



Cooperative Research Centre for Coastal Zone, Estuary & Waterway Management

# ESTUARINE, COASTAL AND MARINE INDICATORS FOR REGIONAL NRM MONITORING



*Executive Summary  
and Recommendations*

Report to DEH, MEWG, ICAG.  
May 2004

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# Executive Summary: Prologue to the Users' Guide for Estuarine, Coastal and Marine Indicators for Regional NRM Monitoring

May 2004

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This report was commissioned by the Australian Government Department of Environment and Heritage (DEH) For the Monitoring and Evaluation Working Group (MEWG) and Intergovernmental Coastal Advisory Group (ICAG).

**Important:** The advice in this document is provided to the Monitoring and Evaluation Working Group for their consideration. It does not represent guidance that has been agreed to by the Monitoring and Evaluation Working Group. For agreed advice, please refer to the Australian Government's 'Natural Resource Management Monitoring and Evaluation and Standards and Targets' website ([www.deh.gov.au/nrm/monitoring](http://www.deh.gov.au/nrm/monitoring)).

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## Context, purpose and structure of the Users' Guide

The estuarine, coastal and marine indicators package is designed to assist in the identification and selection of indicators that are relevant to a specific NRM region to meet the monitoring needs specified under NHT2 (Natural Heritage Trust) and NAP (National Action Plan for Salinity and Water Quality).

The matter to be addressed through these indicators is: 'Estuarine, Coastal and Marine Habitat Integrity'. We consider this to refer to the ecosystems (habitats and communities) within the estuarine, coastal and marine biomes. Two indicator headings are identified in the Monitoring and Evaluation Framework relating to this matter for target:

- (1) Estuarine, coastal and marine habitat condition; and
- (2) Estuarine, coastal and marine habitat extent and distribution.

This document serves to further specify indicators under these headings.

The purpose of monitoring is to assess the performance of programs, strategies and policies in terms of their achievements towards improved natural resource condition. Specifically, these indicators will: "be used to monitor changes in resource condition associated with each program, strategy or policy" (*National Natural Resource Management Monitoring and Evaluation Framework, 2003*).

The purpose of monitoring the indicators identified in this document is to monitor the impact of specific regional management actions on natural resource condition within the estuarine, coastal and marine ecosystems. It is intended they will be used by regional NRM bodies (and other groups) to assess the performance of their management actions.

The Monitoring and Evaluation Working Group (MEWG) has specified that these indicators directly assess the condition of natural resources, rather than the pressures upon them. Refer to Section 3 for a discussion on pressure indicators.

This document builds upon the significant work already undertaken in developing indicators. It does not seek to invent new indicators, but rather bring together relevant indicators and other information about estuarine, coastal and marine ecosystems to meet the monitoring needs for regional NRM monitoring as specified by the MEWG.

To meet the objective of monitoring changes in natural resource condition in response to management actions, it is anticipated that different coastal NRM regions will have different monitoring needs because:

- (1) NRM issues, and therefore the management actions implemented to address them, will vary between coastal NRM regions; and
- (2) Habitats and communities that exist within the estuarine, coastal and marine continuum will vary between coastal NRM regions.

At the same time, a key objective of the monitoring and evaluation framework is that specific indicators that are used in multiple NRM regions should be nationally consistent to allow for comparisons and maximise efficiency of effort.

To allow for the regional variability in ecosystem types as well as NRM issues, we have developed a framework for selecting indicators, which are accompanied by guidelines for their use. This framework allows users the flexibility to monitor NRM outcomes by using indicators that are relevant to their regional ecosystems and NRM issues, while using consistent monitoring approaches.

The framework for the selection of estuarine, coastal and marine ecosystem extent and condition indicators is based on coastal NRM issues, so that regional NRM groups monitor only indicators relevant to their issues and corresponding management actions. The framework also considers the range of ecosystem types present (and that appropriate indicators may differ in different ecosystem types).

