

Review of Participatory Monitoring in the South Australian Murray-Darling NRM Region

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TABLE OF ABBREVIATIONS

AMLR	Adelaide and Mount Lofty Ranges
CMF	Community Monitoring Framework
CSIRO	Commonwealth Science and Industrial Research Organisation
DENR	Department of Environment and Natural Resources
DEWR	Department of Environment and Water Resources (now DEWHA – Department of Environment, Water, Heritage and the Arts)
DWLBC	Department of Water Land Biodiversity and Conservation
EPA	Environmental Protection Agency
EPBC	Environmental Protection and Biodiversity Conservation
LAP	Local Action Planning
NBN	National Biodiversity Network
NCSSA	Nature Conservation Society of South Australia
NRM	Natural Resources Management
MERI	Monitoring Evaluation Reporting and Improvement
PIRSA	Primary Industries and Resources South Australia
QA/QC	Quality Assurance/ Quality Control
ROR	Regional Outcomes Report
SAMDB	South Australian Murray Darling Basin
S & LM	Soils and Land Management

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Executive summary

Regional Natural Resource Management (NRM) requires data for planning and evaluation decision making. The use of participatory monitoring data in regional decision making processes requires action to improve both the provision of appropriate data and the process for using data in decision making. This review provides an overview of existing participatory monitoring in the SAMDB NRM region and a situation analysis of the national and international experiences of using participatory monitoring data for decision making in NRM. The review of existing participatory monitoring describes the coverage, potential for use and requirements for support of the current network of monitoring programs. The current program is then considered in the light of best-practise and the potential for improvement through strategic support.

Community groups, NRM Board officers and other were surveyed about participatory monitoring data collection and methodology, levels of participant training, program quality control/quality assurance measures, and resources used by the group. One hundred and thirty-six groups were contacted and asked to complete the survey, with responses from 47 groups. Two survey methods were used: an email survey (20 questions) addressing program characteristics and a telephone survey (seven additional questions) addressing the usefulness of the data for decision making, and the level of engagement of community members in the monitoring programs.

There is evidence that both the planning and evaluation processes currently in use by the SAMDB NRM Board are capable of using evidence provided by participatory monitoring programs. However, there remain barriers to data access and real and perceived limitations in data quality assurance and data synthesis. Many of the participatory monitoring programs reviewed do not currently meet all standards for usefulness in regional decision making primarily because they do not understand or prioritise regional decision making as a driver for the monitoring. This may in part be due to a failure of feedback from decision makers to monitoring programs about the usefulness of participatory monitoring data and the required changes to improve utility. NRM Board planning processes should provide feedback on the appropriateness and adequacy of monitoring programs. The engagement of participants in data provision for decision making should be an equal priority with the provision of support for participatory monitoring for purposes such as capacity building. Research will also continue to be a potential user of participatory monitoring data but will need to negotiate the same challenges confronting planning, ie. data appropriateness, adequacy, accessibility and quality assurance.

The supply of monitoring data from participatory programs is potentially very significant. One hundred and twenty-four distinct monitoring themes were identified through the survey, many of these having been established since the establishment of the SAMDB NRM Board in 2004. The large number of themes monitored and the large number of locations where monitoring occurs is the basis of a potentially very useful regional network. Most monitoring programs collect data on a range of indicators or themes and many show willingness to add indicators if the benefits are obvious. Monitoring participants derive pleasure and personal satisfaction from their monitoring activities and report that they have gained knowledge through participation. Participants clearly want to increase knowledge of natural resources in the region and want their data to be useful and used. There is clear evidence that the benefits to participants from involvement in monitoring is in part due to the professional and institutional support provided by the NRM Board and partner organisations.

A large number of programs meet or could be readily assisted to meet standards for monitoring data use in regional decision making. However, the review found that almost all programs are deficient in some respect of data quality assurance for at least one of the attributes or themes that they monitor. This further suggests that the usefulness of much of the data is not being tested by current decision making processes. There is evidence that programs with more professional support may more readily meet QA/QC standards. The level of professional support provided should evolve to prioritise programs with the most potential to contribute to decision making, or be recognised as primarily focussed on capacity building.

There is also evidence that only a few programs are aware of and using the Community Monitoring Toolkit, though some program are using some similar tools from different sources. This indicates that the Toolkit does not meet the needs of project officers or program leaders, or that it has not been adequately promoted. The tools are focussed on addressing many of the identified weaknesses of the surveyed monitoring programs and could be used to rectify some weaknesses by additional promotion and uptake of the Toolkit, and/or the provision of training and support in areas of greatest need such as QA/QC.

With the exception of water quality data available on the SAMDB NRM Board website, little of the data from participatory monitoring programs is accessible without local networks and possibly without additional data cleansing and handling. There is evidence that the accessibility of data has improved since 2005 and that this has been positive for participants and programs. Approximately 50% of programs currently make their data available on the internet or would like to make their data available on the internet.

Recommendations

The primary objectives for the SAMDB NRM Board to support participatory monitoring programs for the purposes of decision making should be to support

- Improved adequacy and appropriateness of the monitoring programs – appropriate attribute selection, collection methods and sampling designs
- Increased quality assurance of the monitoring programs – all actions necessary to promote and communicate the high levels of QA/QC in the programs
- Data accessibility – data is unlikely to be used beyond the local scale if it has to be accessed through individual officers or volunteers or if the data does not have appropriate metadata attached

To meet these objectives it is recommended that the NRM Board:

- Review available online open-access databases for priority monitoring themes and add links to SAMDB NRM website
- Provide coordination / assistance for monitoring groups to upload data to appropriate online databases
- Disseminate information about availability of participatory monitoring data to community, regional, state and national forums for NRM planning and evaluation
- Organise and promote a regional forum on changes in the condition of natural resources. Invite a broad range of participants to highlight the condition and trend in natural resources within the region with the intent of supporting and improving participatory monitoring.
- Promote the discussion and learning from the forum through podcasts, report and powerpoint presentations on the NRM Board website.
- Revise the Community Monitoring Toolkit and the delivery webpages in line with the needs of current programs.
- Promote the toolkit through existing and new forums and through training sessions for monitoring groups.

Background

The SAMDB NRM Board developed a Community Monitoring Framework in 2005 to guide stakeholders on how to achieve the greatest value from participatory monitoring for the participants, the regional NRM Board, the broader community and the natural resources of the region. Practical products to assist implementation have since been produced taking account of the framework.

However, it is recognised that some parts of the Framework are now out of date (e.g. new targets) and new participatory monitoring programs have been developed since the review in 2005 (e.g. Bush Condition Monitoring).

In recent years participatory monitoring in the SAMDB NRM region has matured to a well developed model. The missing link in the current community monitoring efforts is how a strategic approach can be taken to use the information generated from community monitoring to help in regional and or landscape planning and decision making. There are a number of reasons for this not occurring to date:

- Development of a new Regional NRM Plan and Regional NRM Targets
- Staffing turnover and secondments
- Development of a new high level MERI Plan and approach
- Change in focus of participatory monitoring during the drought (particularly for water and wetland monitoring)

This review provides a situation analysis of the national and international experiences of using participatory monitoring data for decision making in natural resource management. The review analyses the literature on participatory monitoring as a background to a survey of participatory monitoring programs in the SAMDB NRM region. From the review and survey the current network of participatory monitoring programs is described in terms of coverage, potential for use and requirements for support.

Defining Participatory Monitoring

Participatory monitoring – individual volunteers or networks of volunteers, who may or may not have scientific training, and who perform or manage monitoring-related tasks such as observation, measurement or computation. Participatory monitoring (sometimes called community based monitoring) may involve professional support for coordination, planning, sampling, analysis or other components of a monitoring program. The level of involvement of volunteers in participatory monitoring varies enormously between monitoring programs,

encompassing programs where the volunteers undertake all activities and programs where volunteers have only a limited role.

Programs of monitoring involving community participation are forms of 'citizen science'. Citizen science may be monitoring focussed, or may be oriented towards resource assessment or other activities. Citizen science has a long history of large contribution to research and knowledge gathering, with one of the oldest examples being the Christmas Bird Survey of the Audubon Society in North America. This survey has been undertaken each year since 1900 and bird population data collected has contributed to hundreds of studies, reports and scientific publications¹. There is a growing literature on the characterisation and improvement of citizen science from which to draw lessons relevant to the circumstances of the SAMDB NRM region.

Reflecting on the Community Monitoring Framework (2005)

The Review of Community Based Monitoring (O'Connor et al. 2005a) and Framework for Community Based Monitoring in the SAMDB (O'Connor et al. 2005b) highlighted that participatory monitoring of natural resources in the SA Murray Darling Basin Natural Resource Management Region contributes to awareness about the condition of the resource and the impacts on resource condition. This type of monitoring underpins many decisions about natural resource management at the local level and has potential to influence decisions about management and investment at the regional level. The review highlighted where established monitoring programs could contribute to evaluation of progress towards the goals and targets for natural resource management in the SAMDB, and where gaps and barriers constrained participatory monitoring from achieving the full range of desired outcomes.

Key findings from the 2005 review were that:

- The participatory monitoring effort in the region was substantial and covered monitoring of wetlands, surface water quality, groundwater, aquatic and terrestrial biodiversity, and land condition.
- Monitoring programs extended across much of the region with a large number of programs concentrated on the Murray River and National Parks.
- The monitoring had the potential to contribute to evaluation activities in the region
- Some programs had limitations with respect to quality assurance and quality control (QA/QC) and even where QA/QC was assured there were continuing barriers to the use of data from inconsistency of methods between different types of groups and

¹ <http://web4.audubon.org/bird/cbc/biblio.html>

programs, lack of clarity of responsibilities for data storage and management, and the incomplete uptake of QA/QC procedures to the maintenance of a standard set of metadata.

Community participants reported that they were motivated by the desire to make a contribution to maintaining the health of the environment (and natural resource management) and to increase their own knowledge and understanding of natural resources. Participants reported that they liked being involved in the monitoring programs because the information gathered assisted them in determining appropriate management actions and allowed them to detect the results of their management interventions.

The biggest challenges facing community based monitoring programs were reported to be the difficulty of renewing the membership and enthusiasm of community groups and the risk of losing experienced and capable participants and project officers. Almost all programs reported that data analysis was limited to different forms of data display and little further analysis of the data was undertaken. There was no single, accessible data storage point for most data, though almost all programs agreed that such a storage and access facility was highly desirable.

There was high confidence that participatory monitoring programs could and did influence decisions about natural resource management at the local level. Confidence in influencing regional decisions about NRM was lower and depended on the type and quality of the monitoring. Key factors limiting the influence of the monitoring were confidence of decision makers in the QA/QC of individual programs, limited recording of standard metadata on monitoring programs, difficulties accessing monitoring data held by community groups and limited or poorly focussed reporting and communication of the results of monitoring programs.

The Framework (O'Connor et al. 2005b) provided a guide on how to support and enhance participatory monitoring to achieve optimal benefits for all stakeholders. The Framework described:

- how community based monitoring could be used in reporting against information needs identified in the region
- tools for rating the quality of data and information collected from participatory monitoring and outlined the steps required to improve data quality from these programs
- how participatory monitoring could be used to build the interest and skills of community participants in managing natural resources
- how tools relevant to different audiences could be used to communicate the results of participatory monitoring
- the various roles and responsibilities of stakeholders in participatory monitoring in the region and how they interact

- the resources and support required to gain the greatest benefits from participatory monitoring for participants and other stakeholders
- a proforma for community groups to prepare their own monitoring plan

The current review re-examines some of the issues raised during the review in 2005 and provides updated recommendations for enhancing the role of participatory monitoring in regional NRM.

Introduction

Participatory monitoring data in regional decision making

Participatory monitoring is increasingly recognised as a useful tool for collection of data on environmental condition, and for engaging the community in environmental issues (Conrad and Hilchey 2011, Schmeller et al. 2009). Using volunteers in monitoring activities has the potential to reduce costs compared to use of professional paid scientists alone, freeing up limited resources from monitoring and directing them towards management (Danielson et al. 2009). However, there is some tension between the twin goals of increasing community participation and engagement in natural resource management, and ensuring participatory monitoring data is of a suitable standard and type to be useful for decision making. The tension can be viewed in terms of the top down demand for monitoring data and the bottom up supply of data. Understanding the characteristics of demand and supply will help to clarify the usefulness and role of participatory monitoring data in regional decision making.

Danielsen et al. (2009) provide a typology of natural resource monitoring with five categories based on differences in professionalism of the primary data gatherers and the primary data users. They further characterise the categories of monitoring programs based on cost, level of expertise required, data quality, ability to inform decisions and potential for enhancing stakeholder capacity (Danielsen et al. 2009). This work provides guidance on choosing the level and type of volunteer participation in monitoring programs and further emphasises the need for understanding of the nature of natural resource monitoring data demand and supply.

Demand for monitoring data

The demand for monitoring data comes from the need to make decisions and communicate. The main areas of data demand for decision making in regional NRM are planning at all scales and evaluation of change and progress towards targets and goals. One of the inputs to planning is research and monitoring data may be used in research for resource assessment, prioritisation, modelling and other purposes. Participatory monitoring data can be used in planning, research and communication where it meets the criteria for that use. Data from participatory monitoring programs may be the only data available for some attributes or at local scales. It is therefore important to understand and anticipate the demand for data. It is only within the scope of a specific planning or research question that the appropriateness and adequacy of a dataset can be judged. This review does not examine

all planning needs in detail but high level planning demands are highlighted. It should also be noted that non-participatory monitoring data (usually collected by government agencies and research institutions) may not meet planning demands where the planning needs are different to those anticipated in the design of the monitoring.

Planning and evaluation

The main use of resource condition data in regional planning is in the preparation of the SAMDB NRM Plan and in reporting progress towards targets set in that plan through the Regional Outcomes Report (ROR). Resource condition targets and management action targets set by the NRM Board were set using a series of workshops with technical experts with knowledge of available data and refined program logic models for each asset (SAMDB NRM Board Plan, 2008). Regional Outcomes Report (SAMDB NRM Board, 2010) used a participatory evaluation process of expert discussion on available lines of evidence to determine the progress towards regional targets. Both of these processes implicitly used participatory monitoring data and could use this data explicitly in the future.

Planning and programs with an interest in using quality assured data on natural resource condition:

- Murray-Darling Basin Plan
- RAMSAR
- National Water Initiative
- Caring for our Country
- Living Coast Strategy
- Tackling Climate Change
- SA Strategic Plan
- State NRM Plan
- No Species Loss
- Industry Plans
- Regional Pest Management Strategy
- Regional Biodiversity Plan
- Local industry plans
- Water Allocation Plans
- Local NRM Plans
- Council Development Plans

Research

Researchers are using citizen science data where they can access it and modern algorithms are allowing mixing of data from different sources and protocols. At a national and global

scale, researchers are using datasets from a variety of sources (including citizen science sources such as the Mount Lofty Range Woodland Bird Survey and the Australian Bird Atlas) to monitor trends in natural resources (eg. State of Australia's Birds², Living Planet Index³, Global Biodiversity Trends⁴, BirdLife International (indices of bird population health)⁵). Most users of resource monitoring data do not discriminate on the basis of the source of the data (Lawrence 2010) but accept and use data which meets the following verifiable criteria:

- Attribute appropriateness
- Data collection method appropriateness
- Data quality assurance
- Data access & permission for use

The survey of participatory monitoring reported in this document examined how the current network of participatory monitoring programs meets these criteria.

Supply of monitoring data

Data volume and diversity

The volume and diversity of natural resource data collected by volunteers through participatory monitoring programs can be enormous. Burnett et al. (1995) estimated that over 60,000 volunteers were active in biological recording in the United Kingdom in the 1990s, with over 9 million flora records collected for the New Atlas of the British Flora alone (Preston et al. 2002). The Community Monitoring Online Database for the SAMDB NRM Board⁶ shows that data (a median of 6 water quality attributes collected at various frequencies) has been collected at approximately 150 sites for up to 10 years.

The diversity of attributes monitored by programs involving volunteers is extensive and limited mainly by personal preference, skill and motivation. There is some form of participatory monitoring occurring for all natural resource management themes in the SAMDB NRM Board Plan, with the exception of the people and atmosphere themes.

²<http://www.birdsaustralia.com.au/soab/state-of-australias-birds.html>

³http://wwf.panda.org/about_our_earth/all_publications/living_planet_report/living_planet_report_graphics/lpi_interactive/

⁴http://forest-trends.org/publication_details.php?publicationID=652

⁵http://www.birdlife.org/action/science/indicators/pdfs/royal_soc_indicators.pdf

⁶<http://www.samdbnrm.sa.gov.au/portals/9/CDMT/index.asp>

Data quality assurance and quality control

Data quality assurance and monitoring program quality control have been one of the greatest challenges to the recognition and use of participatory monitoring natural resource data. Data quality issues are specific for each type of monitoring but can be broadly categorised as issues related to

- observer skill level (or training level)
- use of controls and/or standards
- sampling design (including statistical adequacy of the design)
- ability to measure error
- equipment calibration and standards
- data checking and validation
- document management and data storage

A number of studies have demonstrated that non expert volunteers can collect high quality environmental information. Fore et al. (2001) found that with proper training, volunteers are capable of collecting water samples using professional methods and that volunteer identification of family groups of micro-organisms is sufficiently accurate to allow detection of differences in stream health. Similarly, Foster Smith and Evans (2003) found that volunteers quickly learn to identify macro-benthic (marine organisms such as molluscs) to the level of family. Newman et al. (2003) find that half a day of training is sufficient time to teach volunteers to collect data on woodland animals, to a quality comparable to professionally collected data. Some authors note that while individual volunteers tend to take more time to complete tasks than experienced professionals, the larger number of volunteers can significantly increase the number of monitoring samples or sites included in a monitoring program or network.

However, despite this documented success in some elements of monitoring, many studies highlight that there are limitations to the capacity of volunteers to collect high quality data or manage high quality data collection programs. The volunteers identifying macro-benthic organisms struggled to accurately evaluate abundance of the species, and Newman et al. (2003) report a slight underestimation bias by volunteers. Fore et al. (2001) suggest that the ability of their volunteers to detect large changes in stream health may not have been sufficient to detect smaller changes. A comprehensive study of participatory monitoring programs targeting invasive species in the USA showed that only 39% of programs had any data quality checks in place (Crall et al. 2010).

