National Land & Water Resources Audit

An Initiative of the Natural Heritage Trust

ESTUARINE, COASTAL AND MARINE NATIONAL CONDITION ASSESSMENT

Scoping Report

UTI2

Dr Richard Mount

Natural Heritage Trust

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Contents

EXECUTIVE SUMMARY **3**

INTRODUCTION **5**

SECTION 1 **8**

1 VISION: AN "ASSESSMENT LOGIC" APPROACH TO NATIONAL ECM ASSESSMENTS **8**

1.1 THE ENVIRONMENTAL CONDITION ASSESSMENT FRAMEWORK 10
1.2 VALUE AND BENEFIT OF THE ECAF 17
1.3 NRM ECM REPORT CARDS 18

SECTION 2 **20**

2 NATIONAL ESTUARINE, COASTAL AND MARINE INDICATORS **20**

2.1 INDICATOR CRITICISMS AND CHALLENGES 20
2.2 ECAF – A RESPONSE TO INDICATOR CHALLENGES 24

SECTION 3 **27**

3 CASE STUDY: BURNETT MARY NRM REGION ESTUARINE REPORT CARDS **27**

SECTION 4 **34**

4 SCOPING EACH ECM ENVIRONMENTAL SETTING **34**

4.1 ESTUARIES: SCOPE FOR ASSESSMENT 34
4.2 MARINE ENVIRONMENT: SCOPE FOR ASSESSMENT 40
4.3 COASTAL ZONE: SCOPE FOR ASSESSMENT 44

SECTION 5 **46**

5 ACTION PLAN **46**

5.1 COSTINGS 46
5.2 RECOMMENDATIONS 49

PARTNERS, PARTICIPANTS AND COLLABORATORS **53**

DEFINITIONS **56**

ACRONYMS **57**

REFERENCES **58**

APPENDIX 1. NRM ECM WORK PLAN 2007-2008 PROJECTS LIST 61
APPENDIX 2: ESTABLISHING THE INFORMATION BASE FOR ECM ASSESSMENTS 62
APPENDIX 3: ECAF - FURTHER DESCRIPTIVE MATERIAL 66
APPENDIX 4. SUMMARY OF THE NATIONAL ECAF ROUND TABLES 68
APPENDIX 5. ESTUARY DEFINITION 69
APPENDIX 6. FOUNDATIONAL DATA FOR ESTUARINE ASSESSMENTS AND REPORT CARDS 70
APPENDIX 7. MISSING DATA FOR ESTUARINE ASSESSMENTS AND REPORT CARDS 72

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Executive Summary

- There are considerable challenges in producing national assessments of the ecological integrity of estuarine, coastal and marine (ECM) environments. The focus of the Natural Resource Management (NRM) Monitoring and Evaluation Framework on resource condition or "outcome" indicators is an impediment to obtaining useful assessments in these environments because:
    - there are few data available for assessing resource condition
    - there are few methods for assessing resource condition suitable for national assessments, and few established reference conditions
    - the causative linkages between resource condition and the pressures acting on the environment that are needed to guide management actions are not well established
    - the resource condition indicators currently in use vary considerably from state to state and have specific purposes, such as assessing the performance of sewage treatment plants
    - NRM assets are often yet to be identified and this is particularly the case in marine environments.
- Informed by a series of indicator and report card trials and national round table consultations, the Environmental Condition Assessment Framework (ECAF) is proposed for endorsement as a response to these impediments to a national assessment. Many of those consulted communicated the benefits of, and a desire for, national leadership. The vision for the ECAF "Assessment Logic" is that:

> "The national estuarine, coastal and marine assessment infrastructure will efficiently and logically use all relevant information to produce environmental condition assessments, such as report cards, that directly support every stage of the natural resource management cycle."

- The alignment of assessment frameworks across jurisdictional levels via the adoption of the ECAF would allow for effective and efficient allocation of resources to satisfy assessment and reporting requirements at each level and would:
    - enable comparison of the condition of natural assets through standards-based reporting at the regional, state and national levels
    - enable closer alignment of management and reporting activities
    - provide coordination and leadership to assist inter-agency cooperation, particularly at the Australian Government and state levels
    - assist with directing research efforts
    - facilitate cross-jurisdictional collaboration and capacity building via multi-regional research, management solutions and information exchange.
    - directly support the Program Logic of the Monitoring Evaluation, Reporting and Improvement (MERI) Framework with Assessment Logic.

  All of these outcomes strongly support the implementation of the Integrated Coastal Zone Management (ICZM) Framework and Implementation Plan of the NRM Ministerial Council (2006).
- All national ECM assessments should:
    - prioritise the assessment of the environmental integrity of the natural resource assets, as any social and economic assessments are dependent on it

- ensure their integrity, influence, relevance and value by adopting an open and transparent process and supporting the participation of "trusted messengers"
- adopt a risk assessment approach in the absence of resource condition information
- ensure the reporting process is planned and well focused on a target audience for a specific purpose.

- A set of guidelines is needed to support the production of NRM report cards.
- The scope and direction for an assessment of each of the estuarine, coastal and marine environments is presented. In summary:
  - For **estuarine environments**, the information base and methods for supporting a national assessment have improved since the last assessment in 2002. While the information base has advanced considerably in many states, foundational information is continuing to be a major impediment to meaningful national assessments. However:
    - There is growing consensus on the foundational information required
    - there is a well-founded assessment framework (and software) based on stressors that is almost ready for consideration as a national standard
    - the national information base housed in the OzCoasts web site is well managed and continuing to develop
    - there is a strong collaborative culture among the people who are key to a national assessment.
  - For the **coastal environments** there are continuing definitional problems, though the information base is undergoing rapid growth. It is proposed to scope this environment by:
    - defining the zone as the "shoreline", i.e. the onshore area subject to marine influence and the intertidal zone

    Currently, the information base mostly allows reporting on shoreline type and vulnerability, as there are few monitoring programs of shoreline condition.
  - For **marine environments**, the information base at the <u>regional and state</u> levels is currently not capable of supporting a national assessment of environmental integrity because:
    - fisheries data is too specific to the industry (though progress is being made towards ecosystem-based management)
    - many Marine Protected Area performance assessment systems are yet to be implemented
    - other monitoring programs currently have limited coverage, as assessment of marine environments is a low priority for most states and regions.

    The marine information base at the <u>national</u> level is capable of some broad national assessments, particularly in relation to climate change impacts. Other key considerations are:
    - There is a significant opportunity for national discussions on the adoption of a high level assessment framework, such as the ECAF, to ensure approaches are consistent across all Australian waters.
    - Further work is required to identify a national methodology for defining NRM marine assets.
    - There are some excellent monitoring programs, including remote sensing, that could form the basis of a national approach to marine assessment.

Introduction

The Australian Government has recognised the need for a national assessment of the ecological integrity of the estuarine, coastal and marine environments to support natural resource management. This need has been recognised in policy documents and legislation including the Integrated Coastal Zone Management Framework and Implementation Plan (NRMMC, 2006) and those governing Natural Resource Management. Any such assessment will depend on the states, Northern Territory and Natural Resource Management (NRM) regions (or Catchment Management Authorities), as they hold most of the environmental data and have primary carriage of management responsibilities.

The existing NRM framework for monitoring, evaluating and reporting on the environment was endorsed by the Natural Resource Management Ministerial Council, which includes representatives of the Australian Government and all states and territory governments. The Council endorsed two national level documents to create the framework. These were the:

- National Natural Resource Management Monitoring and Evaluation Framework (NRM M&E Framework), and the
- National Framework for Natural Resource Management – Standards and Targets.

The framework sets broad aspirational natural resource outcomes and identifies matters for which regional targets must be set. A new Monitoring, Evaluation, Reporting and Improvement (MERI) framework is about to replace the old NRM M&E framework. It is similar in that it provides guidance to setting and reporting on performance targets, but articulates how this done in greater detail and enables the use of intermediate targets and outcomes. However, it is the existing NRM M&E framework that provided the policy environment for the work that has informed this Scoping Report.

The NRM M&E framework is strongly directed towards the development and reporting of “resource condition” indicators. This type of indicator seeks to measure the net results, or outcomes, of the influences and pressures acting on any defined environmental system, such as an estuary. They are seen as a way of both assessing the performance of investments in natural resource management and providing the basis for broad national level assessments of how the environment is going.

However, in estuarine, coastal and marine environments, there is little evidence of adequate causal links between an NRM investment and the resource condition or “outcome” indicators. This lack of causal linkages is identified by the Australian National Audit Office report into NHT2 (2008), which highlighted the issues associated with establishing performance indicators of investments. Establishing causal linkages is often difficult because these systems are still not adequately understood in regard to resource condition, and their very high levels of complexity and variability, combined with a lack of investment in basic ecological research, continue to stymie the establishment of ecological conceptual models with the required degree of resolution. This, in turn, often means that the feasibility of monitoring programs that can produce resource condition indicator findings that support either performance assessment of investments or broad environmental assessments is limited.

Further evidence for this view is provided by the limited progress in establishing estuarine, coastal and marine resource condition indicator reporting programs across the states, Northern Territory and regions. Where programs are established, they are quite diverse and specific in their approaches, limiting the ability to compare results. For

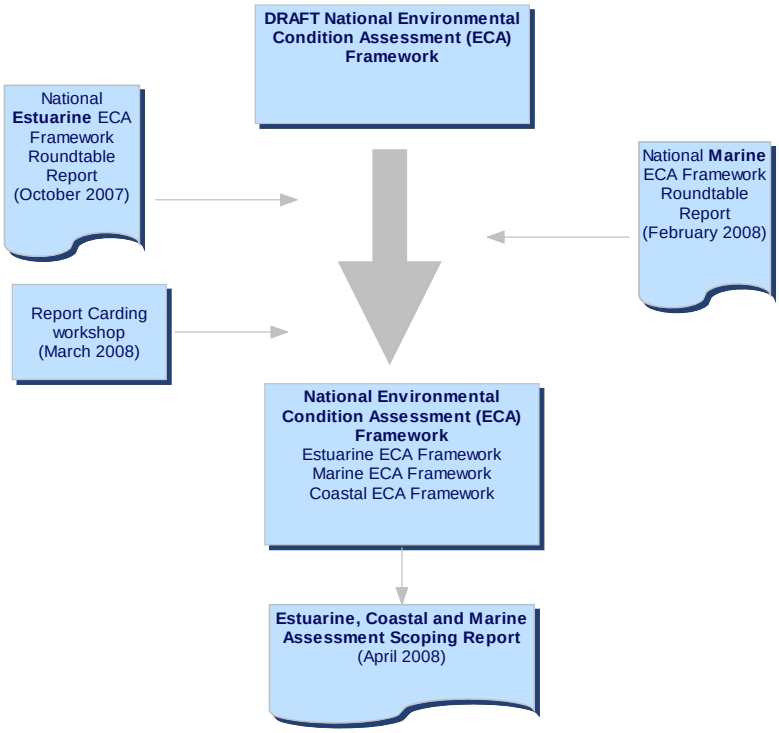
example, two of the more successful environmental reporting programs – the Ecosystem Health Monitoring Program of the South East Queensland Healthy Waterways project in the Moreton Bay area, and the Gippsland Integrated Natural Resources Forum's Report Card program – are very specific to the needs of each program and cannot be directly compared.

Meanwhile, the pressures on these natural assets are increasing, especially with our rapidly changing climate. The Australian community has heightened expectations of NRM managers and, indeed, the resources available for management purposes must be efficiently targeted to best effect. If performance assessment indicators are proving elusive, what is the best way to proceed?

The NRM Estuarine, Coastal and Marine (ECM) Work Plan 2007-2008 was developed by the National Land and Water Resources Audit (Audit) to facilitate the implementation of the NRM M&E framework in ECM environments. Under its auspices, ongoing development of assessment methods has continued. These methods are intended to address the critical issues highlighted in this introduction and build on the excellent work that is being carried out across the country. This document is the final product of the Work Plan and it seeks to scope out a direction for assessing the integrity of these all-encompassing environments.

This document proposes a new generic assessment framework – the Environmental Condition Assessment Framework (ECAF), which could be the basis for a national assessment. The generic framework could be readily "flavoured" to produce a National Estuarine ECA framework (NEECAF), a national Marine ECA framework (MECAF) and a national Coastal ECA Framework (see figure below).

With the recent election of a new government there is uncertainty about how the management and assessment of estuaries, coastal and marine environments will be addressed. It is hoped that this uncertainty will provide an opportunity for the vision and learnings presented here to be considered for endorsement and incorporation into future programs.



SECTION 1

1 Vision: An "Assessment Logic" approach to national ECM assessments

The vision is that…

The national estuarine, coastal and marine assessment infrastructure will efficiently and logically use all relevant information to produce environmental condition assessments, such as report cards, that directly support every stage of the natural resource management cycle.

This vision is based on the insights that:

- there is currently an **inadequate information base** for assessing the condition of estuarine, coastal and marine environments
- the information base needed to **assess** the environmental condition of estuarine, coastal and marine natural resource assets is usually the same information needed to **manage** those resources
- the production of a **national** estuarine, coastal and marine assessment is dependent on state, territory, regional and local information resources
- natural resource **monitoring** information is usually not available in estuarine, coastal and marine environments, though there are **other sources** of information that can contribute to an environmental condition assessment.

Therefore the aim is…

To develop and maintain the information base and associated infrastructure needed to support the management of Australia's estuarine, coastal and marine natural resource assets at the national, state, territory, regional and local levels.

A strategy to support the achievement of this aim is presented here in the form of an assessment framework. The assessment framework articulates a logical pathway for the supply of environmental information needed for every stage of the management cycle, including NRM Program Logic – this may be thought of as "Assessment Logic".

For example, managers need to know (often in this order):

- What natural resources have we got and how do they work? (Inventory, conceptual models, valuing and identifying threats.)
- What are the most important things to manage? (Prioritising.)
- What are the best ways to manage them? (Identifying "theories of change" for program logic purposes; defining and implementing optimal management actions.)
- Are the current management actions working? (Performance assessment, resource condition assessment and adaptive management.)

At every stage an assessment of "how it is going", or at least an estimate of "how it is likely to be going", is needed. Typically, these assessments of environmental condition will range on a spectrum from broader, more theory-based estimates for the earlier questions, to highly specific and measurement-based estimates for the later ones.

At every stage an “information threshold” question needs to be asked: “Is there enough information to adequately answer the manager’s questions?” This question drives the efficiency of the framework and helps to identify whether further information needs to be gathered or whether there is a match between the information needed and the information available. The answers in either case assist with efficiently setting research priorities and directing research resources.

The assessment framework presented here is designed to answer all these management questions. It is an “emerging” approach as, while the overall structure is clear, the detail of the framework is still being developed.

1.1 The Environmental Condition Assessment Framework

This section presents a framework for assessing and reporting on the environmental condition of NRM estuarine, coastal and marine assets at the regional, state and national levels. It has emerged from careful analysis of trials conducted around the country and targeted consultations with key managers, scientists and science communicators during the implementation of the ECM Information Work Plan 2006-2008 (see page 53 for a list of partners and collaborators and Appendix 1 for a full list of Work Plan projects).

The Environmental Condition Assessment Framework (ECAF) is a multi-tiered, flexible, activity-based approach that provides guidance about the information base and associated information infrastructure needed to support the management of estuarine, coastal and marine natural resources with reports and assessments matched to each stage of the management cycle, including NRM Program Logic and the production of national assessments.

The framework:

- addresses both what to report about and the problematic question of how to report when data are scarce
- seeks to strongly match the management of the information base needed for assessment processes with the information needs of the management cycle
- enables information about the environment to be used and then re-used at different levels of management and for different purposes
- recognises that each of the partners in a national reporting system is dependent on each other and that the relationships between the parties are paramount.

The development of this NRM **ECM Environmental Condition Assessment Framework**, or ECAF was driven by an analysis of the information base required for reporting (see Appendix 2) and it has a number of characteristics as follows:

- An "**environmental condition assessment**", or ECA, is a broad assessment of the environmental condition or status of a defined NRM "asset", such as an estuary, key habitat type or key ecological feature, given current management objectives. The key concept is a focus on environmental or ecological condition in a way that contributes to, for example, triple bottom line reporting, pressure-state-response reporting or ecosystem services assessments.
- The ECAF is an **assessment framework** only, not a management framework. It complements and supports the information requirements of management via a systematic approach to information management. It can be thought of as a form of "**assessment logic**" that complements the NRM "program logic" approach.
- The ECAF is a high level assessment framework that acts as a "**translation engine**". This means that it does not attempt to prescribe detailed methods of assessment that are inconsistent with current state and Northern Territory practises. Instead, it defines concepts and standards that allow information generated by those various practises to be translated for national reporting purposes.
- The ECAF is also a "**report card engine**" as it defines both the "back end", or contributing, environmental reports and the processes for producing the "front end" report cards for delivery into the management process.

- It is a **flexible, tiered system** that accommodates a variety of asset types and data availability scenarios. The tiers, or “passes”, efficiently support management with the minimum information needed and assist with directing the research agenda.
- The ECAF doesn’t prescribe specifically how to measure and monitor natural resources; rather it is intended to broadly align reporting mechanisms, so that reports can be **standardised and compared** within and across the different jurisdictional levels.

1.1.1 Brief Background to the ECAF

An analysis of the information base required to support reporting of ECM indicators via NRM report cards was conducted. The analysis made use of the Information Domain Conceptual Model (IDC Model) (Mount, 2007) which defined the information base in terms of three information domains:

- The **Human Aims Domain** articulates what we value (assets) and identifies any existing management intentions that are relevant to the asset.
- The **Asset Context Domain** provides information about where the asset is and how it works and also identifies the direct and indirect human influences and impacts acting on the asset (e.g. via mapping and research).
- The **Gathering New Evidence Domain** refers to the further field observations or evidence (e.g. monitoring) that is required to inform the assessment of the asset.

The IDC Model (see Appendix 2 for more detail) shows that reporting on resource condition indicators via monitoring is a "high level" activity and requires a significant amount of information from all three domains (i.e. clearly established management objectives, information about the form and function of the system and the results of monitoring). This analysis and the findings of the state trials also identified that much of the contextual information (e.g. form, function and pressure or threat information) is much more readily available than monitoring information and is also highly pertinent to management.

