

# Environmental Indicators

For National State of the Environment Reporting

*local and community uses*

**Australia: State of the Environment  
Environmental Indicator Report**

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### PREFACE

The Commonwealth State of the Environment Reporting system supports the *National Strategy for Ecologically Sustainable Development* and helps Australia meet its international obligations, such as those under Agenda 21 and the OECD environmental performance reviews. The first independent and comprehensive assessment of Australia's environment, *Australia: State of the Environment 1996* was released by the Commonwealth Environment Minister in September of that year.

The next step in the evolution of the reporting system is to develop a set of environmental indicators that, properly monitored, will help us track the condition of Australia's environment and the human activities that affect it. To help develop these indicators, Environment Australia has commissioned reports recommending indicators for each of the seven major themes around which Commonwealth state of the environment reporting is based. The themes are:

- human settlements
- biodiversity
- the atmosphere
- the land
- inland waters
- estuaries and the sea
- natural and cultural heritage.

Clearly, none of these themes is independent of the others. The consultants worked together to promote consistent treatment of common issues. In many places issues relevant to more than one theme receive detailed treatment in one report, with cross-referencing to other reports.

Report authors were asked to recommend a comprehensive set of indicators, and were not to be constrained by current environmental monitoring. One consequence of this approach is that many recommendations will not be practical to implement in the short term. They are, however, a scientific basis for longer term planning of environmental monitoring and related activities.

This, the eighth report, deals with the use of the recommended indicators by local or regional environmental managers and with the role of the community in indicator work. It is the result of a pilot study carried out by the Australian Local Government Association and Environment Australia.

These reports are advice to Environment Australia and have been peer reviewed to ensure scientific and technical credibility. They are not necessarily the views of the Commonwealth of Australia.

The advice embodied in these reports is being used to advance state of the environment reporting in Australia, and as an input to other initiatives, such as the National Land and Water Resources Audit and the Australian Local Government Association's Regional Environmental Strategies.

**SUMMARY**

Environmental indicators appropriate to the needs of local environmental managers (including local councils, community groups, and businesses) in six regions from around Australia were identified. The practicality of these indicators and their value as decision-making tools was explored. Links with environmental indicators recommended for national state of the environment reporting were identified. The use of data gathered by the community to support these indicators was investigated.

**Aims of the study**

- explore the use of environmental indicators as tools to improve the flow of information to regional environmental managers;
- explore links between environmental indicators useful to regional environmental managers and those used for reporting on the state of the environment at the national scale; and
- explore the role of community environmental monitoring in providing information about trends in the environment to managers and for use in state of the environment reporting.

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### BACKGROUND

#### Commonwealth State of the Environment Reporting

In 1992 Australia's *National Strategy for Ecologically Sustainable Development* (Council of Australian Governments 1992) was endorsed by the Commonwealth, all State and Territory Governments and Local Government. The objectives of this strategy are:

- to enhance individual and community well-being and welfare by following a path of economic development that safeguards the welfare of future generations;
- to provide for equity within and between generations; and
- to protect biological diversity and maintain essential ecological processes and life-support systems.

The strategy called for the introduction of regular state of the environment (SoE) reporting at the national level to enhance the quality, accessibility and relevance of data relating to ecologically sustainable development.

The broad objectives of state of the environment reporting for Australia are:

- to regularly provide the Australian public, managers and policy makers with accurate, timely and accessible information about the condition of and prospects for the Australian environment;
- to increase public understanding of the Australian environment, its conditions and prospects;
- to facilitate the development of, and review and report on, an agreed set of national environmental indicators;
- to provide an early warning of potential problems;
- to report on the effectiveness of policies and programs designed to respond to environmental change, including progress towards achieving environmental standards and targets;
- to contribute to the assessment of Australia's progress towards achieving ecological sustainability;

- to contribute to the assessment of Australia's progress in protecting ecosystems and maintaining ecological processes and systems;
- to create a mechanism for integrating environmental information with social and economic information, thus providing a basis for incorporating environmental considerations in the development of long-term, ecologically sustainable economic and social policies;
- to identify gaps in Australia's knowledge of environmental conditions and trends and recommend strategies for research and monitoring to fill these gaps;
- to help fulfil Australia's international environmental reporting obligations; and
- to help decision makers make informed judgements about the broad environmental consequences of social, economic and environmental policies and plans.

The first major product of this system was *Australia: State of the Environment 1996* (State of the Environment Advisory Council 1996) — an independent, nation-wide assessment of the status of Australia's environment, presented in seven major themes: human settlements; biodiversity; atmosphere; the land; inland waters; estuaries and the sea; and natural and cultural heritage.

*Australia: State of the Environment 1996* is the first stage of an ongoing evaluation of how Australia is managing its environment and meeting its international commitments in relation to the environment. Subsequent state of the environment reports will assess how the environment, or elements of it, have changed over time, and the efficacy of the responses to the pressures on the environment. The next national SoE report is due in 2001, consistent with the regular reporting cycle of four to five years. In order to assess changes in the environment over time it is necessary to have indicators against which environmental performance may be reviewed. As pointed out in *Australia: State of the Environment 1996*:

"In many important areas, Australia does not have the data, the analytical tools or the scientific understanding that would allow us to say whether current patterns of change to the natural environment are sustainable. We are effectively

driving a car without an up-to-date map, so we cannot be sure where we are. Improving our view of the road ahead by enhancing the environmental data base is a very high priority. Our intended destination is a sustainable pattern of development, but it is not always clear which direction we need to take to get there”.

The development of a nationally agreed set of indicators is the next stage of the state of the environment reporting system. Environment Australia has commissioned expert reports recommending environmental indicators for inland waters (Fairweather and Napier 1998), the land (Hamblin 1998), biodiversity (Saunders *et al.* 1998), estuaries and the sea (Ward *et al.* 1998), the atmosphere (Manton and Jasper 1998), human settlements (Newton *et al.* in press), and natural and cultural heritage (Pearson *et al.* in press).

**State and Territory reporting on the state of the environment**

States and Territories also report on the state of their environments, although formal mechanisms vary between jurisdictions. Table 1 summarises approaches to state of the environment reporting in States and Territories.

Most States and Territories are developing environmental indicators to enhance reporting on the state of the environment. The Commonwealth and the States are cooperating through the Australian and New Zealand Environmental Conservation Council (ANZECC) State of the Environment Reporting Taskforce to ensure that the indicators developed in different jurisdictions are consistent.

**Table 1**

**Commonwealth and State approaches to State of the Environment Reporting in Australia**

Jurisdiction	Examples of recent reports	Scope <sup>1</sup>	Prepared by	Frequency	Legislative requirement?
Commonwealth	<i>Australia: State of the Environment 1996</i>	Comprehensive by broad environmental themes	Independent Advisory Council, reporting to the Minister for the Environment	4-5 years	No
New South Wales	<i>New South Wales: State of the Environment 1993</i> <i>New South Wales: State of the Environment 1995</i> <i>New South Wales: State of the Environment 1997</i>	Comprehensive by broad environmental themes	Environment Protection Authority	3 years	Yes
Queensland	Due 1998	Comprehensive by broad environmental themes	Department of Environment, through sectoral working groups	4 years	Yes
South Australia	<i>The State of the Environment Report for South Australia (1988)</i> <i>The State of the Environment Report for South Australia 1993</i> <i>New report due 1998</i>	Comprehensive by environmental issues. Priority issues are identified	Environment Protection Authority, Natural Resources Council, and Department of Environment, Heritage and Aboriginal Affairs	5 years	Yes

<sup>1</sup> Current scope. The scope of earlier reports may have been different.

## Environmental Indicators Local and Community Uses

Jurisdiction	Examples of recent reports	Scope <sup>1</sup>	Prepared by	Frequency	Legislative requirement?
Tasmania	<i>State of the Environment Tasmania Volume 1 - Conditions and Trends (1996)</i> <i>State of the Environment Tasmania Volume 2 - Recommendations (1997)</i>	Comprehensive by broad environmental themes, with recommendations	Resource Planning and Development Commission	5 years	Yes
Victoria		Reports on specific issues. No formal, integrated state of the environment report	Various government Departments and Statutory Authorities with responsibilities in specific areas	Varies with issue	Varies with issue
	<i>Know Your Catchments, Victoria 1997: an assessment of catchment condition using interim indicators</i>	Broad environmental themes within Catchments	Department of Natural Resources and Environment, Victorian Catchment and Land Protection Council, Victorian Environment Protection Authority		Not for the actual document, although fulfilled part of legislative requirements.
	<i>Environmental Health of Streams in the Western Port Catchment, April 1998</i>	Health of rivers and streams	Victorian Environment Protection Authority	On-going for each catchment	No
	<i>Air Monitoring Data 1992-1995</i>	Air quality	Victorian Environment Protection Authority	Annual	Yes
	<i>Victoria's Biodiversity: Directions in Management</i>	Biodiversity	Department Of Natural Resources and Environment	Once-off	Produced as part of strategy required due to legislation.
Western Australia	<i>Draft State of the Environment Report for Western Australia (1997)</i>	Priority issues	Reference group comprising representatives of relevant Government and Statutory bodies (Department of Environment Protection)	3-4 years	No
Australian Capital Territory	<i>Australian Capital Region State of the Environment Report 1997 (CD ROM only)</i>	Comprehensive by broad environmental themes, with recommendations	ACT Office of the Commissioner for the Environment	3 years (previously annual)	Yes

<sup>1</sup> Current scope. The scope of earlier reports may have been different.

### Regional environmental management

Many important decisions about the environment are made at regional (ie sub-national, generally sub-State/Territory) scales, and the 'region' has become the preferred scale for much national program delivery. This is especially so for coastal, inland water, land and biodiversity programs, reflecting the current arrangements for investing in integrated catchment management, Landcare and related programs.

Increasingly, State/Territory and Commonwealth programs expect regional organisations to nominate priorities and provide advice on their funding and implementation. For example, many of the Natural Heritage Trust programs have adopted this model, relying on the existing structures of regional assessment panels and State assessment panels.

Under current administrative and constitutional arrangements, regional environmental management in Australia is complex, involving a range of organisations, many whose focus is within the region, and some whose responsibilities extend well beyond any particular region. The latter include State/Territory and Commonwealth agencies and many industry or sector-based organisations.

In recent years new coordinating structures have emerged in additions to Local Government and State/Territory Government agencies. These organisations, such as Regional Organisations of Councils and catchment committees, are emerging as central to the development of coordinated approaches to regional environmental management and monitoring.

### Strategic planning and adaptive management

Strategic planning for environmental management is increasingly common at the local and regional scale in

Australia. The strategic planning processes currently operating in one or more regions of Australia include:

- total or integrated catchment management strategies;
- Local Agenda 21 plans;
- regional environment management strategies developed by regional organisations of councils; and
- major regional planning processes such as Far North Queensland 2010.

Most of these strategic planning processes make use of the adaptive management approach. The cornerstone of adaptive management is a recognition that people do not have full control over or understanding of their environment. Regular revision of management plans to take account of unanticipated changes in outlook or condition is therefore essential.

The adaptive management cycle is illustrated in Figure 1. Briefly, the cycle begins by setting objectives and identifying issues. The next step is setting targets which must be achieved if these objectives are to be met and issues addressed. Next, actions are taken to achieve the desired targets. A series of monitoring and evaluation steps which feed back into various stages of the management cycle follows. Feedback takes place on a variety of timescales. In the short-term, it is necessary to determine whether the agreed actions have been properly carried out. Over a longer period, it is possible to decide whether the targets are being achieved (ie whether the actual outcomes are the desired ones). Still longer time scales are required for perceived issues and objectives to change.

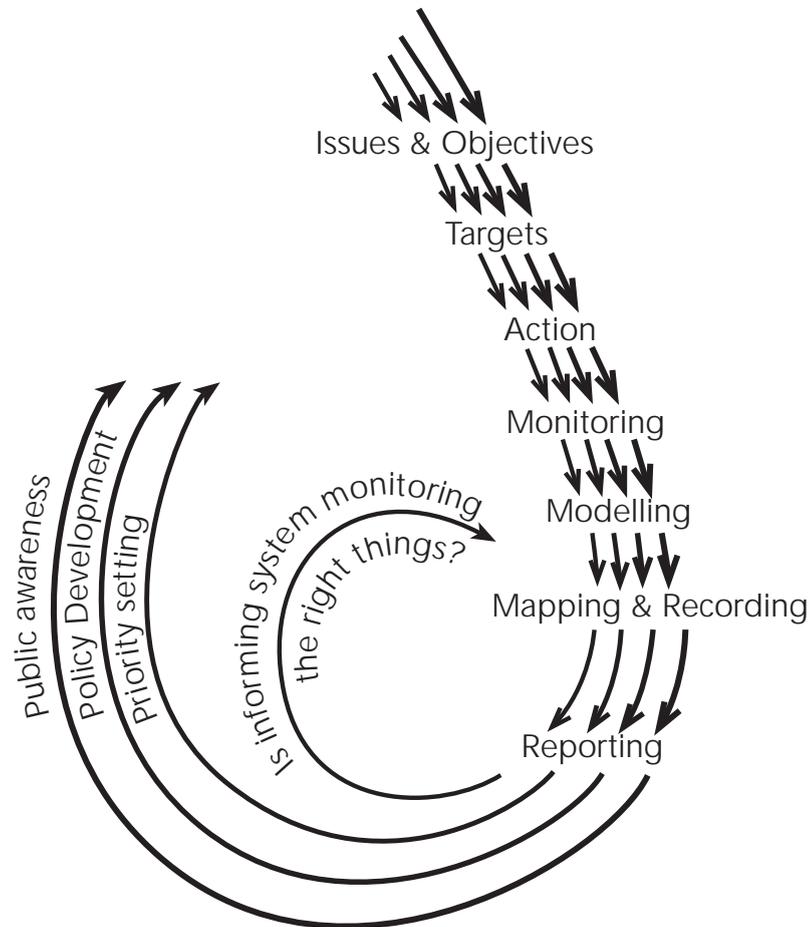


Figure 1: The adaptive management cycle (adapted from Thorman and Heath 1997)

**Information for environmental managers**

The above presentation of the adaptive management cycle emphasises the need for environmental information. In this paper (following Dovers 1996), the system for delivering information to environmental managers is referred to as an informing system. An informing system involves more than simply gathering data and making it available to decision-makers. It also includes the institutions and mechanisms for directing

the collection of data, transforming it into useful information, and making sure the decision-making process takes full account of that information.

This concept of an informing system thus involves agreement and specifications for a range of functions which go well beyond information management. Clarity in organisational roles and simple conceptual tools for adaptive management are just as important as high-tech information systems.

Early in this project the acronym SMART ACCORD was coined to describe the characteristics of a preferred system. 'SMART' refers to the criteria for choosing indicators. They should be:

**S**imple, **M**easurable, **A**chievable, **R**elevant and **T**imely.

**ACCORD** refers to the critical elements of a working partnership between the regional stakeholders in an adaptive management system. Such a system is ideally:

**A**ction-oriented, **C**onsistent, **C**ooperative, **O**pen, **R**egional and **D**ecentralised.

**A**ction-oriented – not just descriptive but focused on outcomes, including setting targets and time frames for what will be done.

**C**ooperative – involving a variety of people from across the region in the design, maintenance and support of the monitoring for management system so that it meets a range of council and community needs. This stakeholder group could contain council planners, community monitoring group members, catchment coordinators, school teachers, and corporate and agency resource managers.

**C**onsistent – agreeing on a uniform nationally consistent approach to the way data are collected and recorded so it will be simple to integrate and aggregate data from across the region and the nation.

**O**pen – ensuring equal access to information for a wide range of groups to avoid the environmental conflicts that arise when all sides don't have equal access to environmental information.

**R**egional – setting up the monitoring system so that environmental issues such as air pollution and salinity that might have their origin in one Council area and their impacts in another are jointly tackled by all the relevant agencies, industries and non-government organisations.

**D**ecentralised – using the Internet or a similarly flexible information system so that everybody can maintain

their own existing databases and yet gain access to monitoring data from a range of sources by using a common network for the common good.

### Environmental indicators

Environmental indicators enhance informing systems in two main ways. First, indicators have a well understood meaning and can be measured regularly.

Environmental indicators are physical, chemical, biological or socio-economic measures that best represent the key elements of a complex ecosystem or environmental issue. An indicator is embedded in a well-developed interpretive framework and has meaning beyond the measure it represents. Trends in the indicators are interpreted to yield valuable information about important aspects of the environment.

Second, environmental indicators can be an aid to communication. They allow information about the environment to be presented concisely. As users of information about the environment become more familiar with the agreed indicators, they can absorb this information more quickly. The efficiency of decision-making is thus enhanced.

Environmental indicators can also help focus and rationalise monitoring programmes by drawing attention to the critical measures required to evaluate environmental trends and conditions.

As noted above, environmental indicators in this project were required to be **SMART**:

**S**imple

**M**easurable

**A**ccessible

**R**eliable, and

**T**imely.

These requirements correspond to selection criteria for environmental indicators specified by Environment Australia (DEST 1994), as shown in Table 2.

**Table 2**

**The SMART filter**

Where possible, a regional state of the environment indicator should be SMART, ie,

<b>SIMPLE</b>	<b>MEASURABLE</b>	<b>ACCESSIBLE</b>	<b>RELEVANT</b>	<b>TIMELY</b>
1. easily interpreted	5. statistically verifiable, reproducible and comparable	8. regularly monitored	12. indicative of fundamental environmental function/s	17. an early warning of potential problems
2. easily monitored	6. able to be combined with others to form indices	9. currently used by public and private managers	13. related to a highly valued environmental aspect	
3. appropriate for community use	7. able to show trends over time	10. cost-effective	14. related to regional environmental policies and management goals	
4. mappable		11. consistent with other regions, States/Territory and nations	15. related to State/Territory and national environmental policies and management goals	
			16. relevant to international treaty reporting obligations	

**Accountability for environmental management**

*The Catchment Management plan provides ... clearly defined goals and objectives ... An important next step will be to begin to establish quantifiable benchmarks and targets ... Environmental indicators can then assist in measuring the environmental performance of the region, if each indicator has an agreed baseline level, agreed acceptable target level and an agreed unacceptable level where intervention may be needed (Stephenson EMF Consultants 1997).*

*Local Authorities play a vital role in drawing the community attention to environmental indicators. The first step would be for LGAs to start to use indicators and report on them in their annual reports. This would be valuable in assisting the development of an Agenda 21 style of local authority management (Galloway 1997).*

*Local government should select indicators for use in monitoring progress towards their goals as stated in their new Municipal Strategy Statements. The use of such indicators will allow LGAs to report consistently to their constituents on their performance in achieving their Municipal Strategy goals or the success of their Planning Schemes in generating desired outcomes. A regional system would enable Councils to monitor their own performance against comparable rural councils (Lewis 1997).*

There is increasing pressure for organisations with environmental management responsibilities - whether Local Government Authorities, catchment committees or private sector organisations - to be accountable for their performance. The public and funding agencies are seeking accountability for:

- how money is spent and the outcomes or results achieved
- how effectively other policy instruments such as planning and approvals processes are used to protect or enhance the environment
- evaluating claims to good environmental management.

The recent Australian National Audit Office report on Landcare programs called for a greater focus on outcomes (1997). The public has a right to expect the same efficient management from environmental programs as from other publicly funded expenditure. The public also increasingly expects governments to use a range of powers and instruments to protect the environment.