Because NRM issues can be identified at a range of spatial and temporal scales, rather than attempting to identify all of these issues, we have used a defined number of 'stressors' in the framework. Section 3 provides more information on stressors.

The framework does not identify indicators in relation to specific community held values, but rather identifies indicators for specific stressors in the environment. These stressors will be the targets of management actions, which are in turn influenced by community values. It is assumed that regional NRM groups will use appropriate methods to identify management actions, including identifying community held values for the use of regional natural resources.

### **The process for identifying indicators using the Users' Guide:**

The key steps to using this document to assist in identifying indicators of changed natural resource condition in response to management actions are listed below and summarised in Figure 1.

1. Familiarise yourself with the nature of the estuarine, coastal and marine ecosystems in your NRM region. Each coastal NRM region will have different habitats and communities present. Section 2 provides some basic information about the types of habitats and communities present in estuarine, coastal and marine ecosystems around Australia.
2. Use the NRM issues identified in your regional NRM plan, (i.e. important NRM issues to be addressed through management actions over coming years), to identify which of the 15 stressors listed in Section 3 are important or relevant to your NRM region of interest.
3. Using Section 3, for each selected stressor, identify the possible indicators under the three indicator categories (Physical-Chemical condition, Biological condition and Habitat extent). For some stressors, more than one indicator may be recommended. In this case, use the 'Indicator profiles' information provided in Section 4 to choose the most appropriate indicator for your situation.
4. Refer to the 'Indicator profiles' information provided in Section 4 to obtain information which will help identify which of the possible indicators may be most applicable, based upon the resources available, the complexity of the indicator (in terms of data collection, and data interpretation and analysis) and whether other organisations may already collect data for this indicator. These profile sheets will also provide guidance on standard methodologies for using the indicator.

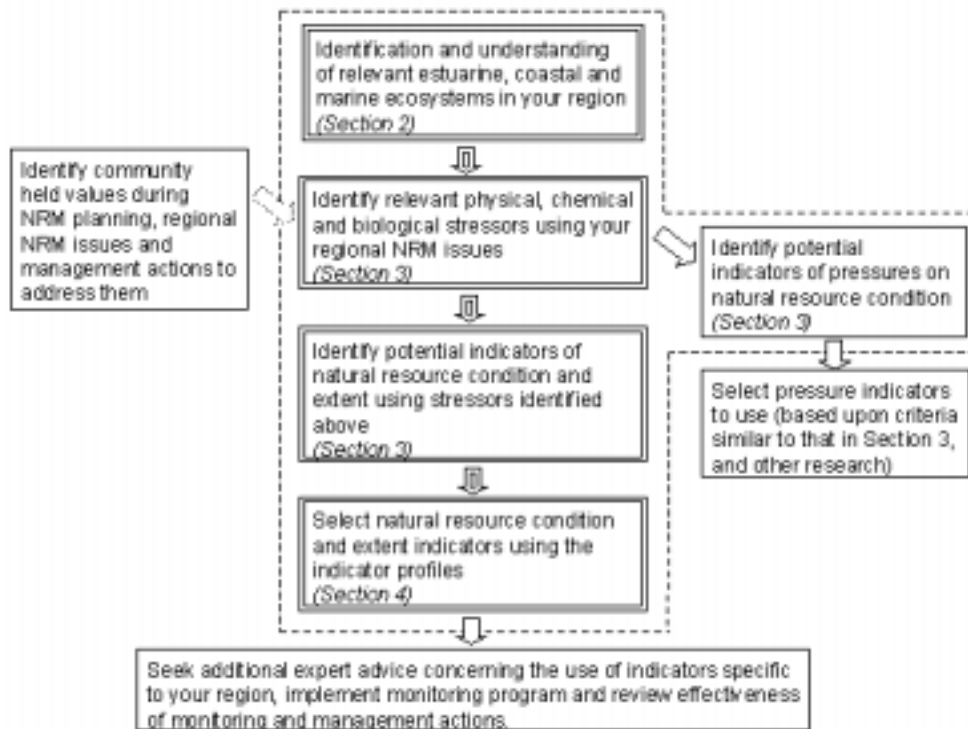


Figure 1. Overview of process for identifying estuarine, coastal and marine indicators for regional NRM monitoring using this document. This document addresses the actions within the dashed box.

