natural resources commission

Review of NSW resource condition monitoring, evaluation and reporting

Final report

October 2012

Enquiries

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List of acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
ACLUMP	Australian Collaborative Land Use and Management Program
BOM	Bureau of Meteorology
CMA	Catchment Management Authority
DoP	Department of Planning and Infrastructure
DPI	Department of Primary Industries
GRDC	Grains Research & Development Corporation
LG	Local Government
LHPA	Livestock Health and Pest Authorities
MDBA	Murray Darling Basin Authority
MER	Monitoring, Evaluation and Reporting
NOW	NSW Office of Water
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
SEWPAC	Department of Sustainability, Environment, Water, Population and Communities
SOG	Senior Officer Group

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1 Executive summary

The *NSW Natural Resources Monitoring, Evaluation and Reporting Strategy 2010-15* (NSW MER strategy, adopted in 2010) has been a significant development in the state's Monitoring, Evaluation and Reporting (MER) arrangements. Aspects of NSW's strategy are comparable to leading national and international MER initiatives.[1]

The Natural Resource Management Senior Officers Group (SOG) asked the Natural Resources Commission (NRC) to review existing datasets and indicators, and provide advice on how to best prioritise efforts under the resource condition monitoring program.

The NRC provided draft advice to the SOG in December 2011.[2] Since then, the NRC has recommended to Government a revised set of five state-wide targets, which are based on landscape systems and highlight the critical role of people in the landscape. More recently, MER programs have come under significant budgetary pressures.

In its advice on the revised state-wide targets, the NRC identified that well-defined policy and evaluation questions should be guiding the NSW MER strategy. This report sets out what the NSW Government can do to ensure these critical policy and evaluation questions are being answered, including:

- **focusing monitoring and analysis on critical knowledge needs –** focus on collecting a core set of long-term datasets that meet identified decision making needs, supported by the current shift towards modelling and forecasting tools
- **collaborating across different scales –** have agencies, CMAs, local and Australian governments, community and industry pool resources and share knowledge to deliver pragmatic, cost-effective monitoring across regional and state scales
- **delivering timely and relevant information –** move away from periodic, resource intensive paper-based environmental reporting, to instead develop interactive, dynamic systems to better support evidence-based, triple bottom line decision making

Adopting the changes in this report should lead to more efficient use of available MER resources by focusing effort on the needs of decision-makers. Benefits of this approach include:

- **focusing investment priorities –** allocating limited resources based on the values identified by communities, an understanding of landscape function and future trajectories
- **validating performance –** developing clear and transparent evidence to measure progress against goals through rigorous analysis and systematic evaluations
- **designing future actions –** allocating scarce resources by identifying trade-offs and understanding risks.

This report provides the NRC's final advice to the SOG on revising the NSW MER strategy. The NRC's recommendations are summarised in **Table 1.**

1 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.

2 NRC (2011) *Review of NSW resource condition monitoring and reporting – Continuing the evolution and reporting in NSW – Draft Report, December 2011*. Natural Resources Commission, Sydney.

Table 1: Summary of recommendations for action by the Natural Resource Management Senior Officers Group

Recommendation		Next steps	
Focusing monitoring and analysis on critical knowledge needs			
1	**Revise the NSW MER strategy to collect primary data that provides the basic information foundation for MER across all scales.**	i.	Adopt the core long-term, state-wide datasets set out in **Table 2,** with the view of confirming their suitability after catchment action plan upgrades – see next steps (x) (agencies and CMAs)
		ii.	Prioritise the further development of six core whole-of-system datasets; land-use, land management, land manager capacity, vegetation condition, soil landscapes and soil condition (agencies)
		iii.	Employ technology and systems to reduce the unit cost of data collection (agencies)
2	**Implement a robust and consistent state-wide approach to measuring, evaluating and reporting progress towards the state-wide target for community capacity.**	iv.	Apply the Rural Livelihoods Analysis Framework to assess capacity of natural resource managers at the catchment scale (CMAs with support from agencies)
		v.	Use multiple lines of evidence to help evaluate progress towards this target, such as CMA surveys and measures from participatory workshops, Australian Bureau of Agricultural and Resource Economics and Sciences and the Australian Bureau of Statistics longitudinal natural resource management surveys (agencies with support from agencies)
3	**Ensure the necessary technical and analytical skills and systems are available to support effective decision making.**	vi.	Continue to develop the technical and analytical capabilities to analyse, combine and interrogate social, economic and biophysical datasets and spatial layers (agencies and CMAs)
		vii.	Continue to improve models and forecasting frameworks, incorporating social, economic and cultural values, and build models for landscapes where little modelling or forecasting capability exists (agencies)
Collaborating across different scales			
4	**Ensure MER roles and functions are clarified in the revised NSW MER strategy.**	viii.	Adopt the MER roles and functions set out in **Table 4** (agencies and CMAs).
		ix.	Establish frameworks to ensure that MER and adaptive management practices are effectively linked between state and regional scales (agencies and CMAs).

Recommendation		Next steps	
5	**Share knowledge for improved evidence-based decision making and cost efficiency.**	x.	After catchment action plan upgrades are completed: a. aggregate social-ecological conceptual and process models to identify opportunities for collaborative MER ideally at scales larger than CMA boundaries to inform better NRM decision making (agencies and CMA) b. identify targeted, regional monitoring programs to meet catchment action plan implementation needs and verify assumptions and predictions in modelling and forecasting tools (agencies and CMA) c. develop a whole-of-government knowledge strategy, including policy and evaluation questions and frameworks for identifying and addressing knowledge gaps, to prioritise knowledge needs and avoid duplication of effort (NRM Knowledge Working Group, agencies and CMA) d. develop business cases for effective funding of re-prioritised whole-of-government knowledge needs (NRM Knowledge Working Group, agencies and CMAs)
		xi.	Ensure all agencies and divisions with links to natural resource management are effectively engaged during catchment action plan implementation and collaborative MER initiatives to capitalise on their data, resources and capacity (Department of Primary Industries, Office of Environment and Heritage, CMAs)
		xii.	Leverage data collected by third parties such as community groups, industry, research and development organisations and local governments (agencies and CMAs)
		xiii.	Present a co-ordinated, whole-of-government MER approach to the Australian Government to attract additional resources and encourage data sharing (agencies and CMAs)
Delivering useful and timely information to decision makers			
6	**Review alternative approaches to reporting in NSW.**	xiv.	Review the value and frequency of existing natural resource management and environment reporting arrangements to better align with decision maker needs (NSW Government)
7	**Implement a whole-of-government approach to information management to support the delivery of timely information products to decision makers.**	xv.	Build on initiatives such as *NSW Government ICT Strategy 2012* and *NSW Spatial Data Infrastructure* to develop and adopt an Information Management Framework to ensure a consistent whole-of-government approach to information management that: a. addresses at a minimum governance arrangements and standards and protocols for data management and data access systems (NSW Location Leadership Group, agencies and CMAs) b. supports a user-driven adaptive management cycle

2 Drivers for improving NSW MER

Effective MER is essential for assessing and reporting on outcomes, informing policy and decision making and driving improvement in natural resource management over time. Importantly, a sound MER framework provides a means of evaluating program performance and investment outcomes, which has been identified as a priority for the NSW Government in a recent NSW Commission of Audit report on expenditure.[3]

In December 2010, the NSW Government adopted the NSW MER strategy to guide the state's natural resource MER efforts over the next five years.[4] One of this strategy's key priorities is to review and prioritise NSW's resource condition MER program and build a business case for appropriate funding to support it. To this end, the SOG asked the NRC to review the existing datasets and indicators, and provide advice on how best to prioritise efforts under the program.

