response in Manning River and Khappinghat Estuaries may also have been partially a result of fire debris, however given the large freshwater flows entering the waterways; it's difficult to determine if this was caused by fire debris, or what is expected following a flood.

The Report Card results show that climatic conditions can play a significant role in the health of our waterways. Further research is needed to investigate the short and long term effects of intense fires on estuary health.

Figure 22: Fire damage and vegetation regeneration along the Southern Parkway in Forster.

How do our indicators respond to weather and fire?

Rainfall and runoff carry sediment and nutrients into our estuaries. How these estuaries are impacted depends on the estuary type and the intensity of the rainfall.

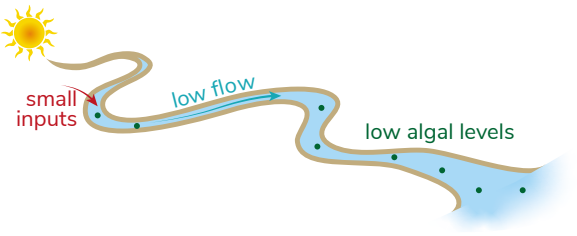
River Estuaries – are generally long and linear with very large catchment areas and a large tidal range. The speed of water flow in river estuaries varies according to rainfall and the volume of catchment runoff.

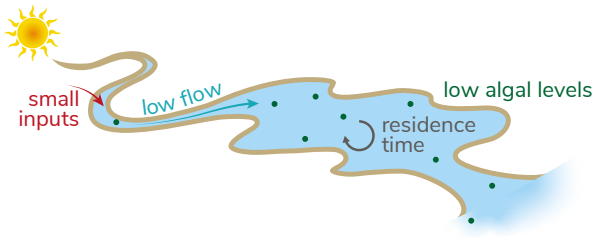
Lake Estuaries – are generally wide and shallow, with moderate sized catchment areas and low or no tidal range. They also have a longer residence time (how long water, dissolved or suspended material remains in the estuary) than river estuaries.

LOW RAINFALL

Low algae levels and good water clarity

If the rain is light it soaks into the catchment and doesn't result in runoff and so has little effect on algal levels and water clarity. Under these conditions, material already deposited in an estuary drives water quality.

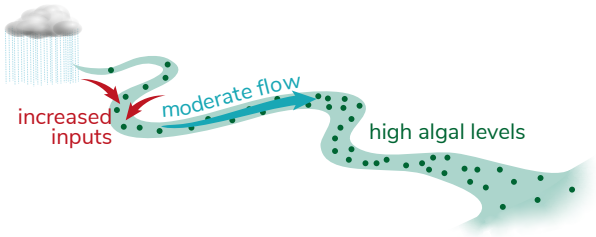


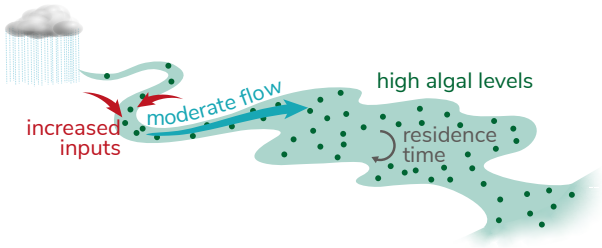


MODERATE RAINFALL

High algal levels and poor water clarity

If rain is moderate then enough nutrients to stimulate algal growth reach both river and lake estuaries. In river estuaries as the river flow is not too fast the water stays in the system long enough (residence time) for high levels of algal growth. A similar process occurs in lake estuaries.

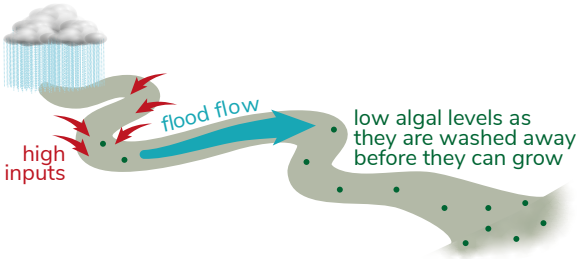




HIGH RAINFALL

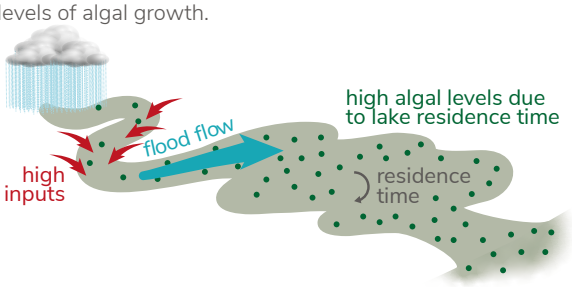
Low algal levels and poor water quality

During flooding conditions in river estuaries, runoff carries with it high levels of nutrients and sediments. However, because the water moves quickly through the system algae doesn't have an opportunity to grow.



High algal levels and poor water clarity

Lake estuaries also receive large amounts of nutrients and sediment during flooding conditions. But because the water is trapped or only moves through slowly (longer residence time) nutrients will remain in the estuary long enough to trigger high levels of algal growth.



The 2019/20 sampling period provided an excellent opportunity to see these patterns in action

Of the river estuaries, Manning River experienced low rainfall during the first half of the sampling period resulting in good water clarity and low algae levels. After flooding catchment runoff resulted in poor water clarity, but low algae levels due to the high flows moving through the river so quickly.

Of the lake estuaries Wallis, Myall and Smiths Lakes experienced rainfall during the middle of the sampling period which led to poor water clarity and high algae levels, this pattern continued during and after flooding conditions due to the long residence time of the lakes.

Management Actions occurring across the Local Government Area

Marine Estate Management Strategy

The NSW Marine Estate Management Strategy (MEMS) is a ten year program of works to coordinate and streamline the management of the 1750 kilometres of coastline, 826 beaches and 185 estuaries in New South Wales. In the MidCoast Council region, Hunter Local Land Services (HLLS) is implementing a large proportion of works on behalf of the NSW Government.

In 2019 MidCoast Council partnered with Hunter Local Land Services to implement Stage 1 of the MEMS in our region. This included a specific focus on protecting eroding river banks and reducing sediment and erosion from unsealed roads.

$866,000 from Hunter Local Land Services was matched with funding from Midcoast Council to create a $2,000,000 project targeting 16 hotspots and upgrading some five kilometres of dirt road, creek approaches and drainage to reduce the impact of sediment from dirt roads on key oyster and commercial fishery areas in Wallis Lake and Port Stephens.

In The Branch River sub-catchment of the Karuah River, works were targeted on The Branch Lane, a 14-kilometre unsealed road which crosses The Branch River and its minor tributaries in multiple locations and regularly erodes during rain events, shedding sediment into the waterway. Sealing and upgrading of adjacent drainage on three significant crossings were targeted with this funding to mitigate these issues. Sealing of a 2-kilometre strip of this road all the way to the major crossing of The Branch River was also funded independently by Council to coincide and value-add to these works.

These works also complemented the Karuah Catchment Grants Management Project which had also been undertaken in partnership with Hunter Local Land Services through the Marine Estate Management Program and targeted the Branch sub-catchment. Together these projects provided a good model of tackling impacts on water quality in a sub-catchment by targeting both public and private land, as well as utilising multiple funding sources.

The Marine Estate Management Strategy also provided funding to address eroding riverbanks through this program, which contribute significant sediment and nutrients to the waterway. $305,000 was provided through MEMS which in turn was matched by $82,000 from MidCoast Council. Over 1150 metres of riverbank were rehabilitated in two key locations: Lower Wallamba River and the Lansdowne River. Not only will these projects reduce sediment from eroding river banks entering the waterways, they will also provide additional fish habitat and increase mangrove growth, while re-establishing the adjacent riparian corridor. The funding from MEMS also included a study of Pampoola to identify sites at risk from future-erosion and develop actions to address this.

Due to the success of this project MidCoast Council and Hunter Local Land Services are currently negotiating Stage 2 works for 2020.

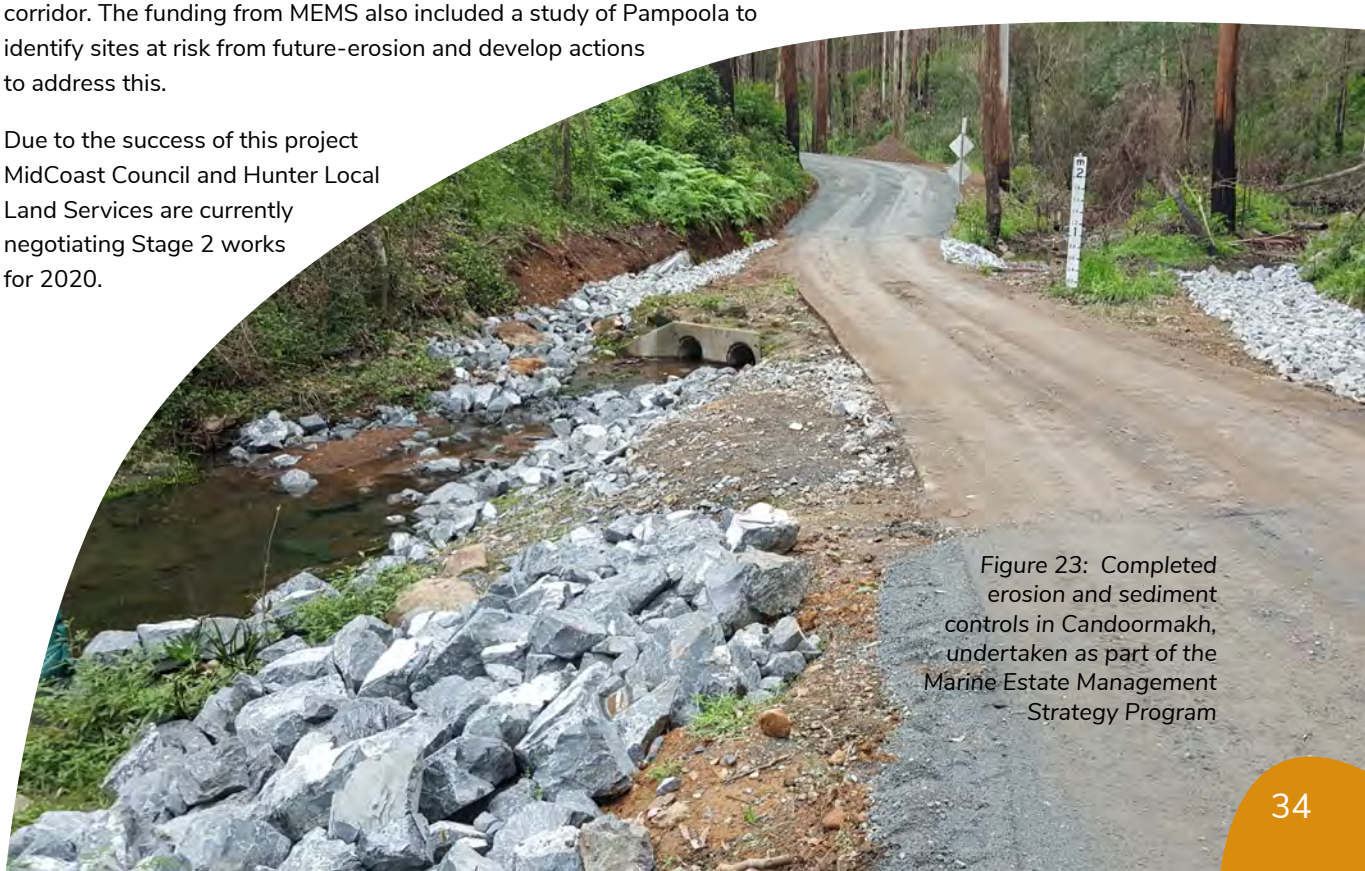


Figure 23: Completed erosion and sediment controls in Candoormakh, undertaken as part of the Marine Estate Management Strategy Program

Management Actions occurring across the Local Government area

Applying water sensitive urban design to new development

When it rains stormwater flows into our waterways untreated off our urban landscape. Before the land was developed, rain would have soaked into the ground and nutrients like nitrogen that occurs naturally in rainfall would have been used up by the vegetation. Hard surfaces in urban areas including roofs, roads and pathways cause an increase in runoff fast tracking a variety of nutrients directly into our waterways picking up additional pollutants such as sediments, petrochemicals, faecal coliforms, and heavy metals along the way.

When nitrogen is in excess in our estuaries it fuels algal blooms. Too much algae reduces the amount of light reaching seagrass, limiting its growth. Seagrass is the basis of the estuary food web and is very important habitat for fish and aquatic bugs, it oxygenates the water. Compared to algae, seagrass is long lived and when algae decompose oxygen from the water body is consumed resulting in low oxygen conditions, impacting on the health of aquatic life. Sediment from the land smothers seagrass, clogs the gills of fish and aquatic bugs. When the condition of the aquatic environment is compromised its inhabitants become stressed and are more prone to disease causing issues such as red spot in fish. Our community value the waterways and they not only support our lifestyle but also a thriving fishing, oyster growing and tourism. Council is focused on protecting waterways from the effects of urban development through the implementation of a water sensitive design policy that makes up part of the Development Control Plan (DCP). This policy requires all new developments to design and install water quality treatments such as raingardens and water tanks to help filter nutrients and sediment out of stormwater before it enters our waterways. In large developments like subdivisions, there is a target in the DCP to ensure that there are no new impacts on our waterways this is called a neutral or beneficial effect target. Since 2015/16, 31 large subdivisions have achieved the ‘no new impact’ target. In the 2019/20 financial year 5 large subdivisions across the MidCoast region and an additional 19 large developments such as commercial, industrial and multi dwellings have also been assessed.

