

# **Guideline SCORING ECOSYSTEM HEALTH**

## **Part 1 – TERRESTRIAL**

A Procedures Manual  
for  
Lake Macquarie City Council

Version 1  
July 2012

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### Document Change History

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### Version History

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1	Nigel Barton	Version 1	July 2011
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### Project Director Approval

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## Introduction

This document provides guidance on some of the methodologies used to monitor and score the health of terrestrial ecosystems found within the Lake Macquarie Local Government Area (LGA). Some of the methods described here are based on previous consultancy reports produced during earlier phases of the program and referenced below.

Lake Macquarie City Council has initiated a program to engage local community participants across the City to conduct ecosystem health monitoring and enhance Council's understanding of ecosystem condition or health. The Community Ecosystem Monitoring Program (CEMP) is a management tool that supports community involvement, identifies changes in ecosystem health, increases our knowledge of the area's biodiversity and builds understanding of threats, impacts and ecosystem processes. Data collected by community volunteers at permanent monitoring sites across the LGA are assessed in combination with data from other sources to monitor and track changes in ecosystem health over time.

During development of the terrestrial component of the CEMP, four consultancy reports (see below) were written. The Lake Macquarie Ecosystem Monitoring Strategy Volumes 1 and 2 document the selection of indicators, scientific merit and practicality and provide a suggested methodology for scoring ecosystem health and for data analysis. The methodologies have been reviewed during the initial years of the monitoring program in order to customise the methods to suit the different vegetation types found within the City.

Long-term monitoring programs require consistency of data collection, storage and analysis and this is achieved through clearly defined procedures. The reader should refer to the documents below for a more detailed description of the various stages of the program. This initial phase has collected preliminary data and informed future direction and resourcing requirements.

The terrestrial method is are based on a benchmark approach that produces a condition score. Thirteen attributes or indicators are measured at regular intervals at permanent survey sites. The data are compared to a benchmark value to calculate an overall site condition or health score. This benchmark approach is similar to that used in NSW Property Vegetation Plans and NSW Biobanking.

The *Guideline Scoring Ecosystem Health* consists of two parts written as two separate documents:

Part 1 - TERRESTRIAL (D01991795)

Part 2 – AQUATIC (draft) (D02584590)

## References

Document Title	TRIM
<b>Consultancy Reports</b>	
Community Ecosystem Monitoring Program Terrestrial Monitoring Manual. LMCC. September 2010	D01717293
Lake Macquarie Community Ecosystem Monitoring Program – Benchmark Surveys. EcoLogical Australia. July 2010	D01799555
Lake Macquarie Community Ecosystem Monitoring Program – Training Events. EcoLogical Australia. June 2010	D01812815
Lake Macquarie Community Ecosystem Monitoring Strategy Volume 1: Terrestrial and Wetland Ecosystems. EcoLogical Australia and BMT WBM. January 2010	D01677387
Lake Macquarie Community Ecosystem Monitoring Strategy Volume 2: Aquatic Ecosystems. EcoLogical Australia and BMT WBM. January 2010	D01677388
<b>Data</b>	
Benchmark Sites Completed Field Data Sheets	F2009/01118
Benchmark Field Data Analysis	D01799558
Community Ecosystem Monitoring Program – Field Data Sheets – Autumn 2010	D01803185
Community Ecosystem Monitoring Program – Field Data Sheets – Spring 2010	D01969484
Community Ecosystem Monitoring Program – Field Data Sheets – Autumn 2011	D02126849
Community Ecosystem Monitoring Program – Field Data Sheets – Spring 2011	D02300675
Community Ecosystem Monitoring Program – Field Data Sheets – Autumn 2012	D02584441
<b>Data Analysis – Health Grades</b>	
Terrestrial Benchmark Site Scoring - 2010	D01969479
Community Ecosystem Monitoring Terrestrial Site Scores	D02343447
Scores for Benchmark Sites located in Sustainable Neighbourhoods	D01873101
Terrestrial Indicator Scoring Table Methods 1-3. January 2011	D01851077
Waterway Standardised Scoring Methodology	D01991837
Terrestrial Monitoring Manual	D01717293
The Ecosystem Footprint 2010 – 2011	D02393714
<b>Site Location Maps</b>	
Benchmark Sites	D01801738
Community Monitoring Sites	D02312569

## **PART 1 - TERRESTRIAL HEALTH SCORES**

- Ecosystem Types
- Benchmark Sites
- Benchmark Values
- Indicators, Scoring and Weighting
- Worked Examples
- Community Monitoring Sites

## 1.1 Ecosystem Types

For a description of Ecosystem Types recognised in Lake Macquarie, refer to the Community Ecosystem Monitoring Program Terrestrial Monitoring Manual (D01717293). The document also provides a map showing distribution of ecosystem types across the city.

## 1.2 Benchmark Sites

Health scores are determined for individual sites by comparing data for each parameter against a benchmark for similar sites in pristine condition. To determine benchmark values, one hundred and twenty one (121) benchmark sites were completed between 15<sup>th</sup> March and 10<sup>th</sup> April 2010. The surveys were preferentially undertaken on Council owned land or Crown land in areas of expected excellent condition. Other sites were located on National Parks and Wildlife Services land and State Forest land. Data from the benchmark surveys were used to recommend a benchmark figure for each indicator within each vegetation class (Keith Class) sampled.

The sampling design for benchmark sites allowed each Keith Class (or vegetation category) within an ecosystem type (e.g. Rainforest, Forest etc) to be sampled using multiple sites (minimum five sites per Keith Class) and to approximately weight the number of sites according to area or discrete patches. Since there is variation within a Keith Class across the City, sample sites were not clustered. The total sample sites for an ecosystem type (e.g. 34 for Forest) were randomly distributed across the City. This design provides a benchmark average for a Keith Class that minimises local variation and increases the likelihood of detecting real change at community monitoring sites. Community monitoring sites are classified by Keith Class, allowing direct comparison with the benchmarks.

For a full description of how benchmark sites were selected refer to *Lake Macquarie Community Ecosystem Monitoring Program – Benchmark Surveys (D01799555)*. A summary is provided below and benchmark site locations provided in Fig. 1. Information on individual sites as well as site photos are available as referenced.

- Council/Crown/National Park and Wildlife Services/State Forest data layers were used to clip the study area from the Ecosystem layer, derived from LHCCREMS vegetation mapping.
- Calculated hectares available by Keith Class (within ecosystem type)
- Selection of candidate locations/polygons so that a representative sample of each Keith class making up the Ecosystem types were selected
- Analysed options for locating number of sites within these candidate location/polygon to meet Council's requirements for a total of 130 sites with approximately 25 replicate sites within each ecosystem type and 5 replicates per Keith Class.
- Derivation of a recommended number of sites to be located in each location/polygon proportional to location/polygon size.
- Generated random site locations within the candidate locations/polygons based on following rule set:
  1. Each site is to be at least 20m from a disturbed edge (in most cases much more than 20m);
  2. Each site must have a minimum separation from an adjoining site of 200m;
  3. Sites are to be located within a minimum patch size of 15ha (in most cases much more), including adjacent remnant area of the same or differing ecosystem type.



