Wetlands (inland aquatic ecosystems)

Status of information for reporting against indicators under the National Natural Resource Management Monitoring and Evaluation Framework

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Cover photo: Whistling ducks in flight above Yellow Waters Billabong, Kakadu National Park (photo by Ian Dixon)

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Foreword

Effective management of natural resources requires good quality data and information at the right level of detail to be available for those who need it. Australia invests significant resources each year in the collection and maintenance of data to inform natural resource management decisions.

Since 1997, the National Land & Water Resources Audit has played a vital role in the national coordination, collation and reporting of this information. The Audit collaborates with a range of partners, including the Australian Government, state and territory governments, regional natural resource management bodies, industry, the private sector and community organisations.

This booklet is part of a series that describes the status of data and information relevant to national indicators agreed under the National Natural Resource Management Monitoring and Evaluation Framework. It specifically reports on the status of activities that are being used to develop a set of indicators of wetland extent, distribution and condition. It also identifies a first approximation of the types and availability of information that would be required to report against these indicators. Identifying this information is an important step in building investment and collection programs to improve data availability and reporting activities.

Noteworthy advances in identifying information needs related to wetland indicators include:

- strong cooperation built across jurisdictional programs to improve information and knowledge about wetland typology
- progress towards building a national set of conceptual models to help identify appropriate indicators for a range of wetland types
- improved state and territory capacity to address the information needs required to report on wetland condition.

Geoff Gorrie
Chair, Audit Advisory Council

Acronyms and abbreviations

AETG	Aquatic Ecosystem Task Group
DIWA	Directory of Important Wetlands in Australia
FARWH	Framework for the Assessment of River and Wetland Health
National M&E Framework	National Natural Resource Management Monitoring and Evaluation Framework
NRM	natural resource management
the Audit	National Land & Water Resources Audit
WWTF	Wetlands and Waterbirds Taskforce

Contents

Executive summary

This booklet summarises the current capacity to report on the wetland indicators pertaining to the inland aquatic ecosystem integrity 'matter for target' agreed under the National Natural Resource Management Monitoring and Evaluation Framework (National M&E Framework).

The two inland aquatic ecosystem integrity indicators specifically for wetlands are:

- wetland ecosystem extent and distribution
- wetland ecosystem condition.

The national Wetlands and Waterbirds Taskforce, established under the Natural Resource Management Ministerial Council, has recommended a range of indicators for monitoring wetland extent, distribution and condition as part of its review of the National M&E Framework indicators for inland aquatic ecosystem integrity. The specific data needs required for further development and application of the indicators have been initially assessed. A common set of protocols for wetland mapping is also under development.

Nationally consistent wetland information is critical if we are to:

- manage Australia's natural resources
- achieve sustainable land management
- improve our capacity to manage biodiversity and other environmental values.

The data and information systems used to assess wetland extent and condition and to provide primary wetlands data are fragmented and often limited. They operate at national and state and territory levels, and have been established at different times, to varying degrees of completeness and scale and for a range of purposes. The developers of existing state and territory systems are conscious of the need to adopt national standards as they become available. Some states, such as Queensland, have a dedicated website from which information can be accessed.

The proposed National Wetland Inventory (NWI) will provide the overall national information infrastructure for wetlands. It will be the principal source of nationally collated data and information — supplied by the states and territories, according to national standards — for reporting on the agreed indicators. Continuing development and implementation of the NWI should be a priority.

Coordinating the collection, collation and reporting of wetlands across multiple agencies at jurisdictional levels and natural resource management regional bodies, with their different needs and perspectives, will be a challenge. However, there is great collaboration and willingness among the National Land & Water Resources Audit's partner organisations to improve understanding, capacity and outcomes of wetlands management.

Introduction

This booklet summarises the current capacity to report on the wetland indicators pertaining to the inland aquatic ecosystem integrity 'matter for target' agreed under the National Natural Resource Management Monitoring and Evaluation Framework (National M&E Framework). The framework was developed in 2002 to assess progress towards improved natural resource condition. One of the framework's key requirements is a set of indicators for monitoring progress on each of the 'matters for target' set under the framework (see Appendix 1 for more information).

Indicators can support evidence-based decision making at different scales. At local and regional levels, the indicators help identify and measure the effectiveness of on-ground activities. At the state and territory level, they provide a basis for reporting on resource condition and trends, and for refining investment priorities. National issues can be identified when the indicators are collated across the country. This is necessary to inform sound policy and program decision making.

The National Land & Water Resources Audit ('the Audit') was responsible for developing these indicators and supporting national collection, collation and reporting against each indicator. The Audit works with theme-based national coordination committees, sponsored by the Department of the Environment, Water, Heritage and the Arts, and the Department of Agriculture, Fisheries and Forestry to develop and implement indicators for natural resource management (NRM) programs. The committee for wetlands, the Aquatic Ecosystem Task Group (AETG), receives expert technical advice from the Wetlands and Waterbirds Taskforce (WWTF). The AETG and WWTF have representatives from each state and territory.

The WWTF meets approximately four times a year to consider the following key issues:

- coordination and partnerships
- standards and indicators
- data infrastructure and systems
- trials and information delivery
- communication and products
- analysis and assessments.

Daly River, Northern Territory (photo by Ian Dixon)

National indicators

The National M&E Framework identifies indicators for assessing inland aquatic integrity — specifically wetlands (Box 1) — under two main headings:

- wetland ecosystem extent and distribution[1]
- wetland ecosystem condition.[2]

As part of the Audit's mandate to develop indicators, potential indicators relevant to these headings were assessed and redefined following a series of state and territory workshops held across Australia in November 2006, and considered at a national workshop in Victor Harbor, South Australia in March 2007 (Conrick et al 2007).

The indicators (outlined in Table 1) were developed after critically investigating the alignment and integration of the National Water Commission's Framework for the Assessment of River and Wetland Health (FARWH) and the National M&E Framework (the following section provides more information about the national assessment framework). The indicators have been trialled through projects in NSW, Vic, SA, NT and WA.

Darter waterbird dries its wings, Yellow Waters Billabong, Kakadu National Park, Northern Territory (photo by Ian Dixon)

1 'Extent' is the area of the wetland, measured in hectares; 'distribution' refers to the spatially referenced wetland and associated descriptive attributes (information that groups wetlands of similar typology together).

