2015 Waterway & Catchment report

Great Lakes Council 2015 Waterway and Catchment Report

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Introduction

The Great Lakes region depends heavily on the health of local waterways and their catchments. 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 and episodic fish kills are all examples of what can go wrong.

This report has been presented to accompany the 2015 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. A summary of the management responses undertaken in each estuary to address water quality are also presented here.

The Goal for our waterways is to maintain or improve their condition in order to protect biological diversity and maintain ecological processes

Water quality - ecological health

Good management of our lakes requires understanding of how they work, predictions about future conditions and informed choice about actions to get the outcome the community wants. Great Lakes Council and Office of Environment and Heritage (OEH) 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. OEH research allowed the development of a solid understanding of the impacts of catchment activities on lake health. It also concluded that 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 health of the waterways in the Great Lakes region is fundamental for achieving the Vision set out in the Community Strategic Plan 'Great Lakes 2030': 'A unique and sustainably managed environment balanced with quality lifestyle opportunities created through appropriate development, infrastructure and services'. Since 2008, OEH have undertaken an ecological health monitoring program in Wallis Lake as part of the state-wide Monitoring, Evaluation and Reporting

Figure 1.1.1 Wallis Lake

Strategy (MER). As part of the Strategy, Wallis Lake was selected as one of seven estuaries 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 Great Lakes Council, in cooperation with state and federal agencies, has ensured that the program has been expanded to cover other key sites across the Great Lakes Local Government Area (LGA). The OEH have provided an independent scientific evaluation on the ecological health of Wallis Lake, Karuah River and Estuary, as well as Myall Lake and the Bombah Broadwater in the Myall Lakes.

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.

Ecological health results presented in easy to understand Report Card

The results of ecological health monitoring have been presented in a Catchment and Waterways Report Card (see Appendix) 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 currently 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 areas of Wallis, Smith and Myall Lakes and the Karuah River against further declines in water quality.

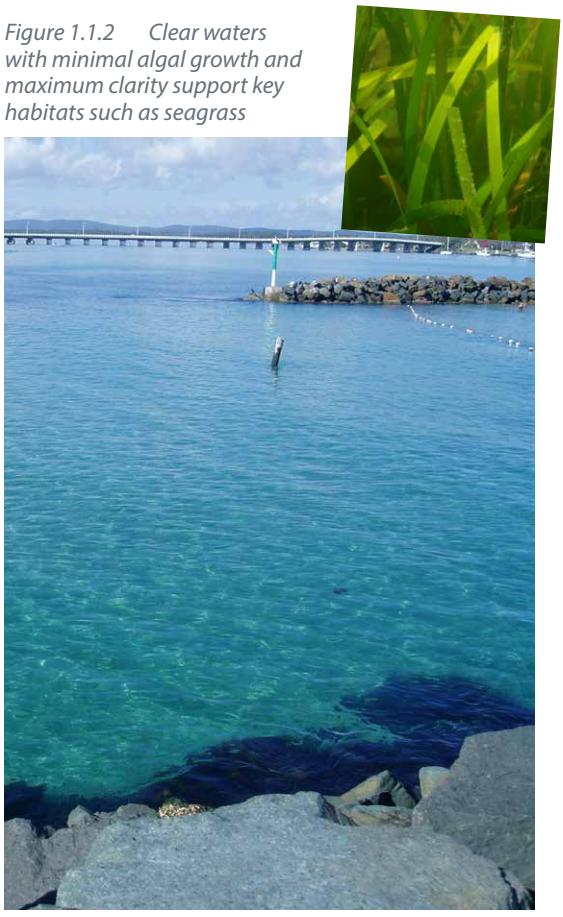
In addition to the ecological results, management actions being undertaken in the catchments are also presented in the Report Card. A more detailed description of the management actions is provided in this report. These management actions have been developed to target specific environmental values which Council and the community have determined as important to the region.

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 1.1.2 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 and Myall Lakes as well as the Karuah River 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.

1. 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 1.1.1.

Algal growth can be measured by assessing chlorophyll a levels in the water and sediment inputs are assessed by measuring the turbidity. These indicators are easy to measure and directly relate to the environmental values.

While the extent of seagrass beds, 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 1.1.1 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	✓	
Great Lakes 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. Great Lakes Council and 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.

2. 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 were all classified as 'Lakes' and Wallamba River, Karuah Estuary and the Lower Myall River as a 'River estuary' (Roper et al. 2011).

Table 1.1.2 Trigger Values for New South Wales Estuaries (from Roper et al. 2011)

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

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 occurr 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).

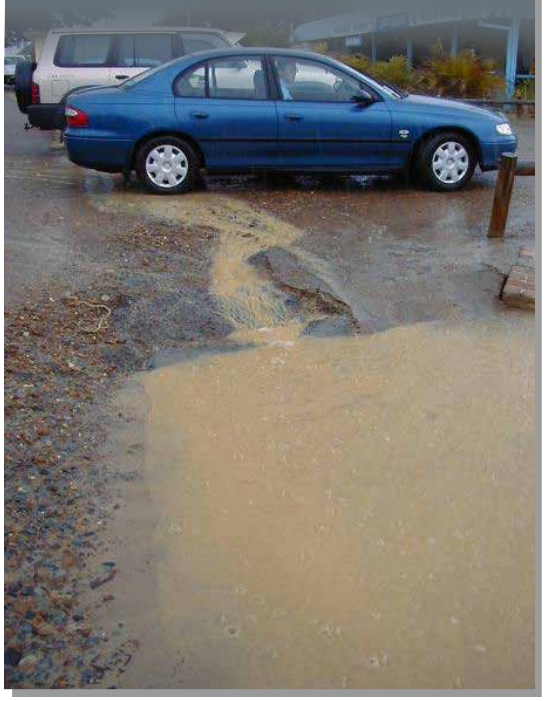
Sediment

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).



3. Collecting the data

The Great Lakes region has been divided up into 10 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. Five zones were sampled in Wallis Lake estuary (Wallamba River, Wallamba Cove, Pipers Creek, Wallis Lake and Charlotte Bay). There are three zones in Smiths Lake and three zones in the Myall Lakes.

Samples were collected on six occasions between summer and autumn from December to March. 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.

Figure 1.1.3 Office of Environment and Heritage staff carry out the monitoring of the waterways in the Great Lakes Region

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.

4. 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 1.1.3. 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 1.1.3 Worst expected value for Condition Calculations

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

WEV = worst expected value

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.

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

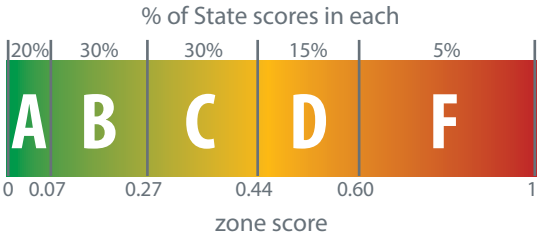
The final 'zone score' for each reporting zone is then the simple average of the indicator scores.

5. 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 Great Lakes analyses. Cut-offs were then defined as representing a percentage of the scores for the State (Table 1.1.4). 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 Figure 1.1.4.

Figure 1.1.4 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.
- 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.

Table 1.1.4 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

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 (2011-2012 for instance was a particularly wet summer and this was reflected in the sampling data).

This year (2014-2015) rainfall in the sampling period was average and relatively similar to the rainfall recorded in 2013-2014. The average rainfall is clearly shown by the shaded line which represents the average rainfall over the last 70 years.

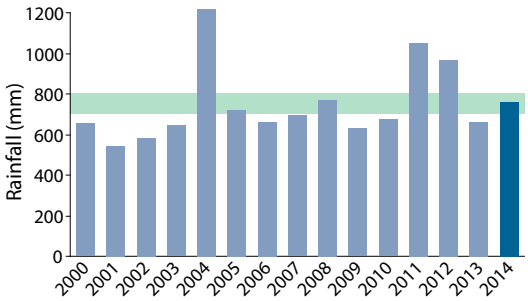


Figure 1.1.5 Data presented includes total rainfall September to March each year. The rainfall data is taken from the Forster Bureau of Meteorology rainfall station (Tuncurry Marine Rescue) (www.bom.gov.au/ climate/data). The same trends were seen in data from Wootton and Bungwahl stations. The shaded line represents the average rainfall over the last 70 years.

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Acknowledgements

The methodology presented here was developed by the Office of Environment and Heritage, Scientific Services Section with input from Hodge Environmental and the International Water Centre.

Figure 1.1.6 Great Lakes Council staff collecting water samples

Wallis Lake

Catchment description

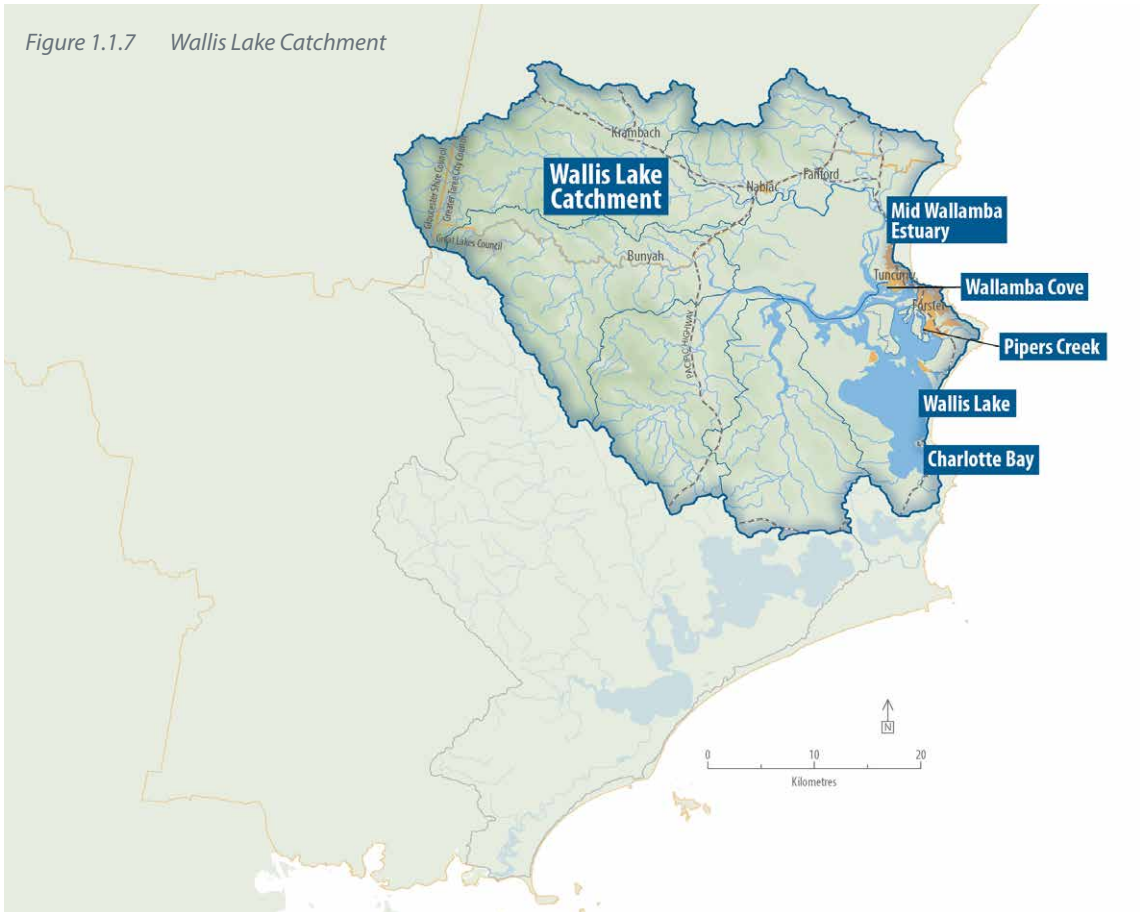
The Wallis Lake catchment extends over 1400 square kilometres and is shared between the Great Lakes Council Local Government Area (LGA) (65%) and the Greater Taree City Council LGA (35%). This catchment includes the region's major urban centre of Forster-Tuncurry.