### Estuarine, coastal and marine ecosystems and geographical extent

Estuarine, coastal and marine ecosystems form a continuum comprising a diversity of habitats and communities, extending from the landward influence of saltwater out to the oceans. The importance of these ecosystems and the types of communities and habitats that exist within estuarine, coastal and marine ecosystems are described in section 2 of the Users' Guide. The key habitats and communities are identified in Figure 2.

With respect to the seaward extent of estuarine, coastal and marine ecosystems, NRM regions will define their own geographical area of interest. For the purposes of this project, we consider NRM regions may extend to three nautical miles off the coastline, therefore potentially including marine ecosystems but excluding ecosystems beyond the continental shelf (i.e. deep water marine ecosystems).

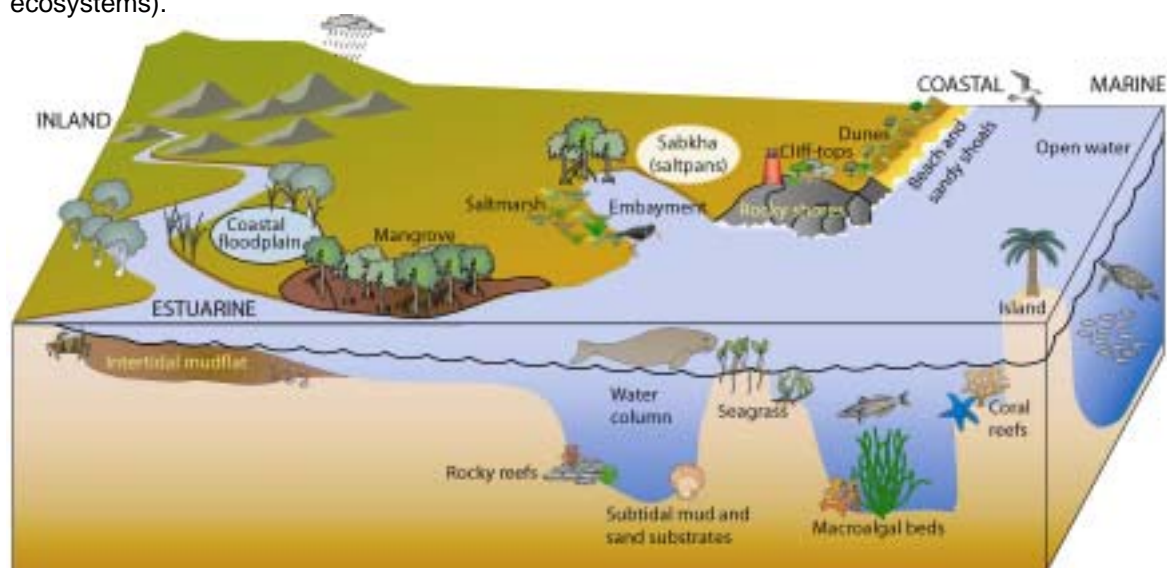


Figure 2. Common communities and habitats present within estuarine, coastal and marine ecosystems.

## Identifying indicators based on NRM issues and environmental stressors

The indicators framework is designed to encourage the selection of indicators based upon regional situations. However, stakeholders do not all use the same language when describing NRM issues. The way in which NRM issues are defined can vary on temporal and spatial scales (e.g. elevated chlorophyll concentrations versus climate change). They may also be defined as *causes* of natural resource problems, or *symptoms* of natural resource problems (e.g. inappropriate land clearing versus turbid water). Or they can be defined as a change in the state of a naturally occurring component of the environment (e.g. changed freshwater flows or elevated nutrients). It is not possible to compile a comprehensive list of NRM issues and identify specific indicators for each.