2 'Condition' (or 'health') is the relative integrity of the wetland ecosystem compared to a reference state. It includes being able to maintain key ecological and physical processes, ecosystem services, and communities of organisms.

Table 1 Proposed indicators for wetland extent, distribution and condition

Indicator theme	Indicator
Wetland extent and distribution	Extent and distribution of wetlands
	Extent and distribution of important wetlands[a]
Wetland condition	
Catchment disturbance	Infrastructure in catchment[b]
Physical form and processes[c]	Area of wetland — change in wetland area
	Wetland topography — change through erosion, excavation, banks
	Soil disturbance — change through physical disturbance, compaction or cultivation
Hydrological disturbance[d]	Physical modification to hydrology in-flow, drainage and extraction (catchment and wetland scale)
	Changes to water regime timing, frequency, duration, extent and depth, and variability, including groundwater contribution
Water and soil quality[e]	Turbidity (light climate) regime
	Salinity regime
	Change in pH
	Soil properties — change in salinity, acidity
Fringing zone vegetation[f]	Change in fringing zone (measured by change in vegetation condition and extent)
Biota[g]	Change in wetland vegetation
	Change in invertebrate diversity and community composition
	Change in wetland-dependent vertebrates (fish, frogs, reptiles, birds, mammals) presence, breeding and abundance
	Change in introduced species (weeds and feral animals) presence and abundance
	Change in algae (as a measure of primary productivity rather than water quality)

[a] Those wetlands recognised as being of international and national importance. Extent includes land within administrative sites (eg Ramsar) that may include other vegetation types or may not cover the whole wetland area.
[b] Incorporates the effects of land use, change in vegetation cover and infrastructure on the likely run-off of water, sediments, nutrients and other contaminants to wetlands.
[c] Uses measures of local topography, physical structure and connectedness to assess the state of local habitat and its likely ability to support aquatic life.
[d] Includes surface water and groundwater.
[e] The effects on biota due to changes in water and soil quality characteristics.
[f] Structural and condition features of the zone surrounding a wetland.
[g] The response of biota to changes in the environment.

Box 1 Challenges in defining a wetland

Wetlands, as recognised by the Australian Government through the Directory of Important Wetlands of Australia (DIWA), encompass all natural waterbodies and are defined as:

> ... areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. (Environment Australia 2001)

The definition is based upon the Ramsar wetland classification for use at a national and international level (http://www.ramsar.org).

The wetland classification system used in the DIWA (Environment Australia 2001) identified 42 different wetland types in three categories:

- A — marine and coastal zone wetlands (13 wetland types)
- B — inland wetlands (19 wetland types)
- C — human-made wetlands (10 wetland types).

Several methods of classifying wetlands have been developed, both in Australia and internationally. Many are based on the Cowardin et al (1979) classification of wetlands into marine (coastal wetlands including rocky shore), estuarine (including deltas, tidal marshes and mangrove swamps), riverine (wetlands along rivers and streams), lacustrine (wetlands associated with lakes) and palustrine (marshes, swamps and bogs) wetlands.

Reservoirs (including water storage areas, excavations, wastewater ponds, irrigation channels, rice fields and canals) and subterranean (inland subterranean wetlands) are also identified as wetland types. In a Cowardin classification, wetland subtypes are identified based upon their geographic location, climate variables, water sources, dominant vegetation, or other distinguishing characteristics.

However, wetlands are traditionally thought of as those waterbodies belonging to the lacustrine (lakes) and palustrine (marshes, swamps and bogs) systems, and this interpretation has been used in the development of the new indicators for the National M&E Framework and the 'matters for target'.

A national assessment framework

While work was under way to examine the National M&E Framework and investigate possible indicators, the National Water Commission was developing an approach to undertake river and wetland health assessments during its Water Resource Assessment 2005. The assessment framework (FARWH) provides the overarching framework for developing information needs and reporting on wetland and river condition (NWC 2007).

FARWH (Box 2) is an assessment framework requiring information about individual indicators of river and wetland health. The National M&E Framework is an indicator framework that is developing specific indicators related to river and wetland health. Both frameworks are complementary and can be used in tandem (Figure 1). Both frameworks:

- recognise the premise that ecological integrity is a fundamental measure of wetland health (although other components of the environment are just as important, and should be included in an assessment of ecosystem health)
- identify and use indicators (selected under six themes that are major drivers of ecosystem health) for measuring key river and wetland ecological processes

Box 2 About the Framework for the Assessment of River and Wetland Health (FARWH)

FARWH was developed to:

- provide methods for aggregating and integrating existing river and wetland health information
- facilitate comparable national reporting of state, territory and regional NRM assessments, such as
  - the Murray-Darling Basin's Sustainable Rivers Audit
  - Victoria's Index of Stream Condition
  - Tasmania's Conservation of Freshwater Ecosystem Values project.

FARWH incorporates a range of river and wetland attributes indicative of key ecological processes, based on the assessment framework used to produce the Audit's 2002 assessment of river condition. FARWH recommends selecting wetland ecosystem condition indicators under the six themes:

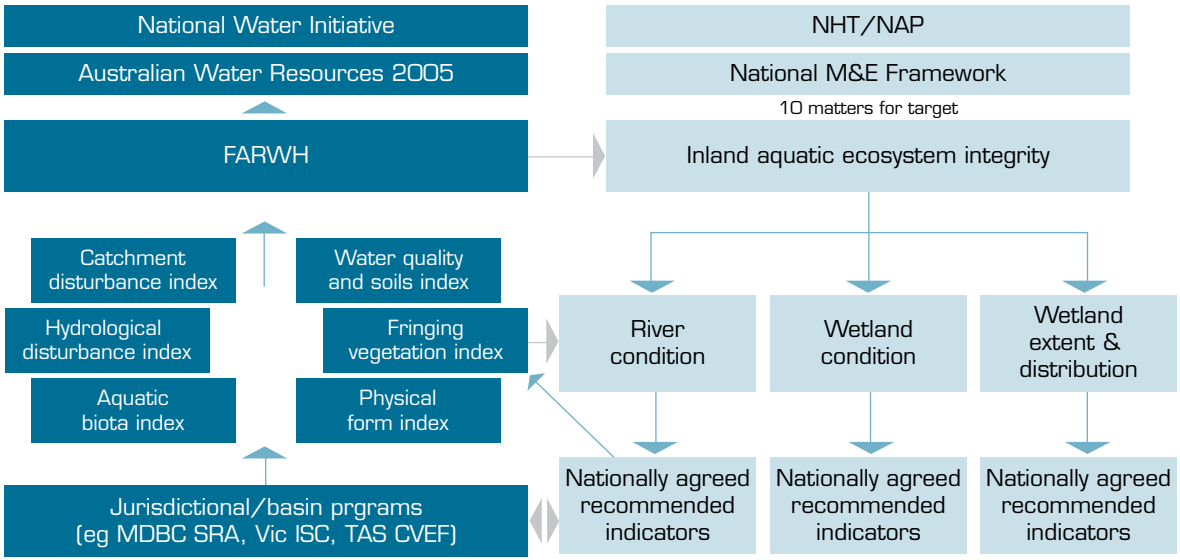
1. Physical form
2. Water quality and soils
3. Aquatic biota
4. Hydrological disturbance
5. Fringing zone
6. Catchment disturbance.

