Australian Government

National Land & Water Resources Audit

An initiative of the Australian Government

ESTUARINE, COASTAL AND MARINE HABITAT INTEGRITY

INDICATOR HEADING

Estuarine, coastal and marine habitat condition

INDICATOR GUIDELINE

Animal or plant species abundance

Animal or plant species abundance

Recommended by the Audit for further consideration

This version of the guideline has been developed through the National Land and Water Resources Audit and was informed by expert review and broad consultation on national indicators via national coordination committees and their associates. Version 1 – June 2008 does not yet have the final endorsement of any jurisdiction. The document is for guidance only and is presented to provide a basis for on-going discussion. It may require further consideration by a jurisdictional based reference group before national endorsement.

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Status of indicator agreement

The National Land & Water Resources Audit (the Audit) coordinates the collation of data to support reporting on natural resource condition required under the National NRM Monitoring and Evaluation Framework (National M&E Framework).

The National M&E Framework identifies three requirements for monitoring natural resource condition:

- a set of resource condition indicators to measure progress toward the agreed national outcomes on a medium and long term basis
- a set of indicators for monitoring community and social processes relevant to or affected by NRM programs, as well as measures of the adoption of sustainable development and production techniques
- contextual data pertinent to the indicator being considered.

The Audit Advisory Council has agreed to a process for achieving a practical set of indicators under the National Monitoring and Evaluation Framework.

This process is to:

- obtain on-going **recommendations** from the relevant **National Coordination Committees** for each thematic area (including "Matters for Target") on appropriate indicators, protocols and information needs
- seek **endorsement** from the **Audit Advisory Council** that the indicators and protocols can be implemented at the national, state / territory and regional levels
- seek **agreement** from the Natural Resource Policies and Programs Committee (**NRPPC)** (or the Marine and Coastal Committee –**MACC**- for Estuarine, Coastal and Marine) that the indicators will be used and promoted by jurisdictions to underpin evaluations of NRM initiatives.

The NRPPC and MACC report to the Natural Resource Management Ministerial Council (NRMMC).

Introduction

This suite of "indicator guidelines" is relevant to the Estuarine, Coastal and Marine Habitat Integrity Matter for Target.

Two indicator headings are identified:

1. Estuarine, coastal and marine habitat extent and distribution
2. Estuarine, coastal and marine habitat condition.

Initially, 31 potential indicators were developed to measure the effect of the stressors on ecosystem condition (physical/chemical and biological) and habitat extent (Scheltinga et al., 2004). These indicators were reviewed at a national workshop (Souter and McKenzie, 2006) and further refined to 19 nationally agreed indicators (Table 1).

Drawing on a series of state/territory trials and national consultations; the documentation for the indicators has been modified from a "protocol" format that sought to define both measurement standards and reporting (information) products to one that presents "guidelines" for the collection and storage of monitoring data.

> These "indicator guidelines" should be used as standards for the collection, collation and storage of data in order to assist NRM service providers and community groups make observations that can potentially be pooled and re-used at a later date.

Ten ECM indicators were prioritised and guidelines have been developed through extensive consultation and reviewed by key experts in the field.

Table 1. Nationally agreed ECM Resource Condition Indicators. Indicators prioritised for documentation and included in this document are shown with an asterisk.

Indicator heading	Indicator
Estuarine, coastal and marine habitat extent and distribution	1. Extent and distribution of key habitat types*****
Estuarine, coastal and marine habitat condition	Biological condition 2. Algal blooms 3. Animal or plant species abundance***** 4. Chlorophyll a***** 5. Coral bleaching 6. Mass mortality events 7. Pest species (number, density, distribution)***** 8. Targeted pathogen counts 9. Vertebrates impacted by human activities Physical/chemical condition 10. Dissolved oxygen***** 11. Nutrients***** 12. pH 13. Presence / extent of litter (marine debris)***** 14. Salinity (EC) 15. Sedimentation/erosion rates***** 16. Shoreline position 17. Temperature 18. Toxicants (in water / sediments / biota)* 19. Turbidity / water clarity*****

Animal or plant species abundance

Matter for target:

Estuarine, coastal and marine habitat integrity

Indicator heading:

Estuarine, coastal and marine habitat condition

Indicator name:

Animal or plant species abundance

This document presents the recommended monitoring guidelines for collecting, collating and reporting information on animal or plant species abundance for national, state/territory and regional application.