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's top three producing estuarine fisheries and is utilised extensively for recreation including boating, fishing and swimming.

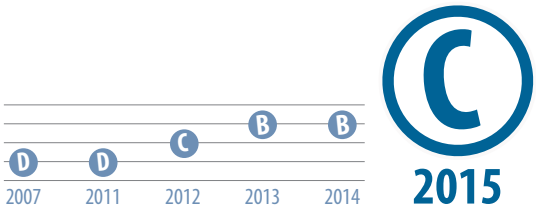
The Wallis Lake catchment contains habitat for threatened and international migratory species and contains 35% of the seagrass beds of New South Wales, as well as the second largest representation of saltmarsh in the State.

Figure 1.1.8 High quality Saltmarsh area on Minimbah Creek within the Wallis Lake catchment.

Figure 1.1.7 Wallis Lake Catchment

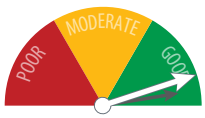


Mid Wallamba Estuary



Algae

Water clarity



Ecological health declines slightly

Waters of the Mid Wallamba have remained clear most of the time, but the amount of algae in the water continues to be higher than desired. Nutrients from the catchment combined with clear waters and the still, hot conditions led to overall high concentrations of algae.

Rainfall in the summer of 2014-2015 was about average and fell consistently from December until March. Catchment works to reduce erosion of soils from bare paddocks, stream banks and unsealed roads are taking effect and have reduced sediment input. Due to the constant rain, the turbidity target was exceeded in 40% of samples but those exceedances were very small – only 2% of the worst value. This has resulted in a good score for water clarity (turbidity).

The weather conditions were ideal for algae, with the heavy rain bringing nutrients into the river and clear warm waters combining to stimulate growth. Algal abundance (chlorophyll) exceeded the trigger values every time it was measured, and those exceedances were moderately large (20% of the worst value). Unhealthy growth of small algae in the waters is stimulated by nutrients washed from urban areas and pastures, or from stock directly accessing waterways. If this continues, then algae may reach levels in the water which are detrimental to fish, humans and livestock. Even though the rainfall was less this year, the clear waters provide plenty of light and this combines with the nutrient loads to grow undesirable amounts of algae.

Great Lakes Council has initiated actions to control sediments and nutrients from the catchment as part of the Water Quality Improvement Plan. The results for 2014 continue the trend for improvement in turbidity since 2012. The chlorophyll data show that targeted work in the catchment is still required.

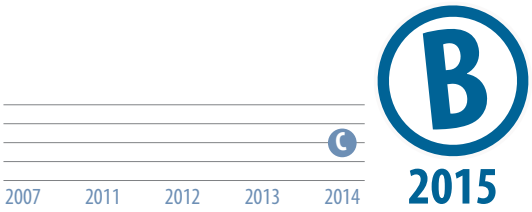
Great Lakes Council's Water Quality Improvement Plan has been in place for six years. For the waters of the mid Wallamba the interim target was to improve their modified condition to more closely resemble 'high conservation value conditions'. The plan specified a 2.7% reduction in chlorophyll and a 17 % reduction in turbidity. The turbidity target has been exceeded but chlorophyll concentrations have actually increased, probably due to the additional light fuelling growth as turbidity is reduced.

Estuary description

The Mid Wallamba Estuary sub catchment covers almost one third of the Wallis Lake catchment (550 km^2). 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.

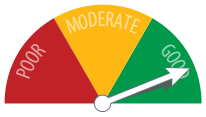
Wallamba Cove



River end of Cove

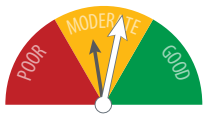
Algae

Water clarity

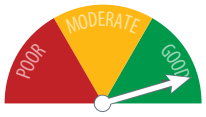


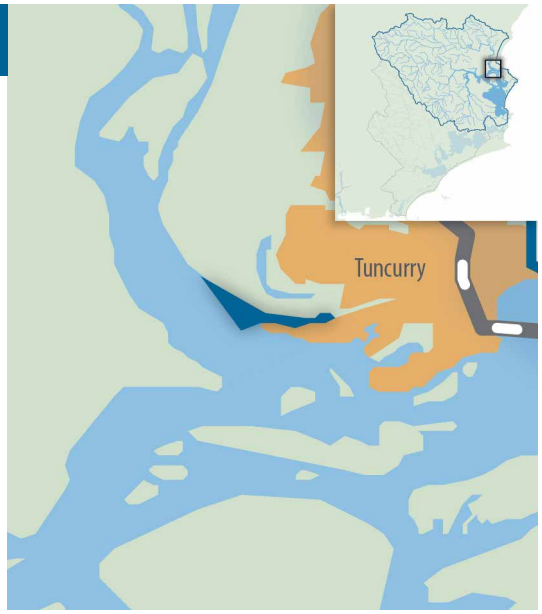
Upstream end of Cove

Algae



Water clarity



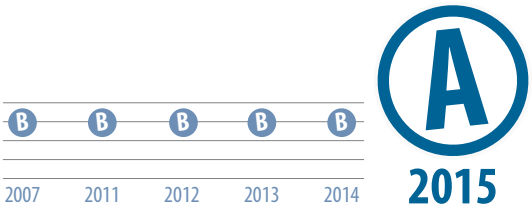


Algal growth still too high in Wallamba Cove

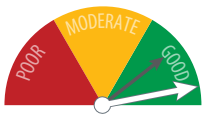
The results for Wallamba Cove are similar to last year, indicating that estuary health in the Cove requires improvement. The algal levels show that targeted work in the catchment to reduce nutrient inputs is the highest priority.

In Wallamba Cove, there is a difference in health between the site near the river and the upstream site. The difference is mainly driven by algae. At the upstream site there are high levels of algae, all samples exceeded the trigger, by 6 to 33% of the worst value. Turbidity criteria were also exceeded in 80% of samples, but generally by only a small amount. This information shows clearly that urban runoff is having a large effect in Wallamba Cove, but that effect is somewhat diluted at the downstream end by mixing with the Wallamba River.

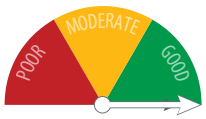
Pipers Creek

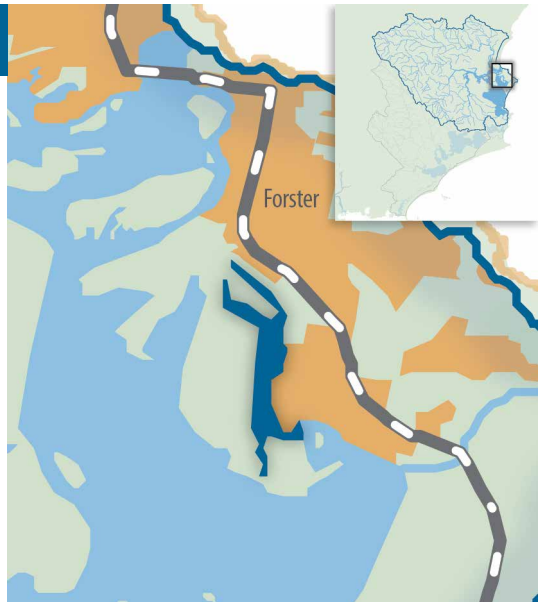


Algae



Water clarity





Pipers Creek now in excellent condition

The ecological health in Pipers Creek continues to improve, moving into the excellent category, waters in Pipers Creek remained clear. The nutrient loads from the urban catchment of Forster resulted in algal levels that are now low enough for Pipers Creek to get an 'Excellent' grade.

Ecological health in Pipers Creek is strongly influenced by inputs from the large urban catchment. Control of nutrients from houses, lawns, pets and the like, that can wash into the Creek through stormwater are now showing great results.

The trigger value for chlorophyll was exceeded in half of the samples collected, though the exceedances were quite small. Similar to 2011, 2012 and 2013, this shows a constant pattern of mild excess algal growth rather than the occasional very large bloom.

Water clarity was excellent with turbidity levels less than trigger values all of the time. This maintains the improvement seen from previous years back to 2007. Low turbidity levels are critical for the protection of important habitats such as seagrass beds which enhance the biodiversity of the system. This was a good result for Pipers Creek and shows that with the additional efforts being made to control nutrient runoff from the catchment; it may be possible for Pipers Creek to achieve excellent water quality in the future.

Recent improvements made to water quality should not be lost as a consequence of future development or re-development in this catchment. There should therefore be a continued emphasis on achieving water quality targets for all development and protection of existing native vegetation.

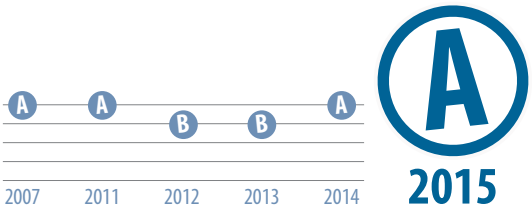
Great Lakes Council's Water Quality Improvement Plan has been in place for six years. The interim targets for Pipers Creek were a 13% reduction in chlorophyll and a 32% reduction in turbidity. The improvements seen mean that both these targets have been exceeded.

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, pets and the like. 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.