- use a reference-based approach to assess each indicator against a pre-existing condition
- require the use of indices that can be aggregated to generate scores that can be reported and compared at the regional, state or national level.

Classifying wetlands for condition and extent assessments

Different wetland types depend on varying physical and ecological processes to maintain their condition. Wetlands are an important part of the natural landscape, providing provisional (food, water), regulatory

Figure 1 Linkages between the Framework for the Assessment of River and Wetland Health and the development of indicators under the National Natural Resource Management Monitoring and Evaluation Framework



FARWH = Framework for the Assessment of River and Wetland Health; NAP = National Action Plan for Water Quality and Salinity; National M&E Framework = National Natural Resource Management Monitoring and Evaluation Framework; NHT = Natural Heritage Trust

Source: Conrick et al (2007)

The recently discovered Cooper's Creek turtle (*Emydura macquarii emotti*) is a key component of the still intact biodiversity of rivers and landscapes of the Lake Eyre Basin. This species epitomises the ability to survive in the extreme 'boom and bust' environment of these inland systems (photo by Angus Emmott).

(floods, droughts), supporting (soil formation, nutrient cycling) and cultural (recreational, spiritual) ecosystem services. The value of wetland ecosystem services such as filtering contaminants, sustainable food resources and reliable water supplies has been recognised in recent years, prompting governments to reassess how they manage wetlands and maintain vital wetland functions. Incorporating a wetlands classification system is crucial to assessing changes in their condition and services.

In Australia, wetland classification continues to evolve. The contemporary approach has used the wetland classification system of the Ramsar Convention to describe wetlands of international and national importance. The wetland classification system used in the DIWA (Environment Australia 2001) identified 42 different wetland types in three categories (see Box 1).

Reporting on the condition of wetlands will require the use of indicators appropriate to the type of wetland being assessed. For example, the character of a tropical ephemeral wetland will be different from a permanent alpine marsh. Therefore, statements of condition will relate only to the type of wetland being assessed.

In recent years, wetland classification has been reassessed to improve understanding of wetland function and ecosystem services provided by different wetland types. A classification system that can be used in the broad-scale mapping of wetlands therefore needs to be developed. This approach incorporates the development of a conceptual model for each wetland type.

The proposed indicators for reporting against wetland extent and distribution under the National M&E Framework will require that all wetlands are assigned a wetland type. At the national scale, climatic and wetland ecosystem categories could be used to classify wetlands into broad types. The proposed wetland classification system is shown in Table 2.

Mound Springs, Maree, South Australia (photo by Debra Jeisman)

Table 2 Proposed wetland classification system

Resolution	Category	Attribute
Continental	Climate	Equatorial Tropical Subtropical Desert Grassland Temperate
Ecosystem	Wetland system	Marine Estuarine Riverine Lacustrine (lake) Palustrine (swamp) Subterranea Nival (permanent snowfields and ice) Reservoir (artificial water bodies)

Wetland conceptual models

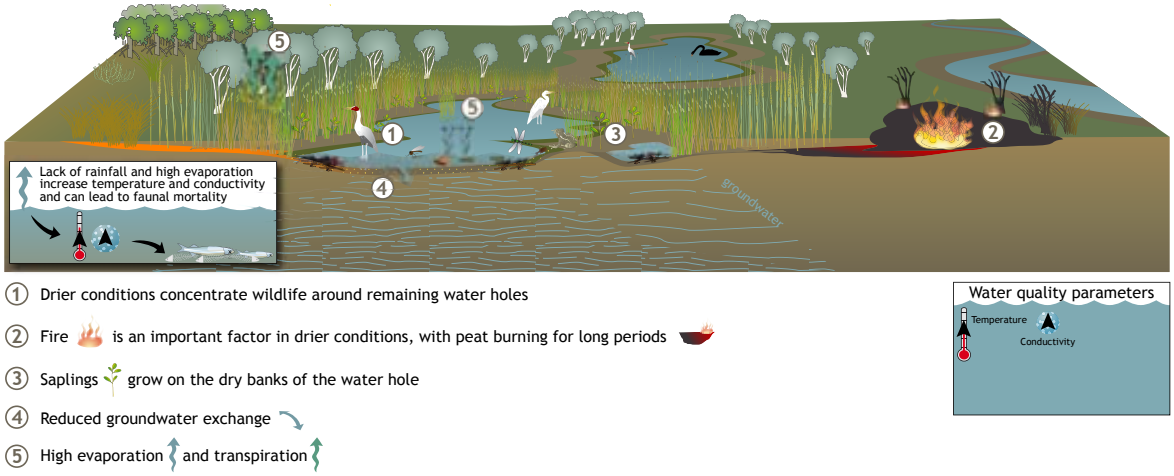
The character and ecological significance of different wetland types are driven by different processes. An understanding of the wetland system being assessed will therefore be critical in determining the type of indicators and associated information required for the development of a monitoring regime.

Conceptual diagrams are a useful way to develop condition indicators for wetland monitoring and evaluation. They provide a pictorial representation, at the landscape or ecosystem scale, and include the major ecosystem components, processes and functions, and influences on condition such as stressors or pressures (Wilkinson et al 2007).

An example of a generalised conceptual model for palustrine (swamp) wetlands is shown in Figure 2.

A number of jurisdictions are developing conceptual models of major wetland types as part of their planning, monitoring and evaluation activities. Queensland, New South Wales and South Australia have made significant progress, with activities being coordinated for the Lake Eyre Basin and the Murray-Darling Basin.