For most Australian ECM natural resource systems, information is not available to undertake a comprehensive resource condition assessment based on monitoring. A flexible, layered assessment framework (i.e. the ECAF) is proposed to enable **reporting at different stages of the management cycle with varying levels of information**.

The ECAF is designed to ensure that assessments occur within a common structure, thereby facilitating consistency in approach, data interpretation and reporting.

The ECAF presented here is synthesised from reviewed national and international frameworks (Arundel and Mount, 2007) and discussions with leading marine and estuarine managers and researchers from around Australia. It also builds on the learnings from the National Indicators Workshop held in February 2006, the two ECAF National Round Tables in late 2007 (one for each of the marine and estuarine environments), and the 2008 National NRM ECM Report Carding Best Practise Framework Workshop (see Appendix 1 for a full list of Work Plan activities).

1.1.2 How the ECAF works

The logic of the ECAF is presented diagrammatically in Figure 1. It introduces the concept of a multi-layered system for assessing the condition of any natural resource "asset" or "asset class". An asset is broadly defined to be any aspect of the natural environment of interest for management purposes. The layers in the system are referred to as "First Pass", "Second Pass" and "Third Pass" to align with the notion that this is an **action-based** framework and that these are **activities** to be conducted by those with NRM reporting responsibilities.

For each asset, an **increasing level of information** is generated by moving from first through to third pass assessments, while at the same time the assessment efforts are

focused on progressively fewer assets altogether. For some assets, movement to the second or third pass **may not be necessary** if management intentions are met. For example, if an asset is protected from threatening pressures through exclusion measures, resource condition monitoring may not be needed.

The outlined approach is consistent with, and provides a method and reports for, each standard phase of management and delivers the information needed for the MERI Framework's Program Logic. The following subsections characterise each pass by summarising the starting conditions for each pass, noting the primary activities and outputs for each pass and identifying the relationship of the pass to the management sphere.

FIRST PASS ASSESSMENT: SUPPORT UNDERSTANDING

Given the current Human Aims (e.g. management intentions) as a starting point, collate **existing** information about the assets to characterise the assets and the direct and indirect human influences and impacts (driver/threats/pressures) operating on them. This will enable the production of:

- inventories and data gaps reports
- conceptual models
- susceptibility (vulnerability) reports
- threat or pressure type reports
- degree-of-modification reports.

Key aims of this pass are to produce assessments that support management to understand:

- "what we have got" and "how it works", and
- "the direct and indirect human influences and impacts operating on it".

These aims are designed to enable the improved identification of assets and threats and what further information needs to be gathered.

SECOND PASS ASSESSMENT: FOCUS AND ENABLE PRIORITISING

Given the assets and threats identified by management (perhaps following the First Pass assessment), this pass focuses on **supplementing the existing information base** to further refine the definition of and **quantify** the assets and pressures and, where possible, identify **causative linkages**. In addition to all or any First Pass reports, it is designed to produce:

- threat or pressure assessments
- vulnerability (*sensu* Allen Consulting, 2005) assessments
- risk assessments.

The aim of this pass is to:

- deliver information about "how things are likely to be going", including risk assessments, to enable refinement of management priorities.

This aim supports management to identify specific resource condition targets or outcomes and prioritise (further) on-ground actions and their associated monitoring programs.

THIRD PASS ASSESSMENT: SUPPORT ADAPTING

Given the specifically defined targets and monitoring defined by management intentions (maybe from the Second Pass), this pass provides information that assists management to assess the performance of policy and actions, i.e. adaptive management, via:

- all or any First and Second Pass reports plus
- resource condition or status and trend indicator reports.

The aim of this pass is to produce assessments that:

- assess "how things are going" and identify what needs to change.

This aim supports management to adapt targets, actions and monitoring.

SUMMARY LIST OF POTENTIAL REPORTS AND OUTPUTS FROM THE ECAF "REPORTING ENGINE"

1. First Pass:
   - inventories and gap analyses
   - classifications
   - conceptual models
   - susceptibility assessments
   - types of pressures/threats assessments
   - degree-of-modification assessment
   - scientific research reports
2. Second Pass (all above plus):
   - pressure/threat assessments
   - vulnerability (*sensu* Allen Consulting, 2005) assessments
   - risk assessment
3. Third Pass (all above plus):
   - resource condition or status and trend indicator reports
4. Overall Environmental Condition Assessment e.g. ECA Report Card:
   - based on information drawn from all <u>available</u> passes

REPORT CARDS

[For further details about Report Cards see "NRM ECM Report Cards" section on page 18.]

A report card presents a summary of the environmental condition assessment and can be produced at any pass. The report card is dependent on the reports produced at each pass (i.e. the "back end" or contributing reports) and presents the overall environmental "condition". If enough data is available, a score may be produced, such as A-E. This score is based on an assessment of the available environmental information given the current management objectives.

environmental condition + management objectives = ECA report card score

The **environmental condition** may be obtained based on an information base consisting of the back end reports. It may be based on current well-founded

monitoring programs through to estimates of "likely condition", based on the best available theoretical and practical knowledge. It may need some kind of reference condition, which could take the form of either a:

- comparison with itself as a measured trend through time
- comparison with a similar, though unimpacted, or near pristine asset
- comparison with a modeled asset, such as pre-settlement or "natural" asset condition.

The **management objectives** may be as broad or focused as required and, ideally, set an "acceptable" agreed range for environmental condition. For example, for a national assessment of estuaries, it may be reasonable to use the environmental protection values defined in the National Water Quality Management Strategy, as a broad, high level set of management objectives, as follows:

- near pristine
- slightly to moderately modified
- severely modified.

These categories closely align with those produced for the National Estuaries Assessment 2002. This means that in the absence of defined management objectives for any particular estuary, its National Estuaries Assessment category could be used as an assumed or surrogate default objective.

The inclusion of management objectives in the report card scoring process is based on the insight that natural or near pristine reference conditions are often not practical or feasible for ECM assets (e.g. see Hirst, 2008). Comparing assets to a naturalness-type yardstick will condemn some assets to perpetually receive low scores, even though they may be producing ecosystem services that satisfy currently agreed management objectives. For example, a "highly modified" estuary may be well managed and continue to function in a way that meets the standards of those living around it, even if it is never "near-pristine" again. If management intentions are included in the scoring process, it could receive a high score (e.g. a "B") even though it may be heavily impacted on a naturalness scale. However, to minimise the problem of "sliding baselines", naturalness assessments should also be a continuing part of the reporting process, where possible.

Table 1. Examples of relative Environmental Condition Assessment (ECA) Report Card scores for three broad management intentions categories

Broad Management Intentions i.e. "managing for … conditions"	Relative Environmental Report Card Scores						
near pristine ("naturalness" yardstick)	A	B	C	D	E		
slightly to moderately modified		A	B	C	D	E	
severely modified			A	B	C	D	E

The biggest advantage of including management objectives in the scoring process is that it **enables comparisons** to be made of very different natural systems with very different management regimes, i.e. across state boundaries. The worst scores will be given to assets that are not in the condition that the people managing them intend them to be in. This means that the political and social processes of allocating funding can potentially be targeted to the areas of greatest concern.

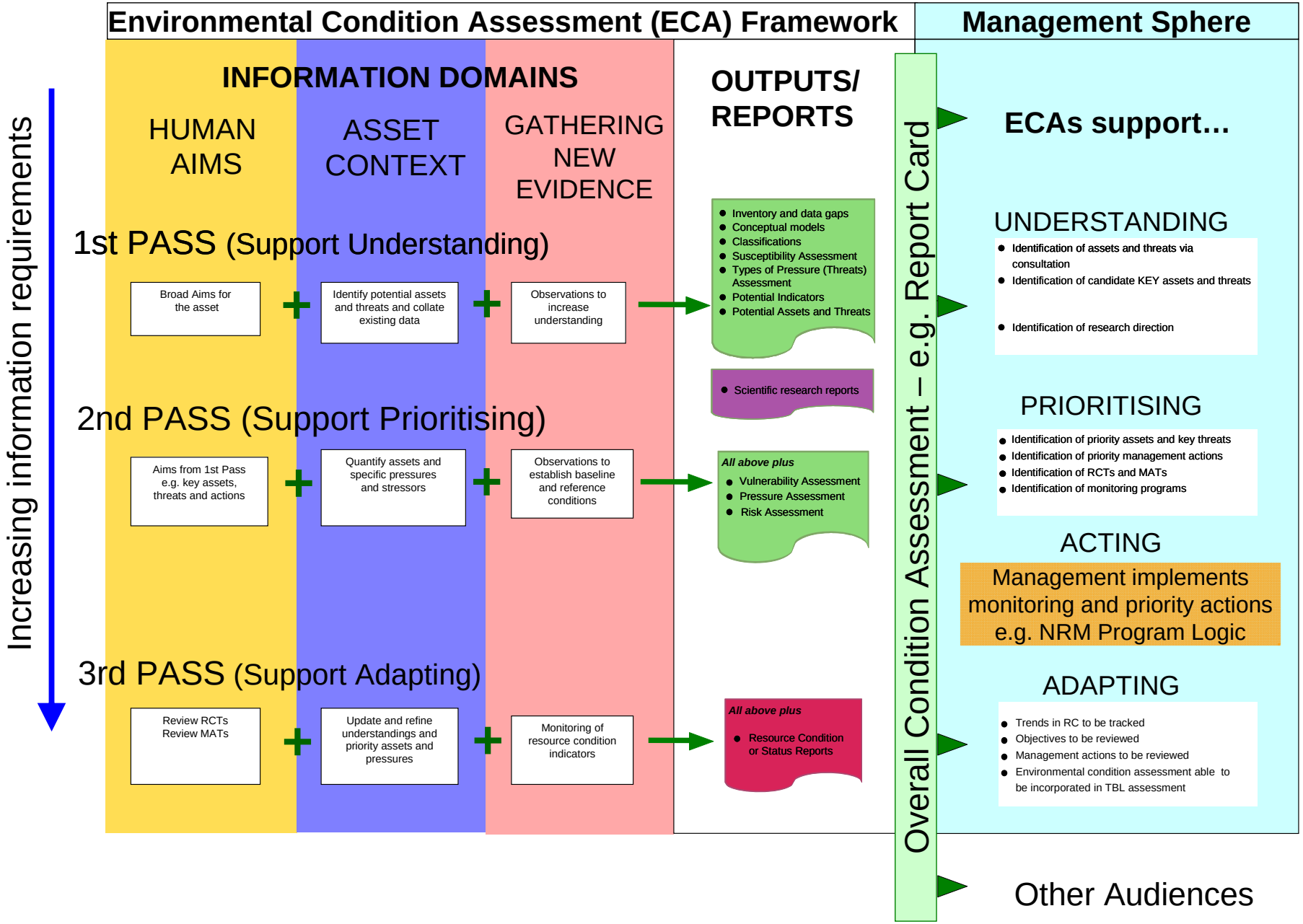


Figure 1. The Environmental Condition Assessment Framework (ECAF). Colours relate to the information domains and assessment types in Appendix 2

1.2 Value and benefit of the ECAF

The ECAF focuses on national level reporting and is clearly dependent on the states, Northern Territory and regions, as they are the primary sources of environmental information. It aligns different reporting mechanisms so that reports can be standardised and compared.

The alignment of assessment frameworks across jurisdictional levels via the adoption of the ECAF would allow for effective and efficient allocation of resources to satisfy assessment and reporting requirements at each level.

In summary, a nationally agreed ECAF would:

- enable comparison of the condition of natural assets through standards-based reporting at the regional, state and national levels
- support the Australian Government, states, Northern Territory and regions to address their reporting and management needs more efficiently, through closer alignment of management and reporting activities
- provide coordination and leadership to assist inter-agency cooperation, particularly at the Australian Government and state levels
- assist with directing research efforts
- facilitate cross-jurisdictional collaboration and capacity building via multi-regional research, management solutions and information exchange.

Recommendation: That the ECAF be prepared for endorsement as the high level assessment framework for estuarine, coastal and marine environments.

Recommendation: If the ECAF is endorsed, that an implementation strategy is developed including:

- documentation of the framework
- preparation of training material and implementation of a training program for NRM managers.

1.3 NRM ECM Report Cards

A recent ECM Report Card Workshop drew together leading marine and estuarine scientists, science communicators and managers from across the country. The workshop and its report were the culmination of a process designed to shape the emerging ECAF (see page 5) through the use of report card trials (described in the following section).

ECAF and Report Card Trials

Following the National Estuarine Environmental Condition Assessment Framework (NEECAF) Round Table in November 2007 (Arundel and Mount, 2007), a series of report card trials were initiated by the Round Table Action Groups and existing projects were adapted to include elements of a desktop trial of the ECAF. This included:

- the Burnett Mary reporting trial (Scheltinga and Tilden, 2008)
- the Western Australia Estuaries NEECAF Report Card Trial (WA Department of Water, 2008)
- the Victorian NEECAF Estuaries Report Card Trial (Arundel, Barton, Becker and Quinn, 2008)
- the NSW Indicator and Report Card Trial (Roper et al., 2008).

The Burnett-Mary and the NSW participants have also liaised with the OzCoasts web site managers to trial delivery of reporting products at the national level.

Though the trials were relatively limited, substantial promise has been shown on the efficacy of the ECAF as a high level assessment framework that acts to “translate” state and regional reports into national level information products.

The NRM ECM Report Card Workshop, March 2008

The workshop objectives were:

- within the context of the ECAF, identify the structure and core components for an NRM ECM Report Carding Best Practice Framework (BPF)
- identify what needs to be done to produce and implement an NRM ECM Report Carding BPF.

The following principles and learnings about NRM ECM report cards were obtained:

- The ECAF is capable of producing NRM report cards and is consistent with known ECM report card activities occurring around the country.
- Each report card must be designed for a purpose and for a clearly defined target audience.
- Successful report cards form only one part of an overall communication package.
- The integrity of the reporting process is critical to building trust and respect, and thus, its value and influence. Transparency of the reporting process is the best way to ensure integrity. Trusted messengers are important report card allies.
- A report card needs to have a multi-tiered structure or layout with a simple top level score and/or comment, followed by brief summaries of the “back end” or contributing reports at the second tier and access to the underlying back end reports at the third tier.
- The summarised top level score should be derived from the environmental condition assessed in the light of current management intentions.

- A lack of adequate data or management objectives should be reported. That the data is absent and needed will form the content of the report. This builds incentive to strive for better quality information, rather than being "data driven".
- A developer's guide to NRM report carding that presents the ECAF and current science communication best practice is critical to setting national reporting standards.

There was interest shown in the VPSIRR software package as a tool for conducting reporting on environmental condition (see Section 3, page 8 for a case study and Section 4.1.3, page 35 for more details).

Recommendation: For report cards, further work is recommended in the following areas:

- Production of a Best Practise NRM ECM Report Card Developers Manual, drawing on existing standards wherever possible.
- More detailed definition of the back end or contributing reports, including susceptibility, vulnerability and risk reports.
- Consideration given to further development of the VPSIRR software package to, firstly, peer review the statistical framework of the software, and, secondly, enable easier implementation of standard approaches to scoring. For example, it would be possible to develop standardised settings in the software that can produce regional, state and national scores derived from the same information content.
- Determine whether it is important to go beyond report card grades and identify management actions.
- Further development of the rules around aggregating and integrating indicators for report card purposes.
- Trialing of the ECAF report card process with report card writers and trialing of the resulting report cards with audiences.
- Development of management objectives for each asset – a critical component of the ECAF which should be given a high priority.

The report card process is critical to the ECAF and, at this stage, it needs further development. A number of steps are indicated above, all of which offer fruitful outcomes.

The delivery of report cards within the context of a rich national repository of high quality information consistent with the ECAF report cards and NRM indicators is an ideal situation (see the Case Study on page 27). This ideal scenario is being showcased in the new "NRM Reporting Module" on the OzCoasts web site. The site has inherited excellent content from the Coastal CRC and is currently undergoing major expansions of data content to cover coastal and nearshore marine areas and the development of new modules for NRM reporting and coastal vulnerability. Site visitation is among the highest of any Geoscience Australia web site.

Recommendation: That the OzCoasts website continue to be developed and supported as the location for reporting national estuarine, coastal and marine assessments.

SECTION 2

2 National Estuarine, Coastal and Marine Indicators

The role of the estuarine, coastal and marine (ECM) resource condition indicators is reviewed and evaluated in this section, including with respect to the ECAF.

Though there is a pending adoption of the new Monitoring, Evaluation, Reporting and Improvement (MERI) Framework, the NRM ECM Information Work Plan 2006-2008 was informed by the National Natural Resource Management Monitoring and Evaluation Framework (NRM M&E Framework) and the associated National Framework for Natural Resource Management – Standards and Targets (NRMMC, 2003). These documents set broad aspirational natural resource outcomes and identified matters for which regional targets were to be set ("Matter for Target"). Several targets were relevant to the assessment of estuaries, particularly estuarine, coastal and marine habitat integrity, and to significant species, invasive species and water quality.

To provide more detail on how to assess each Matter for Target, a set of Resource Condition Indicators was developed for the NRM M&E Framework (2003). Two resource condition indicator headings were identified with regard to estuarine, coastal and marine habitat integrity:

- estuarine, coastal and marine habitat extent and distribution
- estuarine, coastal and marine habitat condition.

A users' guide to these documents (Scheltinga et al., 2004) helped regions to interpret the national framework for estuarine coastal and marine systems. It provides a list of stressors on these systems and identifies potential indicators to measure the effect of the stressors on ecosystem condition (physico-chemical and biological) and habitat extent.

A national workshop convened in February 2006 reviewed the ECM indicator headings, issues and indicators (Souter and McKenzie, 2006) and identified 19 nationally agreed indicators (Table 2).

2.1 Indicator criticisms and challenges

Strong views were expressed at the workshop over management issues and objectives and the need to encourage the development of "more comprehensive" condition indices and pressure indicators (Souter and McKenzie, 2006). It was identified that further work was required to:

- identify which indicators, or combination of indicators, should be used to provide a meaningful assessment of resource condition
- develop pressure indicators to provide context for the resource condition indicators, and guidance for management action
- develop climate change indicators, such as alkalinity, shoreline position and biological indicators.