A recent study in the Mount Lofty Ranges and SAMDB NRM regions shows that uncoordinated volunteer monitoring of bird species can detect many of the trends demonstrated by a coordinated, systematic survey conducted by professionals (Szabo et al. 2011). Minimum population estimates from the two surveys agreed very well, however, the

participatory monitoring program tended to underestimate species normally detected by call and four species with low detectability were not detected in the volunteer surveys at all, despite the larger survey effort (Szabo et al. 2011). These results are qualified by those of Tulloch and Szabo (2011) who showed that a large number of the broad habitat types of southwest Western Australia were incompletely inventoried for bird species despite more than 12 years of participatory monitoring surveys (26,423 surveys from 470 volunteers) as part of the Bird Atlas of Australia. This incompleteness is explained by a mixture of characteristics of bird species and volunteer behaviour (Tulloch and Szabo 2011). The *ad hoc* manner of surveying by volunteers means that volunteer monitoring such as that used in compilation of inventories and atlases can have spatial and temporal biases, related to season (Peterson et al. 1998), accessibility (Reddy and Dávalos 2003; Szabo et al. 2007; Williams et al. 1996), site attractiveness (Boakes et al. 2010; Romo et al. 2006), climate (Robertson and Barker 2006) and habitat type (Szabo et al. 2007).

The bird survey studies in the AMLR and SAMDB NRM regions and the southwest of Western Australia illustrate that quality assured and controlled monitoring programs requiring high levels of skill of data collectors can be designed for participatory monitoring if the motivation is right. They also illustrate that even large participatory monitoring programs may not be capable of meeting the demands of decision makers if they are not designed to do so.

Data access

Given the range of potential users of resource condition monitoring data, easy access is critical for rapid use and for data integrity and storage. It is unreasonable to expect that all the purposes to which participatory monitoring data in the SAMDB could be used will be met if data is not easily and cheaply available. The availability and use of web-based technology to store and share data has grown enormously since the Framework was developed in 2005 and has profoundly influenced participation in and size of databases in recent years (Firbank et al. 2003; Gouveia et al. 2004). Search algorithms and the ability to automatically recode or use data from different sources and standards are also improving and resulting in lower barriers to use of accessible data for multiple purposes. However, access (particularly online access) to monitoring data of any kind is still limited in South Australia. Table 1 provides a snapshot of natural resource data made available to the public from South Australian Government agencies and CSIRO.

The SAMDB NRM Board has made the Community Monitoring Online Database available for water quality monitoring data since March 2010. This database provides a model for data access and storage for participatory monitoring programs by allowing for:

- Direct entry of community surface water data Information about surface water monitoring groups
- Public access to the collected data
- Greater uptake and use of data collected
- Designed for use by individuals with limited computer experience

Table 1. A snapshot of natural resource data accessibility on SA government and CSIRO websites.

Agency	Data	Website	Accessibility/Cost
DENR	Biological Survey Data	http://www.environment.sa.gov.au/Knowledge_Bank/Information_and_data/Biological_databases_of_South_Australia	Online request with data "cost of recovery" min charge is \$97 (GST Incl.). Two week turn around for data
EPA	Air quality and water quality	http://www.epa.sa.gov.au/	Data is available online and is free.
CSIRO Marine Data Trawler	CMR research scientists data	http://www.cmar.csiro.au/warehouse/jsp/loginpage.jsp	Data is available online and is free, although public users have only limited access to Warehouse content.
CSIRO -MarLIN	Marine and Atmospheric Research (CMAR) Laboratories Information Network.	http://www.cmar.csiro.au/marin/	Divisionally-held datasets. Only dataset descriptions available online
PIRSA	Primary industries data	http://www.sardi.sa.gov.au/about_us_2/facilities/sa_aquatic_sciences_centre	Reports available online. Raw data not available/found.
Water	State wide water monitoring data. e-NRIMS / Water Connect	https://www.waterconnect.sa.gov.au/RMWD/Pages/default.aspx	Raw data is available online and is free. Not much data – website only started October 2010.
DEWR/CSIRO - The Ocean Biogeographic Information System (OBIS)	Marine biogeographic data from all over the world	http://www.obis.org.au/	Data is available online and is free.

Motivation for participatory monitoring

Social capital and serious leisure

Participation in natural resource monitoring activities requires practitioners to attain expert knowledge and skills, and often to interact with other members of community groups. The types of activities involved in resource condition monitoring have been termed 'serious leisure' by Stebbins (1992). The psycho-social benefits of participation are balanced against the costs of time, personal expenses, effort and perseverance. The socio-cultural context in which people participate in monitoring is recognised as a critical element in the success of many large ongoing programs (Stebbins 1992; Bell et al. 2010). Qualitative studies of volunteer motivation (Douglas and Rollins 2007, Bell et al., 2008) suggest that a sense of efficacy, and a positive social experience are the two strongest factors that motivate volunteers. Douglas and Rollins (2007) reported that volunteers were often happy to work long hours in repetitive tasks in unpleasant weather conditions, when they felt that the work was making a positive contribution to biodiversity. For continued motivation and engagement it was also important that volunteers felt valued, and that they were having a positive social experience.

Because of the mixed motivations for participation in monitoring activities, it can be difficult to find a match between the supply of participatory monitoring data (collected where, when and how individuals and groups determine to be appropriate according to their motivations – albeit informed by the desire to provide information to external users) and the demand for data (set by research, planning and communication questions which may not take account of the motivations of data collectors). The study of Tulloch and Szabo (2011) highlights how the mismatch between motivations for supply and demand can result in a large dataset representing enormous human effort which is nonetheless incomplete and inadequate for many decision making purposes (26,423 volunteer bird surveys from 470 volunteers across southwest Western Australia over 12 years had identified 12 out of 21 broad habitat types with less than 95% inventory completeness).

The more control and codification in monitoring activities by organisations wanting the data, the less flexibility available to the participants in the program to determine when, where and how monitoring will be undertaken. The review of community based monitoring in the SAMDB NRM region in 2005 (O'Connor et al. 2005a) indicated that groups in the SAMDB were generally accepting of support in the form of standard monitoring methods, training and direction in sampling protocols and QA/QC. However the use of standard approaches and top down determination of monitoring locations may deter some participants if the direction they are given does not fit with their expectations of participation. The evolution of a monitoring program is often a slow process and can be influenced by social, cultural and political processes (Bell et al. 2010).

The consequence of mismatched motivations for data supply and demand from participatory monitoring programs is that changes in demand can provide both positive and negative feedback to data collectors. Positive feedback can come from recognition of the usefulness of the data, influence on evaluations and planning decisions, recruitment to groups through exposure and communication and additional resources or support to adjust or enhance the monitoring program. Negative feedback can come from unmanaged or implied criticism of the existing monitoring program, raised expectations of volunteer time and effort, communication contrary to participant beliefs, and lack of due recognition. A balance must be struck between designing or redesigning monitoring programs that capitalize on volunteer motivations and creating demand for participatory monitoring data where volunteer motivation is low.

Data ownership and permitted use

Data ownership and permitted use add complexity to the issue of using data from participatory monitoring programs. The development of the National Biodiversity Network (NBN) in the United Kingdom provides salient examples of issues for access and use of volunteer-collected data (Lawrence 2010). The NBN had a difficult beginning due to a failure to recognise the attachment volunteer recorders have to their data through personal meaning, expectations of data use and access and priorities at local scales (Lawrence, 2010). The importance of trust between data collectors and data users was greatly underestimated and retarded the early development of the NBN. While many participatory monitoring programs desire their data to be useful and offer access if they have the means (e.g. 20 of invasive species participatory monitoring programs surveyed in the USA housed their data on accessible internet platforms (Crall et al. 2010), not all programs will have thought through the implications of accessibility to their data. Lawrence (2010) reports that volunteer collectors have raised concerns about unscrupulous use of data (e.g. 'poaching' from locations where threatened species are identified), undesirable commercial use (e.g. consultants using volunteer data to make money) and misuse or unanticipated use (e.g. to justify developments which might otherwise be undesirable).

Key lessons from participatory monitoring studies

A large and increasing number of studies and reports are demonstrating the value of participatory monitoring for evidence-based and consultative natural resource management decision making. The attraction of widening the network of potential monitors at relatively low cost has to be balanced against the need for appropriate and quality assured data. Key lessons for the design and management of participatory monitoring to meet the multiple needs of stakeholders at a local and regional level are:

- Data needs for planning, evaluation and communication must be well articulated and participatory monitoring programs designed and supported to meet defined and appropriate data needs
- ‘Who’ collects the data is less important than ‘how useful is the data’. With increasing internet access to datasets, the limitation for data use from participatory monitoring is whether the data collection meet standards for attribute appropriateness, collection method appropriateness, quality assurance, and access and permission for use
- Monitoring data must be easily accessible for the greatest range of appropriate users. Access to data from both participatory and institutional monitoring programs remains a major limitation to maximising the use of monitoring data in decision making. Community groups must be supported to understand the implications and benefits of access to data and to make data accessible
- Monitoring programs should be developed to support decision making but also to support the psycho-social benefits for community participants

Methodology

Survey design

The survey was developed in two different formats in order to maximise response rate, one for conducting over the phone and another to be emailed out to monitoring groups. The email survey consisted of 20 questions, which included questions on data collection and methodology, levels of training, quality control/quality assurance measures, and resources used by the group (Appendix 1). The telephone survey consisted of the same 20 questions and seven additional questions about the usefulness of the data for decision making, and engagement of community members in all levels of the monitoring process (Appendix 2).

A list of known participatory monitoring programs was compiled from contacts supplied by the NRM board, LAP officers, through networking and online research.⁷

In June/July 2011, 136 groups were contacted and asked to complete the survey. Completed surveys were received from 47 groups. Of the responses, 28 were completed by community group members and 19 were completed by project officers/coordinators/facilitators. Twenty-one respondents had their primary affiliation with the SAMDB stream sampling network, 10 were from wetland groups, four people responded to the survey on behalf of a LAP, and there were 12 respondents associated with other organisations, such as DENR, or NCSSA.

⁷ The survey aimed to be representative and as comprehensive as possible. Some monitoring programs were not surveyed due to resource constraints, the availability of some respondents during the time of the study and the lack of an inventory of monitoring programs prior to the study.

Mapping participatory monitoring program locations

Survey respondents were asked to provide the spatial location of their monitoring program or sites. Some survey respondents were able to provide GPS locations or Easting and Northing, but others could only provide spatial references as the nearest town. Some participatory monitoring programs, particular water monitoring groups, already supply spatial data to the NRM Board or government agencies.

The locations of participatory monitoring programs were mapped to the nearest known location to indicate the extent of known monitoring within the SAMDB NRM region (Map 1). (mapping precision of each monitoring activity has been specified in the shape files provided to the Community Monitoring Project Officer at the SAMDB NRM board). Groups whose monitoring activities are region wide, do not have the full extent of their activities characterised on the map, in some cases they are not included on the map at all (Koala monitoring, MMLAP, GWLAP, EHMPC, NCSSA, Trees for Life). A few groups for whom no spatial data was available or provided are not mapped at all (Birds Australia, some DENR).

Data analysis

Information gathered about the monitoring methodology of different programs was used to assess the usefulness of data for regional decision making. The characteristics assessed included how well the attributes monitored aligned with NRM targets, the appropriateness of the sampling design, the appropriateness and verifiability of the monitoring methodology, participant skill level and training, and quality control/quality assurance processes used. Characteristics of each monitoring activity within a program were classified on a three point scale where:

- 1 = PARTICIPANT LEARNING – does not meet minimum standards for informing regional decision making, but may be valuable for participant learning and engagement
- 2 = COULD MEET STANDARD – could be readily modified to meet minimum standards for use in regional decision making
- 3 = MEETS OR EXCEEDS STANDARD – can be used for regional decision making.

Each component of the community monitoring process was considered separately, the criteria being whether the program would have the potential to have an influence on regional planning.

The overall assessment of how well monitoring programs meet required standards is subject to the limitations of program self reporting. The results are indicative of the readiness of programs to meet the standards required for use in a broad range of regional decision making processes and could be improved by analysis of individual monitoring program plans, QA/QC protocols, datasets and communication documents. This was beyond the scope of the review.

Analysis of the qualitative data was also conducted. Following broad consideration of the data, responses to qualitative questions were coded using a grounded theory approach, and grouped in order to identify key themes.

Limitations

Survey response rate:

Only 47 of the 136 groups contacted returned the survey (8 of the 136 informed us that they were no longer involved in monitoring). Contact details of groups were not always available or up-to-date.

Uncertainty about hierarchies:

The diverse nature of participatory monitoring added complexity to the survey process. Interactions between members of community groups, LAP officers, Board staff, and other organisations do not follow a set pattern. Participants who conduct independent monitoring are sometimes involved in a broader catchment network, a region wide program, or both. Some groups are supported by multiple organisations, or by sub groups within the same organisation. The scientific experience and skill of 'community members' varied significantly, in many cases, 'community members' were highly experienced and highly skilled in NRM management and monitoring. The experience and skill level of 'project officers' also varied, although there were few cases where project officers did not have experience in monitoring and monitoring design. This difficulty in categorising respondents adds complexity to the analysis of the results.

Underreporting by community monitoring members vs project officers:

The diversity of survey respondents highlights the range of people and structures involved in participatory monitoring in the region. However, it also led to some difficulty in the assessment of the program characteristics. In particular, some community participants were unsure of answers to questions about the planning, and data storage components of their monitoring programs. This may have led to an under-reporting of monitoring plans, and data cross checking activities.

Results

The results are divided into three sections:

Part 1 Overview of participatory monitoring in the SA MDB:

Who monitors what and where?

Part 2 The process of participatory monitoring in the SAMDB:

motivations for, challenges to, and support of participatory monitoring.

Part 3 Outcomes of participatory monitoring in the SAMDB:

Perceptions of use, quality control, communication and suitability for planning.

Part 1: Overview of participatory monitoring in the SAMDB

A list of all known participatory monitoring groups within the SAMDB NRM region is shown in Appendix 3.

Themes monitored

There were 47 responses to the e-mailed survey (Appendix 1) and verbal survey (Appendix 2). These respondents reported 124 distinct themes that they monitored. Twenty-one groups monitored only a single environmental theme, whilst the remaining 26 groups monitored between two and six different themes. Many groups also reported monitoring different attributes (i.e. pH, salinity) within the same theme. Of the total themes monitored by all programs, the most commonly reported were fauna, surface water and vegetation (Figure 1). Groundwater, soils and land management, pests and other themes were less commonly monitored. Individual monitoring programs often reported monitoring multiple fauna themes (i.e. frogs and bats); which explains why this was the most monitored theme (Figure 1). However, when analysed per monitoring program, the greatest proportion of groups monitored surface water as a theme (Figure 2).

The mixture of themes that different groups monitor are explained further in Table 2. For example, out of the total number of groups who monitored ground water, 64% also monitored surface water, 64% also monitored vegetation and 57% also monitored fauna. Table 2 shows that many monitoring programs are prepared to monitor multiple themes and that there are sets of themes which are naturally combined together (some of this is explained by the mixture of attributes measured by standard wetland monitoring

programs). One participant explained that their participation had increased from initially monitoring water quality to now including monitoring of frogs and bats:

'it's not until you get into it, and the people that you deal with, and they seem to infect you, it just grows on you.'

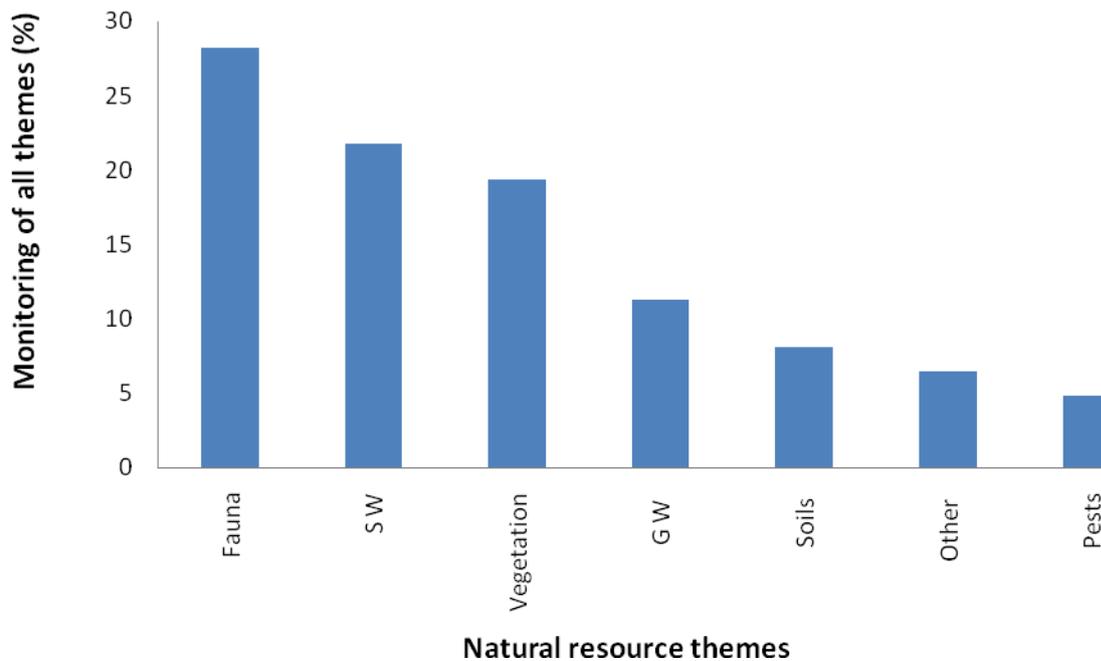


Figure 1. Percentage of the total different themes monitored

Themes monitored = 124. Fauna = animals, birds, amphibians etc; SW = surface water in rivers, streams, wetlands etc; GW = ground water, usually monitored by digging bores; Soils = soils and land management, including physical measures of soil chemistry, and use of natural resources, other= any natural resource not described in the other categories; Pests= any measurement of pest prevalence, including in conjunction with control measures such as baiting.