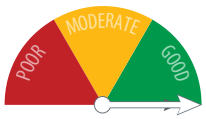
The samples for this Report Card are taken next to Big Island adjacent to Forster Keys.

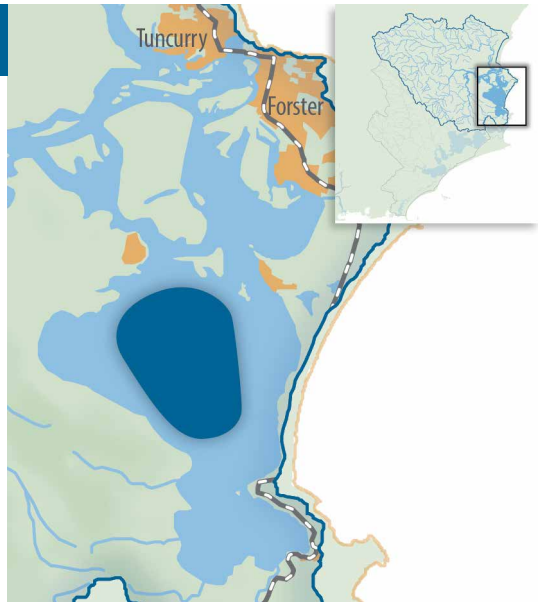
Wallis Lake



Algae

Water clarity





Wallis Lake scores as good as last year but moderate algal growth remains

Wallis Lake is of a high conservation value, with abundant seagrass and high biodiversity. In Wallis Lake ecological health was excellent this year, with the amount of algal growth remaining in the excellent category. Chlorophyll samples exceeded the trigger value in only 15% of samples (down from one third last year) and the size of the exceedances was small. This probably reflects the on-going work to reduce runoff of nutrients from the catchment.

Wallis Lake has long been recognised as having high environmental values due to its extensive seagrass beds. Seagrass beds are important estuarine habitats that not only support biodiversity but provide essential ecosystem services such as nursery areas for aquatic bugs, fish and many other species. Seagrass beds in turn support a healthy community of larger animals such as turtles, large bodied fish, crabs, birds and dolphins. Healthy seagrass beds depend on good ecological health to survive.

All turbidity samples remained below trigger values meaning the waters are very clear, allowing plenty of light to penetrate the water, this means that seagrasses can survive to greater depths and maintain a large area of coverage.

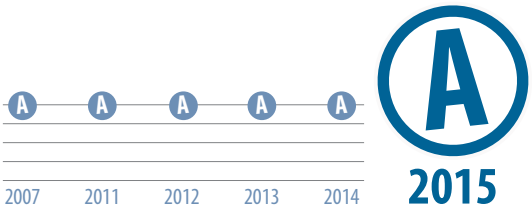
Great Lakes Council's Water Quality Improvement Plan has been in place for six years. The interim target for Wallis Lakes was no reduction in estuary health. The general trend has been for excellent results, with a couple of good scores, which is typical of natural variation. This shows that the target has been achieved.

Estuary description

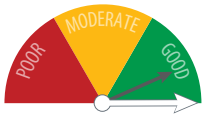
Wallis Lake is in the centre of the estuary and receives runoff from a narrow catchment immediately surrounding the lake. Adjoining areas directly influencing Wallis Lake include Coomba Park, Green Point and the rural residential land on the western side of Wallis Lake. During large rainfall events, 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.

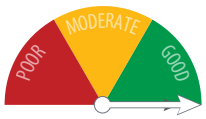
Charlotte Bay

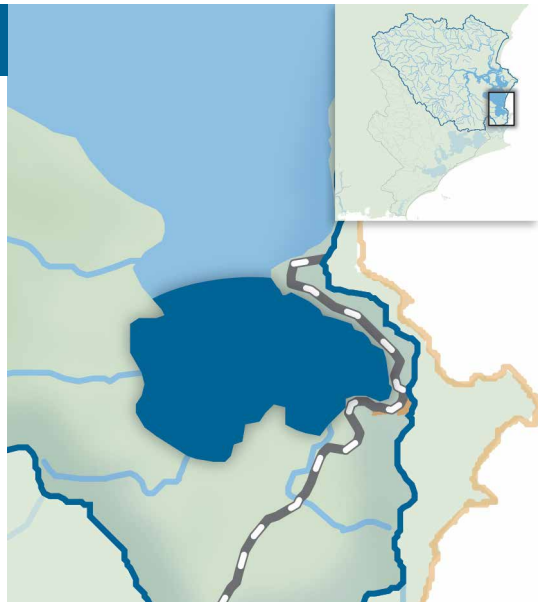


Algae



Water clarity





Charlotte Bay remains in excellent condition

Charlotte Bay is of high conservation value, with abundant seagrass and high biodiversity. In Charlotte Bay ecological health remained excellent, algal growth is at very low levels, continuing the excellent scores for the last couple of years. Water clarity was excellent.

Charlotte Bay was identified in the Water Quality Improvement Plan as having high environmental values primarily due to its extensive seagrass and macrophyte beds, which support possibly the highest diversity of sponges and associated animals in New South Wales estuaries. Good water quality, particularly clear water, were identified as being important in protecting this unique ecosystem.

The water quality results for Charlotte Bay have remained excellent, with no exceedences of algae or turbidity trigger values for any samples. The waters are very clear, allowing plenty of light to reach the seagrasses and associated sponges. The average rainfall means that the inputs of nutrients are reduced to a level where Charlotte Bay can remain in excellent condition.

These results justify Council's position in relation to water quality targets for new development which prevent further nutrient inputs to the lake.

The results from 2015 show that if there is not a continued effort to prevent of excessive nutrient inputs to the lake, excessive algal growth could occur quickly, but when pressure is reduced conditions will improve.

Great Lakes Council's Water Quality Improvement Plan has been in place for six years. Its interim targets for Charlotte Bay was no reduction in estuary health. The general trend has been for excellent results, with a couple of good scores, which is typical of natural variation. This shows that the target has been achieved.

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.

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's 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.

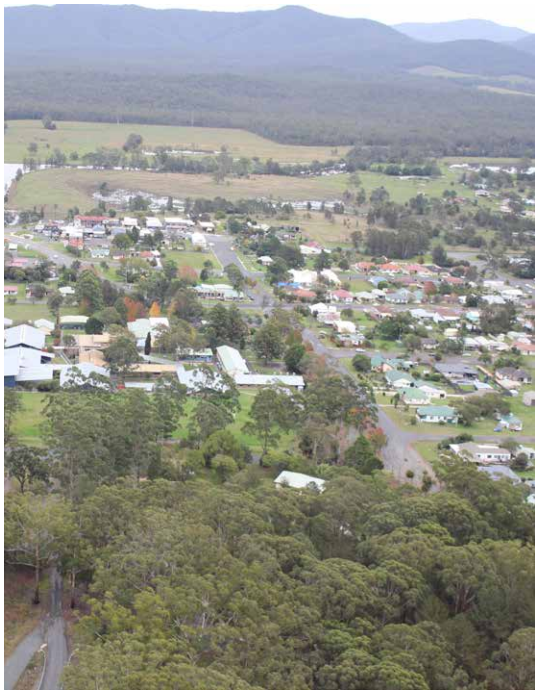
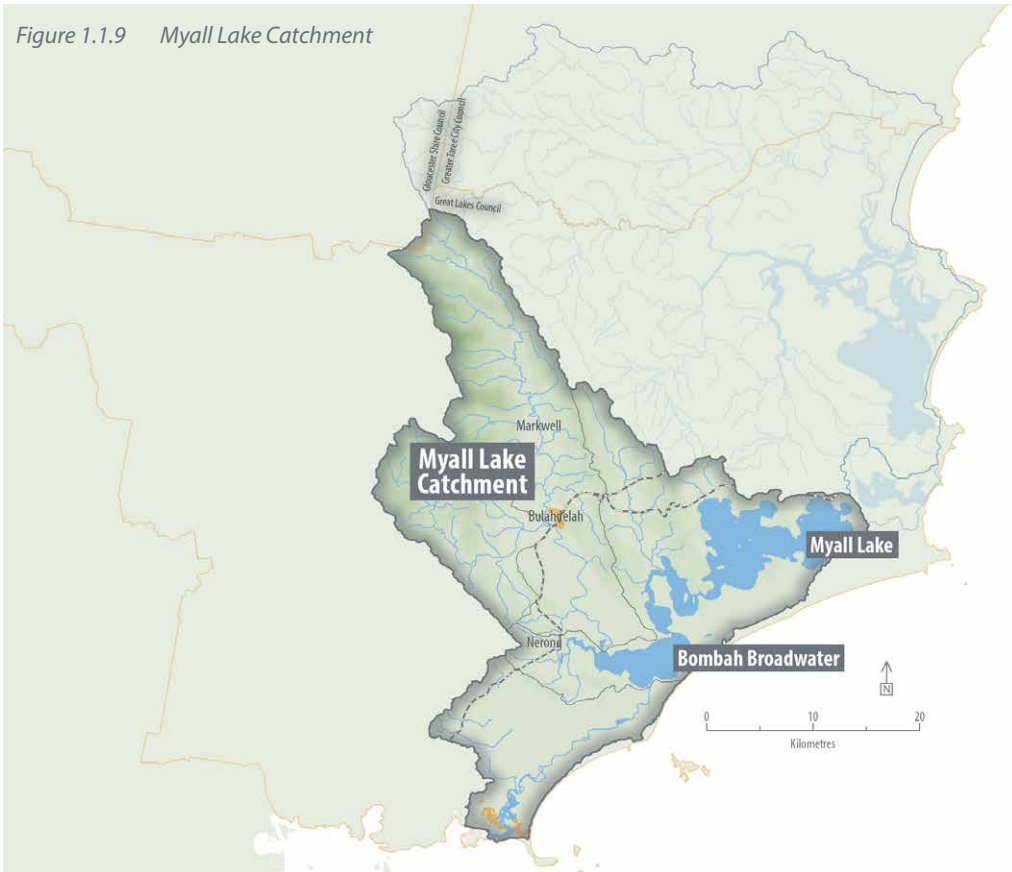
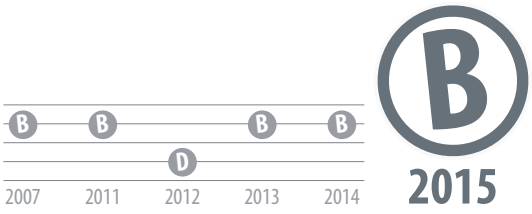


Figure 1.1.10 The township of Bulahdelah lies within the Myall Lakes catchment.