These, with the other criticisms and issues presented below, have driven the development of the responses outlined in Section 2.1.2.

Estuaries

Barton (2003), in the Victorian report *Estuarine Health Monitoring and Assessment Review*, argues that a poor understanding of pressures and the physical, biogeochemical and ecological processes operating in estuaries, "has hampered the development of state-

wide indicators and monitoring program[s]". She concludes that without this knowledge it is not feasible to objectively measure estuarine condition.

Table 2. Nineteen nationally agreed Resource Condition Indicators (Souter and McKenzie, 2006) with the prioritised indicators shown in bold with an asterisk.

NM&EF indicator heading	Indicator
ECM habitat extent and distribution	**Extent and distribution of key habitat types***
ECM habitat condition	Biological condition
	Algal blooms
	Animal or plant species abundance*
	Chlorophyll a*
	Coral bleaching
	Mass mortality events
	Pest species (number, density, distribution) *
	Targeted pathogen counts
	Vertebrates impacted by human activities
	Physical/chemical condition
	Dissolved oxygen*
	Nutrients *
	pH
	Presence and amount of litter (marine debris) *
	Salinity (EC)
	Sedimentation/erosion rates *
	Shoreline position
	Temperature
	Toxicants (in water / sediments / biota) *
	Water clarity (turbidity)*

There is also a lack of feasible condition indicator methods with reference conditions that enable a quantifiable measure or index – such as the ongoing failure to develop a benchmarking method (like AUSRIVAS or SIGNAL) to estuarine "health" using benthic macroinvertebrates in freshwater environments. This is considered to be related to the paucity of estuarine species, their high degree of tolerance to changing conditions and the high variability of the systems (e.g. see Moverley and Hirst, 1999).

Fish indices, chlorophyll a measures, algal blooms and changes in seagrass extents all have problems with establishing a suitable reference condition. While water quality measures often have national reference and targets set, many experts have indicated that those objectives specified in the National Water Quality Management Strategy (ANZECC, 2000) are often too broad and need to be refined and established for each system of interest – a task that is proving elusive to many jurisdictions. Many water quality monitoring programs are typically designed to assess the performance of specific sewage treatment works rather than broad environmental integrity.

The difficulties also manifest as a lack of resource condition data. For example, the NSW indicator trial milestone reports show that while there is substantial success in compiling data about the estuaries and their catchments and the pressures influencing them (see Appendix 6), there are few data about the resource condition (see Appendix 7 about the missing data sets). The pattern of data availability found in NSW was repeated in every state indicator trial. In the Queensland trial, the report authors emphasise that their whole assessment system is dependent on identifying the stressors acting on the system and then drawing conclusions about which resource condition indicators are needed, if any.

Marine

In the marine environment there are limited examples of the application of resource condition indicators for measuring the condition and trend of ecological integrity. Typically, most marine ecological assessment programs fall into three broad categories – fish stock and sustainability assessments, marine protected area (MPA) performance assessments and broad ecosystem condition assessments. Fishing based assessments are the most advanced and well resourced, though usually focus on the resource being fished, rather than ecological integrity (Chesson and Whitworth, 2004). The MPA performance assessments frameworks are undergoing rapid development as there is a large increase in the number of marine reserves around Australia. However, most have not yet produced assessments.

Broader ecosystem condition assessments, such as those under development for NRM purposes by the Marine Futures program in Western Australia, or the marine assessment program supporting the marine regional planning work of the National Oceans Office, are largely still in the throes of determining the assets of interest and suitable indicators for measuring them. Where broad monitoring of the condition of the marine environment has taken place, there is often a short time series and the monitoring locations are very limited in spatial coverage (Hirst, 2008) – for example, the Reef Plan Water Quality monitoring program (Prange et al., 2006).

Coastal

There are few indicators specifically designed to assess the coastal zone apart from those noted in the previous two sections. The shoreline itself is assessed in some jurisdictions, though these assessments are usually only at the stage of either case studies or assessment of the vulnerability of the shoreline (e.g. Sharples, 2006). Some mapping of coastal values has taken place in some states (e.g. Blake et al., 2002) and some interesting shoreline condition assessments methods are emerging (e.g. Migus, 2008).

A national vulnerability assessment of the shoreline to the impacts of climate change is taking place that is a “First Pass” type assessment (Sharples and Mount, 2008; Mount and Bricher, 2008). The results will be useful for reporting about shoreline types and habitat extent and distribution at the national level. It is notable that there are almost no long-term monitoring programs of shoreline habitats even though they are highly likely to be heavily impacted (Hirst, 2008; note exception of the 30 year shoreline erosion monitoring in South Australia). Dune vegetation and dune erosion rates are vulnerable to climate change (Voice et al., 2006) and are tractable to measurement using remote sensing methods, but are not widely mapped or monitored (Mount and Bricher, 2008). Coastal wetlands suffer a similar fate.

Habitat condition

There is a lack of indicators for directly assessing the condition of key ECM habitats, to complement the “Extent and distribution of key ECM habitat types” indicator. In spite of the indicator heading “ECM Habitat Condition”, there is no way to report on habitat condition monitoring programs, such as seagrass or rocky reef condition. A project was conducted under the ECM Work Plan to test the feasibility of producing a specific indicator for the purpose (Hirst, 2008). The conclusions drawn from the project findings are that there is no current information base available for national reporting of habitat condition, though there are some potential candidate methods and programs that could be further developed to fill that role.

Climate change

Many of the existing indicators are capable of picking up climate change signals. However, additional indicators may be required for assessing ocean acidity and changes in water temperature.

Indicators produced by the Australian Government

In most cases data for supporting assessments in the ECM environments is sourced from local, regional and state levels. However, there are a suite of indicators that may be supported with remote sensing data collected over the whole of Australia by organisations such as the Bureau of Meteorology and CSIRO. In particular, CSIRO Land and Water is starting to produce high temporal resolution maps of a number of potential indicators in nearshore marine waters and some estuaries, including changes in habitat extent, water clarity (turbidity) and chlorophyll a levels (Dekker, Anstee and Brando, 2004). The chlorophyll a measures could be used to estimate primary productivity and algal bloom extents and frequency; however the methods need further development. Nearshore marine ecological features could be identified and monitored, including river plumes, eddy fields, and up-wellings. There is also value in monitoring high magnitude but low frequency events.

A trial is being conducted by CSIRO Land and Water for the Audit to test the feasibility of producing the required image and spectral library data sets in NSW, Queensland, Western Australia, Northern Territory and Tasmania. There is further potential to deliver the information products, such as river plume, chlorophyll a and water clarity maps, in near real time via OzCoasts. A prototype web site for delivering this coastal waters satellite information called Environmental Land and Marine Observational Website (ELMOW) has been developed by the CSIRO L&W and could be considered for "porting" across to Geoscience Australia's OzCoasts web portal. This would require a business case to be developed by the stakeholders, who potentially include all the states, the NRM Regions, NOO marine regional planning, Oceans Policy Scientific Advisory Group, MPA managers (state and national) and the fishing and mining exploration industries. This business case could be developed under the auspices of the Intergovernmental Coastal Advisory Group (ICAG) and/or the Marine and Coastal Committee (MACC).

Recommendation: That ICAG and the MACC consider developing a business case for the incorporation of a web application, such as ELMOW, for delivering near real time remote sensing via OzCoasts.

In summary

There are serious problems with focusing on resource condition indicators in estuarine, coastal and marine environments. The large list of ECM resource condition indicators (Table 2) is proving unwieldy and impractical as a set of performance assessment or ecological integrity indicators at the national level. This is mostly due to:

- a lack of methods with feasible reference conditions
- a lack of resource condition monitoring data
- the limits placed on the interpretation of the available data by the often specific original purpose for the data collection.

Others argue that the indicators need to be embedded within a framework that identifies causative links and supports their interpretation (Scheltinga et al., 2004; Moss et al., 2006; Scheltinga and Moss, 2007; Rissik et al., 2005).

An indicator is missing for direct assessment of the condition of key ECM habitats, such as seagrasses, mangroves and reefs, to complement the "Extent and distribution of key ECM habitats" indicator. Nationally produced indicators such as nearshore marine water clarity, chlorophyll a and temperature are becoming feasible, but still need further development to make them operational.

The views expressed here are consistent with the Australian National Audit Office's (ANAO) recent report on NHT2, which found that identification of resource condition indicators for performance assessment purposes was often confounded by the absence of a causality chain between the investment and the measured effect on resource condition (ANAO, 2008). The ANAO further identified that there was a significant lack of scientific data to underpin the regional investment strategies and a virtually universal lack of a quantifiable connection between the resource condition targets (long term outcomes) and the investment outputs.

The Millennium Ecosystem Assessment project (MEA, 2003) (i.e. the guiding framework for the ecosystem services approach) also notes that higher level assessments are more likely to focus on pressure and vulnerability rather than resource condition.

2.2 ECAF – a response to indicator challenges

The ECAF is an initiative under the ECM Work Plan 2007-2008 to address these issues and progress the development of improved assessment methods – with a particular focus on estuaries, coastal and marine environments.

The ECM resource condition indicators were reviewed in the context of the criticisms and the state indicator trials and reduced to the 10 shown in bold in Table 2. The criteria applied were:

- environmental integrity (not human health or aesthetics)
- usefulness and feasibility for national level reporting
- the need for a national standard (protocol).

Of those indicators not prioritised, some were rolled into retained indicators, some were unable to be adequately assessed at the national level, and others were too specific or fundamentally unsuitable.

Given the problems with resource condition data in estuarine, coastal and marine environments, how does the ECAF address the selection of indicators? The ECAF provides a framework that allows the user to readily see the state of the information base and decide what sort of indicators could be supported by the information base and, if currently unsupported, what is required to obtain support. Indicators can be supported by the information available from most passes, including from susceptibility, pressure, vulnerability, risk or resource condition reports. The ECAF also enables the production of overall environmental condition report card scores, which can be tracked through time as a trend.

The process described for selecting indicators in the "Users' Guide to Estuarine, Coastal and Marine Indicators for Regional NRM Monitoring" Scheltinga et al. (2004) (see Figure 2) is consistent with the three passes outlined in the ECAF, that is: **understand** your system; **prioritise and prepare to act** (by identifying key assets, pressures and stressors) and; following selection of indicators and implementation of monitoring and management programs, **adapt** by reviewing the effectiveness of both programs. Scheltinga et al. (2004) provide details of the process required in the ECAF Second Pass to identify issues and related stressors, and select potential measures of condition, extent and/or pressure.

A new indicator that directly assesses the condition of habitats is proposed for development. Nationally produced ECM indicators should receive serious consideration for habitat extent, water clarity, chlorophyll a, algal blooms and temperature.

Some specific recommendations follow:

Recommendation: In estuarine, coastal and marine environments and within the context of the ECAF, the information product component of the performance assessment-oriented resource condition indicators has limited meaning and should be presented as a guideline rather than a protocol.

Recommendation: That the resource condition indicator protocols be treated more as measurement standards, to assist NRM service providers and community groups to make observations that can be pooled and re-used, and as useful but not central components of an assessment framework.

Recommendation: That monitoring programs for directly assessing the condition of key habitats types, such as rock substrates, coral reef, seagrass, mangrove, saltmarsh, dunes and the intertidal zone be established.

Recommendation: That the infrastructure and methods needed to produce national level ECM indicators, via remote sensing methods, such as habitat extent, water clarity, chlorophyll a, algal blooms and temperature, continue to be developed.

Recommendation: That ICAG and MACC consider the development of a business case to provide remotely sensed information products developed by CSIRO Land and Water via the OzCoasts web portal.

Recommendation: That climate change indicators continue to be developed, such as ocean acidity.

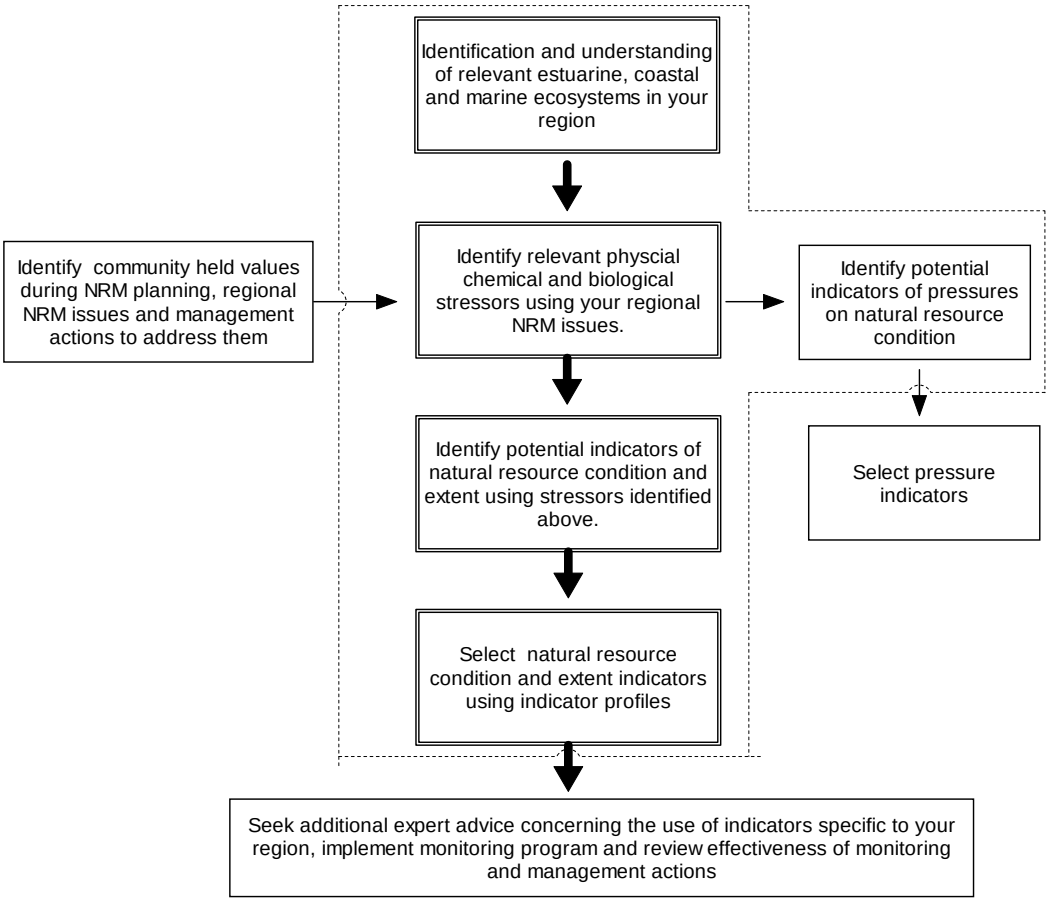


Figure 2. Overview of process for selecting estuarine, coastal and marine indicators for regional NRM monitoring. Source: Scheltinga et al. (2004). Scheltinga only address actions within the dashed box, but do include a list of possible pressure indicators for each stressor.

SECTION 3

3 Case Study: Burnett Mary NRM Region Estuarine Report Cards

Source: Scheltinga and Tilden, 2008

The aim of this project was to examine how estuarine condition and pressure (risk) data can be reported at a variety of levels, from local to national, to be useful to the relevant resource managers at those levels.

The project produced mock-ups of national and regional web pages of estuarine report cards that contain real data. Reporting at the local government and state level for State of the Environment (SoE) reporting purposes was also examined, though not actively engaged, during this project.

Reporting needs of local government

Local governments from the Burnett Mary region were consulted on their needs for estuarine reporting products through the Burnett Mary Regional Group (BMRG), which has local government coordinators within the organisation. However, due to the amalgamation of councils within Queensland and the council elections held in mid March, the local governments were unable to provide advice on their current or future needs. However, a simple method of reporting on the estuaries located within a local government boundary, and for providing information at local government level, was thought to be useful.

Queensland State SoE reporting needs

State Government SoE and SoE on-line managers were consulted during the project but, due to the imminent release of the Qld SoE report, were unable to provide advice on their reporting needs. They were, however, excited about the reporting products produced for the BMRG and on OzCoasts and talks are continuing to produce a “State” report which will be based around reporting on stressors.

Burnett Mary regional reporting

The starting web page is the “Burnett Mary Region State of the Estuarine Environment regional summary” page (see Figure 3). This regional summary page provides:

- a text summary for the region as a whole and a link to download the full *State of the Estuarine Environment Report*
- a Google interactive map of the region, highlighting the position of all the estuaries studied, with the estuary selected specifically shown
- a summary of the overall health, risk and trend of each of the estuaries monitored
- information on the *Key stressors* in the region
- *Information about the assessment process*, i.e. the Stream and Estuary Assessment Program (SEAP) framework used to monitor the estuaries
- a link to the national reporting OzCoast website.

