Angas River Catchment BioBlitz

DEWNR Technical note 2016/23

Government of South Australia
Department of Environment, Water and Natural Resources

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We would like to thank the landholders who allowed us to come on their properties and establish monitoring sites.

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Summary

Natural Resources SA Murray-Darling Basin (NR SAMDB) in partnership with the Science, Monitoring and Knowledge Branch (SMK) of the Department of Environment, Water and Natural Resources (DEWNR) is working to expand and complement the existing monitoring of aquatic ecosystems across the Eastern Mount Lofty Ranges to better understand current ecological condition and to enable the detection of change resulting from management actions due to the implementation of the Eastern Mount Lofty Ranges (EMLR) Water Allocation Plan (WAP).

Citizen science is gaining in popularity as a method of research and community engagement. Citizen science involves the participation of the wider community in scientific projects to inform and better engage the community in decision making. The three fundamental components of a citizen science methodology are: research, education and community engagement. Citizen science is a research approach, where scientists partner with the public to conduct scientific research. The partnership may occur as either **contributory**, where citizens collect data for scientists' project but have no other involvement; **collaborative**, where scientists involve citizens in creation and running of projects with mutual objectives; or **co-created,** where projects are initiated by citizens to answer their own questions; supported by scientists (Shirk et al. 2012). Citizen Science Projects have been identified by the Government of South Australia as a priority for community engagement and as a potential tool for the collection of monitoring data appropriate for use by government agencies. This trial had a contributory approach with the objective to create a collaborative partnership into the future.

This project trialled a citizen science approach to:

1. effectively engage the EMLR community in participating in the implementation of the EMLR WAP
2. collect ecological information with appropriate quality control to enable reporting against WAP objectives
3. collect baseline data in the Angas River Catchment before management actions such as methods to secure low flows have been implemented.

The trial focussed on 16 sites along the Angas River Catchment.

Key methods for data collection trialled were:

- Macroinvertebrate data collection and identification (EPA methods)
- Vegetation sampling methods: photopoint, abundant species, transects
- Hydrological data collection method (via gauge board readings).

Twenty volunteers participated in the BioBlitz which consisted of an evening information/training session and a full day of survey the following day. Community opinions of the methods trialled and the overall information presented to them was collected using an evaluation survey.

Macroinvertebrate samples were collected and sorted from all sites at which water was present on the day of the BioBlitz using standard methods employed by the Environment Protection Authority (EPA). Preliminary analysis showed differences in species richness collected at the different sites with the sample at Quarry Road,having the highest richness. Sites and habitats (pools and riffles) also showed differences in community composition and proportion of trait groups expected to respond to different flow conditions.

The methods used resulted in high quality data that can be used as a baseline for monitoring the implementation of the WAP and is directly comparable to other data collected by the EPA. The macroinvertebrate collection and sorting methods used in the BioBlitz were however more rigorous, and time-consuming, than the methods the participants had been exposed to previously. Feedback from the participants indicated that they would require on-going assistance if they were to undertake this type of monitoring in the future. Some expressed concern about how the methods compared to the methods they have used as part of existing monitoring programs.

The vegetation monitoring trialled three methods: photopoints, most abundant species and transects. Transects were only established at some sites. Vegetation monitoring was undertaken at both sites with and without water, resulting in a number of dry sites included.

A preliminary analysis of the most abundant plant species data showed clear groupings of sites based on functional groups associated with their water requirements. It is expected that the implementation of the EMLR WAP should result in more flows occurring in the watercourses, in which case a shift in the composition of the vegetation is expected to occur. The mid Doctors Creek Catchment's sites would be expected to see an increased abundance of water loving species. The sites where vegetation indicates stable water levels may see an increased abundance of species with higher water requirements. Participants felt they would require on-going assistance and further training to undertake the abundant species and transect methods of vegetation monitoring trialled. They also felt not enough time was spent on plant identification training.

A limited amount of water level data was collected as part of the BioBlitz, with many sites dry and several inundated to below the level of the height gauge. However, it was identified that water level monitoring can be quickly, easily and accurately undertaken by volunteers, but this trial was not able to assess this fully. Community water level data, verified against photos taken at the time of recording, is likely to be used for groundtruthing hydrological modelling, used to measure ecological response to changes.

The Angas River BioBlitz has demonstrated that citizen science projects where community members partner with experts and agency staff can assist with the monitoring requirements for the implementation of the EMLR WAP. Overall the event was very well received with 100% of attendees indicating that it was well run and would recommend the event to others. Volunteer and staff feedback was sought to identify what worked well and what could be done to improve the approach for future events; based on this, future considerations for an ongoing citizen science approach are:

- Ensure key questions sought to be answered by the data collected are shared and understood
- Work closely with community groups and non-government organisations in the planning and delivery of the event
- Enable volunteers to work alongside trained experts to learn new skills and to provide confidence in the data collected
- Include both theoretical and practical components to enable the participants to gain an understanding about the purpose of the monitoring and the chosen methods
- Enable participants to try more than one type of monitoring activity
- Be mindful of the complexity of tasks and provide appropriate levels of training and time for those tasks
- Develop localized guides to identify common species (in this case for watercourse vegetation and macroinvertebrates)
- Ensure there is effective communication with the community post the event and show them the clear pathways for where their data is going to be used.

Suggested protocols for future citizen science macroinvertebrate, vegetation and hydrological monitoring are provided as well as a discussion on the potential use of the data for reporting on the EMLR WAP. A follow up presentation providing the results in this report and discussing the ways forward for future monitoring activities is planned by DEWNR (NR SAMDB and SMK). A tiered approach to assessment such as those presented in Figure 4.1Figure 4.2 will be presented to community for comment to enable a collaborative approach to monitoring to be developed for the future.

Ecological data collected as part of this project will be stored in the Biological Databases of South Australia (BDBSA) and will become publicly available via the Atlas of Living Australia. DEWNR is currently developing protocols for the storage of macroinvertebrate data. Hydrological data is anticipated to be stored in DEWNR's Hydstra surface water database.

1 Introduction

1.1 Overview

Freshwater assets across the MLR are facing key challenges from climate change, increased demand, increased intermittency (periods of no flow) and other land management practises. Several management actions are planned to reduce these risks including the introduction of threshold flow rates. Key to ensuring the ongoing health of our freshwater assets is monitoring their response to management actions. Long-term ecological data sets coupled with hydrological data are key to determining trends in the condition of these assets. Surveying macroinvertebrates, water quality/quantity and vegetation by qualified experts can be costly and does not provide opportunities for education or interaction with community groups. Establishing and supporting a group of volunteers trained in approved EPA/DEWNR methods could potentially improve EMLR WAP monitoring program by:

- Increasing the frequency of surveys
- Improving the spatial coverage of surveys
- Building relationships with a pool of trained volunteers to potentially help with future monitoring requirements
- Enhancing the sharing of local knowledge with government officers
- Enabling a collaborative approach between government officers and the community to water management issues

Natural Resources SA Murray-Darling Basin (NR SAMDB) is working to expand and compliment their existing monitoring of aquatic ecosystems across the Eastern Mount Lofty Ranges to better understand current ecological condition and to enable the detection of change resulting from management actions due to the implementation of the Eastern Mount Lofty Ranges (EMLR) Water Allocation Plan (WAP). This project trialled the use of community assisted macroinvertebrate, aquatic vegetation and hydrological monitoring to develop a better understanding of resource condition and to detect change as a result of management actions. A 'BioBlitz' approach to community monitoring was employed in which members of the community received training from scientific experts and use this training to assist in observations, collection and identification of macroinvertebrate samples, vegetation and hydrological monitoring.

1.2 Angas River Catchment

The Angas River Catchment is in the EMLR. The township of Macclesfield is located in the upper catchment and Strathalbyn is approximately midway down the catchment. Mean annual rainfall in the upper catchment is between 750 to 800 mm/year and drops off steeply down catchment to 491 mm/year at Strathalbyn. The upper catchment is hilly and is comprised of a number of sub-catchments which converge upstream of Strathalbyn. Downstream of Strathalbyn the Angas River traverses the Angas Bremer Plains to discharge into Lake Alexandrina near Milang. Flows downstream of Strathalbyn are dependent on upstream flow and there is significant discharge to groundwater through this lower reach.

There are a number of community groups as well as numerous individuals who have been working towards improving the natural resources of the Angas River Catchment. These include the Goolwa to Wellington Local Action Planning Association and Angas River Catchment Group, and at the more localised scale the Flaxley Landcare group, Doctors Creek Landcare Group and the Angas Bremer Water Management Committee.

There are a number of existing monitoring sites in the Angas River Catchment (Figure 1.1). Water quality monitoring has been undertaken by community members as part of the Community Surface Water Quality Monitoring Program (CSWQMP, formerly known as Waterwatch) (SAMDB NRM 2016). The Environment Protection Authority (EPA) has undertaken aquatic ecosystem monitoring at five sites in the catchment (four in 2010 and one in 2008). There are three continuous streamflow monitoring gauge stations as well as other historical gauge sites. Other monitoring and surveys have been undertaken in the catchment of various biotic and abiotic parameters; of particular relevance was recent work (2012–14) through the Goyder Institute for Water Research towards determining environmental water requirements in the Mount Lofty Ranges (Maxwell et al. 2015).

1.3 High Demand Zones

In some management zones of the EMLR, the demand for water is higher than the consumptive use limits. In these areas there is concern that water resources are being negatively impacted, or there is serious risk that they will be, particularly if all license holders use their full water allocations. Managing water demand applies to groundwater, watercourse and surface water sources. This represents a key risk to socioeconomic values and environmental assets. DEWNR has commitment to address high demand zones through a range of management actions in consultation with the EMLR community.

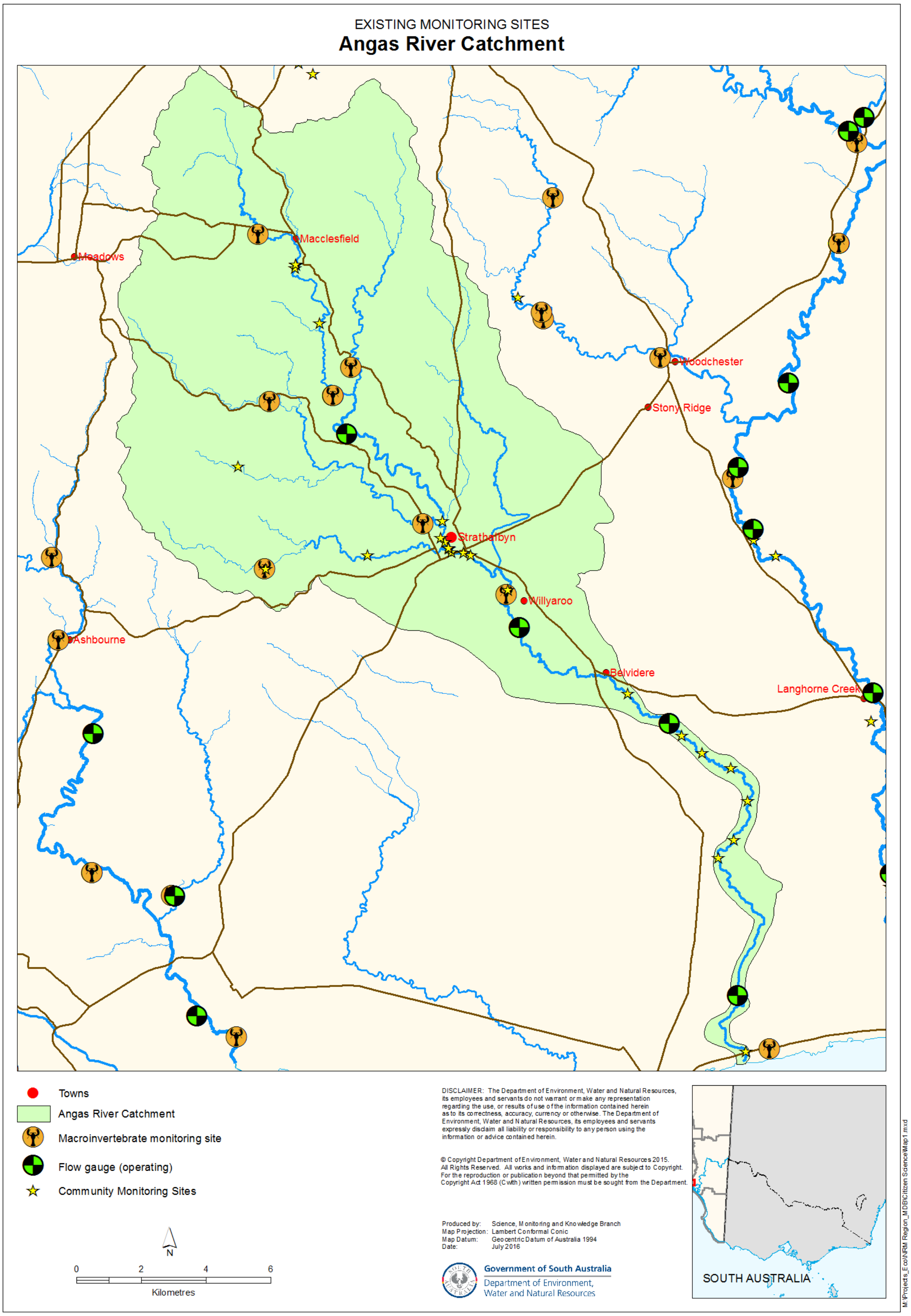

Figure 1.1 Location of existing monitoring sites in the Angas River Catchment

1.4 Citizen science

Citizen science is gaining in popularity as a method of research and community engagement. Citizen science involves the participation of the wider community in scientific projects to inform and better engage the community in decision making and community behaviour change. The three fundamental components of a citizen science methodology are: research, education and community engagement. Citizen science is a research methodology, where scientists partner with the public to conduct scientific research. The partnership may occur as either **contributory**, where citizens collect data for scientists' project but have no other involvement; **collaborative**, where scientists involve citizens in creation and running of projects with mutual objectives; or **co-created,** where projects are initiated by citizens to answer their own questions; supported by scientists (Shirk et al. 2012). Such a partnership typically requires an educational component (e.g. scientists teaching participants from the public to collect robust data) and a community engagement component (e.g. interaction between scientists and the public participants).

The Discovery Circle is a is a five-year long Citizen Science program conducting research, education and community engagement projects aimed at cultivating public awareness of environmental assets and issues while promoting environmental stewardship. It is a $1.5 million initiative that aims to connect communities to their natural environments, the program is led by the University of South Australia, with DEWNR and the Adelaide and Mt Lofty Ranges Natural Resource Management Board as key partners.