The NRC considered it appropriate to take a broad perspective when reviewing the resource condition MER program, given its strong links to natural resource management programs such as the upgraded catchment action plans.[5] In addition to reviewing the existing resource condition datasets and indicators, the NRC investigated:

- the role and function of MER within NSW's regional model for natural resource management
- how MER can ensure the best-available information informs natural resource management planning, evaluation and reporting at various scales.

2.1 NRC's resource condition MER review findings

The NRC's review found that aspects of NSW's existing MER strategy are comparable to leading national and international initiatives.[6] There has also been good progress in implementing the NSW MER strategy over the past few years. However, the NRC also found much scope for improvement, with both users and suppliers of MER data identifying a range of shortcomings.

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 natural resource management investment at these 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 and decision making.

3 NSW Commission of Audit (2012), *Final report: Government Expenditure*, May.

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

5 The NRC's MER review Issues Paper suggested that the NRC would explore the usefulness, practicality and cost efficiency of the datasets for decision making. This was agreed to by the SOG.

6 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.

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 environmental and natural resource management reporting. Most thought that there is an over-emphasis on monitoring for arbitrary reporting purposes, instead of for evaluation and decision making.

2.2 How can we improve MER in NSW?

The NRC has identified that well-defined policy and evaluation questions should determine what information is generated under the NSW MER strategy, and how it is delivered.

A best-practice approach to MER suggests hypothesis-driven evaluation questions are an essential foundation for well-designed and effective MER.[7] For example, MER should be designed to answer questions that decision makers are interested in, such as:

- are the intended management actions, plans or policies likely to make a difference?
- what are the risks and trade-offs of the intended management actions, plans or policies?
- were the management actions, plan or policy implemented correctly?
- did the management actions, plan or policy make a difference?
- how can things be done better, or more economically?
- if a management action, plan or policy is not working, what else should be tried?

At the state scale, the NRC has recently recommended the existing 13 state-wide targets be simplified into five new targets, each supported by state level policy and evaluation questions. At the regional scale, CMAs and agencies are also working together to identify assumptions, knowledge gaps and evaluation questions through the catchment action plan upgrades.

This report sets out what should be done next to ensure these critical policy and evaluation questions are being answered, including:

- focusing monitoring and analysis on critical knowledge needs
- clarifying roles and function of MER at different scales
- delivering more useful and timely information products to decision makers.

Adopting the changes in this report should lead to more efficient use of available MER resources by focusing effort on the key needs of decision-makers. The NRC is aware that MER programs, and natural resource management in general, are under significant budgetary pressures. Fortunately, the upgrading of catchment action plans presents an ideal opportunity for NSW to establish a foundation for more cost-effective and collaborative MER programs.

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

3 Focusing monitoring and analysis on critical knowledge needs

Key messages:

- **Given diminishing resources, the revised NSW MER strategy should focus on ensuring a set of core long-term, state-wide natural resource management datasets is maintained.**
- **NSW needs better knowledge about soils, land use and management, land manager capacity and vegetation condition to ensure sufficient information is generated to understand the social, economic and ecological implications of decisions around critical resources.**
- **Core long-term, state-wide datasets should be complemented by additional datasets that are strongly linked to decision making needs and are collected in a more strategic, targeted manner.**
- **NSW should continue its shift towards the use of modelling and forecasting frameworks, supported by more targeted, cost-effective and collaborative MER programs.**

In its initial brief, the SOG asked the NRC to review the existing datasets and indicators, and advise on how to prioritise efforts under the resource condition MER program. As a result, the NRC, in consultation with agencies and CMAs, has identified 22 core long-term, state-wide datasets for natural resource management decision making that the NSW MER strategy should ensure are available in the long-term.

This chapter identifies these core datasets, and highlights six which are underdeveloped (in particular, social-economic datasets) and should be improved as a priority under the NSW MER strategy. It explains how the core datasets should also be complemented by a range of additional datasets linked to specific decision making needs; for example, statutory, regional, short-term or issue specific datasets.

This chapter also explains how NSW should also seek to reduce the cost of data collection, and continue to shift towards increased modelling and forecasting.

3.1 Prioritising data collection

In its draft report to the SOG in December 2011, the NRC identified over 220 datasets spread across the 13 state-wide natural resource management targets.[8] Around 100 of these datasets (45 per cent) were direct measures (or *primary* datasets) for single values.[9]

Despite this range of data, the NRC's review found that CMAs were largely relying on a small subset of datasets to inform their decision making, mostly those that provide information on fundamental biophysical components of the landscape. Some CMAs indicated that the coverage and resolution of these datasets is patchy or coarse in their regions.

8 The NRC understands there are likely to be more datasets being collected.

9 The remainder were: 17 per cent *derived* datasets (generated from interpolations, difference and/or multiple measurements from one or more *primary* datasets); 30 per cent *evaluated* datasets (generated using *primary* and *derived* datasets to create metric or indices); and 8 per cent *regulation* or *classification* datasets (those that support regulatory functions or classify entities).

In addition, the 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.

Collection of these 220 datasets is being driven by a framework that is geared towards answering high-level questions about resource condition, often at the expense of answering more direct questions on ecosystem function and the consequences of local management interventions. Collecting this breadth of information under the NSW MER strategy is unsustainable given current resources.

Instead, the revised state-wide targets and upgraded catchment action plans, and their increased focus on policy and evaluation questions, are paving the way for a more targeted, efficient approach to MER. The revised MER strategy should focus on identifying and maintaining datasets that most effectively provide sufficient information:

- about fundamental variables that indicate how landscapes are functioning
- to answer key state-wide policy and evaluation questions
- to understand trade-offs involved in balancing production and conservation outcomes.

Box 1: Principles guiding the NRC's review process

To guide our review process, the NRC developed the following principles to underpin the selection of priority monitoring programs and datasets:

- policy and evaluation questions should drive monitoring needs and activity
- where possible, monitoring programs and datasets should build knowledge and inform decision making at multiple scales
- priority monitoring programs and datasets should be able to be collected and maintained in the long-term
- priority monitoring programs and associated datasets should be able to satisfy statutory and/or compliance requirements
- modelling and forecasting frameworks should inform the selection of priority monitoring programs and datasets
- the ability to develop derived and evaluated datasets and knowledge from primary data (and the value of these derived and evaluated datasets) should inform the selection of priority natural resource management monitoring programs and datasets
- commitments to existing long-term national and state monitoring programs and datasets should be recognised in selecting priority natural resource management monitoring programs and datasets.