To provide a common starting point in the process of selecting indicators, the key environmental stressors important to estuarine, coastal and marine ecosystems are used rather than specific NRM issues. Figure 3 shows the relationship between environmental stressors and the causes and symptoms of natural resource 'problems' – all are commonly used to describe NRM 'issues'.

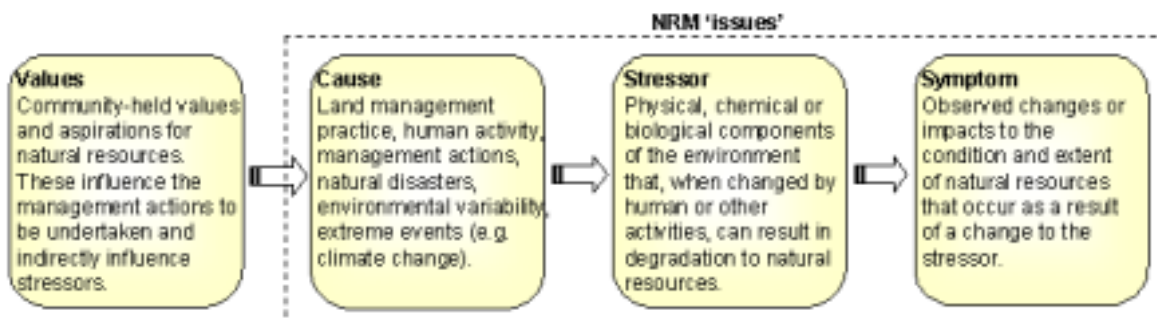


Figure 3: Relationship between values, causes, stressors and symptoms as used in the Users' Guide.

Physical, chemical and biological stressors are major components of the environment that, when changed by human or other activities, can result in degradation to natural resources.

The stressors used in the indicators-selection framework are:

- Aquatic sediments** (changed from natural) – Change to load, distribution/movement patterns, settlement/resuspension rates, grain size of suspended or settled sediments
- Bacteria/pathogens** – Bacteria, viruses, protozoans or fungi that cause disease
- Biota removal/disturbance** – Removal, loss or disturbance of individual organisms of a specific species, not areas of habitat
- Excess Freshwater** (hyposalinity) – Localised or point source discharge of freshwater (not diffuse catchment run-off)
- Excess Salt** (hypersalinity) – Localised or point source discharge of salt or salty water
- Freshwater flow regime** (changed from natural) – Changes to pattern/amount of catchment waters entering estuarine and coastal systems
- Habitat removal/disturbance** – Removal, loss or disturbance of large areas of habitat, such as those listed in the 'Key habitats' indicator profile
- Hydrodynamics** (changed from natural) – Changes to local patterns of waves, currents or tidal exchange
- Litter** – Human-made rubbish/debris
- Nutrients** (changed from natural) – Change to load, bioavailability, concentrations of nutrients
- Organic matter** (changed from natural) – Organic matter is carbon-based material derived from plants or animals (e.g. decaying plant matter or animal wastes). It can be in either dissolved or particulate forms
- Pest (plant, animal) species** – An invasive organism that is detrimental to an ecosystem
- pH** (changed from natural) – Acidity or alkalinity of water
- Toxicants** – Loads, concentrations or bioavailability of pesticides, herbicides, organics, oils, hydrocarbons, metals, metalloids, organometallics, radiation, other toxic chemicals and contaminants
- Water temperature** (changed from natural) – Local and surface water (sea, estuary) temperature

Section 3 of the Users' Guide provides information for users to identify indicators based upon the relevant stressors, which are based upon the relevant NRM issues, by following these basic procedures:

- (1) Read through the NRM issues listed (i.e. potential cause and symptom lists) and mark those that have been identified through the regional NRM plan as being important and to be addressed with NRM actions;
- (2) Identify the stressors that are listed as related to those NRM issues;

- (3) Identify the recommended *potential* indicators to monitor for changes in natural resource condition related to a change in the selected stressor. The indicators are listed under three categories:
- (1) Estuarine, coastal and marine habitat condition – Physical-chemical condition;
  - (2) Estuarine, coastal and marine habitat condition – Biological condition; and
  - (3) Estuarine, coastal and marine habitat extent and distribution.