Citizen science projects typically engage a large number of participants with little training for a short time period with the advantage that data can be gathered across large spatial (or temporal) scales (Figure 1.2). However, citizen science projects can also involve participants who are highly skilled and contribute a significant portion of their time; such projects have a restricted number of participants are usually cover smaller spatial (or temporal) scales. The trialled BioBlitz approach fits in the middle range of this diagram where a moderate spatial scale was selected and a moderate skill required of participants as they were working concurrently with experts who were able collaborate on the production of results. This trial had a contributory approach with the objective to create a collaborative partnership into the future.

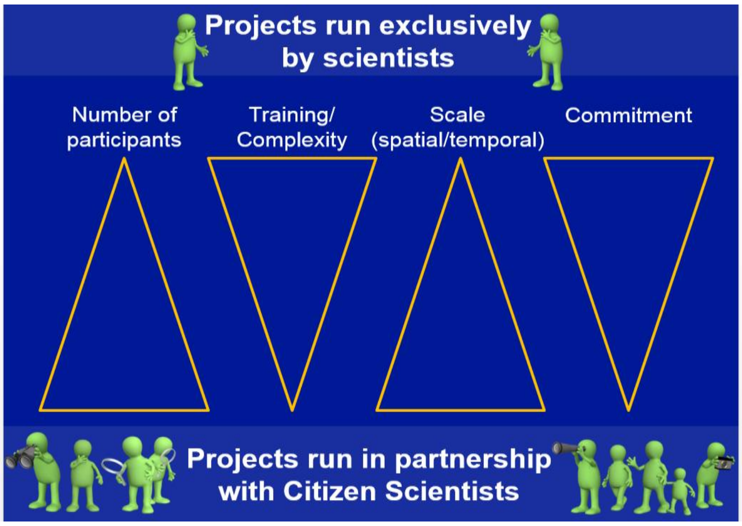

Figure 1.2 Model for Citizen Science projects

1.5 Aim of the BioBlitz

This project aimed to trial a citizen science approach to:

1. Effectively engage the EMLR community in participating in the implementation of the EMLR WAP
2. Collect ecological information with appropriate quality control to enable reporting against WAP objectives and
3. Collect baseline information suitable to informkey DEWNR management questions such as:

   What is the hydrological and ecological response to management actions to increase low-flow in MLR streams?

The intended outcomes of the project were:

- Increased ability to report the status of aquatic ecological assets in high demand zones through the collection and collation of baseline condition data.
- An informed section of the community engaged in water planning and contributing to water management outcomes
- Increased knowledge and understanding on how to engage the community to aid in the collection of data of suitable quality for evaluation against WAP objectives
- Increased capacity of the community to aid in future data collection.

The outcomes of this project will be used to guide future investment in citizen science for reporting against WAP objectives. Some of these outcomes are expected in the short term whereas others are likely to have longer and ongoing timeframes.

1.6 Monitoring indicators

For the purpose of this project three key parameters were selected for monitoring:

- Macroinvertebrates.
- Vegetation
- Hydrology and Water Quality

Macroinvertebrate monitoring has historically been used in goverment monitoring programs (e.g. EPA) as well as community monitoring programs (e.g. Waterwatch) to monitor ecosystem health and water quality. However, Waterwatch methods recorded only species number and SIGNAL score, and was designed to assess questions about water quality (Chessman 2003). This project was used to investigate the feasibility of collecting macroinvertebrate data using EPA methods with community members. Macroinvertebrates have been extensively used worldwide to understand changes to ecosystems in response to changes in the flow regime (timing, duration, magnitude and rate of change of flow) (Poff and Zimmerman, 2010). Recent work using macroinvertebrate trait groups has demonstrated that macroinvertebrates are likely to be a useful indicator to monitor flow regimes in the Mount Lofty Ranges (Maxwell et al. 2015). Macroinvertebrate identification to the level required for use in standardised monitoring requires a high level of training. This project therefore trialled an approach whereby citizen scientists assisted collection of macroinvertebrate samples, and worked alongside trained experts, to undertake the sorting of macroinvertebrates. Further identification in the laboratory was undertaken by experts as part of this method.

Vegetation monitoring was chosen as the composition of watercourse vegetation is strongly driven by recent hydrological conditions (e.g. water depth and duration). Analysing the composition of watercourse vegetation by water plant functional groups can therefore provide insights into the recent flow regime at a given location (Brock and Casanova 1997; Casanova 2011). This parameter requires plant identification skills. Three methods were therefore trialled ranging from least through to most complex:

- Photopoints
- Most abundant species
- Transects

For hydrology, the monitoring indicators were presence of water, depth of water and flow rate. These parameters can be simply measured and were intended to supplement current continuous monitoring stations which are expensive and therefore only installed at a small selection of sites in the Angas River Catchment. Permanent water level gauge boards were installed to provide standardised water level monitoring.

2 Methods

2.1 Site selection

Sites were selected by the authors and other regional and DEWNR staff. All sites were required to be safe, and either on public land or easily accessible private land (with the landholder's permission). Other criteria for site selection were:

1. Known community interest
2. Previous surveys or monitoring at the site (e.g. Goyder, EPA, CSWQMP, continuous streamflow monitoring)
3. Surface water management zone representation
4. Proximity to water resource management actions
5. Demand zone representation.

Following an initial desktop identification of potential sites, all but two of the sites were visited by the authors, and sixteen sites were short-listed for inclusion in the BioBlitz (Figure 2.1).

2.2 BioBlitz format

The BioBlitz event was held over two days consisting of a two-hour evening session followed by the BioBlitz field day on 6 May 2016. The evening session aimed to provide participants with the context for the BioBlitz, an overview of the methods and information about how the information would be used. The BioBlitz day was focused on data collection. In order to be able to collect and processes the samples and data on the day, the participants were divided into four teams that performed different tasks. Each team was led by external experts in the field and DEWNR staff. Participants could switch between teams over the lunch break. Macroinvertebrate samples were delivered to the Strathalbyn Natural Resources Centre where sorting and identification was undertaken.

<u>Procedure</u>:

Team 1 – Undertook the vegetation and hydrological data collection in the morning and afternoon. (Catherine Miles and Philip Roetman)

Team 2 – Collected macroinvertebrate samples in the morning and sorted macroinvertebrate samples in the afternoon (Lead by Sally Maxwell)

Team 3 – Collected macroinvertebrate samples in the morning and carried out physical habitat surveys in the afternoon (Lead by Doug Green)

Team 4 – Sorted and identified macroinvertebrates in the morning and afternoon. (Lead by Sonia Giglio and Peter Goonan)

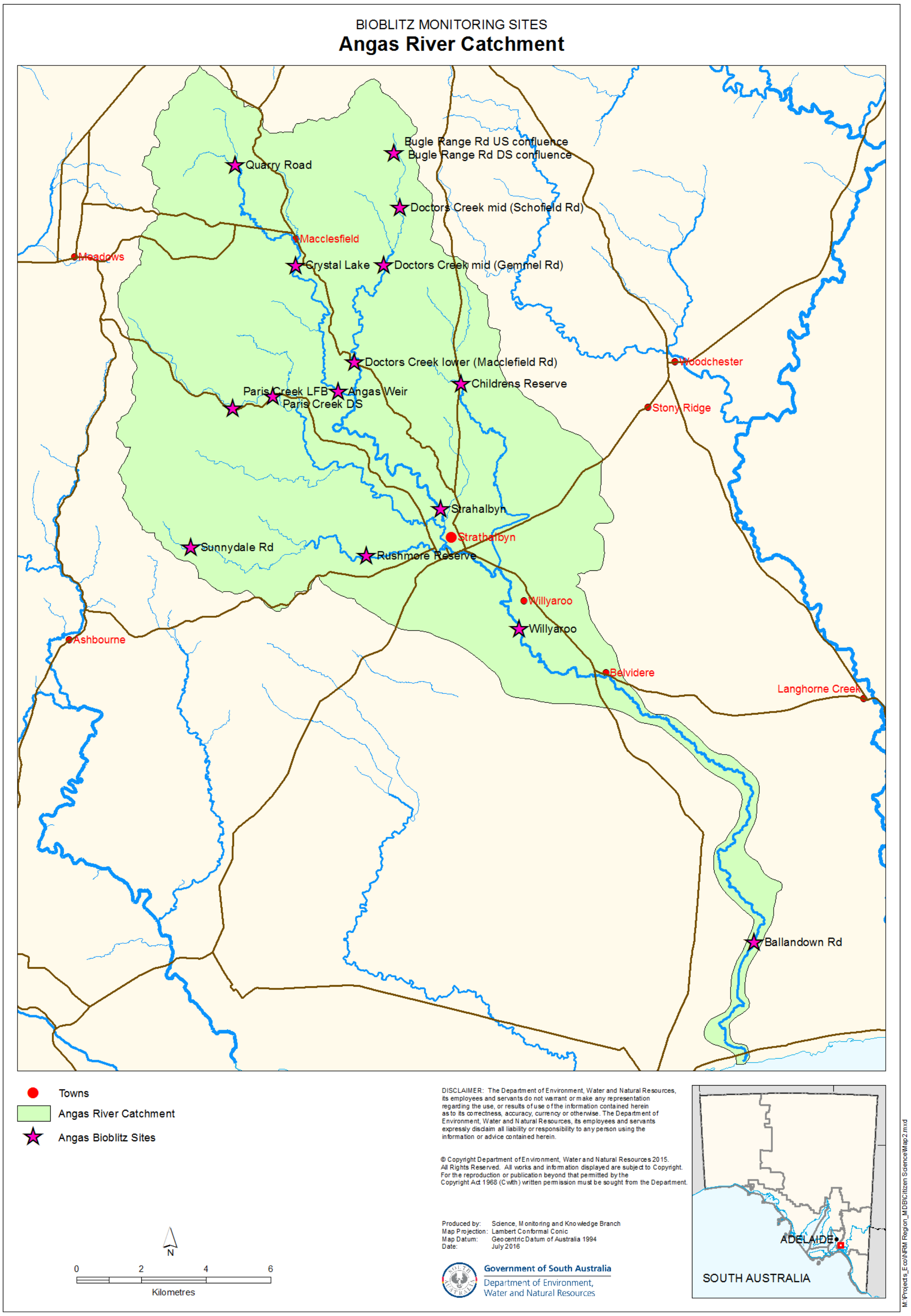

Figure 2.1 Location of BioBlitz monitoring sites in the Angas Catchment

2.3 Macroinvertebrate survey

2.3.1 Collection

The macroinvertebrate collection method follows the Australian River Assessment System (AUSRIVAS) method which is a standardised collection method used by the EPA in South Australia (SA EPA, 2002). A site is considered to be a stretch of watercourse approximately 100 metres long. Two samples were collected per site: one from riffle habitat, one from pool habitat, unless water is not present in which case only one or no samples were taken. A combined 10 metre sweep was collected for each habitat using a 30 cm D-shape or triangular frame net with 250 micron mesh. This process is repeated for riffle habitats (where present) to encompass all microhabitats (Standard AUSRIVAS methodology).

A video of the sampling method was produced for the project and shown to participants during the night information session. It may be viewed at the Natural Resources SAMDB Community water monitoring webpage.

Where there is a single pool or riffle habitat of sufficient size to collect the 10 metre sweep, then only one of those habitats is sampled per site. Where the pools or riffles are too small, then multiple pools or riffles can be sampled from the 100 m site to make up the 10 metre sweep. Where less than 10 m is available then it was still sampled as best as possible and the number of sweeps noted.

Water quality parameters were collected for each site:

- Salinity (electrical conductivity)
- Specific conductivity
- pH
- Dissolved oxygen
- Temperature
- Turbidity
- Total dissolved solids

Three different water quality sampling meters were used on the day.

The flow rate, water depth and substrate composition were also recorded. A copy of the field data sheet is provided in Appendix A.

For this event a cautious approach was taken to citizens working in water based on current DEWNR practice. Citizens were not permitted to enter water more than 30 cm deep. However, through this event it has been recognised that a dedicated Citizen Science working around water safe work instruction should be developed to appropriately assess the risks in context.

2.3.2 Sorting

The sorting was also based on the EPA method which is based on the AUSRIVAS method. Each sample was sorted in a white tray for 40[1] minutes; if at the end of 40 minutes no new taxa have been found in the preceding five minutes then the sorting is finished, but if new taxa have been found then sorting continues for another five minutes, and so on until up to one hour of sorting has been undertaken.

[1] Note: the EPA method uses 30 minutes but an additional 10 minutes was allowed for this project to account for citizen training time.

Taxa were identified on the day predominantly to family level, using Gooderham and Tsyrlin (2002) and the assistance of staff from the EPA (Peter Goonan) and SA Water (Sonia Giglio). A voucher specimen was collected for each sample and later identified by SA Water. The abundance of each taxa were recorded in categories of 1 to 10, 11 to 100, 101 to 1000 and greater than 1000. A copy of the data sheet is provided in Appendix A. Voucher specimens were identified to the lowest possible taxonomic level in the laboratory by SA Water, following the BioBlitz.

2.4 Physical habitat and vegetation

The physical habitat survey was composed of four parts:

- Water level
- Photopoint
- General vegetation habitat survey
- Vegetation transect

Due to time limitations a vegetation transect was not undertaken at each site.

Copies of the data sheets are included in Appendix A.

2.4.1 Water level

A water level gauge board was installed at all sites (except those at which there is a continuous streamflow gauge prior to the BioBlitz) and elevation of these surveyed using Real-Time Kinematic Geographical Positioning System (RTK GPS), which enhances the precision of position data derived from satellite-based positioning systems.

Where water was present, the depth was read from the gauge board and recorded. In some situations the gauge board could not be installed in the lowest point of the channel resulting in the water level being below 0 on the gauge board, in which case the depth of water was measured using a ruler. A photo of each gauge board was taken for verification.

2.4.2 Photopoint

Fixed photopoints were established at each site using the method and materials employed by the Goolwa to Wellington Local Action Planning group. Each photopoint consists of a steel dropper with a fixed camera plate attached, along with an attached aluminium site ID code, and the accompanying signage with instructions for taking photos. The camera body was placed on the camera plate with the bottom sitting flush to the left back corner. Pool and riffle habitat were included in the photo for assessment over time.