The NRC also collaborated with agencies and some CMAs to identify a shortlist of primary datasets that are considered important for tracking change in resource condition and informing decision making. These were largely drawn from the original 100 primary datasets identified in the NRC's draft MER report in December 2011.

3.2 Core long-term, state-wide datasets

Using the NRC's review principles, the shortlist of primary datasets and other advice[10], the NRC has identified 22 core long-term, state-wide datasets for natural resource management that are fundamental for decision making at a range of scales. These datasets are shown in a conceptual model in **Figure 1**, and described in more detail in **Table 2**. These datasets cover social, economic and biophysical aspects of natural resource management.

The 22 datasets have been chosen for their ability to be (i) monitored, (ii) made available as spatial layers, (iii) combined, analysed and interpreted, and/or (iv) integrated with program performance information[11], to help decision makers:

- understand landscape function, such as cause and effect relationships
- detect issues early to inform management actions
- identify risks, trade-offs and future options for management actions
- predict broad, future trajectories of social-ecological systems
- answer the key state scale policy and evaluation questions
- prioritise investments
- determine whether outcomes and value for money have been achieved.

These core state-wide datasets, when combined with targeted and/or regional monitoring, will help the NSW Government answer key policy and evaluation questions within the *NSW 2021 plan*[12], including about:

- the environmental health of rivers and catchments
- the capacity of regional land managers and communities.

Under a revised MER strategy, mechanisms should be in place to ensure these core datasets are available in the long-term to support improved natural resource management decision making in NSW.

In practice, this might mean:

- maintaining a 'watching brief' on the core datasets that are already well developed in NSW through past collection, in particular the statutory drivers that maintain their priority for collection
- developing strategies to leverage data collected in these areas by community, industry, research and development organisations and other Government programs
- prioritising and resourcing monitoring programs in NSW where gaps are likely to occur because they are not collected under statutory programs or cannot be obtained from the private sector or other government programs
- working with the Australian Government to build and maintain datasets of interest at national and state scales.

10 Dangerfield, M. (2012) *Essential datasets and implications for funding NRM MER at the state scale – A report to the Natural Resources Commission.*

