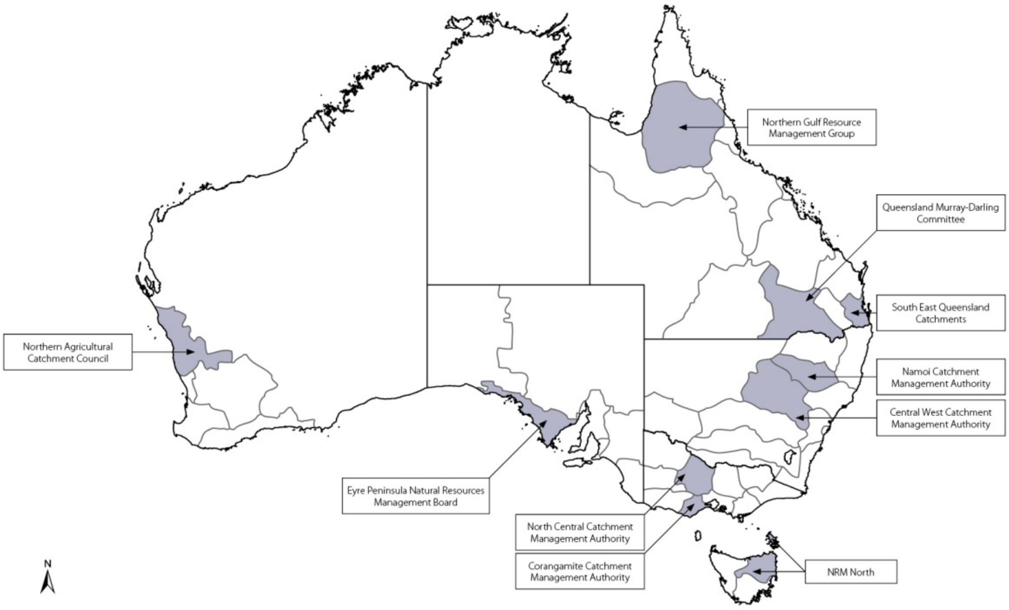
AUSTRALIAN

REGIONAL ENVIRONMENTAL ACCOUNTS TRIALS

2011-2012



Draft Guidelines

Australian Natural Resource Management Groups

Version 7 – March 2012

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Document development history

This Guide is a working document and is therefore classified as DRAFT. It is being reviewed and updated as knowledge on how to conduct environmental accounts grows, and as the associated science improves.

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SECTION 1 ACCOUNTING FOR NATURE

"Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history (and) this has resulted in a substantial and largely irreversible loss in the diversity of life on Earth".[1]

Millennium Assessment, 2005

1.1 Introduction

Public policy decisions on population, water reform, climate change and food security are taking place in a vacuum because we have no accounting system in place that measures the impact these pressures are having on the long-term health of our environment.

We use economic accounts to present a statistical picture of the structure of the economy and measure the detailed processes that make up its production and distribution. This information is used by governments, financial markets, businesses and individuals to guide policy and inform investment decisions.

It took nearly a century of the industrial revolution before we recognised the value of a systematic collection and reporting of economic statistics. When we did, it fundamentally changed the way we manage our economy. If we are to achieve society's goal of maintaining healthy and productive landscapes, we need to apply this same discipline to managing our natural capital. If you don't measure it, you can't manage it.

Australia has grown wealthy on the production of food and fibre that is so seemingly abundant across our vast continent. However, we now know that much of our modern agricultural systems operate in landscapes affected by historical practices with an increasingly recognised need to more accurately address the environmental trade-offs in terms of the health and functionality of our land,

Most farmers are concerned about it, most Australians are concerned about it, but the current markets demands drive the unacknowledged trade-offs, because we have not found a way to reflect the costs of protecting our natural capital into the price of food and fibre.

We are making poor decisions because accounting for economic output (GDP) does not include the costs to the natural capital on which much of our economic activity is based. It is unlikely that many of these costs will ever be 'priced' by the market, so it will never be possible to embed environmental accounts into the GDP.

Over the next 40 years, the need to feed 9 billion people will place even greater pressures on the health of the world's natural resources. This is against a background of a new challenge of climate change, which is likely to drive temperature increases and increased climate variability to levels the Australian continent has not experienced for tens of thousands of years.[2]

Australian governments are now spending over $8 billion a year on the environment[3], and individual landholders and businesses invest considerable time and resources in an effort to manage these pressures. Yet because there is no accounting system in place we do not know whether these investments are repairing, or even maintaining the natural capital that underpins our economic wellbeing.

We already have economic accounts and social indicators that we use to inform decisions. If environmental accounting is to contribute to the sustainable management of the world's natural capital, it must be able to measure the impact economic activity is having on the health of ecosystems.