At each site the following photos for the photopoint were taken:

- Site identification tag
- Site
- Angled shot of the ground from the photopoint.
- Overview of the location of photopoint from the most obvious approach

2.4.3 Vegetation habitat

The cover of each of the five most dominant species present within the pool and the riffle (where a riffle was sampled for macroinvertebrates) was visually estimated. The aim of this survey was to provide a rapid assessment of the most dominant species within the habitat area that would be inundated, if the habitat were filled to enable gross changes in composition to be detected in future. This area was found to be difficult to visualise in the field and therefore the data sheet provided in Appendix A is slightly modified to include one column to record the species growing in the aquatic zone (area that would be inundated if the watercourse were full), and the fringing vegetation. Overhanging vegetation was not included, although if large trees or shrubs were growing in the habitat their basal area could be recorded if it was of significant cover. Open water and bare dirt, mud, rock and litter were recorded to assist assessors estimate the vegetative cover but not included as one of the five species. Participants were keen to record all species growing at a site as part of this survey, however this was very time consuming and the additional data generated was not able to assist in the analysis.

2.4.4 Vegetation transect

A vegetation transect survey method was developed to provide a more quantitative approach to detect changes in vegetation composition at the sites. It was intended that a transect could be recorded for each of the sampled pool and riffle habitats, however time restrictions prevented transects being surveyed at all sites, and in all cases where transects were established only the pool habitat was surveyed. In most cases the transects started at the photopoint post, but in some cases a separate marker was installed as the start point.

A tape measure was laid from the start of the transect (ideally situated on the outer edge of the floodplain) across the channel to the far side of the floodplain. Where the channel or far side was inaccessible, the transect was extended to one metre beyond where the tape could reach. The GPS location of the start was recorded and the bearing of the transect. The cover of each species occurring in each one square metre along the transect, on the downstream side of the transect, was recorded (Figure 2.2).

For each square metre, the distance along the transect was recorded, and the position (floodplain, bank or channel). In future the elevation of each square metre could be related to the gauge board.

Cover of each species was estimated. Categories were not provided but it was recommended to participants that the estimates need only be broad. For example:

- All of the quadrat = 100%
- Nearly all of the quadrat = 90%
- Three quarters covered, half covered, one quarter = 75%, 50%, 25% (respectively)
- Very little 1%

It is recommended that to aid with future analyses and consistency of data capture across the MLR cover estimates are made in percentages for each species (J Nicol (SARDI) 2016, pers. comm., 3 August).

Ideally plants should be identified to species level, particularly the most common species, however if time is insufficient genus level will suffice, and introduced exotic species can be grouped under introduced annual/perennial grasses/broadleafs. Some commonly occurring species were pre-entered on page 1 of the datasheet.

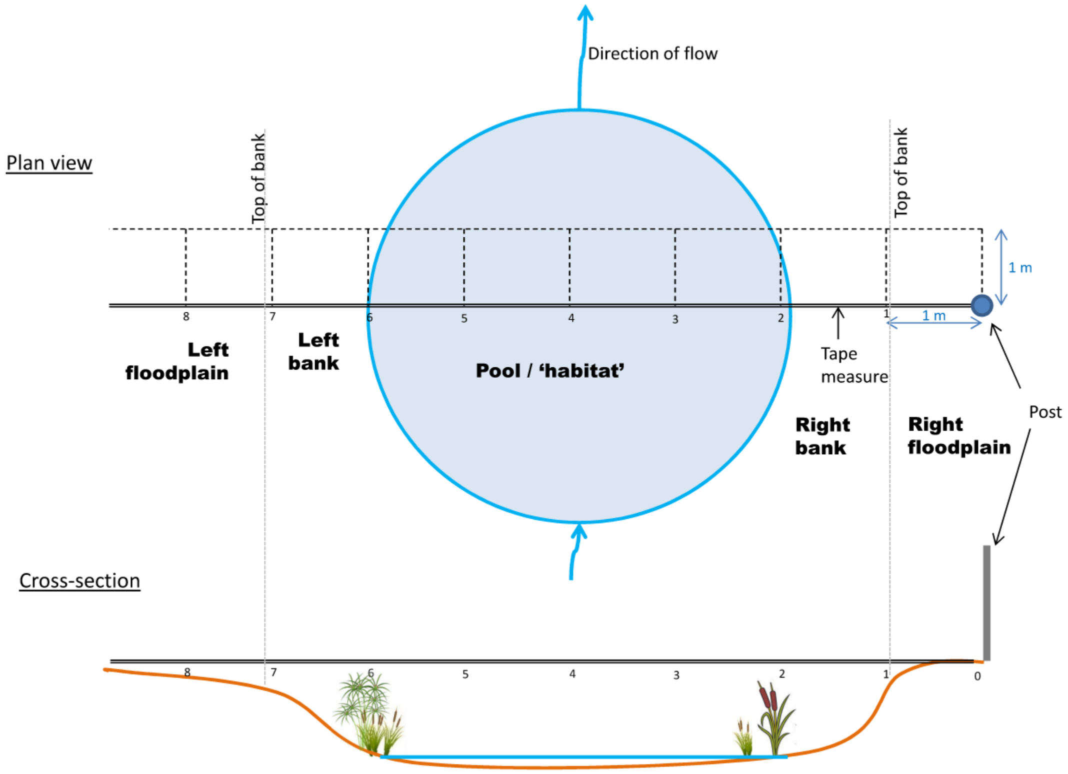

Figure 2.2 Vegetation transect method

3 Results

3.1 Survey overview

The objectives and results of the Blitz were threefold:

1. Effectively engage the EMLR community in participating in the implementation of the EMLR WAP
2. Collect ecological information with appropriate quality control to enable reporting against WAP objectives
3. Collect baseline information suitable to inform key DEWNR management questions.

A summary of which sites were surveyed on the day, and which were surveyed on subsequent dates, are presented in Table 6.1 (Appendix A).

Macroinvertebrate samples were collected and sorted for all sites at which water was present and sufficiently deep on the day of the BioBlitz. The voucher samples were identified after the BioBlitz by SA Water. (Note: The Willyaroo pool voucher sample was not taken for verification).

Physical habitat surveys were undertaken at all but one of the sites at which macroinvertebrate samples were collected on the BioBlitz day, with one dry site also surveyed. The remaining sites were surveyed by staff over the following week. Very little rain fell in the weeks leading up to the BioBlitz, meaning that it would have been some months since any surface water run-off was generated. However there was more significant rainfall in the week between the BioBlitz and when the remaining sites were surveyed, so that more water was present than on the day of the BioBlitz.

3.2 Macroinvertebrates

Macroinvertebrate samples were collected and sorted from all sites where water was present on the day of the BioBlitz. Data analysis and results are presented in Appendix B. A total of 108 different taxa were recorded. Preliminary analysis showed differences in species richness collected at the different sites with the sample at Quarry Road having the highest richness. Sites and habitats (pools and riffles) also showed differences in community composition and proportion of trait groups expected to respond to different flow conditions.

Across all sites the pools and riffles were significantly different in species composition, but separation of the habitats were lower when based on trait groups alone. It anticipated that there will be a greater proportion of flow-associated trait groups with increases of low flows throughout the catchment. However some results may be confounded by changes in water chemistry and it is therefore important to monitor water quality concurrently with macroinvertebrates. Nutrient levels, not collected as part of this trial, would be a valuable addition to current understanding. A review of methods for collecting should be considered as there has been concern expressed by the EPA regarding the reliability of field testing kits (P Goonan (EPA) 2016, pers comm, 26 July). Comparisons between laboratory tested and field testing kit data may be a way to ensure reliability of community collected data for future use.

3.3 Water chemistry and flow

Gauge boards were not installed at the sites where there is continuous streamflow monitoring, therefore no depth was recorded for these sites. A separate report has been prepared by DEWNR Water Resource Monitoring Unit documenting location and elevation of the gauges.

Of the sites with gauge boards, six were dry when monitored. At three of the sites with gauge boards, water was present but it was below the level of the gauge board. The Strathalbyn site was dry when visited prior to the BioBlitz and would have been dry on the BioBlitz day (6th May) but was full on the day it was monitored (17 May) with the water level above the height of the gauge board. The Strathalbyn site is likely to have filled due to local run-off from the surrounding urban areas rather than non-urban run-off. This is likely as no water was recorded at other sites monitored on the same day, that were dry prior to the BioBlitz.

The main purpose of collecting the gauge data is to inform the hydrological modelling of low flows and implementation of management actions. For this purpose, cross sections are required for each gauge in order to convert stage height to a discharge rate (litres/second); therefore no analysis of the data is presented here.

Water quality results are presented in Appendix D.

3.4 Physical habitat and vegetation

3.4.1 Photopoints

The photopoint has been recorded in the Goolwa to Wellington Local Action Planning (GWLAP) photopoint database and DEWNR corporate system. Photopoints are most useful for recording change over time and therefore no analysis of the photopoints has been undertaken at this stage.

3.4.2 Abundant species

Surveys of the most abundant species were undertaken at all sites (although not all sites were surveyed on the day of the BioBlitz due to time restrictions and these were surveyed in the week following by staff). Twenty three species were recorded as part of these surveys (at more than 1% cover), ten of which were native. A preliminary analysis of this data is presented in Appendix C which uses a classification of plants by their environmental water requirements (water plant functional groups, WPFG), a method that has been found to be useful for understanding vegetation in light of changes to flow regimes (Casanova 2011).

The sites in the mid and lower Doctors Creek Catchment were dry at the time of the BioBlitz and were dominated by species that indicate these sites are commonly dry. This is in contrast to sites in the upper Doctors Creek Catchment which were also dry at the time of the BioBlitz but the plant species indicates the sites are saturated for 8 to 10 months a year. The analysis also group sites where water was present and the vegetation indicates water levels are likely to remain stable (not fluctuating); the water level in these sites was mostly shallow (<0.5 m) and is likely to be maintained by groundwater. Another group of sites included both wet (Willyaroo and Paris Creek downstream) and dry (Ballandown Road) habitats but the vegetation indicates a more variable flow regime occurs.

3.4.3 Vegetation transects

Vegetation transects were established at seven sites. Vegetation transect data is the only quantitative method trialled, which is able to detect quantitative change in the location of plant species in relation to changes in flow. Given time constraints, data are not analysed here, but methods for using the data in future are discussed in Section 4.3.4.

3.5 Data storage

A copy of all raw data collected has been supplied to Natural Resources SAMDB. Data has also been loaded into DEWNR's data storage systems as follows.

Macroinvertebrates

Macroinvertebrate data has been prepared in the BDBSA Electronic Load Tool template and stored in the DEWNR BioDataStore awaiting load. It will be loaded by DEWNR staff when the invertebrate function has been finalised in BDBSA. Prior to load any NSXCODES unavailable at time of preparation will need to be updated. A list of these required NSXCODES has been provided for creation.

Vegetation

Vegetation data has been loaded into the Biological Databases of South Australia (BDBSA) under the survey ID SU1088 - ANGAS RIVER BIOBLITZ.

Photopoints

Photopoint images have been stored in the DEWNR BioDataStore for ease of access. No metadata in addition to that included in the file name has been supplied at this stage. This is an interim arrangement until DEWNR image storage systems are reviewed.

3.6 Participant evaluation

Twenty volunteers participated in the BioBlitz and 15 (75%) filled out an evaluation. Several of the participants were not able to stay for the entire BioBlitz and left at lunch time. 43 % of the participants had attended previous training in the topics and 20% had on-the-job experience. Ages ranged from 24 to 76. The participant evaluation results are presented in Appendix C.

Overall the results indicated a high level of satisfaction with the event and the information presented, and nearly all respondents felt they had increased their awareness and knowledge of the topic as a result of participating. 100% of responders said the event was well run and would recommend the event to others. A lower proportion (69%) of respondents indicated their skills and knowledge to change how they do things was increased, and 46% indicated they had increased their capacity and skills to change how they do things. 54% of responders were undecided on this point. These results indicate that, while the BioBlitz had improved people's knowledge, it had not given the majority sufficient confidence to apply the methods on their own. This conclusion is supported by the participants' comments, which included comments to the effect that they felt they did not assist greatly in the collection of the data, and that the field work was too rushed to provide them with the training they needed to implement the methods.

The feedback also indicated some concern by participants about how the macroinvertebrate collection and sorting methods used in the BioBlitz differed from methods they have been using as part of the existing CSWQMP (which they generally referred to as Waterwatch).

Their concerns included:

- The method being taught was beyond their skill level
- An awareness of the limitations in using the data they have being collecting (e.g. under the CSWQMP) due to less scientific/monitoring rigor.
- They would be expected to apply this method in future for their CSWQMP monitoring, and how changing the methods would affect the continuity of the data.

Survey responses are presented in Appendix E.

4 Conclusions and recommendations

4.1 Overall evaluation

The project aimed to trial the citizen science approach to:

1. Effectively engage the EMLR community in participating in the implementation of the EMLR WAP
2. Collect ecological information with appropriate quality control to enable reporting against WAP objectives and
3. Collect baseline information

The project was successful in achieving the first aim for the targeted group of landowners and catchment groups invited, with twenty volunteers participating in the BioBlitz and feedback indicating a high level of satisfaction with the event and increased knowledge about the topic. The second and third aims were achieved for the macroinvertebrate and vegetation data, however the hydrological and water quality data was less reliable with differences in the instruments used in the field and placement of some of the gauge boards. These issues are easily rectified by checking meters are calibrated consistently across agencies. Several gauge boards will be moved to improve measurements in the future.

The project also achieved the first, second and third intended outcomes of the project:

- Increased ability to report the status of aquatic ecological assets in high demand zones through the collection and collation of baseline condition data
- An informed section of the community engaged in water planning and contributing to water management outcomes
- Increased knowledge and understanding on how to engage the community to aid in the collection of data of suitable quality for evaluation against WAP objectives

The project provided the project team with valuable knowledge and understanding that will assist in engagement of the community in future WAP data collection. In particular, the project provided an improved understanding about how government, commity organisations and universities can work together to achieve project outcomes. The project showed that the non-government organisations were a critical link to the community and made an invaluable contribution to resourcing and running of the event. The communication between DEWNR and community groups could have been better, particularly in the planning phase. As this was the first event of this kind it is anticipated that this would significantly improve simply throught the knowledge gained of how to run such an event. Through the participant (volunteer and staff) evaluation, the project has gathered feedback that has guided the recommendations provided in Sections 4.2 and 4.3 below.

Through ongoing discussions between the authors and participating experts in the BioBlitz, the importance of having a clear question to answer when participating in citizen science activities has been emphasised. This Biobliz sought to gather baseline data to increased ability to report the status of aquatic ecological assets in high demand zones through the collection and collation of baseline condition data. Further events to assess changes to this baseline would again need to have clearly defined questions with joint ownership of community members and DEWNR.

4.2 Recommendations for future citizen science events

The general aim of the BioBlitz was to test a citizen science approach using a contributory approach to citizen science. A contributory approach was chosen given that the community hadn’t encountered the methods used before and their appropriateness for use with community members was unknown. Through ongoing discussions with participants it is hoped that a more collaborative approach can be designed which entails greater ownership by the community and a collaborative model.

