Catchment Management Authority Murray

CARING FOR OUR COUNTRY

Billabong Creek Riparian Vegetation Mapping 2011-12

September 2012

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Certified System Quality ISO 9001 SAI GLOBAL
Certified System Environment ISO 14001 SAI GLOBAL
Certified System Health & Safety AS 4801 SAI GLOBAL

DOCUMENT STATUS

Version	Doc type	Reviewed by	Approved by	Date issued
v01	Draft Report	Jamie Kaye, Monica Hersburgh	Jamie Kaye	13/03/2013
v02	Draft Report	Jamie Kaye, Anthony Conallin	Jamie Kaye	14/02/2013
v03	Final Report	Anthony Conallin	Jamie Kaye	13/03/2013

PROJECT DETAILS

Project Name	Billabong Creek Riparian Vegetation Mapping 2011-12
Client	Murray Catchment Management Authority
Client Project Manager	Anthony Conallin
Water Technology Project Manager	Jamie Kaye
Report Authors	Jamie Kaye
Job Number	2309-01
Report Number	R01
Document Name	2309-01_R01v03 Billabong Creek Veg

Cover Photo: (Billabong_Ck_4_42_L_SD.jpg) Billabong Creek looking downstream, Reach 4, Site 42, between Conargo and Wanganella.

First Floor, 103 Murphy Street
Wangaratta VIC 3677
Telephone (03) 5721 2650
Fax (03) 5721 3063

ACN No. 093 377 283
ABN No. 60 093 377 283

EXECUTIVE SUMMARY

Water Technology was engaged by the Murray CMA to assess the key attributes of riparian vegetation of the middle and lower Billabong Creek to assist with identifying investment priorities for the system in the future. The project area covers the middle and lower sections of the Billabong Creek, from Walbundrie to Moulamein, a creekline length of 561 kilometres.

Assessment parameters and field methods were proposed by Water Technology ecologists and discussed and agreed upon with Murray CMA project managers. The following methods were adopted to ensure the key deliverables could be captured:

- Victorian "Land manager self-assessment method" (tree density, cover of over and understorey, weediness, recruitment, logs and litter, patch size and connectivity)
- Sub-set of Victorian "Index of Stream Condition physical habitat variables (stream-side zone width, presence of significant discontinuities, macrophyte cover and Large Woody Debris abundance)
- Internally produced indices of tree health, threat /land-use pressures and trajectory
- General site information and photo-point information
- Flora information (rapid species listing, commentary on native and exotic flora present) and predicted condition trajectory (Improving, stable or declining) for the site

The project area was divided into three reaches, principally based upon the level of river regulation and therefore divided at the confluence of the flow regulated tributaries Yanco and Colombo Creeks 60 sites were assessed within the project area. Assessments commenced on the 24th May 2012 at the upstream end at Walbundrie. Sites were assessed consecutively downstream and the last site was assessed at Moulamein on 29th June 2012.

Results from all the field data provides a snapshot of condition across the project area. Condition trends by theme are as follows:

- Habitat Quality – This measures vegetation and habitat condition. The results indicate that the condition of frontages is quite variable and that there are no very strong condition trends across the project area. However, average site scores out of 20 for the three reaches suggest generally that the middle Reach 3 (13.8/20) is in better condition than the downstream Reach 4 (12.8/20), which in turn is in slightly better condition than the upstream Reach2 (12.3/20).
- Riparian and Instream Health - The data shows a general trend of condition decline in score as one moves downstream from Reach 2 (12.0/20) to Reach 4 (10.4/20), however the site scores are variable within reaches.
- Canopy Health - The heavily regulated downstream Reach 4 shows a distinct decline in tree health. While Reaches 2 and 3 had the same 'proportion of expected healthy canopy cover' at 75%, Reach 4 was significantly lower at 62%.
- Weed Cover - Weed cover is considerably higher in the wetter upstream Reach 2. Reach 3 showed the lowest weed cover percentage, approximately half the cover measured within Reach 2. Although the downstream Reach 4 is weedier than the middle reach, it has a much lower weed cover percentage than the upstream Reach 2.
- Condition Trajectory - The results show that the middle Reach 3 has no sites considered likely to decline under current management arrangements. Although the upstream Reach 2 has the highest percentage of sites considered to have an improving condition trajectory, this reach also has the highest percentage of sites likely to decline in condition. Reach 4 has more sites likely to decline than improve.

Other notable observations during field assessment show:

- a steady transition in vegetation, from temperate River Red Gum forests and woodlands in the eastern upstream end of the project area at Walbundrie, to near semi-arid Black Box woodlands at the western end of the project area
- the channel shape is observed to change from relatively steep upright banks to a flattened bank profile downstream from the Berrigan Road near Urana
- the highest quality site assessed was within the middle Reach 3, 20 kilometres west of Jerilderie
- the poorest quality site was within the highly regulated downstream Reach 4, near the Coleambally outfall, approximately 30km east of Moulamein

Site specific and reach-wide recommendations for ongoing management of the Billabong Creek study area include:

- Canopy Longitudinal Continuity should be further investigated to identify significant breaks so that revegetation or stock management may be implemented to minimise the lengths of breaks, allowing improved creek bank stability, improved instream ecology and a more continuous riparian corridor.
- The concept of 'Protect the Best' may be adopted whereby the highest quality frontages are managed firstly to ensure their condition does not decline.
- 'Minimum Standards' could also be considered whereby a minimum acceptable vegetation condition standard is identified based on Habitat Quality score, and the poorest sites are targeted for improvement activities.
- The continuation of tree health monitoring, particularly in Reach 4, could help inform environmental flow recommendations for the lower Billabong Creek.
- A weed control program could be developed with the assistance of weed lists recorded at each site within the project area.
- With the cooperation of the landholder and assistance from the Murray CMA, Site 36 could be formally protected and used as a demonstration or reference site to help inform land managers of the values and appearance of a high quality site.
- Reach 2 key recommended actions – Weed management.
- Reach 3 key recommended actions – Protect the best frontages.
- Reach 4 key recommended actions – Investigate the cause of poor tree health in the vicinity of Site 55 and continue to monitor tree health to inform environmental flow recommendations.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The Murray Catchment Management Authority (Murray CMA) is a statutory body with the principle role to set future direction for natural resource management (NRM) in the Murray Catchment (Figure 1). One of the key natural resource assets identified in the Murray Catchment is Billabong Creek, which runs between the Murray and Murrumbidgee Rivers.

The creek's headwaters are east of Holbrook in the foothills of the Great Dividing Range, and from there it flows in a generally westerly direction across the Riverina plain before emptying into the Edward River at Moulamein.

The creek has a catchment area of 791 square kilometres and is the main drainage line between the Murray and the Murrumbidgee Rivers, via the Yanco and Colombo Creeks (MyCMA 2012).

Water Technology was engaged by the Murray CMA to assess the key attributes of riparian vegetation of the middle and lower Billabong Creek to increase their knowledge of the condition of the vegetation and to assist with identifying investment priorities for the system in the future. The project area covers the middle and lower sections of the Billabong Creek, from Walbundrie to Moulamein. The project reach, as indicated as a red line in Figure 1 below, has a creekline length of 561 kilometres.

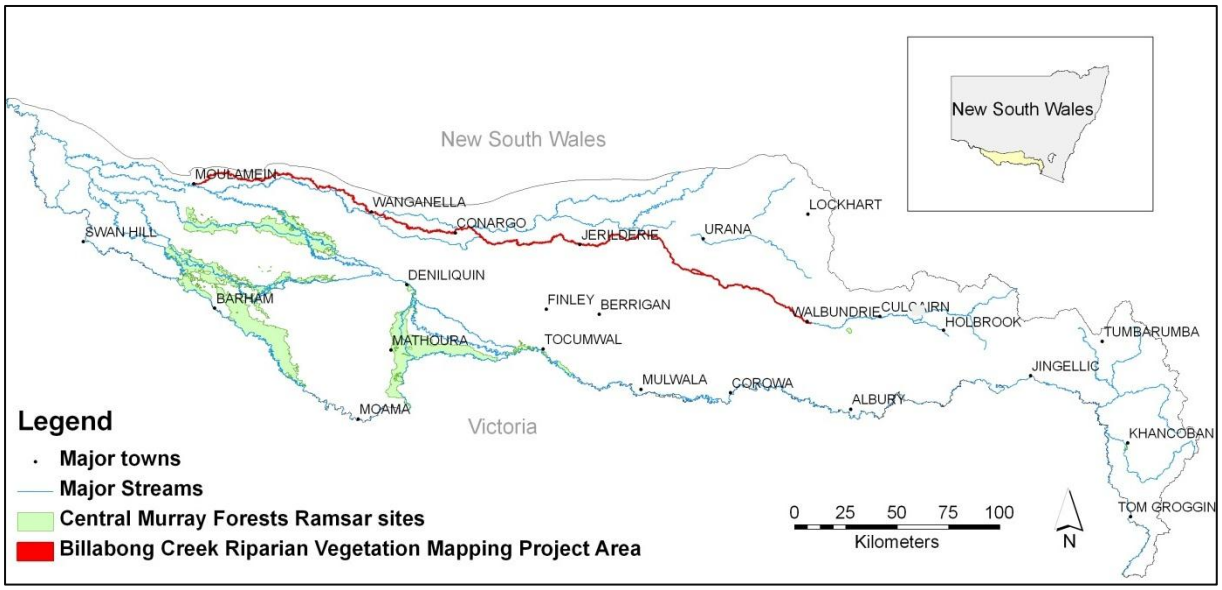


Figure 1 NSW Murray Catchment with project area highlighted in red (MyCMA 2012).