1. Definition

Estuarine, coastal and marine systems contain many species that are important to humans for economic, recreational or cultural reasons, or to the system's ecology.

AIM: To detect changes in the abundance of animal or plant species within estuarine, coastal and marine ecosystems and link these changes to human impacts.

INDICATOR: Change in animal or plant species abundance.

2. Rationale

Change in plant and/or animal abundance is a widely used indicator of human impacts in marine and coastal environments, for which there is a large body of existing knowledge and literature (Kingsford and Battershill 1998). Observed changes in animal and plant populations allow biological and ecological responses to human impacts to be directly measured rather than inferred from physico-chemical measurements. Such changes can be readily linked to ecosystem functioning as animal and plant species play direct roles in the provision of important ecosystems services such as primary productivity, detrital decomposition, nutrient cycling and energy flow to higher trophic levels (fish, birds). A range of plant and animal species (notably seagrasses, macroalgae, mangroves and corals) also constitute important habitats in marine and coastal environments providing physical structure, refuge and food for a range of associated plants and animals. Changes to the structure and extent of such habitats may diminish local biodiversity and impair ecosystem functioning.

3. Monitoring methodology

The choice of suitable target plants and/or animals is a critical step in the establishment of any monitoring program. Good general advice can be found in Warwick (1993) and Jones and Kaly (1996). In general, the following points should be considered when choosing target species: sensitivity to particular stressors (if known), economic and social value of species, life-history (including life span and phases), habitat-specificity (habitat specialists maybe more sensitive to changes in habitat structure), cost and practicality of sampling and analysis, and population dynamics (stable species populations may be more simple to monitor)., Rare and highly variable species should be avoided as a means of monitoring coastal and marine environments.

A recent trend in ecological impact assessments has been to monitor assemblages of species rather than a few pre-selected "indicator" species. In essence, this means all species sampled are identified, counted and included in the analyses. This approach has a number of advantages over a single measure. Information about all species present is retained within the analysis, rather than discarded. It is also a more powerful approach to analysing ecological change within a system because it is able to integrate the responses of multiple species within a system increasing the sensitivity of the test. By comparison, measurement of species richness (numbers of species) alone, may fail to detect an impact at a site because significant changes in species composition (eg from natural to stressed) may not necessarily be followed by corresponding changes in species richness.

3.1 Monitoring locations

The choice of monitoring locations should correspond with the scale of the perceived impacts, which may in turn dictate the choice of suitable indicator taxa or assemblages. Impacts in marine and coastal systems may either be point-source (eg a sewage outfall) or diffuse (eg run-off) in character, requiring different sampling strategies. In both cases, randomized and replicated sampling is required to sufficiently characterize the extent of impacts. Selection of suitable reference/control locations is in theory simpler for point-source impacts, but should also be attempted where possible for diffuse impacts (Hirst and Kilpatrick 2007). In general, reference/control locations should be as similar to the 'impacted' location/s as possible in terms of abiotic (eg depth, sediments, currents etc.) and biotic variables, whilst remaining free of the impact under investigation. Some pilot sampling or prior research may assist in the selection of appropriate reference/control sites.

3.2 Monitoring frequency required

In an ideal world, sampling should provide information about the pre-impact condition of locations. For example, if one wanted to assess the impacts associated with opening a (naturally closed) estuary, information about the estuary prior to, and after, the implementation of these changes would allow for a more rigorous assessment of the potential impacts. As many impacts in marine and coastal systems already exist (and in some cases have existed for many decades), such information is not always available, increasing the uncertainty of the conclusions drawn from monitoring (ie changes must be inferred from other information, primarily the use of reference locations, rather than directly analysed).