Figure 2 Conceptual model of a generic palustrine (swamp) wetland in the dry phase



Source: Conrick (2007)

Jabiru eating a file snake, Yellow Waters Billabong, Kakadu National Park, Northern Territory (photo by Ian Dixon)

Coordinating these activities will ensure that, where possible, a single set of comparable models is developed.

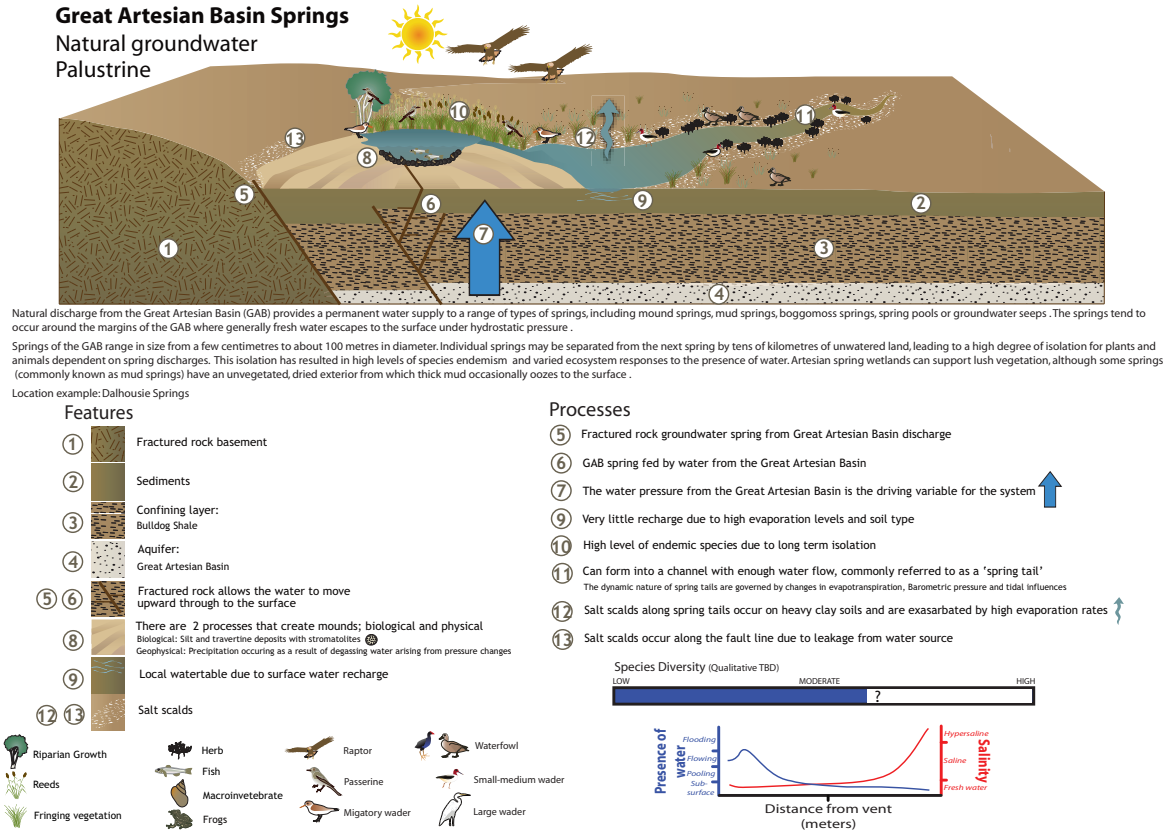
In Queensland, conceptual models are being generated for palustrine (swamp) and lacustrine (lake) wetlands within the framework of the wetlands classification system. The classification system divides Queensland into two major climatic regions: the grassland and arid areas, and the temperate, tropical and subtropical areas.

In South Australia, conceptual models have been developed for fifteen wetland types:

- peat wetlands
- karst systems
- artificial bore drains
- freshwater meadows
- inland interdunal watercourses
- Great Artesian Basin springs
- river red gum/eucalypt woodlands
- swamps
  - grass sedge
  - inland arid zone
- lakes
  - artificial
  - volcanic
  - inland salt
  - arid zone
  - coastal dune
  - terminal depression.

Figure 3 shows an example of a conceptual model for Great Artesian Basin springs.

Figure 3 South Australian conceptual model for Great Artesian Basin springs



Source: Updated from Scholz and Fee (2008)

Indicator data needs

The Audit has completed an initial assessment of the specific data required to report against the National M&E Framework indicators (Beaten Track Group 2004).

The key data needed about wetland extent are spatial delineations of the extent of wetlands across Australia; the data may be used to create wetland maps, for example. Processes will also need to be put in place to update the wetland extent maps, thus enabling changes in extent in selected areas to be monitored.

Data needs in relation to wetland condition are being refined in state and territory trials. An approximation of data needs against the condition indicators being trialled is outlined in Table 3.

A set of draft protocols and guidelines for measurement and reporting of wetland indicators has been prepared and is being developed.

Rainbow bee-eater in flight. Tropical floodplain wetland with lilies, swamphens in the background (photo by Darryl Ding)

Waterlilies (*Nymphaea*) in a wetland near Clermont, Queensland (photo by Arthur Mostead)

Table 3 Data needs for wetland condition indicators

Data need	Catchment disturbance	Physical form and processes	Hydro-logical disturbance	Water and soil quality	Fringing zone	Aquatic biota
Land use	***	**	***	**	*	*
Vegetation	***	*	*	*	***	***
Roads	***	***	**	*	*	*
Digital elevation models	***	***	***	**	**	*
Dams and levees	***	***	***	**	**	*
Water bodies	***	***	***	**	**	***
Soils	**	***	*	***	**	*
Turbidity	*	***	**	***	*	*
Salinity	*	**	***	***	*	*
pH	*	**	**	***	*	*
Soil acidity	*	**	**	***	*	*
Macroinvertebates	*	*	**	***	*	***
Fish	*	*	**	**	*	***
Amphibians	*	*	**	**	*	***
Reptiles	*	*	**	**	*	***
Birds	*	*	**	**	*	***
Weeds	*	*	**	**	***	***
Feral animals	*	*	**	***	***	***
Algae	*	**	*	***	*	***

*** = specific data that may be used for measurement of the indicator, as defined in the protocol

** = critical contextual data that may be needed to understand the indicator

* = useful data that helps to understand the indicator

Data availability and gaps

Data availability and gaps are discussed in this section in terms of:

- data needed to underpin the development of wetland condition indicators
- data needed for reporting on the indicators and understanding the indicators in context
- measurement of change and trends for all indicators.