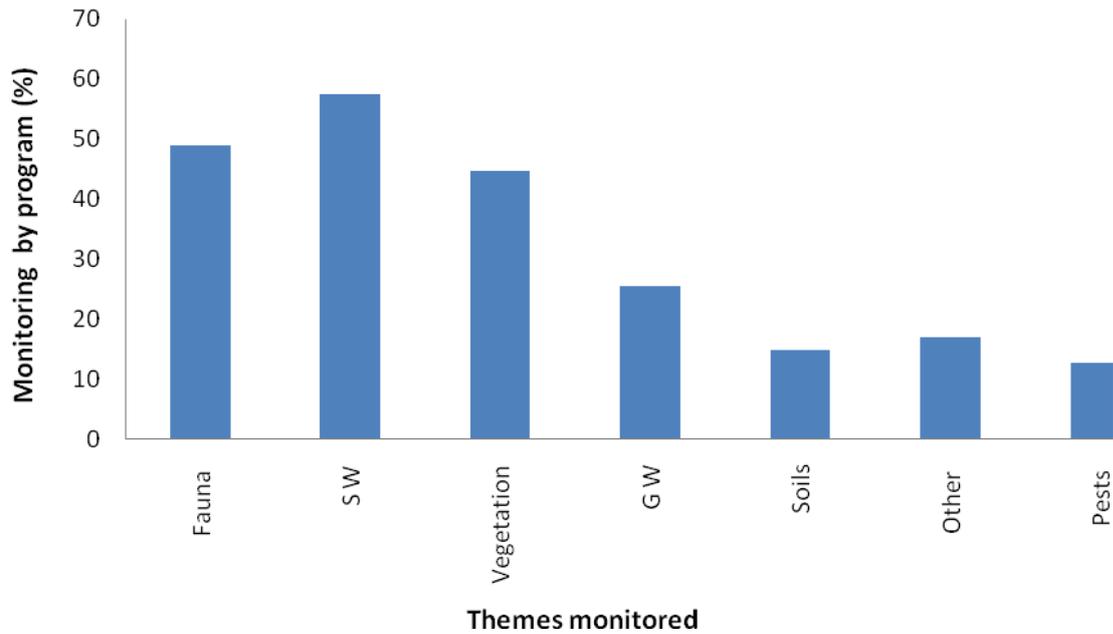


Figure 2. Percentage of participatory monitoring programs monitoring each theme (Monitoring programs responded = 47). Labels are as in Figure 1.

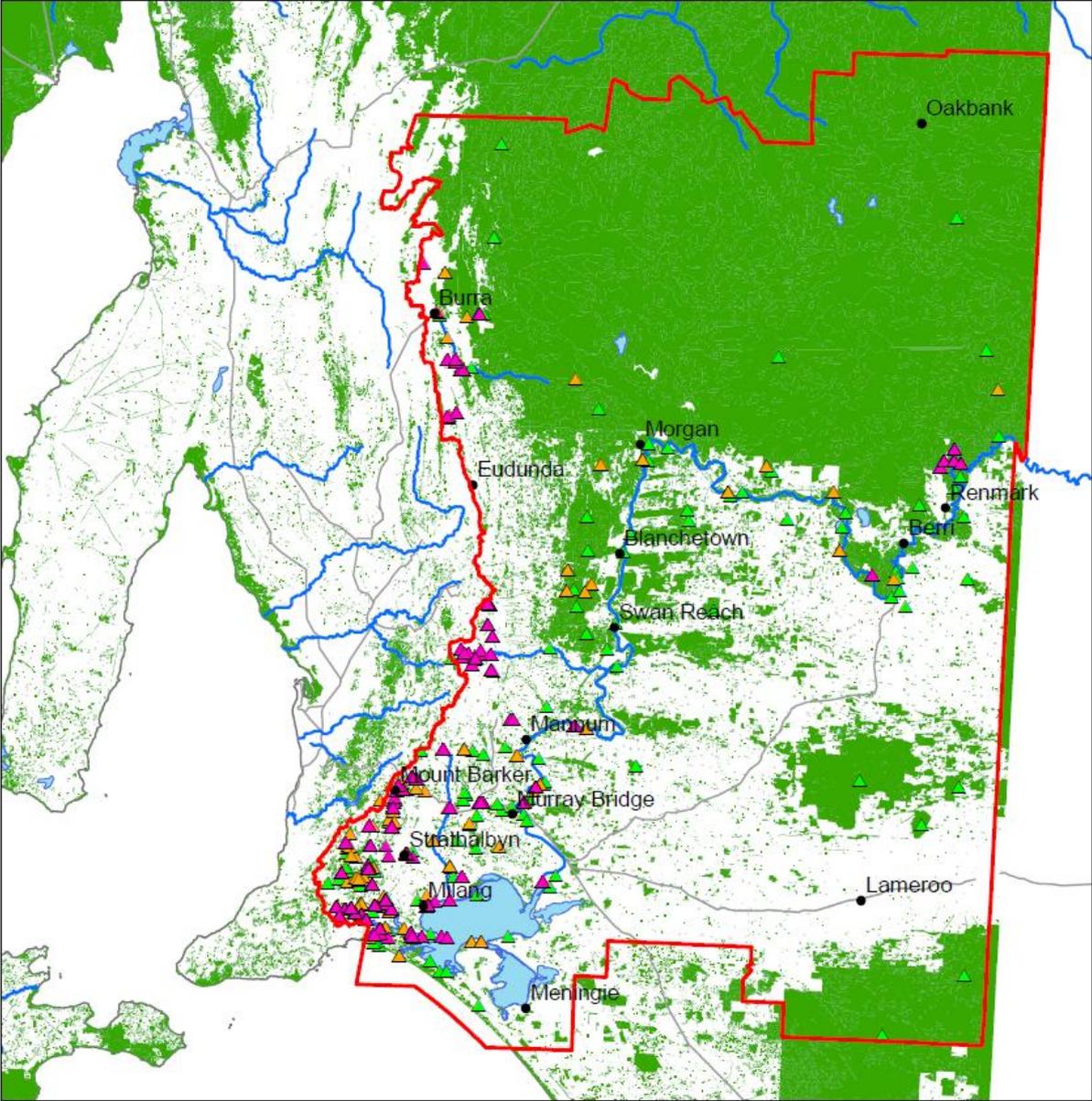
Table 2. Pairwise comparisons used to show the combinations of themes monitored.

	Ground water*	Surface water	Vegetation	Fauna	Soils	Pests	Other
<i>Ground water</i>		33	38	24	9	33	50
<i>Surface water</i>	64		42	26	27	50	38
<i>Vegetation</i>	64	37		41	36	67	63
<i>Fauna</i>	57	33	58		27	67	63
<i>Soils</i>	7	11	17	9		0	25
<i>Pests</i>	14	11	17	15	9		38
<i>Other</i>	29	15	21	15	9	50	

*The table is read such that, for all the groups that monitor the theme given in **bold** (column headings), x percent also monitor the theme given in *italics* (row headings) e.g. of all the groups that monitor ground water, 64% also monitor surface water; of all the groups that monitor surface water, 33% also monitor ground water. Colours grade from yellow (high percentage of groups monitoring theme mixtures) to green (lowest % of groups monitoring theme mixtures).

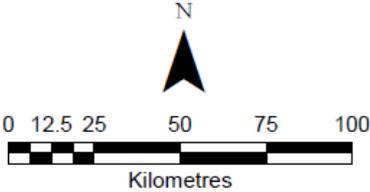
Location of themes monitored

Map 1. Location of participatory monitoring in the SAMDB NRM region



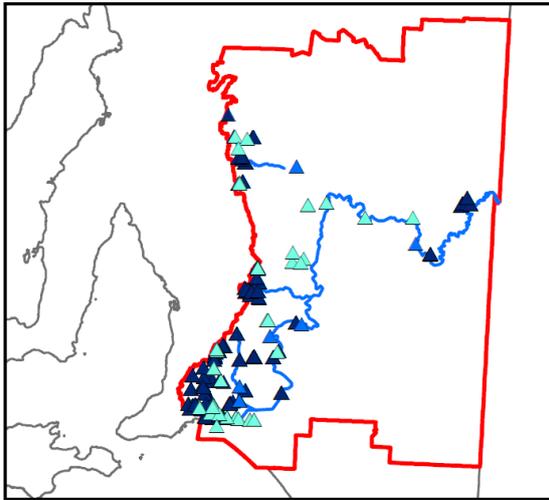
Legend

- ▲ Community Monitoring Online Database
- ▲ Surveyed Participatory Monitoring Groups
- ▲ Birdpedia
- Towns
- Major roads
- Watercourses
- ▭ MDB NRM region
- ▭ Lakes
- ▭ Vegetation

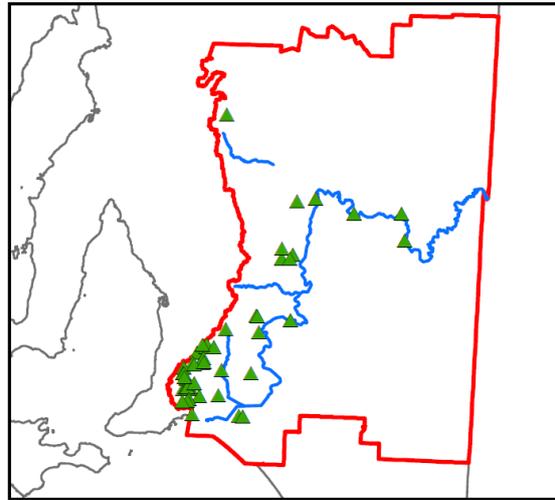


Map 2. Location of participatory monitoring by theme in the SAMDB NRM region

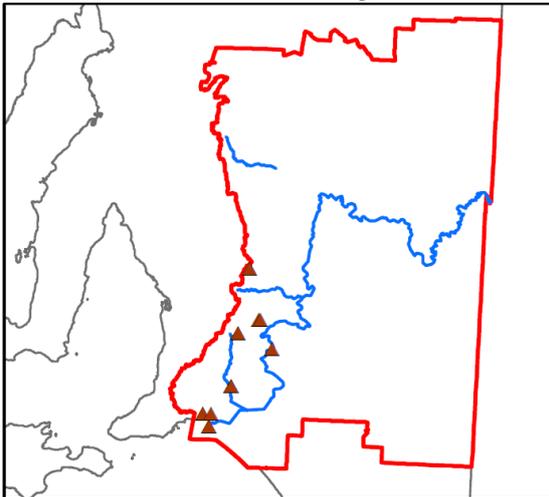
Water



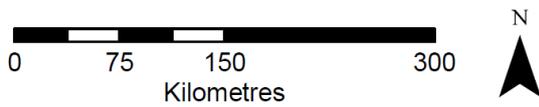
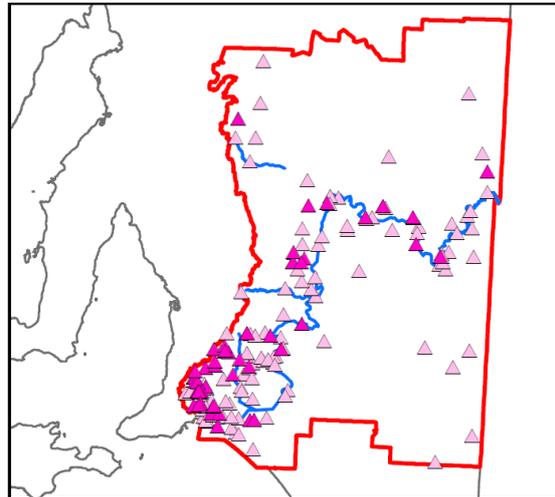
Vegetation



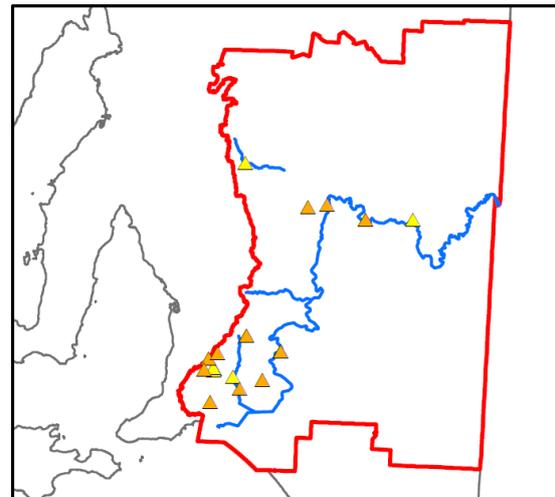
Soils & land management



Fauna

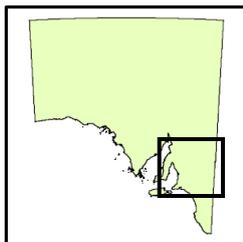


Pests & Other



Participatory Monitoring 2011

-  Surface Water
-  Ground Water
-  Community Monitoring Online Database July 2011
-  Vegetation
-  Soils & land management
-  Fauna
-  Birdpedia
-  Pests
-  Other
-  Watercourses SAMDB
-  MDB NRM region



Part 2: Investigation of participatory monitoring in the SAMDB

Purpose of participatory monitoring

The question 'what is the primary purpose of your monitoring program' was answered by 35 responses, 22 from participants in the telephone survey, and 13 from participants who completed the survey via e-mail. Twenty-four respondents conduct their monitoring activities within a group, and 11 operate as individuals within a supported network. Eighteen of the responses came from participants affiliated with the stream sampling network, four from wetland monitoring programs, and the remaining 13 responses from groups which operate primarily independently or with other organisations such as DENR, NCSSA. Despite the diversity of the respondents, several key themes emerged from this question.

One of the most highly reported purposes of participatory monitoring was to increase knowledge of the resource. Only four respondents of the 35 did not list increasing knowledge of natural resources as one of their primary motivations. A high proportion (approx 40% of respondents) indicated that their monitoring would contribute to their own local management of natural resources, or inform them of the effectiveness of local on-ground works. Monitoring purposes ranged from conservation-oriented (monitoring the effects of a water regulator on wetland condition) to commercial-oriented (informing timing of irrigation). The next most commonly reported reason for wanting to increase knowledge about natural resources was to contribute to region-wide knowledge about the resource (approx 25 %). Other reasons listed included concern for a particular species, concern about the impact of a problem such as the drought, or deforestation on a resource such as water, or bird life. Three respondents stated that their monitoring efforts were conducted with the aim of gathering evidence about the extent of an existing problem, and that their intention was to use this evidence in campaigning for a change in management.

Capacity building, sometimes described as education and engagement, emerged as the next most dominant purpose of participatory monitoring programs.. Three of the four respondents who did not mention increasing knowledge of natural resources as a motivation (two LAP officers and one school group) listed education and engagement as their primary objective. Most respondents gave further details about how they intended to use the additional knowledge gained through monitoring. Project officers were more likely to mention capacity building as a driver than community group members, however community group members also discussed the importance of using their results to educate and engage the broader community.

A large number of groups also indicated that (contributing to) research was a key purpose of their monitoring program. In almost all cases, research was always combined with either contributing to regional knowledge of the resource, or with seeking additional knowledge about a resource due to concern about a potential threat. Professionals from non NRM Board groups were the most likely to list research as one of their key purposes. Community group members who had been involved in monitoring groups for a long time also listed research as a key purpose. It is possible that this difference may only indicate a difference in language between professionals, or long term NRM volunteers and shorter term, or more casual volunteers. It may also suggest that there is a difference in understanding about the need for design, reporting, analysis and interpretation of monitoring in order to accurately detect change. Other responses included personal interest, and monitoring to fulfil a contractual obligation.

Some of the responses to the survey suggest that a desire to increase knowledge of natural resources is motivated by a perceived decline in the health of natural resources. Two respondents mentioned that they were monitoring to make sure that problems could be detected and addressed before they escalated. Seven respondents specified that their monitoring was prompted by concern about an existing problem, (three of these intended to use the results of monitoring to campaign for management change). Analysis of the timing of when monitoring programs began supports the idea that some programs emerge or attract personnel as a reaction to changing environmental conditions. There is a spike in the number of new monitoring themes taken up by groups in 2003 (Figure 2), (predominantly consisting of surface water, ground water and vegetation monitoring) which may be linked to the drought.

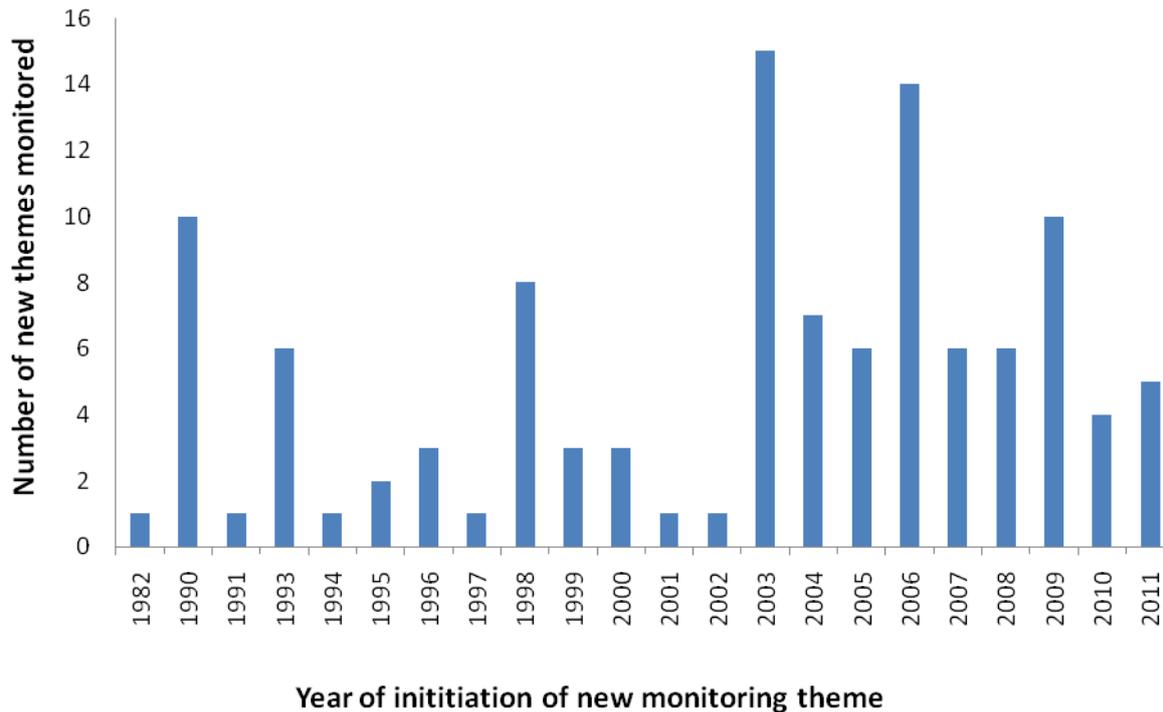


Figure 3. Initiation of new monitoring activities by year

Each point represents the monitoring of a new natural resources theme e.g. a new wetland monitoring program established in 1997 that monitors surface water, vegetation, and ground water would count as three points in 1997; or an additional element of monitoring is added to an existing program (if the wetland program introduced frog monitoring in 2001, that would count as one point for 2001).

Benefits of participatory monitoring

Respondents reported that personal satisfaction or ‘serious leisure’ was one of the main benefits from participation. The benefits include pleasure at seeing a positive change in resource condition, learning new skills, personal interaction with like-minded people, and interacting with nature. Approximately 75% of all respondents to this question listed at least one element related to personal satisfaction.