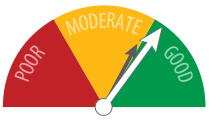
Figure 1.1.9 Myall Lake Catchment



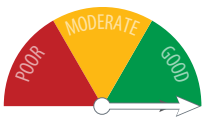
Bombah Broadwater

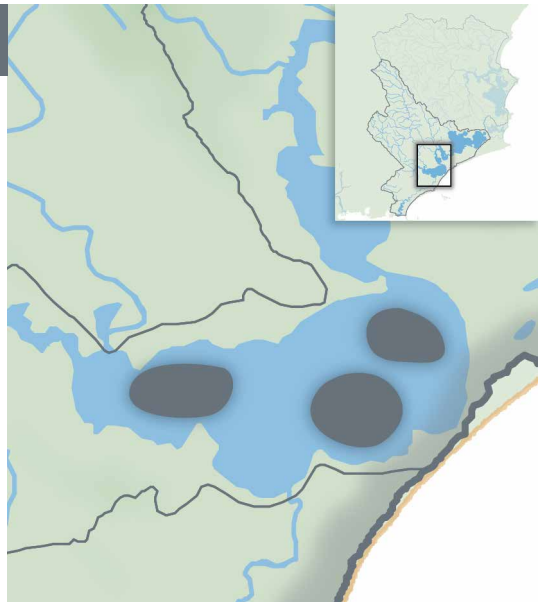


Algae



Water clarity





Good grade but algal growth remains a problem in Bombah Broadwater

The Bombah Broadwater is part of the Myall Lakes National Park. Overall ecological health of Bombah Broadwater remained the same as last year. However, there were still large amounts of algae over summer.

Excessive algal growth in Bombah Broadwater, as a consequence of nutrient inputs from the upper Myall River catchment, has been a concern in Bombah Broadwater for at least a decade. High levels of algae threaten the conservation values of the Broadwater and adjoining Myall Lake.

The marked improvement in ecological health of the Broadwater in 2013 and 2014 has continued into this year, but the elevated algal growth has persisted, though it has mostly remained below bloom levels. As a consequence, between 80 and 100% of the chlorophyll samples were greater than the desired level though exceedances were only moderate (9 – 12% of worst value). This still resulted in a fair grade for chlorophyll.

The good news is that water clarity has remained excellent, with all samples less than trigger values. This is a consequence of less runoff and a reduction in the large blue-green algal cells which can also lead to turbidity. The continuing high level of algal growth indicates that more needs to be done to control nutrient levels entering the Broadwater and the short-term target is to reduce the frequency and severity of these extended blooms.

Great Lakes Council's Water Quality Improvement Plan has been in place for six years. Its interim target for Myall Broadwater was a 2.4% reduction in chlorophyll and a 10% reduction in turbidity. Chlorophyll concentrations have actually increased, they peaked after heavy rains in 2011 and 2012 and have still not fully subsided. Water clarity is however excellent, exceeding targets.

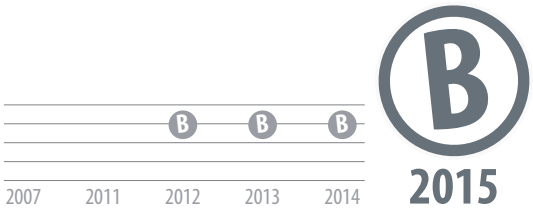
Estuary description

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.

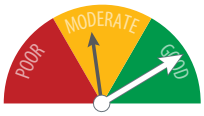
While the Bombah Broadwater itself is surrounded by National Park, it receives the majority of its inflow from the Upper Myall River and Crawford River catchments which together drain an area of approximately 440 square kilometres. These catchments are largely occupied by agricultural land with forestry 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.

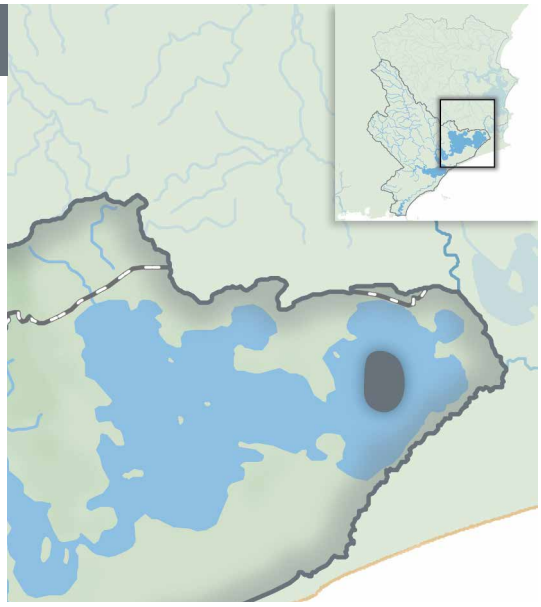
Myall Lake



Algae



Water clarity



Good grade but algal growth still an issue in Myall Lake this year

Myall Lake has high conservation values; it is an internationally listed protected wetland and is part of Myall Lakes National Park. Overall, the health has remained good. Water clarity in the Myall Lake was excellent but there continues to be some undesirable growth of algae.

Myall Lake was identified in the Water Quality Improvement Plan as having very high environmental values primarily due to its extensive macrophyte beds and listing as an internationally significant wetland under the Ramsar convention. Good water quality, particularly clear water, were identified as being important in protecting this unique ecosystem.

The water quality results for Myall Lake were good overall. The clarity was excellent with no exceedances of turbidity trigger values for any samples. The waters are very clear, allowing plenty of light to reach the macrophytes on the lake floor.

Greater than desired growth of algae occurred in 60 to 80% of samples, but exceedances were generally small. The higher than desired level of algal growth in Myall Lake emphasises the ongoing need to control nutrient levels entering the Myall Lakes system via the upper Myall River.

Great Lakes Council's Water Quality Improvement Plan has been in place for six years. Its interim target for Myall Lake was no reduction in estuary health. This year's chlorophyll concentrations are about the same as when the Plan commenced, and the turbidity results are excellent. This shows that the target has been achieved.

Estuary description

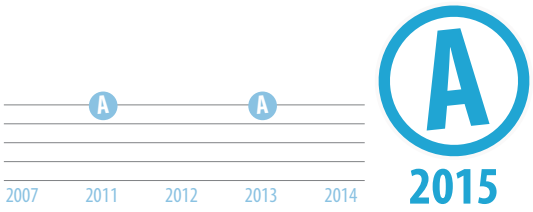
Myall Lake along with the Bombah Broadwater is part of the Myall Lakes system which is comprised of four linearly connected brackish to freshwater basins: Myall Lake, Two Mile Lake, Boolambayte Lake and the Bombah Broadwater.

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

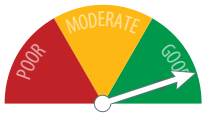
Myall Lake is directly influenced by a small fringing catchment which is contained within the Myall Lakes National Park. During times of high rainfall however, water from the Broadwater (and therefore the Upper Myall River and Crawford River catchments) influences Myall Lake by carrying with it nutrients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

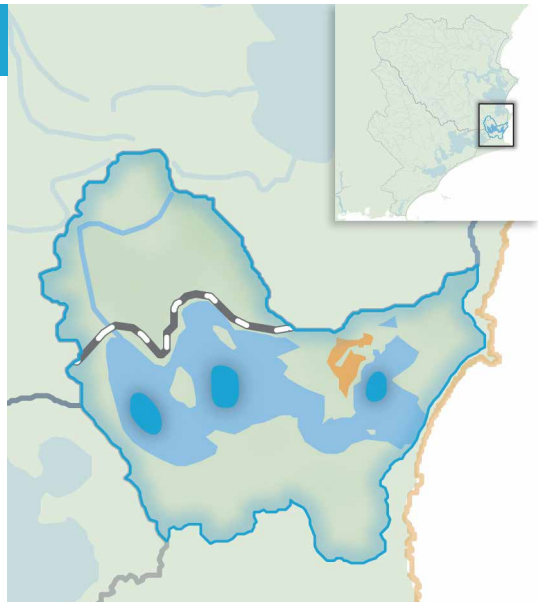
Smiths Lake



Algae



Water clarity



Smiths Lake in excellent condition despite some algal growth

Smiths Lake continues to be in excellent ecological health with very clear waters to allow growth of seagrass. There was slightly more algal growth than desired in the middle parts of the lake but this did not affect the overall score. Smiths Lake is part of the Port Stephens Great Lakes Marine Park and a large part is Sanctuary Zone. It has high environmental values primarily due to its extensive seagrass and macrophyte beds. Good water quality, particularly clear water, were identified as being key in protecting this important ecosystem.

Water clarity was excellent at all sites within Smiths Lake with no recorded exceedances of turbidity trigger values. Chlorophyll values were above trigger values 40% of the time in Wamwarra Bay (which is within the Sanctuary Zone) and 17 % of the time Symes Bay but the values only elevated by 2 – 3% of the worst value, resulting in an excellent score for chlorophyll in these locations. In the central basin, chlorophyll scores were only good, exceedances occurred in 33% of samples and exceedances were greater, though still small (6%). This indicates that these sites, which are closer to the urban development, may be getting greater nutrient inputs. If there is not a continued effort to prevent excessive nutrient inputs to the lake, excessive algal growth could occur. However, when the chlorophyll scores are combined with the excellent turbidity scores, the overall grade was excellent.

Great Lakes Council's Water Quality Improvement Plan has been in place for six years. Its interim targets for Smiths Lake was no reduction in estuary health. The overall trend has been for excellent results, this shows that the target has been achieved.

Estuary description

Smiths Lake has a catchment area of 35.89 square kilometres. It is an intermittently closed and open coastal lagoon and the lake entrance is artificially opened when levels approach 2.1 metres 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.

Management Actions - LGA wide

Landcare and Sustainability Groups

Sustainable farming practices and capacity building in the catchment continue to be supported by Karuah & Great Lakes Landcare and Great Lakes Council. In 2015, a Memorandum of Understanding to facilitate future partnership projects and funding applications was formally adopted by Karuah & Great Lakes Landcare and Council.

The Great Lakes Sustainable Farming Program was a collaborative project between Great Lakes Council, Karuah & Great Lakes Landcare, Greater Taree City Council and the Hunter Central Rivers Catchment Management Authority (now Hunter Local Land Services). The aims of the program were to facilitate sustainable and productive land use across the Great Lakes catchments.

The Great Lakes Sustainable Farming Program was funded through 'Caring for our Country' grants secured in 2008 and 2010, with the most recent grant concluding in June 2013. A number of the sustainable farming groups have become independent entities with many of them signing up to become subgroups of Karuah & Great Lakes Landcare.