2. METHODS

A meeting was held in April 2012 at which assessment parameters and field methods were proposed by Water Technology ecologists and discussed and agreed upon with Murray CMA project managers. The methods adopted needed to be rapid and repeatable. There also needed to be a balance between scientific rigour and practicability so that a reasonable number of sites could be assessed within the budgetary constraints. The method also needed to be well documented and relatively easy to apply so that future monitoring could be undertaken by suitably skilled consultants or Murray CMA staff.

It was agreed that the key deliverables would include:

- Ground-truthing of Murray CMA remote analyses for:
    - riparian canopy width,
    - longitudinal continuity, and
    - broad vegetation type (including presence of exotics such as willows, where relevant)
- On-ground assessment of:
    - intactness of understorey canopy layers
    - extent of regeneration of all canopy layers
    - condition of riparian trees
    - land-use type, any major threats to riparian vegetation condition and the trajectory of those threats

It was agreed that the following methods be adopted to ensure the key deliverables could be captured:

a) Victorian "Land manager self-assessment method" (tree density, cover of over and understorey, weediness, recruitment, logs and litter, patch size and connectivity)
b) Sub-set of Victorian "Index of Stream Condition physical habitat variables (stream-side zone width, presence of significant discontinuities, macrophyte cover and LWD abundance)
c) Internally produced indices of tree health, threat /land-use pressures and trajectory
d) General site details (including broad vegetation type) and photo-point information

It was agreed there was no need to assess detailed floristics at each site and that these attributes would instead be reported on by exception (e.g. notation of presence of weeds of significance, threatened species, key gaps in floristic community in comparison to other sites).

2.1 Reach Determination

Billabong Creek originates from headwaters to the east of Holbrook and generally flows in a westerly direction. The upper reach of Billabong Creek, from its headwaters to Walbundrie, has had vegetation condition monitoring undertaken in recent years and was therefore excluded from this project.

The project area was divided into three reaches, principally based upon the level of river regulation and therefore divided at the confluence of the flow regulated tributaries. The reaches 2, 3 and 4 were assigned to the project area as follows:

- Reach 2 (unregulated reach) – Walbundrie to Colombo Creek confluence
- Reach 3 (regulated reach) – Colombo Creek confluence to Yanco Creek confluence
- Reach 4 (highly regulated reach) – Yanco Creek confluence to Moulamein (i.e. downstream extent, confluence with the Edward River)

Effort was made to ensure all reaches were adequately sampled so that condition results could be reported on a reach by reach basis.

2.2 Field Assessment Parameters

The field assessment sheets developed for this project have been provided in Appendix A. The components assessed at each site are summarised below.

2.2.1 Site Information

The following detail was recorded for each site assessed:

- Assessor names and date assessed
- The land tenure type (i.e. Crown or Freehold) and the land manager if known
- Access details to locate and enter the site, and noting whether site access was Unrestricted (e.g. can drive to the crown land frontage), Limited (public land but access via foot and over fences etc.) or Restricted (e.g. can only be accessed through freehold land)
- GPS coordinates for the peg located in the middle of the site
- The length, width and area of the assessment site and a sketch of the site and features
- Photograph GPS locations, photo number and description

2.2.2 Frontage Management

The current landuse of the assessed frontage was noted. Landuse pressures thought to be impacting on condition of the site were identified (e.g. grazing, recreation, timber removal etc.) and a severity rating attributed to each threat (i.e. High, Medium or Low).

2.2.3 Land Manager Self-Assessment Method (Habitat Quality)

This method is a rapid and simplified version of the Victorian 'habitat hectares' approach developed by Parkes et al. (2003). This method is designed to measure the quality of native vegetation and habitat against a set of known benchmarks. Habitat quality is determined by comparing seven vegetation and three landscape components against known benchmarks. These benchmarks have been identified by botanists after looking at mature and undisturbed examples of each of the 21 Ecological Vegetation Class (EVC) Groups. They have nominated a range of values (percentage, number, length etc.) that best represents the average characteristics for that EVC Group (DSE 2004a). This project used only one EVC Group, that being Group 15 – Riparian Forest or Woodland.

The assessment of habitat quality applied in this method is an estimation of how altered the site is from a notionally optimal state.

The Land Manager Self-assessment Method produces a total condition score out of 20. The 10 assessed components are briefly described below and the highest score for each component, and therefore weighting, is shown in parenthesis:

1. **Large Trees** (2) – the observed number of large trees per hectare, as specified by a diameter at breast height appropriate to the relevant EVC Group
2. **Canopy Cover** (1) – the canopy cover provided by the tallest stratum of native trees greater than 5 metres tall
3. **Understorey** (5) – the cover of understorey provided by native species and the relative life forms that this cover represents
4. **Weediness** (3) – the proportion of the site covered by exotic vegetation, including both woody weeds and ground weeds
5. **Recruitment** (2) – the proportion of the mature species recruiting at the site, where the number of recruiting individuals is at least 10% of the mature population of that species

6. **Organic Litter** (1) – the proportion of the ground covered by organic litter including leaves, twigs and branches with a diameter of greater than 10 centimetres
7. **Logs** (1) – the length of logs per hectare, defined by the length of stumps, fallen trees and branches with a diameter of greater than 10 centimetres
8. **Patch Size** (2) – this component was modified for application on the linear creekline feature. Rather than being defined as the size of contiguous linear patch, it was defined by the width of vegetation away from the water's edge (i.e. width <30m = 0, 30-49m = 1, ≥50m = 2)
9. **Neighbourhood** (2) – the proportion of the area within a 1 kilometre radius that is covered by native vegetation
10. **Distance to Core Area** (1) – the distance from the site to a block of native vegetation of greater than 50 hectares in size.

All sites assessed used the same EVC Group, that being Group 15 – Riparian Forest or Woodland. However, the benchmark values differed between Forests and Woodlands and sites were defined as one or the other when in the field. Sites were assessed as Forests where the canopy trees were more abundant, taller and with a relatively closed canopy cover. However, most sites were assessed as Woodlands with only 4 of the 60 sites being assessed as Forest.

2.2.4 Riparian and Instream Health

The Riparian and Instream Health assessment components were selected to complement and expand upon the Habitat Quality assessment by providing measures more specific to waterways. Five condition components were assessed, each scored out of four for a total score out of 20. Four of the five components were adopted from the Index of Stream Condition (ISC) 2004 (1st edition) method. The fifth non-ISC component assesses the presence of macrophytes along the toe of the bank being assessed. The Riparian and Instream Health components are as follows:

1. **Width of Streamside Zone** – the width of woody vegetation measured from the toe of bank perpendicular to the flow, as per the 2004 ISC (1st edition) 20% cover rule
2. **Longitudinal Continuity** – vegetation is considered to be continuous where woody cover of vegetation provides at least 20% cover, extending at least 5m from the toe of bank and where any gaps in vegetation are less than 10 metres
3. **Instream Habitat** (large wood) – the presence of instream physical habitat is based on wood loadings within the stream, assessed as per the 2004 ISC (1st edition) reference photographs and scoring (See the ISC 'Large Wood Reference Photographs' in Appendix B)
4. **Bank Stability** – the bank stability is measured by comparing the condition of the bank with the relevant photographs and descriptions shown in the guide within Appendix B. The factors taken into account in this assessment include bank profile, slope, amount of vegetation, amount of exposed roots and amount of erosion.
5. **Macrophytes** (rushes and reeds) – the presence and relative abundance of macrophytic vegetation growing along the toe or face of the bank is measured.

2.2.5 Canopy Health Assessment

A visual guide to tree health was undertaken by estimating the proportion of expected healthy canopy cover present at each site. The visual guide tree health is provided in Appendix B.