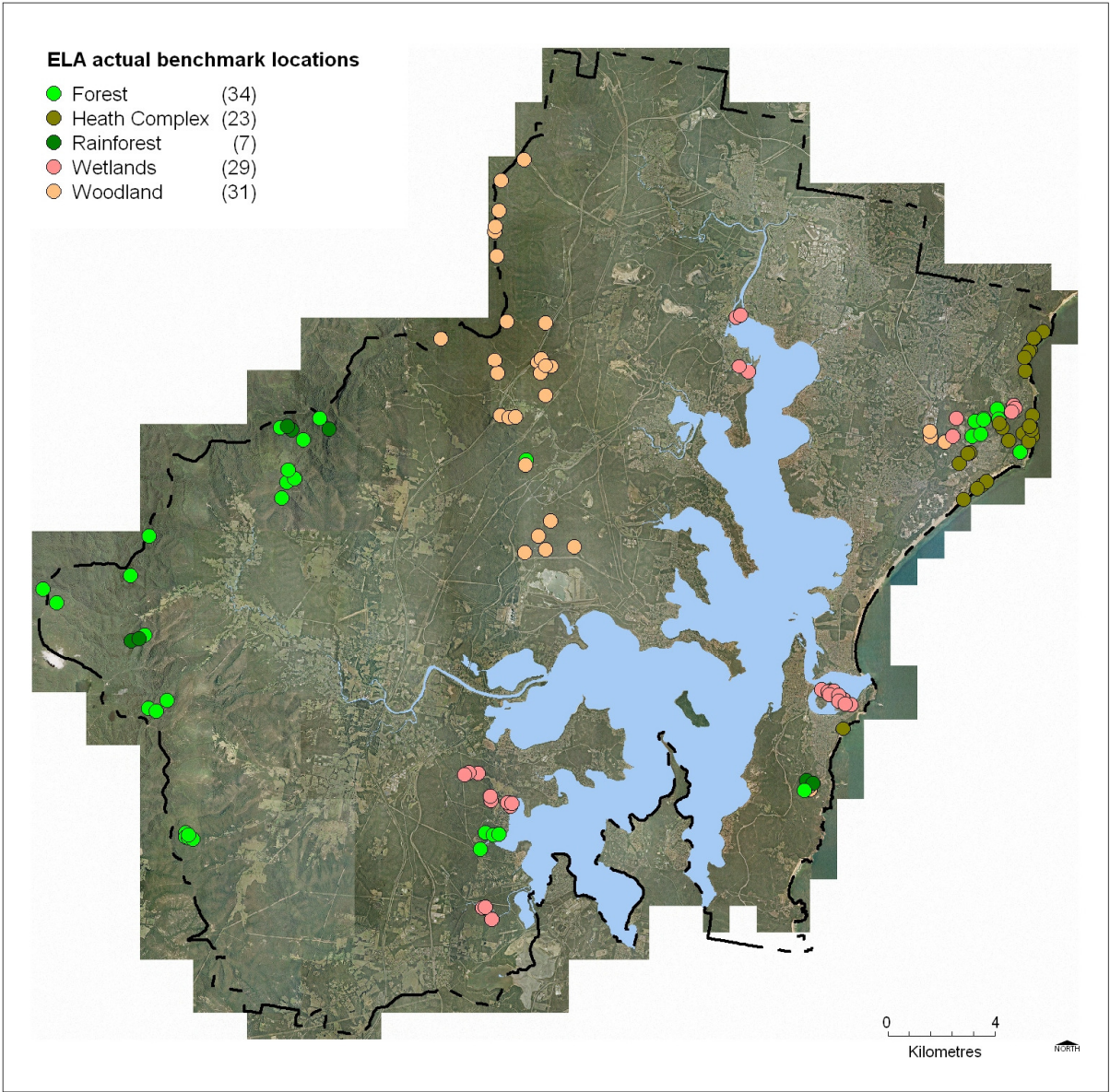


Figure 1. Map showing the distribution of “benchmark sites”. Number of replicates within each ecosystem type shown in parentheses

### 1.2.1 Benchmark Values

The statistics (mean, median, maximum) for sites within each Keith Class were calculated. Benchmark values were decided through interrogation of the data and expert opinion provided in an external workshop. Benchmark data collected for some sites and indicators were considered atypical for the ecosystem type and more appropriate benchmarks were substituted. For a discussion of benchmark values, refer to *Lake Macquarie Community Ecosystem Monitoring Program – Benchmark Surveys (D01799555)*.

Table 1 below provides benchmark values for each Keith Class

#### Additional Rules

Given the diversity of ecosystem types, both in structure and species diversity, there is a need for some explanation on how specific benchmarks were derived:

- *Heath variant of Coastal Dune Dry Sclerophyll Forest*: Within this type it is possible to have some vegetation above 1m, however, it is unlikely to have tall trees present in true Heath variant. Therefore, the benchmark score includes 30% native canopy cover even though this will be a low canopy.
- *Maritime Grasslands*: In Maritime Grassland the tallest stratum was less than 1m, and therefore recorded as ground cover. Nil recruitment was recorded since there was no canopy present to be regenerating.
- *Coastal Headland Heaths*: This type had a relatively high score for canopy cover (56%), due to a dense low canopy, though a low score was given for the recruitment benchmark. Whilst the recruitment range for this type was 0-2 in the data, the benchmark was set at zero as recruitment within this type does not necessarily suggest pristine condition. In fact recruitment in Coastal Headland Heath would indicate some level of recent disturbance. The same can be said for Maritime Grassland/Coastal Headland Heaths.
- *Littoral Rainforest* - an emergent canopy of potentially hollow-bearing tree species tends to be restricted to littoral rainforest sites where considerable shelter from coastal winds is available. It was decided that the lack of hollows was not indicative of poor ecosystem health as other factors, described above, also play a role.

Keith Class	Trees with Hollows	Length of Fallen Logs	Recruitment	Large Tree DBH	Native Spp	Weed Spp	Native Copy	Native Mid-storey	Native Ground cover	Organic Litter	Rock Cover	Bare Ground	Exotic Cover
Coastal Dune Dry Sclerophyll Forests	2	7	2	2 large (80cm) + 3 med (50cm) Heath Variant NIL	40	0	30	20	30	60	0	10	0
Coastal Floodplain Wetlands	1	10	1	2 large (50cm) + 3 med (30cm)	15	0	20	1	90	30	0	5	0
Coastal Freshwater Lagoons	0	1	1	Nil	15	0	25	5	60	10	0	10	0
Coastal Headland Heaths	0	0	0	Nil	34	0	56	20	55	90	0	10	0
Coastal Swamp Forests	3	10	3	2 large (80cm) + 3 med (50cm)	28	0	15	15	60	45	0	15	0
Coastal Valley Grassy Woodlands	3	11	4	2 large (80cm) + 3 med (50cm)	41	0	40	13	55	95	0	5	0
Hunter-Macleay Dry Sclerophyll Forests	3	45	2	2 large (80cm) + 3 med (50cm)	38	0	30	12	30	60	0	10	0
Littoral Rainforests	0	10	2	2 large (50cm) + 3 med (30cm)	25	0	60	30	10	70	0	20	0
Mangrove Swamps	0	0.5	1	2 large (30cm) + 3 med (25cm)	2	0	20	0	45	30	0	25	0
Maritime Grasslands	0	0	0	Nil	2	0	0	0	15	0	0	80	0
Maritime Grasslands/ Coastal Headland Heaths	0	0	0	Nil	37	0	27	10	40	80	0	5	0
North Coast Wet Sclerophyll Forests	5	68	2	2 large (120cm) + 3 med (80cm)	54	0	28	54	40	75	0	10	0
Northern Hinterland Wet Sclerophyll Forests	2	36	2	2 large (120cm) + 3 med (80cm)	51	0	65	35	25	80	0	5	0
Northern Warm Temperate Rainforests/ Subtropic	7	59	6	2 large (110cm) + 3 med (70cm)	42	0	65	45	15	70	5	10	0
Saltmarshes	0	0	0	Nil	5	0	0	0	70	5	0	20	0
Sydney Coastal Dry Sclerophyll Forests	8	70	5	2 large (100cm) + 3 med (70cm)	46	0	29	19	30	70	0	0	0
Wallum Sand Heaths	0	0	0	Nil	42	0	40	10	30	80	0	15	0

