APPENDIX 4

Estuary Health Cards & Report

Shoalhaven Estuary Health Report Cards 2010 - 2011

Technical Report

April 2012

This technical report and associated estuary health report cards have been prepared by Danny Wiecek and Ray Laine (Office of Environment and Heritage) on behalf of Shoalhaven City Council

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1. Introduction

In recognition of the need to better understand the health of its estuaries, Shoalhaven City Council applied for and received grant funding from the Office of Environment and Heritage (OEH) under the Estuary Management Program to develop an Estuary Health Monitoring Program for eight estuaries in the Shoalhaven. These included the Shoalhaven River, Lake Wollumboola, Swan Lake, St Georges Basin, Lake Conjola, Narrawalle Inlet, Burrill Lake, and Tabourie Lake.

Estuary management plans have been completed for each of these eight estuaries, with key objectives to undertake estuary health and water quality monitoring. As partners with Council in implementing these estuary management plans, OEH provided technical support to Council in all aspects of the Shoalhaven Estuary Health Monitoring Program including setting up the program and analysing and reporting of the results.

Information from this monitoring program will be used as a baseline to track how well each estuary is being managed over time and whether implementation of the completed estuary management plans are leading to improved estuary health. In addition, Council wanted to develop report cards that could be used to inform the community of the current health of its estuaries.

This technical report documents the sampling program used and the analysis that has been undertaken to generate the estuary health report cards. This will allow future sampling and reporting to follow the same methodologies.

It is important to note that 'estuary health' refers to the condition of the estuary rather than issues associated with its use. As a result, issues such as the ability to harvest shellfish or safe bacterial levels for recreational activities are assessed through other targeted programs monitored by Council.

2. Sampling Program

2.1 Indicators selected

The Shoalhaven estuary health report cards with the exception of the Shoalhaven River and Swan Lake are based on chlorophyll a and turbidity data collected monthly by Council between January 2010 to February 2011, and estuarine vegetation (seagrasses, mangrove and saltmarsh) change between 1985 and 2006 calculated by the NSW Department of Primary Industries. The Shoalhaven River estuary health report cards are based on chlorophyll a and turbidity data collected monthly by Council between September 2009 to February 2011, and estuarine vegetation (seagrasses, mangrove and saltmarsh) change between 2003 and 2010 calculated by the NSW Department of Primary Industries. Due to insufficient sampling over the 12 month period Swan Lake has not been assessed for the purposes of estuary health report cards.

These indicators were chosen as they are used in the NSW Government Natural Resource Monitoring, Evaluation and Reporting (MER) Program (estuary theme) as indicators of estuary condition (DECCW, 2010a; DECCW, 2010b). Turbidity, chlorophyll a and estuarine vegetation change are considered to be appropriate measures of estuary health as they are measures of aquatic ecosystem status and can be linked to catchment disturbance. In addition, chlorophyll a and turbidity could be readily incorporated into Council's existing program of water quality sampling.

Chlorophyll a indicates the amount of microscopic algae, called phytoplankton, growing in the water. Excessive input of nutrients from catchment runoff (urban stormwater, agricultural runoff, and sewage overflows) can increase chlorophyll a levels and lead to algal blooms and detrimental effects on estuarine plants and animals. Chlorophyll a samples were analysed in a NATA accredited laboratory.

Turbidity is a measure of light scattered by suspended particles such as sediment, algae and dissolved material in the water which affect its colour or murkiness. Turbidity can increase from sediments transported in catchment runoff (particularly after heavy rainfall), shoreline erosion and increased microscopic algae. Increased turbidity can have detrimental impacts on seagrasses and fish.

Seagrasses are aquatic flowering plants that form meadows near shore. They are highly productive, provide nursery and foraging habitat (for fish, crustaceans and molluscs), bind sediments against erosion and help regulate nutrient cycling. They are very sensitive to changes in water clarity.

Mangroves grow between mid and high tide levels. They are an important food source, provide habitat for a number of species such as crabs and juvenile fish, protect shorelines and cycle nutrients and carbon. While an increase in mangroves can be a positive outcome where they are recolonising in areas previously removed, increases in mangrove distribution can sometimes be at the expense of other important habitat types such as saltmarsh, which could be viewed as a negative outcome.

