natural resources commission

REVIEW OF NSW RESOURCE CONDITION MONITORING, EVALUATION AND REPORTING

Continuing the evolution of monitoring, evaluation and reporting in NSW

Draft Report

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List of acronyms

CAP	Catchment Action Plan
CMA	Catchment Management Authority
COAG	Council of Australian Governments
DECCW	NSW Department of Environment, Climate Change and Water
MER	Monitoring, Evaluation and Reporting
NRC	Natural Resources Commission
NRM	Natural resource management
NSW	New South Wales
OEH	Office of Environment and Heritage
SCaRPA	Site and Catchment Resource Planning and Assessment
SOG	Senior Officer Group

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1 Introduction

In December 2010, the NSW Government adopted a revised strategy to guide the state's natural resources monitoring, evaluation and reporting (MER) efforts over the next 5 years.[1] One of this strategy's key priorities is to review and prioritise the state's resource condition MER program and build a business case for the appropriate level of funding to support it. To this end, the Natural Resource Management (NRM) Senior Officers Group (SOG) asked the Natural Resources Commission (NRC) to review the existing datasets and indicators, and provide advice on how best to prioritise efforts under the program.

In broadly the same time period, the Government asked the NRC to develop State of the Catchments reports. More recently, the NRC set out a whole-of-government approach to Catchment Action Plans (CAPs) including greater attention to analysing and describing social-ecological systems operating in catchment landscapes. The Catchment Management Authorities (CMAs) began reviewing and upgrading regional CAPs using this new approach. Similarly, at the local government scale, many councils began preparing community strategic plans under the Integrated Planning and Reporting Framework. Each of these tasks requires data collected by the resource condition program, and influences the state's needs for MER.

Given this, the NRC considered it appropriate to take a broad perspective to the review of the resource condition program. It has specifically considered the priority of the existing resource condition datasets and indicators. In addition, it has thought more broadly about the role and function of MER within the state's regional model for NRM, and how MER can be effectively implemented to ensure the best-available information informs the planning, evaluation and reporting of NRM at various scales.

The NRC used a pragmatic approach, which included exploring recent developments in MER in NSW and beyond, and identifying the most useful and practical datasets that will support the state's agencies, CMAs and other decision-makers and natural resource managers in their work. (See Box 1.1 for an overview of its review process.) This report explains its key findings and draft recommendations, and suggests next steps for implementing these recommendations.

Box 1.1: NRC's review process

In undertaking this MER review, the NRC has:

- produced an issues paper to facilitate initial consultation for the review
- interviewed over 40 suppliers and users of MER data in NSW, including MER theme team leaders, MER management teams, CMAs, local government and agency policy staff
- compared the state's MER approach with other national and international MER initiatives
- reviewed the current indicators and datasets to characterise then prioritise a core set that is fundamental to the program
- reviewed past MER review reports and draft technical reports
- tested its preliminary findings and recommendations with agencies and CMAs.

[1] New South Wales Government (2010) *New South Wales Natural Resources Monitoring, Evaluation and Reporting Strategy 2010-2015*, December.

1.1 Overview of key findings

This NRC's review found evidence of some good progress in the state's MER strategy, and identified areas for improvement. It also identified some risks and opportunities associated with the task it was given in this review.

1.1.1 Evidence of good progress

The NRC found that the revised MER strategy is a significant advance on the previous strategy. It recognises the crucial role of MER in adaptive management, and aims to deliver appropriate information to support decision-making at all stages of the adaptive management cycle. It emphasises the value of evaluating and reporting on achievements of NRM investments, and clarifies roles and responsibilities of key MER partners. It also strengthens accountability, enhances communication and engagement between providers and users of MER data, and improves data acquisition, management and sharing arrangements. In these areas, the revised MER strategy is as good as or better than other national and international MER initiatives.[2]

There has also been good progress in implementing MER over the past few years, including progress towards some of the revised MER strategy's objectives. For example:

- Agencies have established baselines for each of the state-wide targets.
- Agencies and CMAs have established collaborative MER programs – such as the *Practical Partnerships Program*, *Soil Watch* and the *Program Performance* pilot – which are helping CMAs better understand the performance of their on-ground investments.
- The resource condition MER program has started to rely more on models to predict future trajectories of the state-wide targets (for example SCaRPA and CERAT[3]). This will help to direct monitoring programs towards collecting data that verify the assumptions in the models and predicted trajectories.
- Agencies are beginning to make MER data publicly available and more easily accessible to users, including by providing an online inventory of MER data.
- The agencies and CMAs have begun planning to develop whole-of-government knowledge strategies that set out their knowledge needs for the future.[4]

1.1.2 Areas for improvement

The NRC also identified much scope for improving the state's MER efforts. During its consultations for this review, both users and suppliers of MER data identified a range of shortcomings. For example:

Users (and potential users) stated that much of the state-wide data being collected is not relevant for decision-making at regional and local scales, as it is not linked to key questions around NRM investment at these scales. This is largely because the existing resource condition MER program was designed for reporting against NRM targets at the state-scale at a single

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2 Thomas, M., Parsons, M., Southwell, M. and Flett, D. (2011) *Benchmarking NRM and MER initiatives against the NSW Natural Resources MER Strategy.* A Report to the NSW Natural Resources Commission. University of New England.

3 Computer based decision support tools (SCaRPA) *Site and Catchment Resource Planning and Assessment* and (CERAT) *Catchment Eutrophication Risk Assessment Tool*.

4 This initiative builds on OEH's current work in developing a range of Knowledge Strategies to support their business.

point in time, and not around the more dynamic process of supporting investment decision-making at regional or local scales. In addition, they stated that:

- for some regions, the coverage and resolution of the state-wide datasets are poor
- they had limited awareness and understanding of the available datasets
- they lacked the specialised skills to analyse and interpret the data, especially in relation to integrating socio-economic information into catchment planning, investment decision-making and reporting.

Suppliers of data stated that the current funding is insufficient to deliver an MER program that provides essential information in priority areas. They also put the view that some of the state-wide targets – particularly the community targets – are difficult to measure at the state-scale. Some stated that these targets should be expressed, monitored, evaluated and reported on at the CMA scale with agency support.

Both users and suppliers of data questioned the value of existing state of environment and catchment reporting. Most put the view that there is an over-emphasis on monitoring for reporting purposes rather than to inform evaluation and decision-making.

1.1.3 Risks and opportunities with the NRC's review task

The NRC's review of contemporary literature on effective MER also identified a more fundamental shortcoming of the task given to the NRC for this review – that is, prioritising the existing resource condition datasets and indicators. This literature cautions against focusing primarily on what datasets a monitoring program should collect (starting with the 'answers' first) rather than on what evaluation questions the program needs to answer for decision-makers. It suggests that conceptual models of landscape function and hypothesis-driven evaluation questions are an essential foundation for well-designed and effective MER.

The NRC notes that the recent pilot planning process for upgrading the CAPs for the Central West and Namoi CMA regions – which coincided with the timeframe for this review – is providing the necessary foundations for effective MER. During this process, CMAs and agencies came together to assess the best-available local, regional and state scale data and integrate these data using systems thinking. They then developed a range of conceptual models (including state-and-transition models) that describe how the regional landscapes function and respond to disturbances. This provided insights into the certainty of the assumptions that underpin management actions in those regions.

As a result of whole-of-government process, the upgraded CAPs for these regions are a significant advance on the previous versions. And importantly, the CMAs are now well-placed to design regional MER programs to test the more uncertain assumptions during CAP implementation, and enable them to adjust their management actions as they learn from success and failure. In other words, they are well-placed to design strategic and forward-looking MER programs that will answer the key evaluation questions and thus effectively support active adaptive management.

This suggests that NSW has a significant opportunity to use the process of upgrading the remaining 11 CAPs to establish a solid foundation for cost-effective MER programs that support adaptive management across the state. Similarly, it may also be possible to link this process to local councils' development of community strategic plans and thus integrate MER into all levels of government natural resource decision-making. In the NRC's view, this is a vital next step in

the evolution towards effective MER across all scales, and will also enable NSW to be a leader in demonstrating effective adaptive management of natural resources.

1.2 Overview of recommendations

Based on the findings outlined above, the NRC has developed two sets of recommendations (Table 1.1). The first set provides its advice in relation to the specific task it was set by the SOG – **prioritising the existing resource condition datasets** and indicators. The second recommends a range of actions to **accelerate the evolution towards more effective MER** across scales, rather than focusing on datasets and indicators alone.

These recommendations will require **on-going strong leadership and governance** from the Natural Resource and Environment CEO's Cluster and the SOG to drive the changes required to continually improve MER in NSW. The benefits of adopting these changes include more efficient use of the limited MER resources available by focusing effort on the key needs of decision-makers. A MER program that is directed towards these needs will be better placed to inform decisions on how we manage our catchments to improve landscape function and resilience, where we should target our interventions and what we should monitor to demonstrate our results and test our assumptions.

The NRC suggests the implementation of any adopted recommendations should be reviewed as part of the MER strategy's own review processes. This could also include any learnings from the NRC pilot to test alternative approaches to NRM reporting in NSW (as recommended in section 1.2.1)

1.2.1 Prioritising the existing datasets and indicators

The NRC considers that the resource condition program can be improved by refocusing on building and improving a set of data categories that are fundamental to decision-making and understanding the health of landscapes at the macro-scale. If SOG adopts this approach, the NRC recommends that the program **focus on 12 key data categories.** These categories reflect the feedback from agencies and CMAs about the most useful and practical datasets for their work, and are detailed in Section 2.6. It also recommends that the resource condition program's main objective should be to ensure that the data collected within these categories have good resolution at different scales, and form an information 'backbone' for decision-makers and natural resource managers operating at all scales.

However, in line with contemporary scientific opinion on effective MER discussed in section 1.1.3 above, the NRC considers that ideally, NSW should take **a more strategic view to knowledge-gathering** by documenting our understanding of how landscapes function and clearly articulating the questions we need to answer to manage these landscapes effectively. This could be done before decisions about refocusing the resource condition program are made, so the resulting knowledge strategy can drive those decisions. However, if this is not practical, it could be done in the short to medium term, so the strategy can drive further improvements in the state's MER efforts.

1.2.2 Accelerating effective MER across all scales

To take advantage of the opportunity discussed in section 1.1.3 above, the NRC **recommends** that the resource condition MER program's **primary focus** should be on **supporting** the remaining **CAP upgrades** for the next 16 months.[5]

[5] CAPs are due to be completed in March 2013.

This is to ensure that the CMAs are well-placed to develop effective regional MER systems that are based on conceptual understanding of landscape function, and include monitoring (and research) programs that collect the appropriate and most relevant information required to make sound NRM investment decisions now and into the future.

In addition to this, the NRC recommends the **role and function** of MER at the state and regional scales should be sharpened in some areas, and the **connections between** MER efforts at these scales should be strengthened. In particular, it recommends:

- **At the state scale, the agencies should focus on:**
  - Improving the availability and use of decision-support tools and models to inform planning, evaluation and reporting.
  - Piloting alternative approaches to NRM reporting in NSW.
- **At the regional scale, the CMAs should focus on:**
  - Improving the effective integration of socio-economic information into catchment planning and decision-making.
  - Designing effective MER programs that are linked to evaluation questions and conceptual models of landscape change in their upgraded CAPs.
- **Collectively, agencies, CMAs and local government should focus on:**
  - Strengthening and extending collaboration in MER.
  - Leveraging information generated from community and industry monitoring programs.
  - Accelerating the improvement of mechanisms to access and share data and information.

The NRC believes this sharper focus will achieve better alignment between MER activities and recent developments in the NRM model, and help to ensure that MER is embedded in the adaptive management and business cycles from the outset. It will also clarify what monitoring, evaluation and reporting needs to be undertaken at each scale, and make opportunities for collaboration between partners easier to recognise.

Table 1.1 sets out the NRC's draft recommendations and suggested next steps for implementing these recommendations over the next years.

Table 1.1: Draft recommendations to the SOG and next steps to improve natural resource MER

Draft recommendations	Next steps
Prioritising datasets and indicators (Chapter 2)	
1. That the resource condition MER program focus on improving and maintaining a core set of essential data that provides the basic information foundation for MER across all scales	A) Realign resource condition MER programs to provide a core set of essential state-wide datasets (SOG) B) Develop a whole-of-government knowledge strategy that defines the priority knowledge and information needs for NRM across all scales in the long term (SOG) C) Develop a business case for effectively funding the re-prioritised MER program (SOG)
Accelerating effective MER across all scales (Chapters 3 to 5)	
State scale (Chapter 3)	
2. That the resource condition MER program and agencies support the remaining CAP upgrades to ensure they are based on the best-available local, regional and state scale data	A) Develop a coordinated approach for the provision of NRM data, information and knowledge for CAP upgrades (SOG) B) Support agency staff to provide face-to-face technical and scientific support in CMA regions (SOG)
3. That agencies and CMAs continue to improve the availability and use of decision-support tools and models to inform planning, evaluation and reporting	A) Better utilise conceptual and predictive models to guide and inform monitoring programs (agencies, CMAs) B) Improve models that can address social and cultural values and landscape thresholds or 'tipping points' and build models for landscapes (such as rangelands) where little modelling capability exists (agencies) C) Identify likely future demand for modelling products and technical support, with a view to developing a business case for future funding (agencies)
4. That the NRC, agencies and CMAs pilot alternative approaches to NRM reporting in NSW	A) Pilot alternative approaches to evaluating and reporting on NRM at the regional scale (NRC, agencies, CMAs) B) Reconsider the statutory requirements of State of Environment reporting at local and state scales, with a view to make them more relevant and useful to decision-makers and the community (DPC)
Regional scale (Chapter 4)	
5. That CMAs, with support of agencies, improve the effective integration of socio-economic information into catchment planning and decision-making	A) Explicitly address Targets 12 and 13 in the upgraded CAPs and undertake MER in relation to these targets at this scale (CMAs, with agency support) B) Increase availability of socio-economic data by incorporating in decision-support or spatial tools (CMAs and agencies) C) Working collaboratively to identify knowledge gaps and explore and pilot socio-economic frameworks, methods and

Draft recommendations	Next steps	
		tools that enable the integration of socio-economic information into catchment planning and NRM decision-making (CMAs, agencies, NRC)
	D)	Incorporate adaptive capacity assessments into analysis of landscape function and pilot alternative methods for assessing NRM contribution to economic sustainability and social well-being, for example social return on investment analysis at program level (CMAs, agencies, NRC)
6. That CMAs design effective MER programs that are linked to evaluation questions and conceptual models of landscape change in their upgraded CAPs	A)	Develop evaluation questions and conceptual models of landscape change as part of the CAP upgrade process and revise MER plans accordingly (CMAs)
	B)	Increase investment in MER to ensure that catchment planning and investment decisions are well informed (CMAs)
Strengthen connections and increase alignment (Chapter 5)		
7. That MER partners strengthen and extend collaboration in MER	A)	Use the whole-of-government CAP upgrade process as the initial mechanism for driving stronger collaboration between agencies, theme teams, CMAs, local government and communities (CMAs, agencies, local government)
	B)	Build on and extend collaborative MER programs, such as the Practical Partnerships Program, Soil Watch, and the Program Performance pilot (agencies, CMAs, local government)
	C)	Support and enhance the sharing of NRM data, information and knowledge between NSW and Australian governments in a more coordinated manner (DPC)
8. That MER partners seek to leverage information generated from community and industry monitoring and evaluation programs	A)	Support community and industry monitoring programs to leverage additional information and enhance community participation in NRM (CMAs, local government, agencies)
	B)	Link community and industry monitoring activities with MER programs where appropriate (CMAs, local government, agencies)
	C)	Seek access to information collected by industry and other parties under environmental management systems and environmental impact assessments (CMAs, local government, agencies)
9. That MER partners accelerate the improvement of mechanisms to access and share data and information	A)	Adopt standard protocols for data collection, management and use (SOG, agencies, CMAs, local government)
	B)	Improve communication on available MER data and information to potential users, including extending the Data Inventory (agencies, CMAs, local government)
	C)	Make spatial base layers and monitoring data readily available on-line to users in open access systems (agencies, CMAs and local government)

1.3 Structure of this report

The following chapters discuss each of the recommendations in detail, including the findings on which they are based and the suggested steps for implementation over the next 2 years:

- Chapter 2 focuses on prioritising the datasets and indicators to be collected under the resource condition MER program
- Chapters 3 and 4 discuss sharpening the focus for MER at the state and regional scales
- Chapter 5 focuses on strengthening the connections between and increasing the alignment of MER efforts at various scales.

1.4 Providing feedback on these draft recommendations

This report is a working draft and is intended to generate comments from relevant and interested stakeholders. It is not a public document at this stage.

The NRC particularly seeks feedback on the report and draft recommendations from the Senior Officers Group, Chairs of the MER Management Team, CMAs, Local Government Shires Association and Department of Local Government. Comments from Australian Government agencies and other state jurisdictions outside of NSW are also welcome.

Please provide feedback in writing to the NRC prior to 30 January 2012. The NRC will consider this feedback and produce a final report for the SOG's consideration in March 2012. The final report will be made publicly available on the NRC's website.

2 Prioritising state-wide resource condition datasets and indicators

The NRC was asked to advise how to best prioritise the existing resource condition datasets and indicators. In doing so, the NRC took a pragmatic approach that involved reviewing recent literature on MER and available documentation on the resource condition MER program, and asking experienced NRM managers, scientists and policy makers about the most useful and practical datasets for their work.

The NRC found that:

- Best practice monitoring programs are strategic and forward-looking, in that they are designed to answer key evaluation questions to support effective adaptive management.
- CMAs are not aware that many of the state-wide datasets exist. They primarily access and use only five of these datasets, which provide information on some of the fundamental biophysical components of our landscapes, such as the extent of native vegetation communities. However, some CMAs indicated that the coverage and resolution of these datasets is patchy or coarse in their region. In addition, many put the view that the datasets are not well-linked to CAP targets or the management questions they most need to answer in their business.
- Agencies responsible for collecting the data identified seven state-wide datasets that they consider are most useful and practical to collect, many of which overlap with those used by CMAs. They also identified some specific challenges in monitoring and evaluating some of the state-wide targets, including the lack of resources to develop scientifically robust monitoring programs to evaluate and report at the state scale.

Based on these findings, the NRC considers that the resource condition MER program should refocus its efforts on improving the quality of, and maintaining the relatively small number of existing state-wide datasets and spatial layers that are fundamental to NRM decision-making and macro-landscape health at both state and regional scales. In the longer term, as we learn more about our landscapes' functions and values, agencies, CMAs and local government should collaborate to develop a strategic, forward-looking approach to information gathering.

The sections below discuss the NRC's key findings in more detail, including how we should identify what should be monitored, what NSW currently monitors and how much this costs, which datasets the CMAs use, and which datasets the data suppliers think are most useful. The final section sets out the NRC's recommendations, including the datasets that the resource condition MER program should focus on.