Users should, where possible, select indicators from all three categories. Table 1 provides a summary of the indicators recommended in the Users' Guide and the stressors they relate to; and

- (4) Refer to Section 4 for profiles on each indicator to assist in further identifying the most appropriate indicators to monitor.

Table 1. Indicators recommended in the Users' Guide and the stressors they relate to.

INDICATOR	STRESSORS														
	Aquatic Sediments	Bacteria/pathogens	Biota removal/disturbance	Excess freshwater	Excess salt (hypersaline)	Freshwater flow regime	Habitat removal/disturbance	Hydrodynamics	Litter	Nutrients	Organic matter	Pest (plant, animal) species	pH	Toxicants	Water Temperature
<b>Physical-chemical condition</b>															
Dissolved oxygen										✓					
Estuary mouth opening/closing						✓		✓							
pH													✓		
Presence / extent of litter								✓							
Salinity			✓	✓	✓		✓								
Sedimentation/erosion rates	✓														
Total nutrients in the sediments WITH dissolved nutrients in the sediments										✓					
Total nutrients in the water column WITH dissolved nutrients in the water column										✓					
Toxicants in biota														✓	
Toxicants in the sediment														✓	
Turbidity / water clarity	✓														
Water current patterns								✓							
Water soluble toxicants in the water column														✓	
Water temperature															✓
<b>Biological condition</b>															
Algal blooms								✓		✓					
Animal disease / lesions													✓		
Animal kills											✓		✓	✓	
Animal or plant species abundance	✓	✓				✓									
Animals killed or injured by litter								✓							
Benthic microalgae biomass								✓		✓					
Biomass, or number per unit area, of macroalgae								✓		✓					
Biomass, or number per unit area, of epiphytes								✓		✓					
Chlorophyll a								✓		✓					
Coral bleaching															✓
Death of marine mammals, endangered sharks and reptiles caused by boat strike, shark nets or drum lines		✓													
Occurrence of imposex														✓	
Pest species (number, density, distribution)											✓				
Targeted pathogen counts	✓														
<b>Habitat extent</b>															
Extent/distribution of key habitat types	✓					✓									
Extent/distribution of subtidal macroalgae										✓					
Seagrass depth range	✓														

## Pressure indicators

Pressure indicators are not identified in the main indicator framework because the national monitoring and evaluation framework specifies indicators should represent the condition of natural resources. However, in measuring the impact of management actions on the condition of natural resources, other approaches, such as the Australian Government's State of the Environment (SoE) reporting ([www.deh.gov.au/soe](http://www.deh.gov.au/soe)), recommend including pressure indicators because they more directly respond to management actions.

The Users' Guide provides a list of possible pressure indicators against each of the stressors identified above. These indicators have not been subjected to the same rigorous selection process as the condition and extent indicators and the document does not provide indicator profiles on each of these.

Pressure indicators are divided into two categories, direct and indirect measures. Direct indicators measure the actual pressure influencing a stressor (e.g. measuring the actual change in median freshwater input as a pressure on freshwater flow regime, or the discharge of nutrients from a sewage treatment plant). Indirect indicators are a surrogate measure of the pressure influencing a stressor (e.g. measuring the percentage of median annual freshwater flow impounded or extracted as a pressure on freshwater flow regime). Some of these pressure indicators may also be used by regional NRM groups in developing/as management action targets, especially the indirect indicators.

## Indicator profiles

Section 4 of the Users' Guide contains profiles on each of the 31 indicators, using the standard template requested by MEWG, but also including some additional types of information. The document intends to provide enough information for users to identify indicators suitable to their regional NRM monitoring needs and guidance on the standard use of those indicators. The document recommends users seek expert advice to confirm the suitability and use of the indicators in their regional context, and provides details on where such expert advice can be sought.