Wetland extent information

Wetland inventory data

A review of wetland inventory data across Australia identified 135 datasets, the majority of which had metadata descriptions (Auricht and Watkins 2008). A breakdown of the data is outlined in Figure 4.

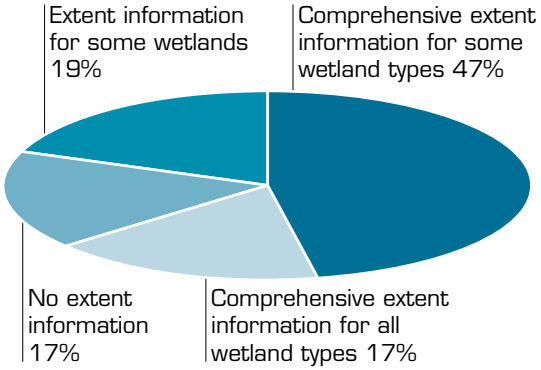
Approximately half of the datasets had comprehensive extent information for some wetland types; however, the majority of these datasets relate to estuarine and coastal wetland types. The 'comprehensive extent information for all wetlands' includes only two datasets for a complete jurisdiction (Victoria and Tasmania), and these refer only to inland wetlands.

Knowledge of wetland extent in Australia is limited. At present, Queensland is the only jurisdiction generating baseline data in a format that could be used in the National M&E Framework. Figure 5 shows a simplified representation of the current status of wetland extent mapping information availability and accessibility in the different states and territories.

The review also highlighted that there are wetland extent datasets held within various state agencies; however, as these are being finalised they are not currently available to the public. Governments intend to make these available and the South Australian Government, for example, is working on a program to develop and improve their wetland extent and distribution dataset.

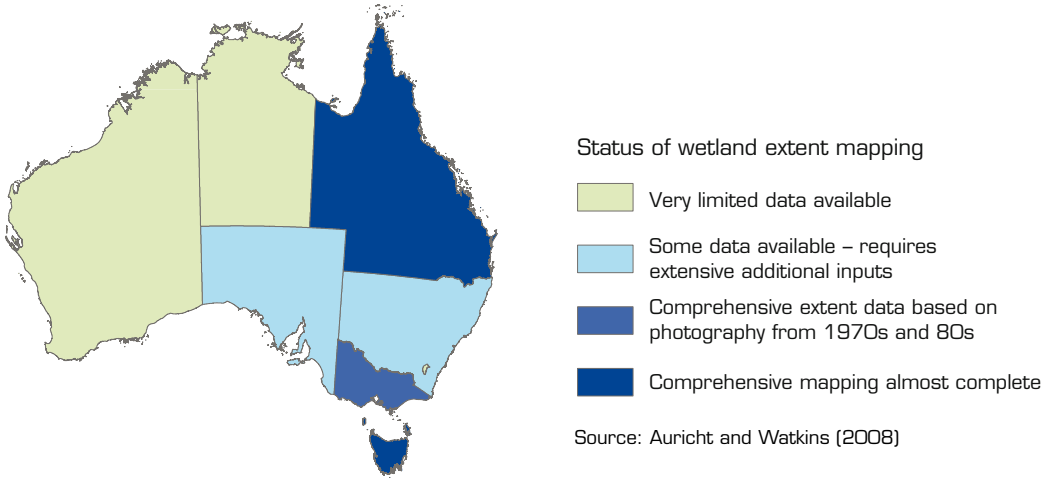
A preliminary indication of the spatial extent of the South Australian dataset is presented in Figure 6.

Figure 4 Level of wetland extent information in wetland inventory datasets



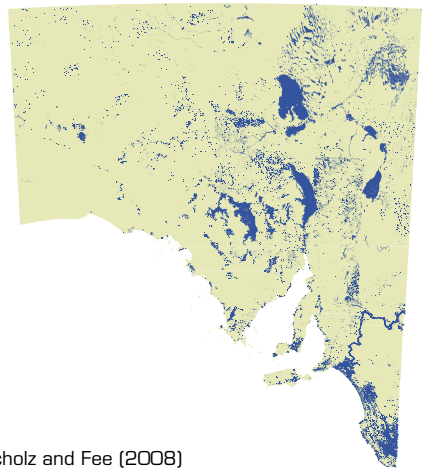
Source: Auricht and Watkins (2008)

Figure 5 Simplified representation of the status of wetland extent mapping by state and territory availble through online searches (June 2008)



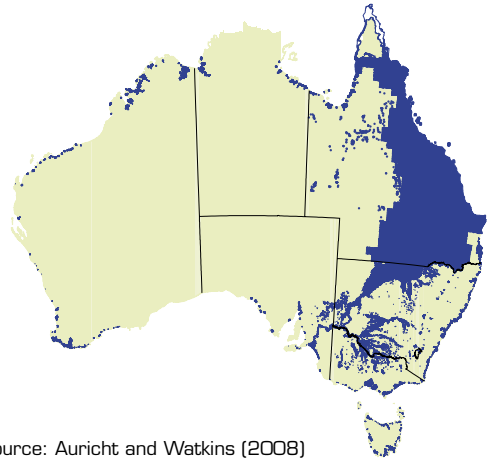
Source: Auricht and Watkins (2008)

Figure 6 The location of preliminary wetland extent and distribution data being gathered by the South Australian Government (June 2008)



Source: Scholz and Fee (2008)

Figure 7 Detailed representation of the location of wetlands with extent data available to the public (June 2008)



Source: Auricht and Watkins (2008)

Wetland extent information datasets that are readily accessible to the public are shown in Figure 7. These include:

- Queensland Wetland Mapping Program
- Queensland Coastal Wetland Vegetation
- Wetlands GIS of the Murray-Darling Basin Series 2.0
- Coastal waterways geomorphic mapping
- Geomorphic Wetlands Augusta to Walpole (Western Australia).

Hydrological datasets (such as Course Cultural Topographic datasets — Drainage Network) have not been included, as these generally do not include wetland extent information.