2.1 How should we identify what to monitor?

Before considering the priority of the existing resource condition datasets and indicators, the NRC reviewed the literature to understand best practice in developing a monitoring program – or more specifically, how to best identify what we need to monitor. Based on this review, the NRC identified three fundamental steps that form the foundation of an effective natural resource monitoring system:

1. **Develop conceptual models of landscape and ecosystem function.** These models describe how systems work, help identify and predict the consequences of management actions, and clearly distil the things that NRM decision-makers need to know at all scales.
2. **Pose good evaluation questions that can evolve over time**. These questions must be scientifically tractable yet test the policy and management options identified in conceptual models.
3. **Design the monitoring program to answer these evaluation questions.** The program should collect data only on the things that decision-makers need to know, should help our understanding of what interventions work and don't work, and improve policy and management actions as we go. [6]

These three steps lead to monitoring programs that enable and facilitate forward-looking, predictive natural resource management, which is essential for effective adaptive management. Developing such programs requires the selection of a core set of biophysical measurements that can be delivered with sufficient resolution to both inform and answer evaluation questions at a range of scales.

Traditionally, many MER systems in Australia and overseas have relied on 'backward-looking' monitoring programs that follow a general pattern of 'collect the data now, and ask the evaluation questions later'. This approach can lead to monitoring a large number of things (the 'laundry list') which stretches available resources thinly. As a result, key parameters may be poorly monitored or be monitored with less than optimal coverage in space and time.[7]

NSW's MER strategy has evolved to meet a range of different monitoring priorities. Initially, it was designed to provide compliance monitoring for regulatory functions. More recently it has focused on the provision of information to report on the state-wide natural resource targets the NSW Government adopted in 2005. These targets predominantly focus on trends in resource condition and the pressures that drive such trends. Consequently, the current monitoring framework generally aims to answer high-level evaluation questions about resource condition, often at the expense of answering more direct questions on ecosystem function and the consequences of local management interventions.

NRC's expectations for upgraded CAPs require the use of a systems analysis, using the best-available biophysical, social and economic information to describe the social ecological systems operating in the catchments. In most cases, this will require CMAs to use conceptual models

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6 Amended from Lindenmeyer, D.B. and Likens, G.E. (2010) *Effective ecological monitoring*. CSIRO Publishing, Collingwood Victoria. See also Rumpff, L. (2011) *The process in making adaptive management meaningful – using process models to guide investment of native vegetation*. In Decision Point , Issue 47 available at http://ceed.edu.au/wp-content/uploads/2011/03/DPoint_47.pdf; Rumpff, L. Duncan, DH., Vesk, PA., Keith, DA. And Wintle, B. (2011) State-and-transition modelling for Adaptive Management of native woodlands. *Biological Conservation* 144 (2011)1224-1236; Maddox, D., Poiani, K. and Unnasch, R. (1999) *Evaluating Management Success: Using Ecological Models to Ask the Right Monitoring Questions*. In Ecological Stewardship – a common reference for Ecosystem Management Vol III, edited by Sexton, W.T., Malk, A.J., Szaro and Johnson, N.C. Elsevier Science, CA.; and Lookingbill, T,R., Gardner, R.H., Townsend, P.A, and Carter, S.C. (2007) Conceptual Models as Hypotheses in Monitoring Urban Landscapes. *Environmental Management* 40: 171-182.

7 Lindenmeyer, D.B. and Likens, G.E. (2010) *Effective ecological monitoring*. CSIRO Publishing, Collingwood Victoria.

(such as state-and-transition models) to illustrate system function, thresholds and hypotheses for management interventions. This adds another important layer to the MER function beyond the traditional condition and trend reporting. For example, it allows more robust analysis and priority setting using existing data, and provides stronger links between NRM investments and predicted and observed outcomes (and can tease out distinctions between natural variation and human interventions). However, it also means that the resource condition program now needs to deliver the technical advice and skills to help CMAs turn data into knowledge at the regional and even local scales, as well as continuing to provide policy-makers with the information they need at the state scale.

2.2 What is NSW currently monitoring?

The natural resource theme teams have identified around 220 datasets required for the current resource condition MER program (Attachment 1). Although measurements on many of these parameters were collected prior to the setting of state-wide targets, most have been used to establish baselines and report on condition and trend across the 13 state-wide targets in the 2010 State of the Catchment reports (across 96 condition and pressure indicators). Over 10 new datasets (or indices) are being developed as an input into the 2013 State of the Catchment report cards.

Many other natural resource and environmental datasets and information exist across agencies that are not included in the resource condition MER program. For example, data collected under the NSW Rangeland Assessment Program[8] and biodiversity data collect by NSW State Forests.[9]

The NRC's analysis of the resource condition MER program datasets found that:

- The **'water'** theme accounts for 60 per cent of them, the **'biodiversity'** theme for 20 per cent, the **'land'** theme for 12 per cent and the **'community'** theme for 8 per cent.
- Around **60 per cent** are 'static' datasets, meaning they provide a snapshot in time or are only sporadically updated as required (eg, NSW land use map, native vegetation extent and soil landscape maps). The remaining **40 per cent** are 'dynamic', meaning they are regularly updated.
- **Four** datasets are (or will be) used multiple times to assess progress across two or more state-wide targets (eg, the NSW land use map is used for native vegetation, riverine ecosystems and land managed within its capability).
- **Four** relate to land use mapping and are used for different state-wide targets (eg, the NSW land use map; riparian vegetation – land uses in 100m buffer; the modelled catchment runoff for pre-clearing and current land use; and the catchment land use).

8 Green, D., Richards, R., Hart, D. and Watson, I. (2001) *Rangeland monitoring, condition assessment and resource inventory activities in New South Wales conducted by the Department of Land and Water Conservation – report prepared for the Rangeland Theme of the National Land and Water Resources Audit* .

9 For example of activities see, NSW DPI (2011) *Current research projects – forest and rangeland ecosystems*. Available at http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/321665/Current-Project-Summaries-for-web_FOREST-and-RANGELANDS_210611.pdf

Theme teams have classified the datasets into three categories – condition, pressure and contextual. The contextual datasets provide source data for the condition and pressure indicators used in state of the environment reports or provide other information required to analyse and interpret condition and pressure indicators. The condition and pressure datasets are commonly derived from data analysis, interpolation or assessments from one or more contextual datasets.

However, even with this classification, the NRC found that it is not always clear what has been measured to generate a given dataset. For example, the dataset descriptions are often ambiguous about the type, source and quality of the primary data that goes towards the evaluations. As a consequence, it is not easy to identify and compile an inventory of what exactly is being measured, and at what frequency and intensity. Therefore, the existing inventory of datasets is not particularly accurate or helpful.

In addition, the NRC found that some stakeholders use other terminology to classify the datasets. For example, the datasets are often referred to as primary, derived or metric. This inconsistency may be partly in response to the uncertainty over the purpose of the evaluation datasets. In the NRC's view, consistent definitions and descriptions are essential to enable meaningful evaluation of the MER strategy.

Building on the feedback from its consultation, the NRC has proposed an alternative way to think about and classify the datasets. It considers that it may be useful to focus on the key distinction between **primary** datasets, and those that are **derived** from primary datasets or **evaluated** using primary or derived datasets:

- **Primary datasets** are generated from direct observation or measurement, such as those for the core biophysical parameters for soil, water, vegetation and biodiversity, and the core socio-economic parameters for land use, human activity and natural resource managers' capacity. These datasets need to be both measured and monitored, and require sampling protocols either through direct measurement or observation, via remote sensing or through the various survey/workshop techniques for human activity measures.
- **Derived datasets** are generated from interpolations, difference and/or multiple measurements from one or more primary datasets.
- **Evaluated datasets** are generated by using primary and derived datasets to create metrics or indices using a range of analytical approaches.

In reviewing 200 odd datasets identified by the theme teams in this way, the NRC found that 45 per cent of datasets are primary,17 per cent are derived, and 30 per cent are evaluated. The remaining 8 per cent could be classified as regulation or classification datasets, as they support regulatory functions or classify entities or types of things. Attachment 1 provides a draft list of the datasets by these categories.

This classification helps to recognise the primary data generated from direct observation or measurement (which are the true building blocks of the MER system) and those that are derived or evaluated. The MER strategy should design its monitoring programs to collect and update data for the primary datasets. This decision is important as obtaining data at sufficient scale and intensity to make primary datasets useful for all decision-making is the most expensive part of MER. Section 2.6.1 explains how this classification system could be used to help prioritise the existing datasets.

2.3 How much does the current resource condition MER program cost?

The best-available information suggests that the total annual cost of the current resource condition MER program is around **$13 m**.[10] This accounts for around **1.3 per cent** of the total NRM investment (of around $1 billion) via NSW agencies and CMAs in the 2009-10 financial year.[11] A historical rule-of-thumb suggested CMAs should allocate **5 per cent** of their total investment towards MER activities.[12]

Theme team leaders consider that the current investment in MER is not enough for the program to effectively report on progress towards all the state-wide targets. For example, it will not allow (amongst others):

- assessment of vegetation condition, including the continuation of the practical partnerships program between agencies and CMAs described in section 5.1 (state-wide target 1)
- development of groundwater dependent ecosystem inventory (state-wide target 6)
- further data collection for soil condition or land managed within capability (state-wide target 10 and 11).[13]

In the theme team leaders' view:

- Over **$19 m** is required to provide **essential**[14] information in priority areas and conduct periodic reporting and/or periodic snapshot assessments in the remaining areas. This is an increase of around **$6.4 m** (or **50 per cent)** on the current funding, and is equivalent to **1.9 per cent** of the total NRM investment in 2009-10.
- Around **$26 m** is required to provide **comprehensive**[15] information and inform NRM at a range of scales. This is an increase of around **$13 m** (or **100 per cent**) on the current funding, and is equivalent to 2**.6 per cent** of the total NRM investment in 2009-10. [16]

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10 Source: Internal paper provided by the Chair of the resource condition MER management team. Nearly $3.7m in operational costs and over $9.4m in FTEs (1 FTE = $115k). Excludes $3.5m in capital costs.

11 NRC (2010) *Progress towards healthy resilient landscapes – implementing the standard, targets and catchment action plans – December 2010*. Natural Resources Commission, Sydney; after *NSW Government Budget Paper 2009-10*. Estimate includes all operational, program and grant funding for each agency, less any funding streams that could be readily indentified as not contributing to the state-wide targets and NRM. For more discussion on this, and other funding streams see the NRC's 2010 Progress Report.

12 DIPNR (2005) *Guidelines for an integrated Catchment Action Plan, Annual Implementation Program and Investment – working draft*. (the then) Department of Infrastructure, Planning and Natural Resources, Sydney. This was commonly referred to as 80:15:5 rule (on-ground/ activities/administration/MER). The guidelines are not current policy, and this measure is provided as a simple comparison.

13 Source: Internal paper provided by the Chair of the resource condition MER management team

14 As defined by the NSW resource condition management team - an ***essentia***l program as one that provides comprehensive information in priority areas, complemented by periodic reporting and/or periodic snapshot assessments in the remaining areas

15 As defined by the NSW resource condition management team - a ***comprehensive*** program as one that meets all the requirements of an MER Strategy designed to provide data and information to inform natural resource management at a range of scales

16 Source: Internal paper provided by the Chair of the resource condition MER management team.

Table 2.1 compares the current funding with theme leaders' views on the required funding by target area. This table indicates that:

- Three target areas account for more than 80 per cent ($10.5 m) of the total current funding **– native vegetation, riverine ecosystems and groundwater**. Of these areas, only the riverine ecosystems area needs a significant increase (108 per cent) on current funding to provide comprehensive information.
- Two target areas account for more than half of the remaining 20 per cent ($2.5m) of the total current funding **–estuaries and coastal lakes and marine waters**. Estuaries and coastal lakes needs a significant increase to provide essential information (150 per cent) or comprehensive information (275 per cent).
- The **soil and land management** target areas (the 'land' theme) appear to be poorly resourced ($ 0.3 m) compared to the other target areas that are fundamental to macro-landscape health (e.g. vegetation and rivers).These target areas need a significant increase in funding to provide essential information (333 per cent) or comprehensive information (933 per cent).
- All **other target areas** require a significant increase in funding (> 100 per cent) to provide even essential information.

It is not clear from the information provided in the *NSW Natural Resources MER Strategy 2010-2015 Implementation Plan (Version 1.1)* how theme teams assessed their future funding requirements. The NRC suggests that the Resource Condition MER Management Team review this information with theme teams, especially in light of the new requirements under the CAP upgrade process.

2.4 Which of the current datasets do CMAs use?

The NRC asked senior staff at all 13 CMAs which indicators and datasets they had used in the recent past, and for what purpose.[17] It also asked what key gaps and issues they had identified with these datasets, and which were likely to be most useful to them in the current CAP upgrade process. The NRC was especially interested in CMAs' use of existing datasets for systems analysis of their catchment, and in which datasets provided key measures of landscape health.

The NRC found that many CMAs do not know what state-wide datasets are currently available. For many, the list of datasets included in the issues paper for this review was the first comprehensive inventory they had seen. This may be due to the fact that the data inventory compiled by the Office of Environment and Heritage (OEH) was only recently released, and its availability on the OEH website has not been communicated to CMAs.

17 See Hyder (2011*) Review of NSW resource condition MER – CMA interviews – summary of findings*. Report commissioned by the Natural Resources Commission, Sydney.

Table 2.1: Cost comparison between current funding for resource condition MER and *essential* and *comprehensive* programs[18]

	Cost[19]						
Target area	Current ($m)	Essential ($m)	Cost diff. (on current) ($m)	(%)	Comp'sive($ m)	Cost diff. (on current) ($m)	(%)
Native veg.	2.8 [20]	3.0	**+0.2**	+7	3.9	**+1.1**	+39
Fauna / **Threatened species**	0.2	0.8	**+0.6**	+350	2.0	**+1.8**	+900
Invasive species	0.2	0.3	**+0.5**	+250	0.4	**+0.2**	+100
Sub-total	$3.2m	$4.1m	**+$0.9m**	**+ 28%**	$6.3m	**+$ 3.1m**	**+ 97%**
Riverine ecosystems	2.5	5.2	**+2.7**	+108	5.2	**+2.7**	+108
Groundwater	5.2	5.9	**+0.7**	+13	7.2	**+2.0**	+38
Marine ecosystems	1.0	0.95[21]	**-0.05**	-5	1.4	**+0.4**	+40
Wetlands	0.06	0.7	**+0.6**	+1000	0.9	**+0.84**	+1400
Estuaries and coastal lakes	0.4	1.0	**+0.6**	+150	1.5	**+1.1**	+275
Sub-total	$9.17m	$13.7m	**+$4.53m**	**+49%**	$16.3m	**+$7.13m**	**+78%**
Soil / **Land managed within capability**	0.3	1.3	**+1.0**	+333	3.1	**+2.8**	+933
Sub-total	$0.3m	$1.3m	**+$1.0m**	**+333%**	$3.1m	**+$2.8m**	**+933%**
ESSWB	NA[22]	NA	**-**	-	NA	**-**	NA
Nat, resources managers' capacity	0.3	0.2	**-0.1**	-33	0.4	**+0.1**	+33
Sub-total	$0.3m	$0.2m	**-$0.1m**	**-33%**	$0.4m	**+$0.1m**	**+33%**
Total	$12.97m	$19.4m	**+$6.4m**	**+$49%**	$26.2m	**+$13.2m**	**+102%**

18 Source: Internal paper provide by the Chair of the NSW resource condition MER management team.

19 This includes operational costs and FTEs (1 FTE = $115k), and excludes capital costs.

20 This excludes capital cost of $3.5m for SPOT satellite imagery.

21 This excludes capital cost of $90 k for radiometer.

22 The NRC understands (the then) Industry and Investment did not provide costings as it believes it is necessary and desirable for CMAs to undertake MER for this state-wide target.

The NRC also found that the main state-wide datasets CMAs have accessed and used are those associated with:

1. vegetation extent, condition and communities
2. soil condition and soil landscapes
3. land use mapping (including National Parks and State Forests layers)
4. water quality, and
5. riverine condition (particularly Riverstyles®).

Many CMAs also suggested the state-wide datasets are not sufficiently linked to their CAP targets or management questions to make them useful for their business needs. In addition, they indicated that the coverage and resolution of these datasets varies across the state As a result, some CMAs have good coverage across their region, while other CMAs have patchy or coarse coverage.

Many CMAs have commissioned their own data collection to address coverage gaps or deficiencies. CMAs were particularly concerned about the limited state-wide data on vegetation classes and condition. They also identified other key data gaps across the targets areas for fauna, threatened species, groundwater, natural resources managers' capacity and economic sustainability and well-being.

Several CMAs expressed concern about the prospect of rationalising the state-wide datasets, and suggested that a precautionary approach should be taken. This is because most CMAs are starting their CAP upgrades, are in the early phase of using systems and resilience thinking, and are unsure which state-wide datasets will be most useful for this task. Many believe they will be in a more informed position to understand their data needs once their CAP upgrade is complete.

2.5 Which datasets do agencies think are most useful and practical?

Agencies are responsible for collecting data, maintaining the datasets, and helping evaluate and report on progress towards the state-wide targets. Most are also responsible for developing models for a range of state-wide target areas that can be used to predict the trajectory of resource condition and/or track responses to a range of management interventions.

In interviews with agency staff, the NRC asked people in a range of positions which datasets they consider to be most useful for decision-making and practical to collect.[23] They identified the following 6 datasets:

1. vegetation extent, condition and communities
2. riverine condition and hydrology
3. land capability, land-use and management
4. soil condition
5. groundcover, and
6. cultural heritage.

[23] See NRC (2011) *Review of NSW resource condition MER – summary of stakeholder interviews.* Natural Resources Commission, Sydney.

These provide the necessary information to support agencies' legislation and compliance requirements, predictive modelling development and land management (such as National Parks).

They also indicated that they faced challenges in measuring and evaluating progress towards some of the state-wide targets, for example:

- In the **fauna and threatened species** target areas, monitoring the population, distribution and trends for a meaningful number of fauna and threatened species is expensive and resource-intensive given fauna's mobile nature. The current approach of using a small sample of case studies does not capture the meta-population dynamics of fauna.
- In the **wetlands target** area, the independent monitoring program has not had sufficient coverage to enable meaningful reporting at the state scale, and riverine and vegetation data from other theme areas has had to be used.
- In the **economic sustainability and social well-being area** and **natural resource managers' capacity** target areas, significant support from CMAs is required to enable monitoring and evaluation. MER against these targets needs to be a collaborative effort involving both CMAs and agencies.