It is difficult to make any general recommendations about the frequency of sampling, except to say that the detection of impacts may vary over time. Impacts may only be manifested at certain times of the year, or impact only certain life-history stages. Moreover, where point-source impacts are monitored there may be a lag-effect corresponding with the cumulative affects of

impacts over time. As with sampling in space, temporal sampling should be replicated and randomized in time to sufficiently characterize temporal changes in plant/animal abundance.

3.3 Data measurement method

Standard field sampling methods for measuring plant/animal species abundance (eg line transects, quadrats, catch per unit effort) can be found in many texts. A good general review of methods used to monitor temperate and tropical marine ecosystems can be found in Kingsford and Battershill (1998).

3.4 Data storage and management

Data should be stored by state/territory agencies and by the collectors (if different) of the data. Metadata documentation should be completed for all datasets.

3.5 Data analysis and interpretation

In order to link changes in animal/plant abundance to human impacts, and thus detect and measure the magnitude of human impacts, one must be able to confidently distinguish human-mediated changes from natural changes in population abundance. This can be a complex task because animal and plant species are typically variable in space and time. To overcome these problems, monitoring designs which simultaneously partition variation due to natural and human-mediated effects are used where possible. Such designs generally incorporate reference locations (free of perceived impacts) against which putative impacts can be measured, coupled with information about the condition of site/s prior to and after the impact (where available). The most rigorous of these designs fall into a category of tests called Before-After-Control-Impact (BACI) or MBACI in the case where there is more than one impacted/reference site combination (see Downes et al. 2002 for a review of these designs).

Where pre-impact information and appropriate reference locations are not available (not an uncommon problem), long-term (>10 years) trend data may be sufficient to detect some human impacts by comparing changes against a long-term baseline. However, it will always be difficult to distinguish natural from human-induced variation using such designs. The collection of environmental variables (ie correlates) is an important step in understanding the observed changes and may also be helpful in interpreting long-term ecological trends.

Poor monitoring designs may lead researchers to fail to detect impacts where they occur, or incorrectly infer impacts where none exist. **Detecting human impacts in marine and coastal environments is often complex and we suggest seeking specialist advice prior to undertaking any sampling of plant/animal populations.** Statistical analysis is often highly complex requiring specialist input and advice.

Good reviews of methods for detecting ecological impacts include Green (1979), Warwick (1993), Schmitt and Osenberg (1996) and Downes et al (2002).

3.7 Reliability, validity and quality assurance

Quality assurance and control is important to minimise avoidable errors in data collection and thus provide greater confidence in condition assessments. Individuals must have had adequate training in sample collection and identification.

3.8 Metadata

Metadata documentation should be completed for all datasets. The metadata statement should be consistent with current ANZLIC standards, which now complies with ISO 19115.

See the following web site for the Metadata Profile:
<http://www.osdm.gov.au/ANZLIC_MetadataProfile_v1-1.pdf?ID=303

For Metadata Guidelines see:
<http://www.osdm.gov.au/ANZLIC_MetadataProfileGuidelines_v1-0.pdf?ID=397

4. Reporting / information products

4.1 Audiences

Resource managers will be the main audience for information on specific estuaries and coastal waters.

4.2 Products

Information products need to be developed for this indicator. The results of monitoring need to be interpreted by experts in the light of all the available information (ie foundational and contextual information) and an assessment made about the meaning of the results. This assessment should be reported to resource managers and may need to be reinterpreted for the various levels of reporting (ie local, regional, state and national).

The information products should report undetected impacts as well as detected impacts. The Great Barrier Reef Long Term Monitoring Program (AIMS) trend and assessment reports provide a good synthesis of information products.

4.3 Confidentiality

Data confidentiality is the responsibility of the data custodian.

4.5 Data analysis, integration and interpretation information

Any national/regional level information products (ie interpreted products) need to be linked to the regional/local information that was used to create them (ie to the relevant state/territory and regional databases/information systems). Any specific methodologies, assumptions, additional data and changes in confidence in the interpreted products need to be stated.