Small scale, infill developments such as single dwellings are also included in the DCP providing further protection from nutrient and sediment input to our waterways, these controls are only applied to the Great Lakes region. Since 2015, 713 individual houses have been approved that were required to address water sensitive design. It is estimated that by reducing pollutant loads to the required standard on these lots through raingardens, swales and rainwater tanks we have prevented 177 kg of total nitrogen and 21.5 kg of total phosphorous from being washed into our waterways annually. In addition to the nutrient reductions, it is estimated that 10.5 tonnes of sediment has been intercepted by these water quality treatments on single dwellings each year.

These figures are considered to be conservative as additional nutrient and sediment removal will be achieved on the dual occupancies and other developments such as commercial and industrial development during this time frame.

Management Actions occurring across the Local Government area

Marine Debris

Marine Debris is the rubbish from our everyday lives that washes into our creeks, rivers and oceans creating unhealthy waterways. It is a big environmental issue and Council are working in partnership with government agencies and the local community to help reduce litter sources and remove established litter along our waterways.

Council continue to be participating members of the Midcoast Plastic Pollution Reduction Project working alongside organisations like Tangaroa Blue, Take 3, Australian Marine Debris Initiative, Local Land Services, Taree Indigenous Development and Employment and Friends of Browns Creek to address litter issues and help reduce them at the source. This group has identified current activities in the region and is constructing cohesive messaging and scoping out opportunities for collaboration in the future.

Community Education is a vital component of managing marine debris and in 2019 Council partnered with Local Land Services and Take 3 to undertake Project Loggerhead Turtle. A full day workshop was undertake with around 40 students from five participating high schools - Taree High School, Manning Valley Anglican College, St Clare's High School, Wingham High School, and Great Lakes College, Tuncurry Campus - learning about the impacts of plastic pollution on our environment and wildlife before undertaking a litter clean-up and audit along Dawson River. Follow up programs were held back at school with students undertaking projects to help reduce litter in their own school yards.

Figure 24: Council staff undertaking a marine debris cleanup in the Browns Creek Catchment

Management Actions occurring across the Local Government area

Management of aquatic weeds

Ongoing weed management is an essential activity which safeguards our economy, environment and community. Throughout the MidCoast region Council is working hard to protect our environment from a number of invasive weed species.

Parthenium Weed

Parthenium weed invades pastures and crops and can cause prblems not only for the environment but also for human health. The discovery of parthenium weed in two Upper Hunter locations has led to increased work in the MidCoast to ensure that the weed isn't also spreading in this region.

Increased education of parthenuim weed, particularly for landholders who may be handfeeding and risk bringing the weed onto their properties is underway and increased management by our weeds officers is also taking place across the LGA.

Bitou bush

MidCoast Council has continued to work closely with National Parks and Wildlife Services (NPWS) to deliver a consistent approach to the management of Bitou bush (*Chrysanthemoides monilifera*) along the coastal strip of the MidCoast LGA. Bitou bush invasion is classified under State legislation as a key threatening process to our coastal ecosystems as it out-competes native vegetation and modifies the topography of the sand dune which increases the incidence of wind borne erosion. The Bitou bush control program is undertaken in winter while the Bitou is flowering and most of the native vegetation is dormant, which allows lower concentrations of herbicide to be applied and minimises the adverse impact on native vegetation.

During the 2019/20 campaign, a professional contractor was engaged to treat over 170 hectares of Bitou along our coastline from Crowdy Head to Yaccaba. Council trialled the use of agricultural drones as a new aerial technology in the application of the herbicide. The drone has offered some advantages over conventional helicopter aerial spraying such as the drone's ability to navigate sensitive environmental areas to target large outcrops of Bitou which were previously inaccessible from the air. The drone also effectively treated post-fire vegetation to remove colonising Bitou at Harrington and was able to tackle Bitou growing on steep coastal headlands. The ability of the drone to better target the Bitou also led to a reduction in herbicide usage across the coastal landscape.

In addition, this year also saw special attention given to a section of the coast at Old Bar where a ground based team, worked alongside Manning Coastcare to target over 7 hectares of mature Bitou. Windbreaks were also installed between the Bitou to reduce wind scour (caused by the clumping growth form of the mature Bitou) and to protect the sensitive rainforest vegetation growing behind the dune.

Preliminary and follow up treatments provided greater than 80% control of juvenile and mature Bitou Bush. Council is currently assessing the effectiveness and cost benefit of using drones to control Bitou and other weeds over more conventional techniques such as helicopters and abseiling.

Figure 25: The utilisation of drones has been key in the management of bitou bush in the MidCoast LGA

Management Actions - Manning Catchment

Manning River Estuary Catchment Management Program

The Manning River Catchment and Estuary is one of the greatest assets in the MidCoast region and is vital to the local economy providing social and cultural values that benefit the people that live, visit and work in the region. The ecological health of the Manning River Estuary is under pressure as a result of past and present land management practices. MidCoast Council is developing the Manning River Estuary and Catchment Management Program (Manning River ECMP) to provide strategic direction for future management of the Manning. The Manning River ECMP will ultimately protect and improve the ecological health of the catchment and support the social, cultural and economic values of the region. It will take a whole-of-catchment approach while meeting the requirements of the NSW Coastal Management Act 2016. The NSW Government is assisting development of the Manning ECMP with grant funds under its Coastal Management Program.

Work has been underway on the program since 2018 and since that time members of Council's Natural Systems team have been consulting with our community to find out what they love about the Manning, what's important to them and what are their hopes for the river in the future.

Council has also been undertaking a number of scientific projects including a rapid assessment of the condition of the whole catchment, spatial risk models to identify priority sub-catchments at risk from diffuse-source run-off, and coastal wetland mapping. In addition to these studies Council have completed a Social research project to better understand the motivators and challenges for farmers implementing measures to improve the condition of the Manning Catchment.

Reports from these studies are now available on the Our Manning River web page along with other valuable information on the Manning. The Spatial Risk Assessment identifies the highest risk sub-catchments for diffuse-source inputs of Total Nitrogen, Total Phosphorous and Total Suspended Solids. The report also covers spatial risk for pathogens from stock and septic systems, and riparian connectivity and extent. A report on the Rapid Site Assessment of the entire Manning River catchment provides photographic summaries and data from all 16 sub-catchments.

As part of the community consultation being undertaken a CMP Reference Group was established with members representing the local community, industry and government agencies to ensure community input to the plan continues.

Discussion groups involving 45 stakeholders from Council, NSW government agencies, university researchers and community groups to discuss what's working and what's not, and identify draft management options for the Manning River ECMP. Issues discussed included agricultural impacts; floodplain management (ASS); climate change stressors; modified flow; coastal wetlands; vegetation clearing and degradation; entrance modifications and modified hydrology; sewerage and septic management; sediment and erosion management; urban stormwater; and biodiversity loss.

Using the information gathered since the commencement of the project a draft actions have been developed and the next step is to identify their acceptability, feasibility and viability. Council will also be undertaking consultation with the Aboriginal community to get their input on the plan values, vision, management actions.

A draft of the plan will be exhibited for community input early 2021 before it is adopted later in the year. Figure 26 shows where Council are up to in plan development and where the project is headed over the coming months.

While development of the Manning River ECMP is underway, MidCoast Council continues to implement an established program of works to protect ecosystem health. These actions will be integrated into the plan as it develops.

Management Actions - Manning Catchment

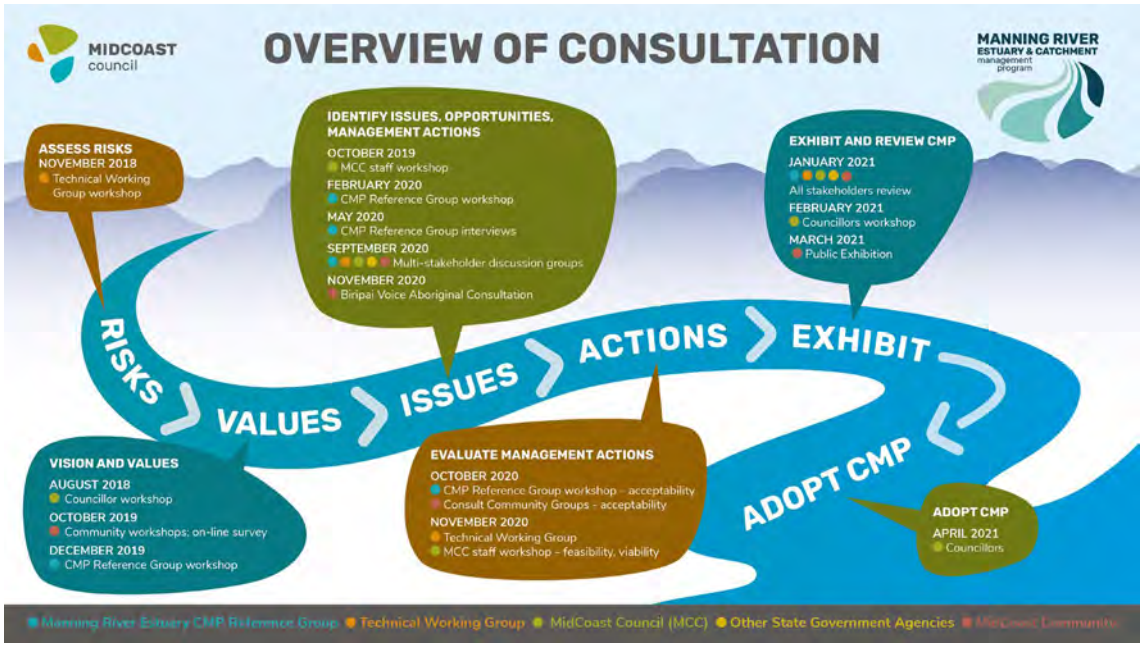


Figure 26: Consultation process for the Manning River Estuary Catchment Management Program

For more information about the program visit www.midcoast.nsw.gov.au/ourmanningriver

Lowland Rainforest Resoration

Lowland Rainforest on Floodplain is an endangered ecological rainforest community which now occurs only as small remnants in scattered localities on the NSW north coast with less than 1000ha remaining. Larger stands of the community typically have a dense canopy, which blocks most light from reaching the ground, creating cool, moist conditions within. Lowland Rainforest on Floodplain supports a rich diversity of plants and animals. Typical tree species in the community include Moreton Bay, small leaved and strangler figs, Bangalow and cabbage tree palms, weeping lilly pilly and brush cherry.

Lowland Rainforest is characterised by a high proportion of frugivorous birds, litter foraging vertebrates, different species of bats, and a broad range of invertebrate groups associated with the decomposition cycle (such as insects and snails).

Since European settlement Lowland Rainforest has undergone a large reduction in geographic distribution due to clearing. Extensive clearing has resulted in fragmentation and loss of ecological connectivity. The integrity and survival of small, isolated stands is impaired by the small population size of many species, enhanced risks from environmental fragmentation, disruption to pollination and dispersal of fruits or seeds, and likely reductions in the genetic diversity of isolated populations.

Weed invasion also poses a major threat to Lowland Rainforest, invasive weeds, particularly riparian vine weeds such as madeira vine, cats claw creeper and balloon vine, smother and outcompete native vegetation. The introduction of an intensive weed control program and the replanting of a variety of rainforest species will contribute to the recovery of these important ecosystems.

Other common threats include grazing by livestock, potential impacts of climate change and impacts associated with human visitation (including soil compaction, possible spread of pathogens, clearing of understorey and inappropriate collection of plant species).

Management Actions - Manning Catchment

Over the last three years MidCoast Council have been working hard to restore three important riverside reserves: Wingham Brush, Andrews Reserve and Flanagan's Creek Spit.

Restoration work that has been undertaken in the Wingham foreshore area has included the control of 8 hectares of invasive exotic weed species that have been severely impacting the native vegetation and the restoration works that have previously occurred on site. So far, 934 supertubes, 775 tubestock and 30 translocations have been planted to reduce competition from fast growing weed species and to close down canopy gaps.

Andrews Reserve in Taree has also benefitted from regeneration works and 515 hours of hand weeding and spraying has gone into the primary and secondary treatment of weeds along the riparian stretch on the 2 hectare site. An additional 2270 trees have been planted over the 3 year lifespan of the project.

The final site known as Flanagan's Creek Spit is located within the Manning Waters Reserve, Taree West. This site has seen weeding across 6 hectares as well as planting of 900 tubestock to connect isolated trees into corridors and islands of vegetation to reduce weed edge effects.

These three reserves and a number of others on the Manning River floodplain form part of the broader Stepping Stone Project, a long-term initiative of Council that aims to create a linkage of rainforest remnants on the Manning in partnership with local environmental groups such as Taree Landcare.

This project was made possible by MidCoast Councils Environmental Rate and supported by the New South Wales Government through its Environmental Trust..

Figure 27: Native vegetation prior to vine removal

Figure 28: Native vegetation following vine removal

Management Actions - Manning Catchment

Restoring Littoral Rainforest

Littoral Rainforest communities could once be found in many locations along the coastline of NSW but today this rainforest type is rare and only occurs in small stands. In total, it comprises less than one percent of the total area of rainforest in NSW. Being a rainforest community it is home to an array of plant and fungi species and an assemblage of native animals from marsupial mice to squirrel gliders.

Over the past three years MidCoast Council has been building the resilience of the Littoral Rainforest along our coastline under the 'Restore the Core' project in areas such as the Blackhead/Redhead Headland and Diamond Beach. Over the life of this project skilled bushland regenerators and volunteers have helped reverse the cause of this degradation by removing established and emerging invasive weeds. With the target weeds including Weeds of National Significance such as Bitou Bush, Asparagus, Lantana and Madeira Vine as well as other invasive weeds including Mother of Millions, Passionfruit Vine, Easter Cassia, Brazilian Nightshade and Cape Ivy.