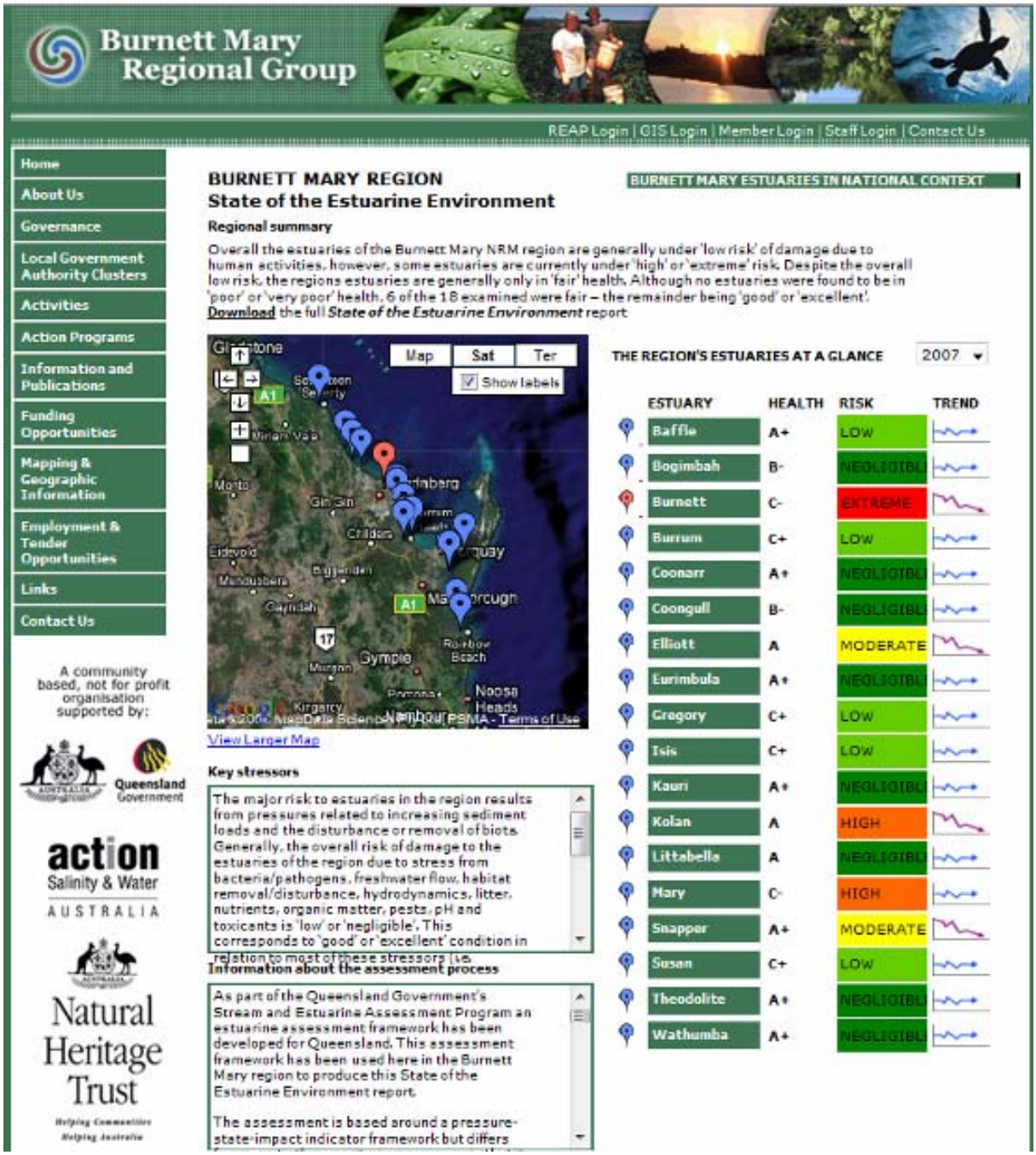
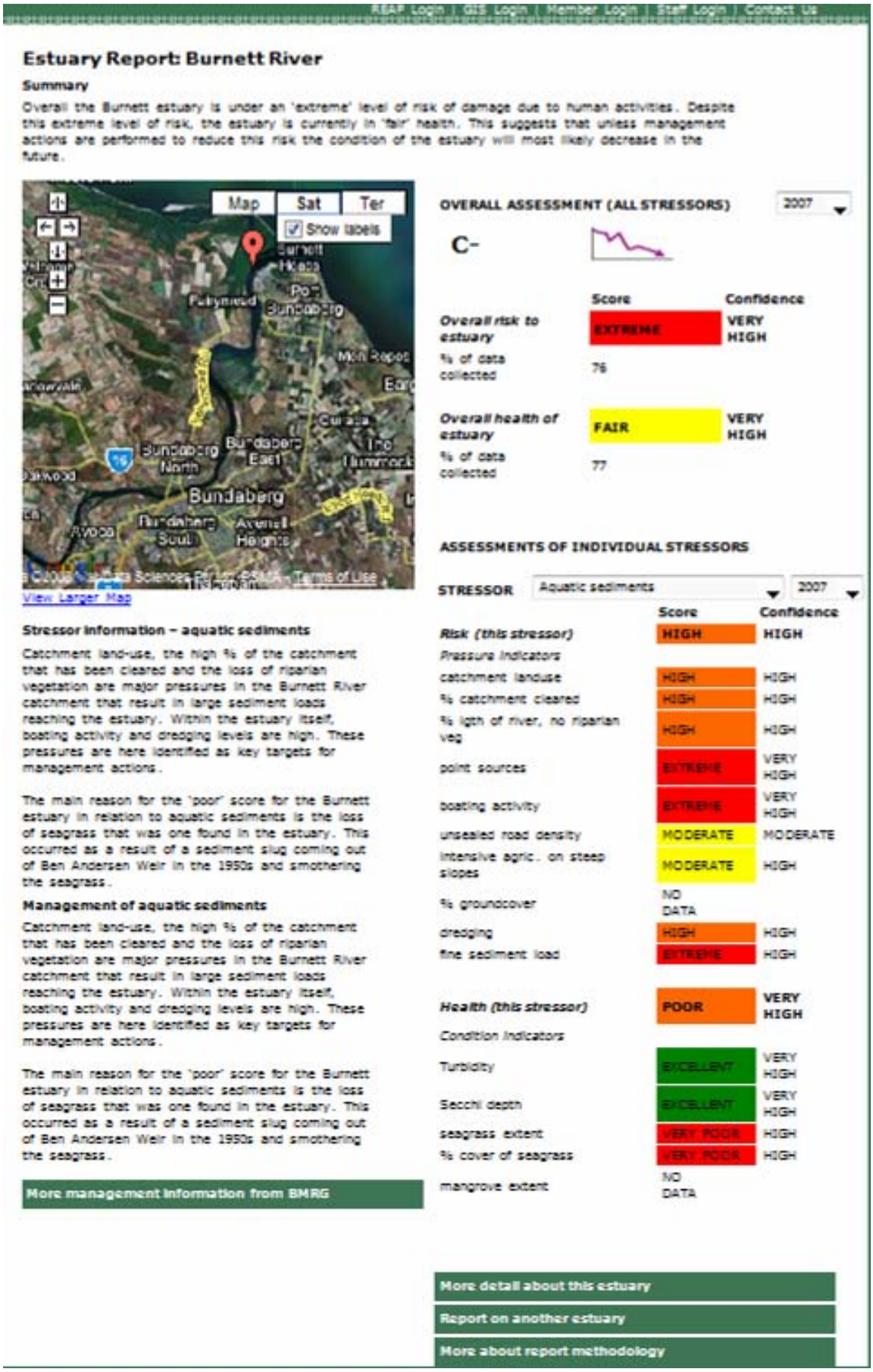


Figure 3. Screen shot of the BMRG regional summary page.

By clicking on the name of an estuary the page changes to a summary of that particular estuary. For example, click on the Burnett estuary name (see Figure 4).



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Estuary Report: Burnett River

Summary

Overall the Burnett estuary is under an 'extreme' level of risk of damage due to human activities. Despite this extreme level of risk, the estuary is currently in 'fair' health. This suggests that unless management actions are performed to reduce this risk the condition of the estuary will most likely decrease in the future.

View Larger Map

Stressor information – aquatic sediments

Catchment land-use, the high % of the catchment that has been cleared and the loss of riparian vegetation are major pressures in the Burnett River catchment that result in large sediment loads reaching the estuary. Within the estuary itself, boating activity and dredging levels are high. These pressures are here identified as key targets for management actions.

The main reason for the 'poor' score for the Burnett estuary in relation to aquatic sediments is the loss of seagrass that was one found in the estuary. This occurred as a result of a sediment slug coming out of Ben Andersen Weir in the 1950s and smothering the seagrass.

Management of aquatic sediments

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More management information from BMRG

OVERALL ASSESSMENT (ALL STRESSORS) 2007

C-

	Score	Confidence
Overall risk to estuary	EXTREME	VERY HIGH
% of data collected	76	
Overall health of estuary	FAIR	VERY HIGH
% of data collected	77	

ASSESSMENTS OF INDIVIDUAL STRESSORS

STRESSOR Aquatic sediments 2007

	Score	Confidence
Risk (this stressor)	HIGH	HIGH
Pressure Indicators		
catchment landuse	HIGH	HIGH
% catchment cleared	HIGH	HIGH
% lgth of river, no riparian veg	HIGH	HIGH
point sources	EXTREME	VERY HIGH
boating activity	EXTREME	VERY HIGH
unsealed road density	MODERATE	MODERATE
intensive agric. on steep slopes	MODERATE	HIGH
% groundcover	NO DATA	
dredging	HIGH	HIGH
fine sediment load	EXTREME	HIGH
Health (this stressor)	POOR	VERY HIGH
Condition Indicators		
Turbidity	EXCELLENT	VERY HIGH
Secchi depth	EXCELLENT	VERY HIGH
seagrass extent	VERY POOR	HIGH
% cover of seagrass	VERY POOR	HIGH
mangrove extent	NO DATA	

More detail about this estuary

Report on another estuary

More about report methodology

Figure 4. Screen shot of the Burnett estuary report page.

The web page in Figure 4 shows:

- a short text *Summary* of the Burnett estuary
- a Google interactive map (zoomed in on the actual estuary – note that further zoom and movement functionality is possible, as with the regional map)
- a summary of the *OVERALL ASSESSMENT (ALL STRESSORS)*, with *Overall risk*, *Overall health* and *trend* "scores", *confidence in the data* and *% of data collected* all shown
- a section on *ASSESSMENTS OF INDIVIDUAL STRESSORS* provides a list of all the indicators for a particular stressor. The score and confidence are provided for each indicator.
- a section on *Stressor information* includes a discussion of the important indicators listed
- information on the *Management of aquatic sediments* (i.e. the particular stressor). This section provides advice on what the key pressures were found to be and suggests which to target for management actions in the future.

The *More management information from BMRG* link goes to information on management actions that are currently occurring or proposed for the future in the estuary's (river) catchment.

The *More detail about this estuary* link was included in case more detailed information on the estuary was needed. We anticipate that this will not be needed, as specific data and information can be requested from BMRG. However, this remains to be discussed with BMRG staff.

The *More about report methodology* link will eventually go to a website with the full detail of the estuarine assessment framework developed by the Queensland Environmental Protection Agency (EPA) as part of the SEAP and used here. The scoring system is fully described in the SEAP (Moss et al., 2006).

National reporting needs (OzCoasts)

In close consultation with Geoscience Australia, national reporting web pages were developed with the data provided by the Queensland EPA study. The following prototype pages have been produced and it is envisaged that when the BMRG *State of the Estuarine Environment Report* is completed in late June, the appropriate data will be delivered to the OzCoast website.

The first of the national reporting pages for the Burnett Mary NRM Region (see Figure 5) shows the 2000 Audit estuarine assessment data (this is Second Pass data under the ECAF system, not First Pass as shown in the screen shot). It shows all the estuaries in the region that were examined in 2000 and the percentage in "near pristine", "largely unmodified", "modified" and "extensively modified" condition.

The year 2008 can be selected from the pull down box which then provides the 2008 BMRG State of the Estuarine Environment data. From this page a summary of the estuaries of the region (% in each scoring category) can be obtained via the pull down box (i.e. overall condition or the condition in relation to any of the stressors – see Figure 6). **Note** that similar information can be viewed in relation to risk by selecting the *Risk* tab. See the "risk" example for the stressor *Biota removal/disturbance* given in Figure 7.

A link from the OzCoast site to the BMRG site will be provided so that anyone interested can "drill down" into the reporting results, right down to the individual indicator level.

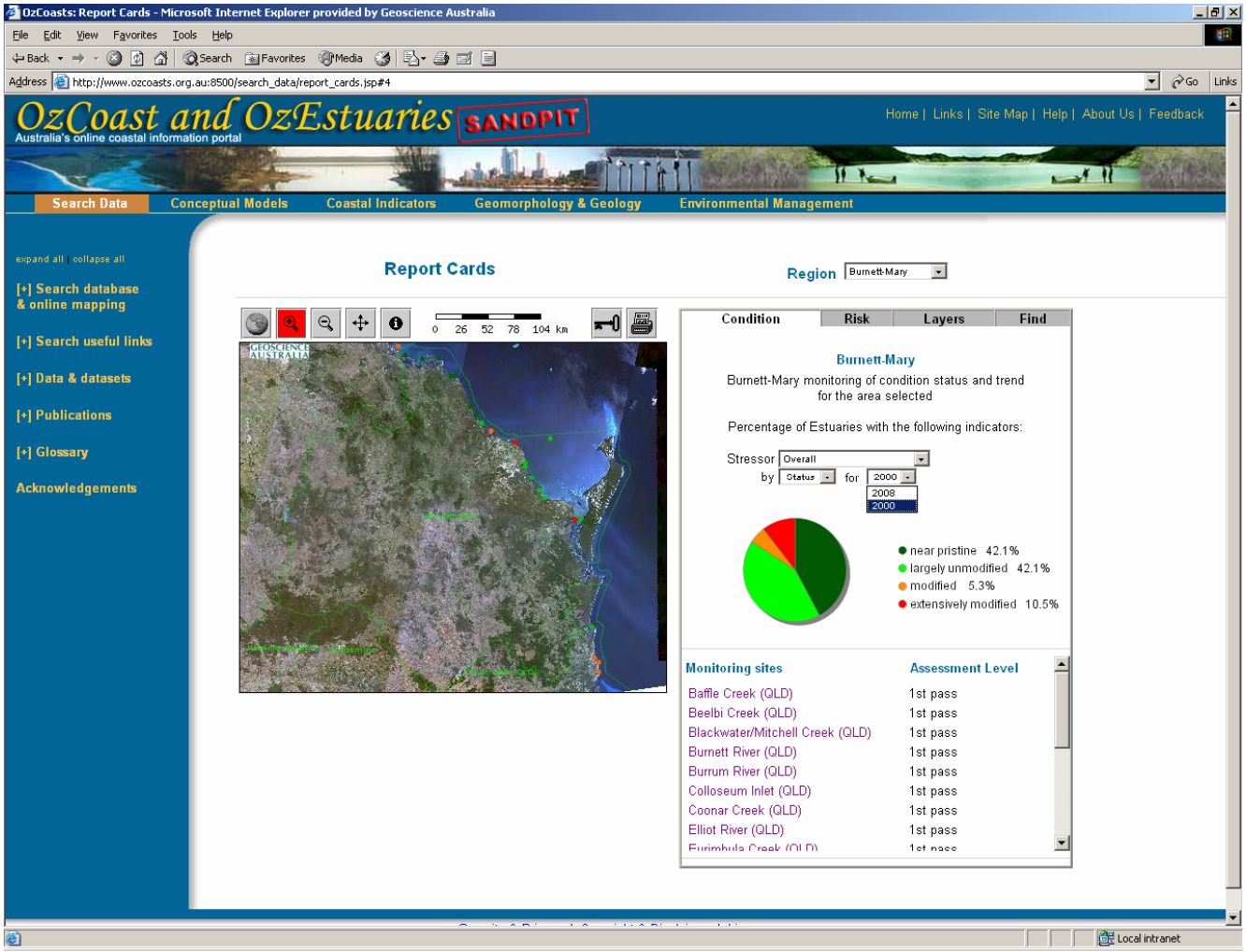

Figure 5. Screen shot of the OzCoast national report page showing the Audit 2000 Second Pass data.

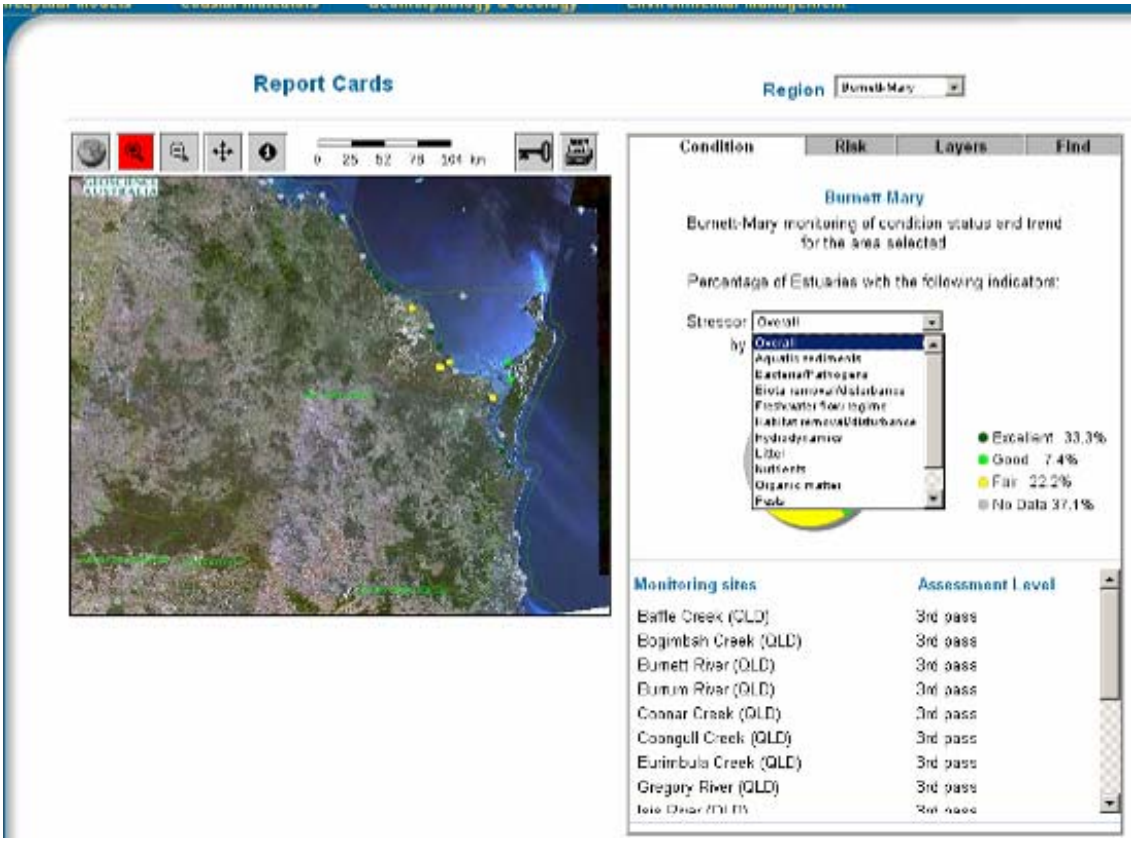

Figure 6. Screen shot of the OzCoast national report page showing the overall health of estuaries in the Burnett Mary Region (with the pull down menu showing how either overall score or scores for each stressor can be selected). A similar pull down menu is available for *Risk*.