Increased knowledge of natural resources was often reported as a benefit, including using increased knowledge of resources to enhance management decisions, and contributing to a ‘bigger picture’ of the condition of natural resources. Approximately 20% of participants referred to the length of their time series as a positive, and highlighted the importance of tracking trends over time to gain a better understanding of natural resources. Six respondents highlight community education or engagement as one of the best things about their program.

Volunteer involvement in different aspects of participatory monitoring 2005 vs 2011

In 2005, community-based monitoring survey results indicated that participants saw potential for an increased level of involvement in components of monitoring programs (Figure 4). Despite the potential to be more involved, results from 2011 indicate that the level of involvement has not increased since 2005 for any of the components of monitoring programs (unpaired t-tests for each activity, $p > 0.05$ for all components).

From levels of actual involvement in 2005 and 2011, it is clear that participants are significantly more involved in co-ordination, data collection, equipment management and communication than they are in planning, data entry, analysis and interpretation (One-way ANOVA, $p < 0.01$).

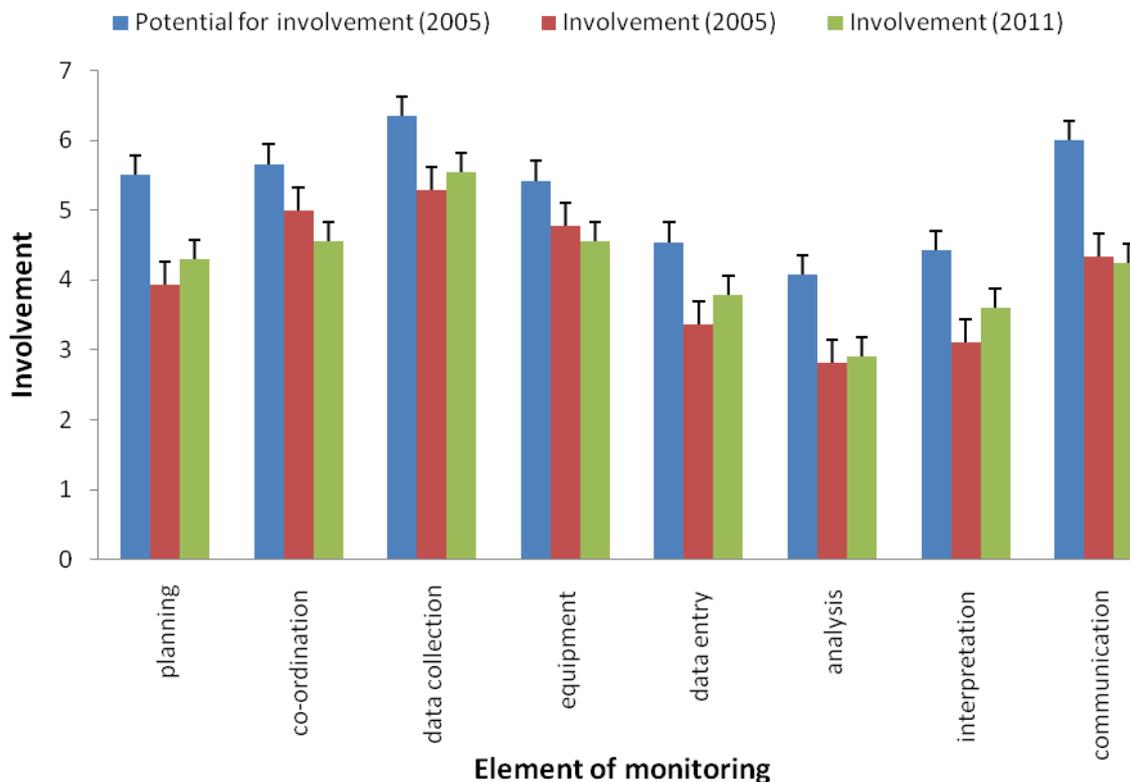


Figure 4. Participatory involvement (2005 & 2011) and potential for participatory involvement (2005) in different components of monitoring

Involvement and potential involvement were rated by survey respondents on a scale of 1 to 7 where 7 is very involved and 1 is not at all involved. Planning= overall design of monitoring program site selection, experimental design, timing, funding; Co-ordination= organising logistics; Data collection= monitoring process, making observations and recording on primary data sheets; Equipment= equipment management- storage, cleaning, calibration, maintenance, transport; Data entry= transferring field data into other form of data storage; Analysis= exploration of results (primarily statistical); Interpretation=interpreting the meaning of the data, explaining trends, considering results in a broader context; Communication= communicating the process of or results from participatory monitoring within group, or to broader community, or to organised body.

Greater participation in data collection and equipment management, and lesser participation in planning, analysis and interpretation may reflect a natural division of labour between professional NRM staff, and unpaid participants from the community. The process of collecting data requires some level of training and skill, and a time investment. However, the training required to successfully complete these tasks is significantly less than the training and time required to prepare a management plan, and to collate and analyse data. Expecting participants to be equally involved in all parts of the monitoring program is likely to be an unrealistic aim for many participatory monitoring groups. Many respondents, mentioned that volunteers analysed and interpreted the data informally themselves for education, or for their own interest, but felt that formal analysis of results might be better left to professional scientists

'We've got good on-ground experience, but we're not scientists.' (survey respondent)

This type of sentiment was expressed more commonly by groups which contributed their collected data to a broader network.

Increasing involvement in analysis interpretation and communication is clearly a goal for some groups. Two groups mentioned that they are limited by their inability to analyse their own data and three groups mentioned frustration at their inability to communicate their data and findings to decision making authorities⁸. The survey in 2005 also showed that participants saw potential to contribute more beyond data collection. There is also a large gap between perceived potential to communicate data, and actual involvement in communication of the data. There seems to be some dichotomy between groups who are happy to maintain their current level of involvement in data collection and equipment management and leave analysis to the scientists, and those who want to be more actively involved in using their data to campaign for change.

Existing support for participatory monitoring

The support provided to monitoring groups may also contribute to the different levels of involvement in different parts of the monitoring programs. Provision of equipment and training to undertake monitoring activities were the most commonly reported types of support, and directly facilitate the involvement of participants in data collection and equipment management.

Groups were asked to select which resources were used in their monitoring program and to identify who supplied these resources. They were also asked what additional resources they thought were required to maintain or improve their monitoring program. Of all monitoring

⁸ In response to the question – 'what are the three greatest challenges for your program'.

activities, most monitoring involved the use of equipment (78%), followed by expert advice (56%) and training (55%). Less than half the themes monitored by groups used grant funding, project officers, educational materials, facilities or any other types of resource (Figure 5). Many different organisations supplied resources to participatory monitoring programs showing a well established support network is already in place (Figure 6).

Of the resources that were supplied, the SAMDB NRM Board most often supplied grant funding, project officers, equipment, educational materials, training, and expert advice. LAP groups, Landcare and other community groups also supplied resources to a considerable proportion of programs in the areas of facilities (29%), project officers (27%), equipment (23%), and training (20%). NGOs contributed expert advice to almost one quarter of monitoring themes.

While participatory monitoring groups and the individuals in the groups most often supplied their own facilities (42% of all facilities supplied), facilities were not perceived to be a required additional resources needed to maintain or improve their program.

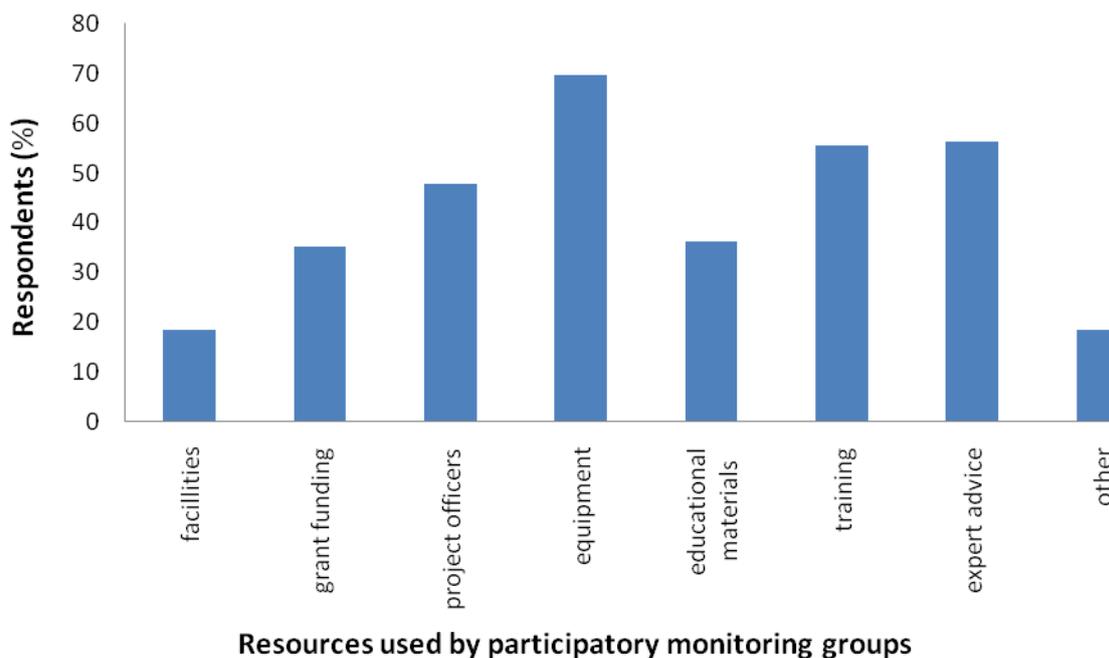


Figure 5. Percentage of participatory monitoring programs and resource use

Facilities = permanent facilities such as buildings; grants = any grant funding; Project officers= project officers or similar employed to assist community groups with community monitoring activities; Equipment= any equipment supplied to groups to help with monitoring activities, including nets, work clothes, vehicles, and tools for monitoring such as peisometers; educational materials= any physical educational materials provided to participants in monitoring programs, including pamphlets books, instructions, articles; Expert advice= any advice provided by experienced scientists, or field workers in elements of natural resource management or monitoring.

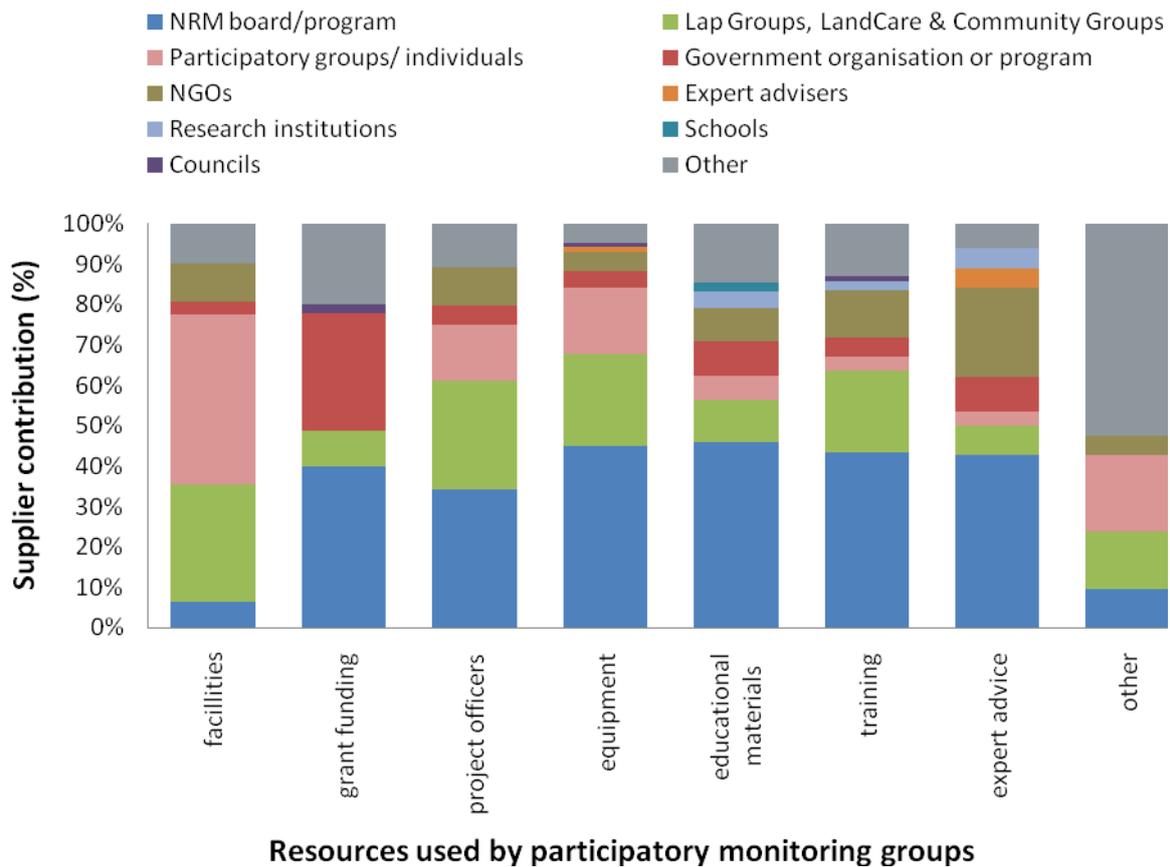
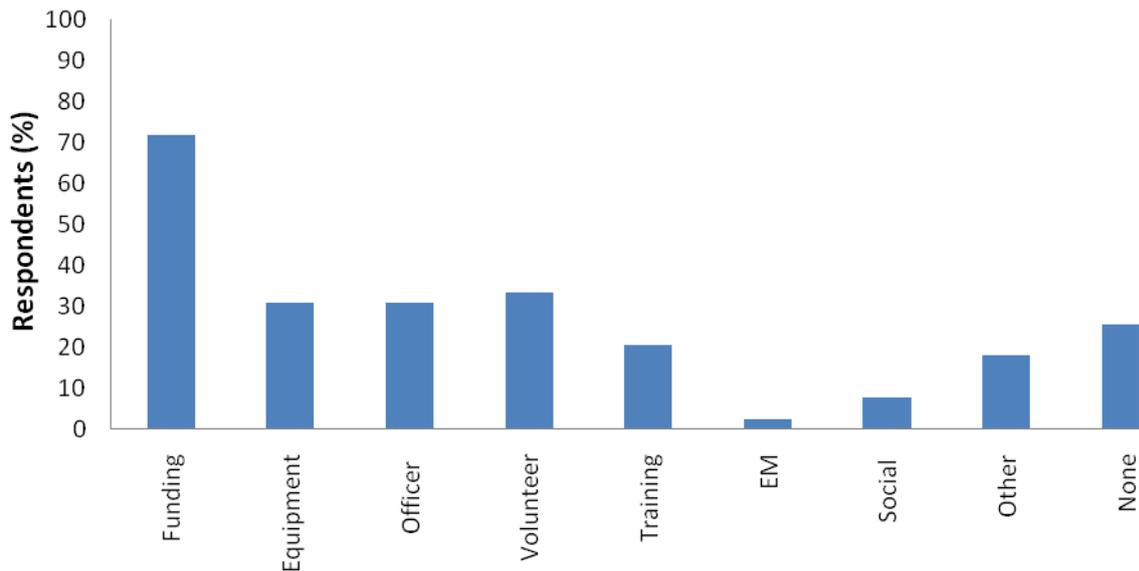


Figure 6. Participatory monitoring programs and resource suppliers
 Labels as in Figure 5.

Additional support wanted by participatory monitoring groups

Ninety-four suggestions (from 39 groups) were given for additional resources required to maintain or improve participatory monitoring programs. Funding was the most commonly reported additional resource required to maintain or improve the existing participatory monitoring program (identified by 72% of all respondents) (Figure 7). In many cases, this referred to a continuation of existing funding, rather than the provision of additional funds. Additional equipment, officer time and volunteer time was reported as being required by more than 30% of respondents. The additional training required may indicate groups’ intention to raise the standard of their monitoring or their desire to increase the number of volunteers. However there was little call for additional educational materials suggesting that the current materials are satisfactory for current purposes.



Additional resources to support participatory monitoring

Figure 7. Resources required to maintain or improve participatory monitoring programs

Funding= continued or increased funding, for the whole program, or specific group, also includes help obtaining funding; Equipment= physical equipment, primarily a tool for monitoring, or a more accurate version of tools currently used; officer= more officer time; volunteer =more volunteer time, EM = educational materials; social = organisation of social events; other= any other type of resource suggested; None= survey respondent said they did not need any other resources.

Of the respondents, 25% indicated they did not need any additional resources. This may be because some monitoring programs are relatively simple and have already been given the necessary training and equipment e.g. monitoring surface water salinity. Respondents who did not answer the question were not included in the analysis, so this figure may understate the number of groups who do not want additional resources. Participants operating as individuals and who also undertook monitoring on their own properties tended to say that they did not require any additional resources.

Challenges faced by participatory monitoring programs

Challenges reported by ongoing participatory monitoring programs are strongly linked to the type of monitoring group. Groups which operate independently of the NRM Board often mentioned funding as one of their key challenges. In addition to a lack of funding, difficulty in negotiating constantly changing funding structures, and inconsistency in funding availability were highlighted. Other challenges identified included:

- recruitment and motivation of volunteers
- increasing the complexity or length of time spent monitoring
- dealing with bureaucrats (apathy)

- limited ability of groups to analyse their own data
- difficulty communicating their data to relevant authorities

These difficulties correspond to elements of participatory monitoring where there is a large gap between perceived potential to participate in monitoring, and actual participation in monitoring (see Figure 3).

Community Monitoring Toolkit

Few respondents in the survey had heard of the Community Monitoring Toolkit. Respondents who had heard of the Toolkit said that they found all of the elements of the Toolkit useful. One respondent (not linked with the SAMDB NRM Board) said that they had their own 'toolkit' which served a similar purpose. Further promotion of the Toolkit is likely to be beneficial in increasing its use by monitoring groups. It may also be of benefit, and a relatively simple task, to improve the layout of the Toolkit sections on the SAMDB NRM Board's website.

Why do people stop monitoring?

A number of the survey respondents reported the cessation of certain themes that they were monitoring or cessation of their monitoring program altogether. Reasons for the cessation of monitoring included:

- lack/completion of funding
- time constraints
- changing personal circumstances and commitments
- monitoring was a one off survey and on-ground works were a priority

Additionally, some monitoring programs are opportunistic and may not be ongoing. In one case a monitoring group had been established to collect evidence to oppose a development in their local area. In addition to undertaking vegetation surveys themselves, the group paid a professional botanist and were successful in identifying an endangered species, and opposing the development. Once the threat had been deflected the group's activities quietened down, but the groups' chairperson reported that they were '*still there waiting to fire up if necessary*'.