11 Such as on-ground investments spatially captured in the Land Management Database Framework.

12 NSW Government (September 2011), *NSW 2021 – A Plan to Make NSW Number One*. http://2021.nsw.gov.au.

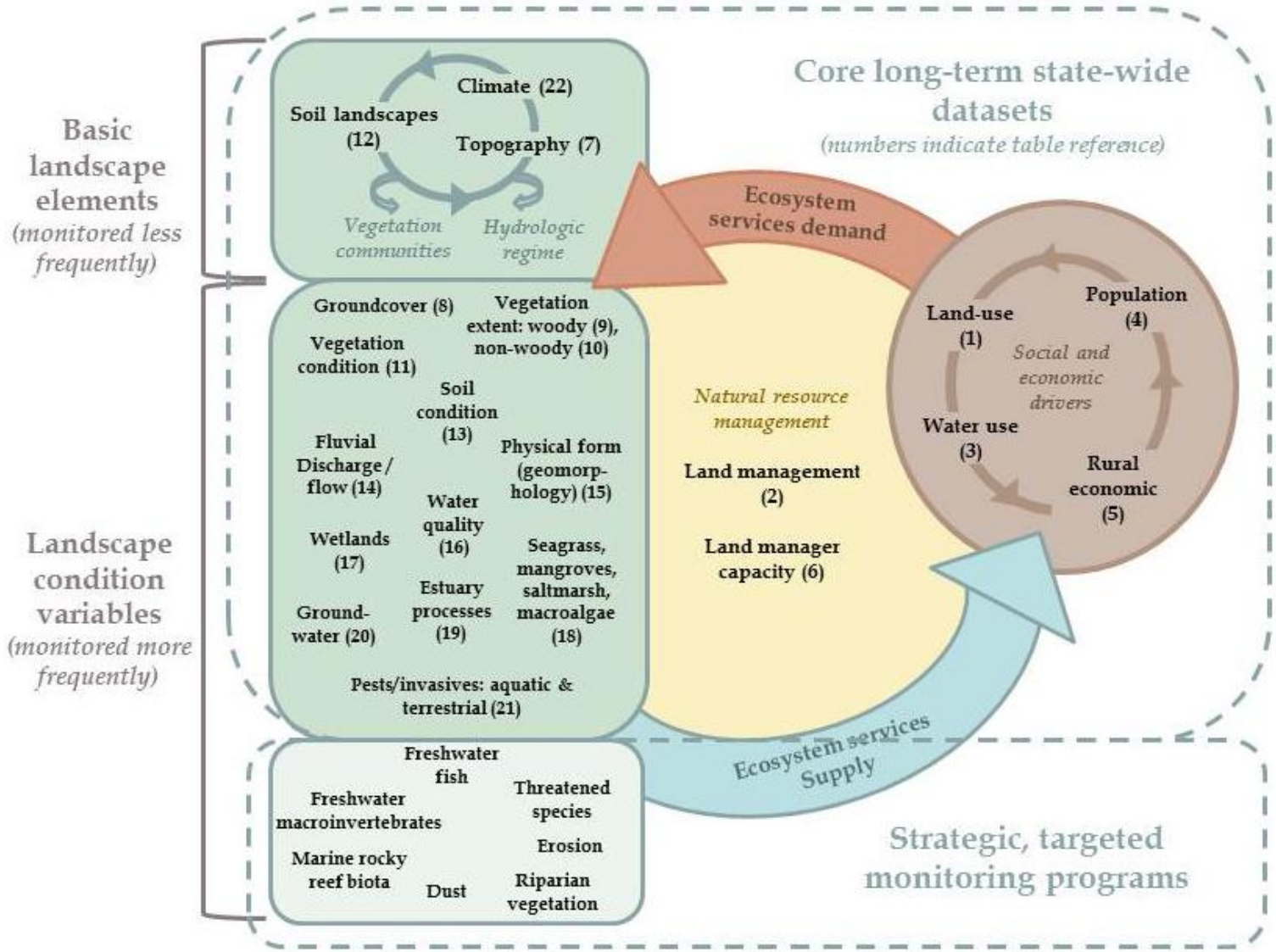

Figure 1: Conceptual model of proposed MER data priorities

Table 2: Core long-term, state-wide datasets for natural resource management MER

Notes: Priority datasets for further development highlighted in red

	Dataset	Example variables	Primary driver for collection *(strength of driver & estimated level of support for continued collection)*		Status *(key below)*		Primary custodian
			NSW Govt.	*Aust. Govt.*	*NSW*	*AG*	
Social-economic	1 Land-use	NSW Land Use Mapping Program	Planning (High & stable)	Planning (High & stable)	✓	✓	ACLUMP (AG) OEH (NSW)
	2 Land management	Stubble & grazing management, adoption of best management practices, DustWatch	NRM (Low-med & stable)	NRM (Med - high & increasing)	×	✓	ACLUMP (AG) CMAs supported by agencies (NSW)
	3 Water use	Entitlements and extraction	Statutory (High & stable)	Statutory (High & stable)	✓✓	✓✓	MDBA (AG) NOW (NSW)
	4 Population	Numbers, density, regional demographic profiles	Planning (High & stable)	Statutory (High & stable)	-	??	ABS (AG) DoP (NSW)
	5 Rural economic	Farm cash income, Farm debt-equity ratio, regional economic profiles	Farm business and trade (High & stable)	Farm business and trade (High & stable)	??	??	ABARES, ABS GRDC (AG) DPI (NSW)
	6 Land manager capacity	Human, social capitals, ABS indices regarding access to economic resources	NRM (Med & increasing)	NRM (Med-high & increasing)	☒	☒	ABARES, ABS (AG) OEH (NSW)
Biophysical-ecological	7 NSW topography (DEM)	Height	NRM – modelling (High & increasing)	Geo-fabric (Med & stable)	✓✓	??	Lands?? (NSW)
	8 Groundcover	Vegetation, bare soil	NRM (Low-med & increasing)	NRM (Med-high & increasing)	✓✓	✓✓	Geoscience, ABARES (AG) OEH (NSW)
	9 Woody vegetation	Extent	Statutory (High & stable)	Statutory (Med-high & stable)	✓✓	??	?? (AG) OEH (NSW)
	10 Non-woody	Extent	Statutory	NRM	✓	??	?? (AG)

Dataset	Example variables	Primary driver for collection *(strength of driver & estimated level of support for continued collection)*		Status *(key below)*		Primary custodian
		NSW Govt.	*Aust. Govt.*	*NSW*	*AG*	
vegetation		(Med & increasing)	(Med-High & stable)			OEH (NSW)
11 Vegetation condition (differentiate riparian condition)	Condition	Statutory (High & stable)	NRM (Med-high & stable)	✓	??	?? (AG) OEH (NSW)
12 Soil landscapes	SMUs	NRM (Low & stable)	NRM (Low & stable)	☒	??	?? (AG) OEH/DPI ?? (NSW)
13 Soil condition	Carbon, pH, wind erosion and water erosion	NRM (Low & stable)	Statutory (Med & increasing)	✓	??	OEH/DPI ?? (NSW)
14 Fluvial discharge/ flow	-	Statutory/water sharing (High & increasing)	Statutory/water sharing (High & increasing)	✓✓	??	BoM (AG) NOW (NSW)
15 Physical form (geomorphol-ogy)	River styles, geomorphic condition	NRM (Med & increasing)	NRM (Med & increasing)	✓	??	NOW (NSW) ?? (AG)
16 Water quality	In situ (temp, turbidity, EC, pH, DO, nutrients)[13]	NRM / statutory (Med & stable)	NRM / statutory (Med & stable)	✓✓	✓✓	BoM[14] (AG) NOW (NSW)
17 Wetland	Extent	Statutory/water sharing (Med & increasing)	Statutory/water sharing (Med & increasing)	☒	??	SEWPAC/ MDBA (AG) OEH (NSW)
18 Seagrass, mangroves and saltmarsh	Extent	NRM (Low & stable)	NRM (Low & stable)	✓	??	?? (AG) DPI (NSW)
19 Estuary processes – tidal gauging, turbidity, chlorophyll a, macroalgae[15]	Time, range	Planning/NRM (Med & stable)	NRM (Med & stable)	✓	??	OEH (NSW)
20 Groundwater	Levels and pressure	Statutory/water	Statutory/water	✓	??	BoM (AG)

13 Opportunities to leverage off existing water quality programs, such as those run by local councils need to be explored.

14 The Bureau of Meteorology is in the process of updating its Australian Water Resource Information System to include water quality data.

15 Used as an indicator of nutrient enrichment.

	Dataset	Example variables	Primary driver for collection *(strength of driver & estimated level of support for continued collection)*		Status *(key below)*		Primary custodian
			NSW Govt.	*Aust. Govt.*	*NSW*	*AG*	
			sharing (High & increasing)	sharing (High & increasing)			NOW – Water Info website (NSW)
	21 Pests / invasive (aquatic & terrestrial)[16]	New, emerging, widespread	NRM / Biosecurity (High & stable)	NRM / Biosecurity (High & stable)	✓✓	??	??? (AG) DPI, OEH, LG, LHPA (NSW)
	22 Climate & weather	Rainfall, evaporation, temperature	NRM/climate change (Med & stable)	Statutory (High & stable)	-	✓✓	BOM (AG)

✓✓ Well underway/established datasets

✓ Established datasets and methods but requires greater coverage and/or frequency

× Requires development

☒ Requires further data capture

Box 2: Issues to resolve

For many of the core datasets, agencies already have well established standards, protocols and methods for data collection. However, for some the following issues need to be resolved:

- **variables (or indicators) to measure** – some datasets such as woody vegetation already have a single well established measure (e.g. 'extent'), while others such as land management and land-use have multiple well established measures from which to identify the most useful
- **sampling strategy** – the frequency and spatial distribution of data collection
- **measuring platform** – identifying the most cost-effective approach to measure the identified variable (ideally, the approach would capture data that could inform multiple measures; for example, satellite imagery like SPOT 5).

In addition, budget constraints are having an impact on the long-term continuity of important datasets. For example, the evaluation of river and vegetation health is being compromised by the recent cessation of funding for:

- the Sustainable Rivers Audit (macroinvertebrate surveys ceased July 2012, and fish surveys will cease July 2013)
- acquisition of SPOT 5 satellite data.

After the catchment action plan upgrades, the NRC has recommended the SOG implement whole-of-government MER processes to develop a strategic, collective approach to identifying and addressing knowledge needs and priorities. This 'knowledge strategy' will help link data collection to policy and evaluation needs, and will allow agencies and CMAs to develop a more effective, and compelling, business case for government funding of essential knowledge needs.

16 Freshwater fish monitoring programs report on the proportions of native and alien fish species.

3.2.1 Development priorities

Many of the 22 core long-term, state-wide datasets listed are already well developed as they are collected to meet statutory requirements and/or under other monitoring programs at local and national levels. However, six (6) of these 22 core datasets are less mature and lack the appropriate historical drivers to further their development. They are as follows, and are also shown in red in **Table 2**:

- land-use
- land management
- land manager capacity (refer to **Box 3**)
- vegetation condition
- soil landscapes
- soil condition.

Many agencies and CMAs have confirmed these areas as key knowledge gaps during consultation with the NRC. Under the revised MER strategy, these six datasets should be prioritised for further development to bring them in-line with the maturity of the 16 other, mostly biophysical, datasets.

In addition, all 22 core datasets need to be geographically tagged (if not already) to ensure spatial application in modelling and forecasting frameworks.

Box 3: Measuring land manager capacity

Data to assess and monitor land manager capacity is required to inform the state-wide community capacity target and to inform the social aspects of other targets.

During the NRC's review, CMAs reported that they will struggle to address community and social targets in the upgraded catchment action plans. 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 natural resource management 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.

The state-wide application of a consistent methodology, the Rural Livelihoods Analysis framework[17], is needed to provide robust measures for this purpose.