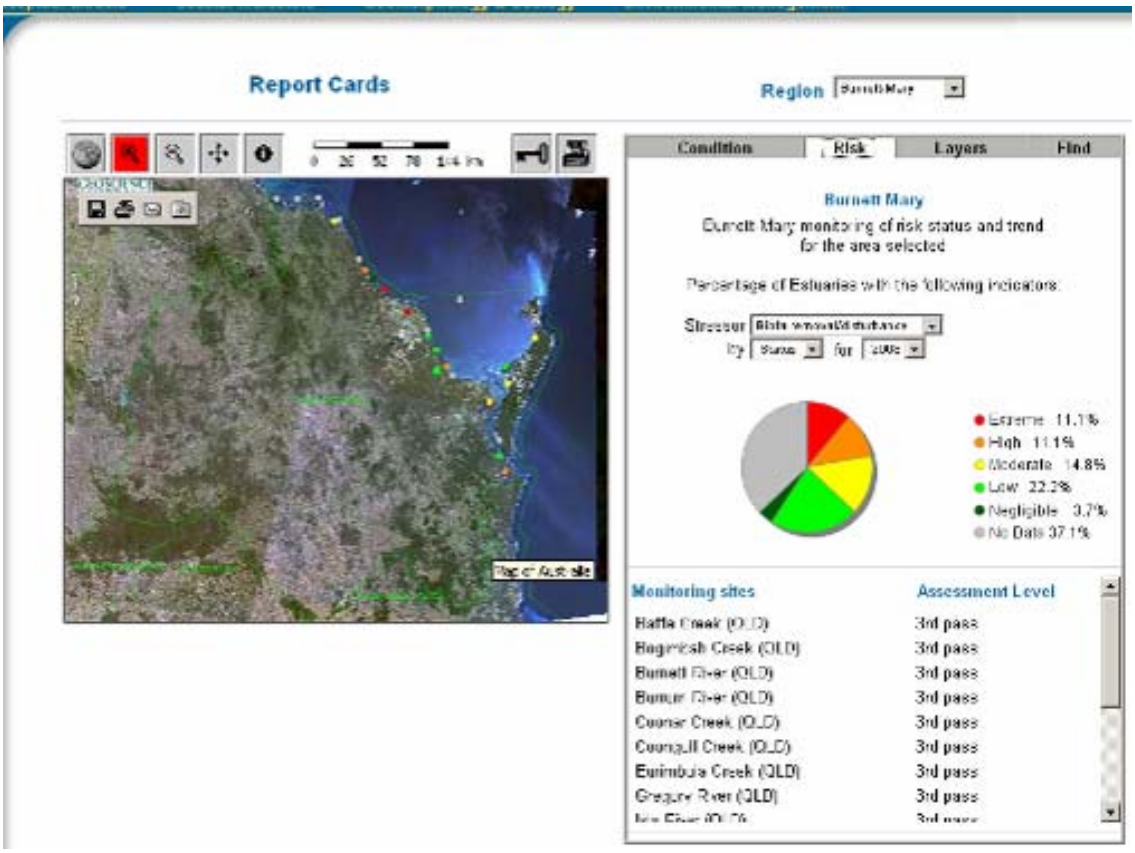

Figure 7. Screen shot of the OzCoast national report page showing the BMRG 2008 Third Pass risk data for the stressor *Biota removal/disturbance*.

Discussion

The trial has clearly shown that information on condition and risk collected at the estuary level, using the SEAP stressor framework, can be used to report at the local, regional and national levels in a way that is useful to the relevant resource managers at these levels.

Compatibility with the National Estuarine Environmental Condition Assessment Framework (NEECAF)

The pilot explored the degree of fit with the draft NEECAF (Arundel and Mount, 2007). The NEECAF is based on the generic ECAF (Mount, 2008) which acts as a "translation engine" so that regional and state environmental condition reports can be "translated" into national report formats. Currently, the ECAF has identified the potential report components at each of its three passes (see page 18).

While some of these ECAF reports need to be further defined, there is clearly the capacity for the SEAP process to produce the bulk of the ECAF content. The overall ECAF report card score (i.e. A-E or 1-5) is similar to the overall SEAP condition score. In principle, the ECAF report card score is made up of the environmental condition score given the current management objectives. The SEAP applies this principle – the overall condition score is generated by a system that directly incorporates management objectives, such as water quality objectives, into the scoring tables.

Table 3. Comparison of ECAF and SEAP components

ECAF Report / Output types	SEAP capacity
First Pass	
• Inventories and gap analyses	• Yes
• Classifications	• Maybe
• Conceptual models	• Yes, per stressor
• Susceptibility assessments	• Yes, implicit in scoring for SEAP "vulnerability"
• Types of pressures/threats assessments	• Yes
Second Pass	
• Degree-of-modification assessment	• Yes
• Pressure/threat assessments	• Yes
• Vulnerability (i.e. "likelihood") assessments	• Yes, per stressor. Called a "risk" assessment; produced by relating SEAP "vulnerability" with Pressures; also translates to "likely condition"
• Risk assessment (i.e. "likelihood and consequence")	• No valuation of assets, therefore no ECAF style "Risk Assessment" can be done
Third Pass	
• Resource condition or status and trend indicator reports	• Yes, per stressor

SECTION 4

4 Scoping each ECM environmental setting

The grouping of estuaries, the coastal zone and the marine environment together is an arbitrary one imposed by the NRM M&E Framework and the Matters for Target. It is not necessarily the optimal grouping for national assessment purposes.

This section provides some observations that will help scope and define these environments in a way that will enable them to be included in future, as yet unknown, priority groupings for assessments. For example, the estuaries, coastal zone and marine environments may be included in the current “Caring for our Country” national priority area of “coastal environments and critical aquatic habitats”.

The section provides summarising commentary and recommended next steps for each of these environments, including

- broad working definitions
- current readiness for assessment
- specific issues and opportunities
- recommended next steps.

All the comments assume that an ECAF is either in place, or is the optimal way to proceed.

4.1 Estuaries: Scope for assessment

4.1.1 Estuaries: Scoping Definition

The Audit defines an estuary as a semi-enclosed coastal body of water where:

- salt from the open sea mixes with freshwater draining from the land
- waters with different salinities mix, or
- marine and fluvial sediments occur together.

However, estuaries included in the last national assessment (NLWRA, 2002) were selected according to the resolution of the available mapping techniques at the time rather than a strict scientific definition, with the result that a large number of often smaller estuaries were not included.

For the purpose of the ECAF it is preferable to:

- establish protocols for measuring the size and bathymetry (depths) of estuaries and their catchments (fluvial and estuarine)
- identify characteristics/attributes of estuaries and their catchments that are potentially useful for describing the “type” of estuary, that is, feeding into classifications of estuaries (see Appendix 6)
- set clear criteria for determining the size and type of estuary to be included in assessments.

The Queensland wetland mapping and classification project (EPA 2005) has defined estuaries, including upstream, downstream and lateral extent, for the purpose of mapping (see Appendix 5). It provides a useful starting point for a national definition.

In many states, estuaries are regarded, or managed, more as extensions of the rivers that flow into them than as extensions of the marine environment. This is more so in states such as Western Australia and South Australia and to a lesser extent Victoria and NSW, where there are many smaller estuaries or paleo-estuaries (i.e. estuaries in advanced stages of maturity) that are intermittently connected to the sea. Where there are significant flows of river water through the estuary, such as in the wet season in northern Australia, the estuary is also treated more as a reach of the river, though in this case there is also recognition of the significant interaction of the river plumes with the marine shelf waters. The larger temperate, permanently open, wave-dominated estuaries, marine inlets and drowned river valleys of Tasmania, Victoria and NSW are generally regarded as forming a part of the marine environment, particularly as the great majority of the species living in them are marine species.

It is not only the physical characteristics of the estuaries that influence their inclusion into either riverine or marine management programs. The well-known "iconic" estuaries with major cities on them are usually the focus of significant research and management programs in their own right. Generally though, estuarine management programs are relatively small compared to river, wetland and catchment programs and estuaries are often not included in marine management programs. For these reasons, some state estuarine managers advocate that estuaries be included in river and wetland programs. For example, in Queensland, estuaries are currently mapped as a type of wetland. In Victoria, estuaries are being included in river reach type assessments. In Western Australia and South Australia, estuaries are usually included in river management programs.

Estuaries are a useful organising entity as people can readily grasp them as a distinct and discrete part of the environment. However, it is quite challenging to unambiguously define every boundary of an estuary and estuaries are made up of other elements of the coastal environment. For example, the shoreline (intertidal zone) and onshore coastal zone both run along the open coast and continue in around estuaries, thus potentially leading to arbitrary divisions of the coast at the seaward end of the estuary. Similar indeterminate boundaries occur with respect to marine pests. Introductions of marine pests often occur in ports, which are usually in estuaries. However, the pests often spread out of the estuary into the broader marine environment.

This discussion has elaborated on some critical definitions pertinent to organising the information base needed for assessing the integrity of estuarine environments. It is recommended that estuaries continue to be treated as a discrete entity for environmental assessment purposes. However, further work needs to be done to more closely define the extent of estuaries.

4.1.2 Estuaries: Current readiness for assessment

Compared to the marine environment, methods for the assessment of estuaries are further advanced. There are more monitoring programs and there is more acute interest in estuaries as they are more directly related to everyday management of human affairs. There is a strong network of estuarine scientists and managers (i.e. the National Estuaries Network) that supports the sharing of estuarine assessment methods and frameworks. There is also a previous national assessment (the National Estuaries Assessment, 2002) on which to build (see a review of that assessment in Arundel and Mount, 2007).

From the perspective of the ECAF, the 2002 national assessment had many excellent attributes and made good use of the available information to produce a "degree-of-modification" report. It has been used for many purposes at the regional, state and national level and the classification of estuaries into modification categories is proving to be robust.

The geomorphic and energy-based classification of estuaries by Geoscience Australia is similarly proving robust and has been updated since the assessment to include more estuaries and develop comprehensive sets of conceptual models for each class of estuary, including for nutrient cycles and hydrodynamics.

Significant information resources about estuaries are held in the OzCoasts web site. There are extensive and detailed conceptual models of a large number of biophysical processes, with associated interpretive information that is thoroughly referenced to recent scientific publications. The web site managers are currently developing an NRM Environmental Reporting module that will be capable of reporting on any NRM asset, including estuaries.

The information in OzCoasts is also consistent with leading estuarine assessment frameworks in Australia, in particular the Streams and Estuaries Assessment Program (SEAP) from the Queensland EPA (see Section 3). This assessment framework builds on the Integrated Estuarine Assessment Framework produced by the Coastal CRC (Moss et al, 2006) (see a review in Arundel and Mount, 2007 and 2008). The ECAF is consistent with this framework - the Burnett Mary Case Study (see page 27) provides an example of the way a detailed regional level assessment framework can be "translated" and presented to the national level.

4.1.3 Estuaries: Specific issues and opportunities

This section discusses some particular issues relevant to scoping a national estuaries assessment, including a comparison of the NEECAF and the ECM indicators with another major assessment framework, the Framework for the Assessment of River and Wetland Health (FARWH). It also identifies the Streams and Estuaries Assessment Program (SEAP) and its associated VPSIRR software as a potential basis for a national approach to assessing the condition of estuaries. The NSW Monitoring, Evaluation and Reporting approach to the collation of foundational system description and pressure data, and the classification methodology, are also considered.

Comparison of the ECM indicators, the NEECAF and the FARWH

The National Water Commission under the National Water Initiative is developing the national FARWH as part of the Australian Water Resources 2005 project. The FARWH (Norris, unpub.) will guide the national assessment of river and wetland health.

The current set of ECM indicators was assessed to see whether they fit into the proposed FARWH (see the section on Current Frameworks and the reviews in Arundel and Mount, 2007 and 2008). The draft FARWH proposes six indices, or themes, for the assessment of river and wetland health, by measuring human-induced change in natural resource condition:

- catchment disturbance
- hydrological change
- physical form and processes
- water (and soils) quality
- fringing zone
- biota.

A comparison of the FARWH with the current set of ECM indicators showed that there were some missing ECM indicators under some themes; particularly catchment disturbance, hydrological disturbance and fringing zone. This is because the current set of

indicators are limited to resource condition and not pressure indicators. Apart from this the FARWH is largely compatible with the current ECM indicators.

The National Estuarine Round Table participants were asked to explore the overlap between the FARWH and the NEECAF and, with some qualifications, considered that it is possible to translate the NEECAF results into the FARWH Themes (Arundel and Mount, 2007). The qualifications were that the NEECAF:

- would require two additional themes – Waterway Activities and Marine Connectivity
- could not meet the requirement of only assessing human-induced change as it is not feasible to distinguish between natural and human change
- could not meet the requirements of defined references and linear scoring.

SEAP and VPSIRR potential

It is proposed that the Queensland EPA Streams and Estuaries Assessment Program (SEAP) and the associated Integrated Estuarine Assessment Framework (IEAF) (Moss et al., 2006) provides a sound basis for further development of a national estuarine assessment framework. These frameworks have been developed in consultation with regional NRM stakeholders and implemented in a variety of circumstances. The approach is consistent with the content of the OzCoasts web site. The methodology is consistent with the ECAF and received strong interest at the National Report Card Workshop (Auricht and Mount, 2008). Two areas require further attention to ensure complete meshing with the ECAF. Firstly, the expansion of the early steps of the SEAP framework to allow the production of more of the First Pass ECAF reports and outputs. Secondly, a definition of the risk assessment framework that is consistent with the Australian Standard (AS/NZS 4360). A useful approach is presented in the Victorian Department of Sustainability and Environment (DSE) report on Land-based Asset Risk Assessments (Annett and Adamson, 2008).

The associated Vulnerability-Pressure-State-Impact-Risk and Response (VPSIRR) software package has received strong interest from a number of key estuarine managers around Australia. It should be considered for further development (see 1.3 on page 8 for further details).

Foundational data

The NSW Monitoring, Evaluation and Reporting (MER) approach to collating foundational data about each estuary, to support the production of resource condition reports, is exemplary. Note that other states have some excellent examples as well, including the Queensland EPA's SEAP, the Western Australian Department of Water's South Coast Estuaries Program and the Victorian DSE's Estuarine Catchment Project. The concept that contextual asset information, describing the system and the pressures or threats acting on it, is essential to developing an assessment methodology is supported by all these programs. The ECAF is built on this concept, giving rise to the notion of foundational data. The data sources consist of measured and modelled parameters. For example, the dilution rate of NSW estuaries is measured in some instances, but is modelled for others.

Given the high value of foundational data, and in spite of the good efforts that have been made, there is a surprising lack of it in most jurisdictions for the vast majority of Australia's estuaries (e.g. see OzEstuaries database, Barton et al., 2008). This is a major barrier (or data gap) to the most basic "first pass" assessment of estuarine condition and must be assigned as the highest priority for data collection.

The collation of foundational data in NSW is a leading example of what can be achieved as it has now has reached a threshold that has enabled a number of models to be developed (Tony Roper, pers. comm.). Significant effort is now being made to establish improved models for nutrient and suspended sediment loads to NSW estuaries. The NSW listing of data sets is proposed as a first version of the National List of Estuarine Assessment Foundational (LEAF) Data Sets (see Appendix 6). The work on estuarine environmental flows also highlights the importance of foundational information; for example, see Hardie, Lloyd and Sherwood (2006)

Estuarine classification

The NSW MER approach to classifying estuaries for assessment purposes is the clearest and most advanced in Australia and **should be adopted as a national standard**. The method is drawn from the US EPA approach and essentially involves classifying the estuaries using the available foundational data sets for each "response" or characteristic of interest (US EPA, 2004). For example, if the response of interest is eutrophication of estuaries, the classification applied to the available data is one that will separate the estuaries into categories reflecting their vulnerability or susceptibility to eutrophication. Different classifications are conducted for other responses, such as water clarity or toxicant pollution. Applying classifications in this way enables stratification of the estuaries into groups that may share indicators, reference conditions and target ranges, or trigger values, thus simplifying assessments and management.

4.1.4 Estuaries: Recommended next steps…

Recommendation: That estuaries continue to be treated as a discrete entity for environmental assessment purposes. However, further work needs to be done to more closely define the extent of the estuaries.

Recommendation: That the EPA, Queensland (2005) definition of an estuary be adopted as the first version of a NEECAF estuary definition.

Recommendation: For the purpose of the NEECAF it is preferable to:

- establish mapping protocols for measuring the size and depth of estuaries and their catchments (fluvial and estuarine)
- set clear criteria for determining size and type of estuary to be included in assessments.

Recommendation: That the Streams and Estuaries Assessment Program (SEAP, Moss et al., 2006) be considered as the basis for further, detailed development of the NEECAF, contingent on the redefinition of the risk assessment framework to one consistent with the Australian Standard (AS/NZS 4360, 2002).

Recommendation: That, if needed, the NEECAF be designed so that it can be reported in the FARWH Themes contingent on the following qualifications:

- that it would require two additional themes – Waterway Activities and Marine Connectivity
- that it will not meet the requirement of only assessing human induced change, as it is not feasible to distinguish between natural and human change
- that it will not meet the requirements of defined references and linear scoring, as the available indicators are not yet available.

Recommendation: That the collection of foundational data is prioritised and that the NSW MER list of foundational data in Appendix 6 is adopted as the first version of the National List of Estuarine Assessment Foundational Data Sets for the NEECAF.

Recommendation: That the collection and collation of foundational data be included as a valid expenditure for NRM funding.

Recommendation: That the NSW MER approach to estuarine classification be adopted as a national standard in the NEECAF.

Recommendation: That the valuable role of the National Estuaries Network be recognised and directly supported.