Communication

Participatory monitoring data was most commonly reported as being shared within the group (72% of respondents), then by word of mouth (50%) or sent to the NRM Board for use

in regional decision making (48%) (Figure 8). Twenty-nine percent of respondents indicated that their data is currently entered into an online database.

Almost 80% of respondents indicated they would like to communicate their data in some other way than is currently the case and 16% didn't want to further communicate their data. Of the additional communication methods identified, online data entry/website creation made up the most significant proportion (Figure 10).

For the groups who didn't want to communicate their data in any other way, all reported that they were currently communicating their data using on average five different methods. Most already enter their data into an online database (for at least one of their monitored themes – mostly water quality), 67% already shared the data within the group, 67% already shared it by word of mouth, 50% already communicated at field or demonstration days, 50% reported sending it to the NRM Board for use in regional decision making, 33% reported in community newsletters/pamphlets, and 33% shared their data with consultants (Figure 9).

NB: there is likely to be over reporting of the proportion of groups who 'sent their data to the NRM Board for use in regional decision making', as some groups reported that they did not know what happened to their data after it was sent to the NRM Board.

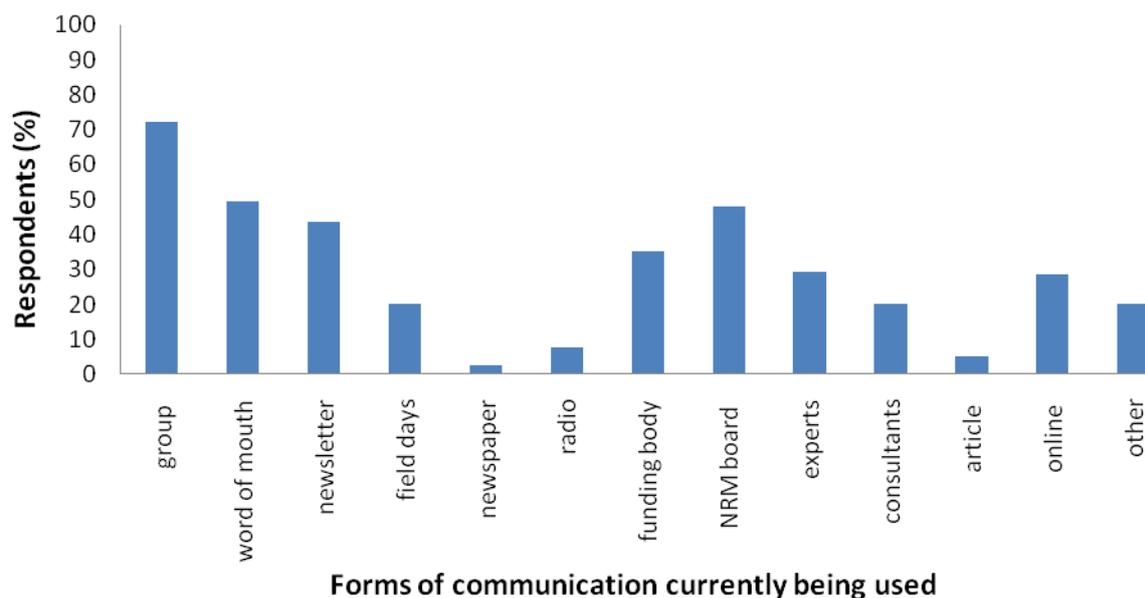


Figure 8. Methods used by participatory monitoring groups to communicate data
 Respondents (46) returned 455 methods of communication, for 119 monitoring themes.

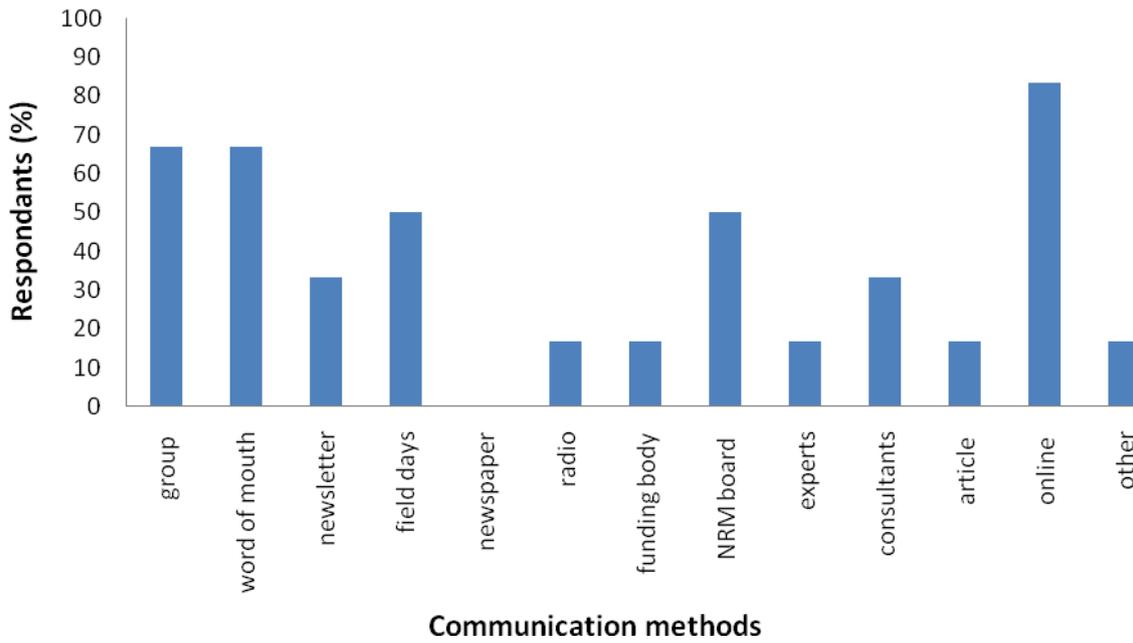


Figure 9. Communication methods already used by groups who do not want to use any additional forms of communication

Labels are consistent with Figure 8.

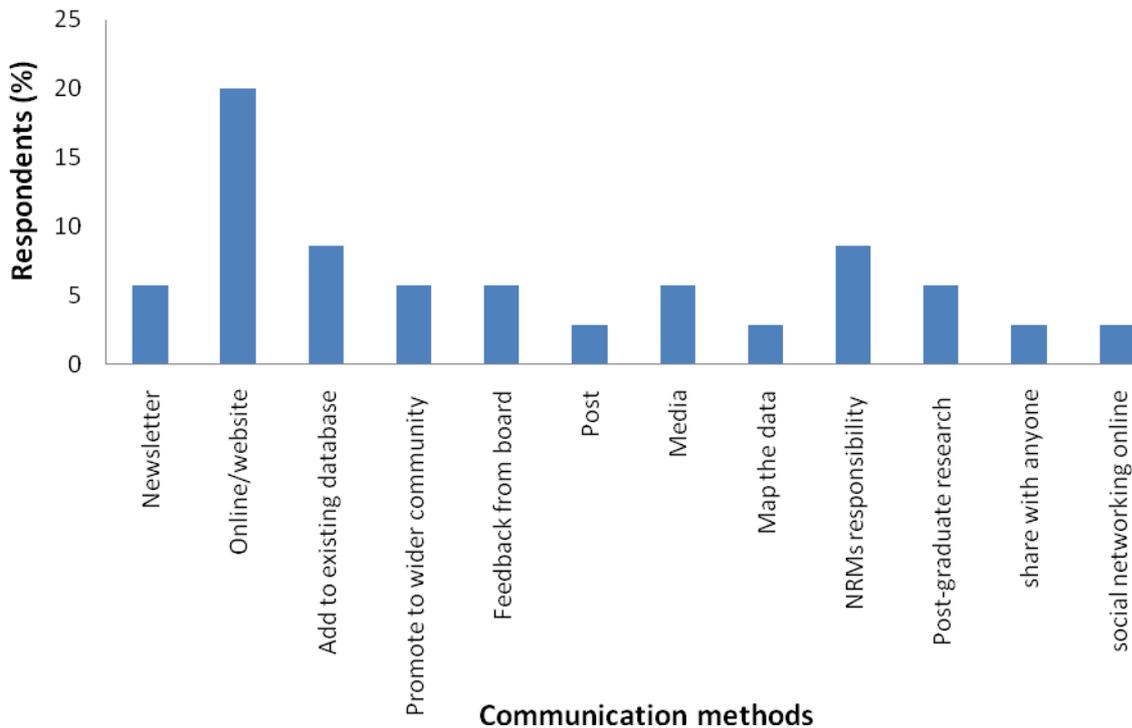


Figure 10. Communication methods identified for use in future

Respondents to this question = 35. Newsletter= local publication shared with the community; online/website= any new form of internet communication; add to existing database= addition of data to existing community data base; promote to wider community= promote results to the wider community; feedback from board= group would like increased feedback from the board; post= posting promotional material; media = increased use of media, NRMs responsibility= participant believes it's the NRM boards

responsibility to decide on methods of communication, and to communicate the data; Post-graduate research= suggests that data could be used for post-graduate research,; share with anyone= survey respondent would be happy to share the data with anyone who wants it, social networking online= share online.

Part 3: The potential use of participatory monitoring in regional decision making

Perceived influence on local and regional decisions

In 2005 respondents reported significantly higher levels of confidence that their monitoring results contributed to local planning than they did to regional planning. This difference in confidence between local and regional planning was no longer statistically significant in 2011 (Two-way ANOVA , $p=0.9205$).

Between 2005 and 2011, respondents' confidence that their monitoring contributed to local planning decreased, while confidence that their monitoring contributed to regional planning increased. While these differences were not statistically significant, they resulted in the loss of detectable difference in confidence in using results at the local and regional level which was observed in 2005 (Figure 11).

There are several possible explanations for the loss of difference between respondents' perceived confidence in the influence of their monitoring on local and regional decision making, such as:

- Improved engagement with the regional NRM Board
- Increased knowledge of regional NRM issues
- Change in the composition of survey respondents between 2005 and 2011.

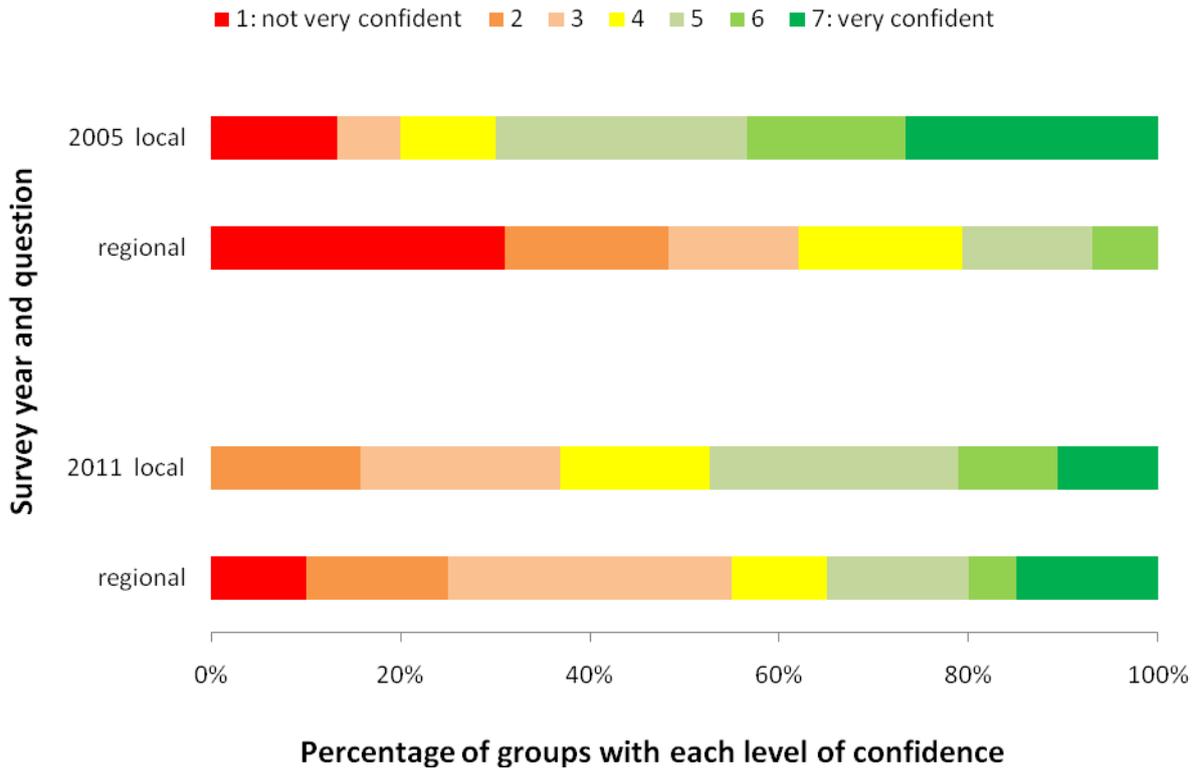


Figure 11. Confidence that participatory monitoring contributes to local and regional natural resource management decisions 2005 vs 2011. Question asked in 2005 and 2011; 7 = very confident, 1 = not at all confident.

The loss of confidence in the data being used in decision making at the local level, appears to be explained at least partially by negative experiences with local government. The only two respondents who were more confident that their work influenced regional decisions than local decisions made negative statement about local government:

‘action is delayed for too long’ (survey respondent) and

‘local government needs to be better informed and manage environment better’ (survey respondent)

Involvement in a monitoring network may also help to increase confidence that data is useful at a regional level. One respondent who was ‘very confident’ that their data was used in both regional and local decision making levels commented that they had no idea what happened to their information after they passed it on. However, their confidence in the program, and the NRM Board staff member with whom they interacted was so great that they were entirely confident their data was being put to good use.

The sentiments expressed by survey respondents varied significantly. Some expressed confidence that their data would affect management decisions at both regional and

local levels if they did find a problem, two respondents suggested that vested interests would distort decision making at regional levels, and that people did not want to know about local level problems. A common sentiment was that respondents did not really know if their data was being used, but that they would like to think it was being put to good use. Multiple respondents added that they would like better feedback about what was being done with the information they were collecting. One respondent stressed the high quality of the data collected by volunteers in their group, and their frustration that it was not being better used by decision making agencies.

Assessment of participatory monitoring programs for use in regional decision making

Table 3 summarises the standard of participatory monitoring programs with respect to the needs of regional planning. The table highlights that the current network of participatory monitoring has a high degree of alignment with NRM targets (see also Appendix 5), monitoring methods are usually appropriate for the resource being monitored, and are objectively verifiable. The level of skill and training of participants is currently sufficient or could readily be made sufficient to allow them to conduct monitoring at the level required for use of the data in regional planning.

Communication of participatory monitoring data is less frequently conducted at a level which could influence decision making, however more than half of all participatory monitoring groups report their data to the NRM Board (in expectation that it is used in decision making), enter it into an online database, or use it for research. Quality assurance protocols are not strictly observed in all programs for all monitoring themes. This may not necessarily mean that the data collected is not to a high standard, but it may reduce confidence in the quality of the data (**NB:** volunteer survey respondents may not be aware of all QA/QC measures taken by professional project officers/coordinators, resulting in underestimation of the standard of QA/QC).

It is significant that almost all community monitoring programs have at least one monitoring theme for which they only meet the minimum standard (89%). Only 3% of all participants meet the defined standard for all the themes they monitor, and almost all programs monitor at least one theme which meets the maximum standard.

These results may help to explain the frustration uncovered in the survey by community group members who feel they are collecting good data which is being ignored. Failure to meet the necessary standard for a single element of the program (such as communication, or quality assurance) is likely to prevent otherwise useful monitoring programs from contributing effectively to decision making. Almost all programs could be made more useful if the scale of their monitoring program (ie. the spatial distribution and number of samples)

was larger or if work was done to combine data from multiple programs to synthesise results at a more regional scale (this is done for some programs). It is axiomatic of many of the participatory monitoring programs that they operate at local or site scale (e.g. monitoring of an individual wetland or wetland complex by a group).

Table 3. Summary of participatory monitoring programs with respect to the needs of regional planning.

Data are presented as the percentage of monitoring themes (n=126) from the 46 projects reviewed.

ASSESSMENT CATEGORY	STANDARD			NOT ASSESSED
	PARTICIPANT LEARNING	COULD MEET STANDARD	MEETS OR EXCEEDS STANDARD	
Theme aligns with regional NRM targets*	12	1	83	4
Sampling design ¹	1	0	11	88
Monitoring methodology				
Appropriate	10	1	80	9
Objectively verifiable data	6	3	78	13
Participant skill level and training	1	15	70	15
Quality assurance²				
Monitoring plan	41	0	54	5
Sampling protocol	52	0	43	5
Replication	71	0	24	5
Data record sheets completed	24	0	71	5
Correct units recorded	38	0	57	5
Data entry validation	60	0	35	5
Database maintained	46	0	49	5
<i>Control site/reference is measured</i>	36	0	5	59
<i>Sampling equipment cleaned & maintained</i>	13	0	28	59
<i>Equipment calibrated regularly</i>	12	0	29	59
<i>Logbook of equipment maintenance</i>	27	0	14	59

Scale	4	89	6	1
Review/adaptive management	13	2	34	52
Communication/reporting	9	4	67	20
MIN ³	89	8	3	0
MAX ⁴	0	1	99	0

¹Sampling design was difficult to assess, as many of the survey respondents had not been directly involved in the sampling design, and had only a rough idea of the elements of sampling design.

²The last four categories of quality assurance are only relevant and reported for water monitoring groups: ie. *control site/reference is measured; sampling equipment is cleaned & maintained; equipment calibrated regularly; Logbook of equipment maintenance is kept.*

³MIN = Percentage of monitoring programs which have at least one monitoring theme (ie. attributes within all programs) in the category

⁴MAX = Percentage of monitoring programs which have at least one monitoring theme (ie. attributes within all programs) in the category

*Broadly relates to all targets (RCTs and MATs) i.e. groups have not been separated into individual targets.