View of the Upper Barron Swamp showing a bare, undulated landscape; near Malanda, Northern Queensland (photo by Arthur Mostead)

Wetland condition data

The states and the Northern Territory have tested the potential indicators using existing data in areas such as New South Wales, South Australia, the Western Australian wheatbelt and the Darwin region. Table 4 shows where projects have been undertaken for trialling the indicators under the National M&E Framework's inland aquatic ecosystem integrity (rivers and other wetlands) 'matter for target'.

The trials varied in their approaches, and therefore in their outcomes. However, each trial built the capacity of individual states to address the development of information to report on the wetland condition indicators.[3]

Some key findings from the six wetland ecosystem condition themes have been derived from individual state and territory Audit projects that tested the applicability of the indicators for their own purposes:

1. Catchment disturbance

- Indicators provided meaningful results, were suitable and could be used without modification.

2. Physical form and processes

- Indicators require further work and development.
- Physical modification to hydrology was useful for saline wetlands, and was recommended to be a priority for development.

3. Hydrological disturbance

- Indicators generally provided meaningful results.
- The water regime indicator was useful, and was recommended to be a priority for development.
- Water extraction and wetland 'wetness' over time were noted as better candidates for a water regime indicator.

Juvenile sooty grunter, (black bream) *Hephaestus fuliginosus*, found in Australia's tropical rivers (photo by Julian Olden)

[3] http://www.nlwra.gov.au/national-land-and-water-resources-audit/rivers-and-wetlands

4. Water and soil quality

- Indicators provided meaningful results.
- The number of water quality parameters required should be reduced.
- The salinity indicator was more informative than pH or turbidity.
- The pH indicator was a good measure of current condition, but this can change rapidly. This indicator was recommended as a priority for development.
- For the turbidity (light climate) and salinity regime indicators, it was noted that setting an indicator for a 'regime' is problematic, as this requires a time period and other external conditions to be defined.
- The soil properties indicator was recommended as a priority for development.

5. Fringing zone

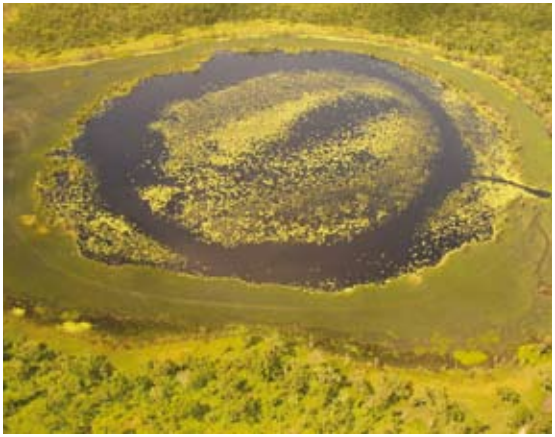
- Indicators provided meaningful results, were suitable and could be used without modification.
- This theme was recommended to be a priority for development.

6. Aquatic biota

- The invertebrate richness indicator was useful (Sim et al 2008).
- Two sub-indices for weed species were useful (Lamche et al 2008).

Other general findings included:

- Data availability and quality for the indicators varied highly across the themes.
- Remote sensing was useful for identifying and measuring all wetland condition indicators to some degree, except for aquatic biota where the assessment of habitat using remote sensing could be used as a surrogate (Scholz and Fee 2008).
- The strength of using multiple indicators is the ability to cross-verify scores.
- The suite of indicators was most appropriate for assessing individual or small numbers of wetlands, rather than summarising a large number of wetlands across a region.



Aerial view of Girraween Lagoon, near Darwin, Northern Territory (photo by Ian Dixon)

Table 4 Current state and territory activity in developing wetland extent, distribution and condition indicators

Indicator heading	Themes	Indicators	Vic	SA	WA	NT	Qld	NSW	Tas	ACT
Wetland ecosystem extent and distribution	–	Extent and distribution of wetlands								
		Extent and distribution of 'significant' wetlands								
Wetland ecosystem condition	Catchment disturbance	Disturbance in the catchment								
	Physical form and processes	Area of wetland — change in area								
		Wetland topography								
		Soil disturbance								
	Hydrological disturbance	Physical modification to hydrology				a				
		Changes to water regime				a				
	Water and soil quality	Turbidity (light climate) regime								
		Salinity regime								
		Change in pH								
		Soil properties								
	Fringing zone	Change in fringing zone								
	Aquatic biota	Change in wetland vegetation								
		Change in invertebrates								
		Change in vertebrates								
		Change in introduced species								
		Change in algae								

Blue highlighting indicates activity in this area; – = no themes included under this indicator heading.

a The Northern Territory trialled water extraction and impervious area indicators for this theme.

Data and information products

Reporting

Reporting of wetland extent and distribution will primarily be for national and state and territory purposes (eg State of the Environment reports, Ramsar reporting). Therefore, the reporting framework at larger scales should be as consistent as possible across the nation. Examples of possible reporting measures include:

- extent of existing mapping
- change in wetland area compared to a specific reference date
- area and numbers of wetlands by
  - type
  - ecosystem or vegetation type (refer to National Vegetation Information System)
  - drainage division, basin and catchment or surface water management area
  - Interim Biogeographic Regionalisation of Australia region, or appropriate aquatic bioregionalisation
  - NRM region.

No national baseline of wetland extent is currently available. Only Queensland has made significant progress in generating this type of information. A new national program to map wetland extent (within an agreed wetland classification) is required before information needed to use the wetland extent and distribution indicator will be available.

For reporting wetland condition, FARWH recommends that an individual wetland is the minimum sample size, although under certain conditions, a series of wetlands may also constitute a sample. It should be aggregated up to a scale that meets the jurisdictional needs (subcatchment, catchment, basin, regional, water management unit, state or national level).

For an assessment of wetland condition or 'health', the minimum recommended number of themes is three. In many cases, it may not be possible to collect directly measured data from all parts of a study area. A variety of approaches, including direct measurements, sampling strategies, remotely sensed data and modelled data may be adopted to counter this problem. FARWH also recommends including several indicators of the aquatic biota theme in the assessment.

Govi Creek Fraser Island (photo by Steven Wall)

National mapping protocol

Reporting on the extent and distribution of wetlands at regional, state and national levels requires knowledge of where wetlands lie in the landscape. This knowledge can only be successfully achieved by detailed mapping.

While all jurisdictions have mapped some of their wetlands — generally in response to specific projects or programs — almost no jurisdiction has mapped a complete coverage. Queensland, for example, has developed and published wetland mapping protocols that are used to develop the state's base wetland maps (EPA 2005). Other states have a variety of wetland maps covering part or all of their regions.