Table 1. Benchmark values derived from the Benchmark Field Data Analysis

### 1.2.2 Indicators, Scoring and Weighting

The following sections apply to both benchmark and community monitoring sites.

#### Indicators

Not all indicators are used to determine a health score for each of the vegetation classes. For Keith Classes found in Rainforest, Forest and Woodland, data for all 13 indicators are used to derive a health score. For some Keith Classes found in other ecosystem types, for example Heath Complex, inclusion of some indicators can result in an artificially high score, particularly for indicators that are assigned a high weighting (see below).

For example, large trees, trees with hollows and canopy recruitment would not be expected to be found at saltmarsh or maritime grassland sites. Although they would meet the benchmark of zero and therefore score 1 (on a scale of 0-1), the site would score highly for attributes that are not present, and would not typically be present. Indicators such as tree hollows have a high weighting because of their functional importance. Inclusion of these indicators contributes to a high proportion of the overall score for a site. To account for these differences, three different scoring methods are used (see Table 2 below) depending on the Keith Class assigned to a particular site.

<b>Ecosystem Type</b>	<b>Keith Class</b>	<b>Method</b>
<b>Rainforest</b>	Littoral Rainforest	<b>1</b>
	Northern Warm Temperate	<b>1</b>
<b>Forest</b>	Coastal Dune Dry Sclerophyll Forests	<b>1</b>
	Coastal Valley Grassy Woodlands	<b>1</b>
	Hunter-Macleay Dry Sclerophyll Forests	<b>1</b>
	North Coast Wet Sclerophyll Forests	<b>1</b>
	Northern Hinterland Wet Sclerophyll Forests	<b>1</b>
	Sydney Coastal Dry Sclerophyll Forests	<b>1</b>
<b>Heath Complex</b>	Maritime Grasslands	<b>2</b>
	Maritime Grasslands/Coastal Headland Heaths	<b>3</b>
	Wallum Sand Heaths	<b>3</b>
	Coastal Headland Heaths	<b>3</b>
<b>Wetlands</b>	Coastal Floodplain Wetlands	<b>1</b>
	Coastal Swamp Forests	<b>1</b>
	Mangrove Swamps	<b>1</b>
	Saltmarsh	<b>2</b>
	Coastal Freshwater Lagoons	<b>3</b>

Table 2 – Reference table used to assign a Scoring Method (1,2 or 3) to a site

## Scoring

The field data value for each indicator is assigned a score, called the Indicator Score (see Tables 3-5). Indicator Scores are either 0, 0.33, 0.66 or 1 depending on how close the field data value for a site and its corresponding Keith Class is to the benchmark value as determined by comparison with the benchmark value for each indicator. To calculate the overall health score for a site, the Indicator Score for each of the applicable indicators (as determined by selection of Method 1-3) is multiplied by a weighting (see below) to give a 'Weighted Score'. Weighted Scores are added to give a value 0-100. This value is converted to a grade A to E (+ and – grades included).

## Weighting

Indicators are weighted according to their relative importance. Weightings vary depending on the number of indicators that apply to a Keith Class. For those Keith Classes where all thirteen indicators apply, the weightings remain constant. For Keith Classes where fewer indicators are used to derive a health score for the site, weightings are adjusted to ensure that the total weighted scores remain on a scale of 0-100 (refer to Tables 3 to 6)

## Additional Notes:

- For indicators having a weighting of 7.5 and an Indicator Score of 0.33 or 0.66, the weighted scores are rounded to 2.5 and 5 respectively.
- For indicators having a weighting of 15 and an Indicator Score of 0.33 or 0.66, the weighted scores are rounded to 5 and 10 respectively.
- For Rock Cover, only one Keith Class, Northern Warm Temperate Rainforests has a benchmark value greater than zero (in this case 5%). For those Keith Classes where the Rock Cover indicator applies, some rock cover adds an additional microhabitat and is considered beneficial rather than a sign of poorer 'health'. Therefore any site with some rock cover is awarded an Indicator Score of 1. For Northern Warm Temperate Rainforests sites are awarded an Indicator Score of zero where there is less than 5% rock and 1 where there is 5% or more. This allows a reduction in score if rock is disappearing from NWTR sites.
- The 'Large Tree DBH' indicator has been refined to include the number of Medium Trees as an indicator of succession.

**Table 3. TERRESTRIAL INDICATOR SCORING - METHOD 1**

Rainforest, Forest, Woodland, Wetland (Coastal Swamp Forest, Coastal Floodplain Wetland, Mangrove Swamp)

Recommended Indicator	Indicator Score				Weighting of Indicator Score
	0	0.33	0.66	1	
1. Hollow-bearing Trees	0	>0% and <50% of benchmark	≥50% and <100% of benchmark	≥ benchmark	15
2. Length of Fallen Logs	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	5
3. Native Canopy Species Regenerating	0	>0% and <50%	>50% and <100%	100%	10
4. Number of Large and Medium Trees	No large or medium trees	< benchmark for large and/or medium trees present	≥ benchmark for large and < benchmark for medium	≥ benchmark for large and medium trees	5
5. Total Native Species Richness	0	>0% and <50% of benchmark	≥50% and <100% of benchmark	≥ benchmark	20
6. Total Weed Species Richness	>6	4-6	1-3	0	5
7. Native Canopy Cover	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	10
8. Native Mid-storey Cover	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	10
9. Native Ground Cover	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	7.5
10. Organic Litter Cover	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	5
11. Rock Cover	<benchmark	N/A	N/A	≥benchmark	2.5
12. Bare Ground	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	2.5
13. Exotic Flora Cover	>66%	>33% and <66%	>5% and <33%	0 to 5%	2.5

**Table 4. TERRESTRIAL INDICATOR SCORING - METHOD 2**  
(Maritime Grassland, Saltmarsh)

Recommended Indicator	Indicator Score				Weighting of Indicator Score
	0	0.33	0.66	1	
1. Hollow-bearing Trees	N/A	N/A	N/A	N/A	-
2. Length of Fallen Logs	N/A	N/A	N/A	N/A	-
3. Native Canopy Species Regenerating	N/A	N/A	N/A	N/A	-
4. Number of Large and Medium Trees	N/A	N/A	N/A	N/A	-
5. Total Native Species Richness	0	>0% and <50% of benchmark	≥50% and <100% of benchmark	≥ benchmark	25
6. Total Weed Species Richness	>6	4-6	1-3	0	25
7. Native Canopy Cover	N/A	N/A	N/A	N/A	-
8. Native Mid-storey Cover	N/A	N/A	N/A	N/A	-
9. Native Ground Cover	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125 and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	25
10. Organic Litter Cover	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125 and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	10
11. Rock Cover	N/A	N/A	N/A	N/A	-
12. Bare Ground	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125 and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	5
13. Exotic Flora Cover	>66%	>33% and <66%	>5% and <33%	0 to 5%	10