The NRC notes that agencies are exploring and applying the latest technology to overcome some of these challenges. For example, OEH recently began developing predictive modelling tools for vegetation condition, fauna and threatened species and wetland biota (both terrestrial and aquatic biodiversity). It aims to integrate efforts across each asset area. It is also trialling remote motion-triggered cameras to monitor and record the distribution of ground-dwelling mammals in National Parks (State Forests have also conducted similar work). The NRC encourages agencies to continue to explore the use of technology to promote cost efficient and effective ways of gathering data.

2.6 Which datasets should the resource condition MER program focus on in the coming years?

In the NRC's view, the findings discussed in the previous sections suggest that the resource condition MER program should refocus its efforts to improve and maintain the quality of the relatively small number of existing state-wide datasets and spatial layers that are fundamental to NRM decision-making and understanding the overall health of our landscapes at a macro-scale. In addition, as we learn more about our landscapes' functions and values, agencies, CMAs and local government should collaborate to develop a strategic, forward-looking approach to information gathering.

2.6.1 Refocus the resource condition MER program

The NRC recommends that the resource condition program focus on building and improving datasets around 12 key data categories that are fundamental to decision-making and understanding macro-landscape health. Its main objective should be to ensure these data categories have good resolution for decision-making at different scales, and form the information 'backbone' for decision-makers and natural resource managers at all scales. This approach will address the key shortcomings of the current program, by closing existing gaps in the coverage and resolution of the fundamental existing datasets and making them more useful for CMAs, and by improving the feasibility of the monitoring task for agencies.

Table 2.2 lists the **recommended set of fundamental data categories and the associated datasets.** The NRC selected this set based on its analysis and the feedback from agency experts, CMAs and other stakeholders. Some of the recommended data categories are contextual base layers while others are more dynamic.

The **contextual base layers** provide the essential basic information about landscapes at any scale. These data categories include:

- **Topography, drainage pattern** and **soil type,** as these define the landscape and land capability in broadest biophysical terms.
- **Land use,** as this expresses the combination of economic opportunities, legislative constraints, cultural values and socio-economic needs over time to make multiple use of the natural resource base.
- **Native vegetation,** as this is the key tool for managing landscapes and a simple and consistent surrogate for land capability and current pressure - native vegetation provides an indicator of past impact and current status of conservation values.

Direct observations and indicators in these five data categories can be generated from 10 of the existing datasets (Table 2.2). Spatial and temporal analysis of these datasets with various correlative and modelling approaches would generate a sound understanding of land capability at the state and regional scale. However, they lack the necessary detail on the state of natural resources. At a minimum, to understand the state of natural resources at the state scale it is necessary to add more **dynamic** data categories.

The dynamic data categories require more regular measurement, and qualify as genuine monitoring. Thus they require significant quality control as well as quality assurance procedures. They include:

- **Water flows**, especially changes over time, as these reflect the combination of natural variation in rainfall and land management and are a generic surrogate for water quality.
- **Groundcover**, as this impacts on many natural resources issues and when viewed in the context of seasonal climatic conditions, is important for predicting disturbances, understanding ecosystem dynamics and developing management options.
- **Population**, **land use change** and **regional economy** as these provide indicators of the demand for natural resources as increases in the metrics of these data categories correlate with demands on the asset stock.
- **Disturbance** and **invasive species** as these are consequences of depleted assets and ineffective management (national to sub-regional scales).

Direct observations and indicators for these seven dynamic data categories can be generated from 22 of the existing MER datasets (Table 2.2). C**limate data** (from the Bureau of Meteorology), including the short and long term predictions at regional and sub-regional scales is also included in this groups as it provides necessary context for properly understanding the other data categories.

Table 2.2: Fundamental data categories and datasets

Data category		Existing MER dataset	
Contextual base layers			
1.	**Topography**	i.	Digital elevation model - base GIS layer for catchment topography
2.	**Drainage pattern**	ii.	Base GIS layer of drainage pattern
3.	**Soil type**	iii.	NSW soil profile records - Soil and Land Information System (SALIS)
		iv.	Soil landscape map series sheets
4.	**Land-use**	v.	NSW land use map (including National Park estate, State Forests and Travelling Stock Reserves)
		vi.	Land and soil capability - by NSW soil landscape (3850 in total)
		vii.	Land and soil capability ratings - at each MER soil sampling site (ibnABDUL database)
5.	**Native vegetation**	viii.	Native vegetation condition land cover (use and tenures as surrogates)
		ix.	NSW extant native vegetation (Keith and Simpson 2006, 2010)
		x.	NSW native vegetation extent using ongoing SLATS analysis of Landsat imagery
Dynamic			
1.	**Water flows**	xi.	HYDSTRA hydrological database of hourly time-series flows
		xii.	Licensed annual water entitlements
		xiii.	Peak daily demand estimates
		xiv.	Modelled (2CSalt) hydrology of coastal catchments - 90th percentile eannual flow volume
		xv.	Long term annual average extraction limit (LTAAEL)
		xvi.	Metered water use from groundwater bores
		xvii.	Groundwater level data
		xviii.	Groundwater quality data
		xix.	Licensed annual groundwater entitlement
		xx.	Wetland extent using satellite imagery
2.	**Groundcover**	▪	No existing state-wide datasets – other jurisdictions undertake work in this area, for example the National Dynamic Land Cover dataset [24] and groundcover monitoring by the Sydney Catchment Authority.[25]
3.	**Human**	xxi.	Average population growth in urban, regional, town and rural areas

[24] In collaboration between Geoscience Australia, Australian Bureau of Agriculture and Resource Economic and Science and state and territory agencies, available at http://www.ga.gov.au/earth-observation/landcover.html

[25] For an overview see SCAN – Issue 1, Winter 2011, available at http://www.sca.nsw.gov.au/__data/assets/pdf_file/0015/24171/SCA-NL_Jun2011_Web.pdf

Data category		Existing MER dataset	
	population		including indigenous
4.	**Land-use change**	▪	No existing datasets - other jurisdictions undertake work in this area, for example the Australian Collaborative Land Use Mapping Program.[26]
5.	**Regional economy**	xxii.	Growth in employment by agriculture, mining and other industry
		xxiii.	Percentage of population who volunteer by urban, regional, town and rural areas
6.	**Disturbance**	xxiv.	Photographic record of each MER soil monitoring site
		xxv.	DustWatch dust concentration records
		xxvi.	Acid sulfate soil risk maps
		xxvii.	Soil monitoring unit boundaries
		:xviii.	Soil condition monitoring 2008 baseline site data
7.	**Invasive species**	xxix.	Local government weeds survey (distribution and abundance of 134 priority weeds)
		xxx.	LHPA emerging pest animal survey (distribution and abundance of camels, horses, donkeys, deer, cane toads)
		xxxi.	Alien fish species in the Murray-Darling Basin (Sustainable Rivers Audit)
		xxxii.	Alien fish species in coastal river basins
8.	**Climate**	▪	Australian Bureau of Meteorology data

If further refocusing and reprioritising is required beyond the fundamental data categories and datasets recommended in Table 2.2 – for example, to control the costs of data collection – the NRC considers that the classification approach it proposed in section 2.2 – **primary, derived, evaluated** datasets – could facilitate this by helping users and suppliers to better understand the use, costs and benefits of the existing datasets.

The collection and management of primary datasets is traditionally the most expensive part of MER strategies, as ongoing activity is needed to both maintain and generate useful information. Derived and evaluated datasets are generally less expensive, because they use data from the primary datasets. However, some derived and evaluated datasets may be more valuable than others in informing NRM decisions, and this value should inform the intensity, scope and scale of **primary** data collection. The NRC notes that this is not currently the case. For example, data collection for more valuable multiple-use derived datasets is assessed in the same way as that for single-purpose datasets.

The NRC recognises that a combination of primary, derived and evaluated datasets will be required for a comprehensive MER strategy. However, the cost of data collection may be reduced by identifying the optimum combination from the existing datasets through further

[26] See for example ACLUMP (2010*) Land use and Land Management Information for Australia: Workplan of the Australian Collaborative Land Use and Management Program*. ABARE, Canberra; and catchment scale land use change mapping (Lower Murray region in NSW), available at http://adl.brs.gov.au/landuse/index.cfm?fa=main.catchmentExamples .

filtering and technical information. The NRC recommends that **if further prioritisation is desirable,** forensic analysis of the current MER datasets using the broad classifications proposed in section 2.2 be used to identify this optimum combination.

2.6.2 Develop a strategic, forward-looking approach to knowledge gathering

The recommendations for refocusing the resource condition program respond to the SOG's specific request for advice. However, as section 2.1 discussed, contemporary scientific literature cautions against focusing on datasets in designing MER programs (starting with the 'answers' first), and suggests that conceptual models of landscape function and hypothesis-driven evaluation questions provide the essential foundations for effective MER.[27]

Therefore, the NRC strongly recommends that agencies, CMAs and local government collaborate to develop a more **strategic approach** to knowledge gathering. This approach should define the key natural resource policy and management **questions**, and direct future monitoring and research efforts towards answering these questions. Where possible, these efforts should complement other knowledge initiatives at other scales, such as the Australian Government's research priorities for rural industries and natural resource management.[28] This will help ensure the monitoring program is forward-looking, and supports effective adaptive management.

Next steps include:

- Realigning resource condition MER programs to provide a core set of essential state-wide datasets (SOG)
- Developing a whole-of-government knowledge strategy that defines the priority knowledge and information needs for NRM across all scales in the long term (SOG)
- Developing a business case for effectively funding the re-prioritised MER program (SOG)

27 See for example from Lindenmeyer, D.B. and Likens, G.E. (2010) *Effective ecological monitoring*. CSIRO Publishing, Collingwood Victoria

28 See for example DAFF (2007) *Rural Research and Development Priorities*. Department of Agriculture, Fisheries and Forestry. Commonwealth of Australia, Canberra.

3 Focus for MER at the state scale

As Chapter 1 noted, shortly before the revised MER strategy was released, the Government asked the NRC to develop State of the Catchments reports. More recently, the NRC set out a new whole-of-government approach to CAPs, and the CMAs began the process of reviewing and upgrading these plans using analytical approaches such as systems and resilience thinking.[29] The NRC chose to conduct this MER review in the context of these developments, given the critical role of monitoring and evaluation information for both these tasks.

In particular, the NRC considered whether – in addition to the recommended changes to the resource condition program's focus set out in Chapter 2 – the focus of MER's more general role and function needs to change to ensure that best-available information is brought to bear in upgrading CAPs and facilitating effective adaptive management at all scales. Several of the review's findings suggest such change is required. For example:

- CMAs indicated they did not know what state-wide datasets are available to support them in upgrading their region's CAP. In addition, many expressed concern that they lack the necessary capacity and skills to analyse and integrate these datasets (particularly as the new approach to CAPs means they are increasingly expected to do so). Similarly, policy-makers noted that it is not their role to analyse and integrate these datasets to distil the concise and accurate information they require at a whole-of-state scale.
- Developments and improvements in site and catchment scale models available to CMAs are essential for effective adaptive management, and are likely to improve CMA decision-making and progress reporting – both in upgrading CAPs and in the other stages of the adaptive management cycle. And while agencies have made recent good progress in this important area, there is uncertainty about on-going funding for this work.
- Many stakeholders questioned the value of state of the environment and catchment reports – particularly their usefulness for informing future priorities and policy settings. They indicated that they need information products that provide the necessary insights for their decision-making, and can meaningfully inform appropriate policy responses in a timely manner.

In the NRC's view, these findings indicate that for the next 12 to 18 months, the **primary focus** of agencies with responsibility for MER should be to support the CAP upgrade process (in addition to continuing to meet the agencies' own requirements for data and information)[30]. In addition, they should continue to develop and improve conceptual and predictive models (and the necessary supporting frameworks) to support decision-making and evaluation, and to develop more useful and timely information products to close feedback loops. The sections below discuss these recommendations in more detail.

3.1 Support upgrades of Catchment Action Plans

In assessing upgraded CAPs to determine whether to recommend their approval to government, the NRC expects these plans to (among other things) describe the social-ecological systems that operate in the catchment using best-available science and knowledge of

29 As described in Walker, B, and Salt, D (2006), *Resilience thinking – Sustaining ecosystems and people in a changing world*. Island Press, Washington DC.

30 For example, for meeting statutory and legislative requirements and strategic decision-making (such as Strategic Regional Land Use Plans).

community values. This is a step up from previous CAPs, and will require the necessary technical skills to use and integrate biophysical, social and economic data.

However, in interviews for this review, CMAs indicated they do not generally have these specialised skills. In addition, most indicated that they did not know what state-wide datasets are available to them. They also suggested they need better supporting information about the datasets (e.g. metadata) and better models to integrate data and information across themes.

The NRC considers that agencies with responsibility for MER can help CMAs in addressing these information, knowledge and capacity shortfalls, and in doing so can significantly advance their capacity for effective adaptive management. This view is based on the NRC's observations on the recent pilot CAP upgrades led by Central West and Namoi CMAs. For these upgrades, agencies and CMAs came together to assess and integrate the best-available local, regional and state scale data using systems thinking. They produced a range of conceptual models (such as state-and-transition models) that describe how the landscapes in those catchments function and respond to disturbances, and generated insights into the certainty of the assumptions that underpin proposed management actions.

As a result of this collaborative effort, the upgraded CAPs are a significant advance on the previous versions. In addition, the effort provides Central West and Namoi CMAs with the necessary foundation to design MER programs that can test their management options, and adjust their investments as they learn from success and failure.[31] In other words, the collaboration has positioned the CMAs to design MER systems that will ensure that they have the information they need to make sound NRM investment decisions now and into the future.

In light of this, the NRC recommends that over the next 16 months, when the remaining 11 CAPs are upgraded across the state, agencies should make supporting the CMAs a key priority and focus of their work. In particular, they should work with the CMAs to help them access, apply and integrate the best-available local, regional and state scale data (including natural resource condition data) to develop high quality CAPs. This will provide the foundation for building high-quality, region-based MER systems across the state, which will generate information to complement the fundamental state-based datasets recommended in Chapter 2. In addition, when coupled with the NRC's audit program, these regional MER systems will greatly increase the likelihood of effective CAP implementation and successful NRM outcomes.

In making this recommendation, the NRC recognises that agency staff with responsibility for MER already have heavy workloads. Therefore, the NRC envisages that while these staff are working to support the CAP upgrades, they would postpone significant work on analysing and reporting outputs for the 2013 state of the catchment report cards until after the pilot state of catchment process is complete.

In addition, the NRC notes that there may also be opportunities to leverage the collaborative efforts of the agencies and CMAs at the local scale. With the introduction of the Integrated Planning and Reporting Framework, all NSW local councils are required to prepare community strategic plans that set out the long-term social, environmental and economic objectives for their communities.[32] The plans must also set out the MER arrangements for tracking implementation progress.

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31 Section 2.1 explains why conceptual models are necessary to build effective monitoring and evaluation programs.

32 As required under the *NSW Local Government Amendment (Planning and Reporting) Act 2009*.

Many local councils have developed their community strategic plans, but others are yet to do so.[33] As a by-product of their work with CMAs, agencies could also support these remaining councils to access and apply the best-available regional and state scale data to develop high-quality community strategic plans. For example, councils can gain a better understanding of the available data and its use for the specific environmental elements of their plans.

Next steps include:

- Developing a coordinated approach for the provision of NRM data, information and knowledge for CAP upgrades (SOG)
- Supporting agency staff to provide face-to-face technical and scientific support in CMA regions (SOG)

[33] Around 45 per cent of all NSW councils have completed their plans (Groups 1 and 2). Another 93 councils will submit their plans by 30 June 2012 (Group 3).

3.2 Continue to improve conceptual and predictive models to support evaluation and decision-making

Conceptual and predictive models are critical tools in adaptive management, as they reduce the level of uncertainty about the most appropriate NRM management actions in a given landscape and improve decision-making in a structured way.[34] They provide a rigorous and scientific approach for testing and calibrating the assumptions that underpin management actions using data from field-based measurements. They can also predict the trajectory in the condition of natural resources given a range of management actions. This is much more effective and efficient than the alternative of trying to use field measurements to interpret the cumulative impact of management actions, as outcomes will always be influenced by other factors, including local management and seasonal conditions from year to year.

One of the key challenges in developing models is finding the right balance between representing complexity and simplicity in landscape systems.[35] As a result, appropriate technical and scientific expertise is required in the development and initial operation phases. However, once they are established, most models can be operated and improved with input from natural resource managers and practitioners 'in the field'.

The NRC recognises that in line with the revised MER strategy, the resource condition MER program intends to develop modelling frameworks. Indeed, during this review the NRC observed that good progress is already being made in this area. However, the CMAs indicated that more and better models are required, particularly for integrating information across themes. The sections below discuss our findings on what is being done in this area, and what more needs to be done in detail.

3.2.1 What progress has been made so far?

During this review, the NRC noted that agencies have already made good progress in developing modelling frameworks based on a range of management interventions to predict future condition of the state-wide targets. Data from monitoring programs will be used to verify or improve the assumptions built into the models. For example, agencies are:

- building a new aquatic biodiversity model that can map likely distribution of plant and fauna communities in rivers and wetlands and predict impacts of land management activities
- continuing to improve existing terrestrial biodiversity and vegetation condition models
- integrating and modelling combined biodiversity and Aboriginal cultural heritage values
- assessing impacts of site works for salinity on in-stream targets for the Murray Darling Basin

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34 See EEA (2008) *Modelling environmental change in Europe: towards a model inventory (SEIS/Forward).EEA Technical Report, No 11/2008.* European Environmental Agency, Copenhagen and Rumpff, L. (2011) *The process in making adaptive management meaningful – using process models to guide investment of native vegetation*. In Decision Point , Issue 47 available at http://ceed.edu.au/wp-content/uploads/2011/03/DPoint_47.pdf

35 Rumpff, L. Duncan, DH., Vesk, PA., Keith, DA. And Wintle, B. (2011) State-and-transition modelling for Adaptive Management of native woodlands. *Biological Conservation* 144 (2011)1224-1236.

- developing and applying coastal models (CERAT)[36] that integrate monitoring data to predict catchment export loads into every major NSW estuary, and
- developing and applying decision-support platforms (e.g. SCaRPA)[37] to help CMAs and other natural resource managers design incentives for multiple NRM outcomes from paddock to catchment scales.

Around half the CMAs are using a range of catchment and site scale models. More recently, Murrumbidgee CMA has applied a suite of catchment and site scale models through SCaRPA in a collaborative project with OEH. This project has:

- compiled a seamless vegetation map for the Murrumbidgee CMA region using state and regional scale data to model the region's biodiversity priorities
- enhanced existing models for water quality, salinity mitigation, and forestry, to help predict the impact of management actions and other changes in these areas
- integrated Aboriginal cultural heritage values with biodiversity values to show the location of potential investment sites with multiple benefits
- calculated the total area of effective habitat created from the CMA's incentive Property Vegetation Plans
- predicted reductions in in-stream salinity based on investments
- assessed and ranked the cost-effectiveness for best environmental benefit from landholder applications to build climate change corridors, and
- developed tools to report collective outcomes by local councils and not-for-profit organisations in the catchment.