The fundamental purpose of creating environmental accounts (design principle #1), is to enable people to understand the condition and direction of changes to their environmental assets, so that society can take practical action to create and maintain healthy and productive land, freshwater and marine resources.

FIGURE 1 – Environmental accounts in natural resource management

Environmental accounts will improve the quality of environmental decisions, in different ways, at multiple scales:

1. ***Information***: environmental accounts provide a statistical picture of the condition and direction of changes to environmental assets and ecosystems over time, and in conjunction with other information on threats, pressures, management and investment information, allow us to better understand that change;
2. ***Policy***: environmental accounts inform policy trade-offs (both positive and negative) between economic development and environmental health;
3. ***Investment:*** a common environmental currency enables traditional decision tools, such as cost/benefit analysis and multi-criteria analysis, to evaluate the cost-effectiveness of investments in environmental management; and
4. ***Monitor and Review***: environmental accounts form part of an adaptive natural resource management process that involves reporting and reviewing outcomes and a further examination of the achievability of the goal.

In 2008, the Wentworth Group in association with others developed a model for building environmental accounts in Australia. This *Accounting for Nature*[4] model has two unique characteristics:

1. It is constructed at a regional scale, which is the scale that best reflects the bio-geographic uniqueness of the Australian landscape, and it is where a substantial amount of data exists or is likely to exist in the near future; and
2. It is built using a common unit of account that allows us to compare the relative health of one asset with another, irrespective of the unit of measurement, and for this information to be aggregated to create regional (and subsequently state-wide, national and international) accounts.

1.2 A Common 'Currency' for the Environment

Accounting for the condition of environmental assets must confront two problems:

- First, we do not have, nor will we ever have, enough money to systematically measure everything; and
- Second, without a common unit of measure that allows us to place diverse scientific information into an accounting framework it is not possible to link environmental health to economic decision making.

Economic accounts are built using a national currency to record and aggregate the value of goods and services. Before money was invented people exchanged goods and services on a barter system. Without a common currency of exchange (money) it would not have been possible to construct economic accounts.

The starting point for building a system of environmental (ecosystem) condition accounts must therefore be the creation of a common, non-monetary environmental currency, one that can be applied to any environmental asset and indicator of ecosystem health, at any location, at any scale.

An environmental asset is "any physical feature in nature that can be measured in time and space."[5] It can be a river or forest ecosystem, a fishery, or any other physical feature, such as groundwater or populations of individual species (eg whales or birds).

An ecosystem is "a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit."[6]

The *Accounting for Nature*[7] model developed in Australia in 2008, seeks to create a common unit of measure of the condition of all environmental assets, including indicators of ecosystem health that can be applied at any location, at any scale, irrespective of the unit of measurement.

Creating a common measure for the condition of environmental assets must address a number of challenges:

- no two environmental assets are the same;
- often different indicators are used to measure the same asset in different locations;

- the cost of data collection creates significant variation in the quality and frequency of information collected; and
- no single indicator can provide a complete picture of ecosystem health.

The *Accounting for Nature* model does this by using the science of reference condition benchmarking. This allows environmental accounts to adopt an economic accounting framework.

Environmental (ecosystem) condition indicators based on reference condition benchmarks are conducive to statistical accounting, because they create a standardised numerical unit capable of addition and comparison. They can assess and compare the condition of environmental assets across regions and between assets, and upscale and aggregate over multiple spatial scales.

This methodology plots the condition of environmental assets on a common scale, and measures how each is tracking towards or away from a good condition over time. It produces a transparent system of accounting where the impact of economic activity (both positive and negative) on environmental health can actually be measured.

The common currency for environmental accounts does not imply a monetary value: it is simply a scientific method for standardising the measurement of environmental assets so the relative state of one asset can be compared with another, and information at different scales and for different assets may be aggregated.

1.3 Regional Environmental Accounts

Australia has come a long way in recent decades in our understanding of how our landscapes and ocean ecosystems function: world class scientific research, the evolution of the Landcare movement, the establishment of regional natural resource management institutions, and the allocation of significant levels of public and private funding to repair results of past decisions and practices.

We need to build on this understanding to spend taxpayers dollars responsibly, show what they get for their money, and provide society with information on the effectiveness of their investments.

There have been many attempts to establish an effective monitoring and evaluation system for natural resource management across Australia. They have all been found wanting, because in attempting to get to technical nirvana we have lost sight of the fact that our landscapes function via very complex systems, undergo regular change, and operate at many scales. Society does not, and never will have, the financial resources to measure everything.