Quality assurance and quality control in participatory monitoring programs

QA/QC processes most often reported as in place in participatory monitoring programs were (Figure 12):

- keeping data record sheets (78% of groups)
- recording the data and time of monitoring (73% of groups)
- recording the correct units (60% groups)
- cleaning and maintaining of equipment (58% of groups)
- had a completed management plan (> 50% of groups)
- calibrated their equipment regularly (> 50% of groups)
- regularly maintained their database(> 50% of groups)

Monitoring programs with a project officer more often reported having all QA/QC processes in place than those without a professional project officer or coordinator (Figure 13). The main QA/QC processes more often reported as being in place by project officers than volunteers were:

- control site/ reference is measured (25% higher)
- replicates are sampled/measured (23% higher)
- entered data is cross checked with field data after entry (23% higher)

Volunteers were rarely sure if their monitoring program had a management plan in place, or if a review had been undertaken. A volunteer who is not aware that a sampling protocol is available, relies on direction from others (usually a professional officer) and may not be able to access or follow a standard protocol without training or other support. These results indicate the importance of professional support for many types of monitoring and monitoring groups, particularly in light of the impact of uncertain or inadequate QA/QC on use by planning authorities who might want to use the data.

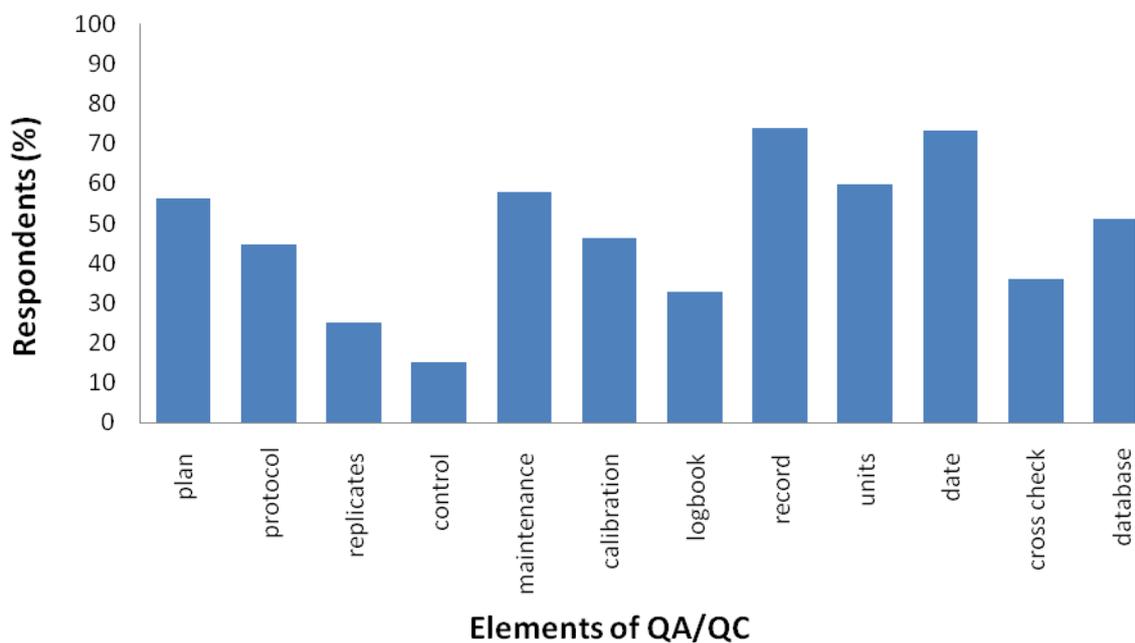


Figure 12. QA/QC processes used in participatory monitoring programs in 2011

Plan = a monitoring plan has been completed; protocol= sampling protocol is available; replicates= replicates are taken; control= a control site/ reference is measured; maintenance= sampling equipment is cleaned and maintained regularly; calibration = sampling equipment is calibrated regularly; logbook= a logbook is kept of equipment maintenance and monitoring activities; record= data record sheets are completed; units= correct units are recorded; date= date and time of day are recorded; cross check= data is cross checked after entry into the database; database= database is maintained regularly.

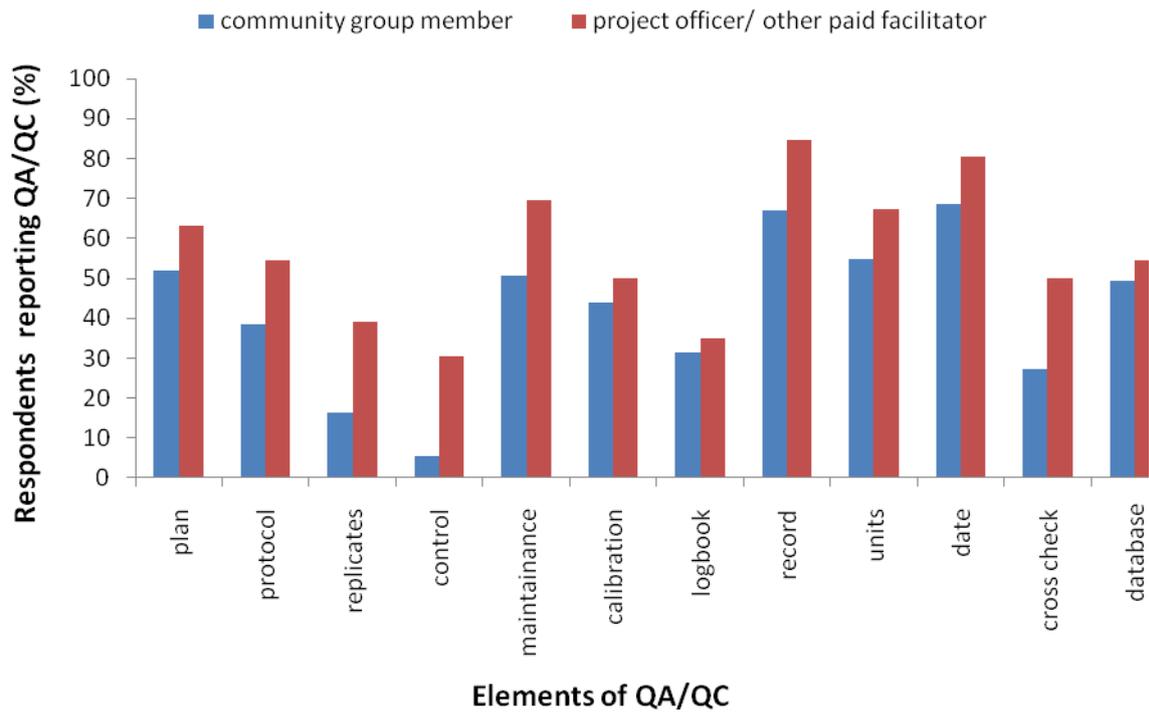


Figure 13. QA/QC processes used, community group members (volunteers) vs project officers (and other paid NRM officers). Labels are consistent with Figure 12.

Synthesis and conclusions

Demand for participatory monitoring data

Using participatory monitoring in regional decision making processes requires action to improve both the provision of appropriate data and the process for using data in decision making. Both the planning and evaluation processes currently in use by the SAMDB NRM Board are capable of using evidence provided by participatory monitoring programs, where it is accessible. This is largely due to the expert-knowledge based methods used for evaluation of progress towards regional Management Action Targets for Regional Outcome Reporting and for setting regional targets for the SAMDB NRM Plan. Movements towards more direct use of resource condition data in development of conceptual and quantitative planning models (e.g. Driver, Pressure, State, Impact, Response models (Gabrielsen and Bosch 2003)) may make limited use of participant monitoring program data due to barriers to access, real and perceived weaknesses in quality assurance and limited synthesis at regional and sub-regional scales.

The demand for high quality data for planning, evaluation, research and communication is likely to grow as pressures on natural resources increase. The apparent upswing in participatory monitoring in the SAMDB NRM region during the drought indicates that monitoring data may be needed more in times of scarcity than plenty. The collection of monitoring data of all types should be informed by clear objectives and explicit decision making needs. Many participatory monitoring programs reviewed here do not currently meet all standards for usefulness in regional decision making primarily because the data collection programs do not understand regional decision making or do not see regional decision making as a driver for their monitoring. This may in part be due to a failure of feedback from decision makers to monitoring programs about the usefulness of participatory monitoring data and the required changes to improve utility. Feedback on the appropriateness and adequacy of monitoring programs should be a responsibility of NRM Board planning processes, equal to the responsibility to support participatory monitoring for purposes such as capacity building. If participatory monitoring data is not useable or will not be used this should be made clear to monitoring programs so that they can adjust their design or prioritise their efforts on meeting local resource management or psycho-social needs.

Research will continue to be a potential user of participatory monitoring data but will need to negotiate the same challenges as planning, ie. data appropriateness, adequacy, accessibility and quality assurance. These are all areas where many of the participatory monitoring programs are currently challenged.

Supply of participatory monitoring data

The supply of monitoring data from participatory programs is potentially very significant. The large number of themes monitored and the large number of locations where monitoring occurs is the basis of a potentially very useful regional network. Most monitoring programs collect data on a range of indicators or themes and many show willingness to add indicators if the benefits are obvious. Monitoring participants derive pleasure and personal satisfaction from their monitoring activities and report that they have gained knowledge through participation. Participants clearly want to increase knowledge of natural resources in the regions, want their data to be useful and used, and in many cases believe that the data is used, though there is little evidence of feedback about how data is used.

Volunteer involvement in different aspects of monitoring programs has remained relatively static since 2005 and indicates that participants have higher attraction or opportunity to undertake some tasks than others. Involvement in data entry, analysis and interpretation is lower than in planning and direct action (coordination, data collection and equipment management). A large number and diversity of organisations are involved in providing resources to participatory monitoring programs. This provides a natural link for the results of monitoring efforts to be shared. It also highlights the need for participatory monitoring programs to be supported by groups and organisations which themselves may receive support from the NRM Board. Enhancement of participatory monitoring programs should recognise the different levels of professional and institutional support needed for the different tasks of monitoring programs and seek to optimise volunteer involvement in the tasks most effectively sustained by volunteers.

Data quality assurance

A large number of programs meet or could be readily assisted to meet standards for monitoring data use in regional decision making. This result may be influenced by the nature of support to the large monitoring programs for water quality and wetland health. However, the review found that almost all programs are deficient in some respect of data quality assurance for at least one of the attributes or themes that they monitor. This further suggests that the usefulness of much of the data is not being tested by current decision making processes. There is evidence that programs with more professional support may more readily meet QA/QC standards. The level of professional support provided should evolve to prioritise programs with the most potential to contribute to decision making, or be recognised as primarily providing capacity building support. It does seem likely that the current level of QA/QC of programs is a consequence of professional support and may drop if this type of support is not provided in future.

There is evidence that only a few programs are aware of and using the Community Monitoring Toolkit, though some programs are not in need of all of the tools. This suggests that the Toolkit has not been adequately promoted or that it does not meet the needs of project officers or program leaders. Many of the identified weaknesses of the surveyed monitoring programs are addressed by the tools and could be rectified with appropriate use of the tools. It may be necessary to further promote the Toolkit and/or provide training in use of some of the tools dealing with areas of greatest need for monitoring programs.

Data access

With the exception of water quality data available on the SAMDB NRM Board website, little of the data from participatory monitoring programs is accessible without local networks and possibly without additional data cleansing and handling. This is not unusual and remains the case for most agency and research institution monitoring datasets. Most surveyed programs did report a range of ways in which they communicate about their monitoring programs, including data, however most also indicated that they would like to use additional methods of communication. There is evidence that the accessibility of data has improved since 2005 and that this has been positive for participants and programs. Approximately 50% of programs currently make their data available on the internet or would like to make their data available on the internet.

Recommendations for action

The primary objectives for the SAMDB NRM Board to support participatory monitoring programs for the purposes of decision making should be to support

- **Adequacy and appropriateness** of the monitoring programs – appropriate attribute selection, collection methods and sampling designs
- **Quality assurance** of the monitoring programs – all actions necessary to promote and communicate the high levels of QA/QC in the programs
- **Data accessibility** – data is unlikely to be used beyond the local scale if it has to be accessed through individual officers or volunteers or if the data does not have appropriate metadata attached

There are many mechanisms of support for improving adequacy, appropriateness and quality assurance and evidence that the monitoring network has benefited from this support. The direction of support for environmental monitoring has traditionally been in the direction OBJECTIVE SETTING → DESIGN → MONITOR & QA/QC → ANALYSIS & REPORT. This sequence remains important for ensuring a useful monitoring program develops, however, it pertains more to the implementation of new monitoring programs than the

improvement of old programs, and is designed with the intent of local use of monitoring data (though other users may be considered). To take faster steps towards improving the use and usefulness of participatory monitoring a new direction is required.

Recommendation 1

It is recommended that further resources for support of community monitoring be first directed to supporting and facilitating increased open access to datasets through the internet. The existing Community Monitoring Database should be expanded for use by datasets other than water quality, where no other more appropriate internet accessible database can be found. Potential supporters of online databases should be canvassed and encouraged to create, expand or open up their databases for participatory monitoring data (e.g. Birds Australia, BirdAtlas; Nature Conservation Society of SA, Bushland Condition Monitoring Database). This approach is recommended as the first step to dealing with further challenges of adequacy, appropriateness and quality assurance.

It is anticipated that programs which can provide data and metadata for online access will benefit through increased likelihood of use of the data. Programs which can be assisted to develop to a standard where they can provide their data for open access will identify their own deficiencies and rectify or seek support to rectify them. It is anticipated that the standards and scrutiny of peer access to monitoring data will act as a driver for improved monitoring rationale, planning and implementation. Programs which cannot or do not wish to make their data openly accessible will opt out and will find other ways to contribute to decision making if that is one of their objectives. Privacy and use concerns should be dealt with on a case-by-case basis.

By making participatory monitoring data accessible, including meta data on quality assurance processes, it will be for planners, evaluators and communicators to decide when and how to use the data.

Actions

1. Review available online open-access databases for priority monitoring themes and add links to SAMDB NRM website
2. Provide coordination / assistance for monitoring groups to upload data to appropriate online databases
3. Disseminate information about availability of participatory monitoring data to community, regional, state and national forums for NRM planning and evaluation

Recommendation 2

It is recommended that the data and experience of participatory monitoring in the SAMDB be celebrated and challenged in an open community discussion forum on the condition and trend of natural resources in the region. The model of reflection and learning used by the SAMDB NRM Board to learn about progress in funded projects could be adapted to the purpose of a regional 'Change Exchange'. Participants should be invited to present their findings and experiences using a range of media with a strong focus on facilitated discussion of observations and findings and adequate time for cross-regional and cross-program networking. Organised sessions could provide stimulation and encouragement for learning about analysing, interpreting and communicating monitoring results.

A forum of the type recommended would facilitate the sharing of best practice and may stimulate greater involvement in and improvement of current monitoring programs. Discussions from the forum could be reported through the NRM Board website in a report, podcasts and powerpoint presentations. Participants could be supported to use web 2.0 tools to promote their monitoring programs by including media training sessions in the forum agenda.

Actions

4. Organise and promote a regional forum on changes in the condition of natural resources. Invite a broad range of participants to highlight the condition and trend in natural resources within the region with the intent of supporting and improving participatory monitoring.
5. Promote the discussion and learning from the forum through podcasts, report and powerpoint presentations on the NRM Board website.

Recommendation 3

Revise and promote the SAMDB NRM Board Community Monitoring Toolkit in line with the needs of the participatory monitoring network highlighted in this report. Existing modules should be reviewed and new modules developed to support increased accessibility of participatory monitoring data.

The tools do not seem to be being accessed in line with identified needs. The links and text on the SAMDB NRM website should be reviewed to ensure tools which are most relevant to current monitoring programs are easily accessed.

Training in the use of tools could be provided to monitoring groups. Training of this type could be offered as sessions at a participatory monitoring forum.

Actions

6. Revise the Community Monitoring Toolkit and the delivery webpages in line with the needs of current programs.
7. Promote the toolkit through existing and new forums and through training sessions for monitoring groups.

References

- Bell S, Marzano M, Cent J, Kobierska H, Podjed D, Vandzinkaite D, Reinert H, Armaitene A, Grodzinska-Jurczak M and Mursic R (2008) What counts? Volunteers and their organisations in the recording and monitoring of biodiversity *Biodiversity Conservation* 17, 3443-3454.
- Bell S, Marzano M and Podjed D (2010) Inside monitoring: A comparison of bird monitoring groups in Slovenia and United Kingdom. In *Taking Stock of Nature: Participatory Biodiversity Assessment for Policy, Planning, and Practice*, ed. A. Lawrence. Cambridge University Press, New York, pp. 232-250.
- Boakes EH, McGowan PJK, Fuller RA, Ding CQ, Clark NE, O'Connor K and Mace GM (2010) Distorted Views of Biodiversity: Spatial and Temporal Bias in Species Occurrence Data. *PLoS Biology* 8:e1000385.
- Burnett J, Copp C, and Harding P (1995) *Biological Recording in the UK: Present Practice and Future Development*. Coordinating Commission for Biological Recording. Ruislip, England.
- Conrad CC and Hilchey KG (2011) A review of citizen science and community-based environmental monitoring: issues and opportunities. *Environmental Monitoring and Assessment* 176, 273-291.
- Crall AW, Newman GJ, Jarnevich CS, Stohlgren TJ, Waller DM and Graham J (2010) Improving and integrating data on invasive species collected by citizen scientists. *Biological Invasions* 12, 3419-3428.
- Danielsen F, Burgess ND, Balmford A, Donald PF, Funder M, Jones JPG, Alviola P, Balete DS, Blomley T, Brashares J, Child B, Enghoff M, Fjeldsa J, Holt S, Hubertz H, Jensen AE, Jensen PM, Massao J, Mendoza MM, Ngaga Y, Poulsen MK, Rueda R, Sam M, Skielboe T, Stuart-Hill G, Topp-Jorgensen E and Yonten D (2009) Local participation in natural resource monitoring: a characterization of approaches. *Conservation Biology* 23, 31-42.
- Douglas C and Rollins R (2007) Motivations, training and supervision of volunteers in conservation. *Environments* 35, 79-89.
- Firbank LG, Barr CJ, Bunce RGH, Furse MT, Haines-Young R, Hornung M, Howard DC, Sheail J, Sier A and Smart SM (2003) Assessing stock and change in land cover and biodiversity in GB: an introduction to Countryside Survey 2000. *Journal of Environmental Management* 67, 207-218.
- Fore L, Paulsen K and O'Laughlin K (2001) Assessing the performance of volunteers in monitoring streams. *Freshwater Biology* 46, 109-123.
- Foster-Smith J and Evans S (2003) The value of marine ecological data collected by volunteers. *Biological Conservation* 113, 199-213.