**Table 5. TERRESTRIAL INDICATOR SCORING - METHOD 3**

(Coastal Headland Heath, Maritime Grassland/Coastal Headland Heath, Wallum Sand Heath, Coastal Freshwater Lagoon)

Recommended Indicator	Indicator Score				Weighting of Indicator Score
	0	0.33	0.66	1	
1. Hollow-bearing Trees	N/A	N/A	N/A	N/A	-
2. Length of Fallen Logs	N/A	N/A	N/A	N/A	-
3. Native Canopy Species Regenerating	N/A	N/A	N/A	N/A	-
4. Number of Large and Medium Trees	N/A	N/A	N/A	N/A	-
5. Total Native Species Richness	0	>0% and <50% of benchmark	≥50% and <100% of benchmark	≥ benchmark	20
6. Total Weed Species Richness	>6	4-6	1-3	0	10
7. Native Canopy Cover	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	15
8. Native Mid-storey Cover	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	15
9. Native Ground Cover	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	15
10. Organic Litter Cover	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	10
11. Rock Cover	N/A	N/A	N/A	N/A	-
12. Bare Ground	0 - 10% or >200% of benchmark	>10% and <50% or >150% and <200% of benchmark	≥50% and <75% or >125% and ≤150% of benchmark	≥ 75% and ≤125% of benchmark	5
13. Exotic Flora Cover	>66%	>33% and <66%	>5% and <33%	0 to 5%	10



### 1.2.3 Worked Examples

#### a. Northern Warm Temperate Rainforest (NWTR) and b. Coastal Headland Heath (CHH)

Worked Examples are shown below in Tables 6 and 7.

Step 1 - Confirm Keith Class for the site being monitored. Keith Class can sometimes be different to expected once a site has been visited, or sites are sometimes located on an ecotone ie on the border between two different Keith Classes. Confirm that the site is a clearly defined Keith Class to ensure the correct benchmark values are used.

Step 2 – Using Table 2, identify which Scoring Method to apply

Step 3 – Open D01812789 – Community Ecosystem Monitoring Terrestrial Site Scores – located in folder F2010/01656

Step 4 - Transfer field data from the site Field Data Sheet to the 'all site field data' sheet. (scanned copies of the field data sheets for each monitoring season are saved in pdf format in F2010/01656)

Step 5 – Insert a new sheet for the current monitoring season and copy the format used in previous years

Step 6 – Transfer Benchmark Scores for the confirmed Keith Class using Table 1

Step 7 – Transfer field data for the site either from the Field Data Sheet (scanned copies of the field data sheets for each monitoring season are saved in pdf format in F2010/01656) or from the 'all site field data' tab.

Step 8 – Compare each Field Data value to the Benchmark for that Keith Class to generate an Indicator Score

Step 9 – Format cells so that the Weighted Score is calculated automatically

Step 10 – Apply formatting to automatically calculate the sum of the Weighted Scores

Step 11 – Convert the sum of Weighted Scores to a Health Grade using table 8 below for reference

Step 12 – Update the Site Scores sheet and add any notes summarising what might have caused changes between monitoring periods

Step 13 – Save file to an assigned TRIM folder, currently F2010/01656

*Example a.*

Site 76 NWTR	Field Data	Benchmark	Indicator Score	Weighting	Weighted Score	Health Grade
Hollow-bearing trees	0	7	0	15	0	
Length of Fallen Logs	79.5	59	0.66	5	3.3	
Native Canopy Species Regenerating	2	6	0.33	10	3.3	
Number of Large/Medium Trees	0/2	2/3	0.33	5	1.65	
Total Native Species Richness	29	42	0.66	20	13.2	
Total Weed Species	0	0	1	5	5	
Native Canopy Cover	63.5	65	1	10	10	
Native Mid-Storey Cover	63.5	45	0.66	10	6.6	
Native Ground Cover	9	15	0.66	7.5	5	
Organic Litter Cover	81.5	70	1	5	5	
Rock Cover	0	5	0	2.5	0	
Bare Ground Cover	9.5	10	1	2.5	2.5	
Exotic Flora Cover	0	0	1	2.5	2.5	
					<b>58.05</b>	<b>C+</b>

Table 6. Northern Warm Temperate Rainforest score sheet

*Example b.*

Site 26 CHH	Field Data	Benchmark	Indicator Score	Weighting	Weighted Score	Health Grade
Hollow-bearing trees						
Length of Fallen Logs						
Native Canopy Species Regenerating						
Number of Large/Medium Trees						
Total Native Species Richness	32	34	1	20	20	
Total Weed Species	0	0	1	10	10	
Native Canopy Cover	33	56	0.66	15	10	
Native Mid-Storey Cover	0	20	0	15	0	
Native Ground Cover	96	55	0.33	15	5	
Organic Litter Cover	98	90	1	10	10	
Rock Cover						
Bare Ground Cover	2	10	0.33	5	1.65	
Exotic Flora Cover	0	0	1	10	10	
					<b>66.65</b>	<b>B</b>

Table 7. Coastal Headland Heath score sheet

<b>Weighted Score</b>	<b>Health Grade</b>
95.00 - 100	A+
85.00 – 94.99	A
80.00 – 84.99	A-
75.00 – 79.99	B+
65.00 – 74.99	B
60.00 – 64.99	B-
55.00 – 59.99	C+
45.00 – 54.99	C
40.00 – 44.99	C-
35.00 – 39.99	D+
25.00 – 34.99	D
20.00 – 24.99	D-
15.00 – 19.99	E+
5.00 – 14.99	E
0 – 4.99	E-

*Table 8. Conversion of Weighted Score to Health Grade*

### **1.3 Community Monitoring Sites**

The Benchmark Sites were selected to generate data from which benchmark scores for pristine sites could be estimated. The Community Monitoring Sites are a random selection of sites, where monitoring is to be conducted by community members with initial Council training and ongoing support.

Approximately 50 sites have been permanently established and sites are monitored every 18 months to allow for seasonal differences. It is intended to expand sites and community participation over time. The following rules applied to selection of community monitoring sites and health grades for sites are scored in the same way as in the two Worked Examples shown above:

- Community monitoring sites are limited to Council owned and Crown land;
- Each site is to be at least 20m from a disturbed edge;
- Each site should be no more than 500m from road access (including fire trail);
- Each site must have a minimum separation from an adjoining site of 200m;
- Sites are to be preferentially located within a minimum patch size of 4ha, including adjacent remnant area of the same or differing ecosystem type.
- Sites are randomly generated; and
- Sites are assessed against OHS requirements prior to community involvement.