3.2.2 What more needs to be done?

During our review CMAs put the view that more and better NRM models are required, particularly for integrating information across themes. They argued that the data involved in building the models should then inform what needs to be monitored and collected. CMAs also suggested that they lack the required capacity to run these models, and expressed concern about the limited funding available to support them in this.

Seven CMAs (and the ACT Government) are now in the early stages of applying components of SCaRPA in their catchments.[38] The demand is likely to increase given the increased expectations for upgraded CAPs to express catchment priorities spatially. However, it is unclear how this demand can be met given the uncertainty around future funding for SCaRPA.[39]

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36 *Coastal Eutrophication Risk Assessment Tool*, for more details see http://www.ozcoasts.gov.au/nrm_rpt/index.jsp

37 *Site and Catchment Resource Planning and Assessment* decision support system. V2 developed in collaboration between NSW Office of Environment and Heritage, Future Farm Industries Cooperative Research Centre and Murrumbidgee Catchment Management Authority.

38 For the 2011-12 financial year some CMAs are applying components of SCaRPA - Border Rivers Gwydir, Northern Rivers, Hunter Central Rivers, Hawkesbury-Nepean, Murray, Murrumbidgee and Lower Murray Darling CMAs.

39 Pers. Com. (2011) Dr. Greg Summerell, Manager Landscape Modelling and Decision Support, Office of Environment and Heritage in the Department of Premier and Cabinet.

The Western and Lower Murray Darling CMA regions are particularly in need of support, as there are currently no catchment or site scale models applicable to these regions. Western CMA suggested this is because there are limited data about the 'rangelands' from which to build relevant and robust models. However, the NRC considers it likely that with appropriate help from agencies useful models for these areas can be adapted or developed.

For example, the Murrumbidgee CMA and OEH found little data for the 'rangeland' areas in the western parts of the Murrumbidgee catchment when they were developing site and catchment scales models for the SCaRPA project discussed above. For this reason, they prioritised developing and improving a suite of model frameworks for these areas using what data were available. Within eight months, they developed three models which are now helping the CMA to prioritise investments in the rangeland areas. The Lower Murray Darling CMA is now collaborating with agencies to apply a similar approach for the rangeland areas in its catchment.[40]

In addition to developing models for the rangelands, the NRC considers the other key priorities are to build and improve models that can address:

- the social and cultural elements of landscapes, and
- landscape thresholds of concern[41] or 'tipping points' like those identified in the recent pilot CAP upgrades (for example, rather than just decision rules based on comparative extent or abundance against some nominal baseline, such as pre-1750s landscapes).

Next steps include:

- Better utilising conceptual and predictive models to guide and inform monitoring programs (agencies, CMAs)
- Improving models that can address social and cultural vales and landscape thresholds or 'tipping points' and build models for landscapes where little modelling capability exists (agencies)
- Identifying likely future demand for modelling products and technical support, with a view to develop a business case for future funding (agencies)

40 *Ibid.*

41 See for example, Biggs HC and Rogers KH (2003) An adaptive system to link science, monitoring and management in practice. In *The Kruger Experience: Ecology and Management of Savannah Heterogeneity*. (Eds. JT du Toit, KH Rogers and HC Biggs) pp. 59–79. Island Press, Washington

3.3 Pilot alternative approaches to NRM reporting in NSW

To use monitoring and evaluation outputs in adaptive management, NRM decision-makers require (among other things) information products that communicate to them what is and isn't working and what needs to be done so they can respond appropriately. Because decision-makers' needs vary at different scales, these products must be tailored so they communicate to and influence their intended audience in the most effective way. For example, a Minister will need different information to assess how a policy is performing than, say, a CMA officer needs to assess whether one particular project design is a better option than another to achieve desired outcomes. Similarly, community members are likely to require quite different types of information products about the state of our natural resources than government decision-makers.

NSW has traditionally relied on pressure-state-response models to analyse the state and trend in the condition of its environmental and natural resource assets. The outputs of these analyses are typically reported in state of the environment (SOE) reports, such the NSW and local government SOE reports. These reports are intended to be a resource for decision-makers and managers, to help guide them in setting future priorities and adjusting policy and programs for improved environmental and NRM outcomes.

Many of the parties the NRC interviewed for this review questioned the value of NSW and local government SOE reports and the recent 2010 state of the catchment reports. In particular, they doubted whether these reports can effectively inform future priorities and policy settings. Some suggested this is because the reports are not explicitly linked into any adaptive decision-making mechanisms operating at the state scale.[42] For example, the collection and reporting of information for these reports is not driven by clear or explicit evaluation questions that decision-makers want to answer. Therefore, the reports provide no explicit reference against which evaluations can be made, and to which decision-makers can respond.

In the past, the NRC has also queried whether the traditional reliance on condition and trend reporting (using pressure-state-response models) is useful in helping us manage our landscapes and understand the effectiveness of our actions at different scales.[43] This kind of reporting can provide some broad, qualified statements about the condition and trend of our natural resources. However, it is not designed to provide finer scale information such as positive outcomes (or continued degradation) occurring at different scales.

The NRC examined other jurisdictions' approaches to information products, to help identify what approach to the reporting part of the MER task NSW could adopt. We found mixed experiences in using the pressure-state-response model and mixed views on its usefulness for informing decision-making (see section 3.3.1 below). Given this and the findings of this review, the NRC considers there is a need to evaluate the usefulness, purpose and timing of SOE reporting at local and state scales with a view to improving the information products available to inform decision-making.

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42 See also critiques by Harding, R. and Traynor, D. (2001) *Informing ESD: State of the Environment Reporting , in Processes and Institutions for Resource and Environmental Management: Australian Experiences (Final report to Land and Water Australia)*. Ed. Y Dovers, S. and Wild Rivers, S, CRES ANU, Canberra, and Magnov, P. (2005*) SoE What? Has ten years or more of SoE reporting across Australia created or contributed to any environmental improvements or outcomes?* Paper presented at State of Australian Cities 2005 Conference, Griffith University.

43 NRC (2010) *Progress towards healthy resilient landscapes – implementing the standard, targets and catchment action plans – December 2010*. Natural Resources Commission, Sydney.

3.3.1 What approaches to reporting are other jurisdictions using?

The European Environmental Agency currently uses pressure-state-response models and state-of-the-environment type reports to inform decision-making at national and trans-national scales. For example, it links reporting indicators[44] to specific policy questions to inform and guide its monitoring programs.[45] It also undertakes integrated environmental and thematic assessments to produce a range of reports including five-yearly 'state and outlook' environment reports, effectiveness of policy measures, and forward-looking reports analysing the impacts of globalisation on Europe.[46]

However, the European Environmental Agency has also found many shortcomings in environmental assessment and reporting within its jurisdiction.[47] It has identified a need to:

- develop more targeted and sound 'forward-looking' integrated environmental assessments at appropriate geographic scales (eg, integrating social, technological, environmental, economic and demographic issues)
- include future perspectives routinely in regular environment reporting activities and systems (such as by adapting existing information systems to regularly capture data on future perspectives and emerging issues, and including more forward-looking perspectives in environmental reporting products)
- strengthen national and regional leadership in producing forward-looking assessments to support policy processes (eg, develop more forward-looking studies under the leadership of regional and national institutions)
- strengthen institutional capacity to perform forward-looking assessments at all levels (such as by increasing expertise and resources to build and carry out forward-looking studies)
- improve institutional capacities to absorb and better utilise the information generated in processes of decision-making.

In addition, the Victorian Commissioner for Environmental Sustainability has recently moved away from using the pressure-state-response model[48] as a basis for its state of the environment reports.[49] It found the PSR methodology did not capture the level of systems complexity

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44 Around 230 indicators covering 23 themes including natural resources, agriculture, biodiversity, environmental scenarios, land use, coasts and seas, tourism, green economy, transport etc.

45 See for example *Land take (Indicator No. 14),* accessed at http://www.eea.europa.eu/data-and-maps/indicators/land-take-2/assessment and *Gross Nutrient Balance (Indicator No. 25)*, accessed at http://www.eea.europa.eu/data-and-maps/indicators/gross-nutrient-balance-1/gross-nutrient-balance-assessment-published. For more discussion on indicators see (2008*) Catalogue of forward-looking indicators from selected sources – a contribution to the forward-looking component of a shared environmental information system (SEIS/Forward). EEA Technical Report, No 8/2008*. European Environmental Agency, Copenhagen, Denmark.

46 See for example, *The European Environment, State and outlook 2010 – Syntheis,* European Environment Agency, Copenhagen, Denmark and *The European Environment, State and outlook 2010 – Land use.* European Environment Agency, Copenhagen, Denmark.

47 EEA (2007) *The pan-European environment: Glimpses into an uncertain future.* EEA Report 2/2007. European Environment Agency, Copenhagen, Denmark and EEA (2008) *Using scenarios for decision-support: Current practice and future directions in environmental policy*. EEA Working paper. European Environmental Agency, Copenhagen, Denmark.

48 Or more specifically the Driving force-Pressure-State-Implications-Responses model.

49 The Victorian Commissioner for Environmental Sustainability is responsible for preparing and recommending SOE reporting frameworks, and preparing the subsequent SOE report.

operating in Victorian landscapes. For example, it reported that the methodology downplayed 'social diversity and local responses, thereby rendering aggregated impacts on drivers difficult, if not impossible to examine'.[50]

The Commissioner for Environmental Sustainability has now adopted a new model of inquiry that places more emphasis on examining the relationship between social and ecological systems, and identifying the gap between current actions and what is thought to be necessary to achieve sustainable landscapes (Figure 3.1). It intends to develop a series of theme-based foundation papers to help gather data, information and community perspectives in preparation for its 2013 report. These papers aim to bring more timely and relevant information to policy makers and the community (rather than waiting for a five-yearly SOE report).

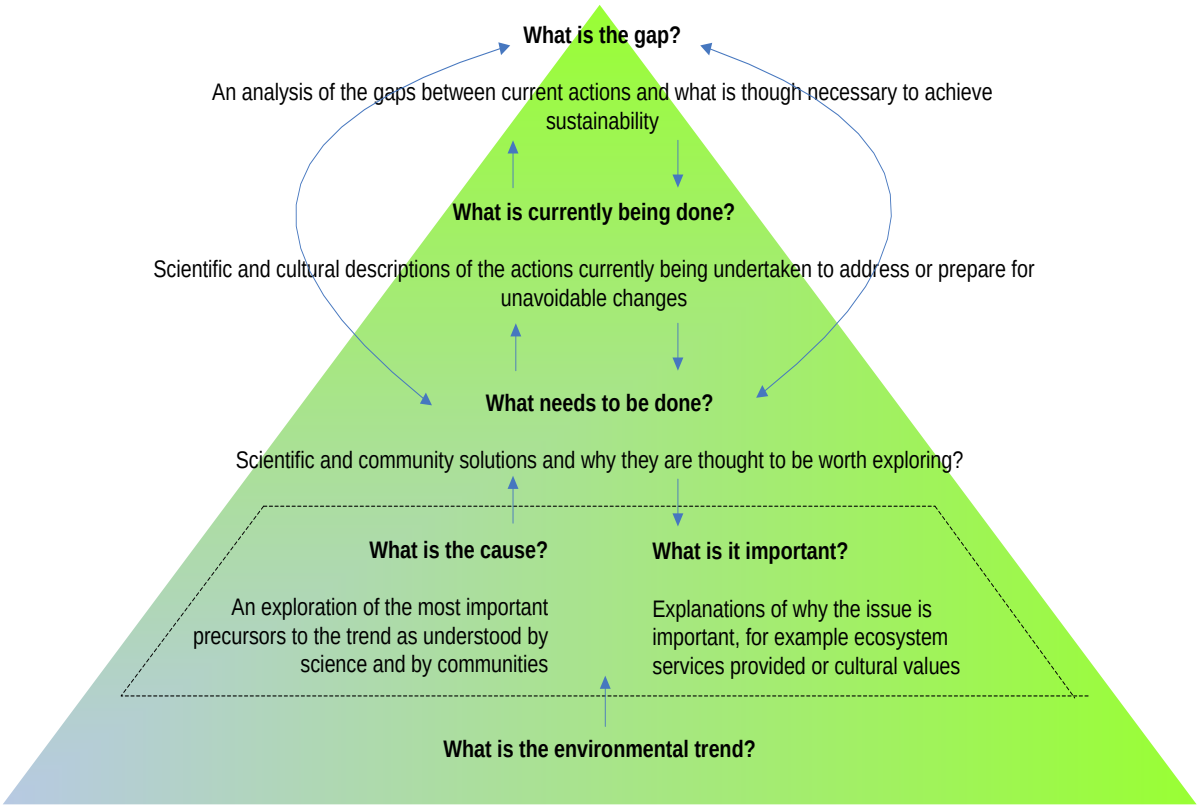

Figure 3.1: Model of inquiry for Victoria's State of the Environment Report 2013

50 CES (2010) *Science, Policy, People – State of the Environment Reporting 2013, Victoria*. Commissioner for Environmental Sustainability, Melbourne; after Carr E.R., Wingard, P.M., Sara C.Y., Thompson, M.C., Jensen, N.K. and Roberson, J. (2007) Applying DPSIR to sustainable development. *International Journal of Sustainable Development &World Ecology* 14 (2007) 543-555.

3.3.2 What reporting approach should NSW adopt?

The NRC recommends governments in NSW evaluate the current role and function of State of the Environment reporting, and whether it is delivering the necessary information to manage our landscapes into the future.

Under terms of reference from the Government, the NRC is required to develop the next round of SOC report cards. Given the concerns around previous SOC reports, the NRC proposes to:

- scope an alternative approach to the 2010 SOC reports, by analysing audience knowledge needs and different communication approaches from other jurisdictions
- piloting and evaluating an approach and draft reporting products.

Ideally, this investigation and pilot will be done from a CMA regional scale (ie, to allow it to look up, down and across scales). Some of the issues the NRC would like to explore include:

- who is the audience?
- what information do decision-makers, natural resource managers and communities' need at different scales (or, what key things do they need to know to do their business)?
- how do these needs differ across different temporal and spatial scales?
- how well do existing reports and other information products meed these needs?
- what alternative or additional information products could better meet decision-makers, natural resource managers and communities' needs?
- what MER tools, systems and architecture are required to develop these alternative or additional information products?
- what might be the capacity and resource requirements and benefits of developing these alternative or additional information products?

Next steps include:

- Piloting alternative approaches to evaluating and reporting on NRM at the regional scale (NRC, agencies, CMAs)
- Reconsidering the statutory requirements of State of Environment reporting at local and state scales, with a view to make them more relevant and useful to decision-makers and the community (DPC)

4 Focus for MER at the regional scale

In addition to reviewing the focus of the resource condition MER program and MER in general at the state scale, the NRC considered the role and function of MER at the regional scale. In particular, it considered where CMAs should focus their MER efforts to ensure that they complement the efforts at the state scale and are able to effectively upgrade and implement their CAPs.

The NRC found:

- There is early evidence to suggest that, provided they get appropriate support from agencies, the CAP upgrade process will provide CMAs with a good foundation for designing effective, forward-looking regional MER programs (discussed in section 3.1).
- However, the community target area presents some particular challenges – for upgrading and implementing CAPs as well as for MER. CMAs reported that they will struggle to meet expectations for them to explicitly address this target area in the upgrading CAPs. For example, they lack the skills and knowledge required to analyse and integrate socio-economic and biophysical information, and to use socio-economic data to measure the impact of regional NRM investments on their communities' social and economic well-being. In addition, the community theme teams reported that although they are responsible for monitoring progress in the community target area at the state scale, they need input from the CMAs to do this, and currently are not receiving this input.

Based on these findings, the NRC recommends that during the CAP upgrade process, CMAs should focus on improving their understanding of the linked socio-economic and biophysical systems in their catchments so they can effectively address the community target areas in their region's CAP. Once they have completed their CAP upgrade (with the support from agencies discussed in Chapter 3), they should focus on designing and implementing regional MER programs that are linked to evaluation questions and conceptual and predictive models of landscape function and response to disturbances. These programs should include collecting data on indicators of progress against the community targets, to enable them to evaluate and report against the upgraded CAPs and contribute to MER of these targets at the state scale.

The sections below discuss these findings and recommendations in detail.

4.1 Improve effective integration of socio-economic information in catchment planning and decision-making

The NSW model for NRM recognises the fundamental inter-relationships between environmental, economic and social outcomes, and requires CMAs to explicitly understand and address these relationships in catchment planning, investment and MER (Figure 4.1). In particular, the two community-focused state-wide targets for NRM – targets 12 and 13 – recognise that the health and productivity of our landscapes are critical for sustaining the communities that rely on them, and in turn, these communities' capacity and actions in managing the land are critical for maintaining this health and productivity (see Box 4.1). The *Standard for Quality Natural Resource Management* (the standard)[51] requires CMAs to use the best-available information to inform their decisions in all phases of the adaptive management cycle, including information on social and economic issues.

51 NRC (2005) *Recommendations – state-wide standard and targets – September 2005.* Natural Resources Commission, Sydney.