This project allowed the volunteers from Hallidays Point Landcare to work in close association with skilled bushland regenerators to address the weed threat. Volunteers also assisted the bush regenerators by performing vital follow-up bush regeneration and assisting with their local knowledge by informing us of previously hidden sources of weeds. The bush regenerators tackled weeds that were in inaccessible locations, such as steep slopes and cliff faces; thereby removing a continual weed seed source.

Addressing the key threat of invasive weeds increases the resilience of the littoral rainforest allowing the succession of seedlings to become established. Unfortunately, the severe drought of 2019/2020 saw the demise of a high proportion of these seedlings. However the works that have been undertaken have increased the resilience of the Littoral Rainforest and therefore it is hoped that this year's seedlings will fare better.

In total 61 ha of high conservation vegetation Littoral Rainforest has undergone primary, secondary and tertiary weed removal to achieve an 80% reduction over three years of the project and Volunteers contributed over 2500 work hours to the project.

The Restore the Core project was made possible by MidCoast Councils Environmental Rate and supported by the New South Wales Government through its Environmental Trust.

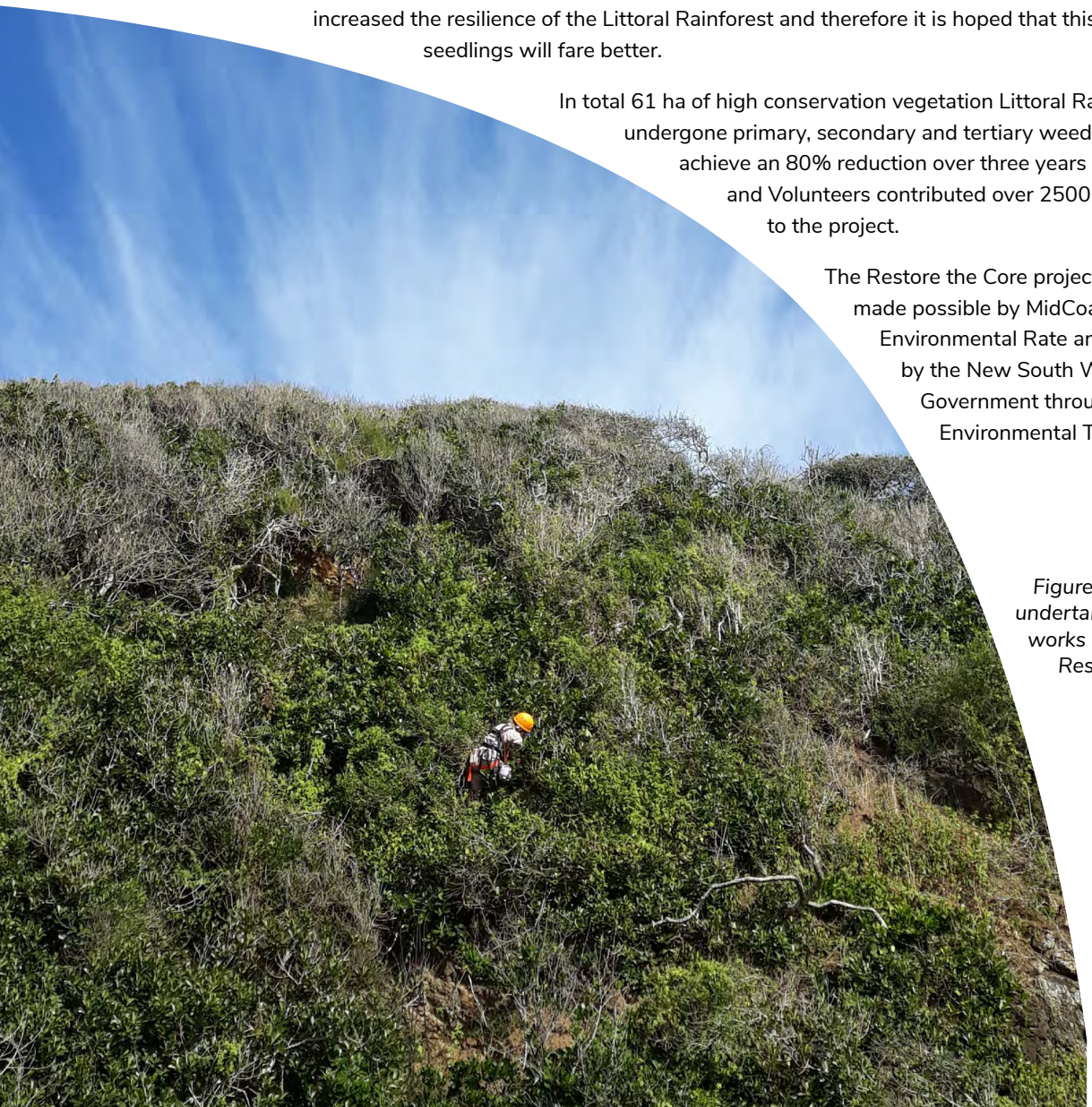


Figure 29: Abseiler undertaking weeding works as part of the Restore the Core project

Management Actions - Manning Catchment

Riverbank Restoration

The Dumaresq Island Riparian Vegetation Restoration and Bank Stabilisation project was designed to help reduce erosion and improve water quality through the installation of hard structures.

Prior to the commencement of the project weed control was undertaken at the site prior to help prevent the fragmentation and spreading of weeds – major weed species included cat's claw creeper (*Dolichandra unguis-cati* and Bamboo).

Figure 30: Mangroves regenerating behind rock fillets to protect the bank from erosion on Dumaresq Island

Once the weed control was completed 410 m of rock fillets were constructed. These rock fillets have allowed for the re-establishment of 0.35 hectares of key fisheries habitat (mangroves and saltmarsh). 420 m of stock proof fencing was also installed to protect the re-establishing mangrove and saltmarsh communities. The fenced off area has permitted one hectare of riparian vegetation to re-establish, the planting 500 native tube stock and undertaking weed management has also assisted in the overall strengthening of the riverbank. Follow-up weeding and planting of 500 tube stock completed.

The results of the project thus far are positive and the landholder has committed to ongoing weed control and planting, maintenance of the fence line and ensuring cattle remain out of the fenced off area.

This project was supported by the NSW Government through the Department of Primary Industries and Fisheries Habitat Action Grant, as well as landholder contributions and MidCoast Council's Environmental Rate.

Management of Aquatic Weeds

2020 has been a bumper year for weeds in the Manning Catchment with the highest priority weeds being brought under intensive management programs.

Huge headways have been forged with Tropical Soda Apple management. Private property and public land inspections across the MidCoast region have been the primary focus for identifying outbreaks of the priority weed Tropical Soda Apple. Conditions are arduous for Council inspectors and contractors undertaking the task in many remote locations including Wingham, Mount George, Number One and Cells River.

Approximately 80 inspections, have revealed infestations of Tropical Soda Apple in varying densities at 34 sites. Council has formed partnerships with Hunter LLS and NSW DPI and is currently working with all affected landholders and community at large to educate and build their capacity to accurately identify plants and manage infestations with the goal of eradication. Tropical Soda Apple is recognised as being in limited distribution in the MidCoast region giving weight to the eradication target.

MidCoast Council's annual Senegal tea plant control program is a continuing priority however the 2019/2020 second pass treatment was unfortunately not completed due to a combination of issues including severe drought, fires, flooding and the onset of Covid-19,

Groundsel bush aka *Baccharis halimifolia* is being managed at various sites in the north east of our local government area. MidCoast Council is currently establishing relationships with all affected land managers, leading a project for the long term protection of significant local aquatic environments including the Cattai wetlands. There has been a major reduction in densities with known occurrences treated along the highway corridor from Coopernook to Stewarts River in collaboration with Roads and Maritime Services and a private property at Coralville in conjunction with the land manager and Hunter Local Land Services.

Management Actions - Manning Catchment

Litter and Marine Debris

Litter and marine debris are one of the biggest environmental issues facing us today. It is the rubbish from our everyday lives that washes into our creeks, rivers and oceans creating unhealthy waterways.

Stormwater is a particular issue, any rain that falls on roofs or collects on paved areas like driveways, roads or footpaths carries with it pollutants and moves them into rivers, lakes, estuaries, beaches and groundwater.

To help protect our waterways from the run-off MidCoast Council has installed a number of Stormwater Quality Improvement Devices (SQIDs) such as Gross Pollutant Traps (GPTs) throughout the Manning Catchment.

GPTs filter stormwater runoff and catch stormwater pollution before it has a chance to enter waterways. Council has recently completed an audit all the GPTs in the Manning to assess how well they are functioning and ensure that they are all in working order. Following the audit a comprehensive clean of each device is being undertaken and rectification works are underway on several devices that had started to deteriorate with age.

Utilising funding from Council's Stormwater Managment Services Charge works will continue for the next 12 months to ensure that all devices are operating at their full capacity and protecting our waterways for many years to come.

Council are also working in partnership with government agencies and the local community to reduce litter sources and remove established litter along our waterways. In the Taree area Council have been working with Friends of Browns Creek, Taree Indigenous Development and Employment (TIDE), Tangaroa Blue and Hunter Local Land Services and have been successful in removing over 980 kgs of material from within the Catchment.

Figure 31: Undertaking maintenance on Gross Pollutant Traps in the Harrington area

Management Actions - Manning Catchment

Rehabilitation of Acid Sulfate Soils

Acid sulfate soils are natural sediments that contain iron sulfides. When disturbed or exposed to air these soils can release acid and other heavy metals, which can have severely damaging effects on aquatic ecosystems. Council continues to address the remediation of a State recognised acid sulfate soil (ASS) hotspot through the staged implementation of the Big Swamp project. The Big Swamp is a 2000 hectare coastal floodplain at Coralville which has been extensively cleared and drained for agriculture. This has resulted in the generation and discharge of ASS pollution into the Manning River Estuary, which has adverse impacts on water quality, aquatic ecology, oyster production and commercial and recreational fishing.

As part of the project in Big Swamp priority areas of the floodplain have been the focus of remediation efforts since 2012 and on-ground works in these areas were completed in 2014. Since 2014, the Water Research Laboratory (WRL) of the School of Civil and Environmental Engineering at UNSW Sydney has been working with the MidCoast Council (Council) to monitor the onsite changes in surface water quality.

Through this monitoring it has been shown that provided substantial rain falls in the Big Swamp catchment, acid sulfate discharges can continue to impact water quality in Pipeclay Canal, Cattai Creek and the Manning River Estuary. Long term monitoring has also indicated that water quality in the Big Swamp area has been improving since on-ground works in the lower end of the project area to restore the natural hydrology have been implemented.

Monitoring will continue on water quality, vegetation and fish stock changes across the site and given the success and water quality improvements already seen expansion of the project may occur in the future.

Figure 32: Big Swamp project area

Management Actions - Manning Catchment

Marine Estate Management Strategy

The NSW Marine Estate Management Strategy (MEMS) is a ten year program of works to coordinate and streamline the management of the 1750 kilometres of coastline, 826 beaches and 185 estuaries in New South Wales. In the MidCoast Council region, Hunter Local Land Services (HLLS) is implementing a large proportion of works on behalf of the NSW Government.

In 2019 MidCoast Council partnered with Hunter Local Land Services to implement Stage 1 of the MEMS in our region. This included a specific focus on protecting eroding river banks and reducing sediment and erosion from unsealed roads.

Over 1150 metres of riverbank were rehabilitated in two key locations: Lower Wallamba River and the Lansdowne River. Not only will these projects reduce sediment from eroding river banks entering the waterways, they will also provide additional fish habitat and increase mangrove growth, while re-establishing the adjacent riparian corridor. The funding from MEMS also included a study of Pampoola to identify sites at risk from future-erosion and develop actions to address this.

Due to the success of this project MidCoast Council and Hunter Local Land Services are currently negotiating Stage 2 works for 2020.

Figure 33: Completed erosion and sediment controls on North Moto Road undertaken as part of the Marine Estate Management Strategy Program

Sharing the Shore

Each year migratory shorebirds from all over the world fly incredible journeys to spend their summer in the MidCoast region stocking up on food. A number of endangered shorebirds also nest along our sandy beaches such as the Pied Oyster Catcher and the Little Tern. The beaches on the MidCoast Council are the most important breeding site for little terns in the state, normally producing up to a quarter of all fledglings in NSW. Flocks of little terns begin to arrive on NSW beaches to breed around September. Pied oystercatchers may be resident all year round and have already started nesting with three documented nests thus far.

To protect endangered shorebird eggs and chicks a multi-agency working group consisting of MidCoast Council, Department of Planning, Industry and Environment, Crown Lands, Hunter Local Land Services, National Parks and Wildlife Service, Indigenous employment group - TIDE, bird watching societies and essential local volunteers, are stepping up efforts to control foxes, install temporary signs and construct temporary fencing to protect shorebird nesting sites. Harrington has 1.6 km of temporary fencing installed and Farquhar has 1 km of fencing. The temporary signs that have been installed remind beach goers to avoid the vulnerable nesting sites, to protect shorebirds and their dogs from 1080 baits and to drive only on designated 4WD beaches below the high tide line. By working together these efforts have seen many shorebird chicks reach adulthood in the past and we expect even greater success this year.

Figure 34: Pied oyster catcher chick

Management Actions - Manning Catchment

Coastal Wetland Mapping

Coastal wetlands are amongst the most sensitive and significant vegetation communities in NSW and provide a range of ecosystem services including capture and storage of floodwater, nutrient cycling, and sedimentation. They provide habitat for threatened flora and fauna species and also provide a range of services to the community including agriculture, fishing, lifestyle and tourism activities.