Saltmarsh is a community of plants and animals that grows above the mangroves at the highest tidal levels. Saltmarsh is important in estuarine food webs, providing a site for invertebrate breeding and a feeding area for economically important fish and shorebirds. Saltmarsh decline is a worrying trend from a number of estuaries in NSW and has led to saltmarsh being listed as an endangered ecological community under the Threatened Species Conservation Act 1995. Declines in recent years have been linked to both increased sedimentation from catchment land use pressures and sea level rise.

A suite of other physico-chemical water quality parameters including salinity, pH, temperature, and dissolved oxygen were also measured by Council and provide useful information for interpreting water quality status.

2.2 Site selection

In general, two or more sampling sites were used for intermittently closed and open lakes and lagoons (ICOLLs), with nine sites being utilised for the larger Shoalhaven river estuary. Site location considerations included:

- Using sites where water quality data has previously been collected to assist with comparative purposes, including MER sampling zones (DECCW, 2009).
- Trying to locate sites roughly in the lower, middle and upper portions of each estuary to get a spread over different salinity zones as estuarine processes may differ in response to salinity.
- Minimising the potential for unrepresentative impacts on water quality caused by human activities in a localised area while still ensuring safe access under all

conditions. In some instances, site selection has involved a compromise between ease of access and the position of structures that may influence water quality.

- It should be noted however, due to accessibility issues some estuaries may not be adequately represented with sample sites being clustered in specific regions.

3. Data Analysis

All raw data collected by Council was provided to OEH for processing. A number of initial data processing tasks for data collected by Council needed to be completed before analysis could begin. These were undertaken to create a data set where statistical analysis could be readily applied. Processing tasks included are described below. All data processing was undertaken in Microsoft Excel spreadsheets.

3.1 Averaging replicate samples

Three replicate samples were taken for chlorophyll a for quality control purposes on a random subset of sites and estuaries. An average of the replicate samples was taken and this average value used for all subsequent analysis. Although replicate sample variation was often above 10% across the dataset, taking an average was considered a better option compared to excluding the replicates with variation above 10% from further analysis.

3.2 Deletion of sample outliers

Based on an expert understanding of likely chlorophyll a and turbidity values in NSW estuaries, 21 samples collected on the 22nd of February 2010 were removed from the 862 sample dataset. An additional 8 samples across a range of date's were also removed. The values provided for these 29 samples were considered to be extreme outliers that were likely attributable to equipment and / or laboratory error.

3.3 Assigning salinity values for each chlorophyll a and turbidity value

For each chlorophyll a and turbidity value, a corresponding salinity value was recorded by Council. Where a salinity value was not recorded, professional judgement was used (based on salinity at this site for all other occasions and its position in the estuary) to assign a salinity value. This judgment was required for two samples out of the 862 samples analysed.

3.4 Determining appropriate trigger values for all estuaries and assigning salinity zones for estuaries classified as 'rivers'

In order to assess the health or integrity of an estuary the NSW Monitoring, Evaluation and Reporting (MER) Program has determined trigger values[1] to indicate estuarine conditions which are not desirable for estuarine health and should "trigger" investigation. These trigger values were determined by calculating the 80th percentile (ANZECC, 2000) of all data for NSW reference estuaries in each estuary class (Roper *et al.*, 2011). These estuary classes are rivers, lakes and lagoons. Separate trigger values were assigned to each of these three estuary classes for both chlorophyll a and turbidity. For 'river' type estuaries, separate trigger values were also assigned for upper, middle and lower salinity zones of the estuary to reflect variation in ecological processes. Shoalhaven River and Narrawallee Inlet were classified as 'rivers', Lake Wollumboola, St Georges Basin, Lake Conjola, Burrill Lake were classified as 'lakes', and Lake Tabourie was classified as a "lagoon".

[1]Note: Trigger values are referred to as guideline values in the report card text for communication purposes.

Estuary class	Trigger values	
	Chlorophyll *a* (ug/L)	Turbidity (NTU)
Lake	3.6	5.7
River – lower (salinity $\geq$ 25ppt)	2.3	5.0
River – mid (salinity 10 to < 25 ppt)	2.9	8.0
River – upper (salinity < 10ppt)	3.4	13.7
Lagoon	2.0	3.3

Table 1: Trigger values for chlorophyll a and turbidity (Roper *et al*., 2011).