4.2 Marine environment: Scope for assessment

4.2.1 Marine: Scoping Definition

For the purposes of NRM management (and this report), the marine environment is defined by administrative boundaries, namely the State Coastal Waters – a three nautical mile buffer from the Territorial Sea Baselines (TSB) and the marine influenced "internal waters" within the TSB. The seaward boundary of the State Coastal Waters does not have much ecological meaning and the landward boundary is not precisely defined for some purposes. For example, the TSB is derived from the position of the Lowest Astronomical Tide, though the mapping for this location is more poorly defined than for the mean high water mark, which is the mapped layer usually used for the "coastline". This means that the intertidal zone is often not precisely represented on maps and is thus challenging to include in analyses. The shoreline is also a steep environmental gradient and small changes in the position of mapped boundaries can have significant consequences for the analysis of data sets. For this reason, it is proposed that shorelines include the intertidal zone and be treated as a separate unit of evaluation, as there are many data sets that relate directly to the shoreline itself.

The lateral boundaries of the NRM regions (i.e. between regions) in the marine environment are defined for most states, but at the time of writing there are continuing problems in obtaining the boundaries for Victoria, NSW, Northern Territory and Western Australia. This lack of defined spatial boundaries makes reporting by NRM region practically impossible in these states.

The boundary between marine and estuarine environments is also challenging to define, as there is no distinct, "crisp" boundary in reality. It is proposed that in the interim, the arbitrary boundary defined by the state mapping agencies be accepted as the estuarine/marine boundary. However, further work needs to be done in mapping the river plumes in the marine environment as, in many cases, they significantly extend the estuarine environmental conditions beyond the mapped estuarine boundaries.

The other ecologically relevant spatial units defined in the marine environment are the Integrated Marine and Coastal Regionalisation of Australia mesoscale bioregions (Commonwealth of Australia, 2006). These bioregions are similar to the Interim Bioregionalisation of Australia bioregions defined on land. They are generally considered to be broadly useful, though for some management purposes, including for NRM, they are regarded as too coarse to be meaningful, particularly for reporting. The bioregional boundaries also do not align with the NRM regional boundaries, further complicating the aggregation, interpretation and reporting of marine data sets. The bioregions should be used as a framework for producing finer scale "ecoregions" (*sensu* Hilbert et al., 2007) or "biounits". The Seascapes project of the Marine Biodiversity Commonwealth Environment Research Facilities (CERF) Hub, and the National Intertidal/Subtidal Benthic Habitat Map project, will both contribute to the development of these ecoregions.

4.2.2 Marine: Current readiness for assessment

The stakeholders in the marine environment are broadly divided into fishers, marine protected area (MPA) managers and others, such as mining, tourism and shipping. The activity in monitoring and assessing the marine environment around Australia is mostly conducted by state level agencies or research organisations, rather than NRM regions. The role of NRM regions in the marine environment is evolving and there are a number with growing marine interests. There are some good examples of environmental reporting programs by government agencies and research organisations that are targeted to an NRM audience, including the Great Barrier Reef Marine Park Authority (GBRMPA)

Reef Plan Monitoring Report (Prange et al, 2007), the Marine and Tropical Science Research Facility (MTSRF) Report Carding project (Browne et al., 2006; Kuhnert et al., 2007) and the Marine Futures Program in Western Australia. In NSW and South Australia, the reporting programs are being run by the state agencies and the reporting delivered to NRM regions.

At the national level there are a series of initiatives taking place that will increase the capacity to report on the ecological condition of the marine environments. These include:

- the Marine Biodiversity CERF Hub, which is seeking to establish more detailed mapping and modelling of marine ecosystems
- the National Incursion of Marine Pests Coordinating Group marine pest program, which is continuing to develop marine pest monitoring protocols and establishing a new national database for storing and accessing the data
- a Department of Environment, Water, Heritage and the Arts (DEWHA) review of existing marine debris (litter) monitoring protocols and database models, with a view to establishing national standards
- the active development of marine remote sensing capabilities led by CSIRO Land and Water, which are focused on the national mapping of a series of ecologically relevant indicators, including water clarity, chlorophyll a levels and river plumes.

4.2.3 Marine: Specific issues and opportunities

The National Marine ECAF Round Table (Arundel and Mount, 2008) findings showed that identification of assets of interest for marine assessments is essential. This issue relates to the spatial reporting units issue in the previous section. The challenges are typified by the lack of clarity about the definition of ecological assets or reporting units. While there is progress in developing conceptual models (e.g., NOO, 2007 – i.e. the South West Western Australia Profiles) and monitoring methods (Hirst, 2008), the definition of the actual assets remains a challenge. The approach taken by the National Oceans Office (NOO) to identify “key ecological features” is interesting (NOO, 2007). The method can include dynamic features, such as eddy fields and breeding aggregations that occur consistently in time (e.g. seasonally), but may be difficult features to define with clear spatial boundaries. The effort to define the assets of interest is likely to evolve as the information base about the marine environment increases.

The marine information base for environmental reporting of resource condition is also limited, particularly for assessing ecological integrity (Chesson and Whitworth, 2004). Most of the data sets available for a national level assessment are either very specific (e.g. fisheries stock assessments) or very broad (e.g. climate change impacts such as sea surface temperature) and in either case, mostly relate to threats and pressures acting on the assets. There is limited base mapping of the sea floor, though the rate of mapping has increased over the last five years. Because of this relative lack of resource condition data, an approach that generates useful management information (e.g. report cards), without access to the current status of the ecological integrity via monitoring, is recommended.

Current thinking indicates that assessments should be based on a risk assessment approach (e.g. MTSRF, Harch; CSIRO, NOO, ref, also estuarine environmental flows literature and methods) and the management of known or likely threats to the marine environment. The Marine ECAF is designed to meet these objectives. If the ECAF is endorsed, other components of the assessment methodology will be required, including the development of marine conceptual models of ecological functioning, the definition of marine assets and threats and the development of marine reporting units. At the same time, the reporting products and outputs, including the “back end” and “front end” reports

can be defined. At the same time, resource condition indicator standards can also continue to be identified and developed.

Ideally, any assessment framework should be consistent across the State Coastal Waters boundary (commonly known as the "three nautical mile boundary"). This would enable regional, state and national level assessments to be constructed in a consistent manner. Currently, there is a lot of activity at the national and state levels seeking to establish environmental assessment frameworks. For example:

- the MPA managers around Australia are actively discussing MPA performance management methods following the recent proliferation of MPA declarations
- a national Marine Indicators Review Group meets regularly
- an Overarching Research and Monitoring Framework for Commonwealth Marine Reserves is under development in DEWHA, for the MPA Management Team
- the NOO is actively developing a national assessment framework for the marine regional planning process.

The time is right to create a consistent national assessment framework for all parties. It is recommended that all parties be invited to a forum to discuss the possibility.

While that forum would have a specific focus, there is also scope for a six monthly ongoing forum for marine managers and scientists to discuss ideas and programs of common interest. The marine managers in the state agencies have expressed interest in interacting with their peers and the forum model most often cited is the National Estuaries Network (NEN). The NEN has successfully stimulated a national approach to estuarine assessment and is a vital and energetic forum for information exchange. The key characteristics of the NEN are the open and frank sharing and discussion of peers; it is from this openness that synergies and mutual dependencies and benefits arise.

4.2.4 Marine: Recommended next steps…

Recommendation: Complete and make available the national NRM regions marine segment boundaries data set.

Recommendation: Assessment frameworks should be consistent across the State Coastal Waters boundary.

Recommendation: Where resource condition status is unavailable and likely to remain so for long periods, assessments should be based on a risk assessment approach and the management of known or likely threats to the marine environment.

Recommendations: That the ECAF be proposed for endorsement as a framework for the next National Marine Assessment.

Recommendation: That all interested parties be invited to a forum to discuss the creation of a consistent national marine environmental condition assessment framework.

Recommendation: A method for defining marine assets needs further work. The "key ecological features" approach used for marine regional planning (NOO, 2007) is worth investigating for NRM purposes.

Recommendation: A method for defining ecologically based reporting units (spatial and temporal) needs further work. The Integrated Marine and Coastal Regionalisation of Australia (IMCRA) mesoscale bioregions should act as the framework within which finer detailed "ecoregions" (*sensu* Hilbert et al., 2007) can be defined.

Recommendation: The production of conceptual models of marine ecosystems is an important step to establishing assets, threats and pressures.

Recommendation: That a forum similar to the National Estuaries Network be created and resourced for marine managers.

4.3 Coastal zone: Scope for assessment

4.3.1 Coastal: Scoping Definition

For the purposes of the next national assessment, the coastal zone is defined here as the onshore terrestrial environment that is subject to marine influence, plus the intertidal zone. An example of the definition of the landward boundary can be found in the recent National Intertidal/Subtidal Benthic (NISB) Habitat Map Series project (Mount and Bricher, 2008):

- The land that is either below 10 m elevation (i.e. 10 m above Australian Height Datum – AHD) or within 500 m of the coastline as defined by the mean high water mark. In the low lying areas this area broadly equates to the distribution of coastal vegetation, such as mangroves and saltmarshes. In the environments with more relief than 10 m, this area broadly equates to the extent of habitats subject to a marine influence, for example, coastal dunes or coastal cliff habitats.

This approach is consistent with the concept of the "shoreline" as defined for the recent national shoreline vulnerability mapping project (Sharples and Mount, 2008, in prep.), though that definition includes the immediate subtidal area as well (i.e. typically less the first 50 m). The shoreline is a powerful concept as it is continuous and occurs in both the marine environment (i.e. along the open coast) and the estuarine environments. It is a concept that is readily grasped by many and may assist in overcoming some of the ambiguity of the word "coastal".

The definition presented here is necessarily imprecise as the "coastal zone" will vary in size depending on the NRM asset of interest. For example, if the asset is a series of large coastal wetlands, then the coastal zone may extend inland considerable distances. On the other hand, beaches generally have a more limited terrestrial extent. The areas influencing the assets may also need to be mapped and defined, though it is not necessary to include them in the coastal zone itself. For example, the entire catchment of a coastal wetland is relevant to understanding the wetland but does not need to be included in the coastal zone. This would also apply to human pressures, such as those associated with increased urbanisation.

The habitats included in this area should at least include:

- dune and dune vegetation
- saltmarsh
- mangrove
- shoreline types including beaches, rocky shores and cliffs.

4.3.2 Coastal: Current readiness for assessment

There is little monitoring of the shoreline in Australia. There are a few isolated programs (Hirst, 2008) and a few long-term studies of shoreline position and intertidal ecosystems and habitats. There are, however, significant programs underway that could contribute to assessments of ecological condition in terms of vulnerability to human impacts, including climate change. This includes the Australian Coastal Vulnerability Assessment (CVA) project run by the Department of Climate Change, with partners including CSIRO, Geoscience Australia, Bureau of Meteorology and many state agencies and research organisations. All available shoreline habitat maps and databases are being compiled and impact assessments are about to be conducted. This body of work will provide the basis for a substantial national assessment of shoreline ecosystems for the first time. The reporting would primarily include changes in key habitat extent, distribution and

condition and changes in erosion and sedimentation rates. An interesting methodology is under development in Tasmania that builds a pressure and condition assessment of ecological and human use values on top of the geomorphic shoreline data sets using the same linear coastline segmentation data model as the CVA (Migus, 2008).

A national marine debris (litter) strategy is under development, including the feasibility of creating national marine debris monitoring protocols and database. There is currently some survey data available, but it is of limited coverage.

The onshore weeds and animal pests databases can be queried for "coastal" pest species, though there can be complications determining the landwards boundary. The intertidal zone species tend to be grouped with marine pests and there is no differentiation between plants and animals. It may be feasible to report nationally on pest species as a whole, whether terrestrial or marine. This approach should lead to reporting simplification and efficiencies.

4.3.3 Coastal: Specific issues and opportunities

The challenge in the coastal zone is to adequately define the scope of the area and the focus of the assessments. The approach recommended here is to define the zone itself fairly narrowly as the "shoreline" and acknowledge that this zone interacts with adjacent areas both contributing and receiving flows of materials and energy. This conceptual model allows for direct and indirect human influences to be included, but limits the focus to the ecological integrity of the shoreline itself.

While there is a great deal of research into the ecological functioning of Australia's shoreline habitats there is little ongoing monitoring. This is puzzling as there is an adequate research base and a serious threat to the ecology in terms of climate change. This lack of monitoring information means that the assessment framework needs to be able to produce reports and assessments based on information other than resource condition (or outcome) monitoring. The most likely level of information available for most Australian beaches may support a First Pass vulnerability or susceptibility assessment, with regard to climate change. The ECAF provides the capacity to report that information in a way that will be useful for coastal managers and should be endorsed for use in this environment.

4.3.4 Coastal: Recommended next steps…

Recommendation: For the purposes of the next national assessment, the coastal zone or "shoreline" is defined as the onshore terrestrial environment that is subject to marine influence, plus the intertidal zone.

Recommendation: That the monitoring of the ecological condition of shorelines be prioritised as they are likely to be significantly impacted by climate change.

Recommendation: That the new national marine debris monitoring protocol and database be considered as the NRM Marine Debris (Litter) Indicator Protocol and data source.

Recommendation: That national pest reporting includes all terrestrial and marine pest species.

Recommendations: That the ECAF be endorsed for reporting about the environmental condition of the coastal zone or shoreline environment.

SECTION 5

5 Action Plan

The direction for the next national assessment must be carefully planned. There have been a great number of shortcomings in the efforts made to date to obtain valid credible environmental information about how the estuarine, coastal and marine environments are going. For example, a focus on resource condition and performance indicators has misjudged the situation as there is an insufficient information base to support this sort of assessment for most ECM assets. The focus must be on efficiently establishing an adequate information base that will enable enough understanding of the functioning of the ecosystems to be able to, firstly, inform the process of identifying the assets (what we care about) and their associated threats, and secondly, ask well-founded questions about the condition of the assets.

Much of the content and structure of that information base can be modelled on a synthesis of the best practise information systems already operating in Australia. There is a coherent assessment framework that has evolved through national consultation and there is a clear demand for national leadership to capitalise on the opportunities. The time is ripe for a truly national assessment information infrastructure, with strong cooperation evident among the key people around the country, particularly with regard to estuaries.

One of the key national policy documents for ECM management is the *National Cooperative Approach to Integrated Coastal Zone Management Framework* and its associated *Implementation Plan* (NRMMC, 2006) with which the ECAF and other directions proposed in this report are completely consistent. The recommendations presented here can be regarded as some of the concrete strategies and actions needed to implement the ICZM Framework, particularly in relation to environmental information management outcomes.

5.1 Costings

Costings for an estuarine assessment can be estimated with some degree of accuracy; however, cost estimates for coastal and marine assessments are much less robust.

Estuaries: One-off foundational information costs

The cost of establishing the foundational data essential to underpin the assessment and management of Australia's estuaries is challenging to estimate as it varies from state to state. While much of the information (other than monitoring information) is available, but not yet collated or made available for assessment purposes, some foundational information remains to be collected or modelled. For example, NSW has collated more information for each of its estuaries than any other state but it has not yet identified the catchments that drain directly to the estuary itself (as opposed to the fluvial or river catchment/s). On the other hand, Victoria has just completed that process for most of its estuaries and has valuable vegetation map layers that contribute significantly to estuarine assessments (Barton, Pope, Quinn and Sherwood, 2008). However, is lacking many of the data sets that NSW has collected (see Appendix 6). Queensland has excellent high quality standardised mapping of most of its wetlands, including estuaries, and has the information base and knowledge base that could support the collation of many of the other foundational information listed in Appendix 6. Yet it lacks the resources to do so.

The Northern Territory and states with smaller population bases, are finding the production of estuarine information bases more challenging. With fewer resources and relatively long coastlines, the mapping and data collation exercises are proportionally

much larger. The mapping of the estuaries and their catchments to a consistent standard (bathymetry, geomorphology, upper, lateral and lower limits) and obtaining basic information about each estuary's hydrology (i.e. fluvial inputs, tidal prism, dilution rates) would greatly assist in developing conceptual models for each estuary in these smaller states. These conceptual models are important steps towards understanding the way the estuary functions and will usefully inform the identification of the values of the estuary and the threats and pressures acting on the estuary. They also provide the foundation for most forms of models, including nutrient and sediment transport models. Models are being used more and more in the assessment of estuaries, for example, in NSW and Queensland.

Following the basic shape and functioning information, the collation of pressure/threat information is required, such as population change, land cover and land use. Often this information exists but needs to be accessed, collated and interpreted for the purpose at hand.

The somewhat bizarre situation of highly skilled and knowledgeable state agencies and research bodies doing difficult and complex science in a few locations, while the most basic questions cannot be answered for most estuaries in Australia, is due to a lack of funding for the simpler, even mundane, but no less challenging job of translating that existing technical expertise into a comprehensive information management system that will enable vastly better environmental condition assessments. It is recommended that at least $750,000 million per state and territory (based on actual costs in NSW, pers. comm. Tony Roper), plus another $1 million to establish the national information infrastructure (standards and databases), would be required to begin to overcome the major hurdle caused by the severe lack of foundational information. This foundational information is the highest priority information to collect.

Estuaries: Ongoing costs

Based on actual costs provided by the Queensland EPA for the Burnett Mary regional estuary monitoring program, the average per estuary cost of running a monitoring program for the full suite of national indicators, plus relevant pressure indicators, is approximately $20,000 per annum. If one accepts the number of estuaries in Australia is approximately 1000 (as per the last Estuaries Audit in 2002) then the total annual cost of monitoring every Australian estuary is approximately $20 million. However, not every estuary needs monitoring, as many are in near-pristine wilderness locations and can be assumed to be in "good" or natural condition. The number of near-pristine estuaries identified in the last audit was almost half the total number of estuaries, so the cost of monitoring the non-pristine estuaries could be approximately $10 million per year. If further savings were made by only monitoring for the relevant indicators, and by prioritising the estuaries most in need of monitoring, a national estuarine monitoring program could be conceivable for about $5 million per annum. Continuous monitoring like this would eventually assist with the development of targets and reference conditions for the participating estuaries.

A further $500,000 per year would cover the costs of managing the information infrastructure developed in the preceding "one-off costs" section.

Marine: One-off foundational information costs

The cost of establishing the foundational data essential to underpin the assessment and management of Australia's marine environment is very challenging to estimate as it varies from state to state and the marine information base is less well developed than the estuarine. Currently, the greatest need in the marine environment is to collate enough information to support the identification of marine assets and then threats to those assets.