Aspects of the Angas River Catchment BioBlitz that participants felt worked well included:

1. Having a mix of presentation and practical field work
2. Having a full day event where participants could swap activities in the middle of the day
3. Successfully engaging a good number of participants
4. Awareness raising about the Angas River Catchment, monitoring methods and purpose.
5. Community members working alongside DEWNR staff and external experts

Areas that could be improved:

1. The publicity materials and information session more clearly communicate the purpose of the event.
2. Simplifying the methods to enable volunteers to collect more of the data or having less sites so that more time could be spent on learning and practicing the new methods.
3. While it was good to trial several methods at once to provide an overview of all methods, future events could focus on fewer indicators allowing participants to focus more on a particular one.
4. Overcoming barriers to volunteer participation; in the case of this event, the workplace health and safety issues around working in or near water prevented volunteers being able to collect macroinvertebrate samples at most sites so participants were only able to watch samples being collected.
5. Having dedicated sessions for plant and macroinvertebrate identification, and/or additional materials to assist with identification of common vegetation and macroinvertebrates, and using common names where possible.

It was not an intended outcome of the BioBlitz for volunteers to be able to learn the macroinvertebrate identification skills in the one day and none of the participants felt they would be confident to undertake the macroinvertebrate sorting methods alone. If future monitoring was to require the same level of identification then expert assistance would be an on-going requirement.

A longer lead time would have assisted in the planning of the Angas River Catchment BioBlitz (e.g. more time to identify sites, position gauge boards, engage with community groups and identify and overcome the issues around collecting samples). However, having prepared the materials for this event and gained a better understanding about how to run such an event, a future river monitoring BioBlitz would require less effort to develop. In addition, more involvement of community groups and non-government organisations in the planning could have assisted in the identification of sites and improved interest and ownership of the event.

An additional recommendation arising from the Angas River Catchment BioBlitz is to address community participants' expectations about how the different data they are involved in collecting is and can be used. Several of the participants expressed concern and confusion about the differences between the methods used in the BioBlitz and those they have previously used. They were unsure about what methods they should use in the CSWQMP in the future and the usefulness of the data they have been collecting to date.

While an end of day wrap-up was planned, many of the participants left early and there was not a formal close and 'where to from here'. Future events should ensure that time is dedicated to closing the day and acknowledging the participants' contribution. Alternatively, a follow-up e-mail within a few days of the event could assist to provide a wrap-up, particularly for those who left early.

Given the trial nature of the BioBlitz it was not possible to provide certainty around ongoing monitoring activities, which caused concern for some participants at the time of the event. A follow-up presentation providing the results in this report and discussing the ways forward for future monitoring activities is planned by DEWNR and should help to alleviate these concerns. A tiered approach to assessment such as those presented in Figure 4.1Figure 4.2 will be presented to community for comment, to enable a collaborative approach to monitoring to be developed for the future.

4.3 Monitoring protocols and methods

4.3.1 Macroinvertebrate monitoring

Participant feedback indicated the community members did not feel sufficiently confident to undertake the EPA sorting method without expert guidance. However, it is likely they would be able to undertake the collection method on their own, provided the issues relating to working in and around water could be overcome. Therefore it is recommended that wader training and appropriate safety resources and procedures be provided. A video has been prepared to assist community members undertake this type of collection in the future. Collections could also be videoed and checked for quality control.

A simplified sorting method could focus the sorting on identifying key taxa to family level that are relatively easy to identify and have been shown to respond to increased zero flow days (Maxwell et al. 2015). Twelve taxa are presented in Table 4.1 from trait groups that are expected to decrease with more zero flow days and trait groups that are expected to increase with more zero flow days. Future training could focus on these families and a photographic guide or reference collection of specimens prepared to assist based on taxa collected locally and accurately identified. Volunteers could also photograph the macroinvertebrates from these families and send the photos to someone with expertise to verify their identification. The data analysis could look for changes in presence/absence of trait groups and families and/or abundance of each.

Table 4.1 Recommended* macroinvertebrate families for monitoring changes in number of zero flow days

Family	Common name	Trait group[2]	Expected response to more zero flow days
Leptophlebiidae	Mayfly	f	Decrease
Psephenidae	Water penny beetle	h	Decrease
Elmidae	Riffle beetle	h	Decrease
Gripopterygidae	Stonefly	h	Decrease
Leptoceridae	Longhorned caddisfly	f	Decrease
Baetidae	Mayfly	f	Decrease
Physidae	Bladder snail	c	Increase
Lymnaeidae	Snail	c	Increase
Hydraenidae	Minute moss beetle	c	Increase
Chironominae	Non-biting midge	a	Increase
Corixidae	Water boatmen	a	Increase
Veliidae	Broad-shouldered water strider	a	Increase

*Ongoing discussions with the EPA are occurring to fine tune this list for future collection. These should be considered indicative at this present time.

The simplified monitoring approach outlined above may be sufficient to inform qualitative reporting against the EMLR WAP whilst engaging the community in monitoring and evaluating the implementation of the WAP. Confidence in the data gathered could be improved by sending off voucher specimens for laboratory

[2] See Table 6.2

identification (i.e. from the families in Table 4.1) and/or having an expert assist with the sorting and identification. The EPA have indicated they would be unlikely to use the data collected without expert involvement in the sorting and identification. DEWNR also require confidence that specimens are being correctly identified. Given the community participants were not confident with the sorting and identification aspects, an option could be to have community members undertake the sample collection and have trained experts do the sorting and identification to standard levels of taxonomic resolution across all macroinvertebrates families. This approach would require additional resourcing but would provide sufficient confidence in the data to enable it to be used to inform water resource planning.

It is recommended that at a minimum macroinvertebrate data is collected in spring to assist with ongoing assessment of WAP objectives. Samples should be collected from pools and riffles, where both habitats are present.

Ultimately, the methods that are used in future monitoring will be driven by the level of investment in the monitoring and the desired level of confidence in the results and the key questions to be answered. Figure 4.1 demonstrates this relationship and the potential methods outlined above.

Trait groups represent groups of taxa which are expected to respond in a similar way to environmental conditions based on shared characteristics or traits. Names have been given to each of these groups to help describe how they respond to their environment and what general strategies are employed for survival. Resilient taxa are those that by definition are able to return after pressures abate (they generally have strong dispersal adaptations) whereas resistant taxa are those that in general resist pressures but remain in the environment and have adaptation such as resistant egg stages. Through work undertaken by the Goyder Institute general prediction about how these groups might respond to changes in the intermittency (the amount of time a catchment is connected) have been made.

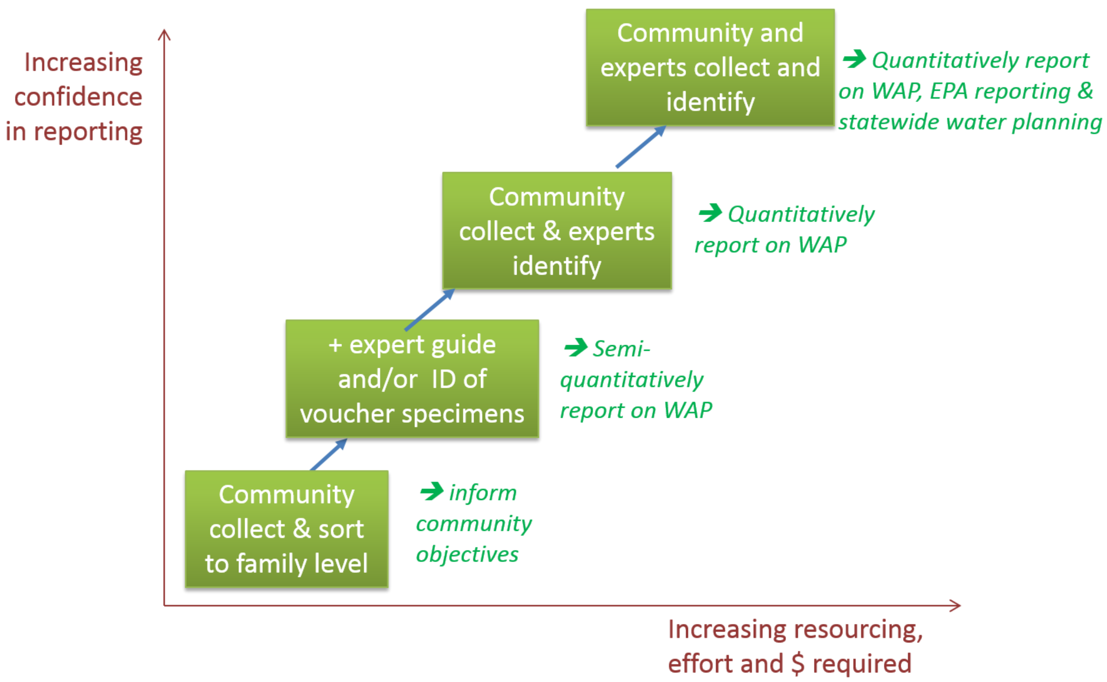

Figure 4.1 Macroinvertebrate survey approaches and applications of the data

4.3.2 Vegetation

Whilst the most abundant species method was relatively quick and did not require high levels of plant identification training (as the method was intended only to record the most abundant species), participants in the

BioBlitz found that it was difficult to visualise the boundaries of the habitat zone and whether to include fringing or bank vegetation. It is therefore recommended that future monitoring record the pool (or channel) vegetation and fringing (or bank) vegetation separately. The accuracy of this method and confidence in future citizen science data collection would be improved by the provision of identification resources such as a short booklet or flier for the most common species, a herbarium and/or a support person who can assist to identify samples or photographs.

Participants also tended to want to record all species present within a site when doing the abundant species survey. In light of this, participants may want to focus on the transect method, which has the potential to provide more quantitative data suitable for detecting changes over time. Future monitoring could focus on recording only the five most abundant species, however the additional data may be even more useful if biodiversity monitoring is an objective of the community involved.

The use of the vegetation transect data would be greatly enhanced by surveying the elevation profile of the transects and linking this data with the water level monitoring. Replicating the transects at each site would also improve the confidence in the data. Key species which are likely to respond to changes in flow regime have been identified through recent work done by the Goyder Institute, this component was lead by SARDI Aquatic sciences (Maxwell et al. 2015).

Late spring to early summer is ideal for watercourse vegetation monitoring as most species will have identifiable features, however spring is the most beneficial for yearly macroinvertebrate monitoring, separate timing for these assessments may be beneficial. At minimum, the surveys should be undertaken at a consistent time of year, as most species will fluctuate in cover over the course of a year. Monitoring should be every one to two years. Most species are likely to fluctuate in presence and cover between years in response to short term climatic variability and therefore the vegetation data will need to be collected and interpreted in conjunction with climatic and hydrological data. The preliminary analysis (Appendix C) demonstrates that the data can be interpreted regardless of whether the site is wet or dry at the time of the survey.

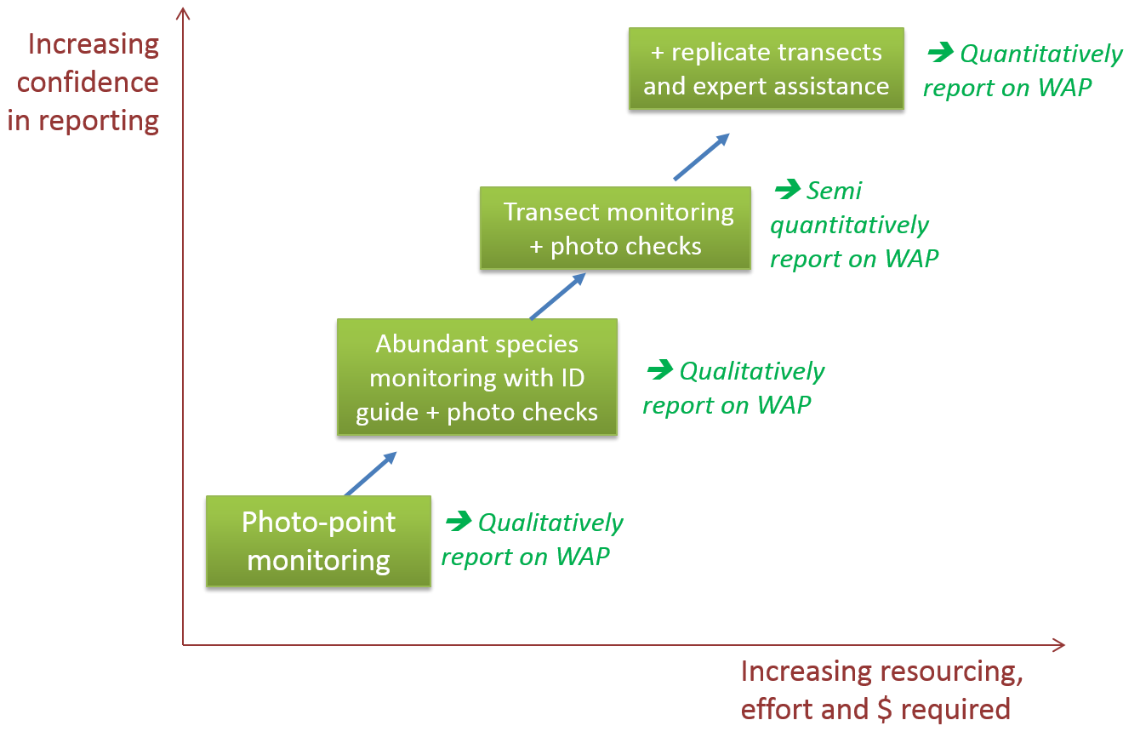

Figure 4.2 Vegetation survey approaches and applications of the data

4.3.3 Hydrology and water quality

Water quality monitoring is currently undertaken by EPA, CSWQMP and DEWNR. Water chemistry data was collected as part of the BioBlitz to provide contextual information for the macroinvertebrate data analysis. One issue that did arise in the BioBlitz was that different meters were used on the day that did not both record the same full suite of parameters, were set to different units, and one is likely to not have been properly calibrated for recording pH. In future all water quality meters should be tested for consistency in a bucket of water prior to use on the day. Given that macroinvertebrates respond to flow as well as water quality, particularly nutrients, it would be of great benefit to collect nutrient samples as part of the suite of variables collected. This could potentially be done by volunteers and sent to a recognized laboratory for processing. However, the additional cost for this work would warrant further assessment for its inclusion.