### **1.4 Results for 2010 to 2012**

Appendix 1 – Health Grades for Benchmark Sites

Appendix 2 – Average Health Grades for Benchmark Sites located within each Ecosystem Type

Appendix 3 – Health Grade Distribution Histograms for Benchmark Sites

Appendix 4 – Health Grades for Community Monitoring Sites

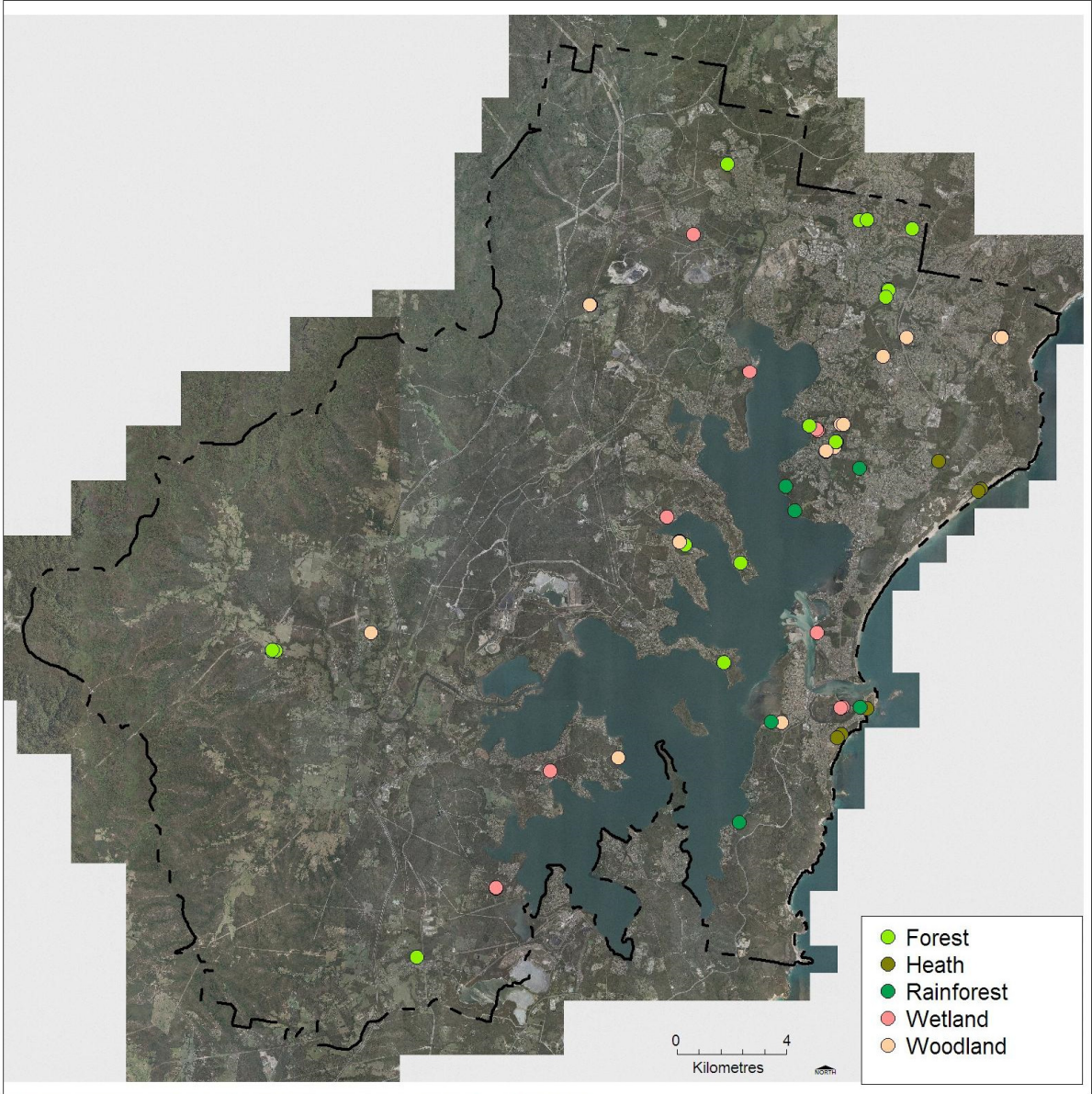


Figure 2. Random distribution of community monitoring sites as of May 2012

## **APPENDICES**

### Appendix 1 – Health Grades for Benchmark Sites

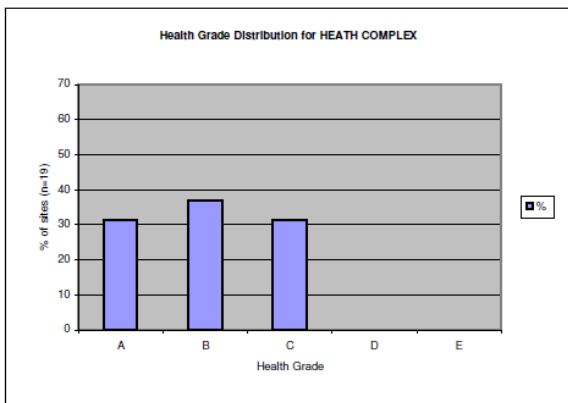
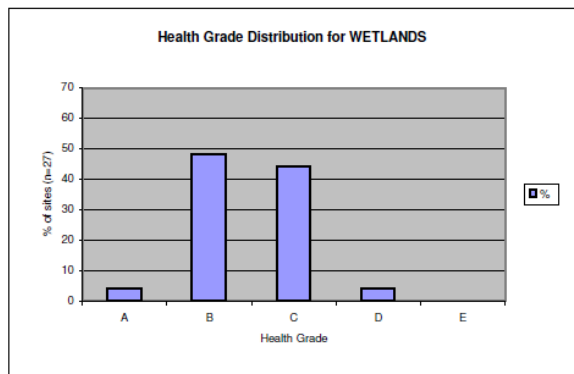
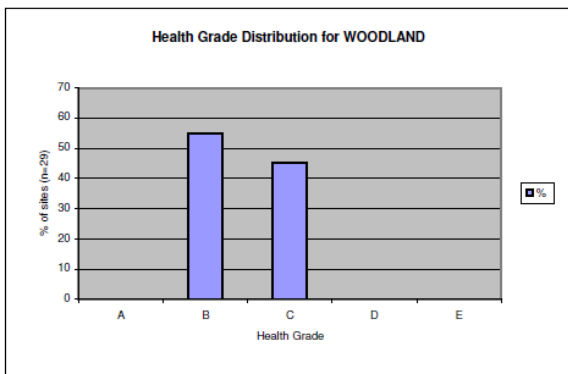
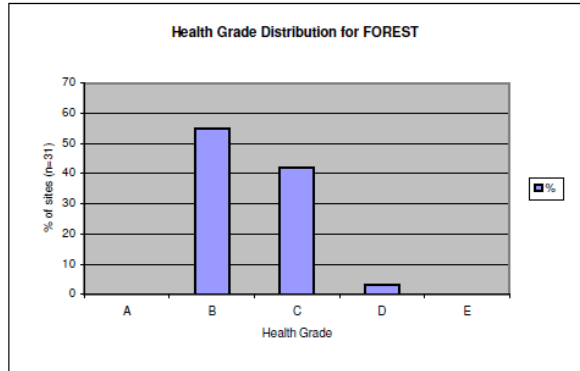
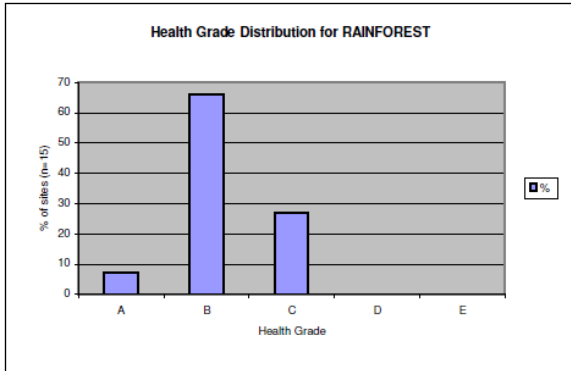
Rainforest			Forest			Woodland			Heath Complex			Wetland		
Site #	Score	Health Grade	Site #	Score	Health Grade	Site #	Score	Health Grade	Site #	Score	Health Grade	Site #	Score	Health Grade
82	82.38	A-	7	78.00	B+	90	70.45	B	59	100.00	A+	52	84.95	A-
50	76.63	B+	65	78.15	B+	91	67.25	B	128	88.10	A	84	79.80	B+
47	78.33	B+	44	77.95	B+	92	73.90	B	127	91.50	A	85	79.80	B+
46	68.10	B	1	77.28	B+	117	67.20	B	57	88.10	A	88	78.25	B+
48	72.28	B	72	69.65	B	110	71.45	B	129	91.50	A	54	78.25	B+
49	74.93	B	73	74.63	B	114	67.25	B	126	83.00	A-	51	74.00	B
78	66.43	B	2	74.65	B	115	68.05	B	58	79.60	B+	19	65.60	B
79	67.98	B	4	68.05	B	116	66.45	B	30	70.00	B	87	74.08	B
81	74.10	B	5	68.93	B	103	67.20	B	123	73.10	B	53	66.35	B
77	63.88	B-	69	65.48	B	105	67.30	B	26	66.65	B	86	69.65	B
80	63.08	B-	11	65.38	B	101	63.85	B-	29	69.80	B	31	61.35	B-
76	58.00	C+	8	61.48	B-	113	64.70	B-	121	60.00	B-	33	64.65	B-
83	56.40	C+	9	64.70	B-	108	60.70	B-	60	61.60	B-	35	64.88	B-
124	48.85	C	42	60.55	B-	109	64.80	B-	27	58.10	C+	36	56.40	C+