The proportion of large tree canopy cover present was assessed by estimating the average projective foliage cover of canopy trees within the assessment area and comparing this to the expected 'healthy' projective foliage cover. Effectively, this is a measure of how far the small leaf bearing branches that make up the canopy are from maximum foliage carrying capacity. Note that absent or fallen branches do not necessarily correspond to reduced tree health and as such are not accounted for as part of the tree health component. Loss of foliage on sub-canopy branches and lower limbs is similarly not included in the assessment. Large dead trees were included in the health assessment and have a canopy health cover of 0% (derived from DSE 2004).

The percentage canopy health was assessed at a number of locations across the assessment area and an average percentage calculated.

2.2.6 Additional Flora Information

Despite floristics not being required for this project, a rapid list of native and exotic species was created at each field site. The lists were created to provide a species abundance number for both natives and exotics. The lists are not exhaustive and should not be considered to be absolute numbers found at these sites at this time of year. Plant names were recorded rapidly and written as scientific or common names. These lists can be accessed from the scanned field sheets if required.

Native and Exotic Vegetation Observations were documented to provide a brief written description of the structure, dominant species and character of vegetation across the site.

2.2.7 Condition Trajectory

Following completion of all condition assessments at a site, a future condition trajectory was predicted based on the landuse and considered recovery/improvement potential assuming conditions remain the same (e.g. the same level of grazing pressure continues). Changes in creek hydrology in the future are unknown and were not considered in the trajectory prediction.

The trajectory was predicted as **Improving**, **Stable** or **Declining**, and commentary was written to rationalise that prediction.

2.3 Ground Truthing of Remote Analyses

The Murray CMA had performed preliminary desktop analysis of geospatial data to start developing an understanding of the riparian vegetation attributes mentioned above. These analyses required ground-truthing to determine the accuracy of the automated results. To validate these analyses, the following measurements were undertaken at GPS located points in the field:

- Gaps in tree cover along a particular bank (i.e. gaps in longitudinal continuity) measured in metres with a rangefinder (e.g. 60 metre gap in the canopy). All breaks that were recorded were also photographed.
- The width of canopy was measured on one bank from both the centre of the creek and from the top of bank. The two measurements were made as the automated width measurement will be made from the creek centreline spatial layer which may be fairly coarse. The two measurements should allow GIS validation to occur with the aid of aerial photo interpretation.

Gaps in longitudinal continuity throughout the project area were recorded opportunistically during field assessment process and therefore not all gaps were identified. The identified gaps represent a sample of breaks in canopy across the project area, captured for GIS validation purposes only.

2.4 Site Selection

The Murray CMA provided spatial data including aerial imagery to facilitate the selection of field sites. A desktop selection of sites based on the following criteria was undertaken prior to entering the field:

- Proximity to a road or track for ease of access
- Proximity to a homestead
- Varying land tenure (i.e. freehold and crown land)
- Differing landuse (e.g. grazing and irrigated cropping)
- Varying Broad Vegetation Type
- Varying vegetation width and continuity.

An abundance of sites were selected and a point shapefile of selected locations was created and provided to the Murray CMA to facilitate landholder contact. An A3 base map series was produced using aerial photography annotated with chosen assessment sites and crown land parcels (Travelling Stock Reserves).

However, once in the field it was evident that site selection needed to be opportunistic and rapid. In order to assess a reasonable number of sites per day, and to ensure good distribution of sites, attempts were made to proceed approximately five kilometres downstream and to locate a site as quickly as possible. Site selection still required good access and, importantly, landholder permission. It was also not practical to cross the creek other than at bridge crossings and therefore long sections of creek were often assessed on the same bank.

2.5 Landholder Contact

Accessing accurate landholder contact information is always difficult. Even if accurate, the landowner or pastoral company is often located away from the property or has leased the property to another land manager. Despite the Murray CMA attempting to contact many landholders, it was found that the majority of the landholders we met in the field did not receive notification. Field assessors had to assume all landholders were unaware of the project and provided a landholder letter on all occasions.

Assessors consulted Conargo Shire Council for landholder information and base maps were marked up with landholder names where known. Contact phone numbers were also provided where known. This helped facilitate the contacting of landholders for greater than half the project area.

It was found that the most efficient and successful landholder contact was achieved during assessments by asking landholders who owned the properties downstream and seeking contact phone numbers from them. This consultation often informed us of absentee landholders and names of people leasing other landholder's properties.

Landholders were contacted by phone usually in the early evening a few days prior where possible. The project was discussed and then permission for access was sought. When landholders could not be contacted, base maps and smart phone aerial imagery was used to locate homesteads closest to the desired assessment site location and then these homes were visited.

2.6 Field Assessment Procedure

2.6.1 Assessment Timing and Site Distribution

60 sites were assessed within the project area between Walbundrie and Moulamein. Assessments commenced on the 24th May 2012 at the upstream end at Walbundrie. Sites were assessed consecutively downstream and the last site was assessed at Moulamein on 29th June 2012. Ten days field assessment was budgeted for in this program and an average of six sites per day was achieved.

The project area was divided into three reaches. Table 2-1 indicates the number of sites assessed within each reach, the length of that reach and the corresponding creek centreline average distance between sites.

Table 2-1 Reach and site numbers

Reach number and description	Number of sites assessed	Creek centreline reach length	Average distance between sites
Reach 2 (unregulated reach) – Walbundrie to Colombo Creek confluence	28	164 km	5.8 km
Reach 3 (regulated reach) – Colombo Creek confluence to Yanco Creek confluence	11	153 km	13.9 km
Reach 4 (highly regulated reach) – Yanco Creek confluence to Moulamein	21	244 km	11.6 km
Total	60 sites	561 km	(9.4 km av.)

2.6.2 Site Assessment Location and Setup

Once an assessment site was decided upon, a wooden peg was hammered into the ground near the top of bank at a location that was as inconspicuous and as discrete as possible. This is to prevent injury to people, livestock, machinery and fauna. The peg was typically located close to a tree or under a fenceline wherever practicable. The peg identified the middle of the assessment area longitudinally, and the width of the assessed area usually depended upon the width of woody vegetation offstream. All assessed areas extended 50 metres upstream and downstream of the peg. The location and dimensions of the assessed area was sketched on the first page of the fieldsheets.

The habitat assessment was carried out over the area indicated in the sketch, that being 100m along the creek, from the toe of the bank offstream to the edge of canopy or for a maximum width of 50 metres. Canopy health, additional flora information, landuse and condition trajectories were noted and assessed over the same area.

The Riparian and Instream Health assessment was undertaken over the adjacent length of bank and instream, that is, 50 metres upstream and downstream from the peg.

2.6.3 Photograph Convention

560 digital photographs were taken during the 10 days of field assessment. A standard convention was adopted for taking photos at each assessment site.

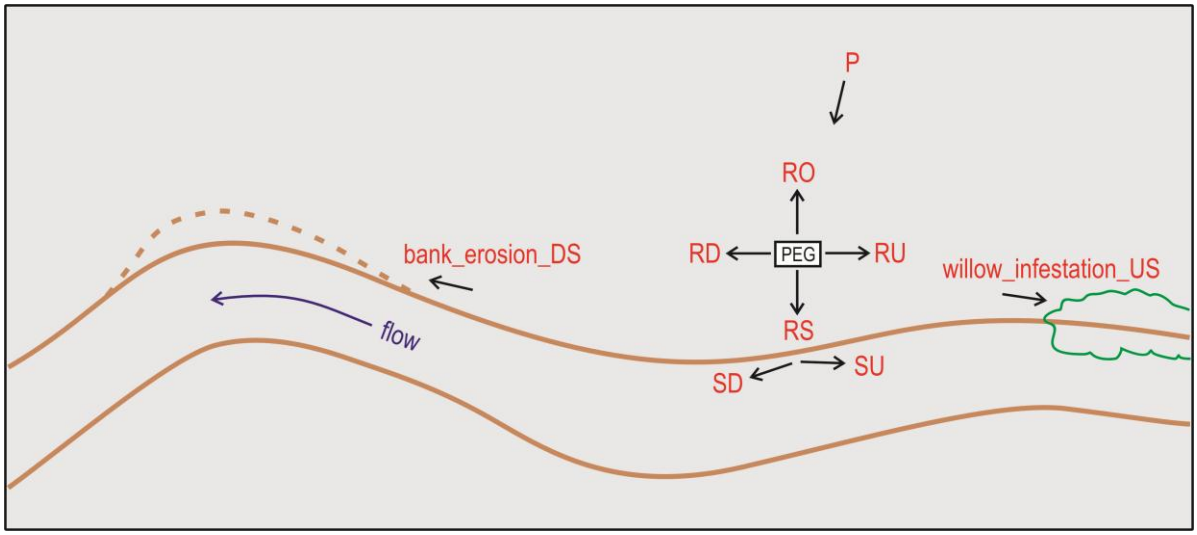


Figure 2 Photograph conventions and codes

The photograph shooting and naming convention adopted for the Billabong Creek Vegetation Mapping 2011-2012 project was as follows:

Photos were renamed by Waterway_Reach_Site Number_Bank_Description/code
For example Billabong_Ck_2_26_R_SU
Referring to a photo taken on Billabong Creek, within Reach 2, at Site number 26, located on the right bank (determined while looking with the direction of flow), from the toe of the bank adjacent to the peg looking up the bed of the stream.