Cross-sections need to be surveyed for each gauge board installed as part of this project in order to convert the stage height data into a discharge (flow rate) value. Gauge height data can be collected prior to the surveying of the cross-sections and later converted when the stage-discharge relationship has been determined. The gauge (stage) height data collected by the community can then be used to assist in ground-truthing and refining the hydrological modelling of low flows with a better spatial coverage than the current network of continuous gauge stations, resulting in more accurate predictions and monitoring of flows (Greenwood et al. 2016).

It is proposed that community monitoring of water level should include recording the observed water level, the time, date and location and must also include a date-stamped photograph of the gauge board for data quality assurance. The photograph will ensure data is of sufficient quality to be incorporated into the State-archive (Hydstra) for future use (Greenwood et al. 2016).

Opportunistic measurements of water level collected by the community at any time of year may be used for flow monitoring as outlined above. However, efforts should initially be focused on quantifying the characteristics of early and late season low flows which represent different surface-groundwater processes. This could entail high frequency of monitoring by community members of a local site following rain events early in the season (e.g. autumn to early winter) to identify when low flows commence and how often they occur and less frequently (e.g. monthly) at the end of the season (e.g. late winter to spring). Observations of no flow will also be important to confirm patterns of low flow variability

4.3.4 Interpretation of the data

The results presented in this report have been prepared based on a single baseline data collection event, however the methods have been designed to monitor change over time for the purposes of reporting on the implementation of the EMLR WAP. The use of the species classification (macroinvertebrate trait groups and water plant functional groups) provides a more powerful tool to interpret the data than species presence/absence alone and should be used for future data interpretation. However the following key points limit the application of the proposed methods:

- The classifications for vegetation and macroinvertebrate groups are based on the best available knowledge at a point in time and impose discrete categories (Maxwell et al. 2015, Casanova 2011). The classification of species (or taxanomic units) may be updated over time; such revisions could include classifying single species differently in different parts of its distribution (e.g. depending on rainfall) or splitting groups. Trait groups may also not be static if new data come to light.
- Although flow regime has been recognised as the ‘maestro’ or ‘master’ variable in aquatic communities of ecological communities (Poff and Zimmerman, 2010) it is not the only driver of macroinvertebrate or vegetation composition. Other factors, particularly land management, water quality and climate, influence species composition and therefore data should be interpreted in conjunction with water quantity where possible.

Macroinvertebrates

Macroinvertebrate data collected as part of this project can be directly related to the key macroinvertebrate data set used statewide by the EPA and used to establish macroinvertebrate trait groups (Maxwell et al. 2015). Macroinvertebrates are key responders to flow and are likely to show responses over a shorter timeframe than vegetation. There are key trait groups which are expected to increase with improved connectivity and those expected to decrease. Species richness is also expected to increase in response to improved connectivity in streams. Quarry Road, one of the sites that has the longest time connected in the Angas River Catchment was also the site with the highest species richness. Within these trait groups there are also key species that are expected to increase or decrease in response to changes in flow. These data can be used directly to update models produced by Maxwell et al. 2015 to assess WAP objectives.

Vegetation

Three methods of vegetation data collection (photopoints, abundant species and transects) have been trialled with monitoring sites established and baseline data collected as part of the Angas BioBlitz. The photopoints can be easily used to provide qualitative reporting of broad changes in vegetation cover and species composition that can be explained by flow regime. Photos are easily understood by a wide audience and can also be useful to explain more analytical data interpretation. Quantitative methods have also been developed for analyzing photopoint data but have not been trialled for watercourse vegetation monitoring in the region.

A preliminary analysis of the abundant species data demonstrates how this method, in conjunction with the WPFG classification, can provide an understanding about the current flow regime of the sites. On-going monitoring of these sites using this method should enable semi-quantitative reporting against the WAP. In particular the analysis would be looking to identify shifts in the dominance of different water plant functional groups (see Table 6.5) that can be related to changes in flow regime. For example, at sites currently dominated by species classified as terrestrial damp, a shift to dominance of terrestrial dry species would be indicative of an increase in the number of zero flow days, while a shift to amphibious species would be indicative of a decrease in zero flow days (more flows).

Transect data will provide more quantitative data useful for detecting change over time. Increases in number of transects within sites would improve confidence in the generality of changes overtime. As with the abundant species method, the transect data analysis will be looking for changes in dominance of different WPFGs over time, but at a finer level of detail, particularly detecting shifts in WPFGs across the watercourse gradient. For example, a shift of vegetation classed as terrestrial damp down gradient (i.e. from occupying the banks to the channel bed) would be indicative of reduced flows at a site, whilst an expansion of amphibious or perennial emergent up gradient would indicate increased flows. The elevation of the transects could be surveyed and this and the vegetation data used in conjunction with gauge board monitoring to provide a better understanding of the relationships between flow regime and water plant composition, building on earlier work undertaken as part of the Goyder Institute project (see Sect. 5 in Maxwell et al. 2015).

Hydrology

Water quality can be highly variable over time and the data collected as part of this monitoring is intended to provide contextual information for interpretation of the macroinvertebrate data. Therefore this water chemistry data, collected in its current form, will not be used for reporting against the implementation of the WAP. As discussed earlier collection of water quality data, including nutrients, may aid in the interpretation of changes to macroinvertebrate communities.

The gauge height data also provides contextual information for interpreting both the macroinvertebrate and vegetation data, and can also be used directly to plan and report on the implementation of the WAP. As noted in Section 4.3.3 above, cross-sections are required in order to convert the gauge height to flow rate and therefore use the data for hydrological monitoring and modelling. Greater spatial resolution in the flow gauging network will enable water managers to identify the degree of variability in sub-catchment flows than can currently be detected through the small number of permanent flow gauges. This will assist with verifying resource estimates and prediction of flow at ungauged sites, enabling management actions to be targeted to where they will be most effective and subsequently reporting directly on the effectiveness of management actions (for more detail see Greenwood et al. 2016).

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6 Appendices

A. Summary of monitoring sites

Table 6.1 Sites survey summary

Site name		Easting	Northing	ID	Land-holder	Macroinvertebrate collection		Physical habitat			
						Pool	Riffle	Flow	Photo point	Abundant species	Transect
Angas Weir		304632	6100928	ANG1	Private	06/05/16	06/05/16	Continuous	06/05/16	06/05/16	06/05/16
Ballandown Rd		318449	6084646	0	Public	Dry	Dry	Continuous	12/05/16	12/05/16	NS
Bugle Range Rd US confluence	New	305915	6108361	0	Public	Dry	Dry	17/05/16	17/05/16	17/05/16	17/05/16
Bugle Ranges Rd DS confluence		306051	6108353	0	Private	Dry	Dry	17/05/16	17/05/16	17/05/16	17/05/16
Children’s reserve		308391	6101405	0	Public	06/05/16	Dry	17/05/16	17/05/16	17/05/16	NS
Crystal lake		303077	6104889	ANG2	Public	06/05/16	06/05/16	06/05/16	06/05/16	06/05/16	NS
Doctors Creek , Gemmel Rd		305789	6104927	ANG11	Private	Dry	Dry	06/05/16	06/05/16	06/05/16	NS
Doctors Creek Lower, Macclesfield Rd		305051	6101849	0	Public	Dry	Dry	17/05/16	17/05/16	17/05/16	NS
Doctors Creek, Schofield Rd -		306189	6106739	0	Private	Dry	Dry	17/05/16	17/05/16	17/05/16	17/05/16
Paris Creek DS		302603	6100672	ANG5	Private	06/05/16	06/05/16	06/05/16	06/05/16	06/05/16	NS
Paris Creek LFB site		301411	6100214	ANG7	Private	06/05/16	Too low	Continuous	06/05/16	06/05/16	NS
Quarry Rd		301030	6107736	ANG3	Public	06/05/16	06/05/16	06/05/16	06/05/16	06/05/16	NS
Rushmore Reserve		305835	6095929	ANG9	Public	06/05/16	Dry	06/05/16	06/05/16	06/05/16	06/05/16
Angas River, Strathalbyn		307982	6097398	0	Public	Dry	Dry	17/05/16	17/05/16	17/05/16	NS
Sunnydale road		300223	6095832	ANG8	Public	06/05/16	Dry	06/05/16	06/05/16	06/05/16	06/05/16
Angas River, Willyaroo		310623	6093917	ANG10	Private	06/05/16	06/05/16	Continuous	06/05/16	06/05/16	06/05/16

Dry = dry on 6/5/16, Continuous = DEWNR continuous streamflow monitoring available for this site, NS = no survey, DS = downstream, US = upstream, LFB = low flow bypass

B. Macroinvertebrate data analysis and results

The macroinvertebrate data (vouchered specimens) was analysed using both species and trait group (after Maxwell et al. 2015, see Table 6.2) data by habitat and by site. Principal Components Ordination (PCO, PRIMERv6 and PERMANOVA 2006) using S17 Bray Curtis similarity and presence/absence transform for species analysis and fourth root transform of the richness of species in each trait group for the trait group analysis.

Table 6.2 Macroinvertebrate trait groups identified through trait analysis (Maxwell et al. 2015)

Trait group	General Traits	Example Macroinvertebrate groups
Trait Group A	Resistant, Obligate Aquatic, Flow Avoiders	Oligochates and Hemipterans
Trait Group B	Resistant, Low dispersing, Flow Avoiders, terrestrial eggs	Coleoperans, Some Dipteran families and Collembolans
Trait Group C	Resistant, Low dispersing, flow avoiders, aquatic eggs	Gastropods, Lepidopterans
Trait Group D	Resilient/resistant, gill respiring, obligate aquatic	Amphipods, Decapods and gastropods
Trait Group E	Resistant, Predatory, Salt tolerators	Coleoptera, Odonata, Trichoptera
Trait Group F	Resilient, gill respiring, flow obligates	Ephemeroptera, Trichoptera
Trait Group G	Resistant, spiracle respiring, flow obligates	Some Dipteran families
Trait Group H	Resilient, detrital feeding, facultative flow responders	Some Dipterans, Trichoptera, Plecoptera

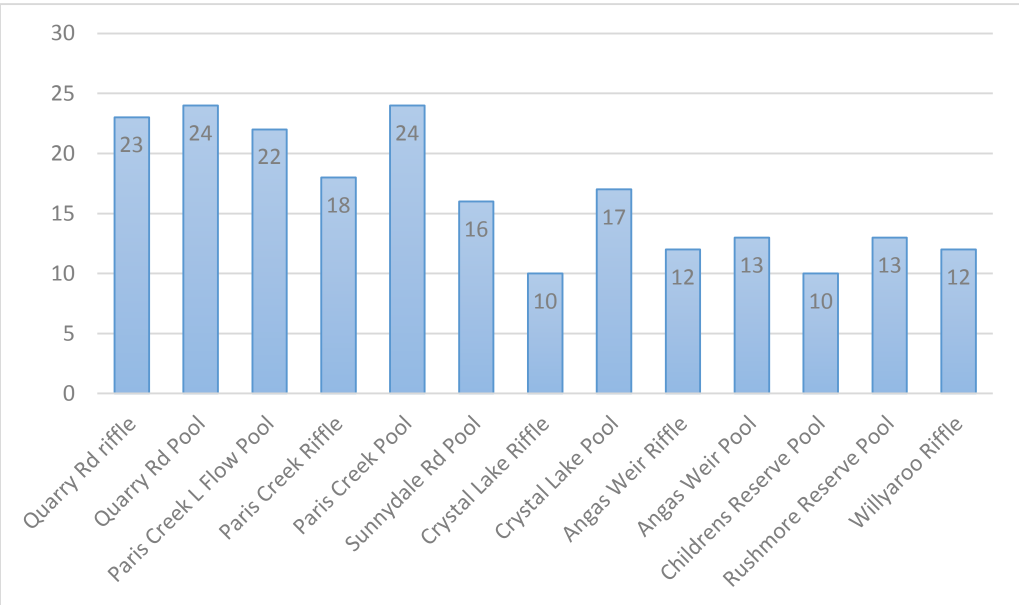

Figure 6.1 Macroinvertebrate taxa richness for each sample

The site with the highest taxa richest across pool and riffle habitats was Quarry Rd with the lowest site richness recorded at Children's Reserve where only pool habitat was present. Paris Creek had the second highest taxa richness recorded with 18 taxa recorded in the riffle and 24 taxa recorded in the pool. These two sites are generally higher up in the Angas Catchment and potentially have greater connection of habitats over time ie less zero flow days.

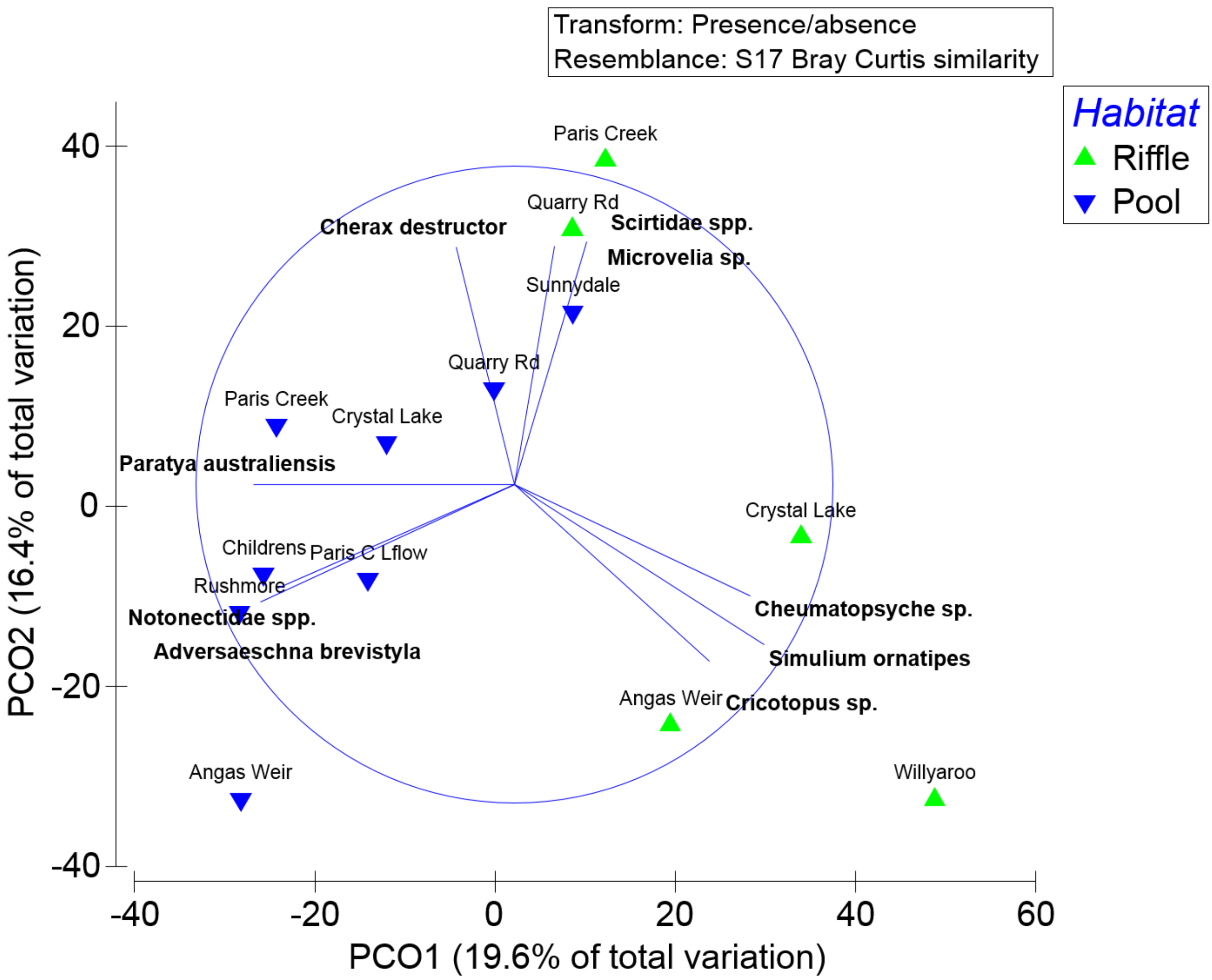

Figure 6.2 PCO of macroinvertebrates species presence absence in Pool and Riffle habitats