125	48.13	C	62	63.13	B-	102	64.70	B-	119	51.45	C	37	57.20	C+
	<b>66.63</b>	<b>B</b>	3	62.28	B-	112	63.08	B-	120	51.60	C	38	57.25	C+
			15	63.83	B-	93	57.35	C+	122	53.15	C	24	66.60	B
			12	58.88	C+	94	57.20	C+	28	51.50	C	18	49.00	C
			41	55.65	C+	111	58.13	C+	61	44.90	C-	34	51.48	C
			71	55.63	C+	106	55.65	C+		<b>70.19</b>	<b>B</b>	17	49.00	C
			6	56.43	C+	104	52.23	C				20	45.75	C
			74	57.15	C+	118	53.85	C				25	49.95	C
			68	53.93	C	89	46.40	C				22	49.85	C
			10	53.20	C	107	48.90	C				21	46.60	C
			66	46.43	C	97	54.70	C				32	42.18	C-
			70	50.48	C	100	51.40	C				23	43.15	C-
			43	53.73	C	99	48.85	C				16	35.68	D+
			63	46.38	C	98	51.40	C					<b>60.80</b>	<b>B-</b>
			64	50.63	C	95	44.05	C-						
			75	53.05	C		<b>60.29</b>	<b>B-</b>						
			67	38.15	D+									
				<b>61.41</b>	<b>B-</b>									

## Appendix 2 – Average Health Grades for Benchmark Sites within each Ecosystem Type

<b>RAINFOREST</b>			
Keith Class	Sample size	Score	Health Grade
LR	5	74.05	<b>B</b>
NWTR	10	62.92	<b>B-</b>
	<b>15</b>	<b>66.63</b>	<b>B</b>
<b>FOREST</b>			
Keith Class	Sample size	Score	Health Grade
CDDSF	8	62.73	<b>B-</b>
CVGW	4	61.97	<b>B-</b>
HMDSF	5	70.24	<b>B</b>
NCWSF	8	55.28	<b>C+</b>
NHWSF	6	60.1	<b>B-</b>
	<b>31</b>	<b>61.41</b>	<b>B-</b>
<b>WOODLAND</b>			
Keith Class	Sample size	Score	Health Grade
SCDSF	29	60.29	<b>B-</b>
	<b>29</b>	<b>60.29</b>	<b>B-</b>
<b>HEATH COMPLEX</b>			
Keith Class	Sample size	Score	Health Grade
MG	7	88.83	<b>A</b>
CHH	5	63.21	<b>B-</b>
MG/CHH	2	53.25	<b>C</b>
WSH	5	57.86	<b>C+</b>
	<b>19</b>	<b>70.19</b>	<b>B</b>
<b>WETLAND</b>			
Keith Class	Sample size	Score	Health Grade
CFW	5	49	<b>C</b>
CFL	5	49.83	<b>C</b>
CSF	8	56.92	<b>C+</b>
MS	4	77.82	<b>B+</b>
S	5	74.77	<b>B</b>
	<b>27</b>	<b>60.8</b>	<b>B-</b>