Measuring environmental outcomes is difficult due to the complexity of ecological relationships. But this complexity should not be an excuse for not monitoring outcomes. This project consistently identified the benefits of using agreed indicators to measure and report on the environmental performance of organisations.

Many local and regional organisations in both the public and private sector are recognising the value of monitoring indicators in order to record and report on environmental management efforts and progress. In several regions there is an emerging recognition that the use of environmental indicators to measure performance is simply good practice.

There is an opportunity for organisations with environmental management responsibilities to develop, monitor and report on a range of indicators in order to measure their performance against their stated strategic goals, where possible using nationally recognised indicators so that the information generated might be used for state of the environment reporting purposes.

### The condition-pressure-response framework

Frameworks are important for organising and presenting information and defining the range of issues

to be considered. They are less important for selecting indicators. Indicators are chosen on the basis of the best available scientific understanding, and can be placed in a number of alternative frameworks to present and organise information.

The condition-pressure-response framework is used for state of the environment reporting in most Australian jurisdictions. The condition-pressure-response framework was originally developed by the Organization for Economic Cooperation and Development (OECD), and has been widely adopted in a modified form by OECD countries and a wide range of other organisations. The condition-pressure-response framework is sometimes also referred to as the pressure-state-response framework.

The condition-pressure-response framework organises information into three broad categories.

- Information about the *condition* of the environment. That is, the quality of the environment and the functioning of important environmental processes.
- Information about human activities that affect the environment. These are called *pressures*. Pressures do not necessarily imply harm, especially if the activity is appropriately managed.
- Information about human efforts to address environmental issues. These are called *responses*.

There are relationships between human activities ("pressures") and the condition of the environment. However, these relationships can be complex and the condition of the environment typically depends upon a wide range of natural as well as human factors. Dryland salinity, while a relatively straightforward example, illustrates this. In some places people have cleared deep rooted vegetation (a pressure). As a result, water is no longer "pumped" from the ground effectively and the level of groundwater rises. These groundwaters are often salty, and when they reach the surface the land also becomes salty (a condition). At the same time, much land is naturally salt affected, so not all dryland salinity is due to human activity. In addition, there can be a delay of several decades between clearing deep-rooted vegetation and the onset of dryland salinity.

Although developed for use within the adaptive management framework, the indicators in this report have also been classified as condition, pressure or response indicators in order to demonstrate how they can be used for reporting on the state of the environment using the condition-pressure-response framework.

## SELECTING PILOT REGIONS

### How pilot regions were selected

Six pilot regions were selected for this study. The project was carried out in association with the Australian Local Government Association, which was closely involved in choosing pilot regions.

The criteria used to select pilot regions were:

- National spread — one pilot region in each State;
- Variations in institutional arrangement. For example, Local Government Authorities, Regional Organisations of Councils, catchment committees;
- Variations in biophysical conditions and environmental issues. For example, different IBRA regions or climatic zones;
- Sufficient scale (size) to address environmental issues; and
- Environmental features or resources of State or national significance.

Each pilot region was required to demonstrate:

- a cash or in kind contribution to the project;
- an involvement in state of the environment reporting, a regional environmental strategy, or some similar process, for example, a catchment strategy;
- a record of ongoing natural resource and environmental management;
- an interest in the use of environmental performance monitoring,
- current or potential involvement in community environmental monitoring; and
- availability of information suitable for or currently used for state of the environment reporting.

The following principles and assumptions underpinned the operations of the pilot projects.

- Environmental reporting should describe progress towards sustainability as defined in local, regional, national or international policies and plans;

- Information derived from indicators should be reliable and readily understood so that managers can adapt their management strategies in the light of experience;
- Information held by central agencies should be made available to communities in user-friendly formats to support informed natural resource management;
- The condition-pressure-response model should be adapted to the decision-making structures, environmental priorities and community needs of each region, without losing sight of the need for a nationally consistent approach; and
- The project should make a practical contribution to solving environmental problems by addressing pressing issues and linking monitoring to management outcomes.

### Working with pilot regions

A consultative approach was adopted throughout this project. In each pilot region, a consultant was appointed, through the relevant local government or regional grouping of local governments, to work with local stakeholders. Each regional consultant prepared a report on the project in his or her region. This paper draws upon those reports.

In addition to face to face meetings with key stakeholders, a number of public meetings were held to discuss issues raised throughout the project.

The project was conducted in two phases.

The first phase, from March to October 1996 involved three pilot regions and concentrated on identifying indicators of value to regional environmental managers and links between these and indicators used for national and State state of the environment reporting.

The second phase, from December 1996 to September 1997, expanded the project to include a total of six pilot regions. As well as identifying indicators, efforts were made to find suitable sources of data for the indicators and show how the indicators could be used by environmental managers.

As might be expected, indicators were generally more developed in regions that participated in both phases of the project. In addition to the extra time and resources available to develop indicators, involvement in both phases enabled regions to become familiar with

the use of indicators. The condition-pressure-response model, was also initially unfamiliar.

The three pilot regions involved in the first phase of the project were:

- South-west Western Australia;
- Southern Region of Councils, South Australia; and
- Far North Queensland.

The three additional regions involved in the second phase of the project were:

- Gippsland, Victoria,
- Huon Valley, Tasmania, and
- Lower Hunter and Central Coast, NSW.

Table 3 summarises the approach to consultation within each region.

**Table 3**

**Stakeholder involvement in indicator selection in the pilot regions**

Pilot region	Stakeholder involvement
South-west Western Australia	Phase 1: Three workshops targeting management and community groups. Phase 2: Agency briefing, community briefing and three workshops targeting management groups
Southern Region of Councils, SA	Phase 1: Discussion paper, followed by a large regional workshop conducted as part of the regional environmental strategy development programme Phase 2: Discussion paper, followed by a large regional workshop, followed by consultations with regional environmental strategy steering committee
Far North Queensland	Phase 1: Discussion paper, followed by large regional workshop targeting managers and the community Phase 2: Questionnaire, desktop study and telephone follow-up
Lower Hunter and Central Coast, NSW	Several regional workshops and liaison with the regional environmental management strategy and state of the environment steering committees
Gippsland, Vic	Discussion paper, followed by two regional workshops, and circulation of draft report to all participants
Huon Valley, Tas	Discussion paper followed by regional workshop followed by a follow-up questionnaire

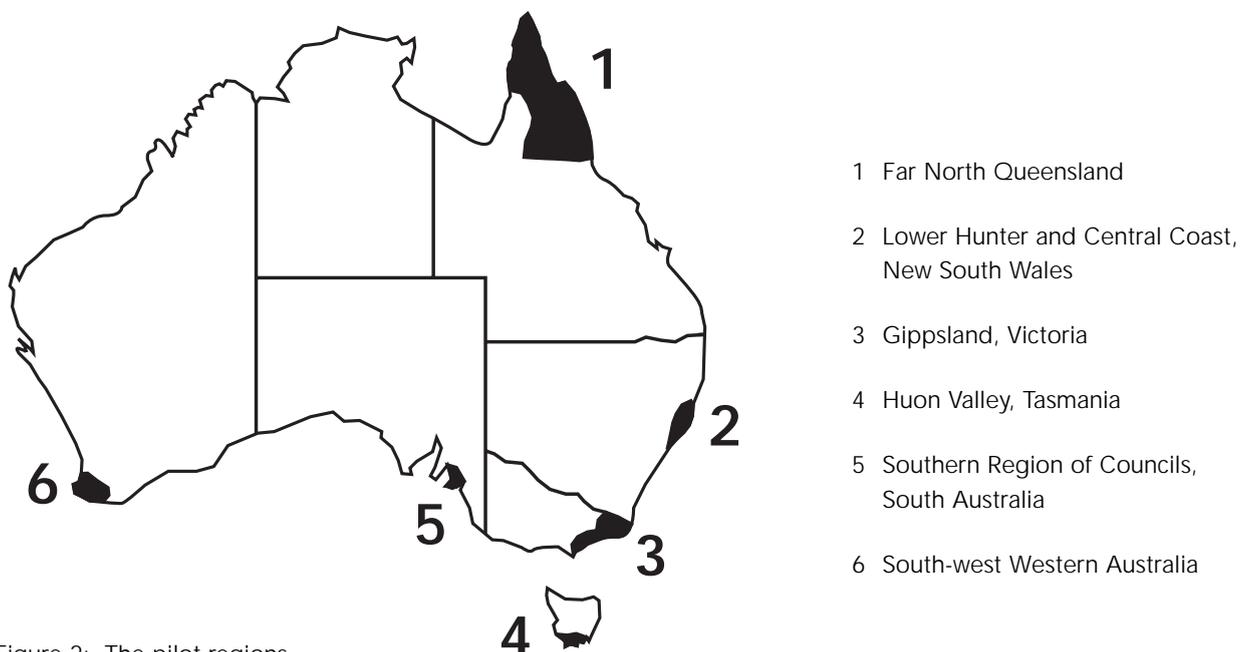


Figure 2: The pilot regions

### SOUTH-WEST WESTERN AUSTRALIA

#### General description of the region

This region comprises 12 local authorities, linked together in the voluntary South-West Local Government Association (SWLGA).

The region covers 24,087 square kilometres in the extreme south-west of the State. The regional population of about 112,000 is boosted during the tourist seasons as the region is the State's premier tourism and recreation destination, attracting about 1.5 million visitors per year.

#### The economic base

The region is the State's green belt (high rainfall), and has a diverse economic base, including tourism, forestry, mining, agriculture, fishing and manufacturing, and contributes some \$3.2 billion to the State economy.

#### State and local planning and management arrangements

Regional planning falls into two categories. For urban issues or specific projects with statutory significance, the Ministry for Planning and the local authorities administer the planning process. For broad-scale natural resource management outside the Department of Conservation and Land Management estate, planning is coordinated by the catchment coordinating groups, with advice from AgWA. Management tends to follow a similar pattern. In urban areas local authorities have most management responsibilities. In agricultural areas land owners are the primary managers, with some coordination by catchment coordinating groups and the Land Conservation District Committees.

#### The environment

Roughly 60% of the region is covered with native vegetation. However, this is not evenly distributed across all the bioregions. There are also areas of considerable degradation. It is estimated that the Swan Coastal Plain has only 5% of its original vegetation. In addition, most of the major river flood plains and wetlands outside State forest are severely compromised by clearing for agriculture and urban development. Two major rivers, the Blackwood and the Warren, have their catchments partly outside the region, and suffer salination and nutrient enrichment.

#### Regional environmental initiatives

Most of the region's abundant natural resources are still in good condition, and there is community-wide support for the concept of sustainable development, as well as some excellent working examples and policy initiatives.

### SOUTHERN REGION OF COUNCILS, SOUTH AUSTRALIA

#### General description of the region

The Southern Region of Councils comprised five councils: the Brighton, Happy Valley, Marion, Noarlunga and Willunga. The region is located in the southern area of Adelaide and covers 680 square kilometres. The rapidly growing regional population of 240,000 is projected to rise to 300,000 by the year 2011.

#### The economic base

About a third of the region is urban. Urban industries include light and heavy manufacturing, petroleum refining, housing, construction, and tourism. Rural industries include grape and almond production, dairy farming and mixed small holdings.

#### State and local planning and management arrangements

Local Government makes the great majority of planning decisions, and these must conform with Council development plans, under the *Development Act 1993*. The State may overrule a Local Government decision, set up new planning rules for a large development, or influence Local Government decisions through a number of financial incentives. State strategic plans provide the framework into which Council development plans fit. Additionally, the Minister for Planning may declare a statewide Plan Amendment Report, to which all Councils must conform as they revise (each three years) their development plans. A development which the Minister deems to warrant an environmental impact assessment is moved into a planning decision process run by the State.

While Local Government makes many small planning decisions, its development plan is always within the context of many medium to large scale actions by the State Government. Thus the decision to construct the Southern Freeway was made in 1994 with limited consultation with southern Councils, even though this

may be the most significant planning decision for the region for some years. When Councils act as environmental managers, they do so side by side with several State agencies and the resulting problems of integration are well known. This problem of integration is especially marked at the coast, where a dozen State agencies have overlapping powers. Any one part of the region may be affected by a number of strategies which are not necessarily coordinated; as a result, the difficult task of carrying through a long-term strategy is rarely achieved, as plans may be overtaken by later plans before they have been implemented.

#### **The environment**

There are a number of areas of environmental significance. These include Adelaide's best beaches; the Willunga Basin; Aldinga Scrub and Washpool Lagoon; Hallett Cove Conservation Park; Aldinga and Port Noarlunga Reefs, both of which are aquatic reserves. There are also some important Aboriginal heritage sites.

#### **Regional environmental initiatives**

The Southern Region of Councils developed a Regional Environmental Strategy (RES) in 1996 and a Regional Environment Project Officer was appointed to coordinate its implementation. The implementation phase will coincide with Council amalgamations and establishment of a Catchment Management Board in the region. It was closely related to Phase 2 of this project.

### **FAR NORTH QUEENSLAND**

#### **General description of the region**

The region includes the Councils of Atherton, Cairns, Cardwell, Douglas, Eacham and Johnstone; and part of Herberton and Mareeba.

In 1995 the region's population was about 185,000, and this is projected to increase to about 290,000 over the next 20 years. Most live on the coastal plain, with Cairns (population 105,000) the main urban centre. The average number of visitors per day is expected to increase from around 27,000 at present to between 50,000 and 70,000 over the next 20 years.

#### **The economic base**

The region's natural resources such as land, water, forests, minerals and fisheries are an important

component of both the vibrant regional economy and the natural environment. The substantial areas of good quality agricultural land support a range of agricultural and horticultural industries (predominantly sugar cane on the coast, beef cattle to the west and intensive irrigation on the tablelands).

Urban growth, including rural residential development, is placing considerable pressure on agricultural land and farming industries through loss of land, fragmentation of farm holdings and the introduction of incompatible urban land uses in rural areas.

#### **State and local planning and management arrangements**

Each Local Government has a planning scheme. The two World Heritage Areas are managed by the Wet Tropics World Heritage Area and the Great Barrier Reef Marine Park Authority. The State and Local Governments have established a Far North Queensland Regional Planning Advisory Committee to develop a series of urban growth, environment, transport, economic, social, natural resource and tourism management strategies.

#### **The environment**

The region contains two World Heritage Areas: the Wet Tropics and the Great Barrier Reef.

The region's water resources are used to meet a number of demands including irrigation, urban supplies, power generation, recreation and ecological processes. The region's coastal waters and wetlands play an important role in providing habitat for marine life, which supports important recreational and commercial fishing and marine-based industries.

#### **State and regional environmental initiatives**

Each Council has a planning scheme which includes a strategic plan, zoning scheme and development control plans for particular precincts/issues. The two World Heritage Areas are managed by independent statutory authorities: the Wet Tropics World Heritage Area and the Great Barrier Reef Marine Park Authority. There is a statutory zoning plan for the Marine Park, and a management plan for the Wet Tropics is currently being finalised.

The State and Local Governments have established a Far North Queensland Regional Planning Advisory Committee to develop the FNQ 2010 series of

strategies. These focus on urban growth, environment, transport, economic issues, social issues, natural issues and tourism management.

### GIPPSLAND, VICTORIA

#### General description of the region

Gippsland is located in south-east Victoria and has an area of almost 41,000 square kilometres. It has a population of 216,500 and encompasses five sub-regions and associated municipalities. These are: East Gippsland, Central Gippsland (Wellington Shire), the Latrobe Valley (Latrobe Shire), South Gippsland and West Gippsland (Baw Baw Shire). Gippsland has a well-developed network of cities and towns, ranging in size up to 20,000 people.

#### The economic base

While the five sub-regions all have a distinct sub-regional economy, overall Gippsland is characterised by a number of key industries including: agriculture (particularly dairy, beef, sheep and horticulture), silviculture (forests and processing), energy (coal mining, electricity generation, offshore oil and gas production), engineering, tourism, fishing and aquaculture, and information processing. Most of these industries draw directly on natural resources.

#### State and local planning and management arrangements

In Victoria there are two principal State agencies responsible for natural resources and environmental management – the Department of Natural Resources and Environment and the Environment Protection Authority. The government has also established regional Catchment and Land Protection Boards to advise and coordinate catchment management activities. Under the recent Coastal Management Act, Victoria has three Regional Coastal Boards to act as the lead agency coordinating planning and management of the coastal zone. Within the region there is a network of Waterway Authorities that are being restructured with the Catchment and Land Protection Boards to form part of the new catchment management authorities.

The Environment Protection Authority is the primary regulatory body in relation to environmental controls on industry, monitoring discharges, water quality and pollution.

Gippsland has five regional municipalities – Baw Baw Shire, East Gippsland Shire, Latrobe Shire, South Gippsland Shire and Wellington Shire. In Victoria, Local Government has no statutory responsibility to report on environmental issues. Local Government, however, does have a strong interest in sustainable environmental management and developing means to improve their environmental accountability.

Gippsland Development Ltd, the regional development organisation established in conjunction with the five shires, has a commitment to sustainable development and environmental enhancement through the protection and maintenance of the region's natural ecosystems. A regional development strategy has been developed and adopted by the five regional shires. Although this strategy focuses on economic development, it sets this within an ecologically sustainable development context. Re-organisation of management agencies in Victoria continues, with the overall trend being towards amalgamation in all sectors. This restructuring is having and will continue to have a significant impact on management responsibilities within the region. In principle, this trend towards amalgamation should improve coordination and accountability, and result in a more systematic approach to environmental management in the region.

The opportunity exists to bring the numerous monitoring programs together in a more coordinated and systematic framework which will assist in interpreting and reporting. This relies on establishing which organisation(s) is the lead agency for each of the seven state of the environment themes. At present, the respective roles and responsibilities of the organisations involved in environmental monitoring and management are not clear, nor is it clear how these organisations relate and report to one another. The new catchment management authorities will undertake state of the environment reporting annually, covering the three state of the environment themes of the land, inland waters and biodiversity, and will play a leading role in developing a more coordinated and systematic framework for environmental monitoring and reporting in the region.

#### The environment

Gippsland has a diverse landscape and an abundance of natural resources and areas of environmental significance. It is nationally and internationally renowned for its natural features and hosts a number of Victoria's finest natural reserves, parks and waterways.

These include Ramsar designated wetlands, extensive native forests, Gippsland Lakes and coastline, and a large number of national parks, including Victoria's most well-known, Wilson's Promontory.

### Regional environmental initiatives

Gippsland Development Ltd was established to coordinate strategic development within the region, in conjunction with the five local Shires.

A range of organisations and community groups are involved in environmental management and monitoring within the region. This project built on actions of government, water authorities, CALP Boards, industry and community groups (particularly Waterwatch and Landcare), and helped develop a more integrated, cooperative approach to environmental management. Developing appropriate environmental indicators, to help monitor environmental conditions, is essential.

## HUON VALLEY, TASMANIA

### General description of the region

The Huon Valley Council area is the southern-most municipality in Australia. It incorporates Macquarie Island and a large portion of the south-west World Heritage Area. It covers 5,620 square kilometres, with most of its population located in the east.

The estimated population is 12,850 (1991 Census). The major population centres are Huonville, Cygnet, Geeveston and Dover. The Huon Valley consists of a number of close-knit communities, each with a strong sense of identity. The natural environment, rural setting and quality of life are major attractions.

### The economic base

The major industries are forestry, fishing, apples, wines, beef cattle, organic products and veneers. However, over 40% of employed persons commute to work outside the region, in the Kingborough and Hobart regions.