The principal component analyses based on the presence or absence of individual taxa (Figure 6.2) shows that pools and riffles separate as having different community composition. ANOSIM (Analysis of Similarities) confirmed that pools and riffles were distinct (ANOSIM Global R = 0.407, p = 0.05). Taxa which were associated with the Riffle samples were *Cheumatopsyche sp.* (Free living Caddisfly), *Simulium ornatipes* (Black Fly), and *Cricotopus sp.* (Non-biting midge). The majority of pool samples grouped to the left of the plot and were associated with Notonectidae spp. (Back swimmers), *Adversaeshna brevistyla* and *Paratya australiensis* (shrimp). There were however, two riffle and two pool samples which were more similar to each other than to the other pool and riffle groups. These samples were the Quarry Rd and Paris Creek riffles and the Quarry Road and Sunnydale Rd Pools. These samples were associated with *Scirtidae spp.*, *Microvelia sp.* and *Cherax destructor* (yabbies'). This result is perhaps indicative of smaller riffle habitats which had close association with pools. It may also indicate that there are other factors that are likely to influence the composition of sample such as water quality.

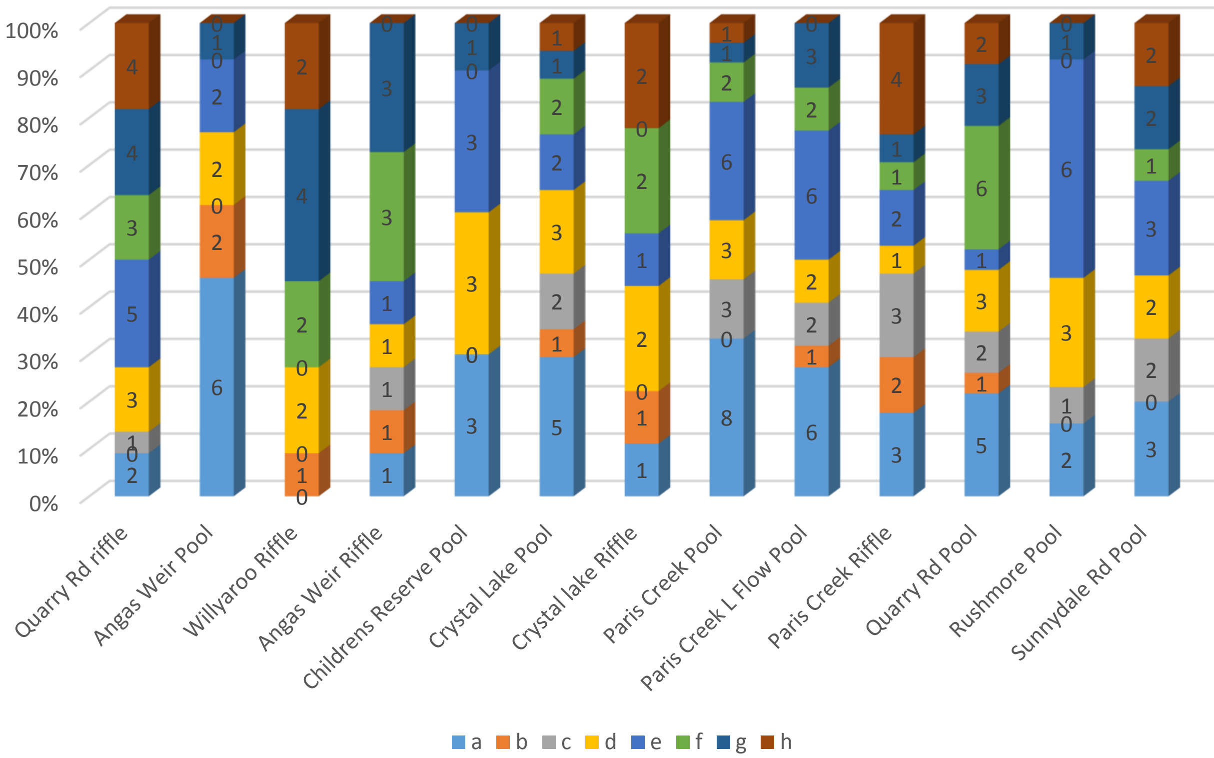

Figure 6.3 Trait group composition of macroinvertebrate samples

Figure 6.3 shows the proportion of each Trait Group present in each sample. Trait groups represent groups of taxa which are expected to respond in a similar way to environmental conditions based on shared characteristics or traits. Names have been given to each of these groups to help describe how they respond to their environment and what general strategies are employed for survival. Resilient taxa are those that by definition are able to return after pressures abate (they generally have strong dispersal adaptations) whereas resistant taxa are those that in general resist pressures but remain in the environment and have adaptation such as resistant egg stages. Through work undertaken by the Goyder Institute, general predictions about how these groups might respond to changes in the intermittency (the amount of time a catchment is connected) have been made. Resilient, Detrital feeding, Facultative flow responders (Trait Group H) were present in all riffle samples collected across the catchment. This trait group was also present in the Quarry Rd Pool, Paris Creek Pool and the Crystal Lake Pool. Resistant, Obligate Aquatic, Flow Avoiders (Trait group A) was in highest proportion at the Angas Weir Pool accounting for greater than 40% of the sample. Resistant, Predatory, Salt tolerators (Trait Group E) were also more prevalent in slower flowing habitat with the highest proportions found in the Rushmore Reserve Pool, the Paris Creek Low Flow Pool and the Paris Creek Pool.

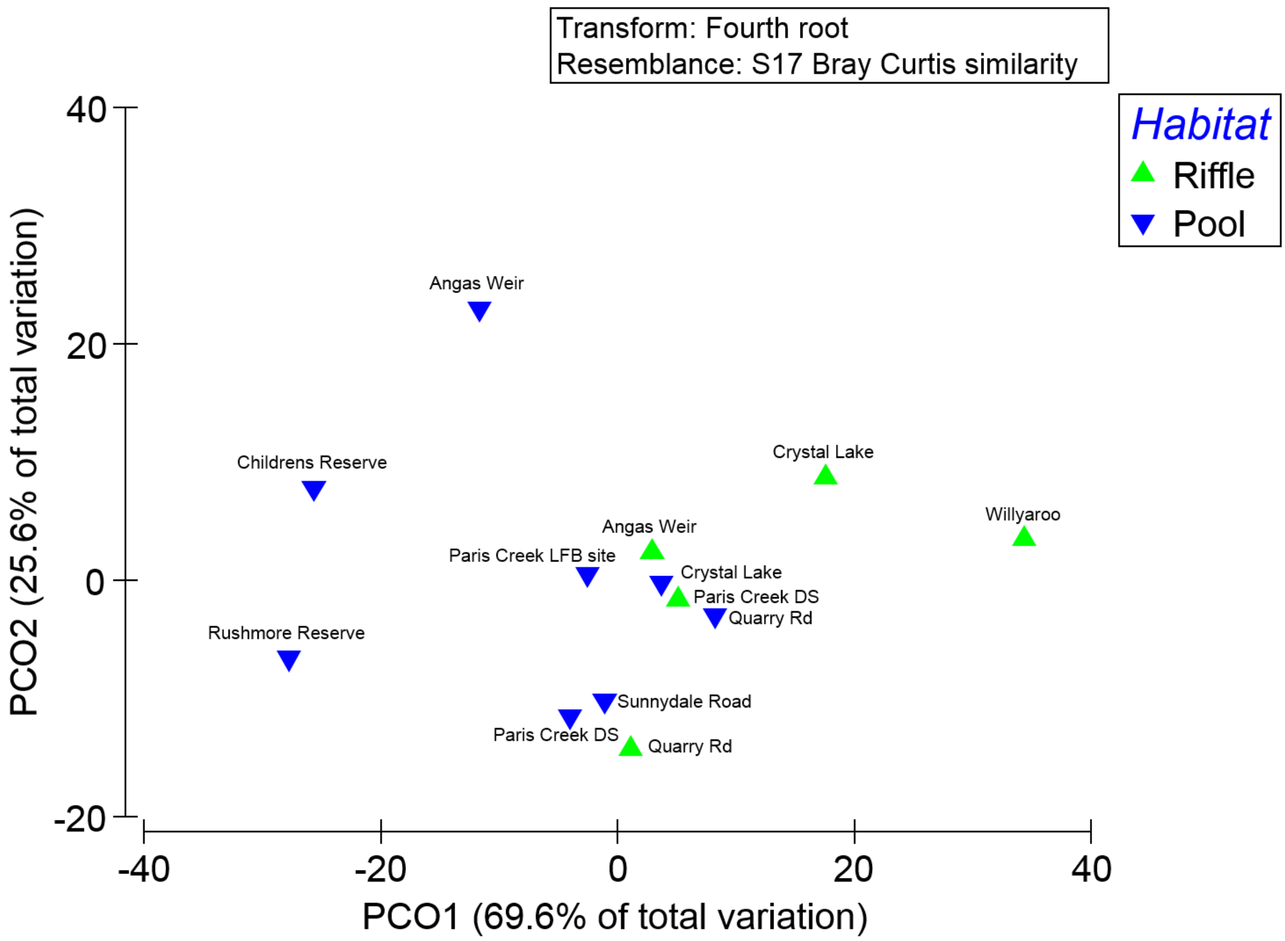

Figure 6.4 PCO of macroinvertebrates trait groups and habitat Pearson Correlation constrained at R = 0.5)

Separation between pool and riffle habitats based on trait groups only, showed less separation between habitats than with species data (Figure 6.4). ANOSIM Global R = 0.154, p = 0.12. Resistant/Resilient, gill respiring, obligate aquatics (Trait Group D) contributed to the similarities characterising the similarity within both pools and riffle habitats. SIMPER analysis showing which groups were associated with each habitat identified the greatest contribution to the similarity within Pool habitats were: Resistant, Obligate Aquatic, Flow Avoiders (Trait Group A), Resistant/Resilient, gill respiring, obligate aquatics (Trait Group D) and Resistant, predatory, salt tolerators (Trait Group E) (Table 6.3). Trait groups which contributed most to the similarity within riffle habitats were trait groups Resistant/Resilient, gill respiring, obligate aquatics (Trait Group D), Resilient, gill respiring, flow obligates (Trait Group F), and Resilient, detrital feeding , facultative flow responders (Trait Group H). Trait groups which characterised the differences between pool and riffle samples were Trait Group H and F which were predicted to decrease with decreasing amounts of flow, both were higher in riffle samples. Resistant, Low dispersing, flow avoiders (Trait Group C) and Resistant, Obligate aquatic flow avoiders (Trait group A) were both found in higher abundance in pool samples than riffle (Table 6.4). The Quarry Rd Pool sample was the most flowing pool sample being high up in the catchment it was interspersed with riffle habitat likely contributing to these similarities.

Table 6.3 SIMPER result showing trait groups similarity within pool and riffle samples

Riffle	Average similarity: 74.60				
Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
d	1.3	15.84	6.72	21.23	21.23
f	1.2	14.45	5.61	19.37	40.6
h	1.04	9.34	1.15	12.52	53.12
Pool	Average similarity: 78.83				
a	1.44	17.37	7.26	22.03	22.03
d	1.3	16.27	6.01	20.64	42.67
e	1.34	15.82	4.26	20.06	62.74

Table 6.4 SIMPER results showing trait groups contributing to differences between pool and riffle samples

	Group Riffle	Group Pool				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
h	1.04	0.55	4.75	1.18	17.79	17.79
f	1.2	0.77	3.94	0.97	14.77	32.57
c	0.66	0.88	3.91	1.09	14.66	47.22
a	0.9	1.44	3.7	1.03	13.88	61.11
b	0.84	0.52	3.67	1.06	13.74	74.85
e	0.94	1.34	3.32	0.94	12.44	87.29
g	1.03	1.1	2.76	1.02	10.34	97.63

C. Vegetation data analysis and results

The vegetation habitat data was investigated using both the species data and water plant functional groups (after Casanova 2011; Table 6.5). PCO was undertaken using 4th root transform, Bray Curtis similarity resemblance and the data was analysed with and without the abiotic factors (i.e. open water and mud / bare ground / rock).