This process could be informed by the NOO's definition of "key ecological features" for the purpose of marine regional planning. Costings were not obtained from NOO, but potentially could be. The process of identifying IMCRA (NOO, 2006) subregions or "ecoregions" (*sensu* Hilbert et al., 2007) would provide a higher and more suitable resolution for the identification of marine assets. Costings could be estimated from previous IMCRA "rounds".

Marine: Ongoing costs

Until the marine assets are established it is not reasonable to identify the costs of a monitoring program for as yet unidentified assets and threats. However, the value of long term monitoring is made clear in the Hirst (2008) report and it is recommended that a series of long term monitoring sites be established for at least each key habitat type. Costings could be obtained from existing long term monitoring programs such as those operating on the Great Barrier Reef. It is further recommended that existing temperate and tropical reef ecological monitoring programs be extended to include representative monitoring sites outside marine protected areas for the purpose of monitoring broad ecological condition. Costs could be estimated from existing programs. Finally, the development of a National Marine Network, similar to the National Estuaries Network (NEN), should be supported, which would cost approximately $10,000 per annum (based on the NEN costs).

5.2 Recommendations

This section draws together the recommendations from all the previous sections. Firstly, a series of recommendations are made about the overall scope of the next estuarine, coastal and marine national assessment. These are followed by specific recommendations for each environmental setting.

ECAF

Recommendation: That the ECAF be prepared for endorsement as the high level assessment framework for estuarine, coastal and marine environments.

Recommendation: If the ECAF is endorsed, that an implementation strategy is developed including:

- documentation of the framework
- preparation of training material and implementation of a training program for NRM managers.

ECAF Report Cards and OzCoasts

Recommendation: For report cards, further work is recommended in the following areas:

- Production of a Best Practise NRM ECM Report Card Developers Manual, drawing on existing standards wherever possible.
- More detailed definition of the back end or contributing reports, including susceptibility, vulnerability and risk reports.
- Consideration given to further development of the VPSIRR software package to, firstly, peer review the statistical framework of the software, and, secondly, enable easier implementation of standard approaches to scoring. For example, it would be possible to develop standardised settings in the software that can produce regional, state and national scores derived from the same information content.
- Determine whether it is important to go beyond report card grades and identify management actions.
- Further development of the rules around aggregating and integrating indicators for report card purposes.
- Trialing of the ECAF report card process with report card writers and trialing of the resulting report cards with audiences.
- Development of management objectives for each asset – a critical component of the ECAF which should be given a high priority.

Recommendation: That the OzCoasts website continue to be developed and supported as the location for reporting national estuarine, coastal and marine assessments.

Recommendation: That ICAG and the MACC consider developing a business case for the incorporation of a web application, such as ELMOW, for delivering near real time remote sensing via OzCoasts.

NRM ECM Indicators

Recommendation: In estuarine, coastal and marine environments and within the context of the ECAF, the information product component of the performance assessment-oriented resource condition indicators has limited meaning and should be presented as a guideline rather than a protocol.

Recommendation: That the resource condition indicator protocols be treated more as measurement standards, to assist NRM service providers and community groups to make observations that can be pooled and re-used, and as useful but not central components of an assessment framework.

Recommendation: That monitoring programs for directly assessing the condition of key habitats types, such as rock substrates, coral reef, seagrass, mangrove, saltmarsh, dunes and the intertidal zone be established.

Recommendation: That the infrastructure and methods needed to produce national level ECM indicators, via remote sensing methods, such as habitat extent, water clarity, chlorophyll a, algal blooms and temperature, continue to be developed.

Recommendation: That climate change indicators continue to be developed, such as ocean acidity.

Estuarine

Recommendation: That estuaries continue to be treated as a discrete entity for environmental assessment purposes. However, further work needs to be done to more closely define the extent of the estuaries.

Recommendation: For the purpose of the NEECAF it is preferable to:

- establish mapping protocols for measuring the size and depth of estuaries and their catchments (fluvial and estuarine)
- set clear criteria for determining size and type of estuary to be included in assessments.

Recommendation: That the EPA, Queensland (2005) definition of an estuary be adopted as the first version of a NEECAF estuary definition.

Recommendation: That the Streams and Estuaries Assessment Program (SEAP, Moss et al., 2006) be considered as the basis for further, detailed development of the NEECAF, contingent on the redefinition of the risk assessment framework to one consistent with the Australian Standard (AS/NZS 4360, 2002).

Recommendation: That, if needed, the NEECAF be designed so that it can be reported in the FARWH Themes contingent on the following qualifications:

- that it would require two additional themes – Waterway Activities and Marine Connectivity
- that it will not meet the requirement of only assessing human induced change, as it is not feasible to distinguish between natural and human change
- that it will not meet the requirements of defined references and linear scoring, as the available indicators are not yet available.

Recommendation: That the collection of foundational data is prioritised and that the NSW MER list of foundational data in Appendix 6 is adopted as the first version of the National List of Estuarine Assessment Foundational Data Sets for the NEECAF.

Recommendation: That the collection and collation of foundational data be included as a valid expenditure for NRM funding.

Recommendation: That the NSW MER approach to estuarine classification be adopted as a national standard in the NEECAF.

Recommendation: That the valuable role of the National Estuaries Network be recognised and directly supported.

Marine

Recommendation: Complete and make available the national NRM regions marine segment boundaries data set.

Recommendation: Assessment frameworks should be consistent across the State Coastal Waters boundary.

Recommendation: Where resource condition status is unavailable and likely to remain so for long periods, assessments should be based on a risk assessment approach and the management of known or likely threats to the marine environment.

Recommendations: That the ECAF be proposed for endorsement as a framework for the next National Marine Assessment.

Recommendation: That all interested parties be invited to a forum to discuss the creation of a consistent national marine environmental condition assessment framework.

Recommendation: A method for defining marine assets needs further work. The "key ecological features" approach used for marine regional planning (NOO, 2007) is worth investigating for NRM purposes.

Recommendation: A method for defining ecologically based reporting units (spatial and temporal) needs further work. The Integrated Marine and Coastal Regionalisation of Australia (IMCRA) mesoscale bioregions should act as the framework within which finer detailed "ecoregions" (*sensu* Hilbert et al., 2007) can be defined.

Recommendation: The production of conceptual models of marine ecosystems is an important step to establishing assets, threats and pressures.

Recommendation: That a forum similar to the National Estuaries Network be created and resourced for marine managers.

Coastal

Recommendation: For the purposes of the next national assessment, the coastal zone or "shoreline" is defined as the onshore terrestrial environment that is subject to marine influence, plus the intertidal zone.

Recommendation: That the monitoring of the ecological condition of shorelines be prioritised as they are likely to be significantly impacted by climate change.

Recommendation: That the new national marine debris monitoring protocol and database be considered as the NRM Marine Debris (Litter) Indicator Protocol and data source.

Recommendation: That national pest reporting includes all terrestrial and marine pest species.

Recommendations: That the ECAF be endorsed for reporting about the environmental condition of the coastal zone or shoreline environment.

Partners, participants and collaborators

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Definitions

Asset: The attributes of a system that hold value for the community and about which the community would be concerned if they were lost or degraded (DNRE, 2002)

Condition (State): The state or health of individual animals or plants, communities or ecosystems (Scheltinga, 2004).

FARWH: the national Framework for the Assessment of River and Wetland Health developed by The National Water Commission under the National Water Initiative, as part of the Australian Water Resources 2005 project.

Framework Structure: The organising principles and overall approach underpinning the framework. For the NEECAF, it consists of the flexible, layered First, Second and Third Passes.

Indicators: Processes, species or community characteristics of a particular habitat that are indicative of a particular set of environmental conditions (Barton, 2003).

National: An adjective describing something that is produced or agreed by jurisdictions at all levels including the Australian Government, state/Northern Territory governments, NRM regions and local governments.

NEECAF: National Estuarine Environmental Condition Assessment (ECA) Framework. A framework developed and adopted by regions, states, territories and the Australian Government

NRM managers: Very broad term including anyone with an active interest in managing natural estuarine coastal and marine resources at the national, state, regional, local or community levels.

Pressure / Driver: Factors that impact on aquatic ecosystems and include pollutants, changes to habitat, changes to flows, pest species and direct human impacts, such as fishing (Moss et al., 2006).

Risk: A combination of the vulnerability of the system and the intensity of the pressure (stressor) on a system – a highly vulnerable system exposed to a high level of pressure is considered at high risk (Moss *et al.*, 2006).

Stressors: Major components of the environment that when changed by human or other activities, can result in degradation of natural resources. Stressors can be a component of the environment that is changed from its natural state, or a component not usually present in natural (healthy) ecosystems (Scheltinga at al., 2004).

TBL: Triple bottom line - decisions that consider economic, social and environmental factors

TLA: Triple letter acronym

Threat: A source of impending danger or harm to the condition of natural resource assets or the services they provide. Can include both pressures and stressors.

Trajectory / Phase: An aspect of the system that varies with time e.g. wet/dry season and open/closed estuary

Value: The worth we assign to an estuary or attributes of an estuary. These are reflected in the management objectives for the estuary

Vulnerability: The resilience or sensitivity of the system to a stressor (Moss, 2006).

Work Plan: NRM ECM Information Work Plan 2006 – 2008. Implemented under the guidance of the Intergovernmental Coastal Advisory Committee (ICAG) by the Audit.

Acronyms

ANAO	Australian National Audit Office
AHD	Australian Height Datum
AquaBAMM	Aquatic Biodiversity Assessment and Mapping Method
BMRG	Burnett Mary Regional Group
BPF	Best Practise Framework
CERF	Commonwealth Environment Research Facilities
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEWHA	Department of Environment, Water, Heritage and the Arts
DSE	Department of Sustainability and Environment, Victoria
ECA	Environmental Condition Assessment
ECAF	Environmental Condition Assessment Framework
ECM	Estuarine, Coastal and Marine
EPA	Environment Protection Authority/Agency
FARWH	Framework for the Assessment of River and Wetland Health
GBRMPA	Great Barrier Reef Marine Park Authority
ICAG	Intergovernmental Coastal Advisory Group
IDC Model	Information Domain Conceptual Model
IEAF	International Estuaries Assessment Framework
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IRCF	Integrated Report Card Framework developed by the MTSRF
LEAF	List of Estuarine Assessment Foundational Data
NRM M&E Framework	NRM Monitoring and Evaluation Framework
MACC	Marine and Coastal Committee
MECAF	Marine ECA framework
MER	Monitoring Evaluation and Reporting
MERI	Monitoring Evaluation Reporting and Improvement
MPA	Marine Protected Area
MSC	Marine Stewardship Council
MTSRF	Marine and Tropical Science Research Facility
NAP	National Action Plan
NEECAF	National Estuarine Environmental Condition Assessment Framework
NEN	National Estuaries Network
NHT	National Heritage Trust
NHT2	National Heritage Trust 2
NIMPCG	National Incursion of Marine Pests Coordinating Group
NISB	National Intertidal/Subtidal Benthic
NOO	National Oceans Office Branch
NRM	Natural Resource Management
NWQMS	National Water Quality Management Strategy
SEAP	Streams and Estuaries Assessment Program
SEQ	South East Queensland
SoE	State of the Environment
TLA	Triple Letter Acronym
TSB	Territorial Sea Baseline
VPSIRR	Vulnerability - Pressure - State - Impact - Risk and Response

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Appendix 1. NRM ECM Work Plan 2007-2008 Projects List

Trialing of the Resource Condition Indicators projects

- Tasmania (DPIW, TAFI, UTAS) (Mount, 2006)
- South Australia (DEH, EPA, Adelaide University)
- Queensland (Burnett-Mary, QLD EPA) (Scheltinga and Moss, 2007)
- New South Wales (Natural Resource Commission and DECC) (DECC, 2007)

Trialing of the ECAF and Report Carding projects

- New South Wales (Natural Resource Commission and DECC) (DECC, 2007)
- Queensland (Burnett-Mary, QLD EPA) (Scheltinga and Tilden, 2008)
- Victoria (Deakin University and DSE) (Arundel et al., 2008)
- Western Australia (Department of Water) (Department of Water, 2008)

Consultation and ECAF development projects

- National Estuarine ECAF Round Table (Arundel and Mount, 2007)
- National Marine ECAF Round Table (Arundel and Mount, 2008)
- National NRM Report Card Best Practise Framework Workshop (Auricht and Mount, 2008)

Data set projects

- ECM National Habitat Map Series (Mount and Bricher, 2007)
    - National Intertidal/Subtidal Benthic (NISB) Classification Scheme (Mount, Bricher and Newton, 2007)
    - NISB Habitat Map
    - NISB Habitat Distribution Map Series
    - Estuarine and Wetland Map Collections
    - National Shoreline Map (Sharples and Mount, 2008, in prep.)
- National shallow waters remote sensing project (Dekker et al., 2008)
    - National Shallow Waters Spectral Library
    - NRM national high temporal resolution maps of coastal waters
    - NRM high spatial resolution imagery for estuaries and islands

Information Infrastructure projects

- OzCoasts web site developments (Radke et al., 2007,2008)
    - Enhanced search facility
    - Extension of OzEstuaries to OzCoasts
    - Creation of the NRM ECM Report Card Module

Appendix 2: Establishing the Information Base for ECM Assessments

For the purposes of better understanding reporting and assessment needs under the National NRM M&E Framework, an analysis of information requirements was conducted. The analysis led to the development of an NRM reporting "Information Domain Conceptual Model" (IDC Model) (Mount, 2007), which is summarised here and presented more fully in Arundel & Mount (2007, 2008).

The Model is presented as a way of thinking about the "types" of information required for ECM reporting and the types of reports possible. The Model has underpinned the development of the flexible, layered ECAF.

The three information domains required for a comprehensive resource condition assessment are represented diagrammatically in Figure 3. In summary, the domains are:

- The Asset Context Domain provides information about where the asset is and how it works, and identifies the direct and indirect human influences and impacts acting on the asset.
- The Human Aims Domain articulates what we value about the asset and identifies any existing management intentions that are relevant to the asset.
- The Gathering New Evidence Domain includes further observations or evidence that is required to inform the assessment.

The **Asset Context Domain** includes information about:

- the **function and physical form** of the asset and
- the **direct and indirect human influences and impacts** on the asset.

There is currently no agreed definition of an NRM asset but it could be either a living or non-living object or process. Depending on the type of asset, the Asset Context Domain encompasses a range of physical characteristics and population attributes and can also include historical information. The information in this domain describes how an asset provides the range of ecosystem services that are defined in the Human Aims Domain.

Information about human influences and impacts points to actions that we have some control over and forms the basis for the development of management strategies. This information also assists in identifying relevant stakeholders to participate in assessment programs. The domain also includes indirect human influences and cumulative impacts.

The domain delivers the existing "common understanding" of the asset and can incorporate many "ways of knowing", including research, expert opinion, and local and indigenous knowledge. The domain is also useful for identifying what we don't know i.e. knowledge gaps.

Developing an understanding of the asset and the influence of human activities is critical to the other domains, namely, identifying what further evidence might be required to assess the condition of the asset and identifying human values associated with the asset.

It is acknowledged that the quality of information will vary and a “level of confidence” should be applied to all information in this domain.

The **Human Aims Domain** identifies both:

- **why we care** about the asset and
- the **management intentions which exist to protect** the asset.

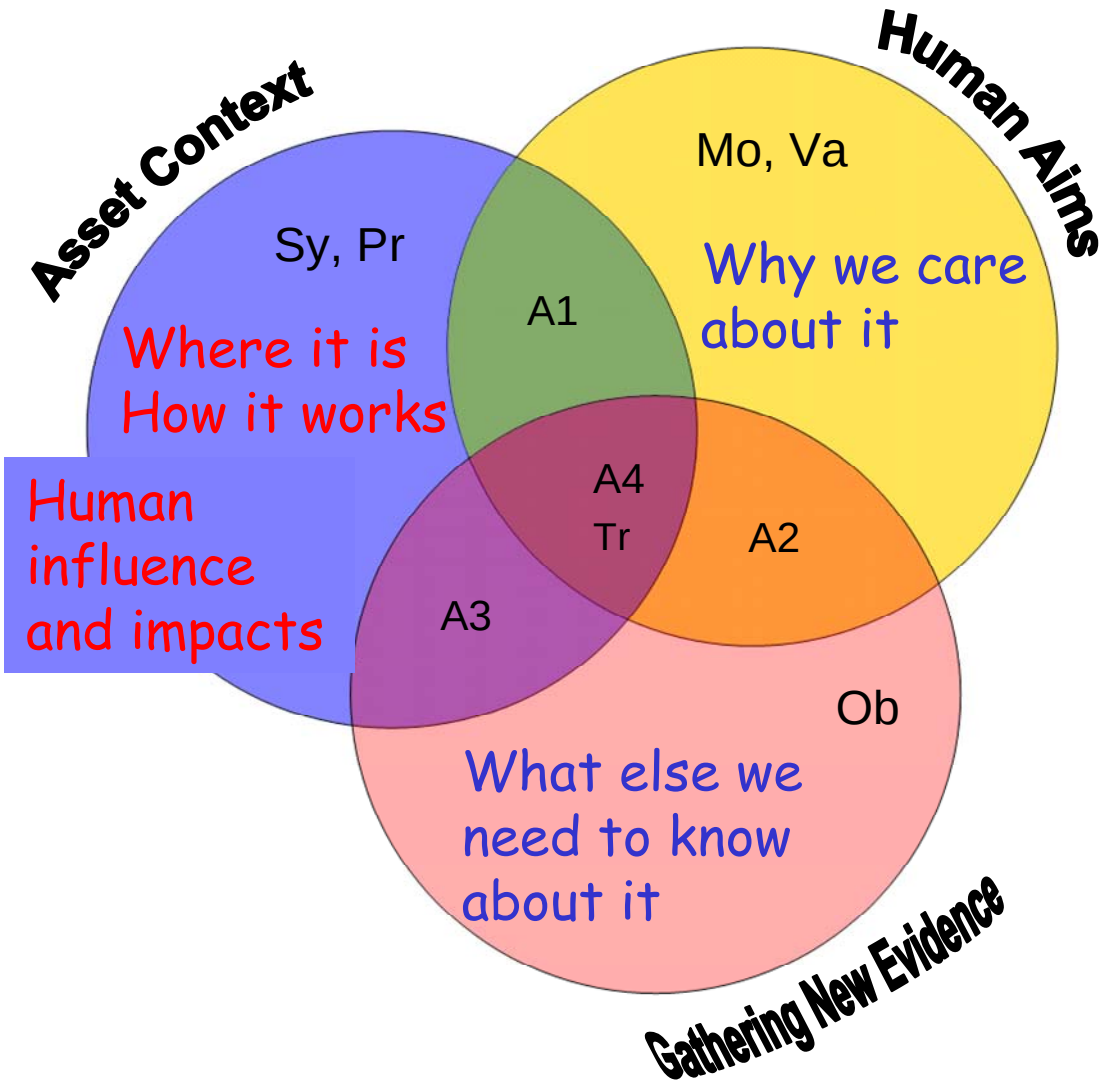
This domain includes **all values** (i.e. economic, social and cultural) assigned to an asset by a range of stakeholders. For example, ecosystem services can be defined in this domain. It also recognises the **standing** (e.g. community opinion or legislation) and **specificity** (e.g. from general policy protecting biodiversity, to recovery plans for particular species) of the value. It is recommended that management intentions should encompass all arrangements including community and indigenous values, regional policies and plans, legislation, treaties and established principles, such as the precautionary principle. The concept of stewardship is included in this domain.