The Manning Estuary is home to significant areas of coastal wetlands and MidCoast Council recently engaged specialists to map all these important coastal wetlands. The study was undertaken using a range of different methodologies including 3D aerial mapping, field surveys both on ground and by boat, and surveying using drone technologies.

Once the field surveys were completed the data was assessed and information on wetland types, vegetation communities, condition and current threats were included in the mapping. Recommendations were also provided for restoration and protection of each of the wetland areas.

Over 8906 hectares in total were mapped including 51 individual areas. Of the wetlands that were mapped 69% were in good/excellent condition, whilst wetlands in fair condition accounted for 19% of the total area mapped and poor/very poor condition equated to 12%. The majority (86%) of all wetland types mapped are protected under State or Commonwealth legislation.

Following the study a fine-scale wetland map was produced that will be used to inform protection and enhancement programs, biodiversity conservation initiatives and water quality improvement projects. The mapping project will also play an important role in the preparation of the Manning River Estuary Costal Management Program which is currently in development with funding assistance from the NSW Government. It will provide strategic direction for the future management of the Manning River Estuary.

Figure 35: Launching the drone as part of the coastal wetland mapping

Management Actions - Khappinghat Catchment

Management of Reserves

Located in the Khappinghat Catchment the Kiwarrak Wilderness reserve is a 26 hectare parcel of council land, which adjoins Khappinghat Nature Reserve at Rainbow Flat.

The Nature Reserve is of ecological significance and contains 5 threatened flora species as well as 15 threatened fauna species, because of this it is imperative that the reserve be maintained in a stable ecological state to allow for movement and additional habitat not only for these species but also other native flora and fauna.

The reserve was first surveyed for weed species back in November of 2012 and at that time only lantana was recorded to be of concern. Weed management was undertaken on site however recent surveys in 2019 revealed quite an extensive infestation of asparagus fern had made its way onto the site (possibly spread by birds from neighbouring gardens) and as such Council undertook additional weed control on both lantana and asparagus with a special focus on control measures for asparagus fern.

Since control measures have taken place the entire reserve system was intensely burnt during the recent bush fires, ongoing management of the reserve will continue into the future as the site recovers in order to protect the site, local wildlife and water quality in the region.

Figure 36: Asparagus fern is a target of weed control in the Khappinghat Catchment

Management Actions - Wallis Lake

Stormwater Quality Improvement

The health of Wallis Lake has received a recent boost with the refurbishment of the Townsend Street constructed wetland in urban Forster. The wetland was originally constructed in 2003 and was designed to remove sediment and filter nutrients from urban runoff prior to discharge into the stormwater system and Wallis Lake. Stormwater runoff form urban areas is one of the major impacts threatening the health of our waterways.

The wetland receives stormwater inflow from 90 hectares of the surrounding urban area that prior to the original construction, would have would have drained untreated directly into Wallis Lake. The refurbishment works involved the removal of existing vegetation and excavation of accumulated sediments captured during the previous 17 years. A total of 985 tonnes of material was removed from the wetland basin. The trash racks that capture large pieces of litter were replaced, the wetland outlet drain was reconstructed and the high flow by-pass channel was cleaned out and lined with rock to reduce sedimentation and assist with on-going site maintenance.

Figure 37: Planting underway at the newly refurbished Townsend Wetland

Following the completion of the construction works, the wetland basin was planted with native macrophytes, which are aquatic plants that grow in or on the edge of saline and fresh water bodies. Macrophytes are an important component in both natural and constructed wetlands as they provide food and shelter for fish, aquatic invertebrates and water birds. Once established, these Macrophytes are very good at removing nutrients from stormwater runoff.

This project compliments the other wetlands (8), raingardens (11) and gross pollutant traps (2) that have been constructed on public land in the Wallis Lake Catchment.

Bank stabilisation

Erosion is a significant environmental issue affecting the health and stability of our waterways. The Wallamba River Estuary is exposed to severe bank erosion in many areas due to past vegetation clearance, ongoing cattle grazing and wash from boating activities. Sediments from this erosion reduce water clarity in Wallis Lake impacting on its ecological health.

Excessive sediments directly impact on the oyster, professional and recreational fishing industries by smothering the gills of fish and creating additional stressors in their environment reducing their ability to fight disease. Reduced water clarity limits the depth at which seagrass will grow, seagrass is the basis of the estuary food web and is very important habitat for fish and aquatic bugs. By reducing sediment loads this project will enhance aquatic habitat for fish and crustaceans.

Water quality and fish habitat in the lower Wallamba River have received a recent boost following the implementation of 2 on-ground restoration projects. Works have involved the construction of rock fillets, revegetation and stock exclusion fencing on severely eroded riverbanks along the Wallamba River at Darawank and Nabiac.

Figure 38: Bank stabilisation works in the Wallamba River

Management Actions - Wallis Lake

Council secured funds through the Local Land Services under the NSW Marine Estate Management Strategy (MEMS) to implement the projects in key areas of the Wallamba River. MEMS is a 10-year strategy, a key deliverable under the Marine Estate Management Act 2014 and aims to deliver the NSW Government's vision of 'a healthy coast and sea, managed for the greatest community wellbeing, now and into the future'.

Project works involved the construction of 930m of rock fillets that provide immediate and direct erosion control and enable the recruitment and regeneration of mangroves behind the fillets that provide important habitat for juvenile fish and crustaceans.

Addressing the erosion of the riverbanks also helps to improve water quality by reducing sediment and nutrient inputs to the Wallamba River and downstream Wallis Lake. Additional works to benefit the river have also involved the establishment of 370m of stock exclusion fencing to keep cattle off riverbanks and 2,000 native tube-stock have been planted to re-establish and enhance riparian vegetation that will provide important habitat for marine life and terrestrial fauna.

The project, which has also been supported by funds from Council's Environmental Rate were completed in July and in the long term will deliver on the objectives of the Lower Wallamba River Rivercare Plan, Wallis Lake Estuary and Catchment Management Plan and the implementation of the Wallis Lake Wetlands Strategy.

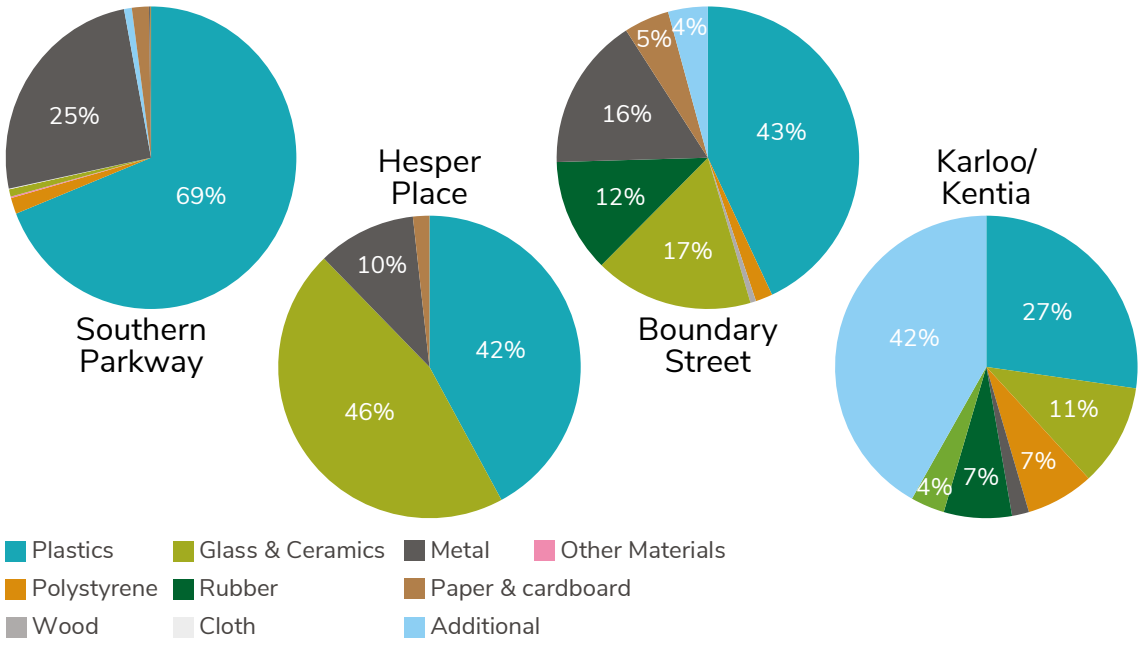
This project compliments a number of projects that have come together over the years to stabilise 11.3 kilometres of the Wallamba River.

Protecting our waterways from litter

Litter entering into our waterways is one of the biggest environmental issues facing us today.

During 2019 an extensive clean-up was undertaken on a number of Forster reserves as part of the Urban Bushland Restoration Program to help remove built up litter before it can enter our waterways. Litter removal was undertaken on the Southern Parkway, Boundary Street, Karloo Street and Hesper Place. Overall over 500 kgs of material was removed and information on the materials collected at each site were uploaded Tangaroa Blue Foundation's Australian Marine Debris Database.

Information on the materials found at each site is included below.



Management Actions - Wallis Lake

Council is also currently working on improving the Stormwater Quality Improvement Devices around the Wallis Lake area. An audit of each of the Gross Pollutant Traps (GPTs) in Forster was undertaken to ensure the devices were working to their maximum capacity and protecting the lake from litter. Following the audit a comprehensive clean of each device was completed and any necessary rectification works were completed.

Management of Aquatic Weeds

The discovery of the Amazon Frogbit aquatic weed in Forster prompted an urgent emergency response from MidCoast Council, NSW Department of Primary Industries and Hunter Local Land Services.

It was the third instance of Amazon Frogbit found in the MidCoast since 2017. The weed is classed as Prohibited Matter under the new Biosecurity Act 2015 and as a result an emergency response was commenced to manage this infestation as swiftly as possible. Various activities to eradicate the infestation were undertaken including primary and follow up treatments to bring the infestation under control.

Amazon Frogbit originates from fresh water habitats of tropical and subtropical Central and South America. Although in the early stages of establishment in Australia, these weeds have the potential to seriously degrade Australia's ecosystems if left untreated. In Australia, the weed is often purchased illegally online, on sites such as Gumtree and eBay, by unsuspecting aquarium owners and can spread to natural waterways accidentally or via deliberate dumping of garden and aquarium waste.

Other significant projects for the Wallis catchment include on-going frogbit monitoring/management at Green Point, control and progressive removal of Camphor laurel trees on public land in the Forster district and a collaborative project engaging locals and managing weeds in the wetland and village areas of Cabarita at Forster.

Figure 39: Weed workshop with a number of different stakeholders

Management Actions - Wallis Lake

Installation of Oyster Reefs

Since 2015, Local Land Services (LLS) and MidCoast Council have been working with the oyster and fishing industries to understand the changing nature of Wallis Lake and develop practical adaptation responses. Both industries have been working with LLS, MidCoast Council and Taree Indigenous Development and Employment (TIDE) to construct an oyster reef in the Wallamba River to protect the riverbank on Gereeba Island. Oyster reefs have been decimated across the world by destructive harvesting practices, poor water quality, diseases and pests and there are now many projects across the country and the world restoring these ecosystems. To help protect the bank from erosion and assist in the establishment of mangroves the project trialled new ways of providing wave protection involving the placement of waste shell from oyster production along the bank.

Live oysters harvested from oyster leases were also added to encourage and possibly accelerate the creation of a living structure. Slowing erosion of the riverbank will reduce the amount of sediment entering the Wallamba River and improve water quality. Oyster reefs also provide good habitat for a range of fish and other marine life, including species targeted by recreational and commercial fishers such as bream and mullet. Site monitoring is being done by LLS, TIDE and the University of Newcastle and early results are promising with live oysters surviving and growing and the structure continuing to protect the young mangroves and the riverbank. Oysters are filter feeders and as their filtration helps improve water clarity it is hoped that the oysters at Gereeba Island will survive and thrive alongside mangroves with both providing habitat for fish and invertebrates.

Monitoring of the site was undertaken in late 2019 in conjunction with the University of Newcastle to see the effects of the installation. Newly recruited oysters were found at all sites where shells had been deployed, indicating recruitment and survival onto the deployed shells. Sediment accretion increased showing that the shells are acting as sediment traps, reducing resuspension and reducing wave action and bank erosion and a higher diversity and abundance of infauna at restoration sites indicates they are functioning as an important invertebrate habitat. Monitoring will continue to see the long term effects of the oyster reefs.

MidCoast Council and LLS are now scoping out additional sites where these methods could be applied successfully and will be working with the University of the Sunshine Coast to map existing oyster reefs and better understand how fish utilise different estuarine habitats and move between them.

Figure 40: Mangrove regenerating amoungst the newly installed oyster reef

Management Actions - Wallis Lake

Control of Feral Species

Feral species such as foxes compete with native species for food and resources. Native wildlife in the Lower Wallamba area has benefitted from multiple fox control programs run in 2019/20. The program targeted areas in Darawank and North Tuncurry as well as the Tuncurry Waste Management Facility, Halliday's Point Wastewater Treatment Plant and Council lands at the southern end of Minimbah Road and Aerodrome Road.

The bushfires in 2019 severely impacted native vegetation and native animals on a large scale across these areas. The feral animal control work has been even more critical this year than in previous as a lack of fauna refugia since the bushfires has left our native wildlife even more susceptible to predation by feral animals.

A number of exciting finds were found during feral animal controls in the Minimbah area, with the NSW listed vulnerable species the Long-nosed potoroo recorded on camera at a number of locations across the Minimbah sandplain.

Urban fox control consisting of den fumigation methods is carried out annually at known den locations through various council reserves in the Forster area.