Table 6.5 Water plant functional group descriptions (after Casanova 2011)

WPFG[1]	Description
Tdry	*Terrestrial dry* – do not require flooding and but require higher soil moisture levels than typically terrestrial species
Tdamp	*Terrestrial damp* –germinate and establish on damp ground but do not tolerate flooding; they commonly grow in low lying areas after inundation has saturated the soil and require soil to remain damp for around 3 months.
Aftl	*Amphibious fluctuation tolerator - low growing* – germinate on damp soil or under water and grow submerged but need to be exposed by the time they flower and set seed; require shallow flooding for around 3 months.
Afte	*Amphibious fluctuation tolerator - emergent* – most photosynthetic parts emerge above the water; tolerate fluctuating water levels and need water to be present around 8 to 10 months.
Aftw	*Amphibious fluctuation tolerator - woody* – woody perennials that require required water present in the root zone all year and germinate in shallow water or drying soil.
Afrp	*Amphibious fluctuation tolerator - plastic* – require water to persist in the root zone and tolerate fluctuating water levels by being able to change their morphology (e.g. elongate shoots or change leave type); can persist on damp or drying ground; usually occupy deeper areas or sites that are wet for longer than Aftl.
Afrf	*Amphibious fluctuation responder - floating* – grow underwater, float or have floating leave; prefer permanent water but can survive on mud.
SE	*Perennial - emergent* – require permanent moisture in the root zone but emerge above the water; prefer stable or minimally fluctuating water levels.
Sk	*Submerged – k-selected* – require >10 cm water for 6 months or more to germinate or reproduce sexually but most have asexual reproductive strategies (e.g. fragmentation, rhizomes); completely water-dependent.
Sr	*Submerged – r-selected* – mostly require drying to stimulate germination and colonise recently flooded areas; usually with short life cycles, persisting by long-lived or dormant seeds or spores they can therefore survive extended dry periods (e.g. one to ten years)

[1]Water plant functional group

Seventy species were recorded across all sites as part of the most abundant species for each habitat (Table 6.6), however participants in the BioBlitz tended to record all species present at each site, therefore this list includes species that were not abundant (recorded as 1% cover). 23 species were recorded at greater than 1% cover. Thirty six of the total species recorded were native and ten of the species recorded at greater than 1% were native. *Typha* sp. (bulrush) was the most common species, recorded at seven sites at > 1% cover, followed by *Cyperus vaginatus* (flat-sedge) and *Pennisetum clandestinum* (kikuyu) at five sites each (Table 6.6). Each species was assigned to a water plant functional group (WPFG; after Casanova 2011) based on an existing classification supplied by J. Nicol (SARDI, pers. com., 10/05/16).

Table 6.6 Most common species recorded in the habitat vegetation survey

Species	Common name	Status	WPFG[1]	Number of sites
Annual broadleaf weeds	Annual broadleaf weeds	Exotic	Tdry	1
Azolla filiculoides	Duckweed	Native	Afrf	1
Chara globularis var.	Chara	Native	Sr	1
Cynodon dactylon	Couch	Exotic	Tdry	2
Cyperus vaginatus	Flat-sedge	Native	Afte	5
Dactylis glomerata	Cocksfoot	Exotic	Tdry	1
Duma florulenta	Lignum	Native	Aftw	1
Eucalyptus camaldulensis	River red gum	Native	Aftw	2
Foeniculum vulgare	Fennel	Exotic	Tdamp	1
Graminaea spp.	Annual grass weeds	Exotic	Tdry	3
Juncus sp.	Rush	Native	Tdamp	1
Lycium ferrocissimum	African boxthorn	Exotic	Tdry	1
Mimulus repens	Creeping monkey-flower	Native	Aftl	1
Myriophyllym sp.	Watermilfoil	Native	Afrp	1
Paspalum distichum	Water couch	Exotic	Afte	2
Pennisetum clandestinum	Kikuyu	Exotic	Tdry	5
Phalaris aquatica	Phalaris	Exotic	Afte	4
Phragmites australis	Common reed	Native	SE	3
Picris echioides	Oxtongue	Exotic	Tdry	1
Rorippa nasturtium-aquaticum	Watercress	Exotic	Aftl	2
Rumex sp.	Dock	Unknown	Tdamp	1
Sonchus oleraceus	Sow thistle	Exotic	Tdry	1
Typha sp.	Bulrush	Native	SE	7

[1]Water plant functional group

The cover of each WPFG and abiotic features for each site is shown in Figure 6.5 (including the cover of open water and bare ground / mud / rock). The cover of abiotic features (open water and bare ground) was dominant at many of the sites.

The results of the PCO is shown for the species data in Figure 6.6 and the WPFG data in Figure 6.7 with and without the abiotic data (open water and mud / bare ground / rock). The comparison with and without the biotic data was undertaken for the purpose of determining the value of recording this data and understanding to what extent it could influence the interpretation of the data, given that water levels can (and did) fluctuate dramatically between sampling events.

The PCO analysis using WPFGs was able to explain more of the variation in the data (81% with abiotic data and 76% without abiotic data) than the species data alone (43% with abiotic data and 33% without abiotic data), demonstrating the usefulness of the WPFG approach. The PCO of WPFGs provides the following distinct groupings:

- Group A: dry sites in the mid and lower Doctors creek characterised by *terrestrial dry* species
- Group B: sites with water present and distinguished by *perennial emergent* (SE) species indicating these sites are permanently moist and/or inundated sites with minimally fluctuating water levels
- Group C: upper Doctors Creek Catchment sites that were dry when surveyed and were characterised by *emergent amphibious fluctuation tolerator* (Afte) weeds indicating water is present for 8 – 10 months a year

- Group D: Paris creek low flows site and Sunnydale site were also characterised by Afte pasture weeds but had some water when surveyed, they therefore separate from Group C where abiotic factors are included in the analysis but are more similar to Group C with the abiotic factors excluded. With the abiotic factors included the PCO was poorly able to explain the variation in the data.
- Group E: mid to lower catchment sites (Willyaroo, Ballandown Road and Paris creek downstream), without the abiotic factors the variability in these sites was poorly explained, but with the inclusion of abiotic factors the Angas Weir site was more similar and the group was better distinguished. These sites have a broader range of WPFGs present, indicating a more variable flow regime than other sites.

If the number of zero flow days increased in the Angas Catchment, it would be expected that the composition of the vegetation at the sites would shift towards a dominance of WPFGs with less water requirements. The Group C and D sites would become more similar to Group A. Group D sites may not change greatly unless groundwater levels were impacted, but Group E sites might fluctuate less as they become more reliant on groundwater and therefore be more similar to Group D.

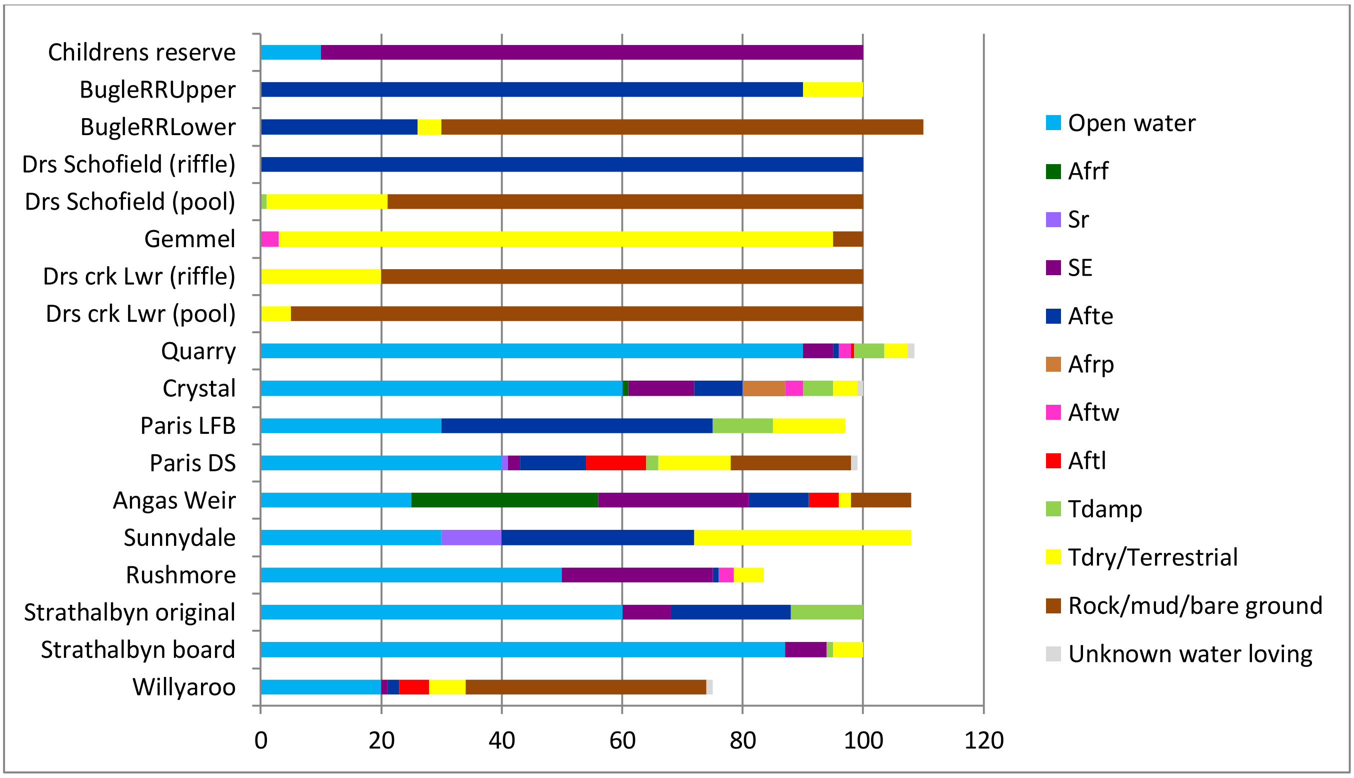

Figure 6.5 Abundance of water plant functional groups at each site

Note: all sites are for the main pool habitat unless otherwise stated

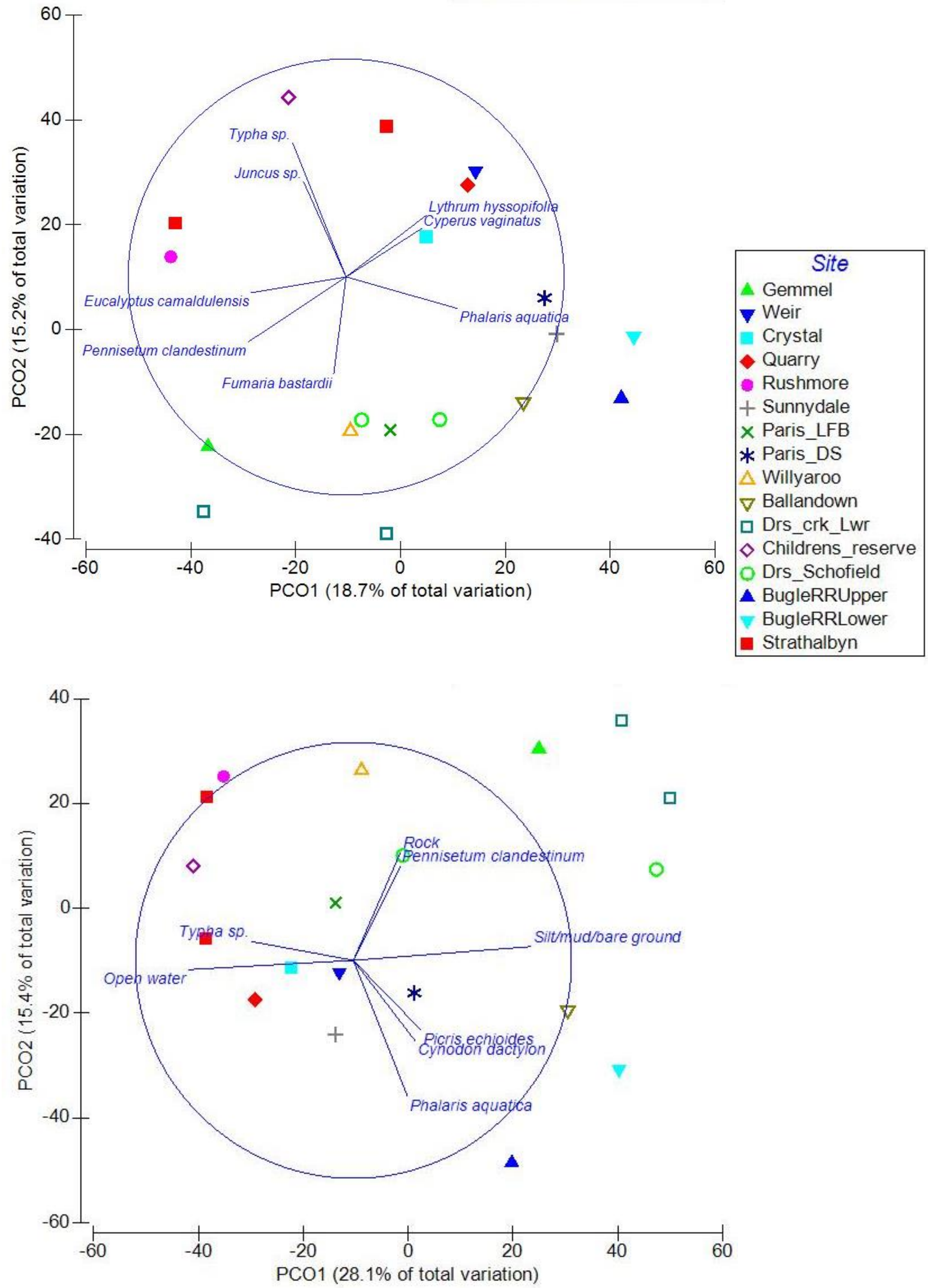

Figure 6.6 Principle Components Ordination of vegetation species cover data without abiotic data (top) and with abiotic data (bottom); Pearson correlations of species overlaid, constrained at 0.4 and 0.42 respectively