The Description/code at the end of the photo name is either a standard convention code (see below) or a description of the feature of note (e.g. bank_erosion, willow_infestation, as shown in Figure 2) followed by a direction if applicable (e.g. US, DS). The 7 standard coded photos listed below were taken at each site and the peg coordinate was attributed to these photos. Feature photos were taken opportunistically and their location coordinates were recorded independently.

Standard photo description codes

P	Peg:	Peg locator photo, usually taken towards the stream with the peg in the bottom centre of frame, with enough detail around and in the background to allow relocation of the peg in the future.
RU	Riparian Upstream:	Taken from the peg looking upstream showing the riparian vegetation.
RS	Riparian Stream:	Taken from the peg looking towards the stream, ideally showing bank vegetation
RD	Riparian Downstream:	Taken from the peg looking downstream showing the riparian vegetation.
RO	Riparian Offstream:	Taken from the peg looking directly away from the stream showing vegetation or adjacent landuse.
SU	Stream Upstream:	Taken from the toe of bank adjacent to the peg, looking upstream at the bed of the stream within channel.
SD	Stream Downstream	Taken from the toe of bank adjacent to the peg, looking downstream at the bed of the stream within channel.

All photos have been renamed and are located in the digital data DVD located in Appendix D. A hotlinked ArcMap project has also been created so that all photographs can be viewed spatially using GIS software. This hotlinking project file can be run from the DVD of digital data contained in Appendix D.

3. SUMMARY OF RESULTS

All assessment data has been entered into a spreadsheet with separate tabs for each assessment theme. This data is provided electronically on the DVD contained in Appendix D.

There are a large number of condition parameters that have been assessed at each of the 60 assessment sites, however, this summary of findings looks at five main themes and provides a brief discussion of the condition trends throughout the project area and between the three reaches.

The five themes for discussion are as follows:

1. Habitat Quality (Land Manager Self-assessment Method)
2. Riparian and Instream Health
3. Canopy Health
4. Weed Cover
5. Condition Trajectory

3.1 Habitat Quality (Land Manager Self-assessment Method)

The total score out of 20 for each site has been displayed graphically in Figure 3. The mapping indicates that the condition of frontages is quite variable and that there are no very strong condition trends across the project area. The Habitat Quality results do not appear to be strongly affected by flow regulation as the overall condition of each reach is similar (see the habitat quality score graph on Figure 3). That said, component scores within the method do indicate some differences between reaches. The stronger differences in component scores are as follows:

Reach 2

- Highest weed cover. This is partly due to this reach having a wetter climate and an abundance of annual weeds at the time of assessment.

Reach 3

- Highest recruitment score
- Highest average width of woody vegetation
- Highest landscape context scores. This indicates that this reach generally has broader riparian zones and higher woody vegetation cover on the adjacent floodplain.

Reach 4

- Lowest recruitment score

Although not part of the Habitat Quality assessment, the native and exotic species count averages for each reach has been graphed and displayed on Figure 3. This graph shows a clear distinction with Reach 3 having the highest average number of native species, and the lowest average number of weed species. Reach 4 also shows a higher native species diversity and lower number of weed species than Reach 2.

N

0 10 20 30 40 50 km

WATER TECHNOLOGY

Moulamein
Wanganella
Conargo
Jerilderie
Urana
Lockhart
Wakool
Deniliquin
Finley
Berrigan
Oaklands
Rand
Walbundrie

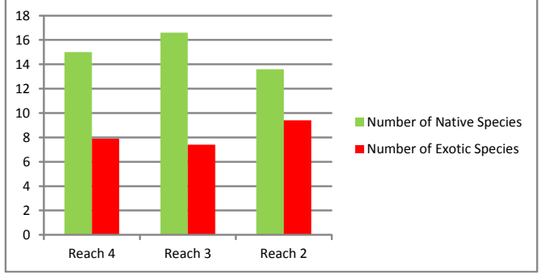
Reach 4
Yanco Ck to Edward River

Reach 3
Colombo Ck to Yanco Ck

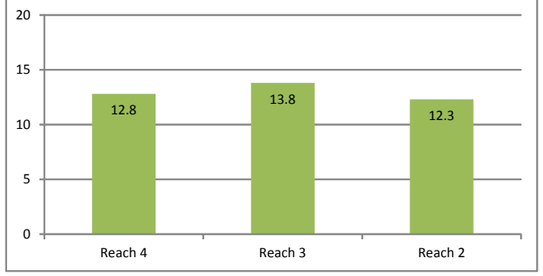
Reach 2
Walbundrie to Colombo Ck

Edward River
Billabong Creek
Yanco Creek
Colombo Creek

Number of Species



Habitat Quality (Score/20)



LEGEND

Habitat Quality (score/20)

19
18
17
16
15.5
15
14
13
12
11.5
11
10
9.5
9
7
6.5
5

Reach break

45 Site number

Waterway

Road

Township

Catchment Management Authority Murray

CARING FOR OUR COUNTRY

Billabong Creek Riparian Vegetation Mapping 2011-12

Habitat Quality

Figure 3

3.2 Riparian and Instream Health

The total score out of 20 for each site has been displayed graphically in Figure 4. The mapping shows a general trend of condition decline in score as one moves downstream from Reach 2 to Reach 4, however the site scores are variable within reaches. The graph of reach averages on Figure 4 shows the decline, from a score of 12.0/20 in Reach 2, to 10.4/20 in Reach 4.

A review of individual component scores within the method show the following trends:

Reach 2

- Despite having the highest overall average score, the width of streamside zone scored the lowest in Reach 2
- Macrophytes were present at a number of sites in Reach 2, but were only found at one site in Reach 3 and were absent at all sites in Reach 4
- Bank stability was best within Reach 2 and showed a steady decline through Reach 3 to Reach 4. Instabilities were often fluvial in Reach 2 but were more stock induced in Reaches 3 and 4

Reach 3

- Highest average streamside zone width

Reach 4

- Lower longitudinal continuity score than the other reaches
- Lower instream habitat score than the other reaches

N

0 10 20 30 40 50 km

WATER TECHNOLOGY

Moulamein
Wanganella
Conargo
Jerilderie
Urana
Lockhart
Wakool
Deniliquin
Oaklands
Rand
Finley
Berrigan
Walbundrie

Reach 4
Yanco Ck to Edward River

Reach 3
Colombo Ck to Yanco Ck

Reach 2
Walbundrie to Colombo Ck

Edward River
Billabong Creek
Yanco Creek
Colombo Creek

LEGEND

Riparian and Instream Health (Score/20)

- 20
- 16
- 14
- 13
- 12
- 11
- 10
- 9
- 8
- 7
- 6

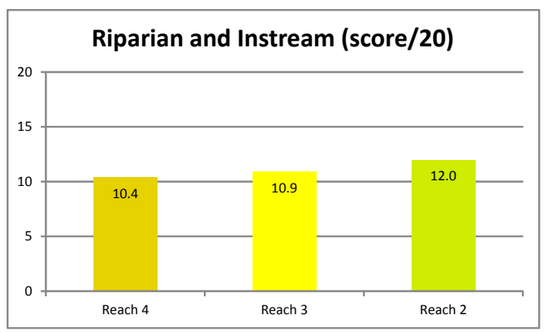
Reach break

45 Site number

Waterway

Road

Township



NSW GOVERNMENT Catchment Management Authority Murray

CARING FOR OUR COUNTRY

Billabong Creek
Riparian Vegetation Mapping 2011-12

Riparian and Instream Health

Figure 4

3.3 Canopy Health

It was observed during field assessment that, following the recent flooding, trees throughout the study area were generally healthy and actively growing. However, the visual guide used to assess canopy health (See Appendix B) considered the amount of dead small branches in the canopy. Despite trees displaying fresh leaf growth, the deadwood within the canopy, particularly the small branches, provided some insight as to how drought stressed trees were prior to the recent flooding.