Agencies will need to support CMAs at the regional scale and undertake periodic evaluations at the state scale. State agencies should also investigate the use of secondary data about land manager capacity (for example, ABS, ABARES) where it is available and appropriate to supplement regional monitoring.

[17] Jacobs B, Brown P, Nelson R, Leith P, Tracey J, McNamara L, Ahmed M & Mitchell S (2011), *Assessing the capacity to manage natural resources in NSW, Monitoring, evaluation*, Final Technical Report to NSW Department of Environment, Climate Change and Water. NSW Government, Sydney.

3.2.2 Confirm data priorities through the catchment action plan upgrades

The shift towards a smaller set of priority datasets is well supported by CMAs and agencies (for example, in feedback provided to the NRC on its draft MER report). Many recognise the 22 core long-term, state-wide datasets are fundamental for natural resource management decision making. However, CMAs and agencies have still expressed concerns about rationalising long-term, state-wide datasets.

For example, during consultation for the NRC's draft MER report, several CMAs suggested that a precautionary approach should be taken. This was because most CMAs were starting the catchment action plan upgrade process and were unsure which state-wide datasets will be most useful in applying systems and resilience thinking. Many believe they will be in a more informed position to understand their data needs once these upgrades are complete.

Similarly, some technical staff in agencies continue to express concerns whether the proposed list will provide the necessary information and resolution to track actual resource condition change in the landscape. In particular, they are worried about the lack of biological datasets or 'biological endpoints' in the core long-term, state-wide dataset list. Others have suggested a sensitivity analysis should be conducted to understand which datasets are the most important to support our existing (and future) modelling and forecasting frameworks.

Given the continued concerns, the NRC suggests the SOG should adopt the 22 core long-term, state-wide datasets in **Table 2**, with the view of confirming their suitability after the catchment action plan upgrades are completed. In **Chapter 4**, the NRC recommends a range of collaborative whole-of-government processes that could be used for this task.

3.3 Targeted, strategic additional data collection

By identifying 22 core long-term, state-wide datasets, the NRC is not suggesting that Government stop collecting all other data. Quite the opposite – additional data collection will still be important for statutory purposes, to test management actions and assumptions, to verify modelling and forecasting and to investigate emerging issues in specific regions.

For example, relevant additional datasets will include:

- datasets collected under other monitoring programs (for example, data from universities and industry, or marine data under the Integrated Marine Observing System)
- targeted, region-specific programs to verify modelling assumptions and support catchment action plan implementation (for example, where modelling based on land-use, land management and water flows can provide predictions for water quality, actual data for water quality should be collected under targeted regional monitoring programs to verify modelling assumptions)
- ancillary datasets collected for NSW statutory purposes, which are likely to continue unless regulations change (for example, threatened species information under PASII)
- spatial records of on-ground activities in the Land Management Database
- datasets that are already well established across the state, and require infrequent updates (for example, barriers to fish passage).

For example, as part of the NRC's review process, agencies have identified an additional 19 datasets as also being critical for evaluating landscape health. These are listed in **Attachment 1.**

The important distinction between the additional datasets listed in **Attachment 1** and the 22 core long-term, state-wide datasets in **Table 2** is that the additional datasets should not necessarily be collected on a long-term, state-wide basis. Instead, NSW should take a more strategic approach – first by ensuring any additional data collection is linked to specific policy and evaluation needs, and then by identifying the most appropriate spatial and temporal scales for collecting additional datasets; for example, focus on collecting data:

- in regions where specific issues are most important
- to calibrate and verify predictive modelling
- to test investment assumptions in catchment action plans.

3.4 Reducing the unit cost of data collection

NSW's ability to monitor the core datasets well, while also strategically collecting a wide range of necessary additional datasets, will depend on being able to reduce the cost of data collection, or the cost per unit of a particular measure. This can be achieved in many ways, including by accessing wider pools of shared datasets and resources, and by employing cost-efficient data collection and technology.

The need to access a wider pool of shared data is discussed further in **Section 4.3**. Industry, community groups, the scientific community and research and development bodies hold large amounts of social, economic and environmental information. NSW needs to identify incentives and mechanisms to encourage greater sharing of information between government and the private sector.

Technology can also play an important role in reducing the unit cost of collecting data. There are many examples where natural resource monitoring already relies on technology to collect reliable and consistent data, including:

- NSW Office of Water oversees a program using telemetered gauging systems to collect river flow data, which feeds into a central database (HYDSTRA)
- Office of Environment and Heritage is trialling remote motion-triggered cameras to monitor and record the distribution of ground-dwelling mammals in National Parks (NSW State Forests have also conducted similar work)
- farmers collect and store significant amounts of soil data on a regular basis through computer based platforms
- the USA National Ecological Observatory Network plans to establish 15,000 sensors collecting 500 types of data across a national network to support the development of new forecasting models.[18]

Employing technology to collect data can have significant upfront capital costs, although once established can often collect data at lower cost per unit than fieldwork-based data collection, as well as potentially generating more reliable and consistent data. Technology can also be an efficient investment in cases where one set of satellite imagery can be used to develop multiple

[18] See http://www.neoninc.org/ for more discussion on this project and other initiatives such as citizen science.

datasets. For example, SPOT 5 satellite imagery forms the basis for four of the 22 core datasets, and strongly informs at least six more core datasets. It is worth noting that OEH has secured SPOT5 capture over summer 2012/13; however, there is currently no funding allocated for imagery capture beyond this period.

NSW should be actively looking for technological solutions that will drive more efficient data collection, though the decision to invest should be subject to a thorough cost benefit analysis.

3.5 Supporting the shift towards modelling and forecasting

The approaches outlined in this report will support the current shift towards using modelling and forecasting frameworks under the NSW MER strategy.

Natural resource management is about moving towards desired futures that are based on community values and embodied by targets. However, it is very hard to think about the future by collecting measurements alone, as resource condition monitoring is better suited to comparing the current situation with the past. Instead, it is more useful to know whether the landscape is trending towards a desired future.

As a result, modelling and forecasting tools are increasingly being used to help:

- visualise future landscapes, using tools such as scenario planning
- forecast what lies ahead, to support informed decision making and risk management
- measure likely progress, using desired futures as the benchmark.

Conceptual and predictive models are critical tools in adaptive management, as they reduce the level of uncertainty about the most appropriate management actions in a given landscape and lead to more structured decision making.[19] They provide a rigorous and scientific approach for testing and calibrating the assumptions that underpin management actions, and can be verified using data from targeted 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 relying on field measurements alone, as outcomes will always be influenced by other factors, including local management and seasonal conditions from year to year.

Given diminishing resources, modelling and forecasting frameworks provide a realistic and practical way to get more value from investment in MER. Although there is an upfront cost in developing a model, modelling can be cheaper in the long-term than ongoing state scale monitoring programs. Modelling can allow for more targeted on-ground data collection; for example, CMAs and agencies should develop regional monitoring programs to verify modelling assumptions and ground-truth condition change predictions.