No consistent national protocol exists for mapping wetland extent. However, at the jurisdictional level, there is considerable interest in the development of a national mapping protocol. The current review of wetland mapping and inventory projects is helping this process. The work of the Queensland Wetland

Program (Box 3) is providing a basis for the development of a national protocol for mapping wetland extent across Australia (Auricht and Watkins 2008).

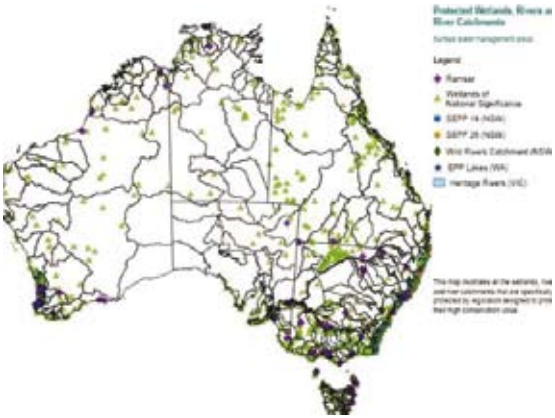
Australian Water Resources 2005

Australian Water Resources 2005 is the National Water Commission's baseline assessment of Australia's water resources in 2004–05. This assessment followed on from the Audit's 2002 assessment (NLWRA 2002) and synthesised information at the national scale to increase the understanding of Australia's water resources. It also identified the knowledge gaps that reduce Australia's ability to manage water resources effectively and sustainably.

The assessment found that more than 3500 wetlands receive a level of site protection in Australia under the International Ramsar Convention and Commonwealth, state and territory legislation (see Figure 8). It also found that flow requirements for wetlands were not well met by the current system of protected areas, and that the capacity to undertake a national assessment of wetland health did not exist.

Under the National Water Initiative, an enduring national water resource assessment system is being developed. The system should include improving the level of protection afforded to Australian wetlands, and developing improved frameworks for assessing wetland health (or wetland condition).

Figure 8 Australian Water Resources 2005: Protected wetlands, rivers and river catchments



Source: http://www.water.gov.au

Murrumbidgee Wetlands at Billilingra, New South Wales (photo by Judy Goggin)

Data and information systems

Assessing wetland extent

The current data and information systems used to assess wetland extent are fragmented and limited. A range of supporting information systems provides access to other critical and contextual information; the major systems are listed in Table 5.

Wetlands mapping programs

All jurisdictions have developed information systems for mapping wetlands to varying degrees. The Queensland model (see Figure 9) is particularly well advanced.

Flock of magpie geese taking off at Leahy Creek, near Proserpine, Northern Queensland (photo by Arthur Mostead)

Box 3 Queensland Wetlands Mapping Program

The Queensland Wetlands Mapping Program aims to support sustainable use and conservation of wetlands across Queensland. Its key components are wetland classification and mapping. The program is a cooperative venture between the Commonwealth and Queensland governments.

The program's wetland mapping process involves sophisticated digital interpretation of satellite image sequences. It also draws on data sources such as other wetland mapping, topographic mapping, regional ecosystem mapping and spring surveys.

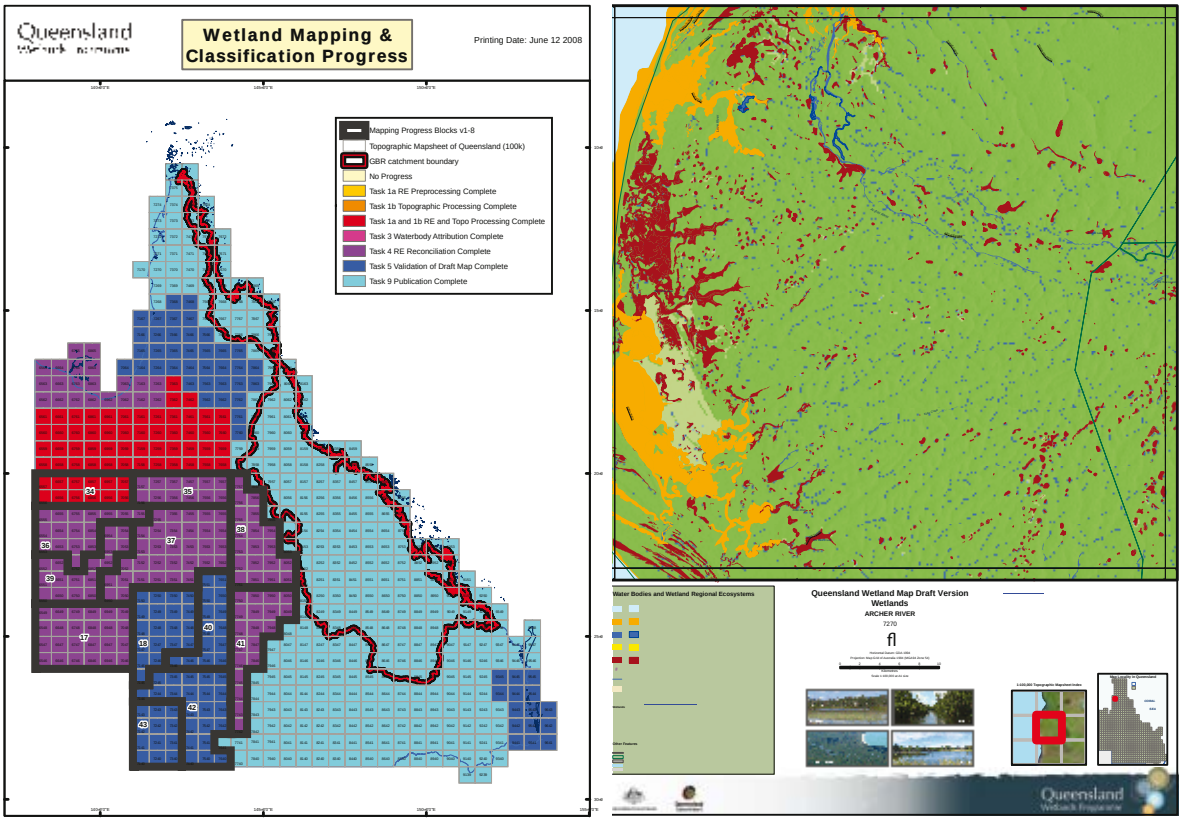
In the Queensland section of the Murray-Darling Basin, wetland mapping identified 10 982 wetlands covering a total area of 380 846 hectares. This is about 2% of the total catchment area.