Over the past year, Karuah & Great Lakes Landcare subgroups have held a number of interesting sessions including: growing unusual vegetables and fruits, holistic management, permaculture, cattle on a small scale, ideas for living sustainably and local Indigenous history and culture. Members have attended sessions on managing sheep, wicker wiper for pasture weed control, oyster farming, raising donkeys, making cheese and fermented foods, a Giant Parramatta Grass Field Day and emergency preparedness in rural areas.

Urban engagement - sustainable gardening

During the Sustainable Farming program, a program aimed at urban residents to achieve similar land management and water quality goals, was trialled. The concept of 'sustainable gardening' was seen as an excellent framework for Council to engage with residents regarding urban impacts on water quality.

Over 12 months in 2012, participants were led through a series of workshops and outdoor training sessions with local gardening experts. The objectives of the program were to work with urban residents to help them to reduce their individual impact on water quality by taking actions in their garden to reduce nutrient application, utilise water and hold water in their soil so that it would not runoff into our waterways. Many actions to achieve this objective have been undertaken by participants including composting, worm farming, mulching and establishing gardens. Numerous participants indicated that being involved in the Program gave them the confidence to 'have a go' and become more relaxed about learning by doing.

In 2014, the sustainable gardening group became a subgroup of Karuah & Great Lakes Landcare. In 2015, the group continues to meet monthly and recently visited a cattle property to share urban and rural perspectives on sustainability.

Figure 1.1.11 Landcare field day

Land for wildlife

Land for Wildlife (LFW) is a national voluntary registration scheme for landowners who manage areas of their property for biodiversity and wildlife habitat. The program encourages and assists landholders to include nature conservation in their land management objectives. The LFW program is free to join, it is not legally binding and registration does not change the legal status of a property.

Great Lakes Council and Karuah & Great Lakes Landcare are partners in delivering the LFW program in our area. Karuah & Great Lakes Landcare volunteers and Great Lakes Council staff help identify and assess wildlife habitats on private lands and their connectivity across the landscape, enabling registration with the program. To date 31 properties across the Local Government Area (LGA) have registered with LFW. In September 2015, a citizen science workshop on the use of motion-sensing cameras to monitor wildlife and feral animals on rural properties was held in Bulahdelah. Karuah & Great Lakes Landcare purchased two motion-sensing cameras that are available to loan through the program so landholders can record animal movements on their land. Many of the objectives of the sustainable farming program have been incorporated into Great Lakes Council and Karuah & Great Lakes Landcare's support of the Land for Wildlife program.

Figure 1.1.12 A Land for Wildlife member in the Monkerai area.

Protection from development and re-development

Council has focused on protecting all waterways in the LGA through its application of water quality targets for development and re-development. These water quality targets are incorporated into the Great Lakes Development Control Plan. For new developments (greenfield sites) water quality targets ensure that there is a neutral or beneficial effect on water quality which means nutrients are not allowed to increase above current levels. To achieve this, developers are required to present a stormwater strategy including measures such as installing raingardens and rainwater tanks.

Since the Development Control Plan was adopted in 2012, 21 subdivisions ranging from 2 lot to 77 lots have been approved with water quality treatments.

Small scale infill development including individual houses and dual occupancies are included in the Development Control Plan providing further protection from nutrient and sediment inputs to our waterways. Since the Water Sensitive Design chapter of the Development Control Plan commenced in 2012, 160 individual houses, 18 dual occupancies / multiple dwellings have been required to address water sensitive design. It is estimated that by constructing raingardens, swales and including rainwater tanks on these small scale developments we have stopped 67 kilograms of total nitrogen, and 6 kilograms of total phosphorus being deposited in our waterways each year. This is the equivalent of keeping 320, 17.5 kilogram bags of Dynamic Lifter out of our waterways annually. In addition to the nutrient reductions, it is estimated that 1.5 tons of Total Suspended Sediments are intercepted by these water quality treatments each year.

These figures are considered to be conservative as additional nutrient and sediment removal will be achieved on the 21 commercial developments where the Water Sensitive Design chapter of the Development Control Plan was also applied.

Management of aquatic weeds

Sixteen hectares of Cabomba infested waterways were monitored in the Wallis Lake catchment to evaluate the effectiveness of a two-year federally funded Cabomba eradication project. The project complements another federally funded project to conduct trials, leading to the registration of a suitable herbicide for the effective control of Cabomba. The program identified that 5.5 hectares were in need of retreatment. The retreatments formed part of ongoing maintenance jointly funded through Great Lakes Council's Noxious Weeds Program and the federal government's Caring for our Country Program. The maintenance program commenced in July 2013 with ongoing monitoring and any subsequent re-treatments being conducted as deemed necessary leading to the longterm goal of eradication.

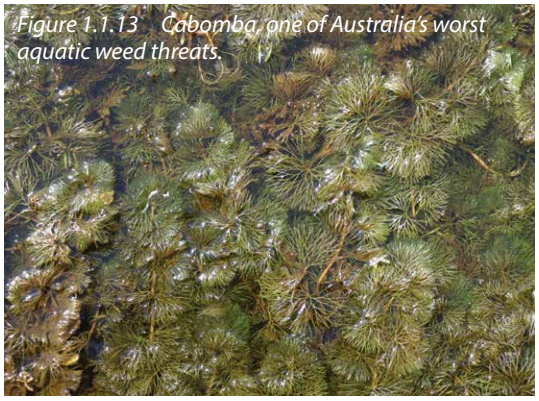


Figure 1.1.13 Cabomba, one of Australia's worst aquatic weed threats.

Management Actions - Wallis Lake

Protection and rehabilitation of key habitats

Council has acquired and rehabilitated 927 hectares of wetlands at Darawakh, Pipers Creek catchment, Minimbah and Lower Wallamba / North Tuncurry to protect water quality and biodiversity. The acquired landscapes are protected as Community Land under the Local Government Act, zoned for Environmental Protection in the Great Lakes Local Environmental Plan. Further, Council actively protects and restores the landscapes by direct and targeted actions, as funding permits.

Council has also restored pre-disturbance hydrology to over 90% of the Darawakh Creek/ Frogalla Swamp through the infilling or decommissioning of 22.2 kilometres of artificial drains and removal of 1.5 kilometres of artificial levees to remediate a significant acid sulfate floodplain wetland system. Monitoring has indicated that the works are having measurable success regarding the protection of the Lower Wallamba River from toxic acid and metal discharges. Further, there has been substantial biodiversity outcomes associated with the program.

Figure 1.1.14 Darawarkh Wetland.

Bank stabilisation

A total of 6.5 kilometres of the Wallamba River has been stabilised with rock protection and10,170 native plants have been planted (including 1,000 in 2014-2015). Ongoing bush regeneration and maintenance conserves10.9 kilometres of streambank.

Rock walls that allow establishment of mangroves have been constructed to reduce bank erosion.

The Wallamba River is exposed to severe bank erosion due to past vegetation clearance, ongoing cattle grazing and wash from boats. Monitoring from Great Lakes Council has indicated an erosion rate of up to 1 metre per year along 12 kilometres of river.

Sedimentation downstream is impacting on the health of the Wallis Lake oyster and fishing industry contributing to turbidity levels, and in turn, affecting the Report Card scores. Sedimentation directly affects oyster leases and turbidity reduces the depth at which seagrass will grow, thus reducing fish habitat.

The Wallamba River Memorandum of Understanding (MOU) brokered an innovative agreement to the management and remediation of these significant riverbank erosion issues affecting the banks of the lower Wallamba River. The MOU was amended in 2010 to address the increasing impact of wash from wake enhancing activities.

The MOU amendments were negotiated with key stakeholders including caravan park businesses, landholders, waterway users and government agencies. Importantly, the amendments provide a designated area for wakeboarding and other wake enhancing activities within Wallis Lake in an area on the western side of Wallis Island and maintains the existing ski zone within the Wallamba River.

It enacted responsibilities on land management agencies and river users to adopt actions and protocols to care for and restore the riverbank landscape to maintain the health of the river and its responsibilities including management of the riparian zone, protection and restoration of the downstream estuary and consider and manage aquatic habitat. Great Lakes Council, with the support of other land management agencies, has been implementing activities that relate to riverbank protection and stabilisation and associated riparian enhancement. Outputs have included installation of 6.5 kilometres of riverbank armouring (rock fillets/revetment), enhancement and re-establishment of riparian vegetation and mangroves, and stock exclusion fencing.

Figure 1.1.15 Rock fillets along the Wallamba River.

Erosion control

Since 2008 the New South Wales National Parks and Wildlife Service have undertaken a local program of track rationalisation and rehabilitation in National Parks to reduce erosion and sediment reaching lakes and waterways. In total, 10 kilometres of roads and trails have been closed, rehabilitated and maintained to reduce erosion and sedimentation in the Wallis Lakes catchment.

Sites for rehabilitation were identified based on the steepness, level of erosion and their location in the catchment. To rehabilitate the roads trails were re-shaped to match the contour of the land, where possible the natural drainage was reinstated and erosion and sediment controls were put in place to reduce sediment transport.

Staff were trained in best practice erosion and sediment control to assist with future management of gravel roads.

In the areas where the roads were closed, signs, gates and bollards were constructed, trees were left across the track and the surface of the land was roughened to promote vegetation growth. These areas have begun to revegetate naturally.

Bush rehabilitation

Wallamba catchment

Nabiac Landcare has been working on regeneration programs in the Nabiac area for over 20 years. The main focus of the group's work in the past has been the regeneration of a 6 hectare area of river flat sclerophyll forest at Bullock Wharf on the Wallamba River. In 2014-2015, the group received a grant to commence works on Woosters Creek at Lilly Pilly Bend in Nabiac village. This ephemeral creek contains remnant riparian vegetation, with large stands of Waterhousea floribunda that is under threat from dense infestations of small-leaved privet and lantana. As part of the grant, the group held an open day that was attended by 25 people, and now has a strong membership of around 20 people. A total of 74 endemic tubestock were planted at Lilly Pilly Bend throughout the year.

Additionally, the group routinely visits the site at Bullock Wharf to manage new weed incursions and maintain the area.

Wallis Lake

Two volunteer bush regeneration groups work on a variety of vegetation types and weeds in Forster. At the southern end of Little Street, a single volunteer maintains a small (0.4 hectare) public reserve containing remnant floodplain rainforest and important SEPP14 wetland (saltmarsh) on Wallis Lake foreshore. The area was overrun with woody weeds, such as lantana and senna, but also contains vine weeds such as climbing asparagus and morning glory. Native vines are also present, and in this highly disturbed landscape, vines are overgrowing old-growth rainforest trees. Ongoing support is needed to complete meaningful restoration of the site.