### Appendix 3 – Average Health Grades for Benchmark Sites



## Appendix 4 – Health Grades for Community Monitoring Sites

Site Number	Ecosystem Type	Date	Keith Class	INDICATORS													SCORE %	RATING	SITE
				1. Hollow-bearing trees	2. Length of fallen Logs	3. Native Canopy Species Regenerating	4. Number of Large Trees / Medium Trees	5. Total native Species Richness	6. Total Weed Species	7. Native Canopy Cover	8. Native Mid-Storey cover	9. Native Ground Cover	10. Organic Litter Cover	11. Rock Cover	12. Bare Ground Cover	13. Exotic Flora Cover			
48	RAINFOREST	11/04/2011	Littoral Rainforest	0	2.5	2	7/6	30	8	67.5	39.5	8	84.5	0	12	8.5	86.55	A	48
69	RAINFOREST	13/04/2011	North Coast Wet Sclerophyll Forest	3	1	2	7/13	39	5	71.5	40	37	100	0	0	5.5	64.8	B-	69
92	RAINFOREST	22/09/2010	Littoral Rainforest	9	32	1	2/3	54	7	43.5	53	35	92	0	13	0	66.45	B	92
92	RAINFOREST	1/05/2012	Littoral Rainforest	6	59	0	9/5	47	5	21.5	56	22.5	98.5	0	1.5	1.5	56.55	C+	92
110	RAINFOREST	30/04/2010	Northern Warm Temperate Rainforest	3	14.5	6	0/0	41	1	75	40.5	41	91.5	0.6	0	0.5	64.68	B-	110
110	RAINFOREST	24/09/2010	Northern Warm Temperate Rainforest	6	23.5	2	0/0	34	2	65.5	26	20.5	86	8	6.5	1.5	63.03	B-	110
110	RAINFOREST	7/05/2012	Northern Warm Temperate Rainforest	6	17	1	0/2	26	3	70	43	41	94	6	0	2	63.00	B-	110
17	FOREST	31/08/2010	North Coast Wet Sclerophyll Forest	3	28	3	0/1	42	21	46	18	41	96	0	4	3.5	59.73	C+	17
17	FOREST	14/03/2011	North Coast Wet Sclerophyll Forest	3	11.5	3	0/1	39	25	38.5	12	23	100	0	0.5	10.5	58.85	C+	17
17	FOREST	13/04/2012	North Coast Wet Sclerophyll Forest	5	16.5	3	0/1	50	26	47.5	29	29	100	0	0	15	63.80	B-	17
18	FOREST	30/09/2010	North Coast Wet Sclerophyll Forest	4	19	3	1/1	53	7	29.5	35	39.5	85	0	4.7	14	70.58	B	18
18	FOREST	3/04/2012	North Coast Wet Sclerophyll Forest	3	16	3	1/2	53	10	23.5	10	49	97.5	0	0.5	11	64.85	B-	18
21	FOREST	14/04/2011	Hunter Macleay Dry Sclerophyll Forest	2	12	4	0/2	54	12	43	23.5	25	88.5	9	0	46	65.68	B	21
27	FOREST	12/04/2010	Hunter Macleay Dry Sclerophyll Forest	2	16.5	>2	1/3	32	10	26	18	50	96.5	0	0	2.5	57.15	C+	27
27	FOREST	31/10/2011	Hunter Macleay Dry Sclerophyll Forest	6	35	2	0/4	52	17	40	8.5	69	77	0	0	5	73.15	B	27
29	FOREST	20/04/2011	Sydney Coastal Dry Sclerophyll Forest	4	5	4	1/3	41	11	36.5	21	29	87.5	0	0	9.5	70.60	B	29
53	FOREST	24/03/2011	Hunter Macleay Dry Sclerophyll Forest	0	42	4	0/0	59	7	48	29	46	97.5	0	3	5.5	47.43	C	53
65	FOREST	23/04/2010	North Coast Wet Sclerophyll Forest	0	21	2	2/3	48	3	30	7	63	100	0	0.5	0	53.88	C	65
65	FOREST	25/09/2010	North Coast Wet Sclerophyll Forest	0	26	2	0/0	53	3	32.5	12	47.5	99	0	0.1	0	57.25	C+	65
65	FOREST	17/09/2011	North Coast Wet Sclerophyll Forest	4	22	2	0/0	56	2	32	15.5	50.5	100	0	0	0	71.55	B	65
66	FOREST	11/04/2010	North Coast Wet Sclerophyll Forest	4	8.5	4	2/3	32	3	30	8	36.5	99.5	0	0.5	0.5	67.25	B	66
66	FOREST	9/10/2010	North Coast Wet Sclerophyll Forest	4	11	2	0/0	48	2	25	9	32	100	0	0.5	1	67.25	B	66
66	FOREST	22/09/2011	North Coast Wet Sclerophyll Forest	0	6	2	0/1	48	2	25	12	26.5	100	0	0	2.5	54.75	C	66
94	WETLAND	9/09/2010	Coastal Swamp Forest	0	84.5	0	0/3	27	2	27	20.5	32	91	0	0.5	0	38.00	D+	94
94	WETLAND	8/05/2012	Coastal Swamp Forest	1	49	1	1/3	34	2	22	24.5	53	100	0	0	2.5	55.60	C+	94
104	FOREST	9/09/2010	Sydney Coastal Dry Sclerophyll Forest	2	19	3	0/1	54	4	20	26.5	69	100	0	2	1.5	58.05	C+	104
104	FOREST	12/03/2012	Sydney Coastal Dry Sclerophyll Forest	4	56	4	0/1	54	3	23.5	23.5	67	100	0	0	2.5	77.25	B+	104
111	FOREST	4/05/2011	Hunter Macleay Dry Sclerophyll Forest	1	16.5	3	0/4	58	14	31.5	28.5	44	98	0	3.5	2	60.73	B-	111
111	FOREST	12/09/2011	Hunter Macleay Dry Sclerophyll Forest	2	16	2	0/6	51	17	37.5	43	41.5	100	0	0	3	64.95	B-	111
114	FOREST	4/04/2011	Coastal Swamp Forest	1	9	2	1/3	42	10	18	28	68	65.5	0	0	3.5	67.40	B	114
115	FOREST	5/04/2011	Hunter Macleay Dry Sclerophyll Forest	1	1	3	1/0	54	12	62	37.5	30	96	0	0.5	31.5	49.95	C	115