19 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

The risks to manage when using models and forecasting tools are:

- **developing tools in isolation of end users** – modellers, policy makers and decision makers should develop tools together to ensure they meet decision making needs
- **using model outputs as the definitive answer** – human judgement and community participation is still required in the decision making process
- **understanding the assumptions that underpin the model** – models must clearly state their underpinning assumptions (and their level of certainty), and these assumptions should be tested, reviewed and discussed
- **data quality** – the quality of data inputs determines the quality of the outputs
- **transparency** – decision making processes should be transparent, therefore stakeholders need to understand how the models and forecasting frameworks work
- **balancing decision rules** – applying rules and benchmarks that allow us to check progress both against the past (for example, pre-European benchmarks) and the future (desired futures expressed by communities).

In practice, farmers already rely on forecasting and models when making decisions. Key examples relate to weather forecasts, where there are good examples of primary industry and the Bureau of Meteorology working together to develop useful information products based on their models.[20] More recently, agencies and CMAs have been using modelling products such as SCaRPA in their catchment action plan upgrades.

Successful adoption of modelling and forecasting tools to inform decision making will require agencies and CMAs to actively develop their capacity in this area; this is addressed further in **Chapter 4.1**. NSW would also benefit from shared learning and capacity building in this area, whereby modellers, policy makers and decision makers work together to develop and test modelling and forecasting tools.

Table 3 on the following page sets out the NRC's recommendations for focusing monitoring and analysis on critical knowledge needs.

[20] See for example research and development initiatives under the Australian Government's Grains Research and Development Corporation at http://www.grdc.com.au/Research-and-Development?pg=1&f=2&c=137.

Table 3: NRC's recommendations to the Natural Resource Management Senior Officers Group for focusing monitoring and analysis on critical knowledge needs

Recommendation		Next steps	
Focusing monitoring and analysis on critical knowledge needs			
1	**Revise the NSW MER strategy to collect primary data that provides the basic information foundation for MER across all scales.**	i.	Adopt the core long-term, state-wide datasets set out in **Table 2,** with the view of confirming their suitability after catchment action plan upgrades – see next steps (x) (agencies and CMAs)
		ii.	Prioritise the further development of six core whole-of-system datasets; land-use, land management, land manager capacity, vegetation condition, soil landscapes and soil condition (agencies)
		iii.	Seek opportunities to employ technology and systems to reduce the unit cost of data collection (agencies)
2	**Implement a robust and consistent state-wide approach to measuring, evaluating and reporting progress towards the state-wide target for community capacity.**	iv.	Apply the Rural Livelihoods Analysis Framework to assess capacity of natural resource managers at the catchment scale (CMAs with support from agencies)
		v.	Use multiple lines of evidence to help evaluate progress towards this target, such as CMA surveys and measures from participatory workshops, Australian Bureau of Agricultural and Resources Economics and Sciences and the Australian Bureau of Statistics longitudinal natural resources management surveys (agencies with support from CMAs)
3	**Ensure the necessary technical and analytical skills and systems are available to support effective decision making.**	vi.	Continue to develop the technical and analytical capabilities to analyse, combine and interrogate social, economic and biophysical datasets and spatial layers (agencies and CMAs)
		vii.	Continue to improve models and forecasting frameworks, incorporating social, economic and cultural values, and build models for landscapes where little modelling or forecasting capability exists (agencies)

4 Collaborating across different scales

Key messages:

- **Whole-of-government catchment action plan upgrades are providing a foundation for collaborative, best-practice MER.**
- **Agencies and CMAs will need to pool resources and prioritise collective effort to deliver pragmatic, cost-effective monitoring at both regional and state scales.**
- **Agencies and CMAs should focus on building skill sets and systems that can analyse, interpret, combine, share and exchange data from a range of sources.**
- **NSW should be harnessing the MER resources and capacity of:**
  - **all state agencies with links to natural resource management**
  - **local and Australian governments**
  - **industry, community and research and development groups.**

Whole-of-government collaboration is critical to implementing the upgraded catchment action plans, and needs to extend to MER. Traditional approaches, where central agencies are largely responsible for resource condition monitoring need to be reconsidered. Instead, government, CMAs, industry and community groups should pool their knowledge and resources to better understand of landscapes and the effects of management actions.

This chapter explains how agencies and CMAs should be working together to implement the upgraded catchment action plans, creating a platform for collaborative MER. It also summarises the proposed roles of agencies and CMAs in more detail; explaining why each role and function is important, and how they differ from current practices. Finally, this chapter highlights the importance of seeking to involve the Australian Government, local government, industry and community groups in collaborative MER programs.

4.1 Catchment action plans as a foundation for collaborative MER

At the regional scale, upgraded catchment action plans are setting a foundation for more effective, and collaborative, approaches to MER.

In upgrading the catchment action plans, CMAs and agencies are coming together to assess and apply the best-available local, regional and state scale data, and are integrating this information using resilience and systems thinking. Based on this knowledge, they have developed a range of conceptual models (including state-and-transition models) that describe how regional landscapes function and respond to disturbances. These models provide insights into the certainty of the assumptions that underpin management actions in each region.

Over time, the conceptual models in the catchment action plans should link with the state scale predictive modelling and forecasting platforms developed by agencies. CMAs can then help verify model outcomes through on-ground regional monitoring (such as using targeted regional fish monitoring to verify the state-wide aquatic biodiversity tool's assumptions and forecasted changes).

During catchment action plan implementation, CMAs and agencies should be designing collaborative MER programs to:

- test assumptions within models
- answer priority evaluation questions
- demonstrate what outcomes are being achieved
- adjust management actions based on learning from experience.

After catchment action plan upgrades it will be important CMAs and agencies continue to look for opportunities to collaborate, in particular to share information and lessons up and down scales. Some CMAs have recently identified scales above CMA boundaries – for example macro-scale social-ecological systems (such as rangelands, slopes and plains, coastal slopes and plains and urban systems) – that could provide an effective way to link state and regional scale MER.

Conceptual models of social-ecological systems identified during catchment action plan upgrades could be aggregated or 'rolled up' to a higher scale to identify common monitoring requirements, assumptions, knowledge gaps and evaluation needs.

4.2 Clarifying agency and CMA roles and functions

Effective collaboration requires that people at each scale understand what they are doing, and why. Role clarity helps people work together in an efficient and cost-effective manner. Therefore, the NRC recommends that the role and function of MER at the state and regional scales be clearly articulated, ensuring each organisation is working effectively, given their resources and the scale at which they operate.

The NRC believes greater clarity around roles and purpose at each scale will:

- ensure the right people are doing the right tasks
- achieve better alignment between MER activities at different scales
- increase cost efficiency and reduce the risk of duplicated efforts
- make opportunities for collaboration between partners easier to recognise
- help to ensure that MER is embedded in adaptive management and business cycles, with clear feedbacks and linkages between state and regional scales.

The following sections summarise the proposed roles of agencies and CMAs under the revised MER strategy, while **Table 4** outlines these roles and functions in more detail. This table also explains why each role and function is important, and how they differ from current practices.