### State and local planning and management arrangements

In addition to the formal statutory arrangements, the Huon Valley Council has developed a specific integrated catchment management structure to deal with environmental issues. This structure has since

broadened to encompass the implementation of *Agenda 21*. This structure has significant implications for the environmental indicators project.

Note that Huon Valley is the only pilot region which did not involve more than one Local Government Authority.

### The environment

The Huon Valley is located 40 kilometres south of Hobart and is bounded to the north by the Wellington Ranges. The partially cleared hills and coastal plains around the D'Entrecasteaux Channel are a significant feature of the landscape. The D'Entrecasteaux Channel is Tasmania's largest sheltered waterway and both the river and channel provide many sheltered bays and navigable waters for recreational activities.

### Regional environmental initiatives

The area is geographically diverse and includes wilderness, button grass plains, tall eucalyptus forest, drowned river valleys, glacial landforms, gorges, ravines, coastal heath lands and lagoons.

The State Government has implemented an integrated planning and environmental management system, the Resource Management and Planning System, within which municipal areas operate. Huon Valley Council has developed and is responsible for implementing the Huon Valley Planning Scheme.

## LOWER HUNTER AND CENTRAL COAST, NEW SOUTH WALES

### General description of the region

This region is located on the east coast of NSW immediately north of Sydney. It covers an area of 6,142 square kilometres within the Council areas of Lake Macquarie, Newcastle, Port Stephens, Maitland, Cessnock (all in Lower Hunter region), Wyong and Gosford (both in Central Coast region).

The area's population of about 810,000 (1995) is growing strongly, due to urban expansion in Sydney.

### The economic base

There are a wide range of land uses, including extensive urban and industrial development, intensive agriculture, grazing, forestry, coal mining and gravel extraction, conservation reserves, electricity generation and tourism.

### State and local planning and management arrangements

There are a large number of planning controls and management initiatives within the regions, both at Local Government and regional levels. All Councils have local environmental plans which provide the main framework for the regulation of land use. A range of additional regional planning strategies are being prepared, but these are not linked well with local Council initiatives.

Local Government Authorities in New South Wales are required to produce annual state of the environment reports. The requirements for these reports are identified in the Local Government Act 1993. The reports primarily relate to physical environmental conditions rather than evaluating the environmental planning framework or the causes of environmental issues. Local state of the environment reports are produced concurrently with Local Government management plans, with the objective of integrating environmental reporting and management.

The only comprehensive environmental strategy prepared for the region to date has been the Lower Hunter and Central Regional Environmental Management Strategy (REMS). This was developed by regional Councils, with extensive stakeholder consultation. The strategy seeks to provide a coordinated environmental management framework for the Councils within the region. One of the priorities of the strategy is to develop regional environmental information and management systems. A regional state of the environment working group has been established and is responsible for developing more consistent approaches to state of the environment reporting and identifying relevant local and regional indicators. REMS has been responsible for preparing two regional state of the environment reports, which have been extremely limited because of lack of resources and focus. One of the recent initiatives of the REMS is a report on a framework for the preparing regional state of the environment reports which seeks to address this issue and proposes an integrated structure for local and regional state of the environment reporting using environmental indicators.

Apart from the current indicators project, regional initiatives being coordinated by REMS are a regional biodiversity conservation strategy, a Council energy reduction program, and a consistent regional policy and code for erosion and sediment control.

There are other regional organisations such as the Regional Organisations of Councils and regional development organisations which are increasingly recognising the importance of developing a regional focus and integrating environmental goals with social and economic planning.

Overall, there is a lack of definable environmental targets within the region. One of the clear benefits of this project was to highlight that if targets are to be set and achieved, then there must be measurable indicators to assess their implementation.

### The environment

The landscape varies from coastal mountains and steep valleys to gently undulating slopes, alluvial plains, large coastal lakes and estuaries, dune and beach systems and rocky headlands.

The Lower Hunter is a sub-region of the Hunter Region which comprises most of the Hunter River Water Catchment. The Central Coast's water catchment areas flow to the sea and the Hawkesbury-Nepean River system.

### Regional environmental initiatives

The Lower Hunter and Central Regional Environmental Management Strategy provides a coordinated environmental management framework for the Councils within the regions.

## COMMUNICATING REGIONS

In addition to the six pilot regions, links were established with a range of other regions in Australia which have been developing or using environmental indicators. The 'communicating regions' included:

- Brisbane City Council
- The Hawkesbury-Nepean Catchment Management Trust
- The Australian Capital Territory State of the Environment Unit
- Gold Coast Council
- Sydney Coastal Councils
- Melbourne City Council.

## Regional institutions in transition

At the time of initiating Phase 2 of the project, two of the pilot regions were experiencing the effects of council amalgamations, which had only recently been completed in Victoria and were current in South Australia.

Given the inevitability of changing administrative structures and the uncertainty and disruption to management and information systems which can result, the issues involved with indicator development in the context of ongoing institutional change were explored.

Two important observations were made:

1. robust indicators and monitoring processes must be able to survive institutional transition and the associated disruption
2. it is critical for the maintenance of long-term data sets that the information generated from monitoring in the past is not lost in the process of institutional reform.

The restructuring of agencies can result in the loss of corporate memory or data sets. Performance indicators for a particular organisation are usually focused on the short to medium term and may be of no further use to the organisation after that time. However, these data may be an invaluable part of a suite of regional response indicators needed to determine long-term trends in the condition of the regional environment.

In addition to council amalgamations, the recent Water Resources Act had a similar impact in South Australia:

*The Onkaparinga Catchment Board will be a significant organisation for all of the region except the small area draining to the Sturt Creek in the north ... The Water Resources Act of April 1997 will*

*transfer a number of significant drainage powers from Councils to Catchment Boards ... the Onkaparinga Catchment Board set up under the Act will make decisions with reference to the whole of the catchment area, a situation not previously existing (Caton & Moyle 1997).*

In the Gippsland region the positive side of the amalgamation processes and establishing the Catchment Management Authorities (CMAs) was noted:

*It is anticipated that the formation of CMAs will result in a more defined framework of the roles and responsibilities within the region in relation to land and water management, with the CMA becoming the lead agency in the region. The CMAs should improve coordination in relation to monitoring and reporting activities, and assist in developing a more integrated and systematic framework for environmental management in Victoria.*

*The new ... Catchment Management Authorities will be the peak body for integrated land and water management in the region and will be responsible for:*

- *the development, ongoing review and coordination or implementation of Regional Catchment Strategies (RCSs);*
- *the provision of advice to Government on both Commonwealth and State resourcing priorities at a regional level;*
- *the provision of waterway and floodplain-related service delivery; and*
- *the negotiation with Natural Resources and Environment (NRE) of an annual project-based works program for regional service delivery which is in line with the implementation of the RCSs (Lewis 1997).*

## SELECTING ENVIRONMENTAL INDICATORS

### Fitting indicators to strategic planning and the adaptive management cycle

Throughout this project, the process of selecting indicators was linked to existing regional strategies and plans already endorsed for the regions. Most Local Governments, community groups and regional organisations are familiar with strategic planning, based on issue identification, development of objectives and action plans etc, but few are familiar with the use of environmental indicators and their relevance to implementing environmental strategies.

Developing links between the indicators used for state of the environment reporting and indicators useful to regional environmental managers was an important aim of this project. Accordingly, an effort was made to relate the condition-pressure-response framework used in state of the environment reporting to strategic planning and adaptive management. Similarly, indicators were classified as condition, pressure or response indicators. Using this scheme had some advantages (see below), but the indicators themselves can be used independently of the condition-pressure-response framework.

For the purposes of this project a 'monitoring for management matrix' which incorporates the condition-pressure-response model into an adaptive management framework was developed. This places the condition-pressure-response model within the more familiar strategic planning approach based on objectives, actions and targets (Thorman & Heath 1997). It introduces a systematic approach to informing these strategies, allowing for strategic interventions (actions) to be tested and refined through observation.

Incorporating the analytic tools and monitoring programs inherent in the condition-pressure-response model will assist in the ongoing refinement of regional strategies. The adapted model embeds the reflective and accountability processes of condition-pressure-response monitoring and may therefore provide a useful discipline to catchment and regional environmental strategy plans, complementing an increasingly strong emphasis on on-ground action.

An example of the use of this 'blended model' is reproduced in Table 4. It draws on the work of Caton and Moyle, who refined the use of the model and adapted it slightly to suit their needs in the Southern Region of Councils pilot.

**Table 4**

**Monitoring and management matrix incorporating the condition-pressure-response model, examples from the Southern Region of Councils, SA**

<i>The nature of the issue (following the regional environmental strategy)</i>	<i>The cause of the issue, noting the indicator</i>	<i>The current condition of the environment, noting the indicator</i>	<i>The objective for the issue, as outlined in the regional strategy</i>	<i>A reasonable target within your overall objective; quantified if possible</i>	<i>Actions to meet this target</i>	<i>The measures which show you are carrying out appropriate processes to address the issue</i>
<b>KEY ISSUE</b>	<b>CAUSE OF THE ISSUE (pressure indicator)</b>	<b>CURRENT CONDITION AND TREND (condition indicator)</b>	<b>OBJECTIVE/ GOAL</b>	<b>TARGET</b>	<b>STRATEGIES AND ACTIONS</b>	<b>PROCESS (response indicator)</b>
Examples:						
Depletion of groundwater	Pumping for irrigation of vines and other crops (Quantity of water pumped from aquifer)	Water tables in the Vale of Willunga are lowering and becoming salinised at their seaward end (Water table depth and salinity)	Restoration of groundwater levels and lowering of salinity levels	Restoration of level and quality to 1970 level (start of record) by 2005	<ul style="list-style-type: none"> <li>• Limit pumping through the license system</li> <li>• Aquifer re-charge through local recycling and re-use</li> </ul>	<ul style="list-style-type: none"> <li>• Number of licenses issued</li> <li>• Number of schemes of water recycling which affect the aquifer</li> </ul>
Extend open space in selected key areas	Loss of open space to competing uses (population numbers)	Incremental losses, especially in coastal areas (% area open space)	Extension of open space to Metropolitan Open Space Scheme concept	Reverse current trend of loss by 2005	<ul style="list-style-type: none"> <li>• Establish land acquisition within Metropolitan Open Space Scheme zones as Council policy</li> <li>• Recognise this policy on planning documents</li> </ul>	<ul style="list-style-type: none"> <li>• Number of Councils within the region adopting this policy</li> </ul>

## Strategies and objectives

The first step in selecting environmental indicators appropriate to the needs of regional environmental managers was to analyse the various environmental strategies applying to each region. In each pilot region strategies related to the environment were in place or under development. These existing processes were not duplicated, but complemented by a focus on the indicators and monitoring strategies needed to support these 'mandates for action'.

Australia has many national and regional ecologically sustainable development policies and strategies. Being able to document the relationships between these broad policies and their regional implementation is central to environmental reporting, for both accountability and management purposes.

In each region, the project identified:

- the relevant regional, State or national policies and plans which provide the mandate, framework or foundation for regional environmental management
- key organisations involved in environmental management or monitoring
- any relevant environmental targets or goals, and
- any relevant benchmarks, baseline studies or monitoring programs.

### Box 1

#### International agreements affecting Gippsland

**Ramsar listed wetlands** – Corner Inlet, the Gippsland Lakes, Clydebank Morass, Sale Common, Dowd Morass and Heart Morass – and two treaties, the Japanese and Chinese Migratory Bird Agreements.

**The International Climate Change Convention** – as the region is Victoria's major electricity generator, a regional approach to meeting the greenhouse challenge is being developed.

**The International Biodiversity Convention** has implications for forest management and the management of rare and threatened species on both public and private land; and biodiversity commitments and those arising from the Montreal Process for monitoring forest management are being met through the Regional Forest Agreements, and the ongoing assessment of the adequacy of the reserve systems.

Source: Lewis 1997

## NATIONAL STRATEGIES AND POLICIES

Within any region, decisions made at a range of scales (from individual to global) affect the environment. State, national and global policies, agreements and treaties have local or regional manifestations. For example, each pilot region has specific environmental features (wetlands, forests or World Heritage Areas) or processes (greenhouse gas emissions, biodiversity conservation) which are the subject of national or international agreements.

Thus, in a fairly direct way, local management is influenced and constrained by wider spheres of activity and political responsibilities, yet the links between the national and State policies and their regional interpretation and implementation are not always direct nor the relationships clear. Nor is it necessarily easy to determine how these policies are integrated at the regional scale, nor how their effectiveness is to be monitored or reported. This has a major bearing on the selection and application of indicators.

If national or international policies are to be effective, they need to be supported by complementary regional strategies. All of the pilot regions are affected by these wider policies, both directly and indirectly. Far North Queensland has two World Heritage Areas and the Lower Hunter and Central Coast region of New South Wales is one of Australia's major electricity and coal exporting regions. Box 1 lists international agreements affecting the Gippsland region.

STATE STRATEGIES AND POLICIES

In addition to those environmental management obligations directed by national policies or international agreements, most regions have a suite of State strategies which cover various aspects of environmental management in their regions. For example, Boxes 2 and 3 list the State policies and strategies affecting Gippsland and South-west Western Australia respectively. In some circumstances, decisions by State/Territory Governments to proceed with developments, such as freeways or urban expansion, are the major determinants of environmental management in the region.

**Box 2**

**Environmental management strategies and plans affecting Gippsland**

East Gippsland Forest Agreement (1997), Department of Natural Resources and Environment (DNRE)

Gippsland Lakes Management Plan (1991), Former, Victorian Department of Conservation and Environment (DCE)

State Environment Protection Policy (1988), Environment Protection Authority (EPA)

Draft Victorian Coastal Strategy (1996), Victorian Coastal Council

Regional Catchment Strategy (1997), East Gippsland Regional Catchment and Land Protection Boards (Vic) (CALP Board)

Regional Catchment Strategy (1997), West Gippsland Regional CALP Board

Gippsland Region: Regional Development Strategy (1996), Gippsland Development Ltd

Protecting Water Quality in Central Gippsland (1996), EPA

Working Together to Protect Water Quality in Gippsland (1992), EPA

Central Gippsland Water Quality Management Strategy (1995), West Gippsland Regional CALP Board

Forest Management Plans, eg, East Gippsland Forest Management Plans (1995), Tambo Forest Management Plan, DNRE

River Management Authorities Strategies, River Management Authorities

Gippsland Lakes Fisheries Management Plan (1995), former Victorian Department of Conservation and Natural Resources (DCNR)

Gippsland Regional Landcare Plan (1993), DCNR

Lake Wellington Catchment Salinity Management Plan (1991), DCE

Gippsland Lakes Strategy (1990), Victorian Department of Planning and Housing (DPH)

Victorian Land Conservation Council (LCC) Reports South Gippsland: Gippsland Lakes Hinterland, LCC

Individual shire strategies, eg, Wellington Shire Strategy Plan (1996), Wellington Shire, East Gippsland Planning & Development Strategy (Draft) (1997), East Gippsland Shire

**Box 3**

**Environmental management strategies and plans affecting South-west Western Australia**

**Atmosphere**

Revised Greenhouse Strategy for WA, 1994, Greenhouse Coordination Council

Local Government and the Greenhouse Effect, undated, Greenhouse Coordination Council and the WA Municipal Association *Environmental Protection Act 1986*, Department of Environmental Protection (DEP)

Smoke Control Guidelines: Guidelines of the control of smoke for development sites, 1994, DEP

Air quality guidelines: A discussion paper on ambient air quality guidelines for WA, 1993, EPA

**Biodiversity**

A Nature Conservation Strategy for WA, 1992 (draft) Conservation and Land Management (CALM)

Agriculture and Related Resources Protection Act, *Conservation and Land Management Act 1986*, Forest Region Management Plans, 1987, CALM

Impact and control of feral animals in south-WA, 1993, Siewert R, Robinson N & Horwitz P Leeuwin Naturaliste Ridge Statement of Planning Policy (draft), May 1997

Management Strategies for the South West Forests of WA, 1992 (draft) Conservation and Land Management (CALM)

Memorandum of Understanding between the Commissioner for Soil and Land Conservation, EPA, DEP, AgWA, CALM & WRC, 1997

Review of Dieback in WA, Volume 1 – Report and Recommendations, Report to the WA Minister for the Environment, Podger FD, James SH & Mulcahy MJ, October 1996

Review of the Department of Conservation and Land Management Prescribed Burning Policy and Practices and Wildfire Threat Analysis, Lewis AA, Cheney P & Bell D, March 1994

South West Strategy, 1994, SWDC

**Estuaries and the sea**

EPA guidelines for an environmental protection policy on the coastal zone in WA: Working draft, 1978

State Planning Strategy, November 1996

WAPC *Environmental Protection Act 1986*

Streamlining – An environmentally sustainable drainage network for the Swan Coastal Plain, Department of Agriculture, 1994, Heady G & Guise

EPA, Western Australian Water Quality Guidelines for Fresh and Marine Waters, EPA Bulletin 711, 1993

The Environmental condition of the Vasse Wonnerup wetland system and a discussion of management options, 1989, EPA Technical Series No. 31

Coastal Management Review Committee, 1995, Final Report of the Review of Coastal Management – WA

South West Environmental Strategy, February 1997, SW(WA)LGA

A representative marine reserve system for WA, June 1994, CALM

**Human settlements**

State Planning Strategy, 1996, Ministry for Planning

Protection of the Groundwater, Wetlands and Associated Ecosystems of the Swan Coastal Plain, A Public Discussion Paper, 1990

EPA State Water Planning, 1989

Groundwater Resources Assessment in WA, a strategy for the future, Western Australian Water Resources Council

Austroroads Environmental Strategy, 1994, Roads 2040: South West Regional Road Development Strategy (draft), Main Roads Department

Urban Rail South West Corridor: Proceedings of a seminar held at Fremantle WA on 1 September 1992, Department of Planning and Urban Development 1993

Southern Province Transport Strategy, Peel Great Southern and South West Regions, Dept of Transport 1996

State Recycling Blueprint, June 1993, Department of Commerce and Trade and the WA Municipal Association

State Planning Strategy, 1996, WAPC South West Recycling Blueprint, South West Waste Management and Recycling Working Group

South West Statistical Division waste disposal study – stage 2, phase 1, Binnie and Partners 1989

#### **Inland waters**

Leschenault Inlet Management Authority, Report to the Community 1995, WA Waterways Commission

Living Streams: A guide to bringing watercourses back to life in south-west WA, Waterways Information No. 7, Waterways Commission, Pen L & Majer K, 1993, Waterways Commission, June 1993

Waterways Guidelines, Review of rural drainage maintenance practices with special regard to nutrient reduction, WAWA

The state of the rivers of the south west of WA, WA Water Resources Council 1992

Environmental Protection Authority, June 1995, revised draft Environmental Protection (South West Agricultural Zone Wetlands) Policy

Select Committee into Land Conservation in 1990, Discussion Paper No. 1, South West Region of WA, Legislative Assembly of WA

Salinity Action Plan, 1997, Government of WA

Select Committee into Land Conservation, 1988, Report on Salinity in WA – A Discussion Paper, Legislative Assembly of WA

Wetlands of the Swan Coastal Plain – their nature and management; Environmental Protection (South West Agricultural Zone Wetlands) Policy, June 1995, EPA

Wetlands of the South West: The role of local government and landowners in the management of wetlands in the south west of WA, SWDC 1991

Water quality guidelines: Guidelines for the control of undesirable biological growths in water, 1992, DEP

Review of Progress and Direction for ICM Monitoring and Evaluation in WA, Integrated Catchment Management Evaluation and Monitoring Group, December 1996

South West Environmental Strategy, February 1997, SW(WA)LGA

State of the Rivers of the South West Drainage Division: Proceedings of the second River Management Workshop held at AIM, Integrated Catchment Management Group, Water Resources Council

The Status of Groundwater Contamination and Regulation in Australia, 1990, WRMC OCC EPA Final Report of the South West Irrigation Review Task Force, May 1994, WA Legislative Assembly, 1988

Report of the Select Committee appointed to inquire into Effluent Disposal, Wastewater 2040 Strategy for the South West, July 1995, WAWA.