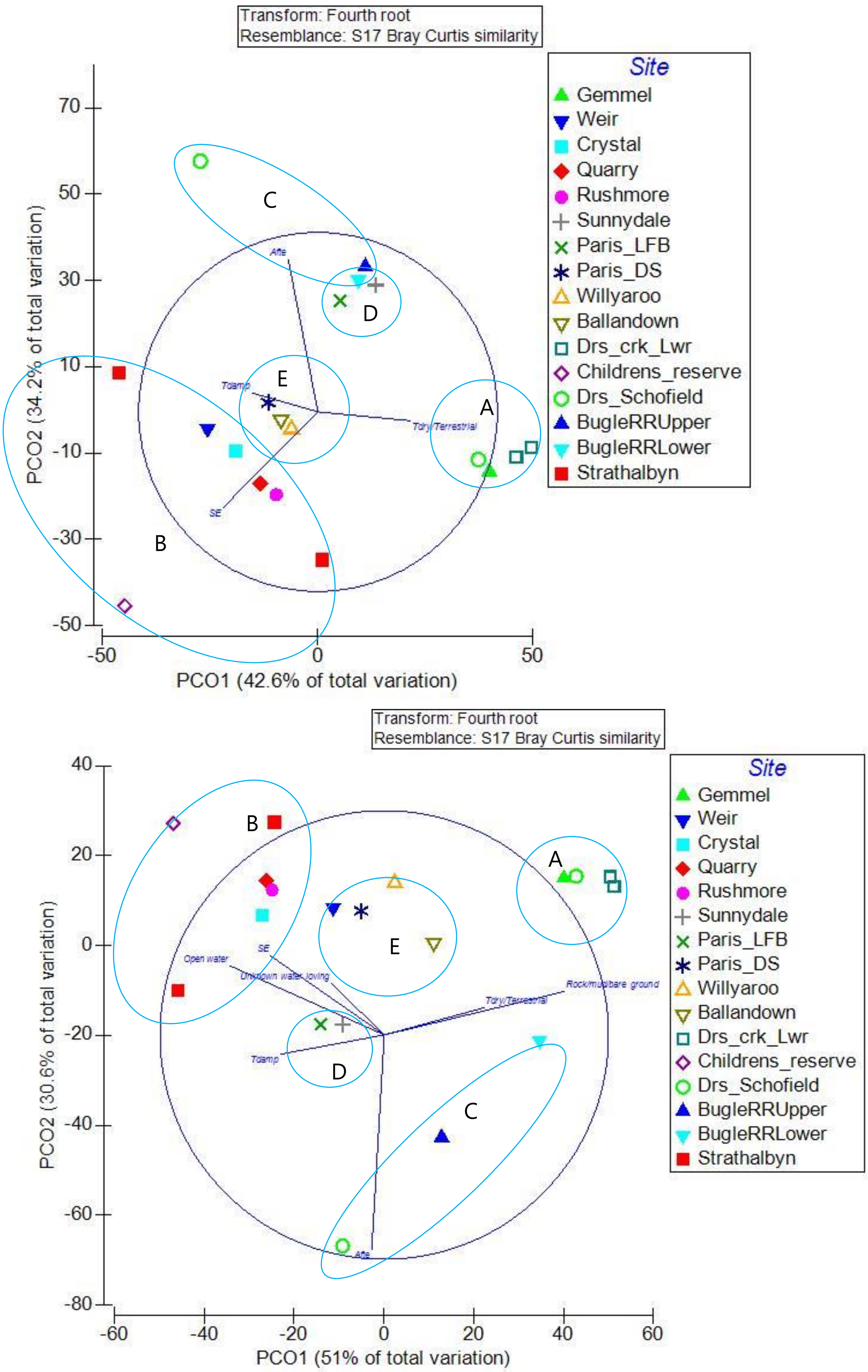

Figure 6.7 PCO of vegetation water plant functional group (WPFG) cover data without abiotic data (top) and with abiotic data (bottom); Pearson correlations of WPFG overlaid constrained at 0.3. Ellipses added for illustrative purposes

D. Water Quality data analysis and results

The results of the salinity (electrical and specific conductivity), pH and dissolved oxygen measurements are shown in Figure 6.10. Salinity (measured as electrical and specific conductivity) was lowest at the central upper catchment sites (Crystal Lake, Paris Creek and Quarry Road sites) and highest at the upper western catchment sites (Sunnydale Road and Rushmore Reserve). These readings are high compared with past community monitoring (SAMDB NRM 2016) but not unexpected given the readings were taken after a long dry period.

The pH readings for Crystal Lake, Quarry Road and Rushmore Reserve are all acidic and notably lower than the other sites. These reading were all collected with the same meter which was not used at any of the other sites and it is highly likely that these low results are due to the meter not being properly calibrated. These data will not be added to corporate data bases and have not been presented in the graphs below. The pH results for the other sites are neutral or close to neutral.

Dissolved oxygen (DO) levels are normally higher in shallow flowing water and lower in still, saline or nutrient rich sites as well as becoming lower with water depth. Therefore the very low result (1.4 mg/L) is surprising as this site was flowing and shallow at the time it was measured, however water was being released from upstream dams at the time as part of the low flow infrastructure installation and potentially the dams could be low in oxygen, particularly if the water was being released from the deeper parts of the dam. The second lowest DO was recorded at the Sunnydale Road site, and the low result is expected, given it was from a small pool without any flow.

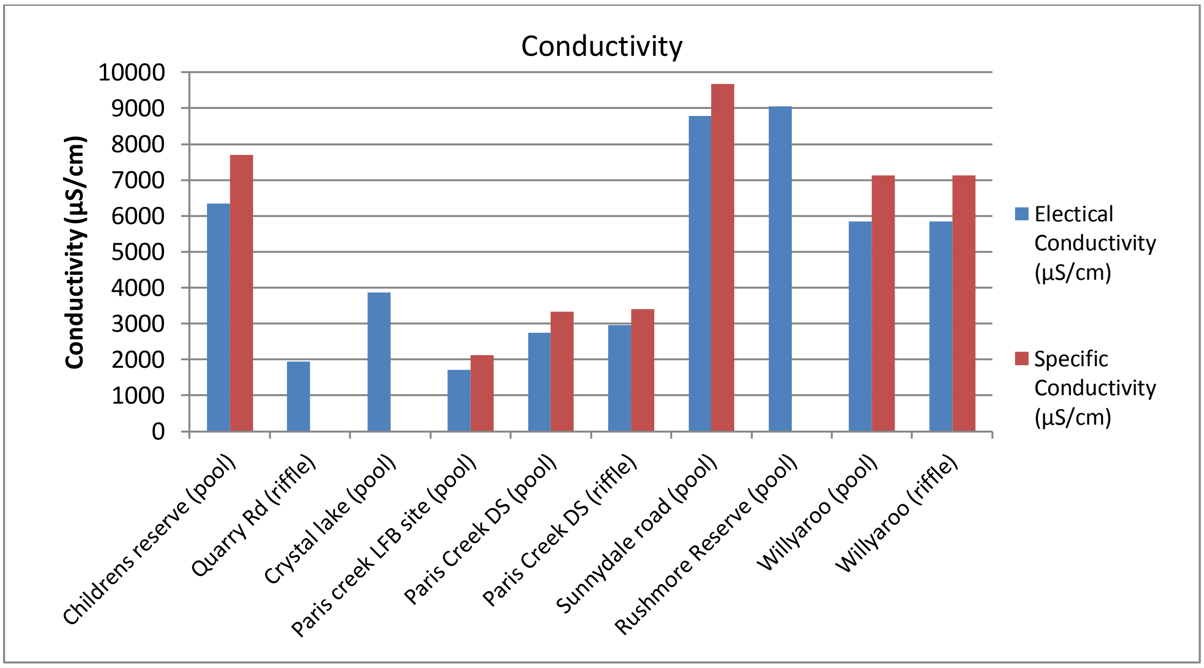

Figure 6.8 Conductivity and Specific Conductivity (µS/cm) collected at macroinvertebrate sampling sites

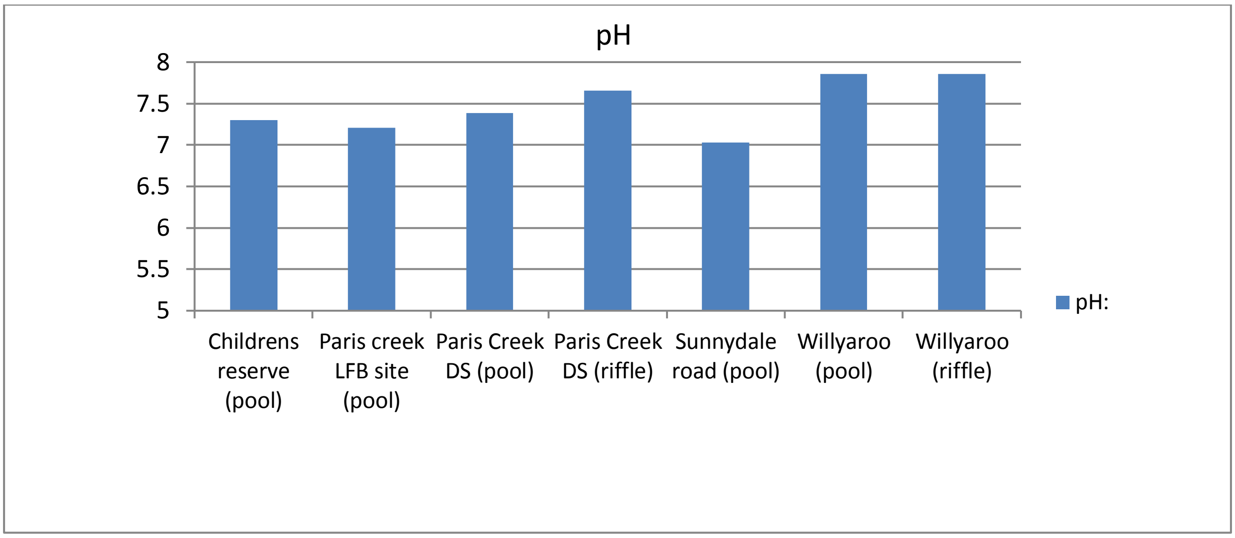

Figure 6.9 pH collected at macroinvertebrate sampling sites

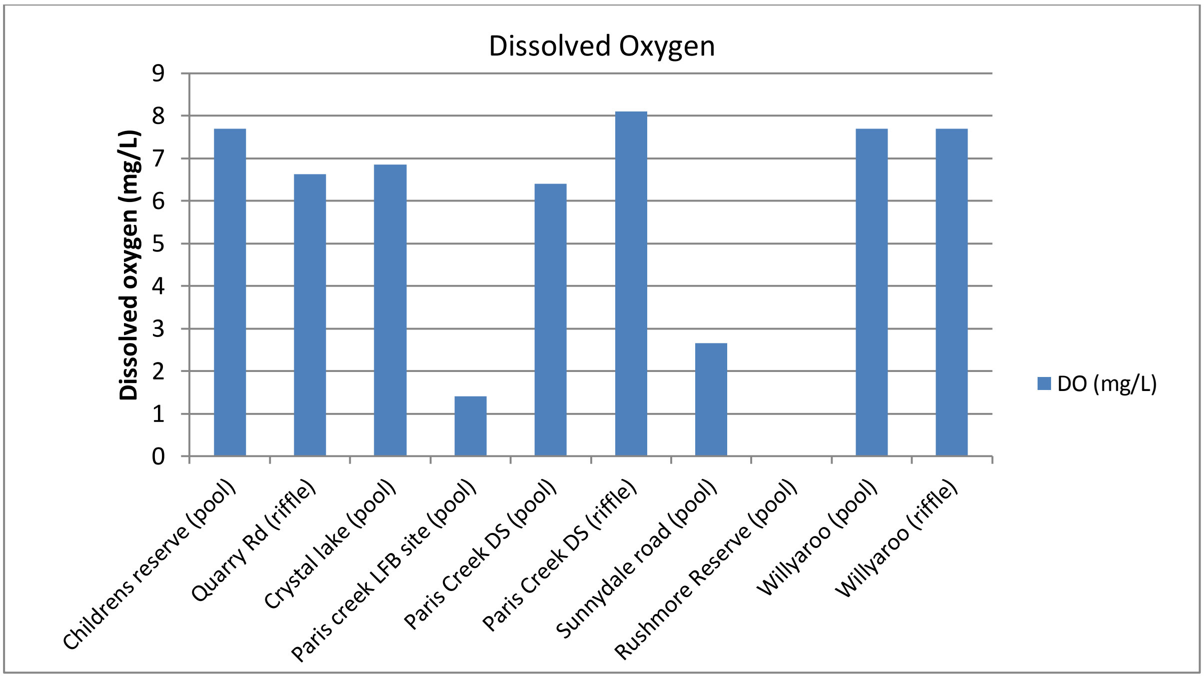

Figure 6.10 Dissolved oxygen (mg/L) collected at macroinvertebrate sampling sites

E. Participant evaluation

Participant background:

- 43% had attended previous training in this topic
- 20% had on-the-job experience in this topic

Participant engagement and satisfaction:

- 100% thought the event was well conducted and would recommend it to others
- 90% thought the level of information was suitable
- 75% thought the amount of information was suitable
- 75% thought the mix of presentation and participation was right
- 70% thought they had learnt something from interacting with other participants

Participant benefit:

- 86% increased their awareness of the topic, 14% undecided
- 93% increased their knowledge of the top, 7% undecided
- 69% increased their knowledge to change how they do things, 31% undecided
- 69% increased their skills in the topic, 31% undecided
- 46% increased theirs skills to change how they do things, 54% undecided
- 62% increased their capacity to make better decisions, 38% undecided
- 42% increased their capacity to change their actions, 58% undecided

What they gained:

Increase awareness of

- the Angas Catchment
- the importance of flow and macroinvertebrates
- monitoring methods
- citizen science

Confidence in conducting monitoring methods without staff supervision:

- Some confident with vegetation sampling and photopoints
- A couple confident in macroinvertebrate sampling
- None confident with macroinvertebrate ID using this method
- Generally not confident to do this monitoring method without supervision

Further training needs:

- Macroinvertebrate ID and collection
- Wader training
- Plant ID

Suggested changes to event:

- More time (too much to learn in the time)
- Split over different days for veg and macros
- Too rushed for people with little plant knowledge to learn to ID the plants
- Some handouts of the most common aquatic/riparian plants would have been really useful
- Dedicated half day to practice ID of bugs without the time pressure
- Some handouts and tips for what to look out for, what the common bugs are, what the various bits of bugs are called so that the key can be followed more quickly
- Make sure everyone gets a chance to practice both macroinvertebrate sampling and ID
- More chance to have a go at sampling
- More clarity about whether it was meant to be a training event or a volunteer assisted survey

General comments:

- Felt the volunteers slowed down the data collection rather than helped
- All would like to be involved again either in the Angas or another catchment
- I thought when I signed up, that it would be about training to increase our skills at Waterwatch. I expected the evening to be about ensuring that our skills were up to scratch and that the following day we would practicing these skills under guidance.
- Unfortunately after an evening of talk, the following day we were exposed to an entirely different method, both on the analysis and critter identification which far from increasing my knowledge, left me with an acute awareness of the difference in methodology between what we do and what DEWNR does, and a sense of pointlessness in continuing to provide the data that we do.
- There seems to be a disconnect somewhere which does not indicate a good prognosis for Waterwatch unless rectified

F. Site photographs

Quarry Road_Fixed vegetation site

Paris Creek LFB site – vegetation photopoint

Paris Creek DS vegetation photopoint

Bugle Range Rd DS confluence vegetation photopoint

Bugal Range Rd vegetation photopoint.

Childrens Reserve vegetation photopoint

Rushmore Reserve vegetation photopoint

Angas Weir vegetation photopoint

Doctors Creek, Gemmel Rd vegetation photopoint

Doctors Creek Mid, Schofield vegetation photopoint

Doctors Creek Lower vegetation photopoint

Crystal Lake vegetation photopoint

Strathalbyn vegetation photopoint

Willyaroo vegetation photopoint

Government of South Australia
Department of Environment,
Water and Natural Resources