4.2.1 Agency priorities

Under a revised MER strategy, agencies should focus their efforts on creating stronger links between policy and management needs (as represented by policy and evaluation questions) and scientific activity – specifically, they should:

- streamline the 13 theme teams into four integrated programs
- maintain a set of core state-wide natural resource management datasets

- develop modelling and forecasting tools
- develop standards and protocols for data management and access
- integrate resource condition monitoring with program performance to enable evaluation of state scale programs
- incorporate regional scale lessons from program delivery into state scale program evaluations.

The NRC has observed that there are some agencies (or parts of agencies) without strong links into the MER Strategy. This review is an important opportunity to broaden the whole-of-government approach to MER and catchment action plan implementation. In particular, greater inclusion of agencies like Department of Planning and Infrastructure and some parts of the Department of Primary Industries (NSW Agriculture, NSW Forests, NSW Biosecurity) will add to the strong collaborative foundations built by the Department of Primary Industries (Catchment and Lands, Fisheries, NSW Office of Water) and the Office of Environment and Heritage.

4.2.2 CMA priorities

CMAs should focus on establishing MER approaches that can effectively help implement the systems-based upgraded catchment action plans. CMAs, in collaboration with agencies, should direct their MER efforts towards addressing the most important knowledge gaps in their regions. CMAs should also start viewing themselves as data suppliers, rather than just users. In particular, CMAs should:

- link their MER to conceptual and process models of landscape change and evaluation questions within the regional catchment action plans
- test assumptions around key management actions
- apply – where appropriate – decision support, modelling and forecasting tools (to continue to help CMAs understand system dynamics and identify the right questions about the management actions they might implement)
- manage data in accordance with state-wide standards and protocols
- evaluate effectiveness of their actions in implementing the catchment action plan
- implement collaborate MER and adaptive management across larger scale social-ecological systems (as described in **Section 4.1**).

Table 4: Recommended MER functions across NSW

Key function		Why is this important?	How is this different?
State scale			
1	Streamline the 13 theme teams into four integrated programs to enable evaluation against key policy and evaluation questions (integrating where relevant, resource condition and program performance elements).	• Focus activity on only the things we want to know. • Create stronger drivers between policy needs and science activity. • Deepen understanding of linkages between social-ecological landscape systems.	• Clearer and more explicit signal of user information needs. • Smaller, more integrated (theme) programs. • Better understanding of monitoring needs, including 'what not to monitor'.
2	Maintain a set of core long-term, state-wide biophysical monitoring programs and datasets for natural resource management; use, where appropriate existing national biophysical, social and economic datasets (that link to policy and evaluation questions).	• Detect change and trends in social-ecological systems and processes (that can take a long time to observe). • Inform and improve predictive and simulation modelling. • Enable robust and credible approaches to test long-term policy and management assumptions.	• Stronger link between data and user and policy needs. • Clearer focus on only the things we need to collect at the state scale. • Efficient use of exiting MER programs.
3	Develop and improve models and forecasting frameworks to support decision making and targeting data collection to verify modelling predictions.	• Enable structured and transparent decision making. • Enable realistic approaches to reporting resource condition change and attributing management action to change. • Inform and evolve the policy and evaluation questions.	• Stronger emphasis on the role of modelling frameworks in supporting decision making, evaluation and progress reporting.
4	Develop and implement data and information collation, storage and sharing systems including establishing appropriate standards and protocols.	• Improve visibility, access and use of information. • Enable efficient and effective information sharing across and between scales	• Stronger emphasis on supporting effective decision making and evaluation.
5	Undertake statutory reporting functions.	• Statutory requirement.	-

Key function	Why is this important?	How is this different?
6 Support CMAs to analyse, evaluate and report progress on whole-of-government and community catchment action plans (and other statutory functions as required).	• Link agreed whole-of-government and community priorities and performance. • Streamline reporting burden.	• Tighter links between agreed whole-of-government and community priorities and performance – closes adaptive loops. • Stronger accountability mechanism across scales.
Regional scale		
1 Apply best available knowledge to establish certainty (or confidence) levels to assumptions underpinning management actions.	• Transparently test assumptions to improve decision making. • Focus MER activity on areas of higher uncertainty and materiality.	• Stronger platform for active adaptive management.
2 Design and establish monitoring and evaluation programs that are linked to conceptual and process models of landscape change and evaluation questions.	• Focus activity on only the things we want to know.	• Better understanding of monitoring needs, including 'what not to monitor'. • Learn about regional systems more rapidly.
3 Maintain, improve or establish data and information collection, collation, storage and sharing systems to meet specified standards and protocols.	• Enable efficient and effective information sharing across and between scales. • Reduce potential duplication of resources.	• Stronger emphasis on supporting effective decision making and evaluation.
4 Collaborate with MER partners to report progress on whole-of- government and community catchment action plan.	• Link agreed whole-of-government and community priorities and performance.	• Stronger accountability mechanism across scales.

4.3 Encouraging broader collaboration

Although the NRC's advice focuses on the roles of agencies and CMAs, NSW should also be engaging with the Australian Government, local government, industry and community groups to share data, resources and capacity.

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[21]. Also, data collected by industry and government agencies through environmental management system monitoring and environmental impact assessments should be accessed and utilised where relevant[22].

NSW needs to identify opportunities and develop strategies to share data and work collaboratively with these groups. For example, the Commonwealth Environmental Water Office has recently funded monitoring in NSW rivers to evaluate ecological responses to environmental watering events.

NSW should make it as easy as possible for the Australian Government to work with those at the state scale by working towards harmonisation with Australian Government initiatives. Agencies and CMAs should also present a co-ordinated front when engaging with the Australian Government.

Data sharing between organisations will also require appropriate standards and data sharing arrangements to be in place.

Table 5 on the following page sets out the NRC's recommendations for collaborative MER across different scales.

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

22 From June 30, 2012, any party that holds a licence under the *Protection of the Environment Operations Act 1997* (NSW) must make any relevant monitoring data freely and publicly available (as described in s. 66 [6] of the Act).

Table 5: NRC's recommendations to the Natural Resource Management Senior Officers Group for collaborative MER across different scales

Recommendation		Next steps	
Collaborating across different scales			
4	**Ensure MER roles and functions are clarified in the revised NSW MER strategy.**	viii.	Adopt the MER roles and functions set out in **Table 4** (agencies and CMAs).
		ix.	Establish frameworks to ensure that MER and adaptive management practices are effectively linked between state and regional scales (agencies and CMAs).
5	**Share knowledge for improved evidence-based decision making and cost efficiency.**	x.	After catchment action plan upgrades are completed: a. aggregate social-ecological conceptual and process models to identify opportunities for collaborative MER ideally at scales larger than CMA boundaries to inform better NRM decision making (agencies and CMA) b. identify targeted, regional monitoring programs to meet catchment action plan implementation needs and verify assumptions and predictions in modelling and forecasting tools (agencies and CMA) c. develop a whole-of-government knowledge strategy, including policy and evaluation questions and frameworks for identifying and addressing knowledge gaps, to prioritise knowledge needs and avoid duplication of effort (NRM Knowledge Working Group, agencies and CMA) d. continue developing business cases for effective funding of re-prioritised whole-of-government knowledge needs (agencies and CMAs)
		xi.	Ensure all agencies and divisions with links to natural resource management are effectively engaged during catchment action plan implementation and collaborative MER initiatives to capitalise on their data, resources and capacity (Department of Primary Industries, Office of Environment and Heritage, CMAs)
		xii.	Leverage data collected by third parties such as community groups, industry, research and development organisations and local governments (agencies and CMAs)
		xiii.	Present a co-ordinated, whole-of-government MER approach to the Australian Government to attract additional resources and encourage data sharing (agencies and CMAs)

5 Delivering useful and timely information to decision makers

Key messages:

- **Well-defined policy and evaluation questions should be guiding our data collection, analysis, evaluation and reporting.**
- **NSW should move towards more dynamic, interactive information products that deliver relevant information to decision makers in a timely manner**

Decision makers need access to more flexible and timely reporting and information products and services than those currently available.