Forster Reserves

The Forster area, including Council Reserves and trees and bushland on private land, currently hold significant populations of threatened species including the squirrel glider. We know that numbers of these special gliders are quite good and that they are breeding, but the area of habitat that the Forster gliders live in is very restricted. Past clearing and development has fragmented the habitat and we know that we need to take special action if we are to preserve gliders in the long-term in Forster." The bushfires in 2019 also impacted the squirrel gliders and other native wildlife.

Over the past 3 years, Council and specialist contractors have delivered on-ground actions including bushland restoration works, such as weed removal, pest animal controls, food tree plantings, rubbish removal, as well as the delivery of community education programs. This work has been made possible with funding assistance from the NSW Government through its Environmental Trust.

The bushfires in 2019 were a setback to previous on-ground works and impacted the squirrel gliders and other native wildlife tremendously. Council and bush regeneration contractors have working diligently to restore and improve native vegetation and habitat for native fauna, particularly the threatened squirrel glider through urban bushland reserves impacted by the October/ November 2019 bushfires. Large areas of The Southern Parkway, Golden Ponds and Zamia Place public reserves were extensively burnt in the fires causing significant damage to vegetation and native wildlife.

The impacts on native vegetation and the significant rainfall in late summer and early autumn saw an explosion of weeds species throughout these reserves. Bush regenerators have been working extensively through these areas over the past 6 months targeting high priority and emerging weeds that threaten the recovery of native flora at the site.

One of the key aspects of the project was to install specially-constructed nesting boxes in areas of public reserves where natural hollows were in short supply. The

Figure 41: Squirrel glider in the Southern Parkway Reserve Forster

initial installation of these boxes was well received by the local squirrel glider population, with monitoring in the first 2 years of the project detecting a high number of squirrel gliders using the nesting boxes. Unfortunately, the bushfires destroyed 24 nesting boxes in the golden Ponds and Southern Parkway Reserves which would have resulted in a number of squirrel gliders having perished. Council have since replaced these destroyed nesting boxes across the burnt reserves and recent monitoring has found squirrel gliders in some of these boxes which is very good news for the local population.

The work has improved the condition of 53-hectares of important bushland reserves stretching from Golden Ponds, The Southern Parkway and through to the Karloo Street Reserve. These reserves will be subject to on-going maintenance bush regeneration works funded through MidCoast Council's Environment Rate to continue to improve the quality and habitat values of these bushland reserves and the surrounding catchment.

Improving Natural Areas

MidCoast Council is responsible for the management of a large and diverse array of natural areas within the Wallis Lake Catchment that provide important water quality functions and habitat for many native species, including numerous threatened species. These lands are all impacted to some extent through the invasion of weeds that compete with and degrade native vegetation.

Bush regeneration works targeting priority invasive weeds are being carried out across 461 hectares of land at Minimbah, Failford, Darawank, and a number of Islands and foreshore lands in the Wallamba River and Wallis Lake. Whilst along the southern foreshore; 175 hectares of land are being treated for transformer weeds in the Buranner Wetland complexes, Coomba foreshore reserve, Coomba Aquatic gardens, Whoota reserve, Wallis Foreshore reserve and the Palms reserve at Elizabeth beach These works help improve the condition of native vegetation across this sensitive landscape that is vital for water quality improvement, notably the filtering of pollutants and nutrients in sediment runoff from the surrounding catchment. Smiths Lake

Figure 42: Bush regeneration works being undertaken in the Wallis Lake Catchment

Management Actions - Smiths Lake

Management of Aquatic Weeds

MidCoast Council has continued to work closely with National Parks and Wildlife Services (NPWS) to deliver a consistent approach to the management of Bitou bush (*Chrysanthemoides monilifera*) along the coastal strip of the MidCoast LGA. Bitou bush invasion is classified under State legislation as a key threatening process to our coastal ecosystems as it out-competes native vegetation and modifies the topography of the sand dune which increases the incidence of wind borne erosion. The Bitou bush control program is undertaken in winter while the Bitou is flowering and most of the native vegetation is dormant, which allows lower concentrations of herbicide to be applied and minimises the adverse impact on native vegetation.

The Smiths lake area has been subject to an integrated pest management program for the management of Bitou bush for more than a decade, boasting greater than 95% control of mature bitou where treated.

Figure 43: The utilisation of drones has been key in the management of bitou bush in the Smiths Lake area

Management Actions - Myall Lakes

Myall Lakes wetland and habitat protection

The Myall Lakes and River catchment is recognised for its productivity, natural assets and immense popularity for nature-based recreation. The catchment contains features such as the internationally-recognised Myall Lakes Ramsar Site, important cultural and biodiversity sites as well as the Port Stephens – Great Lakes Marine Park. According to the Myall Lakes Ramsar Site ecological character description prepared by the NSW Department of Planning Industry and Environment (formally Office of Environment and Heritage) (2012), the Myall Lakes "consist of a mosaic of near-natural wetlands ranging from fresh to brackish and estuarine waters within a relatively unmodified coastal lake system unique in NSW. As a consequence of the habitats provided by this range of wetlands and by the surrounding terrestrial vegetation, the site supports a rich biodiversity." The catchment is within the traditional lands of the Worimi people. Myall Lakes National Park is the 7th most visited National Park in New South Wales, attracting over 1.2 million visitors in 2018.

Fortunately, in comparison with many other landscapes of the MidCoast Region, the Myall Lakes and River catchment were not as significantly impacted by the severe bushfires in 2019. As such, the natural areas of the catchment provide a significant habitat refuge for broader landscape scale biodiversity recovery.

Over the past year, progress has been achieved with regards to the protection of wetlands and important natural landscapes and the conservation of biodiversity in the Myall River and Myall Lakes catchment. For instance:

- The NSW National Parks and Wildlife Service, with Council and other partners, including community volunteers, worked collaboratively to protect an important nesting site of the little tern and pied oystercatcher in the Lower Myall and Port Stephens estuary, including around the sand-spits and islands associated with Corrie Island and Winda Woppa,
- A conservation collaboration with a private landholder in the Bulahdelah locality was extended, which resulted in the addition of 60-hectares of land into permanent private conservation. In total, the private conservation area now occupies 373-hectares of important wetland and dry forest types. This protected area adjoins (and adds significant value) to the Council's Bulahdelah Plain Wetland Reserve (366-hectares). The lands are protected under a Conservation Agreement and 3-years of management funding has been provided by the NSW Biodiversity Conservation Trust to undertake bushland and habitat enhancement work, such as weed and fox controls and bushfire management,
- A number of landholders are partnering with the NSW Government to explore the adoption of Biodiversity Stewardship Agreements and Conservation Agreements in the Myall Lakes and River catchment. These agreements are facilitated by the NSW Biodiversity Conservation Trust (https://www.bct.nsw.gov.au/)
- The Bulahdelah District Pest Animal Management Group continued to deliver excellent collaborative pest animal control programs in the catchment. This included a focus on priority pest species, such as foxes, feral deer and wild pigs. The Group is a strategic and proactive collaboration of community landholders and government agencies, including Hunter Local Land Services, NSW National Parks and Wildlife Service, NSW Forestry Corporation and Council,
- MidCoast Council has commissioned a study to investigate and map the locations of priority connecting habitats and wildlife corridors in the Myall Lakes and River catchment. The work is ground-breaking and provides an excellent spatial basis for conservation and restoration prioritisation. The study is being investigated for publication in a peer-reviewed scientific journal.

Figure 44: Buladelah Plain Wetland is an important conservation site on the Myall River

Management Actions - Myall Lakes

Control of Feral Species

The Bulahdelah Plain Wetland is an important ecological asset which is home to a diverse array of native fauna and flora. Threatened species including the long-nosed potoroo, new-holland mouse, squirrel glider and spotted-tailed quoll have all been found on the site. Many threatened birds have also been recorded including the black-necked stork, white-bellied sea-eagle, spotted harrier, little lorikeet and varied sitella. The grey-headed flying-fox and wallum froglet are also known residents.

Multiple fox control programs have been run at the wetland during 2019-20 targeting foxes with good results achieved across the site. These programs have also benefitted through participation with an adjoining private landholder allowing the program to cover a much larger area of important conservation lands in the Myall Lake Catchment.

Figure 45: Feral animal control is undertaken in the Myall region to protect local wildlife

Management of Aquatic Weeds

MidCoast Council is currently working with National Parks and Wildlife Service and the Hunter Local Land Services to reduce the impacts of the highly invasive aquatic weed Long-leaf willow primrose aka *Ludwigia longifolia*, on high value wetlands and waterways across the region. Long-leaf willow primrose is a native of South America, recorded from Brazil to Argentina and is considered a major weed in its native range. Spread of long-leaf willow primrose is by either seeds or stem fragments. Seeds are extremely small, less than 1 mm long and can be dispersed by water, wind, or human activity. Vegetative propagation occurs via rooting of stem sections. This species was introduced to Australia as an aquatic ornamental plant and was first recorded as naturalised near Sydney in 1991. It has also been recorded from the Port Stephens and Gosford areas on the Central Coast of NSW and near Brisbane in Queensland.

Locally, the RAMSAR listed Myall lakes, are at high risk of degradation caused by the weeds. A long term combined management program partnership between MidCoast Council and National Parks and Wildlife Service will aim to significantly reduce infestations across all land tenures. The project will include an integrated pest management program for weed control and engagement of land holders to build capacity for management of infestations on private properties.

Other continuing priority projects for the Myall catchment include Parrots feather management on the Myall River from Markwell to the Broadwater including Nerong Inlet and Harbour. Significant reductions (greater than 90%) in the density and occurrence of Parrots Feather has been achieved since the project commenced in 2008.

Frogbit management also remains a high priority with Council working closely with affected land holders to ensure The LGA and Myall catchment remains Frogbit free.

Management Actions - Myall Lakes

Restoration of native areas

The Kore Kore Conservation Area is a collection of reserves that was acquired by MidCoast Council in August 2012 with funding support from the Hunter/ Central Rivers Catchment Management Authority (now the Hunter Local Land Services). It was acquired principally for use as a biodiversity offset, as well as for the purpose of water quality protection and contribution to the Durness-Borland Landcare Corridor. More than 200 plant species and 75 fauna species have been recorded within these reserves, with one threatened plants species and ten threatened fauna species including the koala.

All parts of the both reserves are naturally vegetated and as such, there is no current requirement for direct and active plantings of native trees, shrubs or groundcover species anywhere in the reserve areas. Therefore, native vegetation and habitat restoration and regeneration shall be facilitated through natural regeneration actions, including weed control and management works.

Prior to the commencement of weed control actions, the most widespread and common species were *Lantana camara* (Lantana), *Chrysanthemoides monilifera* (Bitou Bush) and *Pinus elliottii* (Slash Pine). Lantana and Bitou Bush were recorded in all habitats as localised patches (of varying sizes) but also as dense stands dominating the understorey along the flats and floodplain of Kore Kore Creek and parts of Shearwater reserves.

Slash Pine occurred as scattered mature trees and dense regrowth (wildlings) in parts of both Shearwater and Kore Kore Reserves. Since 2013, Councils contractor Kleinfelder have undertaken a targeted approach to weed management across both sites, with the site divided up in to management zones based on locality.

For the 2019 campaign the riparian zones throughout Kore Kore Reserve were swept and showed moderate to high densities of Lantana and Bitou Bush were identified. Bridal Creeper was light throughout site and dense in Western end down near Kore Kore Creek.

Small slash pine was cut down and larger trees ringbarked. Camphor Laurel, Senna/ Cassia were hand removed.

Invasive grasses occurred sparsely along all access tracks and up to a moderate density around moist areas on track. Grass species such as Whiskey grass, Broad-leaved Paspalum, Pigeon Grass, Giant Parramatta Grass and Carpet Grass were all identified. Areas that are scheduled for a proposed ecological burn were prioritised for weed control to lessen the burden for weed control post fire.

Figure 46: Brush tailed possum in the Kore Kore Reserve

Management Actions - Karuah and The Branch Estuary

Partnerships for River health

Through an innovative partnership between local farmers, Midcoast Council, Hunter Local Land Services, Landcare Australia and Karuah Great Lakes Landcare, the Karuah-Borland Landcare Program is beginning the journey to improve the health of the Karuah River.

The health of a river is generally the culmination of the surrounding impacts that occur throughout its catchment. Things like unsealed roads, or impacts from clearing or agriculture, allow nutrients and sediment to slowly make their way across the land when it rains or through little creeks and drains down into the main trunk of the river – and in the case of the Branch and Karuah Rivers, into Port Stephens.

Healthy wetlands and native vegetation are essential for healthy rivers. Wetlands and vegetation corridors along riverbanks operate like the river's kidneys, filtering out these nutrients and sediment from the land, while also providing habitat for native species and serving as connecting corridors for these species to move through. Protecting these remaining wetlands and riparian corridors is a key part of restoring the health of the overall river.

Combining forces, the partnering agencies are contributing over $500,000 to this project which is being matched by eight landholders through their own labour and cash contributions, to protect these vital habitats on their properties. Altogether, over 270 hectares of wetlands and 50 hectares of riparian vegetation will be secured on The Branch and Karuah Rivers.

Works such as fencing to manage cattle impact on wetlands and riparian vegetation as well as fragile riverbanks are a key part of the project. Internal fencing and provision of new water points allows the farmer more control over stock movement, as well as being able to get the most out of good pasture or areas that historically haven't been utilised by the cattle.

This project is a great example of multiple public agencies, non-profit organisations and the community coming together to solve big complex problems. Water quality and associated catchment health is too big a problem for the farmers to solve by themselves – they're busy enough running their own farms and businesses after all. Likewise, being private land, there's only so much government agencies can do.