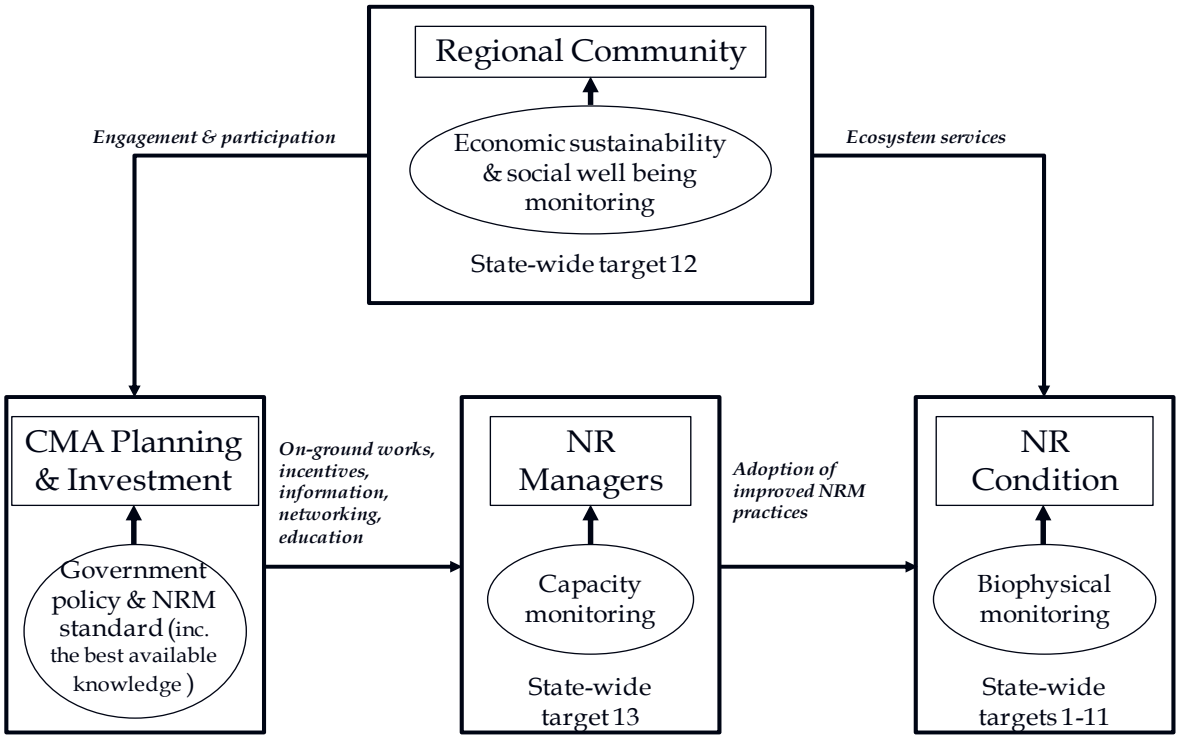

Figure 4.1: Conceptual model of relationship between community and biophysical targets and CMAs[52]

While the initial CAPs focused largely on the biophysical state-wide targets, the NRC has indicated that it expects the revised CAPs to move beyond this, and to identify and integrate the linked social and biophysical factors that make up a landscape. In particular, it expects the revised CAPs to (among other things):

- describe the social-ecological systems operating in the catchment using best-available science and knowledge of community values
- integrate socio-economic and biophysical information to analyse the systems operating in the catchment, and
- propose regional targets and actions that are logically nested and supported by the available evidence. [53]

In addition, the revised MER strategy indicates that CMAs need to play a significant role in monitoring progress towards the community targets, and that there is an expectation that MER for these targets will be a collaborative effort involving both CMAs and agencies.

However, the NRC's findings in this review indicate there are a range of barriers to the effective implementation of the community targets for NRM, and to CMAs meeting the above

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52 Figure sourced from page 3 of Jacobs B, Brown P, Nelson R, Leith P, Tracey J, McNamara L, Ahmed M and Mitchell S (2011) *Assessing the capacity to manage natural resources in NSW,* Monitoring, evaluation and reporting program, Technical report series, Office of Environment and Heritage, Sydney.

53 NRC (2011) *Framework for assessing and recommending upgraded catchment action plans.* Versions 1.*1, May 2011.* Natural Resources Commission, Sydney.

expectations in relation to revising CAPs and monitoring progress towards the community targets. The sections below outline these barriers, and then discuss recent progress and what else needs to be done to overcome these barriers.

Box 4.1: The community targets for NRM

The state-wide targets include two that identify the desired community outcomes of the state's NRM efforts:

- Target 12: Natural resource decisions contribute to improving or maintaining economic sustainability and social well-being
- Target 13: There is an increase in the capacity of natural resource managers to contribute to regionally relevant natural resource management.[54]

Target 12 is concerned with the impacts of NRM investments to meet the biophysical targets on community outcomes. The intent is not to measure the success of NRM against the overall health and well-being of communities since so many other factors affect these outcomes. Rather, it is to ensure that NRM makes a positive contribution to these outcomes. Therefore, regional MER programs need to capture the socio-economic outcomes of local and regional NRM investments, such as enhanced recreational outcomes, as well as the biophysical outcomes.

Target 13 is concerned with the capacity of natural resource managers (primarily private land holders) to adapt to change and adopt more sustainable management practices. Given the amount of land that is privately owned, the capacity of these land holders is critical to NRM and the achievement of the biophysical targets. Therefore, it is important that CMAs and agencies understand what enables and constrains these managers in practicing sustainable NRM, the links between broader policy and institutional issues, and how and why the capacity may vary across the region.

4.1.1 Barriers to effective implementation and MER of community targets

Evidence derived from interviews with CMAs and agency staff and recent studies[55] suggest there are a range of barriers to the implementation and monitoring of community targets. These include cultural and organisational barriers, as well as technical barriers. For example:

- **Cultural barriers** include a lack of acceptance that these targets are relevant, meaningful and practical. This is particularly the case with target 12. In addition, the social sciences are not well understood by natural resource managers, and are generally considered a 'soft' science.
- **Organisational barriers** include a lack of incentives for CMAs to invest in relevant socio-economic assessment skills and strategies. For example, there is no reward system for

54 NRC (2005) *Recommendations – state-wide standard and targets – September 2005*. Natural Resources Commission, Sydney.

55 Gale R., Brock P. & Milham N. (2010) *Assessing the contribution of investment in natural resource management to economic sustainability and social well-being*, Technical report 12 of monitoring, evaluation and reporting program technical report series, Industry and Investment NSW, Orange NSW; Hyder (2011) *Review of NSW resource condition MER*. Report prepared by Hyder Consulting on behalf of the Natural Resource Commission, Sydney NSW; Marshall G (2011) *Improving Economic Accountability of investment decisions under community based environmental governance.* Institute for Rural Futures, University of New England, March; NRC (2011) *Framework for assessing and recommending upgraded catchment action plans, Version 1.1.* Natural Resources Commission, Sydney.

improved socio-economic accountability and landholder capacity. In addition, the institutional and governance arrangements for NRM encourage CMAs to focus on short-term financial indicators rather than longer term socio-economic outcomes. And until recently, there was no specific expectation for CMAs to explicitly address the community targets in their region's CAP.

- **Technical barriers** include the difficulties and complexities inherent in analysing and integrating social and biophysical information, the shortage of relevant socio-economic data, and the poor visibility of the data that are available. In particular, it is generally acknowledged that state-wide target 12 is difficult to define and not readily measurable, which makes monitoring and reporting on progress problematic.[56] CMAs also lack knowledge on how to progress from collecting socio-economic data (for example, through social benchmarking surveys) to analysing the implications of these data and applying this understanding in NRM decision-making.

The barriers identified above are significant and need to be addressed if CMAs are to describe and effectively manage the linked social-ecological systems operating in their catchment.

4.1.2 Recent progress towards overcoming these barriers

Some recent developments should help to reduce the organisational barriers discussed above. For example, the new approach to CAPs and the expectations the NRC has set out for CMAs in revising CAPs (discussed above) will strengthen CMAs' incentives to invest in relevant socio-economic assessment skills and strategies, and encourage them to more effectively integrate socio-economic information into catchment planning and decision-making. In addition, to respond to these incentives effectively, CMAs will need to invest in strengthening their skills and knowledge in this area.

There has also been progress in reducing the technical barriers discussed above. In recent years, the focus on the social and economic impacts of NRM in general has increased. This has resulted in a growing body of work on social, economic and socio-economic impact assessment frameworks and guidelines for use within NRM, which is summarised in Attachment 2. The state of NSW has been highly active in attempting to develop more effective frameworks for assessing adaptive capacity and integrating economic sustainability and social well-being elements into NRM assessment and monitoring.

Many CMAs reported that they view the rural livelihoods framework[57] used to assess natural resource managers' capacity as a good approach. This method reflects the view that natural resource managers' ability to adapt and adopt new sustainable practices is determined by the resources available to them, which can be defined as human, social, natural, physical and financial capital. This participatory method has also been applied to understand capacity of communities and sectors to adapt to climate change. For example, it has been used in the integrated regional vulnerability assessments undertaken in south east NSW[58] and to assess the

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56 Gale R., Brock P. & Milham N. (2010) *Assessing the contribution of investment in natural resource management to economic sustainability and social well-being*, Technical report 12 of monitoring, evaluation and reporting program technical report series, Industry and Investment NSW, Orange NSW.

57 Ellis F (2000) *Rural livelihoods and diversity in developing countries*. Oxford University Press, Oxford, UK.

58 Lee C, Jacobs, B O'Toole, D, (2010) *Integrated regional vulnerability assessment – a pilot in south east NSW*, Summary paper sourced from Poster presentation at the NCCARF 2010 International Climate Change Adaptation Conference.

capacity of livestock systems in Murray Darling Basin[59] and the Australian edible oyster industry[60] to adapt to climate change.

Many CMAs have also begun to use social benchmarking surveys to better understand their community and are collecting their own socio-economic information. For example, Central West CMA has used farm viability thresholds from the Rural Financial Counselling Service to develop state-and-transition models for farm viability as part of its CAP upgrade.[61] Others are attempting to integrate socio-economic information with bio-physical information for planning purposes. For example, Southern Rivers CMA undertook a health impact assessment with the Greater Southern Area Health Service to understand the impact of the extension component of its sustainable native pastures project.[62]

However, despite this progress, CMAs indicated that they still require technical assistance in understanding the socio-economic implications and impacts of their work. This is supported by Attachment 2, which indicates that:

- economic assessment methods are still much more common than social or socio-economic assessment methods
- many of the social or socio-economic assessment frameworks remain either too broad or too specific to be easily applicable in the CMA context, and
- comprehensive and sophisticated integration in measuring social, economic and natural resource outcomes is rare.

4.1.3 What else needs to be done to overcome these barriers?

To ensure the community targets are effectively integrated into NRM planning, decision-making and MER at the regional scale, the NRC considers it equally important to address the cultural and organisational barriers as the technical barriers. In its view, a holistic approach is required to fully integrate the community targets.

In relation to overcoming the cultural and organisational barriers, the NRC's literature review identified some specific suggestions. These included:

- creating incentives for CMAs to uptake community targets and monitoring
- supporting cultural change in valuing the importance of community
- alleviating the time and resource pressures faced by CMAs so they can undertake the necessary MER activities

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59 Crimp S, Stokes C, Howden S, Moore A, Jacobs B, Brown P, Ash A, Kokic P, Leith P (2010) Managing Murray-Darling Basin livestock systems in a variable and changing climate: challenges and opportunities. *The Rangeland Journal*, 2010, 32, 293-304.

60 Leith P, & Howard M (2010) *Climate Change Adaptation in the Australian Edible Oyster Industry: an analysis of policy and practice*. University of Tasmania, Hobart, Tasmania.

61 Central West Catchment Management Authority (2011) *Central west catchment action plan 2011-2021: A shared vision for the management, preservation and improvement of the Central West Catchment's natural resources,* p 38-39. Available at http://cw.cma.nsw.gov.au/AboutUs/cap.html, p 38-39.

62 Greater Southern Area Health Services (2010) *Farm family health and landscape health: A health impact assessment of the extension component of the sustainable native pastures project.* Available at http://www.southern.cma.nsw.gov.au/documents/HIA%20Braidwood%20Report%20FINAL.pdf.

- supporting a more comprehensive use of the livelihoods framework across both community targets
- placing more emphasis on the process of improving adaptive capacity and maintaining economic sustainability and social well-being rather than just measuring these things through specific indicators.[63]

As section 4.1.2 discussed, the new requirements under the CAP upgrade process will address the first of these suggestions. The NRC expects these requirements, together with its reviews and audits, will create much stronger incentives for CMAs to consider the community targets in their CAPs and to work out how best to integrate socio-economic information with biophysical when describing and managing the linked socio-ecological systems in their catchment.

To place more emphasis on the process of improving adaptive capacity and maintaining economic sustainability and social well-being in the catchments, the NRC suggests that these concepts be integrated into the catchment planning process. Therefore it recommends that the methodology for assessing adaptive capacity discussed in section 4.1.2 should be undertaken as part of the CAP upgrade process, as well as in monitoring for target 13. Likewise, it suggests that CMAs investigate alternative methods for assessing NRM contribution to economic sustainability and social well-being, for example social return on investment (SROI) analysis at the program level.

SROI analysis is an established framework for measuring social outcomes associated with an investment and translating these outcomes into their financial value. It involves estimating the value of the social outcomes associated with an investment, then comparing the value created to the investment made to produce a social return on investment ratio. Thus it provides a way to determine the extent to which NRM programs can be credited for social outcomes, and to compare the outcomes associated with alternative programs.

To overcome the technical barriers, the CMAs, agencies and other parties will need to work collaboratively. The visibility of socio-economic data should be improved, for example by incorporating it into decision-making or spatial tools, such as SCaRPA and the Land Management Database. In addition, greater effort should be made to mine existing data in an innovative and comprehensive fashion to answer questions about the social systems operating in the catchment and progress towards community targets.

As section 4.1.2 noted, many of the current socio-economic assessment frameworks are either too broad or too specific to be easily applicable in the CMA context. To address this problem, CMAs and their partners need to identify knowledge gaps and explore and pilot some practical tools to assist them in analysing the linked social-ecological systems in their catchment and to better incorporate socio-economic information into their decision-making.

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63 Refer to Gale R., Brock P. & Milham N. (2010) *Assessing the contribution of investment in natural resource management to economic sustainability and social well-being*, Technical report 12 of monitoring, evaluation and reporting program technical report series, Industry and Investment NSW, Orange NSW; Hyder (2011) *Review of NSW resource condition MER*. Report prepared by Hyder Consulting on behalf of the Natural Resource Commission, Sydney NSW; Marshall G (2011) *Improving Economic Accountability of investment decisions under community based environmental governance.* Institute for Rural Futures, University of New England.

Next steps include:

- Explicitly addressing Targets 12 and 13 in the upgraded CAPs and undertake MER in relation to these targets at this scale (CMAs, with agency support)
- Increase availability of socio-economic data by incorporating in decision-support or spatial tools (CMAs and agencies)
- Work collaboratively to identify knowledge gaps and explore and pilot socio-economic frameworks, methods and tools that enable the integration of socio-economic information into catchment planning and NRM decision-making (CMAs, agencies, NRC)
- Incorporating adaptive capacity assessments into analysis of landscape function and pilot alternative methods for assessing NRM contribution to economic sustainability and social well-being, for example social return on investment analysis at program level (CMAs, agencies, NRC)

4.2 Designing regional MER programs linked to evaluation questions and conceptual models of landscape function

Under the new whole-of-government approach to CAPs, CMAs are expected to have monitoring programs that test the assumptions underlying their investment decisions and support adaptive management processes. [64] As section 2.1 discussed, conceptual and predictive models of landscape function and response to disturbances – such as state-and-transition models – provide the necessary foundation for designing such programs (and choosing appropriate indicators).

These ecological monitoring programs should collect data to update the assumptions in the conceptual models over time and improve decision-making. Models help managers understand systems dynamics and identify the right questions to ask about the management actions they might implement.[65] This helps to focus monitoring programs on the most important things to know, define the most appropriate indicators, and reduce the risk of collecting large quantities of irrelevant or insignificant data. [66]

Figure 4.2 sets out an adaptive monitoring framework underpinned by conceptual models and evaluation questions.[67] The questions in this framework would focus on testing management interventions set out in conceptual models, such as those used in upgrading CAPs. The key characteristics of the framework are that:

- monitoring is directly related to the evaluation questions being posed (which resolves traditional debates about 'what to monitor' and 'what indicator to choose')
- these questions (and thus the monitoring design) evolve as we learn and better understand the social-ecological system (and as new technologies arise)

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64 See NRC's audit scope in Pryce, R. and Maher, T. (2011) *Shaping the landscapes of NSW – the role of evaluation in natural resource management*. Paper presented at the Australasian Evaluation Society International Conference, Sydney available at http://www.aes.asn.au/

65 Rumpff, L. Duncan, DH., Vesk, PA., Keith, DA. And Wintle, B. (2011) State-and-transition modelling for Adaptive Management of native woodlands. *Biological Conservation* 144 (2011)1224-1236.

66 Lindenmeyer, D.B. and Likens, G.E. (2010) *Effective ecological monitoring*. CSIRO publishing, Collingwood, Victoria.

67 Figure adapted from Lindenmeyer, D.B. and Likens, G.E. (2010) *Effective ecological monitoring*. CSIRO publishing, Collingwood, Victoria. pg 72.

- monitoring aims to reduce uncertainty and understand the things we do not know – or, in other words, to answer the questions we want to answer, or to prove that the management assumptions in the model are right or wrong.[68]

Central West and Namoi CMAs are now in the process of adjusting their existing MER plans and systems to complement their revised CAPs (which use state-and-transition models). For example, Central West CMA will use different monitoring approaches depending on the evidence that supports the management assumptions and evaluation questions. Where this evidence is weak and confidence is low, it will use more rigorous experimental monitoring approaches to test assumptions. Where the evidence is strong and confidence is high, it will use more traditional 'surveillance' monitoring.