#### **Land**

Environmental Evaluation of Native Vegetation in the Wheatbelt of WA, DEP, July 1996

A Review of Landcare in Western Australia, December 1995, Landcare Review Committee

Task Force for the Review of natural resource management and viability of agriculture in WA, June 1999

Salinity Action Plan, Government of WA, 1997

Salinity: A situation statement for WA, Report to the Minister for Primary Industry and Minister for the Environment, November 1996

Farm Forestry in WA, Report of the Farm Forestry Task Force, December 1995, CALM

Restoring Nature's Balance: The potential for major reforestation of south west Australia, Shea et al 1988

Source: Galloway 1997

**LOCAL STRATEGIES AND POLICIES**

Each of the pilot regions and indeed most 'regions' or catchments in Australia are affected by decisions made by local authorities, and numerous landholders, businesses and individuals as well as State and Commonwealth processes. For example, the pilot study in South-west Western Australia documented six State agencies, three catchment coordinating groups, 12 Local Government Authorities (and their peak body, the South West (WA) Local Government Association) as the principal public sector organisation making management decisions affecting the environment. It also identified the importance of decisions taken by private sector managers, such as farmers.

The regionalisation, administrative and legal arrangements for environmental management vary considerably between States/Territories and, as these are central to effective management and information handling, the planning and management arrangement applicable in each region are summarised in the section "about the pilot regions".

**STRATEGIES AND TARGETS**

Despite the existence of numerous strategies, plans and policies, the lack of measurable and definable targets for environmental management was a major impediment to the identification of indicators. A consistent picture of this lack of targets emerged from many of the pilots.

**Gippsland**

*... strategies and plans have goals and objectives to be achieved, however in many there is a lack of clear targets or benchmarks to measure success. If the success of strategies and programs ... is to be measured, precise and well-defined targets and benchmarks must be set (Lewis 1997).*

**Lower Hunter and Central Coast, New South Wales**

*Few specific targets and benchmarks have been established within the region, and most have been identified as broad goals and strategies which are not measurable. A common view expressed is that there is inadequate baseline information upon which to establish targets, and this appears to be a key limiting factor in implementation of specific goals (Fallding 1997).*

Commenting on this situation, Fallding (1997) stated that a potential outcome of project efforts to define indicators in the Lower Hunter and Central Coast region might be to prompt the formalisation of targets against which to measure progress.

**South-west Western Australia**

*[While recognising that] there were very few formal goals, targets or benchmarks set from within the region [the numerous strategy and policy commitments gave] legitimacy to the use of environmental indicators [and therefore] it does not seem that much more work is needed in the policy arena to substantiate the need (Galloway 1997).*

### Environmental issues

Using the various strategic plans, as well as the consultative mechanisms outlined above, priority environmental issues for each region were identified.

#### SOUTH-WEST WESTERN AUSTRALIA

The community identified four projects to test the application of indicators to priority issues. These were

- manage biodiversity (protection and repair of ecosystems) using a systems approach which integrates the biogeophysical environment with land use planning and management;
- restore waterway habitats and enhance environmental buffering ability, through protection and rehabilitation of stream banks and foreshores;
- prevent or reduce pollutant entering the waterways and manage both point and diffuse sources of pollution; and
- improve management of solid wastes, especially by increased recycling (as set out in the South West Recycling Blueprint).

#### SOUTHERN REGION OF COUNCILS (SA)

Priority environmental issues identified during the Regional Environmental Strategy (RES) public consultation phase included: urban water management; coastal management; urban revegetation; cleaner production and urban form.

#### FAR NORTH QUEENSLAND REGIONAL ORGANISATION OF COUNCILS

Protecting and enhancing the region's natural environmental values is critical to the future of the region, and a major area of concern for all levels of government and the community. The following priority environmental issues were identified:

- management of the outstanding universal value of the two World Heritage Areas;
- natural habitats on private land;
- conservation of coastal processes;
- tourism in natural areas;

- scenic/landscape amenity;
- catchment management and water allocations;
- location, type and services infrastructure need for transport;
- waste management; and
- conflicts between agricultural and urban development.

#### GIPPSLAND (VICTORIA)

In terms of environmental management, a number of regional priority issues need to be addressed, including: water quality and catchment management, salinity, land degradation, algal blooms, native vegetation retention and biodiversity conservation, loss of native forests, and pest plants and animals.

#### HUON VALLEY (TASMANIA)

The environmental objectives identified in the Draft Catchment Management Plan include:

- minimise contamination of waterways by agricultural runoff;
- sewage effluent to comply with water pollution regulations;
- implement state water quality policies for stormwater discharge;
- protect habitats of representative and unique animals and plants;
- protect wetlands from inappropriate development and practices;
- protect and maintain biodiversity and ecological processes and systems;
- protect the rivers, streams and watercourses from inappropriate development and practices;
- minimise chemical contamination of soils;
- adequate and appropriate management of forests; and
- protect areas of horticultural value and potential from development.

### LOWER HUNTER AND CENTRAL COAST (NSW)

The priority environmental issues in the region are water quality, air quality, biodiversity conservation, urban development pressures and coastal development. Transport is also a key issue but does not rate as highly in the public consciousness.

### COMPARING ISSUES ACROSS REGIONS

Comparing environmental priorities in regions is difficult, because of differences in the strategic planning processes. In some regions a decision was made to concentrate on a smaller group of pressing issues, while other regions developed a fuller list of environmental concerns.

Despite this difficulty, there are clear similarities and differences between regions. The differences between regions are more marked than the similarities. Given the pronounced spatial environmental variation in Australia, this is not surprising.

Biodiversity conservation and vegetation management was an issue in all six pilot regions, as was water quality. Waste management was also a concern in most regions.

Human settlements issues were more prominent in the Lower Hunter and Central Coast region and the Southern Region of Councils. These areas are more urbanised than the other four pilot regions. Some of the issues identified, such as threatened rainforest and acid sulfate soils reflect real biophysical variation between regions. Others may suggest different management priorities.

Coastal issues were important in the Southern Regional of Councils and Far North Queensland Regional Organisation of Councils, but not in other regions.

Heritage emerged as an issue only in Far North Queensland and the Southern Regions of Councils.

Few issues relating to the atmosphere were identified in the pilot regions. None of the pilot regions contains a large city, although there are significant concentrations of heavy industry in the Lower Hunter and Central Coast region. However, the quality of ambient air is a concern for most people, and this is reflected in the choice of indicators (see below). The other major atmosphere issues are the enhanced greenhouse effect and stratospheric ozone depletion. These are generally addressed most fully at the national or global, rather than local or regional scales.

## Identifying indicators

In each region, a suite of environmental indicators relevant to the identified issues and management needs was identified. The indicators were chosen using the “SMART” filter (see above under “environmental indicators”) and the modified strategic planning/adaptive management approach.

Preliminary reports from the scientific experts recommending environmental indicators for national state of the environment reporting were available, as was advice from several of the authors of these reports.

Table 5 lists some of the indicators selected in the Huon Valley, together with the environmental management objectives to which they correspond. Importantly, the indicators have been selected to show progress toward the environmental management objectives.

As noted above, the project was conducted in two phases. As a result, in some regions it was not possible to advance beyond the identification of potentially useful indicators. In most regions, however, it was possible to nominate those indicators most relevant to

regional managers, and to identify possible data sources for, and likely uses of, the indicators.

The selected indicators are listed in Appendix 1, where they are organised according to their relationship to the indicators recommended for national state of the environment reporting.

The differences in the number of indicators identified for each theme in each region reflect the variations in environmental issues considered important. For example, the Lower Hunter and Central Coast region selected the most indicators related to human settlements, and the Far North Queensland Regional Organisation of Councils chose the greatest number of indicators related to Estuaries and the Sea.

The indicators selected by regional environmental managers in this project are a potentially important resource for managers in other regions. The list of indicators in Appendix 1 has been formatted to facilitate cross-referencing between the indicators that regional environmental managers in this project found useful and the reports containing recommendations for national state of the environment reporting. These reports contain much of the scientific and technical information necessary to interpret and apply indicators.

**Table 5**

### Examples of indicators and environmental management objectives in the Huon Valley

Environmental management objective	Indicators
Minimise chemical contamination of soils	<p>Concentration of toxic agricultural products dispersed into waterways (pressure indicator)</p> <p>An inventory of sites with on site soil contamination (condition indicator)</p> <p>The level of biological activity in the soil (number of worms) (condition indicator)</p>
Adequate and appropriate management of forests	<p>Number and distribution of forest patches, classified by type (condition indicator)</p> <p>Weed species abundance and rate of spread (condition indicator)</p>
Protect areas of horticultural value and potential from development	<p>Coddling moth spread (pressure indicator)</p>

In addition to the list of indicators in Appendix 1, a searchable electronic database containing the indicators is available at <http://www.alga.com.au/envindic.htm>. This database shows the data sources and other technical details identified for each indicator. A separate database shows some of the indicators suggested in the course of the project but not included in the final lists.

In some regions relatively few response indicators were developed. Generally speaking, response indicators have been more difficult to identify than indicators of condition or pressure.

Response indicators measure the intensity of efforts to address a particular issue. They are not intended to measure the success of these efforts. The effectiveness of responses should be judged from changes in the condition of the environment or pressures on it.

A lack of response indicators does not imply failure to respond. It simply means that at this early stage in the development of indicators it has not been possible to find objective, unambiguous, quantitative measures of response.

Most environmental monitoring in the pilot regions was related to indicators of the condition of the environment. There is little existing commitment to monitoring pressure and response indicators. As a result, there is little information about the human activities that may be affecting environmental trends, or about the efforts being made to address perceived environmental issues. Where the condition-pressure-response approach has been adopted, it appears that it will help focus attention on anthropogenic

environmental drivers and human efforts to address environmental issues as well as the condition of the environment. It could therefore become a useful environmental management tool, complementing existing management strategies.

### SCIENTIFIC AND TECHNICAL ISSUES

In addition to meeting managers' needs for information, environmental indicators must be based on the best available scientific understanding of environmental systems. For example, the "SMART" filter requires that indicators be "statistically verifiable, reproducible and comparable", "indicative of fundamental environmental function(s)", and "able to show trends over time". Science is required in order to select indicators that satisfy these criteria.

Indicators must be embedded in a clear interpretive framework. This framework will normally be a web of scientific theories, data and practices which identify the indicator as a key element of the complex environmental system it is designed to track, and show how it should be interpreted. Aspects of this interpretive framework might include the ecological processes operating in the system, its natural dynamics, and the spatial and temporal boundaries that are appropriate to it.

This report is concerned mainly with choosing environmental indicators that are useful to local environmental managers. The scientific and technical aspects of indicator selection are dealt with fully in the other reports in this series (see the back of this report for a list of the reports).

## USING THE INDICATORS

In order for environmental indicators to be used effectively they must be:

- supported by data;
- properly interpreted; and
- integrated into management.

Attempts were made to identify data sources to support the indicators, which were selected on the basis of their relevance to management needs. This is not the same, however, as ensuring that indicators are integrated into management. The willingness and ability of managers to understand and act on the information provided must also be considered.

The project identified a number of obstacles to effective use of indicators, as well as opportunities to overcome these obstacles.

It must be recognised that indicators are only one part of an informing system to enable managers to act on environmental information. Indicators are potentially a key part of such a system. Other aspects include monitoring programs, data handling and processing systems, and institutions tuned to respond to environmental information. The following discussion

touches on other aspects of this informing system as they relate to using indicators

### DATA

None of the pilots had a comprehensive suite of existing monitoring programs generating reliable information to support the selected indicators. However, some monitoring relevant to most of the 7 national state of the environment themes is occurring in each region.

In the pilot regions the local and regional monitoring programs documented usually related to:

- statutory obligations, for example, Environmental Protection Agencies focus on air and water pollution
- the operations of integrated catchment management, Landcare and related programs
- Local Governments' traditional focus on urban form and waste management (human settlements)
- industry sector focus, for example, fisheries, agricultural land management or crop yield
- community non-commercial interests (community environmental monitoring) (see Table 6).

**Table 6**

**Management/monitoring responsibilities by state of the environment theme, Gippsland**

State of the environment theme	CALP Boards	DNRE	EPA	Local Government	Community groups	Industry	Coast Board
Biodiversity	•	•		•	•		
Inland waters	•	•			•	•	•
Land	•	•		•	•	•	
Estuaries and the sea		•		•	•		•
The atmosphere			•			•	
Human Settlements				•			
Natural and cultural heritage		•		•	•		

### INTERPRETING INDICATORS

Interpreting indicators may require:

- baselines or benchmarks;
- sufficient time series data to discern trends; and
- an understanding of the system behaviour and dynamics.

The pilot regions encountered difficulties with each of these factors. The problems, and possible solutions, are described below.

### INTEGRATING INDICATORS WITH MANAGEMENT

The pilot regions identified a number of factors required to properly integrate indicators into

management. These included:

- well defined targets (or goals) toward which indicators can measure progress;
- an emphasis on measuring environmental outcomes, rather than concentrating exclusively on inputs and processes;
- an ability to weigh the relative significance of various environmental, economic and social trends;
- targeted communication, which ensures that relevant information is not only gathered, but finds its way to decision-makers; and
- institutional capacity to respond to environmental information.

#### Box 4

#### Selecting and using an indicator in the Southern Regions of Councils

One of the key issues identified in the Regional Environmental Strategy for the Southern Regions of Councils was pollution of stormwater. The strategy adopted an objective of minimising contaminants in stormwater.

The percentage exceedences of water quality guidelines was selected as an indicator to track progress toward this objective. This indicator will use a set of water quality guidelines for the region and report on the number of times they are exceeded. The guidelines are locally derived, and based on the Australian and New Zealand Environment and Conservation Council (ANZECC) water quality guidelines.

A survey of local agencies, community groups, industry, and educational institutions showed that there are several organisations collecting data that could be used to support this indicator.

What is measured?	By whom?	Where?	How often?	Where are data stored?
stormwater quality	Patawalonga Catchment Board, Waterwatch, Community	Stormdrains, Sturt Creek Drain in Edwardstown and Marion	variable	Patawalonga Catchment Board
E. coli	Willunga Council, Marion environmental health officer	L. Port Willunga Creek, L. Field R.	variable 3 monthly	Willunga Council Marion Council
E. coli, salinity, phosphorus	Noarlunga Council	Hackam, Christies, Pedlar Creeks, Onkaparinga	variable	Council
Heavy metal load	Noarlunga Council	Christies Creek	variable	Council
Turbidity, nutrients, dissolved oxygen	HV Council Adelaide University	Minkara Wetland, near HV Reserve	continuous (part) and event driven	University of Adelaide

As the table shows, there are many relevant data available from a variety of data sources. Some of these are already used to manage water quality in the region.

There is a strong possibility that, with some further development, this indicator could become a useful tool for managers in the region. Some of the advantages it offers are:

- it is linked to the regional environment strategy;
- it is a measure of an outcome of the environmental strategy rather than process or inputs;
- it has a defined baseline in the form of water quality guidelines;
- there are agreed methods for collecting the data;
- there are data currently collected which could support the indicator; and

- decision-makers are familiar with water quality measurements and are well placed to act on information provided by the indicator.

Two further steps are required to make full use of the indicator. First, it is necessary to gather the data from disparate sources and analyse them to provide a picture of the success of the strategy over the entire region. Second, targets for water quality should be set so that progress can be gauged against them.

### OBSTACLES AND OPPORTUNITIES INVOLVED IN USING INDICATORS

Experience in the pilot regions highlighted a number of difficulties regional environmental managers face in gathering data to support indicators, interpreting the indicators, and linking indicators to the management cycle. These are discussed below, together with some opportunities for overcoming them. Table 7 summarises the obstacles and opportunities.

**Table 7**

#### Obstacles to, and opportunities for, using environmental indicators

Obstacles	Opportunities
Mismatch between ecological and administrative boundaries	Cooperation between various groups Agreement on key indicators Flexible information systems that can integrate or disaggregate data from different administrative regions
Multiplicity of organisations and strategies	Cooperation between various groups
Ill-defined roles and responsibilities	Cooperatively define the respective roles and responsibilities of regional organisations in relation to monitoring and reporting
Lack of clearly defined environmental management targets	Identify clear, quantitative targets for objectives already established in strategy plans Develop indicators relating to targets
Inadequate, patchy data gathering programmes	Agreement on key indicators and monitoring protocols Cooperatively define the respective roles and responsibilities of regional organisations in relation to monitoring and reporting
Dispersed information sources	Cooperation between various groups Flexible information systems that can integrate or disaggregate data from different administrative regions
Lack of baseline information	In some cases it may be possible to gather baseline information. In others, surrogate measures will be required
Complexity of environmental systems	Draw on existing understanding and expertise (especially work on appropriate indicators) In some cases it may be possible to commission new studies
Lack of integrated or holistic understanding of environmental systems at the regional scale	Take an adaptive approach to understanding regional environmental systems, drawing upon existing expertise and the activities of a range of organisations

### OBSTACLES

#### Mismatched boundaries

Many boundaries (national, State, Local Government, statistical region etc) have been used for management and information gathering, but these rarely relate to ecological boundaries. These different boundaries can confound attempts to consolidate and interpret data sets. Historical datasets are often collected using different boundaries to current data sets. For example, little information (other than some information relating to water) has historically been collected using catchments as the boundaries.

*Monitoring and reporting boundaries are a large obstacle to the development of a comprehensive reporting and monitoring system within the region. At least 40 separate identified regions affect the Lower Hunter and Central Coast. The boundaries of these regions rarely ... coincide and thus cannot be fully compared (Fallding 1997).*

#### Multiplicity of organisations

It is common for several managers to have responsibilities that impinge on any particular environmental issue. These organisations may include Commonwealth, State and local governments, regional organisations, industry groups, individuals, and community groups.

*A vast number of individuals and organisations are involved in environmental management, at the local, state and national level. This presents a challenge in ensuring cooperation and effective outcomes (Lewis 1997).*

#### Ill-defined roles and responsibilities

None of the pilot regions has a single peak region-wide organisation with overall responsibility for state of the environment reporting or for monitoring and environmental management (nor is this likely within the foreseeable future). With many agencies currently involved there are overlaps and uncertainties about responsibility for related aspects of regional ecosystems. An orderly process is required to negotiate the demarcation of these responsibilities.

#### Lack of clearly defined environmental management targets

In each of the pilot regions there are numerous strategies, plans and policies but these consistently lack clear and measurable targets.

*Few specific targets and benchmarks have been established within the region, and most have been identified as broad goals and strategies which are not measurable (Fallding 1997).*

#### Inadequate, patchy data gathering programs

Each pilot region has some monitoring programs but these have usually originated in response to particular problems or single interests. Few monitoring programs attempt to understand whole systems. Fewer still have long term consistency or certainty of funding. Agency monitoring programs are also limited by jurisdictional responsibilities or geographic boundaries.