4.6 Data access and storage

National level products should be developed with the needs of the various stakeholders in mind. Data access and storage for national level products should be through a nationally known and recognised web site such as ‘OzCoasts’. Links should then be made to state/territory and regional web sites to access the underlying products/datasets.

4.7 Product definition statement

Each product should have a product definition statement. The product definition statement follows the same general format as the metadata statement referred to in 3.8.

5. Current national activities

There are no national activities related to animal and plant species abundance monitoring.

6. Future development

As the species and/or assemblages used for this indicator will inevitably vary between locations, the usefulness of any 'nationally reported' datasets needs to be determined and refined.

7. Links to other indicators

Extent/distribution of key habitat types (indicator)

Sedimentation/erosion rates (indicator)

Turbidity/water clarity (indicator)

Significant native species and ecological communities (matters for targets)

Ecologically significant invasive species (matters for targets)

Turbidity/suspended particulate matter in aquatic environments (matters for targets)

8. Further reading

Downes BJ, Barmuta LA, Fairweather PG, Faith DP, Keough MJ, Lake PS, Mapstone BD and Quinn GP (2002). *Monitoring Ecological Impacts. Concepts and Practice in Flowing Waters,* Cambridge University Press, Cambridge.

Green RH (1979). *Sampling Design and Statistical Methods for Environmental Biologists,* Wiley-Interscience, New York.

Hirst AJ and Kilpatrick R (2007). Spatial and Temporal Variation in the Structure of Estuarine Macroinvertebrate Assemblages: Implications for Assessing the Health of Estuaries, *Marine and Freshwater Research* 58:866–879.

Jones GP and Kaly UL (1996). Criteria for selecting marine organisms in biomonitoring studies. In: *Detecting Ecological Impacts*, RJ Schmitt and CW Osenberg (Eds), Academic Press, 29–48.

Kingsford M and Battershill C (1998). *Studying Temperate Marine Environments. A Handbook for Ecologists*, Canterbury University Press, Christchurch, New Zealand.

RJ Schmitt and Osenberg CW (1996). *Detecting Ecological Impacts. Concepts and Applications in Coastal Habitats,* Academic Press, San Diego.

Warwick RM (1993). Environmental impact studies on marine communities: pragmatical considerations. *Australian Journal of Ecology* 18:63–80.

9. Glossary

Abundance — Relates to the number or population of species.

Assemblage — A group species inhabiting the same region and interacting with each other.

Baseline data — Information collected to form a reference set for comparison of a second set of data collected at a later time; used to interpret changes over time usually after some condition has been changed.

Ecosystem services — services provided by ecosystems that benefit humans such as clean drinking water and the decomposition of waste products

Quadrat — An ecological sampling unit that consists of a square frame of a known area.

Spatial — Pertaining to space or distance.

Taxon — A taxonomic group of organisms (of any rank, eg species, genera, family) considered to be distinct from other such groups.

Temporal — Pertaining to time.

Transect — A straight line intersecting biological features along which ecological measurements are taken.

Appendix A: Metadata statement

Monitoring program	The name of the monitoring program
Custodian of data/Contact	The business name and address/contact details of the custodial organisation or responsible party
Summary of program	A brief narrative summary of the program
Geographic extent	The ordinary name(s) of the locations where the data was collected (ie study area)
Indicators monitored	List of all indicators monitored
Method of data collection	Summary of the methods used to collect the data
Past/future sampling	Description of when sampling started, how often it occurred, when it will finish
Quality assurance	Description of the quality control/assurance procedures used
Data access	1) Location: Where and how the data is stored. If it can be accessed remotely (ie from a website) 2) Format in which dataset is stored and available 3) Any restriction or legal prerequisites that may apply to access and use of the data
Other comments	Any other comments
Information source(s)	Where information on the program can be found (eg reports, literature, websites)
Date metadata created	Date when the metadata record was created