The Community Garden volunteers at Penenton Creek, Forster continue to maintain the banks of the creek, when they can spare time away from their vegetable plots. The volunteers clean up rubbish, as well as removing weeds. Woody weeds such as lantana, senna, camphor laurel and date palms once dominated the site, but volunteers are now into the maintenance phase for these species. The ongoing challenge for the group is to manage the more persistent weeds such as asparagus weeds, madeira vine, fishbone fern and invasive grasses from dominating the creek banks.

Council's weeds crew have completed several treatments of weeds on the southern bank of the creek; removing mature date palms, mature camphor laurels, as well as treating fishbone fern and asparagus on the creek bank.

The site includes mangroves, old-growth remnant rainforest trees, sclerophyll species, as well as natives planted to help outcompete the weeds.

The Sanctuary is a 6 hectare remnant of swamp sclerophyll forest adjacent to the golf course in Forster. Two volunteers have maintained this area since 2005, in which time the area has been transformed from a degraded camphor laurel forest with weed understorey, to an active regeneration site full of native regrowth. Garden escapees (from green waste dumping) are now the main focus of works here.

Four volunteer groups are actively regenerating their local bushland reserves in the Wallis catchment. Green Point Coastcare has been meeting weekly since 1996 to reduce weeds along the foreshore of Wallis Lake. Their initial work involved clearing vast tracts of lantana and bitou bush, now the remaining four members are tackling vine weeds, asparagus fern and invasive grasses. In 2014-2015, the group have contributed 214 hours and planted 478 tubestock. The group mainly focus on a 2 hectare area that has casuarinas fringing the lake's edge, with rainforest and eucalypt canopy in some areas.

Three volunteer groups are active at Coomba Park. One group, with six volunteers, works on a 3 hectare site at Coomba Aquatic Gardens. This area contains a sclerophyll forest on the headland point, and a large area of saltmarsh with mangroves fringing the lake. The site was heavily infested with lantana when the group commenced in 1994.

The woody weeds (lantana and senna) are mostly under control. However, vine weeds (passionfruit, morning glory) and garden escapees are proving more problematic in the long-term management of the area.

The Coomba Foreshore group has 12 members who meet weekly to work in a 1.5 kilometre long foreshore reserve that contains both sclerophyll

Figure 1.1.16 A volunteer working on vine weed control at Coomba.

forest and saltmarsh. Woody weeds, such as lantana and senna have been systematically removed, and the group is now working on asparagus weeds (ground and climbing), vine weeds, including morning glory, madeira vine, moth vine and passionfruit vines (two species). Garden escapees and grass weeds are also a problem at this site. The group works in a 7 hectare area on Wallis Lake. The third site contains a 9 hectare area of saltmarsh on Burraneer Road, and is maintained by a single volunteer.

Funding from the Environmental Special Rate continues to support all three groups with mentoring and extension bush regeneration works by contractors.

Charlotte Bay

Two volunteers meet irregularly at the wetland behind the Community Hall at Pacific Palms. The group commenced in 2009 on the 4 hectare site, which contains a mixture of saltmarsh species, old-growth mangroves and orchid-bearing casuarinas; as well as dense stands of cabbage-tree palms, grey gums and swamp mahoganies. Over a six year period of consistent regeneration works, the wetland has been converted from a weed dominated understorey, to a healthy mix of wetland reeds and rushes, and various rainforest understorey species. Funding from the Environmental Special Rate has enabled expansion of regeneration works in an additional 2.5 hectare of foreshore reserve to the south of the site in 2014-2015. This work has focused on priority weed species such as ground asparagus, lantana and coastal morning glory.

The site is a natural wetland, doing vital work in filtering water coming off the adjacent village and infrastructure. The removal of weeds at this site has seen a proliferation of native rushes and sedges, and subsequently improved functioning of this important natural system.

Water Sensitive Urban Design

Over the past five years Great Lakes Council have been building water quality gardens in the Pipers Creek catchment to filter the sediments and nutrients out of the stormwater prior to flowing out into Wallis Lake. Six gardens have been built in the Palms Estate drainage reserve between Kularoo Drive and the Southern Parkway in Forster. An additional garden was built out the front of Council on Breese Parade as a demonstration, filtering water from the road, further protecting Pipers Creek. In 2013, another water quality garden was constructed at the Forster Campus of Great Lakes College. The construction of the ninth water quality garden on the corner of Pipers Bay Drive and Tahiti Avenue, Forster was completed in August 2014. The number of gardens constructed now totals nine. The water quality gardens work by slowing down the stormwater so that large particles like soil drop out of suspension. The water then flows over a planted area and the microscopic alga (biofilms) which grow on the plant roots remove the nutrient nitrogen. The sandy loam soil that the plants grow in also acts as an additional filter removing other pollutants like heavy metals, petrochemicals and phosphorus. The water that then flows into the stormwater drain is cleaner prior to flowing into Wallis Lake.

Figure 1.1.17 Pipers Bay Drive water quality garden.

Great Lakes College: incorporating local water quality issues into the curriculum

In 2012-2013 Council worked with Great Lakes College Forster Campus to design a program to embed local water quality and catchment issues into the geography curriculum for Years 7-10. Council, in cooperation with MidCoast Water, has continued to work with Great Lakes College to run a twice-annual field day with Year 10 Geography students.

To date, over 220 students have learnt about catchment management, threats to water quality in natural areas and water quality improvement gardens through these field days. Class room theory lessons are combined with a specially-designed catchment trailer, dip-netting for macro-invertebrates in the lake and undertaking water quality monitoring in Pipers Creek.

Great Lakes College have begun water quality monitoring at their school site with the Waterwatch program, and have also constructed a water quality improvement garden on-campus for water quality outcomes, and as a practical demonstration of the types of actions that can be taken to improve water quality in urban catchments.

Figure 1.1.18 Great Lakes College

Management Actions - Smiths Lake

Volunteers active in bush rehabilitation

Smiths Lake foreshore group commenced in 2006 to formalise foreshore access ways and rehabilitate the surrounding vegetation. The group has had up to 20 members, but currently there is only one active member. In 2014-2015 80 volunteer hours of bush regeneration were achieved. Woody weeds, such as lantana and bitou bush, but also various scramblers and vines, such as ground asparagus and coastal morning glory are removed from this site.

Managing erosion and sedimentation

Great Lakes Council have stabilised a total of 3220 metres of roadside and unsealed roads to reduce erosion and subsequently the amount of sediment reaching the lake. In the Smiths Lake catchment, significant activity in the area of sealing unsealed roads has been undertaken over the past two years (1130 metres). This completes the sealing of all major unsealed urban roads within the Smiths Lake Village. In previous years, the roadside was stabilised along the Lakes Way near Tarbuck Bay (1801 metres) and Amaroo Drive (approximately 200 metres) has had significant erosion control works. At Patsys Flat Road, erosion control has included installing curb and gutter along 109 metres of road.

Protection of lake water quality from erosion associated with development on steep blocks in Smiths Lake has been a focus for Council. This focus has led to an increase in the lot size for new subdivision in Smiths Lake from 700 m^2 to 1000 m^2. This will have the effect of preventing subdivision of steep erosion prone and vegetated sites and subsequently protect water quality.

Management Actions - Myall Lakes

Erosion control

In an effort to reduce erosion and sedimentation in the Myall Lakes catchment, the New South Wales National Parks Service have rehabilitated, maintained or closed 59 kilometres in the Myall Lakes catchment since 2008. Outside of the National Park, erosion hot spots on gravel roads in the catchment have begun to be addressed. On Old Inn Road a concrete causeway was constructed across the Wild Cattle Creek along with sealing of the road on the approaches to the creek combined with geo-fabric and rock lining of the table drain significantly reducing sediment loads and turbidity to the creek.

Bush rehabilitation

Volunteers in Hawks Nest, known as 'the Bitou Busters', 38 members completed 200 hours at various sites in Hawks Nest, including Winda Woppa, Bennetts Beach and Jimmies Beach. Weeds of concern at all sites include asparagus weeds, polygala, coastal morning glory, lantana and bitou. Grant funding from the Environmental Trust has employed contract bush regenerators to complete additional works across the Hawks Nest landscape, complementing volunteer efforts in the area.

Figure 1.1.19 The 'Bitou Busters' at work in and around Hawks Nest

Management of aquatic weeds

Aquatic weeds were monitored and treated along 46 kilometres of stream bank in the Myall catchment. The ongoing monitoring program has revealed significant reductions in densities and occurrences of the target weed Parrots Feather.

One and a half hectares of Alligator Weed received multiple treatments at the obsolete landfill area contained within Tea Gardens Waste Management Centre. This newly discovered infestation is currently being managed under an intensive, ongoing, integrated weed management program.

One and a half hectares of Salvinia infested water bodies were treated at Tea Gardens.These works are a continuation of an integrated program for the wetland's management focusing on water retention ponds in the area. The main pond infestation has been reduced to >0.1% with monitoring and hand removal efforts ongoing.

Monitoring has revealed no sign of Salvinia in the main water body since January 2014. The use of biological controls and a containment barrier in the creek adjacent to the pond is maintaining weed densities and the eradication program will extend to this area in subsequent years as funds permit.

One hectare of land has been treated for Longleaf Willow Primrose and the integrated management program for Longleaf Willow Primrose in drainage areas of Tea Gardens is ongoing.

Figure 1.1.20 Trail in Myall Lakes National Park showing regrowth is occurring after trail closure.

Land and water on private properties along 8 kilometres of Lewis Creek at Girvan has been under an intensive management program headed by Great Lakes Council. Council has been coordinating the program due to the importance of the weed and complexities with effective management of this highly invasive species. Since 2007, the infestation areas have undergone regular inspections, monitoring and an integrated treatment program aimed at suppression leading to eradication. This program has been highly effective seeing a reduction in excess of 90% of the plants above and below ground vegetative biomass.

Protection and rehabilitation of key habitats

The Water Quality Improvement Plan recognised the critical role that wetland protection and restoration plays in the maintenance and improvement of water quality and aquatic health. Functional floodplain wetlands are particularly important in the protection of receiving waterways from catchment runoff. Given that algae concentrations remain an issue in the Myall Lakes system, it is important that Myall River Floodplain wetland systems are appropriately protected and managed.

One example of a floodplain wetland restoration project is the acquisition and restoration of the Bulahdelah Plain Wetland. This 366 hectare area is located on the Myall River Floodplain above the Myall Lakes Ramsar site. It was acquired by Great Lakes Council and with support from the New South Wales Estuary Grants and the Hunter Central Rivers Catchment Management Authority. The public acquisition of this wetland system has ensured that the important ecosystem services functions are protected against changed or intensified private land use. Further, the wetland is being actively restored so that ecosystem services functions are improved. Council has benefitted from the funding support of the Commonwealth Biodiversity Fund, New South Wales Environmental Trust and New South Wales Estuary Grants programs and is revegetating previously cleared areas of the land, controlling weeds and feral animals and excluding stock.