#### Dispersed information sources

It is often hard to find regionally relevant, reliable figures on important aspects of resource use and environmental change. Integrating, adapting and using relevant information is not as easy as it should be in the 'information age' despite the sizeable investment by governments in collecting and storing environmental data. It can be difficult to locate and gain access to information as it is often dispersed across numerous agencies. Even amongst agencies, sharing information can prove difficult.

#### Lack of baseline information

A baseline is a reference standard against which the impacts of processes or activities are assessed. Ideally, the baseline will be a system that is unperturbed by human influence. Baselines are rarely known, because many major changes to ecological systems have preceded any organised monitoring or systematic observation programs.

#### Failure to analyse or communicate trends

Data that are collected are seldom analysed to identify long-term trends, or repackaged in forms which allow for general understanding.

#### Complexity of environmental systems

Ecological processes are dynamic, with many, often subtle, relationships between ecosystem components.

The timescales for many important ecological processes are long relative to planning horizons, and there may be large fluctuations in the system throughout these lengthy cycles. All of these factors make environmental systems difficult to understand.

#### **Incomplete understanding of ecosystem dynamics**

While there have been numerous studies of specific problems, for example, blue green algae or salinity, few assessments have attempted to integrate the range of resource management issues into a holistic ecological model.

The combined and cumulative effects of numerous individual actions and processes result in significant environmental changes across entire regions, often making it difficult to:

- accurately document the causes of change
- accurately predict future changes or the consequences of current actions
- accurately target resources and policy instruments to minimise the negative changes.

#### **Box 5**

##### **Vegetation disturbance**

The important ecological roles of fire and vegetation were recognised in most of the pilot regions. Indicators selected related to:

1. clearing of native vegetation
2. fragmentation of native vegetation
3. altered fire regimes.

While the critical ecological roles of fire and vegetation are widely recognised, it is often hard to obtain accurate figures on changes in the area and composition of vegetation communities or changes in fire regimes. Obtaining historical data for use as baselines can be even more challenging. There are frequently disputes about the extent and nature of vegetation before European settlement, and the nature or effects of fire regimes. There is much reliance on anecdote. For example, there are suggestions that, in some regions, the prolific growth of woodland species occurred after burning by Aboriginal peoples ceased. The extent to which useful generalisations can be drawn from such accounts is limited. There are therefore legitimate doubts raised about the adequacy of baseline information and knowledge of ecological processes necessary to interpret data generated by the proposed indicators (if they are routinely monitored) at the regional scale.

There are also problems of spatial scale. For example, in 1995 the Commonwealth released national and State-based estimates of vegetation clearance, land cover disturbance, and the likely impacts on biodiversity on a continental scale (Glaznig 1995; Graetz et al 1995). The results of such studies are not necessarily readily disaggregated to provide useful or accurate information at a catchment or regional scale.

#### **OPPORTUNITIES**

##### **Cooperative arrangements**

Many groups and organisations have a role in managing the environment. Maximum efficiency will be achieved when these groups cooperate. Cooperation must extend across spatial boundaries, areas of responsibility, and interests. For example, different local governments in the same catchment must cooperate on water issues; industry groups, community groups and governments must cooperate on waste reduction, and organisations responsible for water issues must work with groups responsible for land management.

Appropriate cooperative arrangements can overcome the mismatches between ecological and administrative boundaries, solve problems arising from the multiplicity of organisations and strategies, and help set targets and goals for environmental management. Cooperation can also improve access to data.

A single cooperative grouping will not necessarily address all environmental issues. Rather, a variety of cooperative coalitions, each addressing particular issues may be necessary.

**Box 6**

**Coordinating environmental data in Gippsland**

The need for a process to coordinate environmental data was recognised in Gippsland. Lewis (1997) outlines the options considered worthy of further investigations:

1. Formalising cooperation and coordination between the Catchment Management Authorities (CMAs), the Regional Coastal Board, State departments, major industry and the Local Government Authorities in Gippsland so that environmental reporting responsibilities are pooled to create a regional state of the environment report.
2. Individual reporting continues, in line with good corporate practice, thus the CMAs, the Regional Coastal Board and the LGAs would report individually on their environmental performance, and from this a regional state of the environment picture could be derived.
3. Some combination or hybrid of the above.

Lewis recommended that:

Once the new CMAs are established, an inter-agency working group should be established ... to explore the opportunity to bring together the numerous monitoring programs in a more coordinated and systematic framework. The working group should aim to achieve a negotiated agreement which specifies:

- which organisation is to be the lead agency for information and monitoring for each of the seven state of the environment themes;
- that the option and prospects for creating a regional information system are actively explored by CMAs, the Regional Coastal Board and the LGAs as soon as possible.

**Indicators and targets**

Establishing an agreed set of environmental indicators can help overcome obstacles to providing better information for environmental management. such as mismatch between boundaries, inadequate data gathering programs, dispersed information systems, and the complexity of environmental systems.

Indicators can help deal with the complexity of environmental systems because:

- they have a sound scientific base;
- they have an established interpretive framework and an agreed meaning; and
- as managers become more familiar with indicators, they can more easily draw conclusions about the effectiveness of environmental management.

Indicators can help deal with the mismatch of administrative and environmental boundaries, because they are being developed at a range of spatial scales. If the same indicators are used in different

administrative regions, they can be readily combined or compared across regions that lie within the same environmental boundary. For example, all local councils in a catchment could use the same water quality indicators.

Indicators can help deal with inadequate data gathering by drawing attention to components of the environment that need to be monitored, focussing data gathering and providing a basis for improved monitoring.

In an indicator based informing system, each indicator will have an established data source, an agreed method for processing and interpreting data, and a baseline or benchmark against which trends can be assessed. Ideally, there will also be targets or objectives associated with many of the indicators. Indicators will be selected to fit with strategic planning and adaptive management.

**Accessing expertise**

Much expertise on environmental systems is available, including from scientific research organisations, State

and Commonwealth Departments and Agencies, local governments and communities, and industry. This expertise can be used to develop indicators and clarify the framework for interpreting them.

A number of reports dealing with indicators and their interpretation are listed at the back of this report.

### Flexible information systems

Once cooperative arrangements have been put in place, and a set of indicators and associated targets agreed, a flexible information system will be needed to draw data together from a variety of sources.

The regional pilots identified the need for information systems capable of being:

- accessed and contributed to by a range of organisations, both government and community;
- applied to various scales and boundaries, and aggregated or disaggregated as necessary;

- open to involvement and input from community monitoring networks, thus giving the systems greater capacity to be refined by local expertise or groundtruthing efforts;
- used to locate and assemble data relevant to regional environmental management;
- used to identify the organisations involved in relevant scientific research or monitoring;
- used to integrate and correlate information from disparate sources; and
- used to display spatially related data over base maps – topography, soils and climate etc.

Pioneering information system initiatives in several States/Territories may meet many of the above specifications. Some examples are described in Boxes 7 to 10.

### Box 7

#### ICMISS – The integrated catchment management information support system

ICMISS is an Integrated Catchment Management Information Support System developed by Rob Atkinson on contract to the New South Wales Department of Land and Water Conservation.

The ICMISS prototype provides access to maps, graphs, tables, real-time data, text and reports from a variety of geographic information systems, database, text and image sources. The source data is stored at different locations on the Internet and combined by the ICMISS server when requested by users.

ICMISS uses the World Wide Web model with:

- many different data servers
- protocols for data sharing
- tool kits for delivery of information
- request and presentation brokers
- capacity for libraries to feed in information
- acceptance as feed-in material and presentation of outputs in a wide range of formats including database, maps, geographic information system reports, photos or text
- capacity to link maps, text or data records
- multiple organisations presenting information in suitable ways.

Systems like ICMISS depend on provision of data in suitable ways. New South Wales is working toward a whole-of-government policy on data sharing, with charges based on cost of delivery.

Issues encountered/to be overcome

Three key issues need to be addressed during the development of ICMISS:

1. application of a common spatial reference for all data sets
2. design of ICMISS software
3. agreements on data supply between agencies.

These three key issues relate to a number of sub-issues, including:

- the need for all linked information to be consistently and accurately geo-referenced three dimensionally
- a method of integrating data sets, map themes and hypertext within a spatial framework using the Internet
- development of a geographic information system type front-end on the World Wide Web to simplify search and display of mapped and spatial information
- the need for agreement between agencies to allow secure access to each information holding
- simultaneous communications between two or more data servers using the Internet
- accessing real-time data feeds using the Internet, for example, the Department of Land and Water Conservation's HITS telemetry system in the Hunter Valley or river gauging stations along the Hawkesbury River
- using a geographic information system type Web browser to select points, lines and polygons in space and to pass this to a Web server for processing
- data descriptions, quality and pricing.

Development of ICMISS was funded by the Department of Land and Water Conservation's Integrated Natural Resources Management Strategy in collaboration with the Hawkesbury-Nepean Catchment Management Trust. Major resource information custodians in New South Wales (Environment Protection Agency, National Parks and Wildlife Service, Agriculture) have been approached to participate in the project. A prototype was completed to demonstrate the benefits and functions that a larger and more complete system (containing more data, faster access, better query and analysis) would provide to a wider audience.

For more information on the project visit the homepage on <http://www.icmiss.dlwc.nsw.gov.au> or contact Greg Long, Department of Land and Water Conservation. Phone: (02) 9895 7445; Fax: 9895 7867; Email: [glong@dlwc.nsw.gov.au](mailto:glong@dlwc.nsw.gov.au)

**Box 8**

**New South Wales EPA State of the Environment Report on the Internet**

The New South Wales Environment Protection Agency (EPA) has posted their state of the environment report on the Internet providing:

- all documents, maps and overlays
- full access to references via interest points, for example, all relevant New South Wales legislation can be accessed via another linked World Wide Web site
- limited zooming in
- search capacity on every page.

**Box 9**

**Goulburn/Broken Natural Resources Monitoring Network**

This network is located within the Goulburn-Broken catchment and is part of the Shepparton Irrigation Region in north-central Victoria. The network provides a focal point for the collection of community monitoring information, specifically Waterwatch and Watertable Watch, and the dissemination of natural resource information relevant to development and sustainability in the region.

**Background**

Watertable Watch and Waterwatch community monitoring programs have been operating successfully in the Goulburn-Broken catchment for the last two years. The result of this has been a high level of awareness of water table and water quality issues in the catchment and the building of a significant environmental database which includes over 2,000 water quality and 6,000 water table readings.

**Roles of the network**

- Liaison with community, industry and education to ensure the information provided will have currency and relevance to the specific objectives of the user.
- Establishment and maintenance of a catchment-wide, integrated and accessible community monitoring database.
- Establishment and support of links between community monitored and agency natural resource databases.
- Provision of communications, software and training support for those involved in community monitoring programs.
- Provision of education on natural resources and information technologies related to the management of those resources.

**Activities of the network to date**

- Production of a monthly snapshot map of water quality in the Country News.
- Development of a Monitoring Network homepage to support community groups, Landcare groups, schools and agencies involved in community monitoring.
- Facilitate access to the Internet for Landcare groups and schools in the region.
- Development of on-line databases to support community monitoring. This includes provision of on-line data entry and information retrieval as well as training. Individuals are able to load data directly on to the Web. Maps are then composed at a central location and posted back on the Web.

**Major problems encountered/overcome**

- Making sure good communication processes are set up with users so that outputs for the system are what is really needed.
- Having good access to appropriate technology and expertise (geographic information systems, database and Internet) to establish the system.

The Natural Resources Monitoring Network is supported/funded by a number of bodies including State agencies (DNRE), Service Providers (GV Water, G-M Water and WangNet), Education (Science and Technology Centre), Landcare (Goulburn Murray Landcare Net and associated dryland Landcare networks) and industry (Shepparton Regional Development Board and McPherson Media).

For more information on the project visit the homepage on [http://www.sheppstc.org.au/environment/nrmn\\_web](http://www.sheppstc.org.au/environment/nrmn_web) or contact Andrew McAllister at the Shepparton Science & Technology Centre. Phone: (03) 5831 8000; Email: [amcallis@netc.net.au](mailto:amcallis@netc.net.au)

**Box 10**

**Avon Catchment Network**

Providing access to land and water management information to communities in the Avon River basin (Western Australia) is the objective of the recently launched Avon Catchment Network.

**Background**

Land and water degradation, in particular rising water tables and resulting salinity, are major issues in the Avon River catchment area. The Avon Working Group consulted communities in the Avon basin and identified a number of planning priority areas concerning land and water management and regional development. These included demonstrating new management and monitoring techniques, increased regional monitoring of groundwater and salinity and more incentives and grants for on-ground use.

**Role**

The network was devised as a method of providing a one-stop-shop for people to get the information they require on land and water management. Accessing information via computer technology is a feature of the network, but contact between people is still an important component of what the network is trying to achieve. The network is envisaged as having an important role in bringing community groups and other organisations together.

**Activities in development**

- Provision of Internet access to seven local communities (more planned).
- Access to a mini geographic information system via the Internet to assist in farm and catchment planning, showing elements such as relief, hydrology, vegetation, soils, property boundaries, infrastructure, aerial photos and catchment boundaries.
- Provision of information on projects and other activities in the Avon River basin on topics such as research, revegetation, contacts, hydrology consultants, grant opportunities, river care, alternative land uses.
- Provision of technical information and/or contacts for topics such as direct seeding.
- Landholders adding data in relation to their property onto the mini geographic information system.

**Major problems encountered/overcome**

- Resourcing the collection and collation of information.
- Technical difficulties in linking the rural communities to the Internet. The Internet was chosen as the most appropriate option for service delivery, but internet service providers in the rural regions are rare.
- Support for the rural communities in terms of technical advice on the geographic information system software and network access. Communities are quite isolated and the people with this expertise are hard to come by.
- Integrating agencies so the network can run efficiently with more than one organisation involved in the structure.

The network is being funded by the National Landcare Program, with support from the Water and Rivers Commission and AgWA.

For more information on the project visit the homepage on <http://www.wrc.wa.gov.au/swanavon/avon> contact Marion White, the Network Coordinator. Phone: (08) 9622 7600; Fax: (08) 9622 7611; Email: [marion.white@wrc.wa.gov.au](mailto:marion.white@wrc.wa.gov.au)

## LINKS TO NATIONAL PROCESSES

### The emergence of common indicators

Indicators selected in each of the pilot regions were compared to the indicators recommended for national state of the environment reporting. Table 8 lists eleven national indicators that were selected by four or more of the pilot regions. In addition, fourteen national indicators were selected by three or more regions.

The number of common indicators is consistent with the number of environmental issues common to several regions. As expected, some of the indicators chosen by pilot regions reflect environmental concerns peculiar to the region, while others relate to shared concerns. Where indicators relate to common concerns, it is desirable that common indicators also be used. Reasons for using common indicators include:

- the scientific basis for understanding the indicator can be shared between regions, and for issues relevant at the national scale much of this work will probably be done at the Commonwealth or State/Territory level,
- baseline data or comparative studies may be available from other regions,
- methods for monitoring the indicators can be shared between regions,
- environmental issues often run across administrative boundaries; using the same indicator to monitor the issue can promote cooperative approaches to identifying and dealing with problems, and
- it may be possible to develop State or national overviews by aggregating data collected at the local or regional level.

**Table 8**

**Common indicators across pilot regions and indicators recommended for national state of the environment reporting\***

Indicator by theme	South-west WA	Southern Region of Councils, SA	Region Far North Queensland	Huon Valley, Tas	Gippsland, Vic	Lower Hunter and Central Coast, NSW
<b><i>Inland waters</i></b> Percent exceedences of water quality guidelines for a suite of bacterial and chemical water quality parameters for human health and recreation		Y	Y		Y	Y
Percentage of total streamlength with riparian vegetation	Y		Y	Y	Y	
Natural river or wetland habitat lost or converted to another land use	Y	Y	Y	Y	Y	
<b><i>Land</i></b> Rate of extension of exotic species	Y	Y	Y	Y		

## Environmental Indicators Local and Community Uses

Indicator by theme	South-west WA	Southern Region of Councils, SA	Region Far North Queensland	Huon Valley, Tas	Gippsland, Vic	Lower Hunter and Central Coast, NSW
<b>Biodiversity</b> Extent and rate of clearing, or major modifications of natural vegetation or marine habitat	Y		Y		Y	Y
The number, identity, condition and area of native vegetation types		Y		Y	Y	Y
Extent of each vegetation type and marine habitat type within protected areas	Y	Y	Y			Y
<b>Estuaries and the sea</b> Dune vegetation (area of dunes covered by vegetation)	Y	Y	Y		Y	
<b>Atmosphere</b> Concentrations of air pollutants (sulphur dioxide, ozone, lead, particles, nitrogen dioxide, and carbon monoxide)	Y	Y			Y	Y
<b>Human settlements</b> Population and household growth rates	Y	Y	Y		Y	Y
Domestic solid waste disposed to landfill/ recycling	Y		Y		Y	Y

\*Y = indicator selected by region

Developing common indicators for use at the regional scale, with well defined links to indicators used at the national and State scales was an important motivation for this project.

Only 12 indicators selected in pilot regions were not also recommended for national state of the environment reporting. In some instances, the parameters in question can be measured meaningfully

at the local, but not the national scale. Soil loss is an example of this (see the indicator "tonnage movement - soil loss per hectare"). While local estimates of soil loss are feasible, these cannot be extrapolated to the national scale.

Other indicators that were selected only for regional application reflect issues that are locally important but would not register on the national scale. The extent of

acid sulphate soils is an example of such an indicator. While acid sulphate soils may be nationally significant, their extent is limited and application of this indicator is therefore limited to certain parts of Australia.

It is also noteworthy that some of the indicators recommended for national use find varying local applications. The recommended national indicator "rate of extension of exotic species" entails monitoring feral pigs in Far North Queensland and coddling moth in Huon Valley.

This project has shown that there is an opportunity for local environmental managers to cooperate with managers in other regions and with State and Commonwealth agencies to generate better environmental information, possibly by developing improved environmental indicators.

### AGGREGATION ACROSS SCALES

Data gathered to meet the needs of regional managers can feed into State/Territory and national reporting systems in four ways.

#### As case studies

Often data are not available to give a complete, quantitative description of national environmental trends. Local or regional case studies frequently offer insights into the nature of these trends and the particular problems or issues they raise. Feral pests may be an example of this. On a national basis, data on feral pests (especially feral animals) are patchy and unreliable. A case study of the damage done by feral pests in one local area may be very useful.

#### Through simple addition

Some indicators lend themselves to simple addition as the spatial scale of interest changes. That is, the indicator value for a larger region is simply the sum of the values for the smaller regions that comprise it. An example is the indicator 'percent exceedence of water quality guidelines', which has been recommended as an indicator for National State of the Environment Reporting (Fairweather and Napier 1998). In order to aggregate across spatial scales, it is necessary to report both the number of exceedences and the number of measurements for each region. The ratio of exceedences to measurements for the State/Territory can be obtained by adding together the exceedences and measurements for each region in the State/Territory. Similarly, the national figure can be derived by adding the exceedences and measurements

for each State/Territory. It is likely that exceedences will be reported on the spatial scale of drainage basins, in which case a similar procedure will apply. However, the problem of mismatch between administrative and environmental boundaries may arise.