Figure 47: Fencing to keep cattle out of wetlands and riparian areas has been installed by local landholders to protect The Branch and Karuah Rivers

Management Actions - Karuah and The Branch Estuary

The only way to address these issues and develop landscape-scale projects is by working together and sharing resources. For instance, on this project Hunter Local Land Services is committing funding from the NSW State Government's Marine Estate Management Strategy to reduce impacts from land on our marine estate. The projects associated with these eight neighbouring properties were bigger than Councils available budget so rather than reducing the scope of the project, Council have partnered Landcare Australia to really make a difference.

Additionally, Landcare Australia and Council have formalised a partnership to undertake a largescale catchment management project in the Karuah River Catchment. This partnership is built on the success of a previous project undertaken between the two parties: The Durness Landcare Project. The Karuah-Borland Landcare Project will improve wildlife habitat, water quality and agricultural productivity while implementing Council's Tops to Lakes program, linking these works with the previous Durness Landcare project on the edge of Myall Lakes Ramsar wetlands, all the way up to the greater Barrington Tops.

The Karuah Catchment Management Grants Program is only the first step in this partnership and more projects are planned for 2020 and beyond.

Protection of habitats and corridors

The Karuah River Catchment has been a regional priority for natural resource management investment and action since the publication of the Ecological Health Assessment for the Karuah River catchment in 2012. This Assessment was commissioned by Council and prepared by catchment and water quality experts from the NSW Department of Planning, Industry and Environment (formally Office of Environment and Heritage). The Ecological Health Assessment identified impaired catchment function and health (from damaged wetlands and riparian zones, eroding lands, cleared lands and sub-optimal groundcover rates) and that this was having impacts on the quality and productivity of some parts of the Karuah River, including The Branch River.

In addition to the partnerships that have been established for river health these catchment interventions and actions have included:

- The NSW Biodiversity Conservation Trust has purchased a conservation property at North Arm Cove and has established a conservation area of over 113-hectares which protects important biodiversity values and the water quality of the significant Bulga Creek (https://www.bct.nsw.gov.au/),
- A number of landholders are partnering with the NSW Government to explore the adoption of Biodiversity Stewardship Agreements and Conservation Agreements in the Karuah River catchment. These agreements are facilitated by the NSW Biodiversity Conservation Trust (https://www.bct.nsw.gov.au/).
- Council continues to work with key local landholders in strategic locations to investigate private land conservation opportunities and outcomes including by way of the use of Clause 4.1B of the Great Lakes Local Environmental Plan 2012 (development incentive for conservation clause).
- The Karuah-Borland Landcare Project an important partnership between Midcoast Council, Hunter Local Land Services, Landcare Australia and Karuah Great Lakes Landcare to protect wetlands and riparian zones for waterway health.

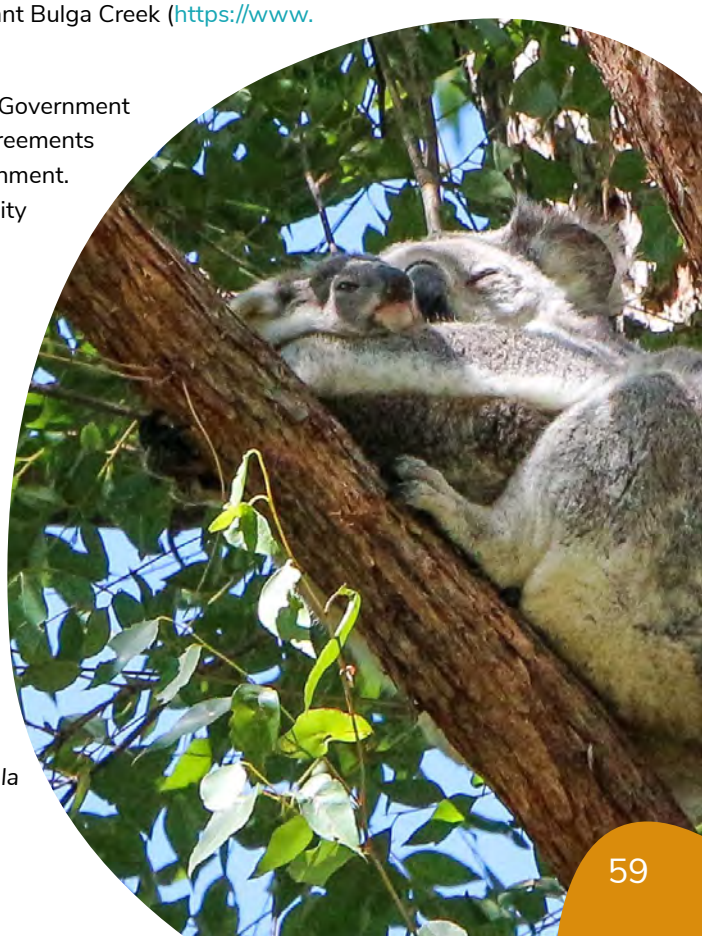


Figure 48: MidCoast Council is working hard to protect wildlife corridors for animals like the koala

Management Actions - Karuah and The Branch Estuary

Managing Aquatic Weeds

Alligator weed and African olive incursions continue to remain the highest priority for management in the Karuah Catchment.

A weed of National Significance (WoNS) alligator weed is present and has been managed on properties along 8km's of Lewis Creek at Girvan for more than thirty years. Alligator weed is considered one of the world's worst weeds because it impacts on both aquatic and terrestrial environments, and is notoriously difficult to control.

African Olive is a weed of limited distribution in our area and MidCoast Council has been working with land managers to control known infestations on public and private land in the Karuah Catchment since about 2012. A state containment line is being formed within the bounds of the MidCoast Local Government area in a bid to stop the north eastern spread of the environmental weed.

This project has achieved a significant reduction to the extent of wild and planted African Olives throughout natural areas, parks, reserves, rural, urban and peri-urban backyards. It has provided for the management of copious amounts of seedling and juvenile African Olives and the chemical treatment or physical removal of hundreds of mature trees.

Figure 49: Removal of African olive plants in the has been a key project in the Karuah

Beyond the Shed

Poultry (including eggs, meat and turkeys) is Midcoast Council's most valuable agricultural commodity ahead of beef, dairy and aquaculture and the Karuah River Catchment is home to the majority of this production.

Intensive poultry farming is a highly regulated industry requiring frequent audits from processors, clients and government regulators. However, much of this auditing focuses on what occurs within the poultry shed.

MCC has successfully secured $100,000 over three years through the NSW Environmental Trust to implement actions from the Karuah River Catchment Management Plan to improve the capacity of the local poultry industry to mitigate risks to water quality associated with the storage and application of poultry litter. Council's contribution includes $95,000 cash from the Duralie Catchment Contribution. Hunter Local Land Services is also providing significant cash and in-kind contributions to the project. Total budget for the project is $253,000.

On-farm projects being funded include soil-testing and nutrient mapping of paddocks; agronomic and composting advice; riparian fencing to manage stock; installation of stock water; and litter composting facilities.

A pilot project focusing on nutrient management targeting what happens beyond the shed was initially conducted with 5 poultry farmers in the region. The pilot was highly successful, resulting in change to management practices, mitigating nutrient risks to waterways and improving farm production methods. 'Stage 2' which commenced in 2019-20 is expanding the pilot throughout the local industry to an additional 17 farms to implement best-practice nutrient management, as well as funding industry workshops and trial-demonstration projects.

If this project is successful, staff will look to expand it through the remainder of the industry in the MidCoast region.

MIDCOAST council

WATERWAY AND CATCHMENT REPORT CARD 2020

Reporting on data
November 2019 to March 2020

This project is funded by MidCoast Council's Environmental Rate and supported by the New South Wales Government through its Coast and Estuary Program and Department of Planning, Industry and Environment.

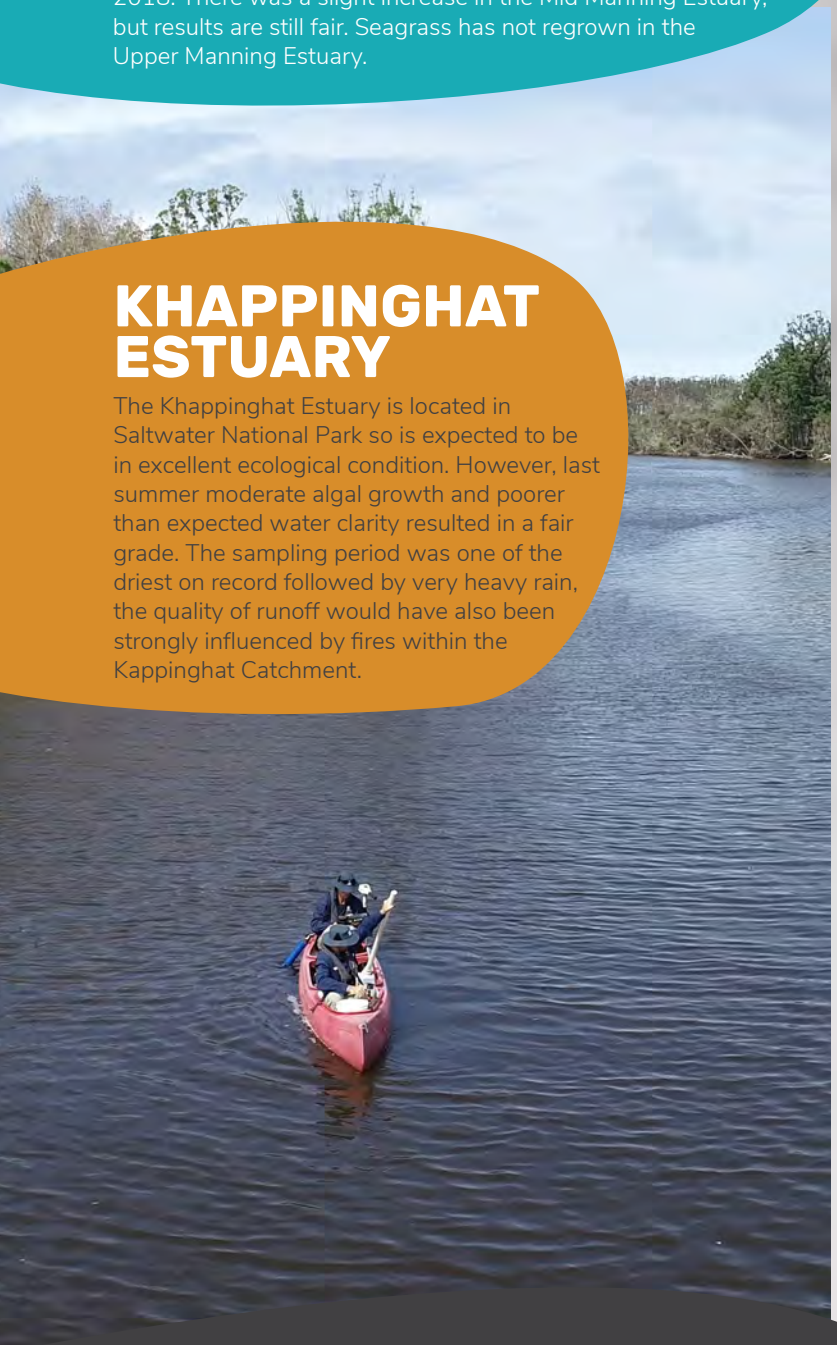
NSW GOVERNMENT

MANNING RIVER ESTUARY

The condition of the Manning River Estuary dropped by one grade in the Upper Manning and Dawson River, but overall has maintained good ecological condition. The Upper Manning and Dawson River Estuaries were in fair condition while good results were recorded in the Mid and Lower Manning Estuaries and Farquhar Inlet.

Apart from the Lower Manning Estuary, algal levels continued to be much higher than desired; this was particularly noticeable in the Dawson River and Upper Manning Estuaries. These results show there is a need for ongoing improvements in nutrient and sediment management from land use activities within the Manning Catchment.

The depth range where seagrass is able to grow in the Lower Manning Estuary decreased to fair, the same level as 2017 and 2018. There was a slight increase in the Mid Manning Estuary, but results are still fair. Seagrass has not regrown in the Upper Manning Estuary.



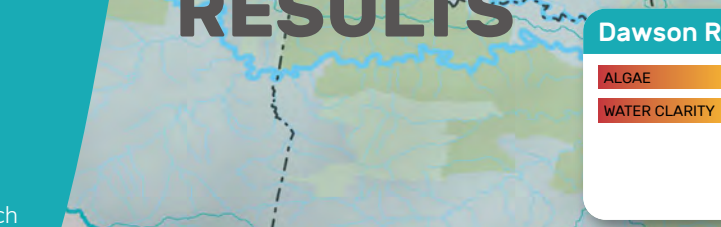
KHAPPINGHAT ESTUARY

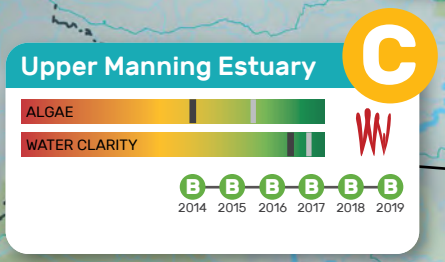
The Khappinghat Estuary is located in Saltwater National Park so is expected to be in excellent ecological condition. However, last summer moderate algal growth and poorer than expected water clarity resulted in a fair grade. The sampling period was one of the driest on record followed by very heavy rain, the quality of runoff would have also been strongly influenced by fires within the Kappinghat Catchment.