Guideline Scoring Ecosystem Health Part 1 – TERRESTRIAL

Site Number	Ecosystem Type	Date	Keith Class	INDICATORS													SCORE %	RATING	SITE
				1. Hollow-bearing trees	2. Length of fallen Logs	3. Native Canopy Species Regenerating	4. Number of Large Trees / Medium Trees	5. Total native Species Richness	6. Total Weed Species	7. Native Canopy Cover	8. Native Mid-Storey cover	9. Native Ground Cover	10. Organic Litter Cover	11. Rock Cover	12. Bare Ground Cover	13. Exotic Flora Cover			
117	FOREST	19/04/2011	Hunter Macleay Dry Sclerophyll Forest	7	47	2	0/4	53	6	36.5	16	23	100	0	0	5.8	63.2	A-	117
121	FOREST	28/10/2011	Sydney Coastal Dry Sclerophyll Forest	0	74	2	1/4	57	0	19.5	8.5	66	100	0	0	0	55.65	C+	121
19	WOODLAND	15/04/2010	Sydney Coastal Dry Sclerophyll Forest	1	92.5	7	0/3	21	0	10.5	21.5	52.5	99	0	0.5	0	57.23	C+	19
19	WOODLAND	8/09/2011	Sydney Coastal Dry Sclerophyll Forest	4	13	2	0/3	37	0	29	20.5	67	100	0	0	0	65.60	B	19
24	WOODLAND	7/09/2010	Sydney Coastal Dry Sclerophyll Forest	8	65.5	4	0/1	40	7	32.5	16	64.5	100	0	0	0.5	72.25	B	24
24	WOODLAND	23/03/2011	Sydney Coastal Dry Sclerophyll Forest	9	23	5	0/1	36	6	31	26.5	49	69.5	0	0	0	74.75	B	24
24	WOODLAND	20/03/2012	Sydney Coastal Dry Sclerophyll Forest	9	5.5	3	1/1	39	12	34.5	30.5	68	91	0	0	0	60.55	B-	24
26	WOODLAND	17/04/2010	Sydney Coastal Dry Sclerophyll Forest	0	0	14	0/0	30	2	32.5	13	71	100	0	0	0	53.90	C	26
26	WOODLAND	2/04/2011	Sydney Coastal Dry Sclerophyll Forest	0	0	2	0/0	32	2	29	6	70	100	0	0	0	43.90	C-	26
28	WOODLAND	20/09/2010	Sydney Coastal Dry Sclerophyll Forest	12	67.5	2	0/2	40	2	27	12	55	100	0	0	0	71.33	B	28
28	WOODLAND	12/04/2011	Sydney Coastal Dry Sclerophyll Forest	2	43.5	3	0/2	39	1	40	20.5	58	100	0	0	0	62.95	B-	28
28	WOODLAND	26/03/2012	Sydney Coastal Dry Sclerophyll Forest	4	4205	3	0/2	36	2	33.5	13	78	100	0	0	0	65.35	B	28
34	WOODLAND	31/03/2011	Sydney Coastal Dry Sclerophyll Forest	3	35	2	0/1	42	1	27.5	8.5	56	100	0	0	0	56.35	C+	34
35	WOODLAND	6/05/2011	Sydney Coastal Dry Sclerophyll Forest	4	52.5	3	1/1	43	2	29	6.5	38	100	0	0	0	68.85	B	35
56	WOODLAND	10/09/2010	Sydney Coastal Dry Sclerophyll Forest	3	22	3	0/0	36	1	35.5	17	38	100	0	0	0	68.05	B	56
56	WOODLAND	24/09/2011	Sydney Coastal Dry Sclerophyll Forest	3	13.5	2	0/0	50	4	45	14	52.5	100	0	0	1	54.80	C	56
57	WOODLAND	12/10/2010	Sydney Coastal Dry Sclerophyll Forest	4	44	2	0/1	44	2	39.5	12.5	52.5	100	0	0	0	61.23	B-	57
57	WOODLAND	4/04/2012	Sydney Coastal Dry Sclerophyll Forest	5	42	3	0/1	38	0	52	14.5	73	100	0	0	0	63.75	B-	57
63	WOODLAND	21/09/2010	Sydney Coastal Dry Sclerophyll Forest	2	42	3	0/0	47	3	30	22.5	45.5	100	0	0	0	71.48	B	63
63	WOODLAND	14/03/2012	Sydney Coastal Dry Sclerophyll Forest	1	34.5	2	0/0	52	2	38	26.5	56	91	0	0	0	61.33	B-	63
103	WOODLAND	20/04/2010	Sydney Coastal Dry Sclerophyll Forest	7	70	5	0/3	47	2	31.5	43.5	56	98	0	0	0.5	73.13	B	103
103	WOODLAND	6/09/2011	Sydney Coastal Dry Sclerophyll Forest	7	106	4	0/4	45	6	39	17.5	28.5	100	0	0	0.5	73.00	B	103
112	WOODLAND	21/03/2011	Sydney Coastal Dry Sclerophyll Forest	6	62	1	2/1	37	1	40.5	5	41.5	99.5	0	0.5	0	63.80	B-	112
119	WOODLAND	22/09/2011	Sydney Coastal Dry Sclerophyll Forest	3	26	2	1/0	36	3	19.6	22.5	37	100	0	0	0	53.05	C	119
1	HEATH	15/09/2010	Maritime Grassland					4	2			8	17.5		73.5	24	69.60	B	1
1	HEATH	27/10/2011	Maritime Grassland					4	4			8	12.5		82.5	10.5	61.35	B-	1
2	HEATH	18/04/2010	Maritime Grassland					3	2			0	3.5		95.5	4	56.50	C+	2
2	HEATH	27/10/2011	Maritime Grassland					3	3			8	9.5		74.5	20	69.60	B	2
39	HEATH	13/04/2010	Coastal Dune Dry Sclerophyll Forest	0	23	0	0/2	6	8	0	14.5	1.5	55	0	19	40.5	24.00	D-	39
39	HEATH	14/10/2011	Coastal Dune Dry Sclerophyll Forest	0	7	1	0/0	6	10	0	12	8.5	46.5	0	11	47	34.80	D	39
42	HEATH	14/09/2010	Coastal Dune Dry Sclerophyll Forest	2	15	2	5/1	33	5	12.5	8	17	57	0	38	11	63.85	B-	42
42	HEATH	30/04/2012	Coastal Dune Dry Sclerophyll Forest	2	5.5	1	5/3	27	6	29	10	24	94	0	6	8	78.00	B+	42

Guideline Scoring Ecosystem Health Part 1 – TERRESTRIAL

Site Number	Ecosystem Type	Date	Keith Class	INDICATORS													SCORE %	RATING	SITE	
				1. Hollow-bearing trees	2. Length of fallen Logs	3. Native Canopy Species Regenerating	4. Number of Large Trees / Medium Trees	5. Total native Species Richness	6. Total Weed Species	7. Native Canopy Cover	8. Native Mid-Storey cover	9. Native Ground Cover	10. Organic Litter Cover	11. Rock Cover	12. Bare Ground Cover	13. Exotic Flora Cover				
13	WETLAND	17/09/2010	Saltmarsh					3	0				90.5	2.5		9.5	0	<b>76.25</b>	<b>B+</b>	13
13	WETLAND	2/04/2012	Saltmarsh					3	0				82.5	2		17	0	<b>84.80</b>	<b>A-</b>	13
14	WETLAND	17/09/2010	Saltmarsh					4	0				60.5			39.5	0	<b>78.15</b>	<b>B+</b>	14
14	WETLAND	2/04/2012	Saltmarsh					4	0				67.5	0		38.5	0	<b>78.15</b>	<b>B+</b>	14
86	WETLAND	21/04/2010	Coastal Swamp Forest	0	5.5	2	0/0	29	5	24	15	81.5	99.5	0	0.5	0	<b>54.80</b>	<b>C</b>	86	
86	WETLAND	19/09/2011	Coastal Swamp Forest	0	4.5	3	0/1	40	8	16	11.5	81	100	0	0	3	<b>63.30</b>	<b>B-</b>	86	
89	WETLAND	9/04/2010	Coastal Swamp Forest	0	2.8	0	0/0	27	8	0.5	47.5	31	69.5	0	4	5.5	<b>35.00</b>	<b>D+</b>	89	
89	WETLAND	1/09/2011	Coastal Swamp Forest	0	7	3	0/3	37	5	55.5	16	36	94.5	0	5	4.5	<b>59.88</b>	<b>C+</b>	89	
90	WETLAND	9/04/2010	Coastal Swamp Forest	0	28	1	0/2	43	9	25	35	39.5	73	0	3	11.5	<b>39.83</b>	<b>D+</b>	90	
90	WETLAND	15/09/2011	Coastal Swamp Forest	2	22	2	0/7	59	10	17.5	35	54	100	0	0.5	7	<b>59.90</b>	<b>B-</b>	90	
113	WETLAND	21/04/2011	Coastal Floodplain Wetland	10	50.5	2	2/7	30	11	53	23.5	77	100	0	0	13	<b>61.65</b>	<b>B-</b>	113	
116	WETLAND	1/04/2011	Coastal Floodplain Wetland	1	0	1	0/6	17	14	19.5	37.5	55.5	100	0	0	12	<b>65.8</b>	<b>B</b>	116	
118	WETLAND	7/04/2011	Coastal Swamp Forest	1	5	1	1/1	14	4	15	8	58	53	0	3	7.5	<b>62.20</b>	<b>B-</b>	118	
120	WETLAND	20/09/2011	Coastal Swamp Forest	3	99	2	0/4	17	23	19.5	0	4	65	0	10.5	34.5	<b>49.68</b>	<b>C</b>	120	
122	WOODLAND	29/03/2012	Sydney Coastal Dry Sclerophyll Forest	8	46.5	3	0/4	53	7	36.5	7	53.5	100	0	0	1.5	<b>69.73</b>	<b>B</b>	122	