3.5 Determining appropriate Worst Expected Values (WEV) for all estuaries

Compliance against a guideline or trigger value is commonly used to assess the ecological condition of a waterbody. The level of compliance is commonly used for reporting purposes. In recognition that most guidelines are published as threshold values which only allow for two possible states, compliant and non-compliant, the OEH Coastal Waters Unit has determined a distance measure that provides for more sensitivity for ecological condition along the gradient from good to poor. In order to determine this gradient the Worst Expected Value (WEV) has been calculated.

The WEV has been calculated based on the 98th percentile of data from all estuaries in each class sampled under the NSW MER program (refer Table 2). This percentile was selected as it provides values that should be close enough to measured values so that small changes in distance are not swamped by a very large WEV, but large enough that most values are less than the WEV. In the small number (2%) of circumstances where measured values are greater than WEV, the measured value can be replaced with the WEV so that the distance measure becomes 1 (which is the highest possible value). I.e A sample will be nearly 0 for slight exceedances of the trigger value and 1 when the sample equals or exceeds the WEV for each of the indicators. Hence, higher scores (those approaching 1) represent a worse condition than lower scores (those approaching 0).

Estuary class	Worst Expected Value	
	Chlorophyll *a* (ug/L)	Turbidity (NTU)
Lake	30	20
River (mid)	30	60
Lagoon	30	20

Table 2: The Worst Expected Values for Chlorophyll a and Turbidity (Great Lakes Council, 2011).

4. Data Analysis and Reporting

Data analysis was completed by OEH consistent with the methodology outlined in the Draft OEH Sampling, Analysis and Reporting Protocols for Estuary Health Assessments (OEH, 2012). All data analysis was undertaken in Microsoft Excel spreadsheets using the following steps below:

Step 1: Calculating the non-compliance score (NC_i) for chlorophyll a and turbidity

This involves assessing the proportion of time that the measured values of chlorophyll a and turbidity are outside the respective NSW MER trigger values (Table 1). The non-compliance score is simply calculated by:

NC_i = number of samples non-compliant with trigger value divided by the total number of samples (expressed as a value between 0 and 1 with 0 equal to all values being compliant and 1 equal to all values non-compliant).

For example the statement used in Microsoft Excel:

=IF(Sample>Trigger Value,1,0)

Step 2: Calculating the distance from the trigger value (DS_i) for chlorophyll a and turbidity

This involves determining the distance that the chlorophyll a and turbidity measured values exceed the NSW MER trigger values for data greater than the trigger. The distance score is calculated by:

DS_i = (measured value – trigger value / (WEV – trigger value)

The distance from benchmark score (DS_i) will be nearly 0 for slight exceedances of the trigger value and 1 when data equal the WEV for each of the indicators.

For example the statements used in Microsoft Excel:

=IF(NC_i=1,((Sample-Trigger Value)/(WEV-Trigger Value)),0)

=IF(DS_i>1,1, DS_i)

Step 3: Calculating the final indicator score for (IS_i) chlorophyll a and turbidity

This involves determining the final chlorophyll a and turbidity score for each sample location. This is achieved by calculating the geometric mean by:

$IS_i = \sqrt{(NC_i \times DS_i)}$

For example the statement used in Microsoft Excel is:

=SQRT(NC_i x DS_i)

Step 4: Calculating the final zone grade (ZS) for chlorophyll a and turbidity

In order to report grades consistently across NSW the Draft OEH Sampling, Analysis and Reporting Protocols for Estuary Health Assessments (OEH, 2012) have specified cut-off values for each grade (Figure 1). These grades represent a percentile spread of the 184 NSW estuaries (Table 3). This allowed consistent gradings to be awarded for final zone grades for both chlorophyll a and turbidity (Table 4). This is done by calculating the average of chlorophyll a and turbidity and assigning the representative grade:

$ZS = (IS_{\text{chlorophyll a}} + IS_{\text{turbidity}})/2$

For example the statement used in Microsoft Excel is:

=AVERAGE($IS_{\text{chlorophyll a}}$: $IS_{\text{turbidity}}$)

=IF(ZS<0.07,"A",IF(ZS<0.23,"B",IF(ZS<0.44,"C",IF(ZS<0.6,"D",IF(ZS<1,"E","E")))))

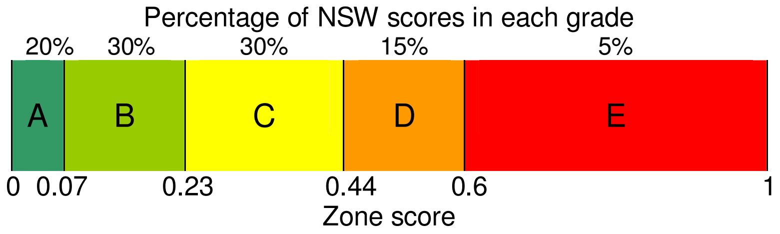

Figure 1: Relationship between the distribution of NSW scores, grades and zone score for chlorophyll a and turbidity used to assign grades of A to E (OEH, 2012).

Percentile	Cut-off zone score
95	0.60
80	0.44
50	0.23
20	0.07

Table 3: Percentile values which define cut-offs for grade scores.

Based on the Grade derived from the Cut-off zone score, an Indicator Estuary Health (IEH) Score ranging from 5 (Very Good) to 1 (Very Poor) was assigned to the zone allowing for the calculation of an Overall Estuary Health Grade (refer to Step 10).

Grade	Result	Definition (example)	Description	IEH Score
A	Very good	All environmental values met (The indicators measured meet all of the benchmark values for almost all of the year)	Equivalent to the best 20 % of scores in the state in 2010	5
B	Good	Most environmental values met (The indicators measured meet all of the benchmark values for most of the year)	Equivalent to the next 30 % of good scores in 2010	4
C	Fair	Some of the environmental values met (The indicators measured meet some of the benchmark values for some of the year)	Equivalent to the middle 30 % of scores in 2010	3
D	Poor	Few of the environmental values met (The indicators measured meet few of the benchmark values for some of the year)	Equivalent to the next 15 % of poorer scores in 2010	2
F	Very Poor	None of the environmental values met (The indicators measured meet none of the benchmark values for almost all of the year)	Equivalent to the worst 5 % of scores in the state in 2010	1

Table 4: Final zone grades, definitions and descriptions for chlorophyll a and turbidity (OEH, 2012).

Step 5: Reporting grades for chlorophyll a and turbidity data

The report cards document grades based on the above methodology. A grade is initially rated for chlorophyll a and turbidity in the report cards as very good, good, fair, poor or very poor based on the percentile values as represented in Tables 3 and 4. Following the initial rating, a percentage exceedence is then reported derived from Step 1: Calculating the non-compliance score (NCi) for chlorophyll a and turbidity. A subsequent qualifier (barely, moderately or significantly) derived from Step 2: Calculating the distance from the trigger value (DSi) is then stated. The qualifier barely, moderately or significantly is categorised based on the percentage DSi. These percentages are: <33% = Barely; 34% to 66% = Moderately; and 67% to 100% = Greatly.

In addition to grading chlorophyll a and turbidity data, the report cards also provide information about the locations where the largest exceedences of chlorophyll a and turbidity occurred for each estuary. A brief description of the likely causes is provided for some locations based on available information, sourced from estuary management plans and associated estuary processes studies and reports.

Step 6: Reporting and comparing chlorophyll a and turbidity data to data collected under the NSW MER Program

Chlorophyll a and turbidity were monitored under the NSW MER Program for five of the eight estuaries monitored by Council (Shoalhaven River, St Georges Basin, Lake Conjola, Burrill Lake, and Tabourie Lake). As the methodology for analysing chlorophyll a and turbidity data was consistent between the two datasets comparisons were able to be made between the data sets for the report cards, but with some qualifications.

The qualifications that need to be made when comparing between the two data sets are primarily based around some differences in sampling regimes. For example, the NSW MER Program used slightly different sampling techniques including sampling during the summer period only targeting chlorophyll a maximums, and sampling over broad zones within the estuary rather than individual sites.