#### Through mapping at different scales

Some indicators can be reported at different spatial scales simply by mapping the values at different scales. Examples are the indicators 'area of salt affected land' and 'area underlain by shallow/rising watertables'.

#### Through transformation of data at different scales

Sometimes different indicators, derived from the same raw data, will be used for reporting at different spatial scales. The data will be transformed differently at different spatial scales. An example is the regional/local scale indicator 'percentage of catchment area with tree cover'. At the national scale, the relevant indicator is the distribution of catchments according to the amount of original tree cover remaining.

### SOME PROBLEMS IN AGGREGATING DATA ACROSS SPATIAL SCALES

Problems in aggregating data across spatial scales include the following.

#### Mismatch between administrative and environmental boundaries

Data are frequently collected within administrative boundaries (Local Government Areas, States, etc) rather than within sensible environmental boundaries (catchments, drainage basins, airsheds, bioregions etc). Further, environmental boundaries vary with issue, and a match between administrative and environmental boundaries on one issue does not guarantee a match for another.

#### Partial coverage

Data for a particular indicator may not be collected in all regions that comprise a larger area or, when data are collected, they may be collected using incompatible methods or timing.

#### Data transfer problems

Transferring data between spatial scales can be difficult for a variety of reasons, including incompatible systems, ignorance of available data, data confidentiality and lack of resources.

**Table 9**

**Comparisons of national and regional needs**

<b>National needs</b>	<b>Regional needs</b>
Compatible and comparable information nationwide	Information suitable for regional management
Indicators for national state of the environment reporting, and other national purposes	Regional informing systems linking monitoring, modelling, mapping and management: based on contracted arrangements, different roles for the various players and preferably using core indicator and protocols
National comparisons and national compatibility of environmental information	Systems for linking information generated and held by a range of organisations at a range of scales
Monitoring and reporting protocols for each indicator and capacity to compare and compile information from many regions and organisations	Comparisons and compatibility of environmental information between organisations and regions
Protocols embedded in national standards	Application of national standards enabling accurate reporting on environmental performance and accountability
Information suitable for national state of the environment reporting	Information suitable for regional use
Improved policy and outcomes at the national scale	Improved policy and outcomes at the regional scale

**Community environmental monitoring**

**COMMUNITY ENVIRONMENTAL MONITORING IN AUSTRALIA**

The size, scope and rapid growth of community environmental monitoring activity has been documented in *Listening to the Land: A National Directory of Community Environmental Monitoring Groups in Australia* (Alexandra, Haffenden & White, 1996). This publication refers specifically to the relevance of community environmental monitoring (CEM) to state of the environment reporting and emphasises the potential for CEM groups to be involved in 'grassroots state of the environment reporting'. Case studies documented in the directory featured some of the most creative and capable CEM groups in Australia. However, while some CEM groups are capable, it is also true that CEM groups – and monitoring programs generally – vary greatly in their ability to collect reliable data that are suitable for regional environmental managers and/or state of the environment reporting.

**FEEDBACK FROM THE PILOT REGIONS**

In each pilot region, CEM groups with the potential to gather data relevant to the selected indicators were identified. Next, any instances where the groups might need to modify their data collection practices in order to meet indicator standards were identified. Finally, the training and support needs of these CEM groups were identified.

Table 10 summarises the regional findings. From these findings, it seems that coordinated programs offer the best prospects for state of the environment data sources, and that the lack of technical support and coordinated and cooperative means of gathering, storing, aggregating, integrating, analysing and using monitoring data are the major factors limiting the potential of CEM to contribute to environmental management in all regions.

**Table 10**

**Community environmental monitoring practices and needs within the pilot regions**

**Southern Region of Councils, SA**

<b>Examples of CEM</b>	<b>Regional issues</b>	<b>Needs identified</b>
<p>Successful groups such as:</p> <ul style="list-style-type: none"> <li>• Waterwatch</li> <li>• DragonSearch</li> <li>• Bushcare, and</li> <li>• Birds Australia</li> </ul> <p>have coordinating offices and researched and agreed monitoring schemes.</p>	<p>Overall, there is:</p> <ul style="list-style-type: none"> <li>• no coordination between community groups</li> <li>• limited use of standard monitoring protocols</li> <li>• ad hoc data storage</li> <li>• risk of data being lost when individuals lose interest or leave the district</li> <li>• dependence on a few individuals to maintain group effectiveness.</li> </ul>	<p>A campaign to attract school and community interest:</p> <ul style="list-style-type: none"> <li>• resources for training and coordination</li> <li>• long-term incentives</li> <li>• a register of individuals who monitor variables of value to state of the environment reporting</li> <li>• a regional information system to enable feedback to participants and links to management.</li> </ul>

Note: The issues identified in each region may not be relevant to any or all of the CCEM groups listed as examples.

**Far North Queensland**

<b>Examples of CEM</b>	<b>Regional issues</b>	<b>Needs identified</b>
<ul style="list-style-type: none"> <li>• Waterwatch monitors the water quality of six major catchments.</li> <li>• C4 (Committee for Coastal and Cassowary Conservation) carries out research on the Southern Cassowary (data quality as yet undetermined).</li> <li>• Property owners on Cape York Peninsula monitor and map Golden Shouldered Parrot nests, and chick numbers.</li> <li>• Coastwatcher Reef-users report on sites over northern sections of the Great Barrier Reef Marine Park.</li> </ul>	<p>Need:</p> <ul style="list-style-type: none"> <li>• to collate and report already collected data</li> <li>• baseline data for managers</li> <li>• statistical validation of data</li> <li>• ongoing updating, maintenance and performance evaluation of monitoring techniques</li> <li>• monitoring protocols that ensure that spatial and temporal factors are always recorded.</li> </ul>	<p>Need:</p> <ul style="list-style-type: none"> <li>• improved coordination of community monitoring groups</li> <li>• increased emphasis on training</li> <li>• more scope for Aboriginal and Torres Strait Islander involvement</li> <li>• more qualitative identification of threatening processes</li> <li>• more response indicators</li> <li>• emphasis on ongoing monitoring, not just snapshots or baseline survey.</li> </ul>

Note: The issues identified in each region may not be relevant to any or all of the CCEM groups listed as examples.

**Huon Valley, Tas**

<b>Examples of CEM</b>	<b>Regional issues</b>	<b>Needs identified</b>
<ul style="list-style-type: none"> <li>• Waterwatch groups</li> </ul>	<p>The Healthy Rivers Project identified three primary weaknesses in local water quality monitoring:</p> <ul style="list-style-type: none"> <li>• incorrect monitoring procedures (data were not scientifically valid)</li> <li>• inadequate data storage and dissemination</li> <li>• lack of a management focus.</li> </ul>	<p>The Healthy Rivers Project is:</p> <ul style="list-style-type: none"> <li>• coordinating monitoring groups into a network</li> <li>• retraining individual group members in basic water monitoring methods</li> <li>• attempting to make better links between monitoring and the decisions which affect the local environment.</li> </ul>

Note: The issues identified in each region may not be relevant to any or all of the CCEM groups listed as examples.

**Gippsland, Vic**

Examples of CEM	Regional issues	Needs identified
A range of community monitoring programs collect useful data on issues relating to inland waters, biodiversity and estuaries and the sea.	There is no coordination system in place to enable data to be shared and integrated for wider use.	A partnership approach is needed to link regional managers with the CEM groups best placed to collect, collate and communicate the relevant changes in the environment.

Note: The issues identified in each region may not be relevant to any or all of the CCEM groups listed as examples.

**Lower Hunter and Central Coast, NSW**

Examples of CEM	Regional issues	Needs identified
Extensive community monitoring is currently being undertaken within the region including: <ul style="list-style-type: none"> <li>• water quality</li> <li>• weather</li> <li>• stream flow</li> <li>• rubbish dumping along estuaries</li> <li>• bird observations and</li> <li>• biodiversity observations by individuals, schools, community groups and individuals.</li> </ul>	Currently, community monitoring is not systematic: <ul style="list-style-type: none"> <li>• no coordination or framework for reporting information at a regional level</li> <li>• monitoring usually developed in response to particular issues in particular locations</li> <li>• monitoring is highly variable in terms of quality, accuracy and duration.</li> </ul>	<ul style="list-style-type: none"> <li>• an integrated community environmental monitoring information network based at a regional environmental resource centre with on-line links to Newcastle University, Councils, libraries and field studies centres</li> <li>• a focus on collecting environmental information to achieve concrete outcomes</li> <li>• professional coordination to maintain acceptable standards and ensure continuity.</li> </ul>

Note: The issues identified in each region may not be relevant to any or all of the CCEM groups listed as examples.

**South-west Western Australia**

Examples of CEM	Regional issues	Needs identified
<ul style="list-style-type: none"> <li>• Ribbons of Blue community water quality monitoring program</li> <li>• Western Australia Water Resources Commission program of community Stream Foreshore Assessments</li> <li>• Land Management Society on-farm monitoring.</li> </ul>	Groups not deemed suitable for state of the environment data collection lack: <ul style="list-style-type: none"> <li>• agency commitment to useable feedback</li> <li>• clear objectives for monitoring.</li> </ul>	Groups need: <ul style="list-style-type: none"> <li>• agency support</li> <li>• a simple methodology</li> <li>• access to equipment and information</li> <li>• strong links to recognised problems.</li> </ul>

Note: The issues identified in each region may not be relevant to any or all of the CCEM groups listed as examples.

**INDIVIDUALS, GROUPS AND NETWORKS**

Regional experience indicates that while individuals and CEM groups across Australia who are already voluntarily monitoring some of the indicators proposed for national use, it is the larger coordinated monitoring networks such as Waterwatch and Birds Australia that are closest to meeting the needs of resource managers

for data consistency, coverage, collation and communication.

Table 11 lists some characteristics that make CEM networks worthwhile prospects to increase the quality and availability of environmental data. The value of forming community monitoring networks is emphasised.

**Table 11**

**Typical characteristics of community environmental monitoring groups and networks**

<b>Individuals and single community environmental monitoring groups</b>	<b>State/Territory and national community environmental monitoring networks</b>
1. usually have a local focus of interest	1. act locally, but are networked regionally or nationally
2. have limited coverage	2. have broader State/Territory or national coverage
3. communicate findings to a limited circle	3. share and compare their findings
4. use widely varying collection methods	4. apply standard methods
5. are limited by self-funding	5. often have access to support funds
6. are restricted by resource limits	6. can sustain long-term monitoring
7. lack coordination	7. may have State/Territory and /or regional coordinators
8. have an interest and/or watchdog focus	8. have an educational and/or management focus
9. use a variety of record-keeping formats	9. use well-designed data sheets and databases
10. have ad hoc technical support	10. have ongoing technical support
11. learn by doing	11. provide regular theory and practice sessions
12. seldom integrate their findings with others	12. are more likely to access agency data

**LINKING STATE OF THE ENVIRONMENT PROCESSES AND COMMUNITY ENVIRONMENTAL MONITORING**

In June 1997 representatives of some of the largest and most creative of the CEM networks were gathered for a workshop in Canberra. The purpose was twofold:

1. to enable the representatives to explore common issues and share 'best practice'
2. to work out ways to bring state of the environment and CEM processes closer together.

Presentations made at the workshop are described briefly in Box 11. All are CEM programs with national relevance. SaltWatch, Watertable Watch and Waterwatch could all contribute to monitoring for the state of the environment themes of land and inland waters. AUSTAG is relevant to estuaries and the sea,

and Volunteer Weather Observers will inevitably make a major contribution to the atmosphere theme. The Birds Australia and Timelines examples demonstrate that volunteer monitoring has an important role in biodiversity monitoring on a continental scale.

This project suggests that CEM networks with reliable protocols, training programs and data recording and reporting systems are capable of producing quality environmental information. What is more, many are already actively monitoring potential environmental indicators. There is an opportunity for environmental managers and those reporting on the state of the environment to benefit from their experience and to assist with any improvements in their coverage and consistency by establishing formal links with representatives of these groups.

**Box 11**

**Examples of community environmental monitoring networks**

**The Gould League Timelines Project:**

- is a CD-ROM-based mapping program
- was made available in September 1997
- assists people to record observations of wildlife
- has all inland vertebrates and butterflies listed, and plants recorded to genus level
- has invertebrates, fungi and seaweeds recorded at family, order or class
- lists 80 activity codes for event descriptions – digging, eating, flying etc
- has an association facility (ie, a secondary animal or plant can be recorded).

*Use of the system assists in overcoming data quality problems because it:*

- helps eliminate common mistakes about names
- contains 6,000 scientific and common species names
- helps eliminate common mistakes about location
- has 211 maps at 1:100,000 showing every place name in Australia
- allows for automatic fixing of latitude and longitude as cursor moves on map
- allows data to be fed into and checked against major biological databases.

**Volunteer Weather Observers:**

- is a national Bureau of Meteorology program
- has 6,000 volunteer monitors involved across Australia
- monitors wind, temperature, humidity, pressure and cloudiness daily
- stores results on computer
- produces data used for weather forecasts, global and regional prediction models.

*Data quality is based on:*

- State, national and international standards
- instrument calibration
- regular inspections.

**SaltWatch:**

- is a Victorian salinity monitoring program
- happens one week in May, after the autumn break (most years)
- samples rivers, streams, lakes, bores and dams for salt concentrations
- usually gets 10 to 100 samples per group
- participants are 65% primary students, 30% secondary students, and 5% Landcare groups (but there are many links to Landcare)
- is recognised as a valuable part of the school curriculum, because it includes science, geography and technology
- is 10 years old and has recently expanded to include urban areas.

*SaltWatch Database:*

- relied on mailed disks for information exchange – information logged was used to create wall charts which were sent back to schools
- has used the Internet for data exchange in 1977 (off-line exchange as well). A database with mapping capacity generates maps within minutes.

*Data quality:*

- has quality control procedures using blind trials (mystery solutions).

**Watertable Watch:**

- operates through the Goulburn Valley Landcare Network
- covers most of the Shepparton irrigation region (500,000 hectares)
- water table levels are mapped by landholders on a monthly basis
- monitors are paid to collect depth data monthly @ \$2 per well
- electrical conductivity measurements are collected twice a year
- data are collated and mapped by the Institute for Sustainable Agriculture
- maps are provided back to Landcare groups.

The Landcare network started to coordinate Watertable Watch but now also addresses weeds, pests, etc. Small subcommittees address each subject in more detail. Farmers are now wanting to move from mapping to modelling, from description to prediction and to ask 'what can be done about the problem?'

**Waterwatch:**

- is a national community water quality monitoring program
- collects ongoing data from 4,000 sites in 86 catchments
- collects local information for local awareness and decision support
- uses Commonwealth funds to extend State and community efforts, for example, Victoria has 23 coordinators but only one State employee, 90 partner organisations, river authorities, water boards, shires, and 500 groups – 1/3 landcare, 2/3 schools.

The 1997 prediction is for 50,000 participants.

*Waterwatch 1994 database:*

- allowed groups to compare and contrast data nationally
- had over 60 fields
- used computer disks for off-line data sharing
- formatted all disks to standard parameters
- allowed for easy and consistent data entry
- had prompt text and help text
- relieved regional coordinators of paperwork.

*Data quality:*

- database has data checking /validation functions
- some training for participants
- State monitoring protocols.

*Waterwatch 1997 database now allows for:*

- uploading to database or downloading to email or Internet
- exporting to spreadsheet and other formats
- local or regional collation
- mandatory and optional fields.

Waterwatch strategy for 1997–2000 is to:

- generate useful data to complement other monitoring programs
- promote three tiers of involvement/expertise
  1. education and awareness
  2. monitoring
  3. AUSRIVAS standard.

**Birds Australia:**

- has been heavily involved in CEM for over 30 years
- started with the Nest Observation Program
- is currently involved in over 35 research projects.

*Atlas of Australian Birds (1977–91):*

- relied on organised observation from over 3,000 people
- generated over 3 million records
- demonstrated the success of CEM on a continental scale
- documented the distribution of species
- overcame the poor documentation of distribution that existed before 1984.

**The Australian Bird Count (1989 to 1995):**

- relied on 1,063 observers
- observed 517 bird species
- monitored 4,587 plots at 2,064 sites
- generated 78,969 data sheets
- observations followed the patterns of human settlement
- project expenditure was approximately \$300,000
- unpaid labour contribution was approximately \$27,000,000 (\$10 p/hr)!

*The Australian Bird Count Database:*

- is being interrogated to answer four questions (with the focus so far on the first two)
  1. What are the seasonal changes in the distribution and abundance of bush birds?
  2. What are the patterns of migration of migratory and nomadic birds?
  3. What habitats are important to the survival of species?
  4. What environmental factors determine the distribution of bush bird species?

*Data quality:*

- some noise, but results are very effective
- large size of the sample dilutes errors.

**AUSTAG:**

- is a national sportfish tagging program:
- is an initiative of the Australian National Sportfishing Association
- collects basic biological data on key recreational fish
- receives corporate sponsorship from a number of key companies.

*Data quality:*

- standardised data collection methods
- supported by a reference committee of prominent fisheries biologists
- Qld program is quality assured, other States to follow
- supported by fisheries agencies in all States except SA and NSW
- has joint projects in fish stock assessment with Vic and Qld fisheries.

*AUSTAG Database:*

- will conform to national Standardised Integrated Recreational Fisheries Information System standards once available
- contains 170,000 tagged fish records and 14,000 recapture records
- data is spatially referenced for geographic information system analysis (used in Qld).

**RECOMMENDED INDICATORS FOR NATIONAL STATE OF  
THE ENVIRONMENT REPORTING AND COMMUNITY  
ENVIRONMENTAL MONITORING**

This project aimed to identify synergies between state of the environment monitoring and CEM, and to integrate information from local, regional, State/Territory and national sources. Reports recommending indicators for each of the seven national state of the environment reporting themes (prepared in parallel with this project) show an awareness of the potential role of CEM when choosing indicators. (See the back of this report for a list of the reports)

The following tables highlight indicators recommended for national state of the environment reporting on land, estuaries and the sea, inland waters and biodiversity, which might be wholly or partially supported by data collected through CEM.

In some cases CEM groups may be the only means of obtaining the geographical coverage and spatial density of data required to support indicators.

**LAND**

In her report recommending environmental indicators for national state of the environment reporting on the Land, Ann Hamblin (1998) writes that:

*Some community-based programs are very successful in contributing to our knowledge of the environment.....*

*To date, however, no coordinating mechanism has been established to gather the information that is collected in a consistent and standardised format.....For this reason, none of the proposed indicators relies on community-based data gathering activities, although in several instances the quality of the indicator and its interpretation could be greatly improved if locally collected data were available. (p 24)*

Hamblin's indicator selections offer enormous scope for community involvement through the landcare movement and the other community groups. Of the 62 indicators proposed, 15 provide the most obvious opportunities for CEM involvement.

**Table 12**

**Opportunities for community involvement in state of the environment monitoring of land indicators\***

**Change in total exposed soil surface contributing to erosion**

"Because of the difficulty in distinguishing woody perennial (non-chlorophyll biomass) from bare surfaces, remote-sensed data must be supplemented by groundtruthing" (Hamblin p 28). The potential for partnerships between national, State/Territory and local data processing agencies and local community groups should be explored in all cases where indicators dependent on remote sensing data have been indicated. If this was done, geo-referenced satellite imagery and orthophotography calibrated by trained local CEM groundtruthing teams could provide more and more of the data needed for global to local state of the environment reporting.