While Reaches 2 and 3 had the same 'proportion of expected healthy canopy cover' at 75%, Reach 4 was substantially lower at 62%. Reach 4 also shows a distinct decline in tree health as one moves from upstream to downstream (Figure 7). This decline may be attributed to the cumulative effects of water extraction as regulated flows enter the creek via the Yanco Creek only and are therefore steadily diminished through extraction as you move downstream. These conditions would have been exacerbated in the recent drought as demand and consumption of water can be higher relative to average conditions.

3.3.1 Canopy Continuity

Site Assessment Canopy Longitudinal Continuity

Longitudinal Continuity of woody vegetation along the bank, principally canopy cover, was assessed at each of the 60, 100m long sites. Canopy continuity along the top of bank was observed as being either Fully Continuous (i.e. no breaks in canopy of more than 10m long within the 100m site length), Mostly Continuous (i.e. some breaks of more than 10m but the majority of frontage vegetated), or Mostly Discontinuous (i.e. breaks in continuity, greater than 10m long, form the majority of the frontage). Figure 5 indicates that the majority of assessed sites have fully continuous vegetation. Reach 2 and Reach 4 sites had a number of sites with discontinuities (18% and 24% of sites respectively) and only one site in the project area (within Reach 2) was assessed with mostly discontinuous canopy cover.

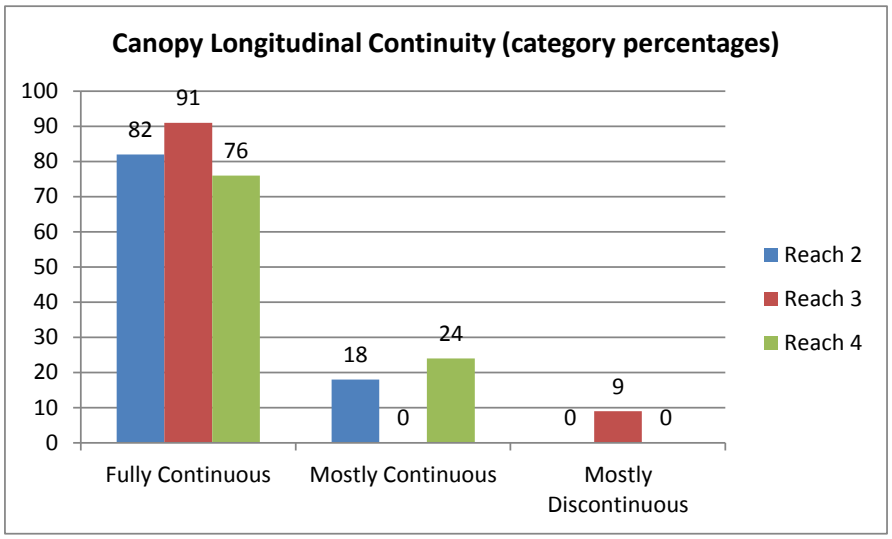


Figure 5 Reach percentage of sites within each continuity category

Project Area Canopy Longitudinal Continuity

The tree canopy longitudinal continuity along both banks is generally very good within the project area. Large continuity breaks (i.e. > 30m) in canopy along a bank were GPS located and measured in the field when identified near site assessment locations. Generally speaking, large continuity breaks were scarce throughout the project area.

The continuity breaks identified during field assessment have been recorded on the attached digital data spreadsheet. The identification and length measurement of these breaks was undertaken so that an automated GIS identification of breaks in tree continuity could be validated. This automated approach is to relate the Creek Centreline with a Tree Layer to locate gaps in the vegetation. Inaccuracies in both layers may lead to misleading results and the field measurements were taken to assist in the validation of automated results by the Murray CMA. Should the automated approach prove inaccurate, high resolution aerial photo interpretation in a GIS will be required to determine the true condition and extent of woody vegetation.

3.3.2 Canopy Widths

Canopy widths were measured at each of the 60 assessment sites. Figure 6 indicates the percentage of sites within each width category (i.e. 5-10m, 10-30m, 30-50m, >50m) plotted by Reach.

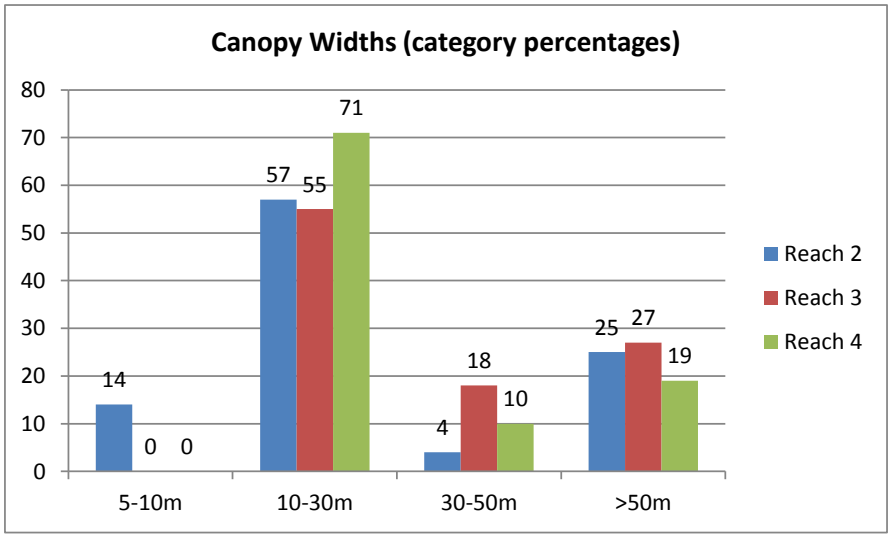


Figure 6 Reach percentage of sites within each canopy width category

This graph indicates that the majority of sites across the project area have a canopy width of 10-30 metres wide. It also shows that a good proportion of sites have very wide canopy width that exceeds 50 metres. The graph also shows that a number of sites (14%, 4/28 sites) within Reach 2 have a relatively narrow canopy width less than 10m.

It is appropriate to note that Reaches 3 and 4 have a flattened bank profile (see Section 4.2) compared to the majority of Reach 2. The flattened bank profile meant that the top of bank, and therefore edge of floodplain, was often approximately 20 metres from the edge of the water. Since the majority of assessment sites within Reaches 3 and 4 had Canopy Widths less than 30m (55% and 71% respectively), this indicates that very often canopy trees did not extend onto the floodplain but were effectively contained within the creek channel.

N

0 10 20 30 40 50 km

WATER TECHNOLOGY

Moulamein
Wanganella
Conargo
Jerilderie
Urana
Lockhart
Wakool
Deniliquin
Oaklands
Rand
Finley
Berrigan
Walbundrie

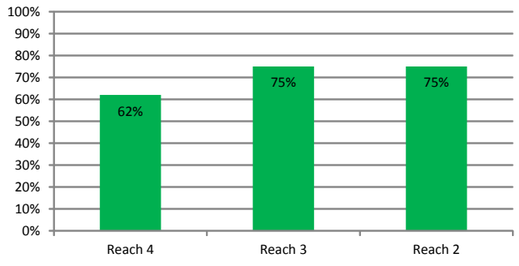
Reach 4
Yanco Ck to Edward River

Reach 3
Colombo Ck to Yanco Ck

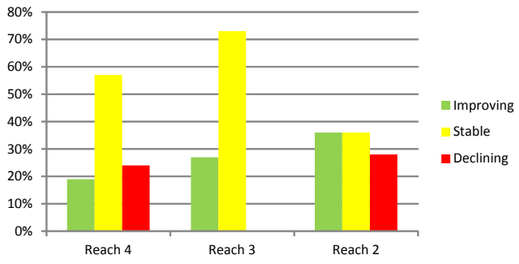
Reach 2
Walbundrie to Colombo Ck

Edward River
Billabong Creek
Yanco Creek
Colombo Creek

Canopy Health



Condition Trajectory



LEGEND

Tree Health (% cover)

95
90
85
80
75
70
65
60
55
50
45
33

Reach break

45 Site number

Waterway

Road

Township

Catchment Management Authority Murray

CARING FOR OUR COUNTRY

Billabong Creek Riparian Vegetation Mapping 2011-12

Canopy Health

Figure 7

3.4 Weed Cover

Weed cover percentages are presented graphically in Figure 8. Weed cover is considerably higher in the wetter upstream Reach 2. Reach 3 showed the lowest weed cover percentage, approximately half the cover measured within Reach 2. Although the downstream Reach 4 is weedier than the middle reach, it has a much lower weed cover percentage than the upstream Reach 2.

This cover percentage trend matches the average number of exotic species identified within each Reach as graphed on Figure 3.