Comparisons were made by comparing the percentage exceedances for both data sets.

When interpreting the two data sets, the prevailing climate, particularly rainfall, over the different sampling periods should also be considered due to the influence climatic conditions have on water quality and estuary health.

The MER sampling period data that was used to inform the NSW State of the Catchment reports is outlined in Table 5 below.

Estuary	**Chlorophyll a**			**Turbidity**		
	Number Samples	Sampling Start	Sampling End	Number Samples	Sampling Start	Sampling End
Shoalhaven River	22	Feb-08	Mar-09	22	Feb-08	Mar-09
Lake Wollumboola	Not sampled			Not sampled		

St Georges Basin	18	Dec-08	Mar-09	18	Dec-08	Mar-09
Lake Conjola	18	Dec-08	Mar-09	18	Dec-08	Mar-09
Narrawallee Inlet	Not sampled			Not sampled		
Burrill Lake	42	Jan-08	Mar-09	38	Feb-08	Mar-09
Tabourie Lake	12	Dec-08	Mar-09	11	Dec-08	Mar-09

Table 5: NSW MER sampling dates (Roper et al. 2011).

Step 7: Assigning scores and grades for estuarine vegetation change

Estuarine vegetation change in extent between 1985 and 2006 for Lake Wollumboola, St Georges Basin, Lake Conjola, Narrawalle Inlet, Burrill Lake, and Tabourie Lake was calculated by the NSW Department of Primary Industries. In addition, change in extent was also calculated for the Shoalhaven River between 1985, 2003 and 2010. The methodology to derive these extents is documented in the NSW State of the Catchment Technical Report Series, Assessing the condition of estuaries and coastal lake ecosystems in NSW (Roper et al. 2011). The results from this assessment, documented in Appendix B, were used for these report cards to provide additional estuary health information.

The five category scoring classes used to assess seagrasses, mangroves and saltmarsh, are based on the Draft OEH Sampling, Analysis and Reporting Protocols for Estuary Health Assessments (OEH, 2012), which are also used under the NSW MER Program (Table 6 below). This is based on percentage vegetation loss or gain in extent between the survey years. Grades were only awarded for the estuary as a whole in the NSW MER methodology and excluded Mangroves as the current understanding of what change in mangrove extent means ecologically is open to debate. For these report cards each estuarine vegetation class was reported on unless specified otherwise. Some vegetation change was unscored due to limited extent coverage and/or data capturing anomalies.

Score Criteria	Rating	Grade	IEH Score
> 10% gain	Very Good	A	5
± 10% gain	Good	B	4
-10 to -40% loss	Fair	C	3
-40 to -70% loss	Poor	D	2
-70 to -100% loss	Very Poor	E	1

Table 6: The scoring classes used for estuarine vegetation change based on percentage loss or gain (Roper et al. 2011).

In order to provide an Indicator Health Score (IEH), an average of the individual ratings for saltmarsh and seagrasses was undertaken as per NSW MER methodology excluding mangroves. This method was applied so that estuarine vegetation as a whole would have the same overall weighting as either chlorophyll a or turbidity in the overall estuary grade.

As noted on the report cards, the analysis of change in extent of estuarine vegetation was completed using different aerial photo interpretation methodologies for the 1985, 2006 and 2010 surveys. In addition, there are also differences in the scale used when digitising making detailed comparisons difficult. As a result, some of the change observed may be due to the different methodologies, as well as actual losses and gains in vegetation extent.

Step 8: Documenting key areas of estuarine vegetation change

In addition to grading estuarine vegetation change, the report cards also provide information about the locations within each estuary where the greatest change had occurred. This was identified by visual comparisons of the two data sets. Information about likely causes of the change were also included where this was available from other information sources, including estuary management plans and associated estuary processes studies for each of the seven estuaries, as well as historical aerial photos.

Step 9: Calculating overall estuary health grades

In reporting on Estuary Health it is useful to provide an overall grade or index that reflects on the overall condition of the estuary. This index is based upon an aggregation of individual indicator scores or indices. In order to calculate the overall estuary health grade or index (from very good to very poor) the unweighted Indicator Estuary Health (IEH) (from 1 to 5) for chlorophyll a, turbidity and estuarine vegetation were firstly averaged.