- Gabrielsen P and Bosch P (2003) *Environmental indicators: typology and use in reporting*. European Environment Agency.
- Gouveia C, Fonseca A, Camara A and Ferreira F (2004) Promoting the use of environmental data collected by concerned citizens through information and communication technologies. *Journal of Environmental Management* 71, 135-154.
- Lawrence A (2010) The Personal and Political of Volunteers' data: towards a national biodiversity database for the UK. In *Taking Stock of Nature: Participatory Biodiversity Assessment for Policy, Planning, and Practice*, ed A. Lawrence. Cambridge University Press, New York, pp. 251-265.
- Newman C, Buesching CD and Macdonald DW (2003) Validating mammal monitoring methods and assessing the performance of volunteers in wildlife conservation- "Sed quis custodiet ipsos custodies?" *Biological Conservation* 113, 189-197.
- O'Connor PJ, Dalby P and Bond A (2005a) A Review of Community Based Monitoring in the South Australian Murray-Darling Basin. SA Murray-Darling Basin Integrated Natural Resource Management Group Inc.
- O'Connor PJ, Dalby P and Bond A (2005b) Community Based Monitoring Framework for Natural Resource Management in the South Australian Murray-Darling Basin. SA Murray-Darling Basin Integrated Natural Resource Management Group Inc.
- Peterson AT, Navarro-Sigüenza AG and Benitez-Diaz H (1998) The need for continued scientific collecting; a geographic analysis of Mexican bird specimens. *Ibis* 140, 288-294.
- Preston CD, Telfer MG, Arnold HR, Carey PD, Cooper JM, Dines TD, Hill MO, Pearman DA, Roy DB and Smart SM (2002) *The Changing Flora of the UK*. London: DEFRA.
- Reddy S and Dávalos LM (2003) Geographical sampling bias and its implications for conservation priorities in Africa. *Journal of Biogeography* 30, 1719-1727.
- Robertson MP and Barker NP (2006) A technique for evaluating species richness maps generated from collections data. *South African Journal of Science* 102, 77-84
- Romo H, García-Barros E and Lobo JM (2006) Identifying recorder-induced geographic bias in an Iberian butterfly database. *Ecography* 29, 873-885
- SAMDB NRM Board (2008) *South Australian Murray-Darling Basin Natural Resources Management Board Regional NRM Plan: Volume 1 Strategic Plan 2009-2019*. South Australian Murray-Darling Basin Natural Resources Management Board, South Australia.
- SAMDB NRM Board (2010) *Regional outcomes report: A report on the implementation of the South Australian Murray-Darling Basin Natural Resources Management Plan*. South Australian Murray-Darling Basin Natural Resources Management Board, South Australia.
- Schmeller DS, Henry PY, Julliard R, Gruber B, Clobert J, Dziock F, Lengyel S, Nowicki P, Deri E, Budrys E, Kull T, Tali K, Bauch B, Settele J, Van Swaay C, Kobler A, Babij V, Papastergiadou E and Henle K

- (2009) Advantages of volunteer-based biodiversity monitoring in Europe *Conservation Biology* 23, 307-316.
- Stebbins RA (1992) *Amateurs, Professionals, and Serious Leisure*. McGill-Queen's University Press, Montreal and Kingston.
- Szabo JK, Davy PJ, Hooper MJ and Astheimer LB (2007) Predicting spatio-temporal distribution for eastern Australian birds using Birds Australia's Atlas data: survey method, habitat and seasonal effects. *Emu* 107, 89-99.
- Szabo JK, Fuller RA and Possingham HP (in press) Volunteer bird counts can accurately estimate bird population sizes. *Ibis*.
- Tulloch A and Szabo J (in review) Understanding volunteer distribution, biases and behavior can improve representativeness of sampling in large-scale datasets. *Journal of Ornithology*.
- Williams PH, Prance GT, Humphries CJ and Edwards KS (1996) Promise and problems in applying quantitative complementary areas for representing the diversity of some neotropical plants (families Dichapetalaceae, Lecythidaceae, Caryocaraceae, Chrysobalanaceae and Proteaceae). *Biological Journal of the Linnean Society* 58, 125-157.

Appendix 1. Participatory monitoring survey 1

Natural Resource Community Monitoring in the South Australian Murray Darling Basin	
Name of community monitoring group	<name>
Key contact for community group	<name>
1. What is your role in the community monitoring program?	<please select> ▼
2. a What is the primary objective of your community monitoring program? <i>e.g. education, capacity building, research, to inform local/site management, to contribute to region-wide knowledge of the resource, to contribute to regional reporting, other</i>	<please describe>
2. b What does the group monitor? <i>please select and complete a new column for each activity</i>	Activity 1 <please select> ▼
3. How long has your group been monitoring for?	Start <please select> ▼
	Finish <please select> ▼
4. What is the frequency of data collection?	<please select> ▼
5. How many people are currently active in the program?	<please select> ▼
6. Where do you monitor? <i>coordinates if known & place name(s)/nearest town(s)</i>	GPS <please describe>
7. What were/are the criteria for choosing monitoring sites? <i>E.g significant site, near to other activities, interest for the site etc (list up to 5)</i>	<please describe>

8. What methodology is used?

(including monitoring protocol, parameters measured, equipment used and timing of monitoring i.e. first week of Spring) OR if a standard method is used, please name and state where a description of this is available

<please describe>

9. What training has the group received to perform the monitoring activities?

Please provide details on the type of training, when it was undertaken, who received the training, who provided the training, and the frequency of update?

<please describe>

10. What quality control/quality assurance measures are used in the collection of data?

not all of these may be relevant to your type of monitoring activity

NOTE-

Select all that apply:

- a monitoring plan has been completed
- sampling protocol is available
- replicates are taken
- a control site/ reference is meas
- sampling equipment is cleaned and ma
- sampling equipment is calibrated regularly (i.e. annu
- a logbook is kept of equip maintenance & monitorin
- data record sheets are complete
- correct units are recorded
- date and time of day are recorded
- entered data is cross checked with field data after er
- database is maintained regularly

11. Where is the data stored?

database name, location, online etc

E.g

<please state>

12. What format is the data in?

datasheets, electronic: excell/access/word etc

E.g

<please state>

13. Who is the officer/person responsible for data management?

<name>

14. Has a review of the program ever been conducted?	<please select>
If so, by whom?	<name>

15. What resources are used in this monitoring project; and who supplies these resources? <i>E.g the group, NRM Board, individual, another group etc</i>	Select all that apply: <input type="checkbox"/> equipment <supplier> <input type="checkbox"/> grant funding <supplier> <input type="checkbox"/> expert advice <supplier> <input type="checkbox"/> project officers <supplier> <input type="checkbox"/> educational materials <supplier> <input type="checkbox"/> facilities <supplier> <input type="checkbox"/> training <supplier> <input type="checkbox"/> other <supplier>
--	---

16. What additional resources do you think are required to maintain or improve your monitoring program? <i>E.g equipment, planning, analysis, field logistics etc</i>	<please describe>
---	-------------------

17. How is the monitoring data currently communicated from your program?	Select all that <input type="checkbox"/> shared within the group <input type="checkbox"/> word of mouth <input type="checkbox"/> community newsletter/pamphlet <input type="checkbox"/> field or demonstration days <input type="checkbox"/> state/national newspaper <input type="checkbox"/> local/state radio <input type="checkbox"/> a report back to the funding body <input type="checkbox"/> sent to NRM board for use in management decisions <input type="checkbox"/> given to regional/local experts <input type="checkbox"/> shared with consultants <input type="checkbox"/> scientific journal article <input type="checkbox"/> entered into online database <input type="checkbox"/> other
---	--

18. Are there any ways in which you would like to further communicate the collected data?	<please describe>
--	-------------------

19. Do you have any additional comments?	<please describe>
---	-------------------

Thankyou for taking the time to complete this survey

Please save and email your completed survey to valerie.lawley@oconnornrm.com.au

Appendix 2. Participatory monitoring survey 2

SAMDB Community Monitoring Survey

1. What is your role in the community monitoring program?
 - a) project officer
 - b) monitoring officer
 - c) coordinator/facilitator
 - d) community group member
 - e) other

2. What does the group monitor?
 - a) surface water
 - b) ground water
 - c) fauna; What species? _____
 - d) vegetation
 - e) pests
 - f) soils & land management
 - g) other

3. What are the objectives of the monitoring program?
 - a) Statutory responsibility
 - b) Education
 - c) Capacity building
 - d) Research
 - e) To inform local/site management
 - f) To contribute to knowledge of the resource
 - g) To contribute to region-wide knowledge of the resource
 - h) To contribute to regional reporting

4. How long has the group been monitoring? Year started: _____ Year ended or ongoing: _____

5. What is the frequency of data collection?
 - a) once a year
 - b) 2-4 times
 - c) >4 times a years

6. How many people are active in the community monitoring program?
 - a) none
 - b) 1-5
 - c) 6-10
 - d) 11-15
 - e) >15

7. Where do you monitor (for each monitored feature)? Please give gps coordinates in known, and place name/ nearest town.

8. What were/are the criteria for choosing monitoring sites? **select up to 5.**
 - a) significant site
 - b) only possible site
 - c) representative site
 - d) indicator site
 - e) problem site

- f) previous work at the site
- g) site expected to show impact/response
- h) near to other activities
- i) near to community group centre
- j) identified in an NRM plan(s)
- k) identified in site or local plan(s)
- l) management responsibility/interest for the site
- m) other _____

Monitored feature	9. What methodology is used? (including monitoring protocol, parameters measured, equipment used and timing of monitoring i.e. first week of spring) OR if a standard method is used, please name and state where a description of this is available	10. What training has the group received to perform the monitoring activities? Please provide details on the type of training, when it was undertaken, who received the training, who provided the training, and the frequency of update if relevant?
a) surface water		
b) ground water		
c) fauna Species 1 Species 2		
d) vegetation Species 1 Species 2		
e) pests		
f) soils & land management		
g) other		
Total number of sites:		

11. What quality control/quality assurance measures are used in the collection of data?

- a) a monitoring plan has been completed
- b) sampling protocol is available
- c) replicates are taken
- d) control site/reference is measured
- e) sampling equipment is cleaned and maintained
- f) sampling equipment is calibrated on a regular basis (annually)
- g) a logbook is kept of equipment maintenance and monitoring activities
- h) data record sheets are completed
- i) correct units are recorded
- j) date and time of day is recorded
- k) entered data is cross-checked with field datasheets after entry

a

l) database is regularly maintained

12. Where is the data stored? e.g database name, location, online etc

13. What format is the data in? e.g datasheets, electronic: excel/access/word etc

14. Who is the officer/person responsible for data management?

15. Has a review of the monitoring program ever been conducted? Yes/No. If so, by whom?

16. What resources are used in this monitoring project and who supplies these resources?

	supplier
a) Equipment	_____
b) Grant funding	_____
c) Expert advice	_____
d) Project officers	_____
e) Educational materials	_____
f) Facilities	_____
g) Training	_____
h) Other	_____

17. Which 'tools' from the Community Monitoring Framework Toolkit (available online at the SAMDB NRM website) are useful to your monitoring project?

- a) Planning and Coordination
- b) Evaluation and Reflection
- c) Communication
- d) Data Collection: Quality Assurance / Quality Control
- e) Data Management
- f) Data analysis and Interpretation

18. Which of these tools need development or improvement to be useful to your monitoring project?

19. What additional resources do you think are required to maintain or improve your monitoring program?

20. I will now list a range of different components of a monitoring program. Could you please rate the **current level of involvement** of community members in activities related to the monitoring program. The rating scale is from 1 – 7 where 1 = not at all involved, and 7 = very involved.*

	Not at all involved	→	→	→	→	→	Very involved
planning	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
coordination	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
data collection	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
equipment management	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
data entry	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

analysis	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
interpretation	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
communication	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

21. How is the monitoring data currently communicated from your program?

- a) Shared within the group
- b) Word of mouth
- c) Community newsletter/pamphlet
- d) Field or demonstration days
- e) State/national newspaper
- f) Local/state radio
- g) Report back to funding body
- h) Sent to NRM board for use in management decisions
- i) Given to regional/local experts
- j) Shared with consultants
- k) Scientific journal article
- l) Entered into online database
- m) Other _____

22. Are there any ways in which you would like to further communicate the collected data?

23. How confident are you that the monitoring program *influences decisions* about natural resource management at the **regional** level? Please rate your confidence on a scale of 1 – 7 where 1 = not at all confident, and 7 = very confident.

Not at all confident	→	→	→	→	→	Very confident
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

24. How confident are you that the monitoring program *influences decisions* about natural resource management at the **local** level? Please rate your confidence on a scale of 1 – 7 where 1 = not at all confident, and 7 = very confident.

Not at all confident	→	→	→	→	→	Very confident
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

For **regional** level: If low confidence (below 4) why and how can this be raised?

For **local** level: If low confidence (below 4) why and how can this be raised?

25. What are the 3 best things about the monitoring program?

26. What are the 3 biggest challenges facing the monitoring program?

27. Do you have any additional comments?

Thank you for taking the time to complete this survey.

Appendix 3. Known participatory monitoring programs in the SAMDB NRM region

* A group is classed as verified, if during the course of the survey, the level of involvement of the group in community monitoring has been confirmed (usually by direct contact with a group member). Not all verified groups are involved in community monitoring, e.g. Yatco Grasslands involved primarily in other activities, Taylorville North group no longer involved in monitoring. Of the verified groups still active, not all completed the survey.

Organisation	Themes	Verified*
Akuna Station	wetland	No
Alexandrina Community Nursery	no longer monitors -stream sampling	Yes
Ali Fricker and Bob Lamb	surface water	Yes
Andrea Clarke	Stream sampling	No
Angas Bremer Water Management Committee	ground water, soils & land management, irrigation	Yes
Angas River Catchment Group	surface water, stream sampling	Yes
Bats for Biodiversity	bats	Yes
Beldora station -- spectacle lakes/ Beldora lagoon	surface water, ground water, vegetation, fauna (birds, frogs, macroinvertebrates)	yes
Berri Barmera Local Action Planning Associations	wetlands	No
Biological Survey and Monitoring Group	vegetation, fauna	No
Birds Australia	birds	Yes
Birds SA	birds	Yes
Blanchetown	wetlands	No
Bookmark Biosphere Incorporated	wetlands	No
Bookmark Creek Wetland Group	wetlands	No
Bremer-Barker Catchment Group	ground water	Yes
Brenda Park Scotts Creek Wetlands Rehabilitation Group	ground water, vegetation, surface water, rainfall, fauna (frogs, birds and bats)	Yes
Browns Well Landcare Group	coordinated rabbit, fox and feral animal control programs	No
Bruce Brooks (Currency Creek Land & Water	stream sampling	No
Burra Creek	surface water, ground water	Yes
Burra Landcare -sampling on their property	stream sampling	No
Butterfly Conservation SA Inc	butterflies	No
Cadell Wetland Group	wetlands	No
Calperum Station (Calperum Station Australian landscape trust)	stream sampling, fauna, vegetation, ground water	No
Clayton Waterwatchers	stream sampling	No
Community Wetland Management Program and	wetlands	No
Conservation Council of SA	fauna (southern emu wren), vegetation	Yes
Conservation Volunteers Australia	fauna (wombats)	No
Coorong and Lower Lakes Recovery team	acid sulphate soil research	No
Coorong and Mallee Farm Forestry Network	vegetation	No
Coorong Consultative Committee	wetlands	No
Coorong Districts Local Action Planning Association	ground water, vegetation	No
Cornerstone Waterwatchers	surface water	Yes
Currency Creek Water Use	water	No

Daryl & Helen Royans (Murrawong upstream of Murray Bridge)	surface water	Yes
David Paton – Ngarkat Surveys and the Monarto	birds	No
Dawesley Creek Catchment Landcare Group Inc	vegetation, water	No
DENR - Burra	water, fauna(reptile, birds, kangaroos), pests(deer), vegetation	Yes
DENR Murraylands malleefowl monitoring program	malleefowl	Yes
DENR/AMLR, Blackhill.	yellow tailed black cockatoos, bandicoots, goannas	No
Doctors Creek Landcare Group	water	No
Earthwatch Institute	fauna, vegetation	No
Eastern Hills and Murray Plains Catchment Group	vegetation, soils & land management	Yes
Echidna Watch	echidna	No
EF School – Strathalbyn	surface water	Yes
EPA- monitoring data	water, air	No
Finniss Catchment Group	stream sampling	No
Flaxley Landcare Group	no formal monitoring	Yes
Friends of Brookfield Conservation Park	vegetation, fauna (wombats)	No
Friends of Burra Parks	surface water	Yes
Friends of Coorong National Park	vegetation, pests (weeds), fauna (birds)	No
Friends of Cox Scrub Conservation Park	vegetation, fauna (birds)	No
Friends of Ferries - McDonald and Monarto C.P. Inc	vegetation, fauna	No
Friends of Gluepot Reserve	vegetation, pests (weeds, rabbits), fauna (birds, reptiles, bats, invertebrates)	No
Friends of Karoonda Nature Park	vegetation (orchids), fauna (echidnas)	No
Friends of Katarapko (Katarapko Community Action Group)	fauna (mammals, including brush-tailed bettong), vegetation, Waterwatch, aboriginal sites, pests(foxes and rabbits)	No
Friends of Kyeema Conservation Park	fauna (birds)	No
Friends of Lenger Reserve -National Trust	surface water, vegetation, pests (weeds, mosquito fish)	No
Friends of Long Island	unknown	No
Friends of Meningie	vegetation	No
Friends of Monarto Fauna Complex	fauna	No
Friends of Moorok	unknown	No
Friends of Ngarkat	fauna(birds)	No
Friends of Riverland Parks	surface water, fauna (malleefowl, kangaroos, possums, pitfall traps, foxes, stone curlew)	Yes
Friends of Southern Mallee Parks	unknown	No
Friends of Totness Recreation Park	vegetation, fauna	No
Friends of Younghusband	surface water, fauna (frogs and bats), vegetation	Yes
Frog Atlas (EPA)	frogs	No
GD & SA Kluske (Hannah and Sally)	stream sampling	No
Gerard Community Monitoring	stream sampling	No
Gluepot reserve	vegetation, fauna (birds, mammals, reptiles), pests	No
Gluepot Reserve Research and Monitoring Committee	vegetation, fauna (birds, mammals, reptiles), pests	No
Goolwa to Wellington Local Action Planning Board Inc.	soils & land management, vegetation(BCMs and other), fauna (bats and frogs)	Yes
Greening Australia	vegetation	No
Gurra Wet P/L	wetlands	No
Gurra Wetland Care Group	wetlands	No