N

0 10 20 30 40 50 km

WATER TECHNOLOGY

Moulamein
Wanganella
Conargo
Jerilderie
Urana
Lockhart
Wakool
Deniliquin
Finley
Berrigan
Oaklands
Rand
Walbundrie

Reach 4
Yanco Ck to Edward River

Reach 3
Colombo Ck to Yanco Ck

Reach 2
Walbundrie to Colombo Ck

Edward River
Billabong Creek
Yanco Creek
Colombo Creek

LEGEND

Weediness (% cover)

- 1
- 5
- 15
- 25
- 35
- 45
- 55
- 65
- 75
- 85

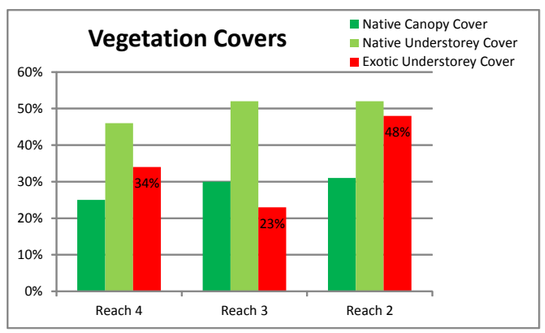
Reach break

45 Site number

Waterway

Road

Township



Catchment Management Authority Murray

CARING FOR OUR COUNTRY

Billabong Creek
Riparian Vegetation Mapping 2011-12

Weed Cover

Figure 8

3.5 Condition Trajectory

The Condition Trajectory results are shown graphically in Figure 9. The graph in Figure 9 indicates the reach wide averages of sites considered to be improving, stable or declining.

Although the upstream Reach 2 has the highest percentage of sites considered to have an improving condition trajectory, this reach also has the highest percentage of sites likely to decline in condition. This reveals the variable condition and management of sites within Reach 2.

The middle Reach 3 has no sites considered likely to decline under current management arrangements. The condition trajectory of most sites (73%) within Reach 3 is stable with the remainder assessed as likely to improve.

Reach 4 has more sites likely to decline than improve.

N

0 10 20 30 40 50 km

WATER TECHNOLOGY

Moulamein
Wanganella
Conargo
Jerilderie
Urana
Lockhart
Wakool
Deniliquin
Oaklands
Rand
Finley
Berrigan
Walbundrie

Reach 4
Yanco Ck to Edward River

Reach 3
Colombo Ck to Yanco Ck

Reach 2
Walbundrie to Colombo Ck

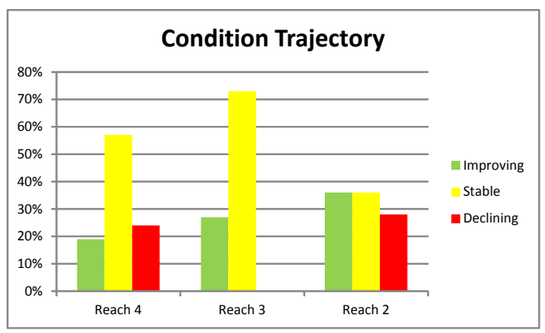
Edward River
Billabong Creek
Yanco Creek
Colombo Creek

LEGEND

- Reach break
- 45 Site number
- Waterway
- Road
- Township

Condition Trajectory

- Improving
- Stable
- Declining



Catchment Management Authority Murray

CARING FOR OUR COUNTRY

Billabong Creek
Riparian Vegetation Mapping 2011-12

Condition Trajectory

Figure 9

4. OTHER OBSERVATIONS

4.1 Project Area Vegetation Changes

Interesting riparian vegetation changes appear as one moves westward along the Billabong Creek. The assessment sites are ordered from the upstream end at Walbundrie (Site 1) westward and downstream to Moulamein (Site 60) at the downstream end. The project area is more arid in the west with the long term average annual rainfall at Walbundrie of 560mm decreasing to 347mm at Moulamein.

A rapid listing of species, native and exotic, was undertaken at each of the 60 assessment sites and some interesting transitions are noted chronologically as follows:

- Silver Wattles (*Acacia dealbata*) are abundant in the sub-canopy between Sites 1 and 8. However, they were not recorded in assessment areas downstream of Site 8 and are replaced with drier climate wattles further west.
- Yellow Box (*Eucalyptus melliodora*) were occasionally observed within assessment areas amongst River Red Gums but were not recorded west of Site 9.
- Nardoo (*Marsilea* spp.) was first observed at Site 16 and was commonly observed at sites to the west.
- Black Roly-poly (*Bassia quinquecuspis* var. *quinquecuspis*) was first observed at Site 19 upstream of the Urana Road. This species was ubiquitous further west.
- Lignum (*Muehlenbeckia cunninghamii*) was first identified at Site 20 downstream of the Urana Road. Thereafter it commonly occurred further west.
- River Cooba (*Acacia stenophylla*) and Canegrass (*Eragrostis australasica*) were first observed at Site 27, upstream of the Colombo Creek confluence.
- Black Box (*Eucalyptus largiflorens*) and Nitre Bush (*Chenopodium nitrariaceum*) were first recorded at Site 32.
- Black Box usually dominates or exclusively occupies the near riparian zone canopy from Site 34.
- River Red Gums (*Eucalyptus camaldulensis*) are present throughout the study area and dominate the banks and floodplain that are more regularly inundated.

The assessors were conscious of these subtle changes in vegetation due to changes in climate and channel morphology as they progressed westward during field assessments. The relatively high rainfall, high banks and large channel capacity of the Billabong Creek seemed to change downstream of Rand. Approximately 10km downstream of Rand, the channel capacity reduces as the creek connects with a broader floodplain. Floodways, wetlands and associated vegetation become more evident near the channel downstream from Site 11. This evidence of overbank flows being more common is reaffirmed by the fact that the public roads move away from the creek to higher ground downstream of Site 11.

The vegetation and landscape seems to change again around the Urana Road. The plains are clearly evident to the north and a few drier climate plants appear including Black Roly-poly and Lignum. The mature River Red Gums also appear shorter, with a more spreading habit, around and downstream of the Urana Road.

There is another transition into Black Box county and associated Nitre Bush around and downstream of Jerilderie. This indicates a transition towards a drier climate again and is also an indicator of less frequent overbank flows. Black Box dominate the majority of the floodplain downstream of Jerilderie, with River Red Gums present only on the Billabong Creek banks and more regularly inundated, or irrigated, depressions and flood runners.

4.2 Channel Shape

There is a distinct channel shape change that occurs approximately between Sites 25 and 26 in the vicinity of the Berrigan Road. The channel changes from relatively steep upright banks upstream to a flattened bank profile downstream. Figure 10 shows the change in shape between Site 23 and Site 26 located approximately 10km further downstream.

Figure 10 Defined steep banks at Site 23 (left) transitioning to a flatter bank profile at Site 26

4.3 Highest Quality Vegetation Identified

The most intact site assessed within the project area was Site 36, on the left or southern bank, within Reach 2, approximately 20km west of Jerilderie off the Conargo Road. This site had the following characteristics:

- The canopy was continuous along the bank and extended more than 50m offstream.
- A relatively healthy Black Box Woodland (with fringing River Red Gum) is present with an extensive native understorey (see Figure 11).
- The site is species diverse with the rapid species list identifying 29 native species. The average number of native species identified at each site across the project area was approximately 15.
- The 'Assessment of Habitat Quality' scored 19/20. The average score for sites across the project area was approximately 13/20.
- A wetland, well connected to the river, and holding water at the time of assessment, was contiguous with the riparian vegetation a short way downstream from the assessed site (see Figure 11).
- There was no evidence of recent grazing by stock.
- All woody species appeared to be naturally recruiting and native vegetation was competing well with exotic vegetation.
- Nine exotic plant species were identified, which is the average number across all sites within the project area.
- A patch of recently poisoned willows was present within the Billabong Creek downstream from the assessment area.
- A number of scarred trees were observed on the edge of the wetland adjacent to the assessment area (see Figure 12).

Figure 11 **High quality riparian frontage and adjacent wetland near Site 36**

Figure 12 **Scarred Trees on the edge of wetland near Site 36**

4.4 Poor Health Vegetation Requiring Additional Investigation

Black Box, River Red Gums and River Cooba were in very poor health or dead in the vicinity of Site 55. Salt was also evident on tree trunks within the Billabong Creek channel. The area needs to be revisited to determine the location of what is presumed to be the input source of saline and possibly agricultural chemical laden water. Figure 13 shows dead river Cooba and very poor health River Red Gums with salt deposits evident at the base of trunks. The site is in the vicinity of the Coleambally Outfall Drain which may be the source.