Once an average score from the three indicators were calculated, the grading scale adopted for the NSW MER Program was used to assign an overall grade (Table 7) (Roper et al. 2011). This grade was then reported in the first sentence of each report card and represents the overall health of the estuary as per this methodology.

Score Criteria	Rating
4.3 to 5.0	Very Good
3.5 to 4.2	Good
2.7 to 3.4	Fair
1.9 to 2.6	Poor
< 1.8	Very Poor

Table 7: Scoring classes used to assign overall grades of very good to very poor (Roper et al. 2011).

5. References

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Appendix A- Summary Statistics

Chlorophyll a Summary Statistics

Shoalhaven River											
Sites	SHR-3	SHR-148	SHR-275	SHR-294	SHR-295	SHR-342	SHR-375	SHR-454	SHR-548	SHR-776	SHR-777
N	13.0	17.0	18.0	17.0	16.0	17.0	17.0	18.0	17.0	17.0	17.0
Min	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Max	19.3	6.3	13.3	6.8	4.3	7.0	15.0	38.3	13.3	8.0	10.7
Mean	2.9	1.4	2.3	1.5	1.3	2.1	2.8	1.7	1.7	1.0	2.0
Median	1.7	0.3	1.2	0.8	0.7	1.3	1.7	1.3	1.7	1.0	2.0
20th Percentile	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.6	0.0	0.0	0.8
80th Percentile	3.5	2.7	3.5	2.3	3.0	4.2	4.9	2.9	3.4	1.7	3.5

Lake Wollumboola		
Sites	WOL-215	WOL-219
N	11.0	10.0
Min	0.0	0.0
Max	54.7	6.7
Mean	12.1	1.7
Median	2.2	1.3
20th Percentile	0.5	0.0
80th Percentile	16.4	2.1

St Georges Basin / Sussex Inlet			
Sites	SGB-28	SGB-33	SGB-772
N	15.0	18.0	16.0
Min	0.0	0.0	0.7
Max	4.5	5.0	4.7
Mean	1.8	1.9	2.2
Median	2.0	1.7	1.7
20th Percentile	1.3	1.1	1.3
80th Percentile	2.7	2.5	2.5

Lake Conjola			
Sites	CON-479	CON-477	CON-53
N	16.0	17.0	16.0
Min	0.0	0.0	0.0
Max	5.0	10.0	4.0
Mean	1.7	2.2	1.8
Median	1.0	1.0	1.3
20th Percentile	0.1	0.1	0.0
80th Percentile	3.6	3.9	3.7

Narawallee Inlet		
Sites	NAR778	NAR309
N	13.0	15.0
Min	1.0	0.0
Max	45.7	49.7
Mean	13.6	5.3
Median	8.2	0.7
20th Percentile	2.4	0.0
80th Percentile	20.7	4.1

Burrill Lake			
Sites	BUR-83	BUR-545	BUR-612
N	16.0	17.0	16.0
Min	0.0	0.0	0.0
Max	13.7	17.7	11.7
Mean	4.6	3.9	3.7
Median	4.3	2.7	3.3
20th Percentile	1.3	1.3	0.7
80th Percentile	6.3	5.9	5.3

Tabourie Lake		
Sites	TAB-781	TAB-530
N	12.0	14.0
Min	0.0	0.0
Max	61.0	18.0
Mean	9.0	4.8
Median	2.8	3.9
20th Percentile	0.5	0.7
80th Percentile	7.9	6.5

Turbidity Summary Statistics

Shoalhaven River											
Sites	SHR-3	SHR-148	SHR-275	SHR-294	SHR-295	SHR-342	SHR-375	SHR-454	SHR-548	SHR-776	SHR-777
N	13.0	17.0	18.0	17.0	16.0	17.0	16.0	18.0	17.0	17.0	17.0
Min	0.9	0.9	0.4	0.3	0.4	1.0	0.3	0.6	0.4	0.3	0.5
Max	21.0	19.3	149.6	51.0	45.7	19.9	26.6	21.0	20.7	20.4	20.9
Mean	5.8	4.2	13.9	8.5	7.1	5.5	9.8	3.8	2.2	3.4	2.6
Median	3.7	2.3	3.0	4.1	3.0	2.4	5.7	3.8	2.2	3.4	2.6
20th Percentile	2.5	1.7	1.3	1.1	1.8	1.3	3.1	2.8	0.8	1.2	0.7
80th Percentile	7.3	3.0	14.7	8.6	8.2	7.4	20.1	6.3	4.6	8.3	13.1