The profiles include information on:

- Definition

- Rationale

- Key information - Stressors this indicator is recommended for, relationship to other stressors and the NRM issues this indicator will be most relevant for; cost per sample, complexity – data collection, complexity – data interpretation and analysis, organisations that can provide additional information.

- Monitoring methods: locations, frequency, data measurement, data analysis and interpretation, data storage

- Monitoring and reporting products

- Proposed responsibilities

- Links to other indicators and matters for targets

- Further information and references

- Glossary

## Integrated reporting

Section 5 of the Users' Guide contains a brief discussion on the value and methods for aggregating data from individual indicators for integrated reporting.

The primary purpose of a monitoring program using indicators identified through the processes described in this document is to provide information about the impact and effectiveness of regional NRM actions on the condition of that region's natural resources. Therefore, reporting will be most relevant at the regional scale. Guidance for assessing and reporting of individual indicators is provided in the indicator profiles contained in the Users' Guide (Section 4).

However, an NRM region may seek to provide an integrated regional report of regional natural resource condition. Such integrated reports have proven to be powerful communication products with the wider community. The responsibility for state-wide or nation-wide reporting of environmental condition, using the indicator data produced by NRM regions is the responsibility State/Territory and the Australian Government. Some of the comments provided in the Users' Guide may be useful for this wider-scale reporting, but these agencies may devise alternate methods for integrated reporting.

## ***Recommendations coming from the Project***

### **1. Pressure indicators needed**

From workshop participants and project team: it is recommend that pressure indicators be identified as they more directly respond to management actions and will, therefore, be better in measuring the impact of management actions on the condition of natural resources. Pressure indicators would directly provide information on the causes of changes to natural resource condition and in some cases, directly measure the stressor itself (rather than the impact of the stressor on natural resource condition).

Refer to section 3 of the Users' Guide for a discussion on pressure indicators and of their value. A list of potential pressure indicators, which could be used for specific stressors, has been included in the Users' Guide but not to the same extent as the condition indicators (i.e. no pressure indicator profiles are provided).

### **2. Indicators must be based on issues**

From workshop participants and project team: as these indicators are to be "used to monitor changes in resource condition associated with each program, strategy or policy" (i.e. management actions), the indicators must be based around NRM issues and not just general ecosystem health/condition monitoring. The results of the indicator monitoring program must be able to be related back to the management actions performed by NRM bodies (against a NRM issue). This approach was adopted in the project.

### **3. Cannot use just '5 standard' indicators across Australia**

From workshop participants and project team: indicators must target only relevant NRM issues. Due to the variation in NRM issues, habitats present, current ecosystem condition and community-held values between regions there cannot be a small number of indicators to be used by all regional bodies across Australia. This approach was adopted in the project.

### **4. Need for conceptual models**

From workshop participants and project team: conceptual models need to be developed, illustrating the relationships between: NRM management actions and impacts/responses by natural resources (i.e. ecosystem processes and condition); and showing the interrelationships between multiple NRM issues, multiple stressors and ecosystem processes.

In addition to helping investigators clarify the relationships among multiple causes and multiple effects, conceptual models are also powerful tools for communicating between the investigative team and stakeholders.

### **5. Need for an electronic version/web-based framework**

From workshop participants and project team: there is a need for an electronic version of the framework. This would allow the relating of any NRM issues with indicators via stressors to be done easily by regional bodies and other stakeholders. Users could search for key NRM issues or associated terms which would further enhance the identification indicators based upon NRM issues.

### **6. Information dissemination**

From workshop participants: there is a need for benchmarks, guidelines and reference condition values, as well as information on how to use indicators, to be provided to regional bodies. Regardless of the use of the User's Guide by MEWG or DEH, it provides a valuable resource to regional NRM groups and should be made available (if required, stating its use as 'additional resources' rather than MEWG agreed advice).

However, although the Users' Guide makes a valuable contribution to this need, training, such as workshops, on the use of indicators and designing monitoring programs would further increase the capacity of regional groups to undertake effective regional monitoring.