Figure 13 Very large dead River Cooba (left) and poor health River Red Gums

5. RECOMMENDATIONS FOR FUTURE WORK

The following provides recommendations for future work or investigation that will help to protect or enhance vegetation condition:

- Canopy Longitudinal Continuity should be further investigated by the Murray CMA to identify significant breaks. Breaks in continuity reduce habitat, restrict fauna passage along the riparian corridor and cause the loss of valuable inputs to the creek (e.g. shade and cover, leaf and log inputs, bank stability). The proposed automated GIS identification of breaks, utilising the field validation data, should be undertaken to identify these gaps. If the process proves to be unsuccessful, Aerial Photograph Interpretation (API) should be undertaken on a GIS to map all significant breaks. The identified breaks could then be prioritised for revegetation depending upon factors such as tenure and/or presence of significant fauna.
- The concept of 'Protect the Best' may be adopted whereby the highest quality frontages are managed firstly to ensure their condition does not decline. The habitat quality scores/mapping could be used to identify high quality areas and approaches made to the respective land managers, firstly to inform them of the asset they have, and secondly to discuss management practice to ensure the quality is maintained.
- 'Minimum Standards' could also be considered whereby a minimum acceptable vegetation condition standard is identified. For example, a minimum Habitat Quality score of 10/20 might be adopted. Sites with a condition score of less than 10 (Note that the average score across the project area is 12.75 and only 5/60 sites scored less than 10) might then be reviewed to determine if the minimum standard could be met through management change (e.g. reducing grazing pressures by closing gates on fenced frontages, repairing fences) or active intervention (e.g. revegetation, fencing, weed control).
- The continuation of tree health monitoring, particularly in Reach 4, could help inform environmental flow recommendations for the lower Billabong Creek. Tree health declined significantly in Reach 4 despite the recovery of trees following the floods. The amount of dead small branches within Reach 4 trees indicated that there was widespread severe drought stress prior to flooding. Future environmental flow determinations for the creek should ensure adequate water reaches the bottom reach of the creek to maintain or enhance riparian and instream health, and canopy health.
- A weed control program could be developed with the assistance of weed lists recorded in the project. Willows were surprisingly scarce within the project area and most of the infestations observed had been recently poisoned. Peppercorns (*Schinus areira*) were the most abundant and spreading woody weed within the project area, mainly in Reach 2. Exotic vegetation observations, and in some cases control recommendations, have been recorded on field sheets and have been entered into the data spreadsheet. Woody weeds were generally more abundant in Reach 2 and the exotic vegetation observation notes will provide a guide to the species present and distribution with the project area. API might also be used to identify woody weeds throughout the project area.
- Site 36 was identified as the best condition frontage assessed across the project area. With the cooperation of the landholder, this site may be identified as a demonstration or reference site.

5.1 Key recommended Actions for Each Project Reach

Reach 2

- Weed management – target woody weeds including Peppercorn (*Schinus areira*), Willow (*Salix* spp.), Ash (*Fraxinus* spp.), African Boxthorn (*Lycium ferocissimum*) and Sweet Briar (*Rosa rubiginosa*).

Reach 3

- Protect the best frontages and secure Site 36 as a reference or demonstration site.

Reach 4

- Investigate the reason for poor tree health in the vicinity of Site 55.
- Ensure environmental flow determinations are adequate to ensure the health of riparian vegetation, particularly trees. Riparian vegetation health may be the controlling criteria for environmental flow recommendations for this reach.

6. REFERENCES

DNRE (1999), *An index of stream condition: Field manual*. Department of Natural Resources and Environment, East Melbourne.

DSE (2004) *Vegetation Quality Assessment Manual – Guidelines for applying the habitat hectares scoring method*. Version 1.3. Victorian Government Department of Sustainability and Environment, Melbourne.

DSE (2004a), *Assessing habitat quality using the 'Land manager self-assessment method', Work Sheet No 4*. Victorian Government Department of Sustainability and Environment, Melbourne.

MyCMA, (2012), *Request for Quote, Billabong Creek Riparian Vegetation Mapping 2011-12*. Murray Catchment Management Authority, Albury.

Lamp, C.A., Forbes, S.J., Cade, J.W. (2001). *Grasses of Temperate Australia, a field guide*. Bloomings Books, Melbourne.

Parkes, D., Newel, G., Cheal, D. (2003). *Assessing the quality of native vegetation: The 'habitat hectares' approach*. Journal of Ecological Management & Restoration Vol 4 Supplement February 2003.

APPENDIX A FIELD SHEETS TEMPLATE

Catchment Management Authority Murray

CARING FOR OUR COUNTRY

Site _____

Reach _____

Billabong Creek Riparian Vegetation Mapping 2011-2012

Assessors _____ Date _____

Tenure Type *Freehold* *Crown* Land Manager _____

Public Access *Unrestricted* *Limited* *Restricted* Bank (L or R) _____

Access Details: _____

Site Peg Location WP # _____ MGAz55 coords _____ E _____ N

RHA Assessment Length _____ m Width _____ m Area _____ ha

Site Sketch

Photographs

WP #	Photo #	Photo Code / Description

FRONTAGE MANAGEMENT **Site ID** _____

Current Landuse: _____

Landuse Pressures		**Values**	**Threats**
Grazing	*High, Med, Low*	*Large Trees*	*Bank erosion*
Runoff	*High, Med, Low*	*Significant regeneration*	*Stock access*
Chemical	*High, Med, Low*	*Native fauna*	*Other access*
Recreational	*High, Med, Low*	*Geomorphic diversity*	*Timber removal*
Timber removal	*High, Med, Low*	*Instream habitat*	*Levees*
_____	*High, Med, Low*	*Wetlands*	*Exotic Flora*
_____	*High, Med, Low*	*Structural intactness*	*Introduced Flora*
_____	*High, Med, Low*	*Width of vegetation*	_____
_____	*High, Med, Low*	*Terrestrial timber*	_____
_____	*High, Med, Low*	*Public Recreation*	_____
_____	*High, Med, Low*	_____	_____

CONDITION TRAJECTORY *Improving, Stable, Declining*

Trajectory comments: _____

_____

_____

_____

_____

_____

VEGETATION

Broad Vegetation Type (BVT) observed _____

Canopy Health Observed Health %'s _____,_____,_____,_____,_____ Average _____%

Native Vegetation Observations: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Exotic Vegetation Observations: _____

_____

_____

_____

_____

_____

_____

_____

RIPARIAN AND INSTREAM HEALTH (assessed adjacent to RHA) **Site ID** _____

		Value	Score
Width of Streamside Zone	≤ 5m	0	/4
	>5 - 10m	1	
	>10 - 30m	2	
	>30 - 50m	3	
	> 50m	4	
Longitudinal Continuity	Mostly discontinuous	0	/4
	Mostly continuous	2	
	Fully continuous	4	
Instream Habitat (LWD)	Very poor	0	/4
	Poor	1	
	Marginal	2	
	Good	3	
	Excellent	4	
Macrophytes (rushes & reeds)	Absent	0	/4
	Present < 50% bank length	2	
	Abundant ≥ 50% bank length	4	
Bank Stability (at peg)	Extreme erosion	0	/4
	Extensive erosion	1	
	Moderate erosion	2	
	Limited erosion	3	
	Stable	4	
		TOTAL	/20

Billabong Creek Riparian Vegetation Mapping 2011-2012

REMOTE / GIS ANALYSIS - FIELD VALIDATION

Date	Location Waypoint #	Bank (L or R)	Canopy Width (m) from top of bank (native & exotic)	Length (m) of Continuity Break	Broad Vegetation Type (BVT)	Dominant woody weed species present

APPENDIX B FIELD ASSESSMENT GUIDES

Appendix 9 – Bank Condition reference photographs

Five reference photographs are provided for the assessment of Bank Condition.

To ensure that the Bank Condition assessment is consistently completed across Victoria, it is critical that the reference photographs are used correctly and frequently. Otherwise selection may be completed based on a persons own frame of reference, which would be shaped by experiences and could vary between assessors.

To correctly use the reference photographs, the relevant part of the photograph should be the focus (i.e. the stream bank). Avoid looking at the overall view, for example, and basing the Bank Condition assessment on the general appearance of the stream.

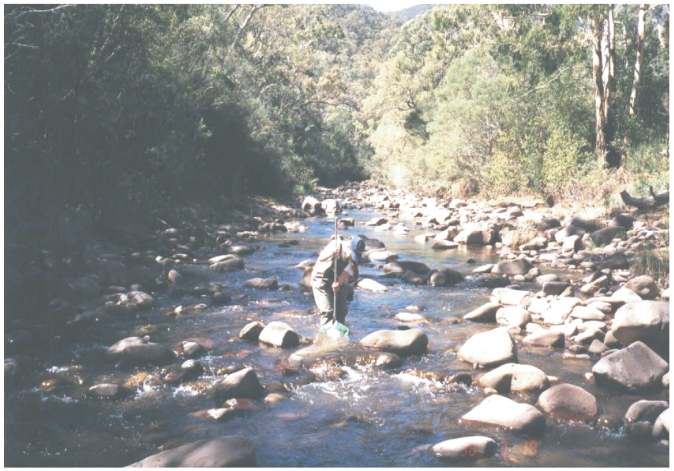
Care should be taken when using reference photographs to ensure a representative score is selected. If field data is being collected in teams of two, one field data collector should refer to the reference photographs while the other fills in the field data sheets.