The NRC believes that by designing MER programs linked to evaluation questions and conceptual models of landscape function, CMAs will be better-placed to quantify and demonstrate the effectiveness of their NRM programs and management actions, and the return on their investments and their contribution towards achieving the state-wide targets. For example, return on investment can be more rigorously calculated and quantified between scenarios under predicted outcomes, observed outcomes and likely outcomes under no investment.[69]

Next steps include:

- Developing evaluation questions and conceptual models of landuse change as part of the CAP upgrade process and revise MER plans accordingly (CMAs)
- Increasing investment in MER to ensure that catchment planning and investment decisions are well informed (CMAs)

[68] See also Rumpff, L. (2011) *The process in making adaptive management meaningful – using process models to guide investment of native vegetation*. In Decision Point , Issue 47 available at http://ceed.edu.au/wp-content/uploads/2011/03/DPoint_47.pdf

[69] For example see Wintle, B., Rumpff, L., Duncan, D. and Vesk, P. (undated) *Keeping the Auditor-General happy: Demonstrating return on Caring for our Country*. Abstract and presentation available at http://www.landscapelogic.org.au/Fenner/Wintle.pdf

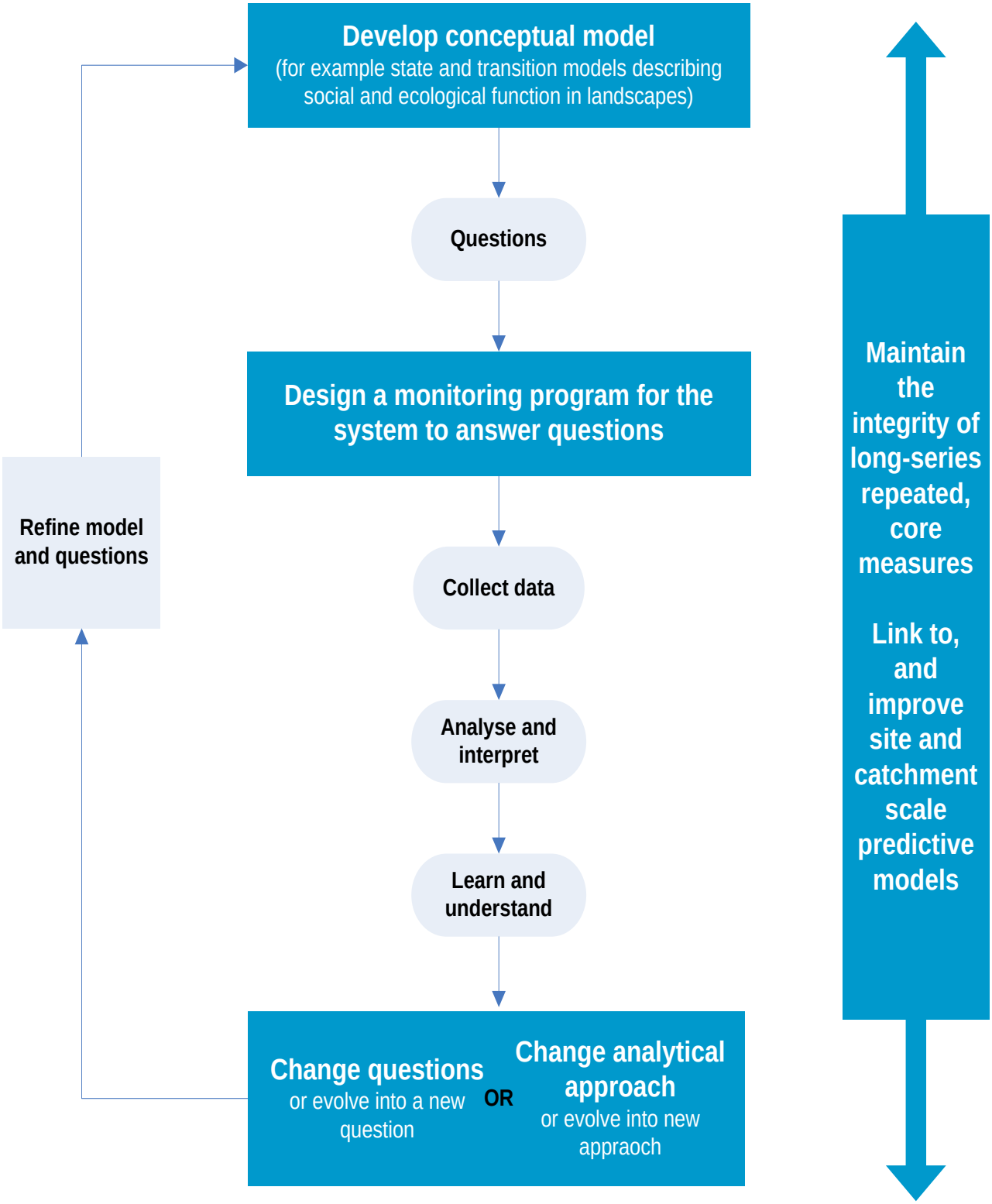

Figure 4.2: Adaptive monitoring framework[70]

70 Adapted from Lindenmeyer, D.B. and Likens, G.E. (2010) *Effective ecological monitoring*. CSIRO publishing, Collingwood, Victoria.

5 Connecting MER between scales

As the previous chapters made recommendation for MER at state and regional scales, the NRC considers it is also important to consider the mechanisms that **connect** these scales. The revised MER strategy aims to develop a system that allows data and information to flow from local to national scales to support decision-making. Key strategies for achieving this goal include building stronger collaborative partnerships with NRM partners at different institutional scales, and having better mechanisms for using, storing and sharing data.

During this review, the NRC found:

- good examples of collaboration between existing MER partners, leading to more effective MER
- a range of good quality data existing at regional and local scales
- progress towards better data management.

However, the review also identified a range of issues that are hindering the flow of information between scales. In particular, these include inconsistent application of standards, protocols and information sharing platforms across scales. The NRC recommends action be taken to build on the current momentum, by strengthening and extending collaboration in MER within the state, leveraging information generated by community and industry monitoring programs, and accelerating the improvement of mechanisms for accessing and sharing data and information. The sections below discuss these findings and recommendations in more detail.

5.1 Strengthen and extend collaboration in MER

The key priorities of the revised MER strategy include building collaborative partnerships among existing and new NRM partners, and:

- enhancing existing partnerships between existing MER partners, including clarifying roles and responsibilities
- engaging local government, including aligning MER activities with regional and state partners
- developing stronger links with Australian Government, including facilitating better links to ensure data flows between scales.

The NRC considers these are important goals, and their realisation should contribute to multiple benefits for all existing (and new) partners – including by reducing the risk of duplication, sharing costs, and enriching both the knowledge and narrative across scales leading to integrated and more effective outcomes. For example, the NRC's recommended whole-of-government NRM knowledge strategy for NSW (discussed in section 2.6.2) should complement research and MER initiatives at other scales (where possible), such as the Australian Government's research priorities for rural industries and natural resource management.[71]

[71] See for example DAFF (2007) *Rural Research and Development Priorities*. Department of Agriculture, Fisheries and Forestry. Commonwealth of Australia, Canberra.

During this review, the NRC observed a number of collaboration initiatives that it considers are good practice and are moving MER in the right direction. It is important to recognise these initiatives, and the outcomes they achieve. For example:

- **Agencies and CMAs** have established joint natural resource condition MER programs such as the *Practical Partnerships Program* (for vegetation condition) and *Soil Watch* (for soil condition and land management). These programs align state monitoring sites with CMAs' investment sites, test management assumptions, and provide information to improve agencies' catchment modelling (see Case Study 5.1).
- **Existing MER partners** have established a working group with local government, the MER Local Government Engagement Working Group. This is an early first step towards building stronger links with local councils and shires and better aligning MER at local government scale.
- **Existing MER partners** have recently established a working group to develop an inventory of datasets to increase their visibility to CMAs for use in upgraded CAPs. This is a first step towards developing a more comprehensive, whole-of-government knowledge strategy after all CAPs have been upgraded.
- **Existing MER partners** have established a working group to coordinate a response to the Murray Darling Basin Authority and the Commonwealth Environmental Water Holder on MER associated with the draft Basin Plan and Environmental Water allocations. This group recommended (among other things) a process to coordinate the preparation of a single MER program (between the MDBA and CEWHA) to identify gaps, overlaps, inconsistencies and build on presentations from NSW CMAs on resilience thinking in NRM and how it translates to MER frameworks.

Case Study 5.1. – Collaborative monitoring programs between agencies and CMAs

The *Practical Partnerships Program* is a collaborative monitoring program between a number of CMAs and OEH. It was initially developed to monitor and assess changes in vegetation condition in response to management actions. More recently it has expanded to monitor and assess soil condition to capture synergies and cost efficiencies of data collection.

The partnerships aim to answer three practical NRM questions:

1. **Does investment in land use or land use management change lead to improvements in resource condition?** This provides project-level information linking land use or land management changes with changes in resource condition (CMA project performance and investment).
2. **Is resource condition improving, declining or stable at sub-catchment, catchment and regional scales?** This provides information on the trajectory of resource condition at larger scales (catchment targets and NSW state-wide targets).
3. **Can we build statistical models to predict resource condition at different spatial and temporal scales?** This investigates the use of tools to construct and evaluate scenarios of potential future vegetation condition (predictive modelling for decision-makers).

The approach pairs treatment sites (within management areas where land use will change) with control sites (areas where land use and management will not change) taking into account their biophysical properties. It conducts initial surveys to establish the baseline condition of both sites. It uses longitudinal studies (same sites monitored through time) to understand the resource condition outcome derived from land use or land management changes.

Further opportunities for achieving better alignment and reduction of duplication of MER activity exist. Stronger collaboration between NSW and Australian government bodies, such as the Bureau of Meteorology and the Australian Bureau of Statistics, will reduce duplication of MER effort and could increase the flow of data between scales. Likewise, opportunity for better alignment of MER activity also exists between the resource condition MER program and activities that are being undertaken by other programs, such as National Parks, Forests NSW and the Environmental Protection Authority. Similarly, the NSW Government's planning system review may provide some opportunity to improve the local, regional and state MER activity across a range of areas.

Next steps include:

- Using the whole-of-government CAP upgrade process as the initial mechanism for driving stronger collaboration between agencies, theme teams, CMAs, local government and communities (CMAs, agencies, local government)
- Building on and extend collaborative MER programs, such as the Practical Partnerships Program, Soil Watch, and the Program Performance Pilot (agencies, CMAs, local government)
- Developing stronger links with the Australian Government, including facilitating better data flows between scales (SOG, agencies, CMAs)
- Supporting and enhancing the sharing of NRM data, information and knowledge between NSW and Australian governments in a more coordinated manner (DPC)

5.2 Leverage information generated by community and industry monitoring programs

Community monitoring programs enhance the capacity of communities to understand NRM and environmental issues, build greater levels of understanding, and allow broader sections of the community to become involved in NRM discussions and decision-making.[72] For example, Waterwatch Victoria aims to involve community groups and individuals in the protection and management of waterways. Reviews of this program suggest it is an effective capacity-building program that is instilling long-term practice change among key audiences[73].

Community-collected data is one form of knowledge that can be used to enhance other forms, such as scientific data.[74] Community monitoring programs can fill gaps in state government run programs and compliment scientific monitoring programs. They can bring more timely information to decision-makers and stretch across broader spatial scales than traditional monitoring programs lead by scientific teams.[75]

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72 Fernandez-Gimenez, M.E., Ballard, H.L. and Sturtevant, V.E. (2008) Adaptive management and social learning in collaborative and community-based monitoring: a study of five community-based monitoring: a study of five community-based forestry organizations in the western USA. *Ecology and Society* 13(2):4

73 Thompson D. (2007) Waterwatch: an integrated capacity building initiative. *Proceedings of the 5th Australian Stream Management Conference*

74 Thompson D. (2007) Waterwatch: an integrated capacity building initiative. *Proceedings of the 5th Australian Stream Management Conference*

75 Danielesen, F., Burgess, N.D., Jensen, P.M. and Pirhofer-Walzl, K. (2011) Environmental monitoring: the scale and speed of implementation varies according to the degree of peoples involvement. *Journal of Applied Ecology* 10.1111, 1365-2664.

Industry, community groups, the scientific community and research and development bodies hold large amounts of social, economic and environmental information. For example, Birds Australia relies on over 7, 000 individual community members ('atlassers') to help compile datasets and atlases on the state of Australian birds across the nation.[76] Also, data collected by industry and government agencies as part of their environmental management system monitoring and environmental impact assessment preparation should be accessed and utilised where relevant.

Well designed community monitoring programs that align with goals or decision-making needs of regional NRM bodies and agencies can provide meaningful inputs to government initiatives. Community monitoring programs have been established to observe, collect and record a range of data for selected plant and animal indicators. In one example, scientists will study the data collected by the community to try and understand how climate change may be changing timing events in the life cycle of the plants and animals (for example, earlier than expected flowering in plants).[77] In another example, volunteer groups across the NSW coastline collect data on the marine environment.[78] This program is supported by protocols to ensure standard data collection methods between groups, training and reviews.[79] This initiative is a collaborative one between CMAs, universities, local volunteers and is funded by the Australian Government Caring for Our Country program.

The NRC believes there are significant opportunities for CMAs and agencies to draw on community and industry data and information during the CAP upgrades. The NRC recommends that agencies and CMAs look for opportunities to support community monitoring programs through the provision of technical, training and coordination services as appropriate. It will also be important over time that community and industry monitoring programs can be linked with regional and state MER programs to ensure knowledge gathering is well focused and efficient.

Next steps include:

- Supporting community and industry monitoring programs to leverage additional information as well as enhance community participation in NRM (CMAs, local government, agencies)
- Linking community and industry monitoring activities with MER programs where appropriate (CMAs, local government, agencies)
- Seeking access to information collected by industry and other parties under environmental management systems and environmental impact assessments (CMAs, local government, agencies)

76 See for example http://www.birdsaustralia.com.au/our-projects/atlas-birdata.html

77 See *ClimateWatch* at http://www.earthwatch.org/australia/get_involved/climatewatch/

78 *Underwater Volunteers NSW.* More information at http://uvnsw.net.au/

79 See for example, Dalton, S.J. and Stephen, D.A. (2009) *A Review of Underwater Volunteer Groups in NSW – report prepared for the Hunter-Central Rivers Catchment Management Authority Group.* School of Environmental and Rural Science, National Marine Science Centre, University of New England, Coffs Harbour, NSW.

5.3 Accelerate improvements to mechanisms for accessing and sharing data and information

Under the revised MER strategy, MER partners intend to improve the arrangements for data acquisition, data management and sharing of data and information. To achieve this, a new Data Management Strand was developed as part of the new governance arrangements for the revised MER strategy.

Effective management of data and information is critical if information is to be used to increase the quality of decision-making. Information management and sharing systems should accommodate the needs of users operating at different scales and with different capacities. For example, technical standards have been put in place to ensure mapping (and access to) new Local Environmental Plans in NSW is consistent across the state.[80]

Since the revised MER strategy was adopted, the Data Management Team has:

- developed an on-line data inventory for the 2010 State of the Catchments reports,[81] with metadata that links to the NSW Spatial Data Catalogue[82]
- developed technical reports for each of the 13 theme teams, with standards and protocols for some teams also[83]
- mapped the spatial location of monitoring sites in all CMA regions that was used in the 2010 State of the Catchments reports.

The NRC did not specifically review the performance of data management as part of this review. However, the parties interviewed did raise some issues around data management. For example, as Chapter 2 discussed, most CMAs did not know what state-wide datasets were available, and both CMAs and local government said they need better information about the datasets (ie, metadata). In addition:

- CMAs and local government indicated that they need a set of standards and protocols to ensure a consistent approach to data collection, evaluation and management [84]
- many CMAs said they could not access imagery already held by other agencies due to licensing restrictions – which suggests that data licensing requires a coordinated approach across all agencies
- many CMAs suggested a common platform for spatial data is required, such as the Spatial Information eXchange coordinated by NSW Land and Property Information.

In particular, the NRC believes MER partners should focus on agreement to adopt standard data collection, management and use protocols where applicable to facilitate better data sharing. The recent public release of (all) technical papers by the resource condition program should facilitate this process. The NRC also suggests government could look to the private

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80 NSW Department of Planning (2009) *Standard technical requirements for LEP maps – March 2009, Version 1.2*. State of New South Wales, Sydney.

81 Available at www.environment.nsw.gov.au/soc/datainventory.htm

82 Available at http://sdi.nsw.gov.au/GPT9/catalog/search/viewMetadataDetails.page?uuid={F744AA2D-793B-4CF3-BEDE-41A96D9975FA}

83 Most recently published on OEH website: http://www.environment.nsw.gov.au/soc/socTechReports.htm

84 Many recognised theme team technical reports would address this issue.

sector for ideas to accelerate progress in this area, as it is driving innovation and cost efficiencies in data acquisition and handling[85], on-line tool development and application of Smartphone apps and social media.[86]

Next steps include:

- Adopting standard protocols for data collection, management and use (SOG, agencies, CMAs, local government)
- Improving communication on available MER data and information to potential users, including extending the Data Inventory (agencies, CMAs, local government)
- Making spatial base layers and monitoring data readily available on-line to users in open access systems (agencies, CMAs and local government)

85 For one example see, ENVAULT data sharing platform developed by Greenspan, available at http://www.greenspan.com.au/__data/page/13368/GTS_Envault_System_4pp_Sept09_LR.pdf; and various samrtphone apps

86 See for example, *leafsnap* an app that can identify tree species from photographs of leaves – developed by Columbia University, University of Maryland and the Smithsonian Institution, available at http://leafsnap.com/

Attachment 1: Resource condition MER program datasets

This attachment list the datasets used by the natural resource MER program. There are around 220 in total. They are presented here in table under each of the thirteen state-wide targets. For each dataset, the table also shows its:

- status
- classification as used by the natural resource MER program
- draft classification as developed by the NRC in this review.

Column A - Status

- **Static** – snapshot in time or only sporadically updated as required
- **Dynamic** – subject to ongoing and regular addition of new data

Column B- Classification as used by the natural resource MER program

- **Condition** – indicates condition of an asset
- **Pressure** – indicates pressure on an asset
- **Contextual** - are either source datasets for the condition and pressure indicators or are other biophysical data required to analyse and interpret condition

Column C - Classification as used by the natural resource MER program

- **Primary -** generated from observed of measured values
- **Derived** – generated from interpolations, difference and/or multiple measurements from one or more primary datasets
- **Evaluated** - generated from primary and derived datasets to generate metrics or indices using a range of analytical approaches
- **Regulation** – support regulatory functions
- **Classification** – entities or types of things

Native vegetation

Dataset	Status	MER strategy classification	NRC draft classification
1. Structurally intact native vegetation extent	Static	Condition	Derived
2. Woody/non-woody native vegetation extent	Static	Condition	Derived
3. Native vegetation condition using land cover, use and tenure as surrogates	Static	Condition	Evaluated
4. Native vegetation condition surface using modelling of field data - Murray and Murrumbidgee	Static	Condition	Evaluated
5. Vegetation condition index - at region and State scales	Static	Condition	Evaluated
6. Native vegetation pressure	Static	Pressure	Evaluated
7. Vegetation pressure index - at region and State scales	Static	Pressure	Evaluated
8. NSW land use map	Static	Contextual	Primary
9. NSW extant native vegetation (Keith and Simpson 2006, 2010)	Static	Contextual	Derived
10. NSW interim native vegetation extent (2008 - V1) (2 yearly SLATS extent change since 1988)	Static	Contextual	Derived
11. NSW native vegetation extent using ongoing SLATS analysis of Landsat imagery	Static	Contextual	Derived
12. National Park Estate	Static	Contextual	Regulation
13. State Forest Estate	Static	Contextual	Regulation
14. Travelling Stock Reserves	Static	Condition	Derived

Native vegetation

Dataset	Status	MER strategy classification	NRC draft classification
	▪ **Static** – 100% ▪ **Dynamic** – 0%	▪ **Condition** – 48% ▪ **Pressure** – 2% ▪ **Contextual** – 50%	▪ **Primary** – 1% ▪ **Derived** – 40% ▪ **Evaluated** – 35% ▪ **Regulation** – 24% ▪ **Classification** - %