The Human Aims Domain allows responsible stakeholders to be identified and hence provides a link to resourcing requirements. Information in this domain also allows the identification of areas where values are not expressed, or management intentions are absent or unclear.

The **Gathering New Evidence Domain** identifies information, additional to that in the Asset Context Domain, required for environmental assessment of an asset at any “pass” (see the next section for details). The level of information required will vary depending on the gap between existing information and that required to meet the stated management intention or objectives for the asset. Types of information could include:

- for the First Pass, last minute incidental observations, ground truthing data and supplementary rapid assessment observations
- for the Second Pass, collecting baseline observations and measurements
- for the Third Pass, results of extensive monitoring programs, i.e. typical time series observations and change detection analyses.

This information allows standards to be set and changes in either the condition of the asset, or the level of risk (including exposure to hazard, vulnerability, likelihood and consequence), to be detected. It also allows testing of conceptual models and underlying assumptions produced in the Asset Context Domain.



Information Domain Component		Example
Sy	where it is, how it works; system type	shallow, tropical, turbid shelf waters
Pr	direct and indirect human influences and impacts; pressures or threats	catchment clearance, high fishing effort
Ob	what else we need to know; observations through time	turbidity measurements for monitoring
Mo	management intentions that exist for it; management objectives	by-catch objective
Va	why we care about it; values	ecosystem values (biodiversity) and human use values (aquaculture, tourism)
Tr	triggers/alerts (reference)	set to 80th percentile

Figure 3. Information domain conceptual model for NRM ECM reporting and assessments. Information domains (Asset Context, Human Aims and Gathering New Evidence) provide the basis for various types of assessments, represented here by the overlaps between the information domains (see Table 4 below). For example, full resource condition assessments (A4), such as indicator reports, require information from all three domains.

Assessment (Outputs and Report) Types

The model also depicts four types of assessments or reports (A1- A4) that are possible, given different combinations of the information domains.

Table 4. Assessment (Report/Output) types (A1-A4) that are feasible with any given combination of information domains, as shown by the overlaps between the domains presented in Figure 1. Some weaknesses of each type are also identified.

Report/Output examples		Weakness
A1	inventory, data gaps, conceptual models, classification, vulnerability, modification, risk	current condition and trends not available
A2	surveillance, early warning	poor causal linkages
A3	knowledge quest, research reports	lack of management relevance
A4	full assessment including A1-A3 (with trigger levels)	complex, long time frames, expensive

An **A1 Assessment** evaluates the management objectives or values assigned to an estuary against an understanding of the system type. This does not require information about current asset condition from monitoring. An A1 report can be a simple descriptive report that relies on collation of existing data from the Assets Context Domain, to a detailed risk assessment.

Applications: Assessments of vulnerability and risk (*sensu* Moss et al., 2006}; identification of "priority" assets; mapping; inventories and data gap analysis; conceptual models.

An **A2 Assessment** reports on aspects of the asset that the community values or that are of potential interest without reference to, or understanding of, the asset.

Applications: Developing information base; surveillance; community engagement/capacity building projects.

An **A3 Assessment** provides information gained by gathering new evidence about the various asset components. It enables an understanding of the system to be developed, but the results are not related to management objectives.

Applications: Research reports; monitoring of assets that may help to help establish management objectives and identify potential indicators.

An **A4 Assessment** provides information about the current condition of the asset, informed by information about the monitoring data and evaluated against specific management objectives.

Application: Full resource assessment; establishment of trigger levels and /or reference conditions.

Appendix 3: ECAF - Further descriptive material

First Pass Assessment (supporting understanding)

The First Pass is used to support our understanding of the asset by assembling what is known about the asset. This requires collation of existing data but does not rely on the results of a monitoring program. Human Aims may be implicit or broadly stated only, but the value assigned to particular assets will, to some extent, drive data collation. Reports produced at this stage are A1 type assessments.

The "Asset Description Assessment" identifies characteristics of the asset (potential asset) and its pressures (potential threats). A First Pass assessment would also enable the susceptibility (or "vulnerability" – *sensu* Moss et al., 2006) of the asset to be determined. While the susceptibility of an asset varies depending on the particular pressure or stressor, for an asset such as an estuary, factors such as flushing rate and entrance status modify the threat from several stressors, such as toxicants and nutrients, and will be relevant to many estuaries.

A "Susceptibility Assessment" allows priority assets to be identified and supports better targeting of management effort and further data collection (e.g. research).

A First Pass assessment enables specific "Human Aims" to be established though a management process. For example, input into the identification of key assets and threats by experts and stakeholders, identification of suitable levels and types of use (e.g. multiple uses vs. conservation) and setting of broad resource condition targets or outcomes (e.g. 10-20 year time frame).

Second Pass Assessment (focus and enable prioritising)

A Second Pass assessment uses the human aims generated by the current social and political management processes (ideally, including those supported by the information collected in the First Pass) to produce assessments that enable further prioritising of key assets and threats. While the susceptibility assessment in the First Pass identifies the susceptibility of the system to various stressors, the level of pressures and/or stressors (hazard) is required to ascertain vulnerability (or "risk" *sensu* Moss et al., 2006). For example, an estuary (or estuarine asset) is highly vulnerable if it is subject to a high level of pressure (e.g. high nutrient load) and is also highly susceptible to that type of pressure (e.g. intermittently closed). Its "likely condition" is poor.

A "Risk Assessment" can be conducted if, in addition to the asset's vulnerability, a valuation of its worth has taken place. This must be done to estimate the consequences of any losses due to impacts caused by the hazard. A risk assessment supports management to prioritise the assets, identify specific management actions and set resource condition targets. The resource condition indicators selected for inclusion in a monitoring program will depend on the stressors present on the asset. For example, for different stressors, Scheltinga et al. (2004) suggests physicochemical and biological indicators to assess condition and others as indicators of habitat extent.

Note that both First and Second Pass output reports and assessments are A1 type assessments.

Third Pass Assessment (supporting adaptive management)

A "Resource Condition Indicator Status Assessment" is a comprehensive A4 type assessment undertaken after implementation of management actions and

incorporating the results of monitoring programs. It enables a report on the **status of the asset** and **condition or outcome trends** to be tracked. This information can be used to assess and refine management actions, evaluate resource condition targets and set trigger or alert levels. If the information is not targeted to a specific resource issue, it could be reused to answer questions about the broad ecology of the region.

Appendix 4. Summary of the National ECAF Round Tables

Under the NRM ECM Work Plan 2007-2008, two national round table discussions were held to develop and assess the emerging ECAF. The significant findings and lessons drawn from those round tables follow.

National Estuarine ECAF

- The participants at the National Estuarine ECAF (NEECAF) Round Table in November 2008 (Arundel and Mount, 2007) indicated enthusiastic support for the ECAF and anticipated that its main values would be that:
    - It would improve communications between jurisdictions.
    - It would improve the efficiency of the assessment process.
    - State and regional assessment and management tools currently employed are compatible with NEECAF.
    - It is important the Framework remain at a “high level” to accommodate differences at jurisdictional levels.
    - The NEECAF was also seen, with some qualifications, to align reasonably well with the Framework for River and Wetland Health (FARWH) themes.

  Participants recommended promotion of the revised NEECAF to regional, state and national agencies and of the need to integrate all aquatic ecosystem assessment frameworks. A further recommendation for improvement was:

    - NEECAF Trial. A trial was suggested as a way of testing the applicability and usefulness of the NEECAF approach. It was recommended that the trials be undertaken in a variety of estuaries with differing levels of available information. (See previous section for results of these trials)

National Marine ECAF

- The participants at the National Marine ECAF Round Table in February 2008 (Arundel and Mount, 2008) indicated strong support for the ECAF and anticipated that the main values of a national marine ECA framework would be that it:
    - provides a practical and logical structure
    - directs research
    - enhances communication
    - facilitates co-ordination between jurisdictions
    - guides identification of indicators.

  No impediment was identified to incorporating or “translating” existing marine assessment programs in Australia into the ECAF format. Further recommendations for improvements were to develop:

    - broad definitions of a marine asset (should include issue of scale)
    - definitions for vulnerability and risk
    - principles to guide movement between passes
    - comprehensive conceptual models that include direct and indirect human interactions and cumulative impacts

Appendix 5. Estuary Definition

Source: QLD EPA, 2005

The Queensland Wetland Mapping and Classification Methodology report (EPA 2005) defines an estuary as:

(a) the mouth of a river where the tidal effects are evident and where freshwater and seawater mix;

and/or

(b) the part of a tidal river that widens out as it approaches the coastline;

and/or

(c) a body of water semi-enclosed by land with sporadic access to water from the open ocean, and

where the ocean water is at least occasionally diluted by freshwater run-off from the land;

and/or

(d) a body of water where salinity is periodically increased by evaporation to a level above that of the open ocean (such a water body is termed a reverse estuary).

The **upstream extent** is defined as the upstream limit of tidal influence at mean high water springs (MHWS). Freshwater areas moved back and forwards by the tides, but not saline, are not considered estuarine.

The **downstream extent** is at or out from the mouth where there is typically some residual mixing between fresh and marine waters (excluding areas only influenced by freshwater during extreme flood events). Generally, the entrance is defined by the downstream limits of the drainage catchment i.e. the estuary heads. Where the heads are undefined, the catchment limits will need to be estimated using other landscape elements. For estuaries that flow directly into open oceanic waters, the lower limit is defined as the mouth of the estuary enclosed by adapting the semicircle rule (Beazley 1978).

The **lateral extent** of the estuary that is outside a channel is defined as the landward limit of tidal inundation or highest astronomical tide (HAT).

Appendix 6. Foundational data for estuarine assessments and report cards

Source: Tony Roper, Estuarine Theme Team, Natural Resources Commission, NSW (12/2007)

TOPIC	FEATURE	VARIABLES	UNITS	CONTEXT CRITICAL	CONTEXT USEFUL
CONDITION DATA					
Biology	Chlorophyll	Annual chlorophyll a statistics	µg/l		
	Seagrass	Areal seagrass extent	m^2		
	Epiphytes	Seagrass epiphyte coverage	% cover		
	Mangrove	Areal mangrove extent	m^2		
		Distance from entrance to mangrove limits	km		✓
	Saltmarsh	Areal saltmarsh extent	m^2		
	Macroalgae	Macroalgae distribution and abundance	m^2		
	Fish assemblages	Species diversity, abundance, nursery function, trophic integrity	no. of taxa		
	Shore birds	Shore birds fledgling success rate	no.		✓
Water Clarity	Turbidity	Annual turbidity statistics	NTU	✓	
	Secchi depth	Annual Secchi depth statistics	m	✓	
PRESSURE DATA [1]					
Demographics	Population	Catchment density	head/km^2		✓
Catchment	Land use	Catchment land use types	m^2	✓	
	Sewerage	Area with no reticulated sewerage	m^2		✓
		Licensed discharge loads	kg/yr	✓	
	Soils	Soil erosion hazard	t/ha/yr		✓
		Acid sulfate soils drainage	km^2 drained		✓
Riparian Use	River health	River style geomorphic condition	class		✓
		Macroinvertebrate assemblages	O/E SIGNAL		✓
		Riparian woody vegetation extent	% presence		✓
		Adjacent land use	m width		✓
		Fish barriers	no.		✓
	Extraction	Water extraction entitlements	m^3/yr	✓	
Foreshore Use	Foreshore structures	Waterway structures	m		✓
	Moorings	Piles and marina licence area	m^2		✓
	Aquaculture	Areal aquaculture extent	m^2		✓
	Invasives	Estuary area infested with *Caulerpa Taxifolia*	m^2	✓	
Waterway Use	Entrance	Presence of training walls or breakwaters	presence	✓	
		Artificial entrance opening level	m AHD	✓	
	Dredging	Dredging volumes for navigation etc	m^3/yr		✓
	Wild harvest fisheries	Annual commercial fish, prawn, mollusc catch	tonnes/yr	✓	
		Estuary extent open to recreational or commercial fishing	% area	✓	
	Fish barriers	Barriers to tidal flow	no.		✓
STRESSOR DATA [2]					
Catchment Exports	Suspended solids	Total suspended solids (TSS) diffuse source inflow	t/year	✓	
		Point source TSS discharges	kg/yr	✓	
	Nitrogen	Total Nitrogen (TN) diffuse source inflow	t/year	✓	
		Point source TN discharges	kg/yr	✓	
	Phosphorus	Total Phosphorus (TP) diffuse source inflow	t/year	✓	
		Point source TP discharges	kg/yr	✓	

TOPIC	FEATURE	VARIABLES	UNITS	CONTEXT CRITICAL	CONTEXT USEFUL
CONTEXTUAL DATA [3]					
Geography	Identifier	Estuary name	name	✓	
		Estuary number (latitude)	5 digit ID	✓	
	Location	Latitude, longitude	ºS, ºE	✓	
	Boundary	CMA, LGA, IMCRA	name	✓	
Geomorphology	Classification	Geomorphic group, type, maturity	class	✓	
	Area	Estuary surface area	m^2	✓	
	Depth	Mean estuary depth	m	✓	
	Volume	Estuary volume	m^3	✓	
	Perimeter	Estuary perimeter	km	✓	
	Length	Distance from entrance to tidal limits	km	✓	
Sediments	Unvegetated	Habitat type	m^2		✓
	Vegetated	Intertidal area (flats+saltmarsh+mangrove)	m^2		✓
Inlet channel	Inlet morphology	Inlet channel dimensions	m		✓
	Entrance	Mean natural berm height	m AHD	✓	
		Entrance dimensions	m		✓
		Entrance opening regime	days	✓	
Oceanography	Ocean tides	Water level statistics	m AHD	✓	
	Waves	Mean wave height, period	m		✓
	Temperature	Sea surface temperature	ºC	✓	
	Sediment transport	Mean gross longshore transport	m^3/yr		✓
Hydrodynamics	Estuary tides	Water level statistics	m AHD	✓	
	Flushing	Tidal, freshwater flushing periods	ratio	✓	
Water Quality (physical)	Salinity	Annual salinity statistics	ppt		✓
	Temperature	Annual temperature statistics	ºC	✓	
	Dissolved oxygen	Annual dissolved oxygen statistics	% sat.		✓
Water Quality (nutrients)	Nitrogen	Annual Total Nitrogen statistics	µg/l		✓
	Phosphorus	Annual Total Phosphorus statistics	µg/l		✓
Catchment	Topography	Elevation, slope statistics	m AHD		✓
	Geology	Regolith stability	class		✓
	Soils	Landscape, type	class		✓
Climate	Air temperature	Annual air temperature statistics	ºC	✓	
Hydrology	Rainfall	Catchment rainfall patterns	mm/yr	✓	
	Runoff	Catchment runoff statistics	m^3/yr	✓	
	Evaporation	Pan evaporation rate, pan factor	mm/yr	✓	
	Dilution	Freshwater dilution of total estuary volume	ratio	✓	

1. Pressures refer to human activities influencing the environment.
2. Stressors refer to physical, chemical or biological components of the environment that transfer the impact of a pressure onto resource condition.
3. Contextual data refers to physical or environmental data necessary for interpretation of resource condition data.

Appendix 7. Missing data for estuarine assessments and report cards

Source: Tony Roper, Estuarine Theme Team, Natural Resources Commission, NSW (12/2007)

Parameter	Missing Values	
	Frequency	Percent
Chlorophyll	87	64%
Turbidity (NTU)	87	64%
Secchi disk	123	91%
Macroalgae	135	100%
Epiphytes	135	100%
Seagrass	15	11%
Mangrove	15	11%
Saltmarsh	15	11%
Fish	34	25%
Coordinates	0	0%
Geomorphology	9	7%
Entrance condition	0	0%
Rainfall	0	0%
Evaporation	0	0%
Surface area	0	0%
Bathymetry	92	68%
Tidal prism	0	0%
Tidal planes	41	30%
Tidal limits	18	13%
Catchment area	0	0%
Salinity	78	58%
Estuary volume	0	0%
Catchment runoff	0	0%
Water load	0	0%
Dilution	0	0%
Residence time	0	0%
Exchange efficiency	131	97%
Tidal flushing	0	0%
Total flushing	0	0%
Population	0	0%
Land use	9	7%
Runoff change	0	0%
Sediment load	0	0%
Sewerage	0	0%
Sewer discharges	0	0%
Nutrient load	0	0%
Vegetation extent	0	0%
Water extraction	0	0%
Stream macroinvertebrates	72	53%
Structures	17	13%
Aquaculture	0	0%
Entrance works	0	0%
Entrance opening	53	39%
Harvesting	0	0%
Invasive species	0	0%
Carbon dioxide	0	0%
Sea level rise	0	0%
Rainfall change	0	0%
Air temp change	0	0%