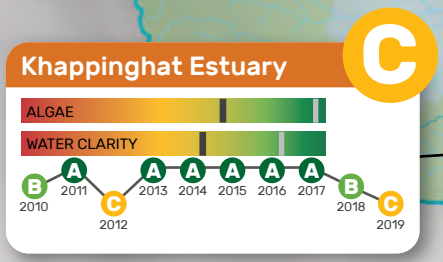
KARUAH RIVER ESTUARY

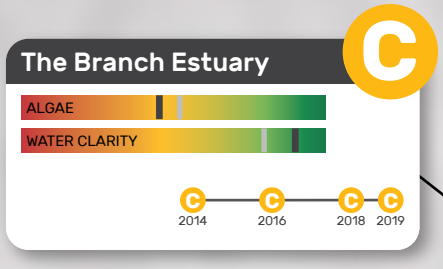
The Karuah River and The Branch Estuaries continued to show signs of significantly impaired estuary health with much higher than desired algal growth and good water clarity. Unlike some other estuaries, excess nutrients from catchment runoff were not linked to the rainfall from late summer indicating that there is a chronic flow of nutrients into the estuary.

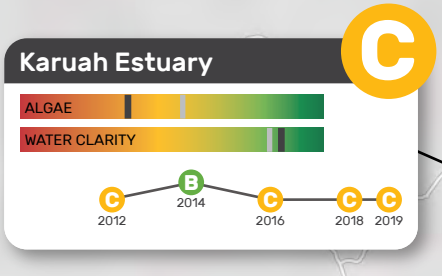
RESULTS

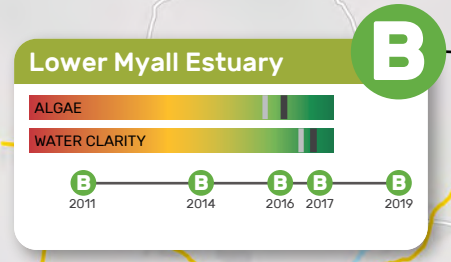


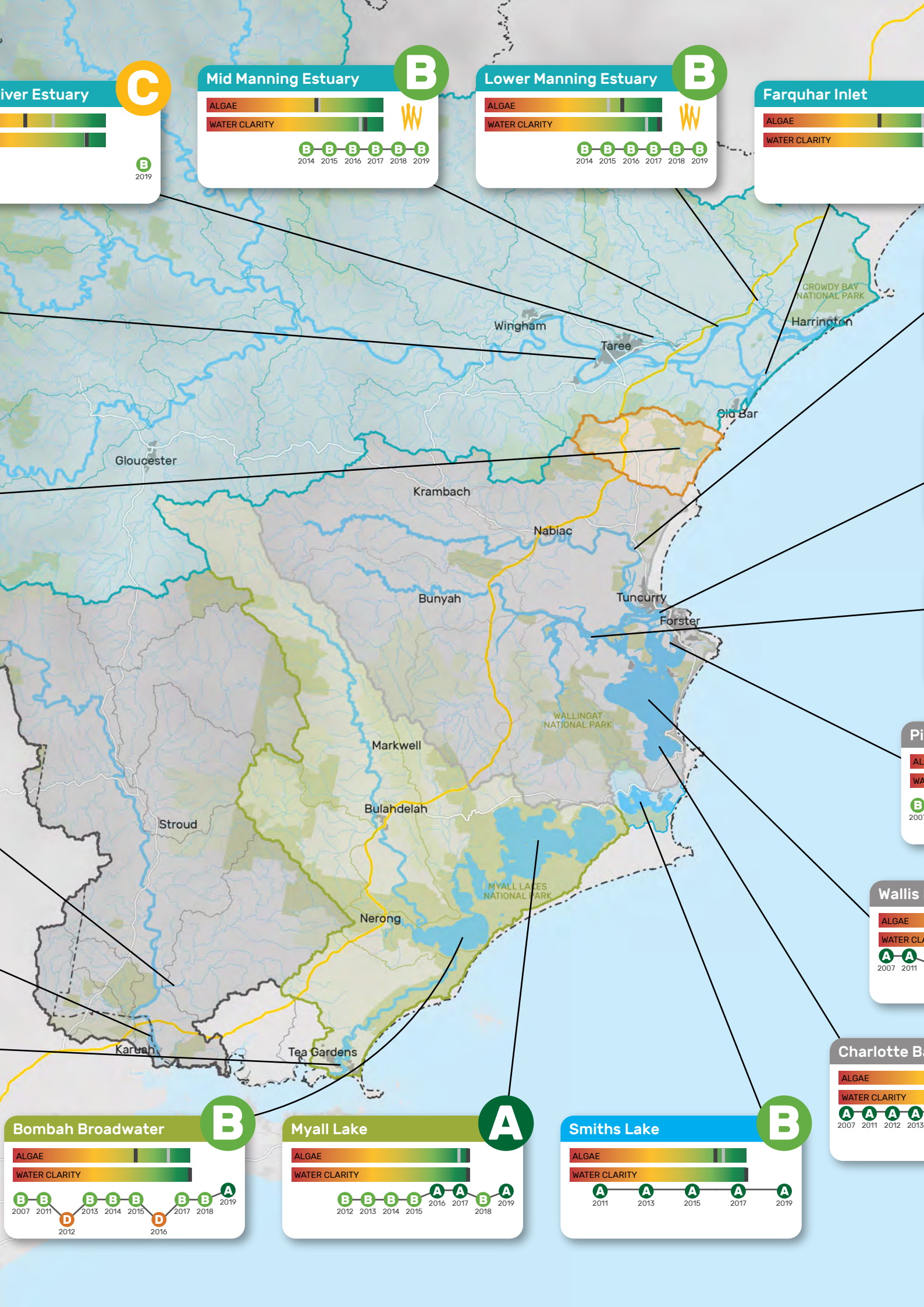








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Bunyah
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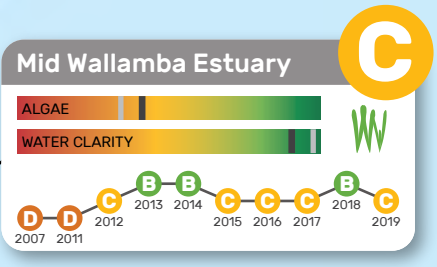
WALLIS LAKE

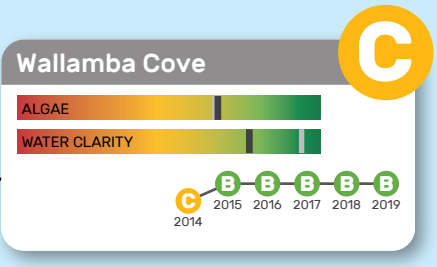
Grades for Wallis Lake, Pipers Creek and Charlotte Bay all dropped from excellent to good this year and were strongly influenced by drought conditions followed by heavy rain. In Wallis Lake and Pipers Creek, the grade was influenced by both water clarity and algal levels. Higher than desirable algal growth in Charlotte Bay was responsible for its drop in grade.

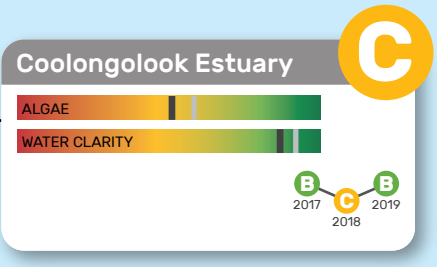
In the Mid Wallamba and Coolongolook Estuaries, water clarity was good but excess nutrient runoff resulted in much higher than desired algal growth. This resulted in a drop from good to fair in the Coolongolook Estuary and a continuation of the fair grade in Mid Wallamba Estuary.

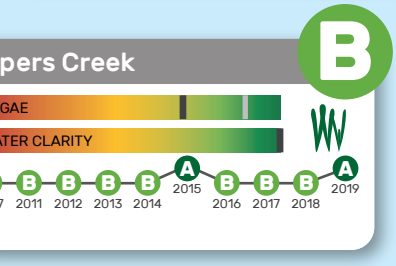
A drop in grade from good to fair in Wallamba Cove was the result of greater than desired algal growth showing that this site continues to be affected by stormwater runoff from Tuncurry.

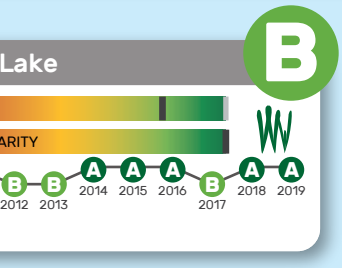
The depth range where seagrass is able to grow has remained excellent at all sites in Wallis Lake and has improved to good in the Mid Wallamba Estuary.

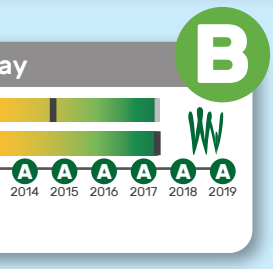










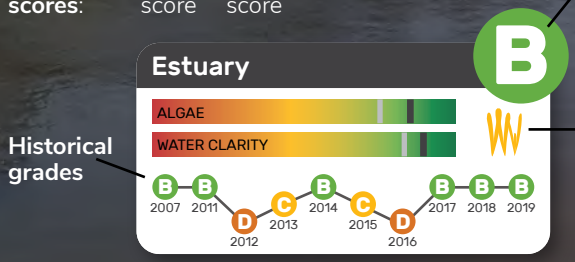


ESTUARY SCORE KEY

very poor — excellent

Indicator scores: 2019 score, 2020 score

Overall grade: This represents ecological condition, it is a combination of algae and water clarity scores.



Historical grades

Seagrass depth range score: The seagrass score indicates how deep the seagrass is growing and if the seagrass area is expanding or contracting. Where there are no seagrass results, no data was collected at these locations.

For more details on the scientific methods and results contained in this Report Card (Waterway and Catchment Technical Report) and how bushfires and floods impact our waterways visit: www.midcoast.nsw.gov.au/reportcard

very poor | poor | fair | good | excellent

SMITHS LAKE

The grade for Smiths Lake dropped this year from excellent to good. Last summer presented challenging conditions including one of the driest summers on record followed by very heavy rain. The storms brought in nutrients which triggered excess algal growth.

MYALL LAKES

Myall Lake's grade remained excellent this year, but excess algal growth after the February rains meant that the grade for Bombah Broadwater dropped from excellent to good. The condition of Bombah Broadwater, and to some extent Myall Lake, is strongly influenced by runoff from the Myall River Catchment and this year, the drop in grade in the Broadwater was due to increased algal levels. Marked variability in condition between the yearly reports emphasises the need to continue to reduce nutrient runoff from land use activities in the catchment.

The Lower Myall Estuary upstream of Tea Gardens maintained its good grade this year. This area is usually strongly influenced by the condition of the outflow from the Bombah Broadwater. However, when there is little catchment runoff, as was the case this year, the waters moved by the tides are the main influence.

USING SCIENCE TO GUIDE WATERWAY MANAGEMENT

What we do on the land impacts on the quality of water that runs off it. When runoff quality is poor it puts stress on the environment, leading to ecological harm.

Results from monitoring and scientific studies combined with local knowledge and expert advice help Council work out where to put effort to have the most effective approach to managing our waterways.

MONITORING

Monitoring is essential to track the condition of our waterways and provides a link to predictive models and management effectiveness. The ecosystem health results presented in the Report Card help document the 'ecological impact' of stressors. Council monitors the condition of our estuaries so that we can confirm that the actions we are taking on land are achieving the changes we expect in our waterways. Monitoring also allows us to check that predictions in computer modelling are consistent with what is happening in the real world – this is known as validating the model.

Rebecca Swanson
Environmental Scientist, Estuaries and Catchments, Department of Planning, Industry and Environment

"Regular monitoring of water quality and ecological health indicators provides baseline data on the current condition of the waterway. This data can be used to track future change in condition that may occur from development in the catchment, or management actions aimed at reducing pollution entering waterways."

MODELLING

Computerised catchment modelling is used to understand the complexities of natural systems. Modelling examines how these systems work in order to make predictions about what happens if we change land use or activity within the catchment. Wallis, Smiths and Myall Lakes have models that identify the most effective actions to implement when taking all these system complexities into account.

Angus Ferguson
Senior Research Scientist, Department of Planning, Industry and Environment

"Ecosystem response modelling brings together the best available science to quantify and couple catchment pressures with ecosystem processes. Models allow scientists and managers to better understand the causes of poor water quality and to make effects based assessments of different management options. This information helps target and prioritise resources to achieve the best possible outcomes for the waterway and the community."

MANAGEMENT

Agriculture is one of the industries where changes to management can reduce the stressors on the environment. Ecological health assesments of The Branch and Karuah Rivers showed that inputs from the catchment were affecting waterway health. Landholders in The Branch are now using this science to help manage their properties, protecting over 270 hectares of wetlands and 50 hectares of riparian vegetation improving wildlife habitat, agricultural productivity and water quality.

Bryan Royce, *Farmer, Le Grande Lande*

"The cattle get into the wetlands and pug the soil, generally making a mess particularly when it's wet. The new internal fence and water points keep the cattle out of the wetlands most of the year meaning we are able to get the most out of the good pasture and help protect the local environment."

HOW DO ESTUARY TYPE AND RAINFALL IMPACT WATER QUALITY?

Rainfall and runoff carry sediment and nutrients into our estuaries. How these estuaries are impacted depends on the estuary type and the intensity of the rainfall.