Fauna

Dataset	Status	MER strategy classification	NRC draft classification
1. Sustainability of native terrestrial vertebrates at region scale - amphibians, birds, mammals, reptiles	Static	Condition	Evaluated
2. Monitor medium-sized, ground-dwelling mammals and fauna on NPWS estate with motion-triggered cameras	Dynamic	Condition	Primary
3. Sustainability of two key fauna populations monitored State-wide	Static	Condition	Evaluated
4. Sustainability of fauna using native vegetation as a surrogate (investigate feasibility)	Static	Condition	Evaluated
5. Distribution loss (historic decline in range) of native terrestrial vertebrate species	Static	Contextual	Derived
6. NSW Wildlife Atlas	Dynamic	Contextual	Primary
7. Atlas of Australian Birds	Dynamic	Contextual	Primary
8. Aerial surveys of waterbirds	Dynamic	Contextual	Primary
9. Fox Threat Abatement Plan (brush-tailed rock wallaby)	Dynamic	Contextual	Evaluated
10. Kangaroo Management Plan (based on annual surveys)	Dynamic	Contextual	Derived
11. Scientific Committee determinations	Dynamic	Contextual	Evaluated
12. Scientific Committee schedules of critically endangered, endangered, vulnerable or extinct species	Dynamic	Contextual	Evaluation
	▪ **Static** – 40%	▪ **Condition** – 30%	▪ **Primary** – 35%

Fauna

- **Dynamic** – 60%
- **Pressure** – 0%
- **Contextual** – 70%
- **Derived** – 15%
- **Evaluated** -50%
- **Regulation** - 0%
- **Classification** - 0%

Threatened species

Dataset	Status	MER strategy classification	NRC draft classification
1. Sustainability (or recovery) of threatened flora and fauna at region scale	Dynamic	Condition	Evaluated
2. Monitor medium-sized, ground-dwelling mammals and fauna on NPWS estate with motion-triggered cameras	Dynamic	Condition	Primary
3. Sustainability of a small number of threatened flora and fauna populations monitored State-wide	Static	Condition	Evaluated
	▪ **Static** – 30% ▪ **Dynamic** –70%	▪ **Condition** – 100% ▪ **Pressure** – 0% ▪ **Contextual** – 0%	▪ **Primary** – 35% ▪ **Derived** – 15% ▪ **Evaluated** -50% ▪ **Regulation** - 0% ▪ **Classification** - 0%

Invasive species

Dataset	Status	MER strategy classification	NRC draft classification
1. Number of new invasive species	Dynamic	Pressure	Primary
2. Distribution and abundance of emerging invasive species	Dynamic	Pressure	Derived
3. New and emerging weeds index	Dynamic	Pressure	Evaluated
4. New and emerging pest animal index	Dynamic	Pressure	Evaluated
5. Impact of widespread invasive species at priority sites	Dynamic	Pressure	Evaluated
6. Overall invasive species impact index - at region scale	Dynamic	Pressure	Evaluated
7. Local government weeds survey (distribution and abundance of 134 priority weeds)	Static	Contextual	Primary
8. Sydney Metropolitan CMA weeds survey	Static	Contextual	Primary
9. Caulerpa Taxifolia mapping (emerging marine weed)	Dynamic	Contextual	Primary
10. LHPA emerging pest animal survey (dist/abun. of camels, horses, donkeys, deer, cane toads)	Static	Contextual	Primary
11. Alien fish species in the Murray-Darling Basin (Sustainable Rivers Audit)	Dynamic	Contextual	Primary
12. Alien fish species in coastal river basins	Dynamic	Contextual	Primary
13. Marine pests in estuaries - presence	Dynamic	Contextual	Primary
14. Wild dog stock losses of sheep, cattle, goats and other	Dynamic	Contextual	Primary

Invasive species

	Dynamic	Contextual	Evaluated
15. Fox Threat Abatement Plan - impact of fox control on threatened species	▪ **Static** – 20% ▪ **Dynamic** –80%	▪ **Condition** – 0% ▪ **Pressure** – 40% ▪ **Contextual** – 60%	▪ **Primary** – 60% ▪ **Derived** – 5% ▪ **Evaluated** -35% ▪ **Regulation** - 0% ▪ **Classification** - 0%

Riverine ecosystems

Dataset	Status	MER strategy classification	NRC draft classification
1. Turbidity trigger value exceedance	Dynamic	Condition	Derived
2. Total phosphorus trigger value exceedance	Dynamic	Condition	Derived
3. Turbidity trend	Dynamic	Condition	Derived
4. Water temperature trend	Dynamic	Condition	Derived
5. Electrical conductivity (salinity) trend	Dynamic	Condition	Derived
6. Predictive model of AUSRIVAS Observed/Expected macroinvertebrate score for coastal rivers	Dynamic	Condition	Evaluated
7. Sustainable Rivers Macroinvertebrate Index (SR-MI) of Filters OE and Filters SIGNAL OE scores	Dynamic	Condition	Evaluated
8. Fish condition index of expectedness and nativeness indicators	Dynamic	Condition	Derived
9. Hydrologic index for MDB and coastal catchments with IQQM flow models	Dynamic	Condition	Evaluated
10. hydrologic index for MDB and coastal catchments	Dynamic	Condition	Evaluated
11. Riparian vegetation - woody/nonwoody/native/non-native in 30m buffer	Dynamic	Condition	Derived
12. River condition index	Dynamic	Condition	Evaluated
13. Hydrologic index for coastal catchments without IQQM flow models	Dynamic	Condition	Evaluated

Riverine ecosystems

Dataset	Status	MER strategy classification	NRC draft classification
14. Alien fish species	Dynamic	Pressure	Primary
15. Alteration of natural temperature patterns - presence of dams	Static	Pressure	Primary
16. Artificial barriers to fish passage	Static	Pressure	Primary
17. Triton database for discrete water quality samples	Dynamic	Contextual	Primary
18. Sydney Water Corporation (Sydney Metropolitan water quality data)	Dynamic	Contextual	Primary
19. Sydney Catchment Authority (Hawkesbury-Nepean water quality data)	Dynamic	Contextual	Primary
20. MDBA Murray River catchment water quality data	Dynamic	Contextual	Primary
21. Dumaresq-Barwon Border Rivers Commission water quality data	Dynamic	Contextual	Primary
22. Aquatic macroinvertebrates in coastal river basins (National River Health Program 1994 - 2000)	Static	Contextual	Primary
23. Aquatic macroinvertebrates in coastal river basins (Coastal SRA 2006 -)	Dynamic	Contextual	Primary
24. Aquatic macroinvertebrates in Murray-Darling Basin (Sustainable Rivers Audit)	Dynamic	Contextual	Primary
25. Freshwater fish assemblages in MDB (Sustainable Rivers Audit)	Dynamic	Contextual	Primary

Riverine ecosystems

Dataset	Status	MER strategy classification	NRC draft classification
26. Freshwater fish assemblages across NSW (I&I long term monitoring sites)	Dynamic	Contextual	Primary
27. Freshwater fish assemblages in coastal basins (Coastal SRA 2006 -)	Dynamic	Contextual	Primary
28. HYDSTRA hydrological database of hourly time-series flows	Dynamic	Contextual	Primary
29. Licensed annual water entitlements	Dynamic	Contextual	Regulatory
30. Regional water quality guideline / target values	Static	Contextual	Regulatory
31. NSW land use map	Static	Contextual	Primary
32. Peak daily demand estimates	Static	Contextual	Primary
33. Geomorphic condition data captured as part of Riverstyles mapping	Dynamic	Contextual	Evaluated
34. NSW extant native vegetation (Keith and Simpson 2006, 2010)	Static	Contextual	Primary
35. NSW interim native vegetation extent (2008 - V1) (2 yearly SLATS extent change since 1988)	Static	Contextual	Primary
36. NSW native vegetation extent using ongoing SLATS analysis of Landsat imagery	Static	Contextual	Primary
37. Modelled (2CSalt) hydrology of coastal catchments - 90th %ile annual flow volume	Static	Contextual	Derived

Riverine ecosystems

Dataset	Status	MER strategy classification	NRC draft classification
	▪ **Static** – 30% ▪ **Dynamic** –70%	▪ **Condition** – 35% ▪ **Pressure** – 10% ▪ **Contextual** –55%	▪ **Primary** –55% ▪ **Derived** – 20% ▪ **Evaluated** -20% ▪ **Regulation** - 5% ▪ **Classification** - 0%

Groundwater

Dataset	Status	MER strategy classification	NRC draft classification
1. Use compared to long term annual average extraction limit	Dynamic	Condition	Derived
2. Groundwater dependent ecosystem (GDE) condition (expert opinion)	Static	Condition	Evaluated
3. Landscape condition (expert opinion)	Static	Condition	Evaluated
4. Regional groundwater levels (expert opinion)	Static	Condition	Evaluated
5. Local groundwater levels (expert opinion)	Static	Condition	Evaluated
6. Groundwater quality (expert opinion)	Static	Condition	Evaluated
7. Aquifer integrity (expert opinion)	Static	Condition	Evaluated
8. GWMA condition index - by groundwater management area	Dynamic	Condition	Evaluated
9. index of groundwater / GDE condition	Dynamic	Condition	Evaluated
10. Location of potential high priority GDEs (desktop assessment)	Dynamic	Condition	Evaluated
11. Entitlement compared to long term annual average extraction limit	Dynamic	Pressure	Evaluated
12. GDE groundwater availability (expert opinion)	Static	Pressure	Evaluated
13. Land-use pressures (expert opinion)	Static	Pressure	Evaluated
14. Regional impacts (expert opinion)	Static	Pressure	Evaluated

Groundwater

Dataset	Status	MER strategy classification	NRC draft classification
15. Localised impacts (expert opinion)	Static	Pressure	Evaluated
16. Groundwater quality impacts (expert opinion)	Static	Pressure	Evaluated
17. Aquifer structure pressures (expert opinion)	Static	Pressure	Evaluated
18. GWMA pressure index - by groundwater management area (GWMA)	Dynamic	Pressure	Evaluated
19. Long term annual average extraction limit (LTAAEL)	Dynamic	Contextual	Regulatory
20. Metered water use from groundwater bores	Dynamic	Contextual	Primary
21. Groundwater level data	Dynamic	Contextual	Primary
22. Groundwater quality data	Dynamic	Contextual	Primary
23. Licensed annual groundwater entitlement Primary	Dynamic	Contextual	Regulatory
	▪ **Static – 55**% ▪ **Dynamic** –45%	▪ **Condition** – 45% ▪ **Pressure** – 35% ▪ **Contextual** –20%	▪ **Primary** –15% ▪ **Derived** –2% ▪ **Evaluated** - 75% ▪ **Regulation** - 8% ▪ **Classification** - 0%

Marine waters

Dataset	Status	MER strategy classification	NRC draft classification
1. Extent of marine protected areas	Dynamic	Condition	Regulatory
2. Recreational water quality compliance in metropolitan areas	Dynamic	Condition	Derived
3. Frequency of marine algal blooms - compliance with ANZECC chlorophyll guideline trigger value	Dynamic	Condition	Primary
4. Rocky reef species - habitat-forming macroalgae extent	Dynamic	Condition	Primary
5. Rocky reef species - purple sea urchin abundance	Dynamic	Condition	Primary
6. Rocky reef species - black lip abalone abundance	Dynamic	Condition	Primary
7. Rocky reef species - eastern rock lobster abundance	Dynamic	Condition	Primary
8. Rocky reef species - commercial fish catches in demersal fish traps by species and abundance	Dynamic	Condition	Primary
9. Estuarine outflows of TSS, TN, TP	Static	Pressure	Derived
10. Faecal coliform and enterococci counts in metropolitan areas - Beachwatch, Harbourwatch	Dynamic	Contextual	Primary
11. SeaWiFS Level 2 remote sensed satellite imagery	Static	Contextual	Primary
	▪ **Static – 20**% ▪ **Dynamic** –80%	▪ **Condition** – 70% ▪ **Pressure** – 10% ▪ **Contextual** –20%	▪ **Primary** –70% ▪ **Derived** –20% ▪ **Evaluated** - 0%

Marine waters

Dataset	Status	MER strategy classification	NRC draft classification
			▪ **Regulation** - 10% ▪ **Classification** - 0%

Wetlands

Dataset	Status	MER strategy classification	NRC draft classification
1. Wetland extent - MER Program	?	Condition	Derived
2. Biological condition - presence, abundance and health of flora and fauna	?	Condition	Derived
3. Pest species - ratio of native to introduced flora and fauna	?	Condition	Derived
4. Water quality - pH, salinity, turbidity, nutrients, algal blooms	?	Condition	Derived
5. Soil condition - pH, salinity, soil moisture, erosion, physical modifications	?	Condition	Derived
6. Wetland condition index - at wetland and region scales	?	Condition	Evaluated
7. Catchment disturbance - catchment cleared, adjoining urban, infrastructure, point sources	?	Pressure	Evaluated
8. Hydrological disturbance - impoundments, regulation, farm dams, bores, irrigation channels	?	Pressure	Derived
9. Habitat disturbance - recreation/lakebed use, protected area, fish barriers, feral animals	?	Pressure	Derived
10. Wetland pressure index - at wetland and region scales	?	Pressure	Evaluated
11. Wetland extent (1987) using satellite imagery	?	Contextual	Primary
	▪ **Static – ?**% ▪ **Dynamic** –?%	▪ **Condition** – 55% ▪ **Pressure** – 35% ▪ **Contextual** –10%	▪ **Primary** –10% ▪ **Derived** –60% ▪ **Evaluated**- 30%

Wetlands

Dataset	Status	MER strategy classification	NRC draft classification
			▪ **Regulation** - 0% ▪ **Classification** - 0%

Estuaries and coastal lakes

Dataset	Status	MER strategy classification	NRC draft classification
1. Water quality data to 2008 from agencies, councils, universities and water authorities	D	Condition	Primary
2. Water quality data (MER Program 2007 -)	D	Condition	Primary
3. Chlorophyll a and turbidity trigger values	Static	Condition	Regulatory
4. Seagrass, mangrove and saltmarsh extent survey West et al 1985	Static	Condition	Primary
5. Seagrass, mangrove and saltmarsh extent survey Williams et al 2006	Static	Condition	Primary
6. Seagrass, mangrove and saltmarsh extent mapping (MER Program 2010 -)	Static	Condition	Primary
7. Seagrass/mangrove/saltmarsh extent change	Static	Condition	Derived
8. Estuarine fish ecology database (EFED) - environmental, catch and biological tables	D	Condition	Primary
9. Estuarine Fish Community Index - diversity, composition, abundance, nursery function, trophic levels	D	Condition	Derived
10. Estuary condition indicator scores and ratings	Static	Condition	Evaluated
11. Estuary condition index scores and ratings - at estuary, region and State scales	Static	Condition	Evaluated
12. Catchment land use	Static	Pressure	Primary
13. Catchment population - 1996	Static	Pressure	Primary

Estuaries and coastal lakes

Dataset	Status	MER strategy classification	NRC draft classification
14. Catchment population - 2001	Static	Pressure	Primary
15. Catchment population - 2006	Static	Pressure	Primary
16. Diffuse source catchment loads of Total Suspended Solids	Static	Pressure	Primary
17. Diffuse source catchment loads of Total Phosphorus	Static	Pressure	Primary
18. Diffuse source catchment loads of Total Nitrogen	Static	Pressure	Primary
19. Licensed point source loads from sewage treatment plants of TSS, TP, TN	Dynamic	Pressure	Regulatory
20. Licensed water extraction from catchment streams	Dynamic	Pressure	Regulatory
21. Change in annual catchment runoff volume	Static	Pressure	Primary
22. Licensed foreshore structures	Dynamic	Pressure	Regulatory
23. Licensed aquaculture area	Dynamic	Pressure	Regulatory
24. Riparian vegetation - land uses in 100m buffer	Static	Pressure	Regulatory
25. Training walls - presence	Static	Pressure	Regulatory
26. Entrance artificial opening level	Dynamic	Pressure	Regulatory
27. Wild harvest fisheries annual catch	Dynamic	Pressure	Primary
28. Estuary pressure indicator scores and ratings	Static	Pressure	Evaluated

Estuaries and coastal lakes

Dataset	Status	MER strategy classification	NRC draft classification
29. Estuary pressure index scores and ratings - at estuary, region and State scales	Static	Pressure	Evaluated
30. Location (latitude, longitude) of estuary mouth	Static	Contextual	Primary
31. Estuary catchment topography 1:25000 map series	Static	Contextual	Primary
32. Catchment drainage basin boundary and area	Static	Contextual	Primary
33. Fluvial/tidal drainage catchment boundaries and area	Static	Contextual	Primary
34. Classification - geomorphic types	Static	Contextual	Classification
35. Classification - chlorophyll response-based types	Static	Contextual	Classification
36. Estuary water surface boundary - macrophytes merged	Static	Contextual	Derived
37. Estuary water surface boundary - macrophytes detailed	Static	Contextual	Derived
38. Estuary perimeter	Static	Contextual	Primary
39. Estuary bathymetry (to January 2009)	Static	Contextual	Primary
40. Digital elevation model of combined catchment topography and estuary bathymetry	Static	Contextual	Primary
41. Estuary hypsometry	Static	Contextual	Primary
42. Estuary volume	Static	Contextual	Derived
43. Mean estuary depth	Static	Contextual	Derived

Estuaries and coastal lakes

Dataset	Status	MER strategy classification	NRC draft classification
44. Tidal limit locations	Static	Contextual	Primary
45. Mangrove limit locations	Static	Contextual	Primary
46. Long term water level records (July 1990 to June 2000)	Static	Contextual	Primary
47. Long term tidal planes (July 1990 to June 2000)	Static	Contextual	Primary
48. Tidal gauging of ebb and flood flows (to June 2004)	Static	Contextual	Primary
49. Mean tidal prism volume	Static	Contextual	Derived
50. Mean tidal range	Static	Contextual	Derived
51. Mean tidal flushing time	Static	Contextual	Derived
52. Digital elevation model of catchment topography for 2CSalt hydrology model input	Static	Contextual	Primary
53. Estuary catchment soil types (2CSalt model input)	Static	Contextual	Classification
54. Estuary catchment climate zones (2CSalt model input)	Static	Contextual	Classification
55. Estuary catchment groundwater flow systems (2CSalt model input)	Static	Contextual	Classification
56. Estuary catchment hydrological response units (2CSalt model input)	Static	Contextual	Derived
57. Mean annual catchment rainfall 1921 - 1995	Static	Contextual	Primary
58. Mean annual pan evaporation rate 1921 - 1995	Static	Contextual	Primary

Estuaries and coastal lakes

Dataset	Status	MER strategy classification	NRC draft classification
59. Catchment runoff for pre-clearing and current land use (2CSalt modelled monthly flows)	Static	Contextual	Evaluated
60. Mean freshwater dilution of total estuary volume	Static	Contextual	Derived
	▪ **Static** – 90% ▪ **Dynamic** –10%	▪ **Condition** – 20% ▪ **Pressure** – 30% ▪ **Contextual** –50%	▪ **Primary** –50% ▪ **Derived** –20% ▪ **Evaluate**d - 10% ▪ **Regulation** - 15% ▪ **Classification** - 5%