The reference photographs are from basins within Victoria.

Bank condition rating: 4

Typical features:

Very few bare eroding banks, none of which are at the toe of the bank.
Banks are **not** vertical and undercut (unless composed of bedrock and/ or located in a gorge).
Continuous cover of vegetation (predominately woody).
Gentle batter.
Very few exposed woody roots.
No evidence of livestock damage.



(Right bank). Gentle batter. Large boulders protecting the toe of the bank. No local erosion visible. Extensive woody vegetation

(Right bank). Gentle batter. Continuous woody vegetation cover - no exposed roots visible. No erosion visible

(Right bank). Very little erosion visible. Some woody vegetation No exposed roots are visible

(Both banks). Gentle batter. No bank instabilities. Extensive fringing woody vegetation

Bank condition rating: 3

Typical features:

Some isolated bare eroding banks, though generally not at the toe of the bank.
Banks are **not** vertical and undercut.
Cover of vegetation is nearly continuous.
Exposed roots present, < 33% cover.
Gentle bank slope

(Left bank). Grass growing on much of the bank. Some woody vegetation. Isolated local slumping which does not extend far up the bank.

(Both bank). Some small scale, isolated bare eroding banks.

(Left bank). Gentle slope. < 33% exposed roots. Near continuous vegetation cover.

(Left bank). Some small scale, isolated bank instabilities. Some exposed roots. Overall the bank is quite stable.

Bank condition rating: 2

Typical features:

Some bank instabilities that extend to the toe of the bank.
Bank may have gentle or vertical slope.
Discontinuous vegetation.
May have > 33% cover of woody vegetation roots.

(Left bank). Surficial erosion over most of bank, but soils are clayey and seem resistant to erosion. Toe of bank is reasonably stable. Discontinuous vegetation.

(Both banks). Some discontinuous slumpings that extends to the toe of the bank.

(Left bank). Discontinuous erosion. Discontinuous woody vegetation. Minimal grass coverage. Bank batter varies.

(Left bank). Surficial erosion over most of bank. Toe of bank is probably reasonably stable.

Bank condition rating: 1

Typical features:

Mostly unstable toe of the bank, may be vertical bank with a toe.
Minimal vegetation on bank.
> 33% cover of exposed woody roots.
Obvious signs of livestock damage to banks.

(Left bank). Mostly unstable toe of bank. Low vegetation cover. Livestock access is unrestricted.

(Left bank). Erosion is occurring along most of bank. Bank appears to have some limited resistance to erosion. Minimal woody vegetation on bank.

(Both bank). Limited woody vegetation on banks. Recent erosion and slumping of banks. Unstable toe of banks.

(Both banks). It is likely that recent deepening has taken place, and triggered erosion of both banks. No woody vegetation on banks.

Appendix 8 – Large Wood reference photographs

Five reference photographs are provided for the assessment of Large Wood.

To ensure that the Large Wood assessment is consistently completed across Victoria, it is critical that the reference photographs are used correctly and frequently. Otherwise selection may be completed based on a persons own frame of reference, which would be shaped by experiences and could vary between assessors.

To correctly use the reference photographs, the relevant part of the photograph should be the focus (i.e. the Large Wood in the stream). Avoid looking at the overall view, for example, and basing the Large Wood assessment on the general appearance of the stream.

Care should be taken when using reference photographs to ensure a representative score is selected. If field data is being collected in teams of two, one field data collector should refer to the reference photographs while the other fills in the field data sheets.

The reference photographs are from basins within Victoria.

Excellent Habitat

Large Wood (instream physical habitat) rating: 4

Typical features:

Abundant instream wood from indigenous woody vegetation taxa.
Site probably never desnagged.
Streamside vegetation probably never cleared.

Abundant large instream wood of indigenous origin. No desnagging or clearing of streamside vegetation.

Abundant large instream wood of indigenous origin.

Abundant large instream wood of indigenous origin.

Numerous pieces of instream wood of indigenous origin.

Good Habitat

Large Wood (instream physical habitat) rating: 3

Typical features:

Numerous pieces of instream wood from indigenous species.
Perhaps limited instream wood from exotic species present also.
Limited impact of desnagging or streamside vegetation clearing.

Abundant large instream wood of indigenous origin. In forested catchment.

Abundant quantity of instream wood in channel. Some desnagging may have occurred at the site in the past.

Numerous pieces of instream wood of indigenous origin. Large wood can be living or dead

Abundant quantity of instream wood of indigenous origin. Some desnagging may have occurred at the site in the past.

Marginal Habitat

Large Wood (instream physical habitat) rating: 2

Typical features:

Moderate visible pieces of instream wood from indigenous species in channel.
abundant pieces of exotic instream wood in channel.
Moderate impact of desnagging.
Streamside vegetation clearing evident.

Moderate quantity of instream wood of indigenous origin.

Very dense coarse instream wood, primarily of exotic origin (willow).

Moderate quantities of instream wood in channel - most appears to be of indigenous origin.

Moderate quantity of instream wood in channel. Some desnagging may have occurred at the site in the past.

Poor Habitat

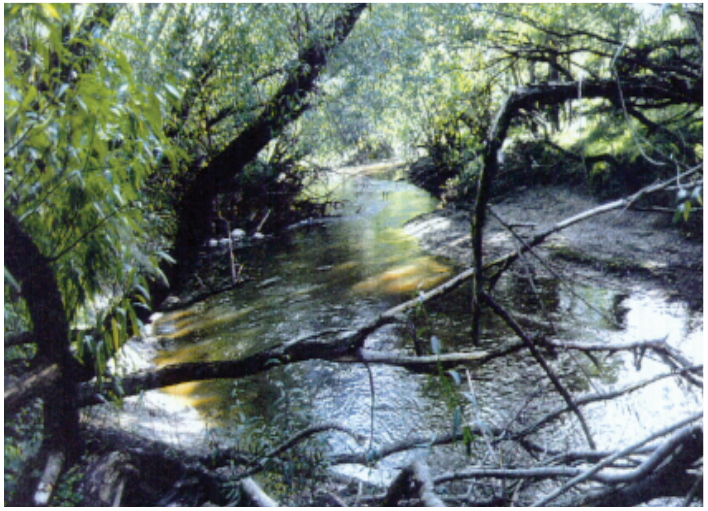
Large Wood (instream physical habitat) rating: 1

Typical features:

Few visible pieces of instream wood in channel (either from indigenous or exotic species).

Few pieces of instream wood

Very limited instream wood. However, it is of indigenous origin



Little instream wood of indigenous origin (there is some fine wood [less than 0.1m diameter] of exotic origin in stream).

Two emergent pieces of large wood of indigenous origin

Very Poor Habitat

Large Wood (instream physical habitat) rating: 0

Typical features:

No instream wood visible

No visible instream wood.

No visible instream wood.

No visible instream wood.

No visible instream wood.

Proportion of expected healthy canopy cover present (visual guide to tree health)

Proportion of healthy canopy cover present : 100%

Proportion of healthy canopy cover present : 45%

Proportion of healthy canopy cover present : 75%

Proportion of healthy canopy cover present : 30%

Proportion of healthy canopy cover present : 65%

Proportion of healthy canopy cover present : 20%

Proportion of healthy canopy cover present : 55%

Proportion of healthy canopy cover present : 10%

Appendix 4 (DSE 2004)

The proportion of large tree canopy cover present should be assessed by estimating the average projective foliage cover of canopy trees in the habitat zone and comparing this to the expected 'healthy' projective foliage cover. Effectively, this is a measure of how far the small leaf bearing branches that make up the canopy are from maximum foliage carrying capacity. Note that absent or fallen branches do not necessarily correspond to reduced tree health and as such are not accounted for as part of the tree health component. Loss of foliage on sub-canopy branches and lower limbs is similarly not included in the assessment. Large dead trees should be included in the health assessment and have a canopy health cover of 0% (derived from DSE 2004).

DSE (2004) *Vegetation Quality Assessment Manual – Guidelines for applying the habitat hectares scoring method. Version 1.3*. Victorian Government Department of Sustainability and Environment, Melbourne.

APPENDIX C ORIGINAL FIELD SHEETS

See Appendix D – Digital Data for the Scanned Original Field Sheets

APPENDIX D DIGITAL DATA