**Total grazing pressure relative to net primary productivity by landcover region**

"The Native Grassland, Rangeland and Ecology Societies of Australia have all compiled study site locations from time to time" (Hamblin p 33).

**Non-domestic vertebrate herbivores per landcover region**

"...this is a much-needed indicator and should be supported by additional funding either at an agency or community level. (Hamblin p 36).

**Gullyng index per major catchment**

"Local evidence of gullyng may be confirmed from Landcare and other community group activities that are the subject of rehabilitation projects and granting schemes under the National Heritage Trust" (Hamblin p 41).

**Change in dust storm index relative to high wind events**

"Using the 152 meteorological stations that record daily wind run and/or wind velocity as well as other basic meteorological data, with historical records of at least forty years (most have records for over 100 years ...." (Hamblin p 41). Much of the daily wind data required to support this indicator are collected by the 6000 Volunteer Weather Observers coordinated by the Bureau of Meteorology.

**Area of pastoral properties reducing grazing damage by alternative use and feral animal control**

"Pastoralists engaged in Landcare and industry monitoring schemes may be an additional information source, through special surveys " (Hamblin p 44).

**Percent area of land affected by dryland salinity, and acidity**

Community salinity surveys using environmental monitoring survey techniques have been taking place in the Goulburn irrigation district for some years now.

**Index of measures to increase perennial vegetation cover**

"Information on the effectiveness of tree-planting (by individuals, community groups and local councils) and the replacement of annual by perennial pastures is the most difficult to obtain, principally because of the variable way in which pastures are recorded in AgStats for different jurisdictions, and the inadequacy of questions on tree planting in the Agricultural census " (Hamblin p 62).

**Rate of extension of exotic species into each IBRA**

"Garden and local government species distributions would be difficult to obtain unless through such avenues as horticultural societies and commercial interests." (Hamblin p 64).

**Number of reports of all, and of new, weeds, pests and diseases**

Many community-based weed control programs are currently monitoring this indicator (Alexandra, Haffenden & White 1996).

**Total nutrient export nitrogen, phosphorus and potassium from each AER and drainage basin**

The Slugbusters, Waterwatchers and Ribbons of Blue CEM programs in Western Australia have evolved very effective protocols and processes for monitoring Phosphorus derived from land activities on a whole-of-catchment scale (White 1995).

**Total immobile contaminant load on land area**

"In future the National Pollutants Inventory will be able to supply data on location and current use of point-source loads and data from community monitoring schemes such as the National Toxics Network (which is GIS based) " (Hamblin p 86).

**Change in status of known highly contaminated sites**

"Toxic Waste Network Database [hold relevant data]" (Hamblin p 89).

**Estimated area of pesticide application**

"Data sources: National Toxics Network, ALGA monitoring schemes listed in 'Listening to the Land' (White and Alexandra 1996)" (Hamblin p 92).

**Implementation of IPM and agri-chemical risk reduction**

"...some Landcare groups (National Landcare Program records, DPIE) [hold data]." (Hamblin p 97).

**INLAND WATERS**

Sixteen of the 53 indicators for inland waters recommended by Fairweather and Napier (1998) could draw on data collected through CEM.

While generally supportive of CEM, Fairweather and Napier (1998) have reservations about current CEM data quality, suggesting that:

Any rush to using community-generated data would fly in the face of national standardisation procedures such as National Association of Testing Authorities (NATA) accreditation, low level nutrient trials, inter-laboratory benchmarking comparisons and the like. The experience from the USA and elsewhere is that,

while not entirely useless, these programs should not substitute for scientific monitoring.

However, they further note that

*Given that community monitoring would likely extend the network of sites beyond any resources currently available to governments and research institutions, Environment Australia needs to carefully consider the role the community could play in the future.*

To test the potential value of Waterwatch data, they suggest comparative trials with certified experts to identify those parameters that could be reliably used for State of the environment purposes and as a precursor to the development of workable quality assurance/control protocols.

**Table 13**

**Opportunities for community involvement in state of the environment monitoring of indicators recommended for inland waters**

**Depth to watertable (C)**

This indicator is monitored by landholders through Watertable Watch in the Goulburn Valley, Victoria.

**Groundwater salinity (C)**

This indicator is monitored by adults and children through SaltWatch in Victoria.

**Guideline trigger levels reached (C)**

“The Secchi disk (and its Waterwatch equivalent of a fixed viewing tube with a cross at the bottom) is the simplest technology that can be employed by anyone in any water body during daylight hours. Overseas, large-scale community monitoring events such as the Great American Secchi Dip-in (held each August) are based on this technique.” (Fairweather and Napier 1998, p 20).

**Algal blooms (C)**

Waterwatch in Victoria has developed a monitoring protocol for this indicator, and some data are held by community groups

**Nutrient loads (C)**

“The maintenance/servicing of the auto-samplers can be coordinated by interested community groups” (Fairweather and Napier 1998 p 23). Waterwatch has a protocol for manually sampling nutrients.

**Pesticide exposure (P)**

Pesticides in water are currently monitored by schools and community groups in Dorset, Tasmania, using CSIRO Enzyme Link Immuno Sorbent Assays (White 1995).

**Pollution point sources (P)**

Stock dip sites in northern New South Wales have been mapped by The Toxics Network.

**Waterwatch participation (R)**

"Waterwatch is a community-based water quality program, initiated in response to the general concern over declining water quality and issues of increased salinisation and algal blooms. Originally developed as an educational program, it is now a national monitoring program

**Instream salinity trends (C)**

"...community groups .... measure salinity routinely." (Fairweather and Napier 1998 p 31) SaltWatch in Victoria has very well-developed data collection, storage and verification techniques for this indicator.

**Riparian stock access (P) and Fenced waterways (R)**

Waterwatch has developed protocols for riparian habitat assessment which may require only moderate adjustments to become completely compatible with these indicators

**AUSRIVAS survey ratings (C)**

"Links with community-based programs like Waterwatch are being actively pursued through the development of training resources for community groups and plans for their involvement in the first national assessment of river health" (Fairweather and Napier 1998 p 48).

**Frogwatch records (C)**

"This indicator is very amenable to community-based monitoring programs. Australian Frog Week (an initiative of the Frog & Tadpole Study Group of NSW), where community groups take tape recordings of frog calls, is conducted every year. Frogs are presently being monitored in some states by various organisations such as Frog & Tadpole Study Groups (NSW, Vic and South Australia), frog societies (Qld), herpetological societies, naturalist societies, Landcare groups, etc., all involving community participation" (Fairweather and Napier 1998 p 48).

**Fish kill records (C)**

"Most current registers rely on public reporting of observed kills of fish, birds, and shellfish." (Fairweather and Napier 1998 p 49)

**Waterbirds (C)**

"The Royal Australian Ornithological Union (Birds Australia) make use of observations from the public, therefore community-based input is possible" (Fairweather and Napier 1998 p 50).

**Exotic flora/fauna (P)**

"There could be community involvement, for example through weed removal programs" (Fairweather and Napier 1998 p 53).

**Consistency (P)**

"Another potential source of this may be the "watchdog" activities of academics, green politicians and community groups." (Fairweather and Napier 1998 p 55).

**Participation (R)**

"There are many community-based initiatives operating now (eg see Alexandra et al 1996) to increase awareness and care for the land, including inland waters. The most obvious of these is Waterwatch - including State variants like Streamwatch (NSW) and Ribbons of Blue (WA) - but similar schemes such as SaltWatch or Algalwatch are also relevant. More generally involvement in Landcare or TCM committees that are relevant to water issues are also applicable to this indicator" (Fairweather and Napier 1998 p 56).

**ESTUARIES AND THE SEA**

The report recommending state of the environment indicators for estuaries and the sea, (Ward *et. al.* 1998) suggests:

- using standard operating procedures (based on best monitoring practice)
- choosing simple measurements that can be obtained rapidly by relatively unskilled teams
- organising volunteers within existing community-based groups
- providing training for local people in the routine observation of simple parameters
- including volunteers in science-based monitoring programs
- combining remote sensing with groundtruthing (using trained volunteers if appropriate).

Ward *et. al.* 1998 stress the need to select the most important attributes for reporting on the state of the environment and measuring these precisely enough to provide a basis for decisions. Greater precision is not

necessary, while lesser precision is potentially misleading.

Imprecise measures on important attributes will generally be more useful for State of the Environment Reporting purposes than accurate, precise and powerful measures of minor aspects of an ecosystem (this is pseudo-power, see Ward & Jacoby 1995). Other decisions on the nature and level of surrogacy depend on the scale of measurement and the resources available. Levels of precision and accuracy required in the measuring program for any particular indicator need to be matched to the reporting needs of that indicator. Once these levels are achieved in a measurement program, further detail is redundant (Ward *et. al.* 1998, p 6)

This observation has important implications for community monitoring. CEM groups must collect data with sufficient rigour to allow change which triggers management responses to be detected. At times, this may imply using advanced techniques that require extensive training. In other cases, less precise (but still scientifically valid) techniques may be adequate.

Table 14 lists 16 indicators (from the 61 recommended for estuaries and the sea) that may be suitable for CEM involvement.

**Table 14**

**Opportunities for community involvement in state of the environment monitoring of estuaries and the sea**

**Seabird populations**

Terns, Hooded Plovers and a range of threatened species are currently monitored by Ternwatch, the Hooded Plover project and the Threatened Bird Network (Alexandra, Haffenden & White 1996).

**Algal bed area**

“Subtidal algal beds should be monitored using a combination of remote sensing tools and groundtruthing based on diver and video surveys “(Ward *et. al.* 1998 p 13). There may be scope for community diving groups to contribute to groundtruthing.

**Dune vegetation**

A possible national Coastcare and Dunecare activity.

**Intertidal Sand/Mudflat Area**

There may be a role for community groups in groundtruthing remotely sensed data.

**Mangrove area**

“... with selected groundtruthing done perhaps by local government operations and community group “ (Ward *et. al.* 1998 p 19).

#### **Saltmarsh area**

"... with selected groundtruthing done perhaps by local government operations and community group " (Ward *et. al.* 1998 p 20).

#### **Seagrass area**

"... with selected groundtruthing done perhaps by volunteers and community group " (Ward *et. al.* 1998 p 21).

#### **Algal blooms**

"The SOP (Standard Operating Procedures) would also suggest more robust sampling and observational approaches to capture better quality data on the frequency of blooms. These might involve training local community groups, volunteers and interested industries (such as aquaculture) to make routine observations of simple bloom parameters." (Ward *et. al.* 1998 p 25).

#### **Fish populations**

"Monitoring may be carried out by the community volunteers in conjunction with routine science-based monitoring at a subset of locations." (Ward *et. al.* 1998 p 29).

#### **Intertidal Reef Species**

"The University of Sydney has ongoing research programs that employ routine observational components to document the dynamics of flora and fauna on intertidal reefs, and these could form the basis for a SOP for the national State of the environment intertidal reef monitoring program" (Ward *et. al.* 1998 p 30). Professor Underwood of the University of Sydney has been training community monitors in coastal monitoring techniques.

#### **Pest Numbers**

"For some pests, particularly the macroscopic ones, monitoring might be assisted by volunteers organised and managed within community-based groups. Where they have a role, they will need to operate under an appropriate State of the environment SOP." (Ward *et. al.* 1998 p 34).

#### **Sentinel Accumulator Program**

" The field collection of materials may be assisted by specially trained volunteers derived from community-based organisations such as marine naturalist or environmental groups" (Ward *et. al.* 1998 p 51).

#### **Turbidity**

"Another strong point in favour of turbidity is that it is a straightforward field measurement that can be obtained rapidly by relatively unskilled monitoring teams. It is a measurement included in Waterwatch programs nationally. Given the simplicity of the technique and its widespread use, large volumes of turbidity data are becoming available for national evaluation and interpretation" (Ward *et. al.* 1998 p 52).

#### **Coastal care Community Groups**

"Coastcare is a popular grass-roots national movement for organising activities and action in coastal issues. A number of allied groups - such as Streamwatch, Waterwatch, Fishcare etc. - also undertake activities related to protection of aquatic habitats in catchments, beaches and in relation to fish. The participation of citizens in these groups is a measure of their awareness and concern about local coastal issues." (Ward *et. al.* 1998 p 59).

#### **Marine Network Participation**

"The Marine and Coastal Community Network is sponsored by Environment Australia. It is a national network independent of government that maintains a marine and coastal awareness service by mailing regular newsletters, and sponsoring various community-based meetings and activities" (Ward *et. al.* 1998 p 64).

**BIODIVERSITY**

The biodiversity indicators report (Saunders *et. al.* 1998) recommends several indicators that may draw on data collected by the community. While groundtruthing of remotely sensed imagery is a fruitful prospect for community involvement, the monitoring of specific populations (target taxa and the distribution of pest plants and animals) at a regional or Interim Biogeographic Regionalisation for Australia (IBRA) scale

appears to offer the greatest breadth of opportunities for CEM activities. Community organisations already excel at much species monitoring (see sections on Birds Australia and the Timelines project in Box 11).

It is also worth pointing out that State/Territory agencies, museums and herbaria – some of the proposed data sources for biodiversity information – already often rely on community contributions to build and improve their collections.

**Table 15**

**Opportunities for community involvement in state of the environment monitoring of biodiversity**

**Environmental amplitude of populations**

The report does not specifically recognise a role for CEM groups but there are numerous examples of successful monitoring of plant and animal populations by volunteers (Alexandra, Haffenden & White 1996).

**Number distribution and abundance of migratory species**

“Historic data are available on the occurrence of all birds, including migratory birds ... based on a survey of birds conducted between 1977 and 1981. This project has not been repeated, however. The data are held by the RAOU. A repeat survey should be initiated which would reflect changes over a 20 year period.” (Saunders *et. al.* 1998 p 37)

**Demographics characteristic of target taxa**

The target taxa selected will vary from region to region. It is likely that community groups will hold, or be in a position to collect, data on the demographic characteristics of a number of target taxa. Note that target taxa have not yet been selected.

**Proportion of bioregions covered by biological survey**

CEM groups hold some data relevant to this indicator.

**Area cleared to area revegetated**

Community groups such as Greening Australia hold some data relevant to this indicator.

**Involvement of community groups in the conservation of biodiversity**

“The data for this indicator would need to come from the groups themselves.” (Saunders *et. al.* 1998 p 57)

**PARTNERSHIPS BETWEEN MONITORS AND MANAGERS**

Both data gatherers and data users benefit from negotiating partnerships as early as possible in the development of a monitoring program. Negotiations establish the links between monitoring and adaptive management from the outset and enable all parties to establish their requirements and the basis of their involvement.

In this sort of partnership, the CEM group or network provides negotiated access to data and, in exchange, gains technical, even financial, support and the satisfaction of seeing environmental improvements result from their work. For data users, partnership contracts can overcome problems of irregular sampling and questionable accuracy often associated with CEM.

A quick survey of the groups named (or implied in the case of biodiversity) as potential data sources for state of the environment monitoring reveals the relationships shown in Table 16.

**Table 16**

**Groups with potential to monitor state of the environment indicators**

<b>Estuaries and the sea</b>	<b>Inland waters</b>	<b>Land</b>	<b>Biodiversity</b>
Bird observers Waterwatchers Streamwatch Environmental groups Marine naturalists Divers and dive clubs Fishers and Fishcarers Tourist operators Aquaculture industry Surfers Marine and Coastal Community Network	Bird observers Land owners Waterwatchers Streamwatch (NSW) Ribbons of Blue (WA) SaltWatch Algalwatch Landcare groups Naturalist societies, Herpetological Societies, Frog and Tadpole Study Groups (NSW, Vic & SA) & Frog societies (Qld), Integrated/total catchment management groups	Individuals Native grassland, rangeland and ecology societies Landcare groups Weather observers Rangeland monitors Pastoralists Local Councils Horticultural societies Commercial interests National Toxics Network	Individuals Bird observers Greening Australia Field naturalists Mammal survey groups and other groups listed under the other themes collecting information on biodiversity

Table 16 suggests an opportunity to:

1. arrange the groups according to their common interests (regardless of state of the environment theme)
2. select indicators of most practical use, aesthetic appeal or intrinsic fascination to these groups (again, regardless of state of the environment theme)
3. identify the industry sectors or Local, State/Territory or national government agencies with the greatest pecuniary or legislated interest in accessing data to support these indicators

4. arrange for potential data gatherers and the potential data users to spend some time together discussing the indicators they have in common
5. be prepared to formalise the relationship only after mutually acceptable arrangements have been made concerning who has custody of the data and who has 'access rights'.

Table 17 shows how national indicators can be arranged in 'suites' calculated to appeal to community groups and potential data users who may have no history of monitoring involvement but who may find this form of presentation attractive for commercial, management, educational or aesthetic reasons.

**Table 17**

**State of the environment indicator suites and potential data collectors and users**

<b>Potential data collectors and custodians</b>	<b>State of the environment indicator suites</b>	<b>Potential data users, partners and patrons from science, agencies and industry</b>
Local Government Authority conservation officers Schools Local conservation groups State Municipal Associations State conservation councils	The Urban Suite	Australian Local Government Association (ALGA) Environment groups Utilities – water, energy etc Australian Bureau of Statistics Department of Housing and Regional Development
Field naturalist groups State conservation agencies	The Field Naturalist Suite	Gould League World Wildlife Fund (WWF) Threatened Species Network Environment Australia Commonwealth Scientific Industrial Research Office (CSIRO) Wildlife and Ecology
Bird observers groups State bird observer groups	Bird Observers Suite	Birds Australia Environment Australia CSIRO Wildlife and Ecology
Airwatch groups Local Government Authority Environmental Health Officers State Environment Protection Agencies Urban conservation groups	The Atmosphere Suite	Bureau of Meteorology National Health and Medical Research Council National Environment Protection Council
Landcare groups Individual farmers State farmer organisations State agriculture departments	The Landcare Suite The Paddock Suite	Farmer Organisations Landcare Australia Department of Primary Industries and Energy
Graziers Traditional owners State farmer organisations State agriculture departments	The Rangeland Suite	Farmer Organisations Rangeland Society Industry sponsors Department of Primary Industries and Energy
Farmers Graziers Landcare groups Shire Councils	The Pest Plant Suite The Pest Animal Suite	National Farmers' Federation Industry sponsors Department of primary Industries and Energy Researchers
Catchment management committees State water agencies Waterwatch groups	The Catchment Suite	Waterwatch Murray-Darling Basin Commission
Waterwatch groups Landcare groups State agencies	The Riparian Suite	Waterwatch
Schools State education departments Subject teachers associations	The School Suite	National Curriculum Frameworks Curriculum writers
Coastcare/Dunecare groups Coastal Councils	The Coastal Suite	Commercial & Recreational Fishing organisations, Surfriders, State and Federal coastal managers
Historical societies Tourism Authorities	The Heritage Suite	Australian Heritage Commission

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## APPENDIX 1

### ENVIRONMENTAL INDICATORS SELECTED IN EACH REGION

This table lists the environmental indicators selected in each region, together with the equivalent indicators recommended for national state of the environment reporting (if any). Page numbers and indicator numbers refer to the relevant report in this series (see the back of this report for a list). Indicators that are listed in *italics* are similar, but not identical to the recommended indicators.