Lake Wollumboola		
Sites	WOL-215	WOL-219
N	10.0	6.0
Min	0.0	0.7
Max	46.7	80.9
Mean	20.3	16.4
Median	11.5	6.3
20th Percentile	4.3	4.0
80th Percentile	30.0	9.9

St Georges Basin / Sussex Inlet			
Sites	SGB-28	SGB-33	SGB-772
N	16.0	17.0	15.0
Min	0.5	0.0	0.2
Max	17.6	21.8	20.4
Mean	3.2	3.9	2.3
Median	1.3	1.5	0.8
20th Percentile	0.5	0.2	0.4
80th Percentile	2.4	3.0	1.7

Lake Conjola			
Sites	CON-479	CON-477	CON-53
N	17.0	18.0	18.0
Min	0.0	0.0	0.0
Max	12.8	9.5	11.3
Mean	0.9	0.7	1.0
Median	0.2	0.0	0.0
20th Percentile	0.0	0.0	0.0
80th Percentile	0.2	0.2	0.5

Narawallee Inlet		
Sites	NAR778	NAR309
N	12.0	14.0
Min	0.0	0.0
Max	26.1	32.9
Mean	11.0	10.6
Median	9.2	4.4
20th Percentile	6.0	0.9
80th Percentile	20.2	17.4

Burrill Lake			
Sites	BUR-83	BUR-545	BUR-612
N	16.0	17.0	16.0
Min	0.0	0.0	0.0
Max	14.5	9.1	7.6
Mean	2.0	0.8	0.9
Median	0.2	0.0	0.2
20th Percentile	0.0	0.0	0.0
80th Percentile	1.2	0.4	0.2

Tabourie Lake		
Sites	TAB-781	TAB-530
N	11.0	14.0
Min	0.0	0.0
Max	48.8	46.9
Mean	15.4	13.5
Median	9.7	10.5
20th Percentile	3.9	1.8
80th Percentile	32.1	20.4

Appendix B- Vegetation Data

Estuary	1985 Distribution (m2)			2006 Distribution (m2)			2010 Distribution (m2)		
	Seagrasses	Mangroves	Saltmarsh	Seagrasses	Mangroves	Saltmarsh	Seagrasses	Mangroves	Saltmarsh
Shoalhaven River	1018000	3476000	1542000	4239366	4179888	2057804	5389000	4486000	2128000
Lake Wollumboola	1145000	0	0	1340071	0	0	n.a	n.a	n.a
St Georges Basin / Sussex Inlet	8538000	252000	36000	3170393	275761	149322	n.a	n.a	n.a
Lake Conjola	527000	0	13000	166010	714	27075	n.a	n.a	n.a
Narawallee Inlet	14000	378000	91000	86505	416161	175548	n.a	n.a	n.a
Burrill Lake	508000	0	157000	764311	0	236834	n.a	n.a	n.a
Tabourie Lake	1199000	0	10000	219062	0	39511	n.a	n.a	n.a

Estuary	Change (m2)			Change %			Grade		
	Seagrasses	Mangroves	Saltmarsh	Seagrasses	Mangroves	Saltmarsh	Seagrasses	Mangroves	Saltmarsh
Shoalhaven River	1149634	306112	70196	27%	7%	3%	A	unscored	B
Lake Wollumboola	195071	0	0	17%	0%		A	N/A	unscored
St Georges Basin / Sussex Inlet	-5367607	23761	113322	-63%	9%	315%	D	unscored	A
Lake Conjola	-360990	714	14075	-68%	0%	108%	D	unscored	A
Narawallee Inlet	72505	38161	84548	518%	10%	93%	A	unscored	A
Burrill Lake	256311	0	79834	50%	0%	51%	A	unscored	A
Tabourie Lake	-979938	0	29511	-82%	0%	295%	unscored	unscored	A