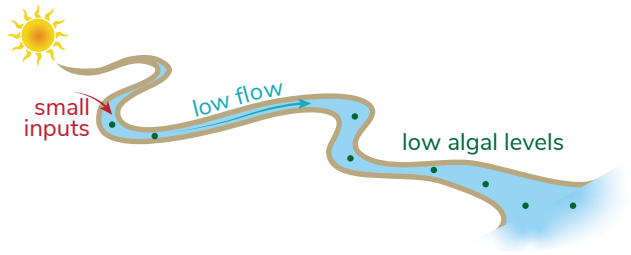
River Estuaries – are generally long and linear with very large catchment areas and a large tidal range. The speed of water flow in river estuaries varies according to rainfall and the volume of catchment runoff.

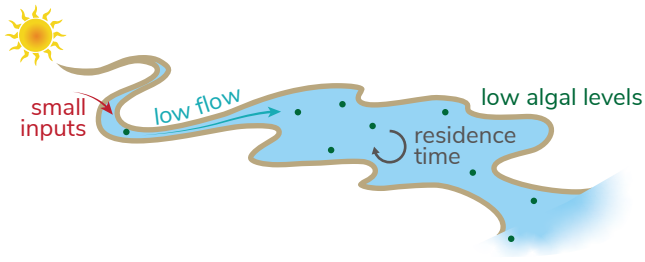
Lake Estuaries – are generally wide and shallow, with moderate sized catchment areas and low or no tidal range. They also have a longer residence time (how long water, dissolved or suspended material remains in the estuary) than river estuaries.

LOW RAINFALL

Low algae levels and good water clarity

If the rain is light it soaks into the catchment and doesn't result in runoff and so has little effect on algal levels and water clarity. Under these conditions, material already deposited in an estuary drives water quality.

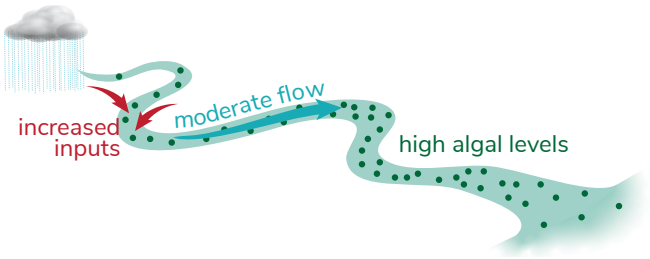


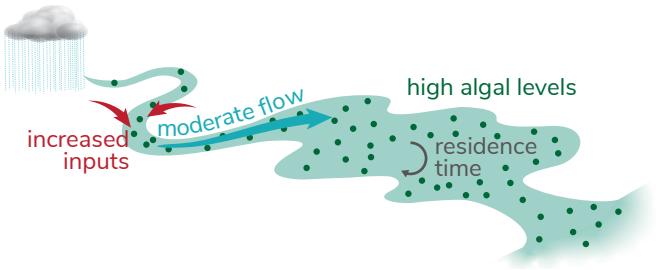


MODERATE RAINFALL

High algal levels and poor water clarity

If rain is moderate then enough nutrients to stimulate algal growth reach both river and lake estuaries. In river estuaries as the river flow is not too fast the water stays in the system long enough (residence time) for high levels of algal growth. A similar process occurs in lake estuaries.

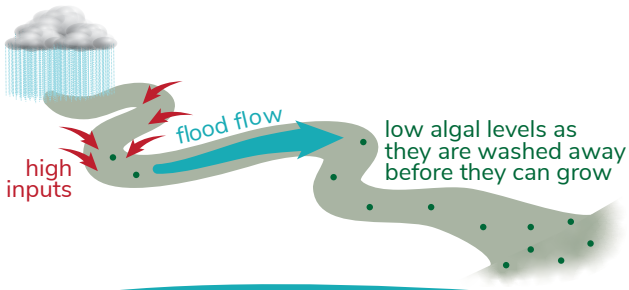




HIGH RAINFALL

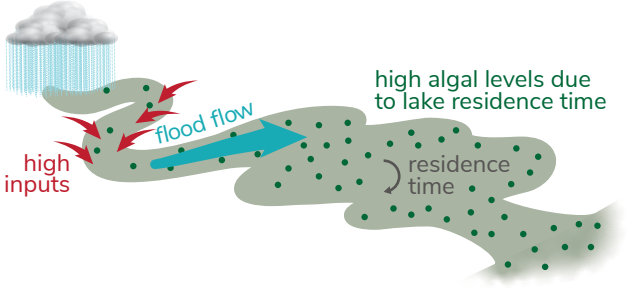
Low algal levels and poor water quality

During flooding conditions in river estuaries, runoff carries with it high levels of nutrients and sediments. However, because the water moves quickly through the system algae doesn't have an opportunity to grow.



High algal levels and poor water clarity

Lake estuaries also receive large amounts of nutrients and sediment during flooding conditions. But because the water is trapped or only moves through slowly (longer residence time) nutrients will remain in the estuary long enough to trigger high levels of algal growth.



The 2019/20 sampling period provided an excellent opportunity to see these patterns in action

Of the river estuaries, Manning River experienced low rainfall during the first half of the sampling period resulting in good water clarity and low algae levels. After flooding catchment runoff resulted in poor water clarity, but low algae levels due to the high flows moving through the river so quickly.

Of the lake estuaries Wallis, Myall and Smiths Lakes experienced rainfall during the middle of the sampling period which led to poor water clarity and high algae levels, this pattern continued during and after flooding conditions due to the long residence time of the lakes.

MIDCOAST council

HOW DO BUSHFIRES AND FLOODS IMPACT OUR WATERWAYS?

Drought, fire and flooding are all an intrinsic part of Australia's environment and natural ecosystems have evolved to respond to these conditions. Fire is particularly important with many plant species dependent on fire to regenerate and ecological burns are now an integral part of ecosystem management. However extreme climatic events can have a significant impact on water quality.

The sampling period for the Waterway and Catchment Report Card 2020 saw a variety of climatic conditions including drought, bushfires and flooding rains. Bushfires that took place in the MidCoast were extreme and had devastating impacts on our community, wildlife and environment.

The majority of the fires occurred in November and December 2019 and mainly affected the Khappinghat, Wallamba River and Manning River catchments.

Intense fires can affect our waterways by removing vegetation cover and thus exposing land to erosion, increasing sediments in our waterways, reducing water clarity and bringing with it nutrients that can cause algal blooms. Fires affect living plant material in many ways, from complete combustion to ash or charcoal, or partially charring leaves and branches. Completely combusted plant material becomes inert, but partially burnt material is readily broken down. If this material enters a waterway following heavy rain in a fire affected area it can reduce oxygen in the waterway as it begins to decompose. Due to the moderate and then heavy rainfall that followed the fires in January and February it is difficult to differentiate the response of the MidCoast estuaries to the bushfires from the response to the flooding.

From the samples that were taken by the Department of Planning, Industry and Environment as part of the Waterway and Catchment Report Card there were no indications of impacts on algae or water clarity in burnt catchments until the period after the floods, when it is likely that nutrients and partially burnt organic matter from the fire debris entered the waterways with rainfall runoff. The breakdown of the partially burnt material likely contributed more nutrients to the waterway, fuelling more algae to grow. The strong post rainfall turbidity response in Manning River and Khappinghat Estuaries may also have been partially a result of fire debris, however given the large freshwater flows entering the waterways; it's difficult to determine if this was caused by fire debris, or what is expected following a flood.

The Report Card results show that climatic conditions can play a significant role in the health of our waterways. Further research is needed to investigate the short and long term effects of intense fires on estuary health.

MidCoast Council have been working to help our environment recover from the effects of the fires. An ongoing program to protect vegetation, wildlife and water quality will include projects such as:

- Post-fire audits and action planning in all fire affected areas
- Bush regeneration and removal of environmental weeds to facilitate natural recovery
- Planting of local native plant species including preferred koala food trees
- Installation of nesting boxes for displaced and affected fauna
- Monitoring of vegetation recovery and fauna usage in Council reserves to assist regeneration

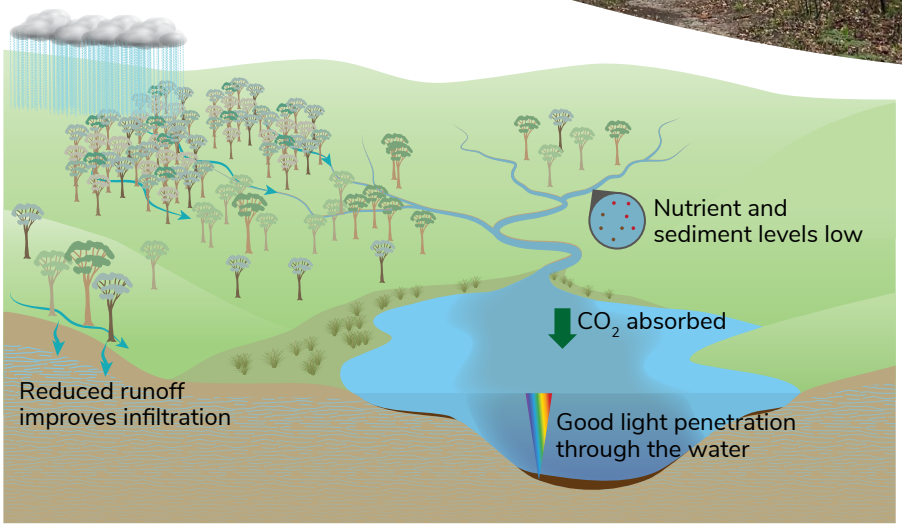
Before, during and after a fire in the catchment

Data from existing monitoring programs, case studies in fire-affected catchments and a review of the current research has been used to summarise the processes occurring in catchments.

Pre-fire

Intact vegetation and groundcover reduces volume and velocity of runoff and reduces the level of nutrients, sediments and organic carbon entering the waterway during a rain event.

Water quality and aquatic ecosystem health is generally good and is largely dependent on the quality of catchment runoff.

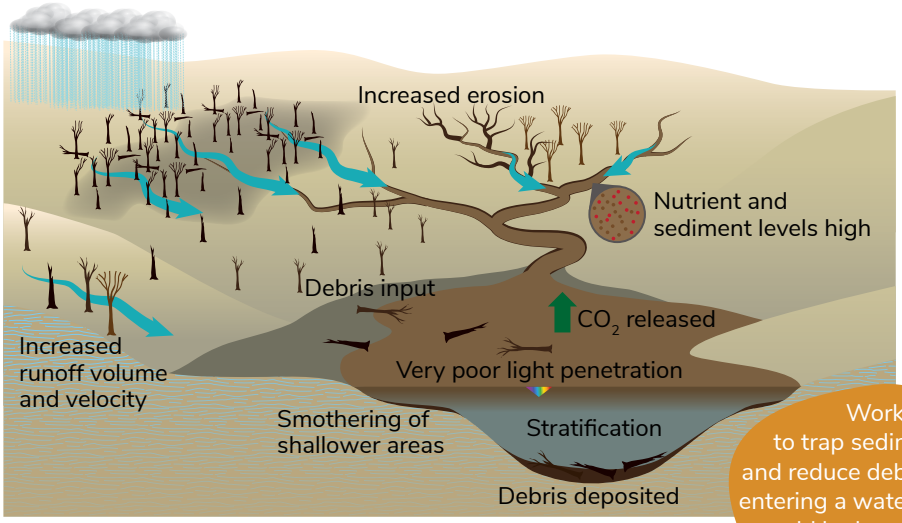


Immediately post-fire following a rain event

Loss of vegetation and groundcover increases volume and velocity of runoff which intensifies erosion.

Increased debris, organic matter, sediment and nutrients enter the waterway, reducing oxygen levels.

Water quality and aquatic ecosystem health is severely impaired, but the severity of impact may be brief.



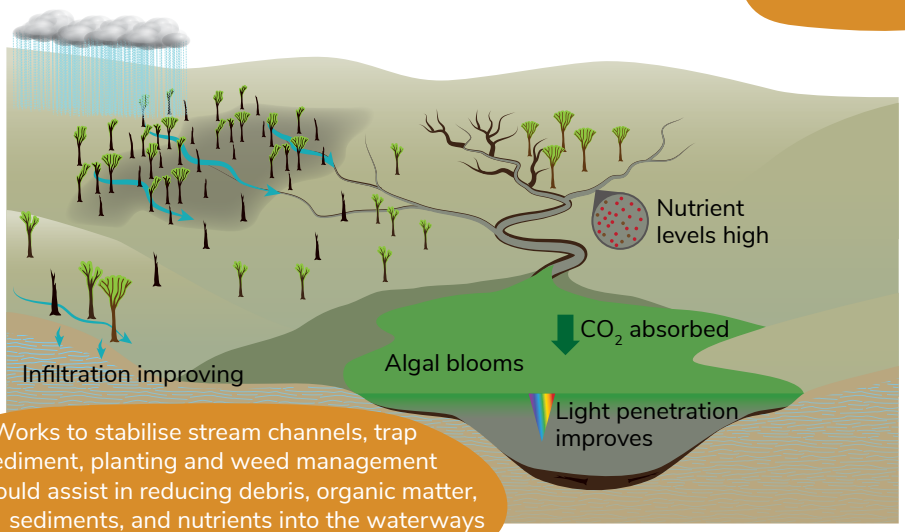
Works to trap sediment and reduce debris entering a waterway would be beneficial

Recovering catchment following a rain event

Regrowth of vegetation and groundcover decreases velocity and volume of runoff which reduces the risk of erosion.

Sediment levels entering the waterway decrease improving water clarity, however with high nutrient levels, algal blooms occur. Processes in the sediment and water fuel further algal blooms.

Water quality and aquatic ecosystem health is impaired.



Works to stabilise stream channels, trap sediment, planting and weed management would assist in reducing debris, organic matter, sediments, and nutrients into the waterways

This project is funded by MidCoast Council's Environmental Rate and supported by the New South Wales Government through its Coast and Estuary Program and Department of Planning, Industry and Environment.

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