Further information about the indicators selected in each region is at <http://www.alga.com.au/envindic.htm>

#### INLAND WATERS

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Depth to watertable (p 12)	Depth and salinity of groundwater		Water table levels			Water table levels
Groundwater salinity (p 13)	Depth and salinity of groundwater		Area affected by saline groundwater			
Percentage of bores capped (p 14)				Number of bores capped		
Net rate of groundwater abstraction or discharge (p 15)			Groundwater extraction and recharge	Groundwater extraction and recharge Extraction/recharge volumes of bores		Levels of abstraction and recharge (especially changes in these)
Percent exceedences of water quality guidelines for a suite of bacterial and chemical water quality parameters for human health and recreation p 17)	Percent exceedences of water quality guidelines	Percent monitoring compliance with Australian Drinking Water Guidelines Percent monitoring compliance with Australian Guidelines for primary contact recreation waters Water quality monitoring effort - cost and number of samples by type of situation		Biological oxygen demand Dissolved oxygen Heavy metal concentrations in sediment Turbidity		Percentage of key river sites meeting criteria for ambient concentrations of pollutants

**Environmental Indicators  
Local and Community Uses**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
The number of water treatment plants and the levels of water treatment or filtration adopted (p 19)			Percent of plants that have primary, secondary and tertiary treatment	Level of sewage treatment		
Nutrient loads (p 22)				Nutrient concentrations	Concentrations of nitrogen and phosphorus in rivers	Nutrient concentrations
Algal blooms (p 22)			Frequency, size and content of algal blooms			Algal blooms
Pollution point sources (page 25)				Point sources of heavy metals (and toxins), and nutrients		Sewerage discharges Urban run-off
			Estimated tonnes of phosphorus and nitrogen discharged from diffuse sources	Total application of fertiliser per hectare by canegrowers		
The distribution of surface water resources by drainage division (p 32)				<b>Water storage, number of dams, dam capacity</b>		
River flow regimes (p 33)				Flow of rivers and streams Number of water conservation programs in place (and volume of potable water saved by these programs)		Flow regimes
Number of structures per kilometre of river, by type (p 39)				Dams on rivers		

**Environmental Indicators  
Local and Community Uses**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Percentage of total stream length with riparian vegetation (p 41)			Fringing vegetation species and abundance	<i>Buffer strip replanting programs</i>	<i>Area and length of riverbank revegetated or regenerated</i>	<i>Riparian management</i>
Extractive industries (p 41)				Dredging		
The degree of clearance in the catchment, as the percentage of original tree cover remaining (p 42)			Percentage of catchment area with tree cover			
AUSRIVAS survey ratings (p 46)					Abundance of macro invertebrates at a given stream point (AUSRIVAS methodology)	Macro-invertebrates
Populations of frogs in surface waters and wetlands (p 48)	Diversity of frog species			Number of frog species	Frogs and frog species present in wetlands and riverbanks	
The numbers of waterbirds of different species on wetlands and the breeding of colonially nesting species of waterbirds (p 50)					Wetland or riverland bird varieties	
Natural river or wetland habitat lost or converted to another land use (p 51)	<b>Number of wetland restoration schemes completed</b>		<b>Condition of existing fringing native vegetation</b> <b>Weeds present in wetlands, species and abundance</b>	<b>Weeds in wetlands</b>	<b>Amount of wetland or river litter, classified by weight or type</b>	Draining of wetlands
Wetland extent (p 53)						Percentage of pre-european wetland remaining
Management effort (page 55)			Number of integrated catchment management programs in place			Amount of money spent on wetland rehabilitation  Water conservation programs

**THE LAND**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Change in total exposed soil surface contributing to erosion, as a percentage of land area per landcover region, stratified by major land use (p 28)			Area under protective vegetation cover			Bare ground by time of year and slope
Total grazing pressure (p 33)						Overgrazing
Gullying index per major catchment (p 40)						Depth and length of gully
			Tonnage movement - soil loss per hectare			
Percent of land managers using agreed Best Practice by land use and/or catchment p 46)			The proportion of farmers adopting specified management practices (testing soil before applying fertiliser, tree planting, fencing off streams)			Percentage of farms under best management practice
Change in land use by catchments, AERs and landcover regions (p 51)	Percentage of area of region in various land uses/crops		Land use by type: grazing - improved pasture; grazing - unimproved pasture; cropping; horticulture; urban; forestry; conservation; multiple land use			
Fire control measures compared with natural fires (p 55)			Number of prescribed fires ignited as part of management plans			

**Environmental Indicators  
Local and Community Uses**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Percent area of land affected by dryland salinity (p 59)			Area of salt affected land			Area of salt affected land
				Distribution and outbreaks of acid sulphate soils		
Rate of extension of exotic species into each IBRA, and of change in their abundance (p 63)	Distribution and abundance of weed species		Density and distribution of weeds and vertebrate pest species	Density and distribution of weeds and vertebrate pest species	Coddling moth spread Weed species abundance and rate of spread (in forests)	
Effectiveness of reduction in damage caused by weeds, pests and diseases that are harmful at ecosystem scale (p 71)				<i>Number of weed control programs implemented during the reporting period</i>		<i>Number of weed control programs</i> <i>Wild Dog Management Reports</i> <i>Pest Management Information System</i>
Dollar value of pesticides sold per land use (p 87)					<i>Concentration of toxic agricultural products dispersed into waterways</i>	
Change in status of highly contaminated sites (p 89)		Number of identified potentially contaminated sites rehabilitated to appropriate levels for that use  Number of potentially contaminated sites identified and area of contamination in hectares			An inventory of sites with on site soil contamination  <i>The level of biological activity in the soil (number of worms)</i>	

**BIODIVERSITY**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Extent and rate of clearing, or major modification, of natural vegetation or marine habitat (p 19)		Area of land cleared in previous year	<i>Area of agricultural clearing per year</i>	Area of land cleared annually  Forest clearing		Vegetation clearance
Location and configuration or fragmentation of remnant vegetation and marine habitat (p 21)	Distance between remnant vegetation patches		Number and size of vegetation fragments and corridors			Fragmentation of vegetation
Number and percentage of species presumed extinct, endangered or vulnerable (p 33)				Number of species that are rare or threatened at the local (rather than national) scale. Broken down into rare and threatened flora and rare and threatened fauna		Threatened species - population and distribution
The demographic characteristics (population size and breeding success) of species selected to illustrate the results of conservation actions) (p 37)	Number and locations of rare and threatened species		Number and distribution of: marron, frogs, and chuditch			Presence or absence of key indicator species
The number, identity, condition, and area of native vegetation types (p38)	Area of remnant vegetation patches	Total area of native vegetation cover within local government area and as percentage of total area of local government area			The number and distribution of forest patches, classified by type	Hectares of old growth forests

**Environmental Indicators  
Local and Community Uses**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Extent of each vegetation type and marine habitat type within protected areas (p 42)	Area of protected habitats	Area within protected conservation reserves within each local government area and as a percentage of area of local government area	Extent of natural vegetation cover and quality  Number and area of different coastal habitat or ecosystem types protected	Area and percent of each vegetation type (including lakes and lagoons) incorporated in protected areas		
The number of protected areas with management plans (p 43)	Percent of protected habitats with management plans					
The area of native vegetation cleared by vegetation type compared with the area revegetated (p 49)	<b>Number of bushcare schemes to restore native vegetation</b>			Area of land revegetated or being allowed to regenerate  Number of trees planted per annum		Revegetation
Number of management plans for exotic (or alien) and genetically modified organisms... compared with the number naturalised (p 51)				Number of management programs for exotic species compared with number of species naturalised		Pest/feral management programs

**ESTUARIES AND THE SEA**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Marine species rare, endangered and threatened (p 12 - see also biodiversity)				Species number of whales, turtles, dugongs, and selected fish		
Seabird populations (p 12 - see also biodiversity)				Number of seabirds and locations of populations throughout the Great Barrier Reef Marine Park	Numbers of estuarine/sea birds and estimated number of breeding pairs	
Coral reef area (p 15)				Area of live coral reefs		
Dune vegetation (area of dunes covered by vegetation) (p 16)	Percent area coastal sand dunes unvegetated		Area of dune, samphire, saltmarsh vegetation	Area of dune, samphire, saltmarsh vegetation		Area of marine habitats
Intertidal sand/mudflat area (p 17)				Area of mudflats and sandflats		Area of marine habitats
Mangrove area (p 18)				Area of mangroves by major species and assemblages		
Saltmarsh area (p 19)				Areal extent of saltmarshes by major species and assemblages		Area of marine habitats
Seagrass area (p 21)			Area of seagrasses by major species and assemblages	Area of seagrasses by major species and assemblages <b>Condition of seagrasses</b>		Area of marine habitats
Beach and dune area (p 14)			<b>Area of dune erosion due to human activities</b>			Area of marine habitats
Dune species (species composition and populations of coastal dune habitats) (p 28)	Species diversity of sand dune vegetation					
Nutrient loads (Inland Waters, p 22)			Loads of nitrogen from rivers to estuaries and the sea	Loads of nitrogen and phosphorus from rivers to estuaries and the sea		

**Environmental Indicators  
Local and Community Uses**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Native species that outbreak in population explosions (or blooms), and the general locations and areas affected (p 38)				Distribution of crown of thorns starfish outbreaks		
Chlorophyll concentrations (p 40)				Chlorophyll a concentrations in estuaries		
Fish stocks (p 43)				Status of commercial stocks (recruitment index, breeding stock index, age structure, ratio of actual to expected catch)		Fish catch and stock
Seafood quality (contamination) (p 44)					Levels of toxins in select marine creatures	
				The extent and incidence of dredging operations in major ports throughout the Department of Environment's far northern region		
Water nutrients (p 54)				Nitrogen and phosphorus concentrations in estuaries		
The nature and cost of beach rehabilitation and stabilisation works (p 58)			Time and money spent on dune tracks, fencing, maintenance and rehabilitation			
Coastal discharges (p 60)	Quantity of sewage effluent pumped to nearshore waters			Number of sewage outlets to ocean Ocean stormwater pollution levels Point source discharges of N, P - tonnes of N and P		

**Environmental Indicators  
Local and Community Uses**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
				Point source discharges of a range of heavy metals		
					Coliform levels at beaches and estuaries	
Coastal population (p 61)			Size and distribution of coastal population  <i>Area of coastal land classified as developed, undeveloped and protected.</i>	Size and distribution of coastal population		Number of residents
Coastal tourism (p 61)				Number of visitors		Number of visitors
				Number of approvals for activities in GBRMPA		
Ship visits (p 66)				Number of ship visits per major port		
				Number of ships (by tonnage) piloted and unpiloted arriving/ departing Cairns seaport  Volume of ballast water discharged within port limits. Volume discharged out of port limits and volume treated (express also as percent)		
Shipping accidents, together with ..... material lost to the environment (p 67)				<i>Volume of oil spilled into marine and estuarine waters</i>  <i>Number of sea dumping permits issued and volume of dumped material</i>		
Sea level (p 69)	Sea level		Sea level			

**THE ATMOSPHERE**

<b>National</b>	<b>Southern Region of Councils</b>	<b>Lower Hunter and Central Coast</b>	<b>South West Western Australia</b>	<b>Far North Queensland Regional Organisation of Councils</b>	<b>Huon Valley</b>	<b>Gippsland*</b>
Average daily rainfall (p 12)		Local rainfall records and distribution		Monthly rainfall distribution at key centres throughout Far North Queensland		
Occurrence of rainfall extremes (p 13)			Rainfall intensity, the maximum rainfall in 24/72 hours for each month, frequency of extreme dry or extreme wet	Rainfall intensity, the maximum rainfall in 24/72 hours for each month, frequency of extreme dry or extreme wet		
Occurrence of tropical cyclones (p 15)				Number of cyclones recorded in the Far Northern Region of the Department of Environment		
Concentrations of air pollutants (sulphur dioxide, ozone, lead, particles, nitrogen dioxide, and carbon monoxide) in urban areas - six separate indicators	Level of sulphur dioxide measured at Christies Beach	Number of exceedences of air quality goals	Nature and level of air borne solids dusts and pollens			Concentrations of oxides of nitrogen, sulphur dioxide, ozone, and particulates
Emission of air pollutants in urban areas (p 43)		Inventory of emissions from different land uses/premises				
	Number of pollution complaints received by councils					
Meteorological conditions that exacerbate air quality problems (p 43)		Number of days per year with stable weather conditions				
Motor vehicle use (p 47)				Volume of liquid and gaseous petroleum fuel sold		

**HUMAN SETTLEMENTS**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Total energy use Indicator 1.1	Per capita consumption of energy	Energy consumption per capita for domestic purposes and industrial consumption		Level of energy consumption per household		
Percentage of annual energy supplied from renewable sources Indicator 1.7		Proportion of energy from renewable sources				
Total annual water use by sector Indicator 2.3	Per capita consumption of water	Annual per capita domestic water consumption and industrial consumption	Municipal water consumption			
		Percent households serviced with treated water				
		Percent households connected to a sewage system	Percent population served by sewage treatment plants			
Land converted from non-urban to urban uses Indicator 3.2		<b>Area of bushland zoned for urban purposes</b> <b>Annual area of residential and rural residential subdivision</b>				Loss of prime agricultural land
Public urban green space per capita Indicator 3.3	Percent land as public open space		<b>Percent of remnant vegetation in public open spaces</b>			Percent open space
Car ownership Indicator 4.2		Total number of motor vehicles registered by type  Motor vehicle ownership per capita	<b>Traffic volume</b>			

## Environmental Indicators Local and Community Uses

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Total time and distance travelled Indicator 4.9		Annual average vehicle kilometres travelled by type of vehicle				
The modes of transport used for trips of different purposes Indicator 4.8		Proportion of journeys by private and public transport				
Population and household growth rates Indicator 5.1	Population of region	Annual number of new dwellings approved	Population density - approval for subdivision/ urban development	Density of population in cities and towns		Population trends over time
Visitor numbers Indicator 5.4			Number of visitors	Number of visitors to Far North Queensland and Wet Tropics Tourist sites		Tourism/ recreation
		<i>Annual number of admissions to hospitals with respiratory illnesses</i>				
Exposure to aircraft noise Indicator 9.2				Measures of aircraft noise over residential and wildlife areas		
				Number of exemptions granted/used for special purpose events (eg motor sports, speed boat racing, concerts)		
				Number and type of complaints to the Pollution control Authority or Police about noise		
Domestic solid waste generated Indicator 10.1		Quantities and composition of waste generated		Volume of solid waste generated		

**Environmental Indicators  
Local and Community Uses**

National	Southern Region of Councils	Lower Hunter and Central Coast	South West Western Australia	Far North Queensland Regional Organisation of Councils	Huon Valley	Gippsland*
Domestic solid waste disposed to landfill Indicator 10.2  Waste recovered - recycled Indicator 10.3		Quantities and composition of waste disposed	Volume of waste recycled by type eg. paper and cardboard, metal, glass etc	Number of solid waste disposal sites and tonnes of solid waste disposed  Number of households recycling  Number of councils with recycling schemes in operation  Volume of waste recycled by type eg. paper and cardboard, metal, glass etc		Percent waste to landfill  Percent waste diverted to recycling or re-use
	Quantity and type of litter by source					
		Percent population with a high concern for the environment  Ranking of specific environmental concerns among population  % population satisfied with environmental management				

**HERITAGE**

Number of sites listed on heritage registers	Number of heritage listed sites			Number and nature of identified heritage listed sites, structures and landscapes		Number of heritage listed sites
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\* The Gippsland pilot identified potential indicators, not those that would be used by local managers. This table only lists those indicators that are in common with national recommendations.

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## LIST OF ACRONYMS

ALGA	Australian Local Government Association	EA	Environment Australia
ANZECC	Australian and New Zealand Environment and Conservation Council	EPA	Environment Protection Authority
CALM	Conservation and Land Management (WA department of)	FNQ	Far North Queensland
CALP	Catchment and Land Protection Boards (Vic)	GDL	Gippsland Development Ltd
CEM	Community environmental monitoring	GIS	Geographic information system
CMA	Catchment Management Authority (Vic)	IBRA	Interim Biogeographic Regionalisation for Australia
CCG	Catchment Coordinating Group (WA)	IMCRA	Interim Marine and Coastal Regionalisation for Australia
CSIRO	Commonwealth Scientific and Industrial Research Organisation	LCC	Victorian Land Conservation Council
DCE	former Victorian Department of Conservation and Environment	LGA	Local Government Authority
DCFL	former Victorian Department of Conservation, Forests and Lands	NIC	National Indicator Coordinator
DCNR	former Victorian Department of Conservation and Natural Resources	OECD	Organization for Economic Cooperation and Development
DEP	Department of Environmental Protection	PSR	Pressure-state-response
DEST	Commonwealth Department of the Environment, Sport and Territories (now Department of the Environment, Environment Australia)	RCS	Regional catchment strategy
DNRE	Department of Natural Resources and Environment	RES	Regional environmental strategy
DPH	Victorian Department of Planning and Housing	REMS	Regional environmental management strategy
DPIE	Commonwealth Department of Primary Industries and Energy	RFA	Regional Forest Agreement
		ROC	Regional Organisation of Councils (sometimes referred to as a VROC)
		SROC	Southern Region of Councils South Australia
		SWWA	South-west Western Australia
		SW(WA)LGA	South West (WA) Local Government Association

## LIST OF ENVIRONMENTAL INDICATOR REPORTS

Environmental indicator reports for national state of the environment reporting are available in seven themes. An eighth report in the series examines community and local uses of environmental indicators. Bibliographic details are as follows:

### Human Settlements

Newton P., J. Flood, M. Berry, K. Bhatia, S. Brown, A. Cabelli, J. Gomboso, J. Higgins, T. Richardson and V. Ritchie (in prep.) *Environmental indicators for national state of the environment reporting – Human Settlements*, Australia: State of the Environment (Environmental Indicator Reports), Department of the Environment, Canberra.

### Biodiversity

Saunders D., C. Margules, & B. Hill (1998) *Environmental indicators for national state of the environment reporting – Biodiversity*, Australia: State of the Environment (Environmental Indicator Reports), Department of the Environment, Canberra.

### The Atmosphere

Manton M. & J. Jasper (1998) *Environmental indicators for national state of the environment reporting – The Atmosphere*, Australia: State of the Environment (Environmental Indicator Reports), Department of the Environment, Canberra.

### The Land

Hamblin A. (1998) *Environmental indicators for national state of the environment reporting –The Land*, Australia: State of the Environment (Environmental

Indicator Reports), Department of the Environment, Canberra.

### Inland Waters

Fairweather P. & G. Napier (1998) *Environmental indicators for national state of the environment reporting – Inland Waters*, Australia: State of the Environment (Environmental Indicator Reports), Department of the Environment, Canberra.

### Estuaries and the Sea

Ward T., E. Butler, & B. Hill (1998) *Environmental indicators for national state of the environment reporting – Estuaries and the Sea*, Australia: State of the Environment (Environmental Indicator Reports), Department of the Environment, Canberra.

### Natural and Cultural Heritage

Pearson M., D. Johnston, J. Lennon, I. McBryde, D. Marshall, D. Nash, & B. Wellington (in prep.) *Environmental indicators for national state of the environment reporting – Natural and Cultural Heritage*, Australia: State of the Environment (Environmental Indicator Reports), Department of the Environment, Canberra.

### Local and Community Uses

Alexandra J., J. Higgins & T. White (1998) *Environmental indicators for national state of the environment reporting – Local and Community Uses*, Australia: State of the Environment (Environmental Indicator Reports), Department of the Environment, Canberra.

SoE Reporting homepage:  
<http://www.erin.gov.au/environment/epcg/soe.html>