Many of the parties the NRC interviewed questioned the value of current environmental and natural resource management reporting. 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. 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 response to this feedback, the NRC believes NSW's evaluation and reporting arrangements can be improved by:

- streamlining current reporting processes
- developing more dynamic and accessible information products and services.

5.1 Streamlining reporting processes

In recent advice on revising the targets, the NRC recommended that the NSW Government reconsider the purpose, content, frequency and delivery of environmental and natural resource management reporting.

The NRC recommends that the NSW Government seek to reduce the overall reporting burden in natural resource management. The NSW Government should work towards developing streamlined and efficient evaluation and reporting processes that are relevant to decision makers and investors across multiple scales.

Ideally, the current demand and rationale for different reports should be clarified to ensure that any revised arrangements and products are relevant and useful for decision makers. Evaluation and reporting processes should be designed to help answer the key policy and evaluation questions at each scale.

5.2 Creating timely, accessible and dynamic information products and services

To use monitoring and evaluation outputs in adaptive management, natural resource management decision-makers require (among other things) information that helps them understand 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 and services must be tailored so they communicate to and influence their intended audience in the most effective way.

Scientific service providers should be delivering relevant, timely and up-to-date information products and services through interactive, web-based interfaces. These products and services should aim to answer policy and evaluation questions at different scales. To achieve this, decision-makers will need to send strong signals to knowledge suppliers about the information they need to answer their specific evaluation questions. Ultimately, this will mean moving away from reliance on periodic resource intensive, paper based environmental status reporting.

There will also need to be stronger integration between resource condition and program performance MER teams, to better understand how effectively current programs and policies are generating positive landscape outcomes.

Ideally, these new reporting systems would be supported by a strategic, whole-of government approach to information management. This would include establishing and promoting appropriate standards and protocols for information collection and sharing, and provisions for making base data available as a web service and for download so that others to access and use this information in line with the NSW Government's Open Government directive.

These dynamic, timely reporting systems will also need to be underpinned by the continued shift towards modelling and forecasting tools (as discussed in **Chapter 3.5**), and ongoing development of the necessary skills in agencies and CMA to interpret, analyse and combine spatial datasets (as discussed in **Chapter 4**).

Agencies have already delivered a range of information products by combining, analysing and interpreting spatial datasets which serve as examples for this approach. For example:

- carbon forestry mapping using a range of national, state and regional biophysical and economic data (OEH)
- mapping for river condition, in-stream values and risk to in-stream values (NOW)
- change in effective habitat combining site and catchment scale data (OEH and Murrumbidgee CMA)
- mapping land capability by soil management units (OEH).

The cost of new information products and services could be offset by cost savings generated by streamlining current reporting arrangements.

Table 6 sets out the NRC's recommendations for delivering useful and timely information to decision makers.

Table 6: NRC's recommendations to the Natural Resource Management Senior Officers Group for delivering useful and timely information to decision makers

Recommendation		Next steps	
Delivering useful and timely information to decision makers			
6	**Review alternative approaches to reporting in NSW.**	xiv.	Review the value and frequency of existing natural resource management and environment reporting arrangements to better align with decision maker needs (NSW Government)
7	**Implement a whole-of-government approach to information management to support the delivery of timely information products to decision makers.**	xv.	Build on initiatives such as *NSW Government ICT Strategy 2012* and *NSW Spatial Data Infrastructure* to develop and adopt an Information Management Framework to ensure a consistent whole-of-government approach to information management that: a. addresses at a minimum governance arrangements and standards and protocols for data management and data access systems (NSW Location Leadership Group, agencies and CMAs) b. supports a user-driven adaptive management cycle

Attachment 1

Additional datasets to support natural resource decision making

Dataset		Comment
1	**Vegetation type mapping (classification)**	▪ Due for completion in 2015, requiring infrequent updates (then, probably at regional scale)
2	**Barriers to fish passage**	▪ Well established state-wide dataset ▪ Useful for developing and testing modelling assumptions
3	**Threats to aquatic ecosystems (point source, levees, impoundments, nutrients and sediment loads)**	▪ Regional monitoring where appropriate to verify modelling assumptions and CAP implementation
4	**Soil moisture**	▪ Combine datasets in Table 1 as surrogates; otherwise, ▪ Regional monitoring where appropriate to verify modelling assumptions and CAP implementation
5	**Groundwater quality**	▪ Regional monitoring where appropriate to verify modelling assumptions and CAP implementation
6	**Aquatic biota (macroinvertebrates and fish)**	▪ Regional monitoring where appropriate to verify modelling assumptions and CAP implementation
7	**Fire mapping (frequency/intensity/seasonality)**	▪ Regional monitoring where appropriate to verify modelling assumptions ▪ Mostly driven by CRC for Fire Ecology; National mapping on TERN/AUSCOVER database
8	**Floods**	▪ Local and regional monitoring where appropriate to verify mapping extent and CAP implementation
9	**Estuaries – nutrients/sediment**	▪ Regional monitoring where appropriate to verify modelling assumptions and CAP implementation
10	**Seagrass condition**	▪ Regional monitoring where appropriate to verify modelling assumptions and CAP implementation
11	**Estuary bathymetry**	▪ Established state-wide dataset, requiring infrequent updates (then, probably at regional scale)
12	**PASII – threatened species**	▪ Statutory program ▪ Regional monitoring where appropriate to verify modelling assumptions and CAP implementation
13	**Wild count (on park)**	▪ Regional monitoring where appropriate to verify statistical modelling assumptions and CAP implementation
14	**Aquifer extent**	▪ Regional mapping and monitoring where appropriate to verify modelling assumptions and CAP implementation
15	**Groundwater dependent ecosystems**	▪ Regional monitoring where appropriate to verify modelling assumptions and CAP implementation
16	**Commercial fish catch**	▪ Statutory program ▪ Regional monitoring where appropriate to verify modelling assumptions and CAP implementation

Dataset		Comment
17	**Nutrients offshore**	▪ Collected under other monitoring programs (e.g. IMOS)
18	**Rocky reef biota**	▪ Regional monitoring where appropriate to verify modelling assumptions and CAP implementation
19	**Ancillary data from the Integrated Marine Observing System**	▪ Collected under other monitoring programs