Figure 9 provides two examples of possible outputs from the Queensland Wetland Mapping Program.

Table 5 National information systems and datasets relevant to the wetlands theme

Main system	Description	Website
Ramsar wetlands	Wetlands recognised under the Ramsar Convention	http://www.environment.gov.au/water/publications/environmental/wetlands/database
Australian Wetlands Database	Wetlands that qualify as being nationally important	http://www.environment.gov.au/water/publications/environmental/wetlands/database
Australian Water Resources 2005	Baseline assessment of the National Water Initiative	http://www.water.gov.au
OzCoasts	National coasts database	http://www.ozcoasts.org.au
National Shoreline Map	Geomorphic and stability mapping	http://www.ozcoasts.org.au
NVIS	Native Vegetation Information System	http://www.environment.gov.au/erin/nvis
IMCRA	Integrated Marine and Coastal Regionalisation of Australia	http://www.environment.gov.au/coasts/mbp/imcra
NRM Regional Boundaries	Defines NRM marine boundaries	http://www.environment.gov.au/erin
ACLUMP	Australian Land Use Mapping	http://www.brs.gov.au/landuse
ARO	Australian Resources Online	http://www.anra.gov.au
ANRDL	Australian Natural Resources Data Library	http://adl.brs.gov.au
NIMPIS	National Introduced Marine Pests Information System	http://www.marine.csiro.au/crimp/nimpis
ASRIS	Australian Soils Resource Information System	http://www.asris.csiro.au
ABS	Australian Bureau of Statistics data	http://www.abs.gov.au

Figure 9 Example of output from the Queensland Wetland Mapping Program



The status of the mapping program at 12 June 2008 (left) and a sample output of a 1:100 000 scale map of Queensland wetland areas (right).

Source: Queensland Environmental Protection Agency, Queensland Wetlands Programme: Wetland Mapping and Classification Project

Discussion and way forward

While major steps have been taken to capture and organise wetland information in some areas, the current level of available information is patchy; some regions have good data, while others have little information. A coordinated approach is required to make meaningful progress in reporting on the extent and condition of the nation's wetlands. Significant progress has been made in designing and communicating the elements of a national assessment framework, although implementation is at a relatively early stage. Priority actions needed to capitalise on this work are listed below.

Indicators and frameworks

- Ongoing commitment from jurisdictions is required to develop an agreed framework for assessing wetland condition.
- Methodologies and protocols for specific indicators need to be developed for use in assessments at the regional or state level.
- Scoring measures and aggregation methods need to be developed for the use of indices when reporting on indicators.
- Development of conceptual models will provide a useful tool for designing monitoring programs and interpreting scores against indices.
- Further work on the wetland catchment disturbance index is required, and should include an assessment of available datasets in jurisdictions outside Victoria.

Data availability and gaps

- Large data gaps across the nation prevent national-scale reporting.
- Improved data availability is required to underpin the development of wetland condition indicators (particularly for measuring change and trends).
- Further work is required on reporting scales for wetland extent, distribution and condition.
- Larger scale operational programs to assess wetland condition are required at the state, catchment and regional levels.
- Metadata on spatial datasets need to be made publicly available when wetland inventory projects start, rather than after they are finished.
- A greater commitment by the wetland monitoring community to reporting of outcomes is required.

- A sampling strategy that reports on a proportion of wetlands (by type or region) may be a valuable method for producing information about wetland condition.

Information products and systems

- Only some jurisdictions, such as Queensland, currently have adequate mapping programs in place.
- Further work is required to develop and endorse a national protocol for mapping wetland extent.
- Further work is required for the spatial delineation of wetland extent across Australia, to allow data collection and mapping.
- Comprehensive wetland mapping is required at a comparable standard across Australia.

Capacity building

- Some regional organisations, and others involved in mapping activities, will require training to increase capacity in mapping activities.
- A toolkit providing guidance on compiling (capture, collation and storage) and presentation of wetland extent dataset needs to be developed.

Archerfish, *Toxotes chatareus* (photo by Julian Olden)

National wetland information infrastructure

- A national information infrastructure, such as the proposed National Wetland Inventory, needs to be developed. Such a system should address key elements of
  - data collection, collation, storage and management
  - development of models
  - communication.
- The system should also include information products and have the capacity to integrate with other existing systems; this will provide a platform to develop and provide freely available information products.

Appendix 1 The National Monitoring and Evaluation Framework

The National Natural Resource Management Monitoring and Evaluation Framework (referred to in this series as 'the National M&E Framework') was endorsed by the Natural Resource Management Ministerial Council in 2002. It was developed to assess progress towards improved natural resource condition through the development of accurate, cost-effective and timely information on:

- the health of Australia's land, water, vegetation and biological resources
- the performance of programs, strategies and policies that provide national approaches to the conservation, sustainable use and management of these resources.

Assessment of information collated under the National M&E Framework will assist the Ministerial Council to 'identify areas of concern and to better target the use of resources'.

The framework identifies three key requirements for monitoring natural resource condition:

1. a set of natural resource condition indicators (including those for the 'matters for target' identified in the National Framework for Natural Resource Management Standards and Targets) to measure progress towards agreed national outcomes on a medium and long term basis
2. a set of indicators for monitoring community and social processes relevant to or affected by NRM programs, as well as measures of the adoption of sustainable development and production techniques
3. contextual data pertinent to the indicator being considered.

The National Land & Water Resources Audit ('the Audit') is responsible for ongoing development of these indicators, as well as supporting the national collection and collation of data, and reporting against each indicator.

Such reporting will help to answer questions such as:

- What is the nature and extent of the issue?
- Is the existing or proposed intervention appropriate for the size of the issue?

Jacana feeding among the waterlilies, Yellow Waters Billabong, Kakadu National Park, Northern Territory (photo by Ian Dixon)

- What types of intervention work best, are most cost effective, and have the best transferability across regions?
- What was the impact of the policy or program investment — in the intermediate and long term?

Monitoring and evaluation of core indicators supports evidence-based decision making at national, state and territory, and regional levels. However, each level may have a wide variety of data and information needs, in terms of content, context or scale. There is also complexity across the three levels of use associated with multiple needs, values, preferences and timeframes.

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