The works will safeguard downstream waterways and will conserve an important area of habitat for significant biodiversity, including threatened species and endangered ecological communities.

In addition, Council has become Trust Manager for the Crown Foreshore Reserve adjoining the Bulahdelah Plain Wetland Reserve and has commenced management interventions to harness ecosystem benefits and protect the natural environment. Such works include the establishment of 2.3 kilometres of stock-exclusion fencing and over 4.7 hectares of revegetation plantings in currently cleared areas. These works will increase the protection of the Myall Lakes system.

Finally, Great Lakes Council has worked with a nearby landholder to facilitate the permanent private conservation of over 200 hectares of naturally-vegetated land. This outcome was achieved through the use of Council's development-incentives for conservation clause in the Local Environmental Plan. This is a substantial positive outcome for local water quality and biodiversity.

Lower Myall

Whilst no data has been collected for the Lower Myall Estuary in Tea Gardens, actions in the catchment have continued and are presented below.

Council is a strategic partner in a project to establish connected habitat corridors and preserve and restore native vegetation at Durness Station, Tea Gardens. The Durness – Borland Landcare Corridor project involves the establishment of corridors of native vegetation linking the northern foreshores of Port Stephens with habitats in Nerong State Forest and Myall Lakes National Park.

The corridors protect 92 hectares of land, which contains 20 hectares of remnant native vegetation. The remaining 72 hectares of land in the protected corridors is being revegetated by the establishment of environmental plantings. Over 65,000 native plants have been established in these corridor areas, to restore functional native vegetation to previously cleared areas. The project is associated with the establishment of stock exclusion fencing and riparian restoration on the trunk and tributaries of Kore Kore Creek as well as the remediation of active gully and sheet erosion sites and un-vegetated steep lands. This will deliver significant water quality benefits to Kore Kore Creek, Monkey Jacket Creek and the lower Port Stephens estuary.

The project is being delivered as part of a major re-development of the agricultural production system on Durness Station to ensure greater sustainability including the establishment of a rotational grazing system and farm-scale offstream watering network. The project site will be utilised for education and awareness activities.

The Durness – Borland Landcare Corridor is being delivered by Landcare Australia Ltd and the landowner with funding provided by a bequest from the estate of the Late Raymond Borland. Council and Hunter Local Land Services are significant contributing partners. As a further contribution to this project, Council has acquired and conserved 122 hectares of land to protect water quality and biodiversity in the Kore Kore Creek catchment. This land is a core conservation node and protects a landscape important for water quality protection. Beneficial, low-intensity uses are being developed in the Kore Kore Conservation Reserve, including walking trails and signage to encourage stewardship and awareness. The Kore Kore Conservation Area has been subject to primary and follow-up weed controls, wild dog and fox controls, enhancement of track conditions and erection of nesting boxes to enhance the condition and function of the native vegetation of the land. Restoration and enhancement efforts of the Reserve are being directed by a Restoration Management Plan.

Management Actions - Karuah River

Whilst no data has been collected for the Karuah and Branch Rivers in the 2015 Report Card, actions in the catchment have continued and are presented below.

Karuah River Catchment Management Plan

The Karuah River Catchment Management Plan was adopted by Council in February 2015. The Plan will be used to guide future action in the catchment within three themes of:

- Water
- Landscape, Production and Community
- Resilient Ecosystems

Initial implementation of the Plan has commenced with a focus on management of riparian and wetland environments, nutrient and sedimentation programs.

Erosion control

To reduce erosion and sediment in the Karuah catchment, the New South Wales National Parks and Wildlife Service have undertaken a program of track rationalisation and rehabilitation. To date, a total of 99 kilometres of roads and trails have been rehabilitated, maintained or closed to reduce erosion and sedimentation in the catchment.

Management of aquatic weeds

The Noxious Aquatic weed, Water Hyacinth, is impacting tens of hectares of water bodies on private properties in many localities throughout the floodplains of the Karuah catchment, including Nooroo, Stroud Road, Washpool, Stroud, Booral and Allworth. Council and private land managers have been undertaking adhoc controls to manage this weed in various areas for many years.

Council intends to form a partnership with affected land holders and seek external funding to implement a long term control strategy to assist landholders manage the problem.

Figure 1.1.21 Participants in the Hotspots Fire and Biodiversity Workshop.

2015 Waterway & Catchment report card

for Wallis, Smiths and Myall Lakes

Great Lakes COUNCIL

NSW GOVERNMENT Office of Environment & Heritage

NSW GOVERNMENT Local Land Services Hunter

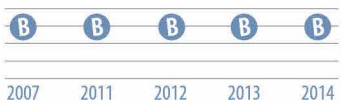
Greater Taree City Council

Karuah Great Lakes Landcare

Water quality improvement projects are made possible by the Great Lakes Environmental Special Rate

Wallis Lake Report Card

Pipers Creek

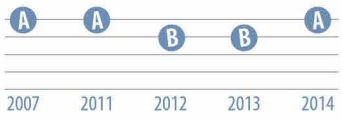


2015

The ecological health in Pipers Creek continues to improve, moving into the excellent category. Waters in Pipers Creek remained clear. The nutrient loads from the urban catchment of Forster resulted in algal levels that are now low enough for Pipers Creek to get an excellent grade.

Indicator	2015 results	Interim target	Progress
Algae		Reduce algal levels	✓
Water clarity		Improve water clarity	✓

Wallis Lake

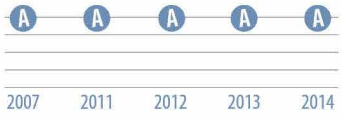


2015

In Wallis Lake ecological health was excellent this year, with the amount of algal growth remaining in the excellent category.

Indicator	2015 results	Interim target	Progress
Algae		Maintain or reduce algal levels	✓
Water clarity		Maintain or improve water clarity	✓

Charlotte Bay

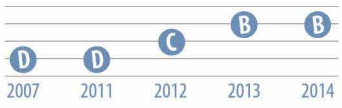


2015

In Charlotte Bay, ecological health remained excellent, algal growth is at very low levels, continuing the excellent scores for the last couple of years. Water clarity was excellent.

Indicator	2015 results	Interim target	Progress
Algae		Maintain or reduce algal levels	✓
Water clarity		Maintain or improve water clarity	✓

Mid Wallamba Estuary



2015

Waters of the mid Wallamba have remained clear most of the time, but the amount of algae in the water continues to be higher than desired. Nutrients from the catchment combined with clear waters and the still hot conditions led to overall high concentrations of algae.

Indicator	2015 results	Interim target	Progress
Algae		Reduce algal levels *Algal levels probably increased as turbidity levels decreased allowing more light to fuel algal growth*	✗
Water clarity		Improve water clarity	✓

Wallamba Cove

2015

The results for Wallamba Cove are similar to last year, indicating that estuary health in the Cove requires improvement. The algal levels show that targeted work in the catchment to reduce nutrient inputs is the highest priority.

Indicator	2015 results	Interim target
Algae		No interim target was set for this site
Water clarity		

Results to be proud of - 6 years on

INDEPENDENT scientific research

provides a solid understanding of the impacts of catchment activities on lake health. Works in the catchment have been targeted to achieve improvements in waterway health.

The Water Quality Improvement Plan established 'achievable' interim targets and long term 'aspirational' targets. Six years since adopting the plan, all sites are strongly trending towards

achieving & sustaining

the interim targets with room for improvement on algal levels at two locations.

Management efforts need to continue so that we can keep making progress towards the long term 'aspirational' targets. 'Achievable' targets were just an interim step and we need to **keep working towards the aspirational targets.**

The report card results are a

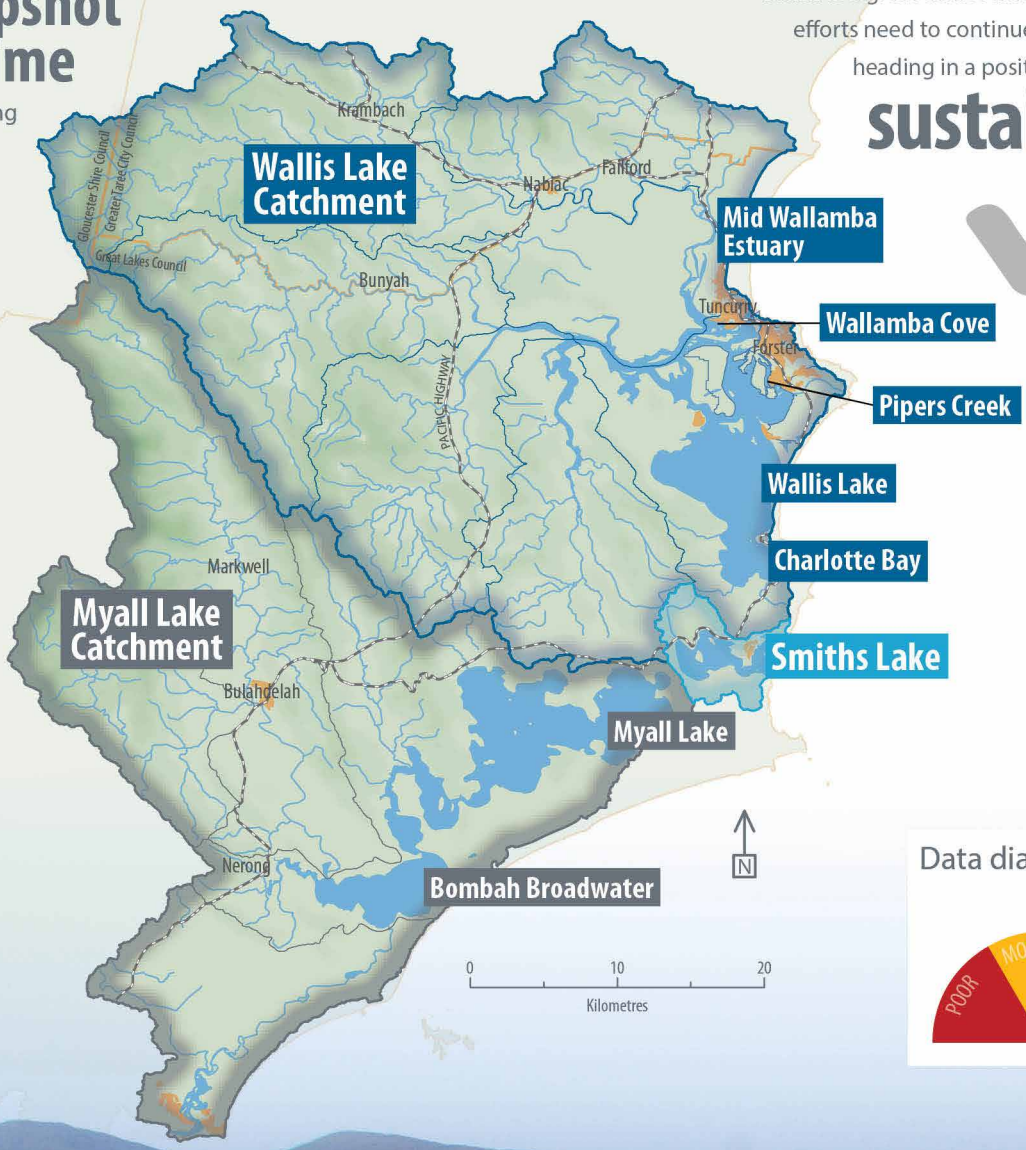
snapshot in time

Rainfall conditions during the sampling period can affect the report card scores but since sampling commenced in 2007, overall results have trended towards maintaining or achieving the water quality targets.