Henschke Cellars	soils, surface water, macroinvertebrates	Yes
High Currency -Property	surface water	Yes
Hindmarsh Island (DENR)	ground water, vegetation, fauna (invertebrates), pests	No
Hindmarsh Island Landcare Group	vegetation	No
Ian Rowen	surface water, general observations of sea and tides	Yes
Jervois Primary School	stream sampling	No
Kanmantoo - Callington Landcare Group	vegetation, pests	No
Katarapko Group & Thieles Flat	wetlands	No
Kroehns Landing Wetland Complex	wetlands	No
Local adaptation Group Waikerie	farm system trials	No
Loveday & Cobdogla Swamps Wetlands Complex	wetlands	No
Loveday Bay wetland, Narrung Peninsula	not monitoring	Yes
Lower Mallee Landcare Group	pests (rabbits), vegetation	No
Lower Murray Drought Reference Group	stream sampling	No
Lower Murray Waterwatch	stream sampling	No
Loxton to Bookpurnong Local Action Planning Association	see Yatco Wetland	Yes
Macclesfield Bushcare Group	pests, surface water	Yes
Maize Island Wetland	wetlands	No
Mallee & Coorong NRM Group	soil & land management, pests (rabbits, foxes, weeds)	No
Mallee Water Resources Committee	water	No
Malleefowl Monarto Community Group	malleefowl	No
Mannum Kesab - roadwatch	surface water, soils and land management, vegetation	Yes
Mannum Rd Lagoon/ rocky gully wetland group	no monitoring	Yes
Mannum to Wellington LAP	ground water, vegetation	No
Mantung Maggea Landcare group	pests (rabbits, foxes), fauna (malleefowl)	No
Marne River Mouth Wetland Complex	wetlands	No
Marne-Nrth Rhine Catchment Group	surface water, ground water	Yes
Martins Bend Wetland Complex	wetlands	No
Milang Snipe sanctuary	fauna (snipes)	No
Milang Wetland Management Committee	wetlands, fauna (snipes)	No
Monarto Landholders Environmental Group	no monitoring	Yes
Monarto Woodlands- DENR	vegetation, fauna	No
Monarto Zoo - field work only	fauna (wombats)	No
Monarto Zoo Monitoring Group - Mallee Minders	revegetation and monitoring	No
Moorrundi Wetland Group	wetlands	No
Morgan Lagoons - MDA	wetlands	No
Mubpook Lagoon Floodplain Management Group	surface water	Yes
Mundoo Pastoral Co,	stream sampling	No
Murray Mallee Local Action Planning Association	no monitoring	No
Murray Watch (Friends of the River Inc)	reporting illegal activities to authorities	No
Mypolonga Landcare Group	unknown	No
Nairne Community Waterwatch - Nairne Community Council Group	stream sampling	No
Narnu Farm	stream sampling	No
Narung Wetlands Group	ground water, surface water, vegetation, fauna (frogs and fish)	Yes
Native Fish Society	fish	No
Native Grass Resources Group Inc	grasslands	Yes
Native Orchid Society of SA Inc	orchids	No
Natural History Society	fauna (wombats), pests (rabbits), flora	Yes
Nature Conservation Society of South Australia	vegetation, birds, BCMS, threatened plants	Yes

Nelwart Wetland Group	wetlands	No
Ngak Indau Wetland	wetlands - may no longer be active	No
Nganamara monitoring in SA Aboriginal Lands	fauna (malleefowl)	No
Ngarkat Surveys - DENR	vegetation, fauna	No
Ngopamuldi NRM Group - Teringie wetlands	surface water, ground water, vegetation	Yes
Nigra Creek Group	water	No
Northern Bremer Catchment Group	surface water	Yes
NRM board: BCM	pests (rabbits, hares), BCMS, echidnas, regent parrots at gluepot, water sampling	No
Obswell database - DWLBC	ground water- bore monitoring	No
Overland Corner Wetland Group	surface water, ground water, vegetation, pests, fauna (birds, fish, and frogs), soils	Yes
Paisley Murbko Growers Group	wetlands	No
Paringa Paddock/Goat Island Wetland Complex	fauna (koalas)	Yes
Paiwalla Wetland Group	vegetation, fauna (fish, birds, frogs, macro	Yes
Point Sturt and Districts Landcare Group Inc.	surface water	Yes
Ramco Wetland Management Group - Hart Lagoon	surface water, ground water, vegetation, fauna (frogs, birds, fish), pests (weeds)	Yes
Ramco Wetland Management Group – Ramco Lagoon	surface water, ground water, vegetation, fauna (frogs, birds, fish), pests (weeds)	Yes
Rangeland NRM Alliance	unknown	No
Rangeland NRM Group	unknown	No
Ranges to River NRM Group	farming	No
Reedy Creek & Lake Carlet Wetland Complex C/O Caloote	ground water, fauna, vegetation	Yes
Renmark North Primary School	fauna(frog watch), pests(rabbits), vegetation	No
Renmark to the Border Local Action Planning Association	wetland, vegetation	No
River Murray Urban Users Local Action Planning Committee/Murraycare	vegetation, pests(weeds, rabbits), fauna (birds,bats)	No
Riverglades	wetlands	No
Riverglades Community Group	stream sampling	Yes
Riverglades Community Wetlands	wetlands	No
Riverland Irrigators	water	No
Riverland NRM Group	water	No
Rockleigh - Mypolonga Native Vegetation Association Inc	fauna, soils and land management, pests, other	Yes
Rodwell Creek - Wistow and Red Creek Landcare Group	vegetation, fauna (native blackfish)	Yes
SA Herpetology Group	lizards, frogs, snakes	No
SA MDB NRM Board Weather Monitoring Network	weather	No
SA Water Corporation	wetlands	No
Sawn Reach Area School Waterwatch	water, vegetation	No
Scientific Expedition Group	surface water, fauna (mammals, birds, reptiles), vegetation	No
Signal Point Riverine Environment Group, Inc.	surface water, soils and land management, vegetation, fauna (frogs)	Yes
Sinclair-Murbko Lagoons	wetlands	No
South West Billiat Landcare Group	pests (foxes, rabbits and goats)	No
Spring Valley Landcare Group Inc	surface water, ground water	Yes
St John Bushland Park Lobethal (Friends of Lobethal	vegetation, pests(weeds)	No
Strathalbyn Field Naturalists and John Ekert	vegetation, fauna(birds, mammals, reptiles, ants, spiders, fish, amphibians)	No
Swanport Wetland Group	wetlands	No
Taylorville North Community Assoc.	wetlands	Yes
Templeton Wetland Group/Banrock Station Wetland	vegetation and other	Yes
The Cliff -Monitoring Group	surface water, fauna (frogs and bats)	Yes
Toolunka Wetland Working Group	wetlands	No

Trees for Life	vegetation (BCMs and photopoints)	Yes
Tungkillo Landcare Group	vegetation, soils and land management	No
Ukee Boat Club	fauna, vegetation, ground water, surface water	No
Unity College Waterwatch	vegetation	No
Upper Murray Wetlands	water	No
Waikerie Primary School - Waterwatch	water	No
Walker Flat & District Progress Association	recycling	Yes
WaterWatch - Lower Murray	surface water	No
WaterWatch - Upper Murray (12 schools, 15 sites)	surface water	No
Western Flat Creek Landcare Group	surface water	Yes
Wetland Habitats Trust	wetlands	No
Whirlpool Corner Wetland Group	wetlands	No
Will Miles / Dana	Stream sampling	No
Yatco Wetland Group	ground water, vegetation, fauna (frogs, birds, and fish)	Yes

Appendix 4. Assessment criteria for the potential use of participatory monitoring in regional planning

Level	1. PARTICIPANT LEARNING	2. COULD MEET STANDARD	3. MEETS OR EXCEEDS STANDARD
Criteria	<i>Does not meet minimum standards for informing regional decision making, but valuable for participant learning</i>	<i>Could be readily modified to meet minimum standards for use in regional decision making</i>	<i>Meets or exceeds standards - can be used for regional decision making</i>
Theme aligns with NRM targets	Theme monitored does not align with NRM plan targets	Theme monitored could align with NRM plan targets with minor modification	Theme monitored aligns with NRM plan targets and monitoring informs NRM planning
Sampling design	Unknown or inappropriate for monitoring objectives	Appropriate for monitoring objectives and regional decision making with minor modification	Appropriate for monitoring objectives and regional decision making
Monitoring methodology			
Appropriate	Unknown or inappropriate for monitoring objectives	Appropriate for monitoring objectives with minor modification	Appropriate for monitoring objectives and regional decision making
Objectively verifiable data	Unknown/data cannot be objectively verified	With minor modification, could provide objectively verifiable data	Provides objectively verifiable data and is consistent or complementary with other monitoring programs
Participant skill level and training	Unknown or insufficient for monitoring activity	With minor modification could meet minimum required standard for monitoring activity	Meets or exceeds minimum required standard for monitoring activity

Level	1. PARTICIPANT LEARNING	2. COULD MEET STANDARD	3. MEETS OR EXCEEDS STANDARD
Quality assurance			
Monitoring plan		Unknown or no plan available	Monitoring plan available
Sampling protocol	Unknown or no protocol available		Monitoring protocol available
Data record sheets completed	Unknown or no formal datasheets completed	Informal data sheets completed	Formal datasheets completed
Correct units recorded	Unknown, incorrect or no units recorded		Correct units recorded
Data entry validation	Unknown or no validation undertaken	Sporadic or inconsistent data validation undertaken	Data entry validation undertaken
Database maintained	Unknown or no database maintenance		Database regularly maintained
<i>Control site/reference is measured</i>	Unknown or no control/reference measured	Control/reference measured at least once per year	Control/reference measured more than once per year
<i>Sampling equipment cleaned and maintained</i>	Unknown or sampling equipment not maintained		Sampling equipment cleaned and maintained
<i>Equipment calibrated regularly</i>	Unknown or no calibration		Minimum calibration undertaken
<i>Logbook of equipment maintenance</i>	Unknown or no logbook of equipment maintenance		Logbook of equipment maintenance actively maintained
Scale	Site or local only	Site or local but when used in conjunction with other data is relevant at the regional level	Regional or site/local and when used with other data is relevant at the regional level

Level	1. PARTICIPANT LEARNING	2. COULD MEET STANDARD	3. MEETS OR EXCEEDS STANDARD
Review/adaptive management	Unknown or no mechanism for feedback and adapting/refining methodology	Informal mechanisms for review/feedback and adapting/refining methodology	Formal mechanisms for review/feedback and adapting/refining methodology
Communication/reporting	Unknown, internal reporting only or no communication/reporting	Communication internal to the group or the NRM project officer level, or informal communication to the general public	Communicating to the general public and NRM decision makers as appropriate

Appendix 5: Surveyed participatory monitoring groups and their potential for reporting against Resource Condition Targets and Management Action Targets

WATER	PEOPLE		Asset ¹ goal	RCT	MAT
	W1	W2	W3		
					Ali Fricker and Bob Lamb
					Angas Bremer Water Management Committee
					Angas River Catchment Group
					Bats for Biodiversity - Mid Murray LAP
					Birds Australia volunteer
					Birds SA volunteer
					Bremer-Barker Catchment Group
					Brenda Park Scotts Creek Wetlands Rehabilitation Group
					Burra Creek
					Conservation Council of SA
					Cornerstone Waterwatchers
					Daryl & Helen Royans -Murrwong
					DENR - Burra
					DENR Murraylands malleefowl monitoring program
					Eastern Hills and Murray Plains Catchment Group
					EF School – Strathalbyn
					Friends of Burra Parks
					Friends of Riverland Parks
					Friends of Youngusband
					Goolwa to Wellington Local Action Planning Board Inc.
					Henschke Cellars
					High Currency -Property
					Ian Rowen
					Macclesfield Bushcare Group
					Mannum Kesab - roadwatch
					Marne-Nrth Rhine Catchment Group AND Spring Valley Landcare group
					Mubpook Lagoon Floodplain Management Group
					Narung Wetlands Group
					Natural History Society -wombats
					Nature Conservation Society of South Australia
					Nature Conservation Society of South Australia - TPAG
					Ngopamuldi NRM Group - Teringie wetlands
					Northern Bremer Catchment Group
					Overland Corner Wetland Group
					Paringa Paddock/Goat Island Wetland Complex
					Point Sturt and Districts Landcare Group Inc.
					Ramco Wetland Management Group - Hart Lagoon
					Ramco Wetland Management Group - Ramco Lagoon
					Reedy Creek & Lake Carlet Wetland Complex C/U Caloote area Landcare Group
					Rockleigh - Mypolonga Native Vegetation Association Inc
					Rodwell Creek - Wistow and Red Creek Landcare Group Inc
					Signal Point Riverine Environment Group, Inc.
					Spring Valley Landcare Group Inc
					The Cliff monitoring Group
					Trees for Life
					Western Flat Creek Landcare Group
					Yatco Wetland Group

*

WATER

Water resources that are healthy, valued and supporting of communities and thriving ecosystems

W1: All water resources are managed sustainably by 2018	W1.1: 100% of water resources have a risk assessment by 2014	No
	W1.2: Key water management policies in place for priority water resources by 2014	No
	W1.3: The environment's right to water is secured through legislation and recognised and accepted by the community, politicians and other stakeholders as a legitimate user by 2014	No
	W1.4: Minimise impacts of irrigation induced saline groundwater flows to water or ecosystem assets	Any PMP monitoring/managing for groundwater salinity
	W1.5: Complete a Basin-wide prioritisation process for the development of land and water management plans by 2012	No
	W1.6: 90% of the irrigated are a achieving WUE as prescribed by the relevant WAP by 2014	Any PMP who has to report on their water use efficiency/ irrigation
W2: Improve water quality to achieve the regionally endorsed environmental values by 2030	W2.1: Maintain SA's position on MDB Authority Salinity Register in balance by 2014	No
	W2.2: By 2014, all appropriate houseboat, vessel (including facilities), and marina strategies, policies and guidelines adopted & implemented	No
	W2.3: 70% of treated wastewater generated in the Region to be reused by 2014	No
	W2.4: Influence investment in cross-state water quality (non-salinity) improvements by 2012	No
	W2.5: 50% of land in the agricultural zone to have neutral or beneficial effects on water assets by 2014	No
	W2.6: At least one major settlement (>2000 people) with neutral or beneficial effects on water assets by 2014	No
	W2.7: By 2014, 70% of water used shall be taken from sources that are fit-for-purpose	No
W3: Water is available to enhance and maintain the ecological character of water-dependent ecosystems	W3.1: Murray Mouth open 100% of time (by dredging) by 2014	No
	W3.2: A robust decision-making framework for annual allocations of environmental water is established by 2011	No
	W3.3: By 2014, 50% of water-dependent ecosystems are delivered their environmental water requirement as identified by the relevant WAP or other policy	No
	W3.4: Re-establish Coorong and Lower Lakes ecological communities present pre-drought (2002) by 2014	Any PMP involved in revegetation etc around the Coorong and Lower Lakes
	W3.5 Barrage fishways in operation at least between June and February and whenever possible including additional attractant flows by 2014.	No
	W3.6: Lower Lake levels maintained between 0.35m and 0.75m AHD2 to achieve environmental benefits [through implementation of Lakes and Barrages Operating Strategy]	No
	W3.7: River operations undertaken to maximise inundation at priority floodplain sites & to improve connectivity between the floodplain and the River by 2014	No

BIODIVERSITY <i>A healthy and ecologically productive environment that sustains biodiversity and is valued by the community</i>	B1: Native ecosystem extent increased to 53% of the Region and native ecosystem condition improved across the Region by 10% by 2030	B1.1: Protect and manage an additional 10,000 ha of existing priority remnant native ecosystems by 2014	Any PMP involved in revegetation and vegetation management
		B1.2: The extent of native ecosystems is increased by 15,000 ha by 2014	Any PMP involved in revegetation
		B1.3: A 10% improvement in the condition of 25% of native ecosystems in the Region by 2014	Any PMP involved in onground works
		B1.4: Increase community appreciation of native ecosystems and species by 30% by 2014	Any increase in volunteer numbers
	B2: By 2030, water-dependent ecosystems in priority areas maintain ecological function, resilience and biodiversity	B2.1: 75% of priority floodplains and wetlands actively managed as per management plans by 2014	Any PMP managing wetlands /rivers/lagoons
		B2.2: Adoption of sustainable grazing practices in water-dependent ecosystems by 2014	No
		B2.3: A 20% increase in connectivity between/within aquatic and terrestrial ecosystems of the Lower Lakes, Coorong and marine environments by 2014	No
		B2.4: Reduce the extent of priority pest plants and animals in priority water-dependent ecosystems by 10% by 2014	Any PMP who monitor/manage pests in wetlands, lagoons, lakes, rivers etc.
	B3: No species or ecosystem moves to a higher risk category and 50% of species move to a lower risk category by 2030	B3.1: Reduce the impact of critical threats to priority threatened species by 2014	Yes- TPAG, BCM sites
		B3.2: Reduce the impact of critical threats on EPBC-listed threatened ecosystems by 2014	Unsure –not enough information
LAND <i>Sustainable, productive landscapes</i>	L1: A 10% improvement in soil and land condition from 2008/2009 levels by 2030	L1.1: Dryland water use efficiency (WUE) is maintained at 80% by 2014	No
		L1.2: 90% of landholders are managing pastures sustainably by 2014	No
		L1.3: 50% increase in participation in early warning system for new pest incursions (communication network)	Any PMP that monitor pests
		L1.4: Species specific control targets for 80% of priority pest plant and animal species are met by 2014	Any PMP that monitor/manage pests
	L2: The area of land affected by land degradation processes is reduced by 2030	L2.1: By 2014 achieve a 6% improvement in wind erosion protection for agricultural cropping land	No
		L2.2: By 2014, a 3% increase in the area of grazing land with adequate soil surface cover (based on 2009 levels)	No
		L2.3: 7,500 hectares of appropriate perennial vegetation established in priority areas by 2014 for the management of dryland salinity	Any PMP undertaking revegetation for dry land salinity
		L2.4: Net balance alkaline inputs are equal to acidification levels	No
ATMOSPHERE <i>A clean and healthy atmosphere with effective adaptation to climate change</i>	A1: Reduce greenhouse gas emissions in the SA Murray-Darling Basin by 60% by 2050	A1.1: Voluntary renewable energy use at 20% and support for renewable energy generation in the Region by 2014	No
		A1.2: Natural resource affecting industries adopting climate change sector agreements by 2014	No
		A1.3: By 2014 increase carbon efficiencies of SA MDB NRM Board vehicle fleet and buildings by 20% and 10% respectively	No
		A1.4: Revegetation for future carbon (CO ₂ e) sequestration of 126,000 tonnes by 2014	Any PMP that undertakes revegetation
	A2: 100% of natural resource managers incorporating climate change adaptation into their forward planning or management by 2030	A2.1: 25% of natural resource managers incorporating climate change adaptation into their forward planning or management by 2014	No