Soil condition

Dataset	Status	MER strategy classification	NRC draft classification
1. Soil condition - sheet erosion (USLE model using remotely sensed and site data)	Static	Condition	Evaluated
2. Soil condition - gully erosion (aerial photographs and satellite imagery analysis)	Dynamic	Condition	Evaluated
3. Soil condition - gully erosion (field survey)	Static	Condition	Primary
4. Soil condition - wind erosion (CEMSYS model)	Static	Condition	Evaluated
5. Soil condition - acidity (site sampling)	Dynamic	Condition	Primary
6. Soil condition - organic carbon (site sampling)	Dynamic	Condition	Primary
7. Soil condition - soil structure (site sampling)	Dynamic	Condition	Primary
8. Soil condition - coastal acid sulfate soils (site sampling)	Dynamic	Condition	Primary
9. Soil condition - soil salinity (historic saline site mapping)	Dynamic	Condition	Primary
10. Overall soil condition index - at site, SMU, region and State scales	Dynamic	Condition	Evaluated
11. Salinity pressure - soil salinity (historic saline site mapping)	Static	Pressure	Evaluated
12. NSW soil profile records - Soil and Land Information System (SALIS)	Dynamic	Contextual	Primary
13. Soil landscape map series sheets	Static	Contextual	Primary

14. DustWatch dust concentration records	Dynamic	Contextual	Primary
15. Acid sulfate soil risk maps	Static	Contextual	Evaluated
16. Soil monitoring unit boundaries	Static	Contextual	Primary
17. Soil condition monitoring 2008 baseline site data	Dynamic	Contextual	Primary
	▪ **Static – 40**% ▪ **Dynamic** –60%	▪ **Condition** – 60% ▪ **Pressure** –5% ▪ **Contextual** –45%	▪ **Primary** – 65% ▪ **Derived** –0% ▪ **Evaluated**- 35% ▪ **Regulation** - 0% ▪ **Classification** -0%

Land management within capability

Dataset	Status	MER strategy classification	NRC draft classification
1. Land management with capability index for each MER monitoring site, SMU and CMA	Dynamic	Pressure	Evaluated
2. Land management within capability index for each LSC hazard - by SMU	Dynamic	Pressure	Evaluated
3. Land management within capability index for each CMA - by SMU and LSC hazard	Static	Pressure	Evaluated
4. Soil landscape map series sheets	Static	Contextual data	Primary
5. Land and soil capability - by NSW soil landscape (3850 in total)	Static	Contextual data	Derived
6. Land and soil capability ratings - at each MER soil sampling site (ibnABDUL database)	Static	Contextual data	Derived
7. Photographic record of each MER soil monitoring site	Static	Contextual data	Primary
8. Landholder surveys of land management activities (standard survey form)	Static	Contextual data	Primary
9. Expert knowledge on land management hazards (standard survey form)	Static	Contextual data	Primary
10. NSW land use map	Static	Contextual data	Primary
	▪ **Static – 80**% ▪ **Dynamic** –20%	▪ **Condition** –0% ▪ **Pressure** –30% ▪ **Contextual** –70%	▪ **Primary** – 50% ▪ **Derived** – 20% ▪ **Evaluated**- 30%

Land management within capability

Dataset	Status	MER strategy classification	NRC draft classification
			▪ **Regulation** - 0% ▪ **Classification** -0%

Economic sustainability & social well-being

Dataset	Status	MER strategy classification	NRC draft classification
1. Business profitability and expansion and trend	Static	Condition	Primary
2. Increased employment and trend	Static	Condition	Primary
3. Gaining more formal and informal skills and trend	Static	Condition	Derived
4. Community networks and interaction and trend	Static	Condition	Derived
5. Participation in NRM and trend	Static	Condition	Primary
6. More effective NRM decision-making and trend	Static	Condition	Evaluated
7. Average population growth in urban, regional, town and rural areas including indigenous	Static	Contextual	Primary
8. Growth in employment by agriculture, mining and other industry	Static	Contextual	Primary
9. Percentage of population who volunteer by urban, regional, town and rural areas	Static	Contextual	Primary
	▪ **Static – 100**% ▪ **Dynamic** –0%	▪ **Condition** –70% ▪ **Pressure** – 0% ▪ **Contextual** –30%	▪ **Primary** – 70% ▪ **Derived** – 15% ▪ **Evaluated** - 15% ▪ **Regulation** - 0% ▪ **Classification** -0%

NRM capacity

Dataset	Status	MER strategy classification	NRC draft classification
1. Human capital eg skills, health and education and trend	Static	Condition	Evaluated
2. Social capital eg family, community and other social networks and services and trend	Static	Condition	Evaluated
3. Natural capital eg productivity of land, water and biological resources and trend	Static	Condition	Evaluated
4. Physical capital eg infrastructure, equipment and breeding resources and trend	Static	Condition	Evaluated
5. Financial capital eg access to income, savings and credit and trend	Static	Condition	Evaluated
6. Overall condition index and trend in NRM capacity	Static	Condition	Evaluated
7. Pressures on each condition indicator vary between CMA regions	Static	Pressure	Evaluated
	▪ **Static – 100**% ▪ **Dynamic** –0%	▪ **Condition** –85% ▪ **Pressure** – 15% ▪ **Contextual** –0%	▪ **Primary** – 0% ▪ **Derived** – 0% ▪ **Evaluated** - 100% ▪ **Regulation** - 0% ▪ **Classification** -0%

Attachment 2: Social-economic guidelines, frameworks and methods

Table 3.1 lists and summarises social, economic and socio-economic impact assessment tools and frameworks for use within NRM.

Title	Organisation / Author	Aim(s)	Approach / Method
Social Impact Assessment for NRM			
Guidebook on social impact assessment	Fenton, M. (2005) Prepared for the Comprehensive Coastal Assessment by Environment and Behaviour Consultants, Townsville, QLD.	To provide planners, policy makers and others involved in regional and urban planning with an initial conceptual and applied methodological framework for understanding and undertaking social impact assessments (SIAs).	The Guidebook describes four specific methods useful in a SIA context: 1. Human service provision thresholds, 2. Demographic profiles and social indicators, 3. Place meanings and environmental values, and 4. Network analysis. The Comprehensive Coastal Assessment process is aimed at providing decision support tools to improve strategic planning, land use, natural resource protection and socio-economic development along the NSW coast.
International principles for social impact assessment	Vanclay, F. (2003) International Association for Impact Assessment (IAIA).	To provide the principles of Social Impact Assessment (SIA) for practitioners to use and discuss around the world.	The principles provide a basis for developing national guidelines in consultation with a range of stakeholders and users. It establishes the core values of the community of practice then derives the principles - it is from this point that truly appropriate and specific guidelines and methods can then be developed.
Guidelines and principles for social impact assessment	The Interorganizational Committee on Guidelines and Principles for Social Impact Assessment (1994)	To present the central principles and some operational guidelines for conducting social impact assessments (SIAs). This document is systematic and interdisciplinary in nature and offers guidelines and principles to assist government and private sector agencies in using SIA to make better decisions.	The guidelines provide a broad overview, focusing less on methodological details and more on the guidelines and principles for the preparation of technically and substantively adequate SIAs within reasonable time and resource constraints

Title	Organisation / Author	Aim(s)	Approach / Method
US principles and guidelines - Principles and guidelines for social impact assessment in the USA	The Interorganizational Committee on Principles and Guidelines for Social Impact Assessment (2003)	To provide guidance for the conduct of social impact assessment (SIA) within the context of the US National Environmental Policy Act of 1970.	Guidelines are integrated within six focus areas: 1. understanding of local and regional settings; 2. dealing with the key elements of the human environment; 3. using appropriate methods and assumptions; 4. providing quality information for decision-making; 5. ensuring that environmental justice issues are addressed; 6. and establishing mechanisms for evaluation/ monitoring and mitigation. A social impact assessment model is outlined followed by suggested social impact assessment variables.
***The Burra Charter* (The Australia ICOMOS charter for places of cultural significance)**	International Charter for the Conservation and Restoration of Monuments and Sites & the International Council on Monuments and Sites (ICOMOS)	To provide guidance for the conservation and management of places of cultural significance (cultural heritage places), based on the knowledge and experience of Australia ICOMOS members.	The Charter sets a standard of practice for those who provide advice, make decisions about, or undertake works to places of cultural significance, including owners, managers and custodians. The Charter can be applied to all types of places of cultural significance including natural, indigenous and historic places with cultural values.
Economic Impact Assessment for NRM			
NSW Government guidelines for economic appraisal	NSW Treasury (2007), Office of Financial Management, Policy & Guidelines Paper www.treasury.nsw.gov.au/__data/assets/pdf_file/0016/7414/tpp07-5.pdf	To help choose the best means to satisfy a specified objective, and to rank competing proposals when resources are limited.	The Guidelines promote a consistent approach to undertaking such appraisals for the assessment of significant spending proposals, including proposed capital works projects and new programs. They are appropriate for the application of economic appraisal to other areas such as asset management, plan and program evaluation, and regulation review proposals.

Title	Organisation / Author	Aim(s)	Approach / Method
NSW guide to better regulation	NSW Department of Premier and Cabinet (2008), Better Regulation Office	To help NSW agencies develop regulation which is required, reasonable and responsive.	The Guide provides details on how to apply the better regulation principles to meet the NSW Government's commitment to cut red tape.
Introduction to cost-benefit analysis and alternative evaluation methodologies	Commonwealth of Australia (2006), Department of Finance www.finance.gov.au/publications/finance-circulars/2006/docs/Intro_to_CB_analysis.pdf	To introduce Cost-Benefit Analysis (CBA) in a non-technical way and outlines the basic steps for its use.	Cost-benefit analysis (CBA) is a method of quantitative economic analysis that is widely used to evaluate existing and proposed projects, programs and policies, and which can inform decision-making. Although CBA is generally a useful instrument for the evaluation of projects, programs and policies, and for showing the opportunity costs of such projects and policies, the use of CBA may not always be appropriate. When performing an evaluation, the choice of evaluation methodology should be appropriately documented and defensible.
Best practice regulation handbook and guide for Ministerial Councils and national standard setting bodies	Australian Government (2007), prepared by the Office of Best Practice Regulation, Canberra www.finance.gov.au/obpr/docs/handbook.pdf	To set out Commonwealth Government requirements for regulatory impact analysis. Compliance with these procedures and processes is *mandatory* for all Australian Government departments, agencies, statutory authorities and boards that make, review or reform regulations. The Commonwealth Government hopes to improve the analysis of proposals and hence the quality of regulation through a structured approach to policy development.	The Guide provides direction for undertaking regulatory impact assessment and preparing a Regulation Impact Statement (RIS) including assistance on undertaking: 1. risk analysis 2. cost-benefit analysis 3. assessments of compliance costs 4. assessments of competition effects, and 5. consultation.
The Green Book - Appraisal and evaluation in central government	United Kingdom Department of Treasury (2003) www.hm-treasury.gov.uk/data_greenbook_index.htm	To promote efficient policy development and resource allocation across government.	The Green Book describes how the economic, financial, social and environmental assessments of a policy, program or project should be combined. The methodology should be used to make an economic assessment of the social costs and benefits of all new policies, projects & programs including economic assessment under regulatory impact analysis.

Title	Organisation / Author	Aim(s)	Approach / Method
Economics for accountability in community-based environmental governance	Marshall, G., McNeill, J and Reeve, I. (2009). Prepared for Institute for Rural Futures, University of New England, Armidale, NSW. www.ruralfutures.une.edu.au/downloads/WP2_373.pdf	To identify an approach to economic accountability that is: consistent with a community-based strategy for environmental management; cost-effective to apply given the capacities of community-based organisations; and, consistent with an 'economic way of thinking'.	Three methods for maintaining economic accountability are distinguished: 1. benefit-cost analysis; 2. multi-criteria analysis; and 3. deliberative methods.
The investment framework for environmental resources	**The INFFER approach** www.inffer.org	To help investors achieve the highest value environmental and natural resource outcomes that are possible with the available resources. It covers environmental threats such as water quality decline, salinity, biodiversity decline and pest plant and animals.	The approach starts by identifying the environmental assets that may warrant investment and proceeds through a series of steps for each asset: collecting specific information about the asset and its potential management; evaluating the cost effectiveness of investment; and identifying appropriate policy responses. It identifies projects with the best prospects.
A framework for the economic assessment of ecological benefits	United States Environmental Protection Agency (2002) www.epa.gov/osa/spc/pdfs/feaeb3.pdf	To provide a common approach to analysing ecological benefits and a better understanding of both the scientific and economic techniques used in these analyses.	This document is intended to address these needs by: 1. proposing a common framework for the economic analysis of ecological benefits; and 2. discussing the elements of ecological risk assessment and economic benefit analysis. The Framework is most applicable for determining, as part of a benefit cost analysis, the ecological benefits of policies or regulatory actions commonly undertaken by governmental agencies such as the EPA.
Use of market based instruments by Catchment Management Authorities in NSW to achieve landscape scale	Collins, D. and Whitten, S. (2007). Report to the NSW CMA Chairs' Council, prepared by the BDA Group and CSIRO Sustainable Ecosystems. www.lachlan.cma.nsw.gov.au/	To assist NSW Catchment Management Authorities (CMAs) in their selection and use of Market-Based Instruments (MBIs) for NRM.	In this report, a preliminary overview of experiences with Market-Based Instruments (MBIs) for NRM is canvassed, and a framework for the selection of MBIs across differing biophysical, economic and stakeholder contexts is presented.

Title	Organisation / Author	Aim(s)	Approach / Method
change	download.cfm?DownloadFile=49A03F9B-1708-51EB-A69387EC296A4F10		
Integrated Socio-Economic Impact Assessment for NRM			
Conducting social & economic impact assessment: a practical guide for NRM bodies	Stanley, J., Clouston, B, Binney, J. (2004). Prepared for Queensland Dept of Natural Resources, Mines & Water www.regionalnrm.qld.gov.au/research_sips/sips/social_economic/pdf/impactassessment.pdf	To provide practical advice for undertaking social and economic impact assessments when designing Natural Resource Management (NRM) plans and investment strategies.	By following the basic procedures outlined in these guidelines and involving the public in the SEIA and decision-making process, regional NRM bodies can both identify potential impacts, while also avoiding conflict of proposed management actions.
Integrating economic and social issues in regional natural resource management planning: a framework for regional NRM bodies	Cavaye, J. (2003) National Action Plan for Salinity and Water Quality, Queensland Department of Natural Resources, Mines & Water. www.dpi.nsw.gov.au/environment/guidelines-socioeconomic-analysis-nrm-decisions/integrating-economic-and-social-issues-in-regional-natural-resource-management-planning.pdf	To assist regional bodies to incorporate economic and social considerations in regional planning and conduct appropriate social and economic analysis.	It provides a logical framework, background information, methods and tools, and references to further sources of assistance in laypersons terms. This is undertaken in three ways: 1. Comparing proposed options to help formulate strategies, e.g. broad scale soil erosion prevention versus more targeted mitigation; 2. Assessing the 'triple bottom line' impacts of existing strategies and targets, e.g. improving water quality; 3. Comparing or assessing the impacts of components or actions involved in existing strategies, e.g. changes to irrigation practice
Socio-economic assessment guidelines for river, groundwater and water	Independent Advisory Committee on Socio-economic Analysis (1998) www.water.nsw.gov.au/ArticleDocuments/34/socio-	To provide River, Groundwater and Water Management Committees with an understanding of how they might carry out a community based socio-economic assessment in the context of the broader water reform	The framework proposes a number of steps, including: 1. profiling the catchment; 2. identifying and assessing the effects of changes in water management regimes;

Title	Organisation / Author	Aim(s)	Approach / Method
management committees	economic%20guidelines.pdf.aspx	process.	3. prioritisation of options; 4. presentation of effects in a consistent manner to government and the catchment community.
Socio-economic impact assessment toolkit - A guide to assessing the socio-economic impacts of Marine Protected Areas in Australia	Department of the Environment and Heritage (2005) www.environment.gov.au/coasts/mpa/publications/nrsmpa-seia.html	To provide a general guide to undertaking socio-economic impact assessment (SEIA), followed by specific guides to methods and sources of information which can be used in assessing the potential impacts of proposed Marine Protected Areas on these selected sectors.	It provides a range of options for assessing social and economic impacts, and advice on appropriate methods for particular situations, including: 1. Scoping; 2. Baseline profiling and identifying who will be impacted; 3. Assessing direct impacts: secondary data analysis of existing data sources; primary data collection such as surveys and focus groups; 4. Assessing flow-on impacts: regional profiling; surveys and focus groups; modelling. Uses and limitations of each method are included, such as likely cost and time required to implement, and the type of information each method can provide.
Resilience assessment in social-ecological systems	The Resilience Alliance www.resalliance.org/3871.php	To provide two workbooks for assessing resilience in social-ecological systems: 1. Assessing and managing resilience in social-ecological systems: A practitioner's workbook; and, 2. Assessing resilience in social-ecological systems - A workbook for scientists.	The practitioner's workbook has been developed specifically to provide guidance to people engaged in natural resource management, through a set of activities designed to explore system parameters and management options for their own system of interest from a resilience perspective. A companion volume (Vol. 2) to the workbook for practitioners provides supplementary notes on the key concepts that are included in the assessment. The Resilience Assessment workbook for Scientists emerged from case-study comparisons of regional SESs in the Resilience Alliance and builds on an initial suggested

Title	Organisation / Author	Aim(s)	Approach / Method
			framework. It is intended as a guide for those familiar with the basic concepts of resilience and systems dynamics.
Assessing the contribution of investment in natural resource management to economic sustainability and social well-being	Gale, R., Brock, P. & Milham, N. (2010) Technical Report 12 of Monitoring, Evaluation & Reporting Program. Technical Report Series, Industry & Investment NSW.	To provide a rapid appraisal approach for gathering evidence specifically about Target 12: 'Natural resource decisions contribute to improving or maintaining economic sustainability and social well-being (ESSW)' with the NSW State Plan.	The document provides a means of assessing Target 12 through a low cost rapid appraisal of ESSW. The approach includes a seven-step rapid technique: 1. Plan the ESSW MER; 2. Select indicators beyond designated indicators (if required) and formulate questions; 3. Review existing socio-economic information and/or investment programs; 4. Decide who to talk to; 5. Collect qualitative data; 6. Collate data from different sources; and, 7. Initiate CMA and agency 'organisational learning'
Assessing capacity of natural resource managers	Jacobs B, Brown P, Nelson R, Leith P, Tracey J, McNamara L, Ahmed M and Mitchell S (2011) *Assessing the capacity to manage natural resources in NSW,* Monitoring, evaluation and reporting program, Technical report series, Office of Environment and Heritage, Sydney	To assess NR managers' capacity to adapt their management practices to achieve improved environmental outcomes.	The approach is based on rural livelihoods analysis (Ellis, 2000) and uses self-assessment processes to rate capacity against a range of indicators organised according to five capitals framework (financial, human, social, natural, and physical). This participatory method provides a subjective, quantitative assessment of NR capacity.