Halting decline and maintaining waterway health is a great achievement, management efforts need to continue in order to keep heading in a positive direction and

sustain the gains

that have been made.



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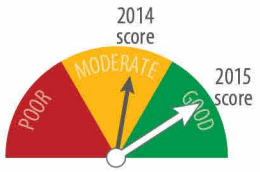


Smiths Lake Report Card

Smiths Lake

A

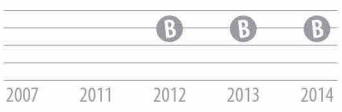
2015

Smiths Lake continues to be in excellent ecological health with very clear waters to allow growth of seagrass. There was slightly more algal growth than desired in the middle parts of the lake but this did not affect the overall score.

Indicator	2015 results	Progress towards targets: Interim target	Progress
Algae		Maintain or reduce algal levels	✓
Water clarity		Maintain or improve water clarity	✓

Myall Lake Report Card

Myall Lake



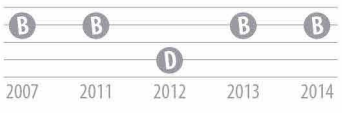
B

2015

Myall Lake has high conservation values. Overall, the health has remained good. Water clarity in the Myall Lake was excellent but there continues to be some undesirable growth of algae.

Indicator	2015 results	Progress towards targets: Interim target	Progress
Algae		Maintain or reduce algal levels	✓
Water clarity		Maintain or improve water clarity	✓

Bombah Broadwater



B

2015

Overall ecological health of Bombah Broadwater remained the same as last year. However, there were still large amounts of algae over summer.

Indicator	2015 results	Interim target	Progress
Algae		Reduce algal levels *Algae peaked during heavy rains in 2011-12 and still have not subsided, but water clarity exceeded targets*	✗
Water clarity		Improve water clarity	✓

Management Actions 2007-2015

Wallis Lake

Removal of aquatic weeds
16 hectares of Cabomba infested waterways treated

Land for wildlife
31 properties across the LGA, and 24 in the Wallis Lake catchment have registered with LFW

Protection and rehabilitation of key habitats
Acquiring and conserving 927 hectares of wetlands at Darawakh, Minimbah and Lower Wallamba/North Tuncurry and Pipers Creek catchment to protect water quality and biodiversity

Water sensitive urban design
9 water quality gardens and two wetlands built to treat 39.6 hectares of land in the Pipers and Muddy Creek catchments
All new houses and subdivisions required to meet water quality targets with water sensitive urban design

Bush rehabilitation
10 volunteers active in bush regeneration at 10 sites

Working with students
Incorporated water quality and catchment management issues into the Great Lakes College Geography curriculum for years 7-10

Rubbish removal
Removal of 14 tons of rubbish from Wallis Lake and Penenton Creek in Forster

Bank stabilisation
Stabilising 6.5km of the Wallamba River with rock protection, planting 10,170 native plants and conserving 10.9km of stream bank

Erosion and sediment control
Protecting creek crossings in the upper catchment. 10km roads and trails closed, rehabilitated and maintained to reduce erosion and sedimentation in Wallis Catchment

Backyard Bushcare
100 residents attended 2 "Weed, Wine & Dine" evenings
52 people signed "Bushland Friendly Gardens" pledge
82 people subscribed to Weed Bulletin monthly emails

Smiths Lake

Bush rehabilitation
1 volunteer active in bush regeneration /water testing at Smiths Lake contributing 80 hours

Roadside stabilisation
3220m of roadside stabilised reducing the amount of sediment reaching the lake

Protection of lake water quality from erosion associated with development on steep blocks
Council increased the lot size for new subdivision in Smiths Lake from 700 m^2 to 1000 m^2

Key stats across catchments
- Erosion control on 39.9ha of land
- 903ha of wetlands protected and enhanced
- 63.9km of stream bank protected plus
- 377ha of native vegetation protected and enhanced
- 10ha of infested water treated for aquatic weeds
- 240m of roadside stabilised to reduce erosion

Projects funded by Hunter Local Land Services

Myall Lake

Removal of Aquatic Weeds
Aquatic weeds monitored along 46km of streambank and 4 hectares of waterways treated

Land for wildlife
31 properties across the LGA, and 4 in the Myall Lakes catchment have registered with LFW

Erosion control
59km roads and trails closed, rehabilitated and maintained to reduce erosion and sedimentation in Myall Lakes Catchment

Protection and management of land for important ecosystem services
Acquiring 371ha of wetlands in the Bulahdelah area, creating a major wildlife corridor at Durness protecting 90 hectares of land and revegetating 70 hectares to protect water quality and biodiversity

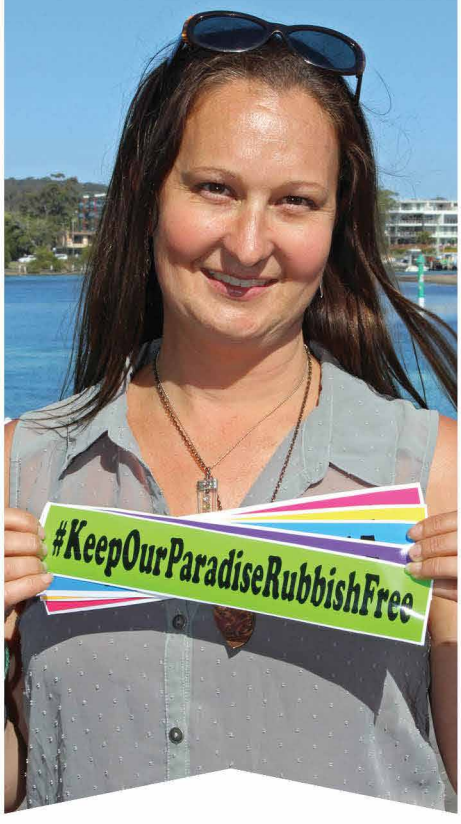
Details on the report card methods and results contained in this report card are available in the 2015 Water Quality Report, or scan the QR code to the right.
www.greatlakes.nsw.gov.au/Environment/The-Big-Picture#waterwayandcatchmentreportcard

Everyday water quality CHAMPIONS

Tina Goqerly

Environmental Campaigner, Tuncurry

"Keep Our Paradise Rubbish Free" - that's Tina's simple message. Growing up in the local area and spending many hours enjoying the local beaches, National Parks and waterways Tina noticed just how much rubbish was turning up around our iconic places. She decided enough was enough - the rubbish has to stop. Leading by example, Tina spends many hours cleaning up all types of rubbish in our local area. Joined by family and friends, Tina is encouraging everyone to join her in the year-round clean-up. "I live in this beautiful area, I love this place and I want others who visit now and in the future to enjoy it too, free of rubbish as I knew it once to be". Look out for Tina's colourful bumper stickers or tune-in to her Facebook page for more news #KeepOurParadiseRubbishFree.



Garry Smith

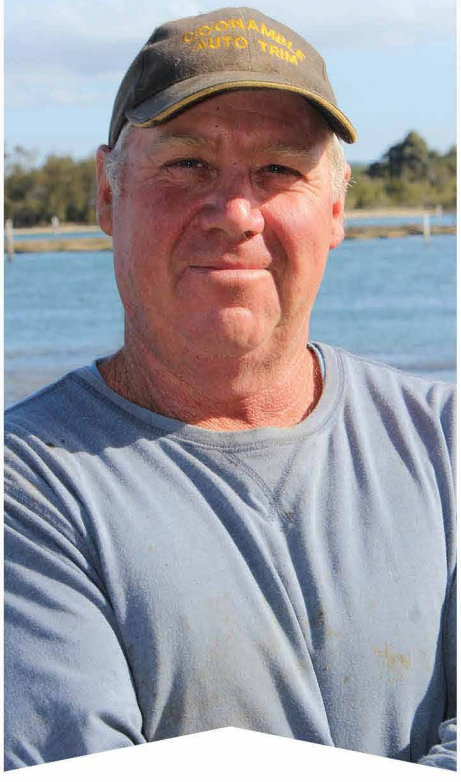
HSIE Head Teacher at Great Lakes College, Forster Campus

For Garry Smith, Head Teacher of HSIE at Great Lakes College, Forster, teaching students about water management is really a 'no-brainer'! If you see Garry with his students it is easy to see how his enthusiasm for our waterways really rubs off. Garry and his team have established an engaging study unit about water pollution which draws on international examples, the annual Great Lakes water quality report card and local expert knowledge. "I'm keen to raise awareness of local environmental issues. I want students to become active citizens in the future and for them to appreciate where they live and what management and protective action is required. It is up to each and every one of us to be proactive in order to protect and sustainably manage what we have for the future."

Anthony Sciacca

Oyster Farmer, Wallis Lake Estuary Committee Member

Local oyster farmer Anthony Sciacca is a great advocate for the health of our waterways. Everyone knows how important clean water is for the viability of our seafood industry and Anthony is a passionate advocate for restoring our catchments. Representing the oyster industry in 1999, he was instrumental in alerting government and the community to the serious water quality issues associated with the Darawakh Creek. Anthony helped lobby for government funds and worked to convince the community of the need for a local environmental rate to contribute to the restoration of Darawank Wetland. He also convinced his peers in the oyster industry to provide a financial contribution towards this project. Committing 20 years to the Wallis Lake Estuary Committee, Anthony has contributed a wealth of energy and local knowledge to see strategies to protect our lakes implemented.



Great Lakes
COUNCIL

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