The *Accounting for Nature* model offers a fresh approach because it is built from a regional scale which is then aggregated upwards into a standardised, national environmental accounting framework.

Managing healthy and productive landscapes requires regional, landscape scale responses because the pressures on our landscapes and marine ecosystems vary considerably from region to region. It is at the regional scale where the management of our land, freshwater and marine resources needs to be made, and it is at this regional scale that we need to build environmental accounts.

The objective is that eventually, each of the 56 Natural Resource Management regions across Australia will produce a set of annual regional environmental accounts.

Once the regional accounts are established, regional data collection and reporting would be aggregated, using a national environmental accounting standard, to produce the national accounts, yielding significant cost savings by removing duplication.

As was the case with the creation of our first economic accounts in the 1940s, the level and quality of information in the regional environmental accounts will vary from region to region in the early years, until regional capacity and adequate data collection systems are built.

1.4 Environmental Accounts Structure

Regional environmental accounts will contain a great depth of information, and can be summarised to display varying levels of detail according to need. The most basic structure of a regional environmental account may be a summary table, displaying the environmental asset classes and the environmental health indices, or Econds, generated for that time period and over time.

Each asset class can be represented in a stock account, which has embedded the assets and associated indicators that are used to measure the health of that asset.

TABLE 1 – Example summary table of an environmental account

Environmental Asset Class	Environmental Asset	Econd		
		2008	2009	2010
LAND	Vegetation	40		
	Soils	60		
	Fauna	80		
WATER	Rivers	60		
	Wetlands	54		
	Floodplain	75		
	Groundwater	68		

1.5 Accreditation

For environmental accounts to be accepted, markets and decision-makers must have confidence that the common environmental currency properly reflects the condition of the environmental assets being measured.

Scientific accreditation of the accounts is required to assure users of the account contains appropriate measures of environmental health in a region, is based on quality data, and that this information can be aggregated to contribute to national and international scale environmental accounting.

Accreditation involves experts assessing accounts against a set of standards and making a judgement as to whether they meet the standards to an acceptable level. A draft Accreditation Standard has been developed to define such standards and assess the regional environmental accounts in these trials.

These environmental accounting standards are being designed so they can be applied in the construction and accreditation of local (sub-regional) and property scale environmental accounts in the future.

1.6 Links to International Accounting Standards

In 1992, the Rio Earth Summit proposed environmental accounts as a way of integrating the environment in decision-making.[8] It was recognised then that the consequence of human activity on the environment is not accounted for in our decisions.

A handbook for integrated environmental and economic accounting was published in 1993.[9,10] This was updated in 2003 when a draft "System of Integrated Environmental and Economic Accounts" (SEEA) was released.[11] In 2012, the first volume of an international statistical standard for environmental economic accounting was adopted by the United Nations Statistical Commission.[12]

To date the emphasis in the SEEA accounts has been on measuring the economic impact of resource depletion, reflecting perhaps its origins from the Club of Rome.[13] Revealing the prices associated with physical assets can tell us how efficiently natural resources are being used to support our economy and how this activity impacts on the stocks of those physical assets. However, if environmental accounting is to contribute to the sustainable management of the world's natural environment, it must also be able to measure the impact economic activity is having on the health of ecosystems.

It is intended that a Volume 2 of the SEEA that establishes a statistical standard for measuring the condition of ecosystems will be developed and put to the United Nationals Statistical Commission in 2013.[14]

The 2012 Regional trials across Australia will test whether the creation of a common environmental currency for the environment, using the *Accounting for Nature* model, is a practical way of incorporating the condition of ecosystems into an accounting framework.[15]

SECTION 2
MANAGEMENT AND CO-ORDINATION OF THE REGIONAL TRIALS

2.1 Regional Environmental Accounts Trials

In March 2010, the Chairs of Australia's 56 Natural Resource Management regions resolved to "pursue the development of a set of a National Environmental Accounts".

Monitoring, evaluation, and reporting is an integral part of their charter, and the quality of their decisions is dependent on the quality of information they have to inform those decisions.

Ten regional natural resource management (NRM) groups across Australia have volunteered to trial the development of environmental accounts for their regions during 2011-12 (Figure 2). These ten regions reflect the wide variety of landscape types and environmental pressures across rural and urban Australia. They also reflect diverse levels of institutional capacity and data availability, from the relatively well resourced and data rich urban regions, to the less well-resourced and data poor remote regions.

More than 20 experts have also agreed to assist the NRM groups undertake these trials. These experts are involved in two committees established to develop guidelines and standards for environmental accounts: the *Scientific Standards and Accreditation Committee*; and the *Technical Accounting Standards Committee*.

The purpose of the trials is to:

- test and modify where appropriate, the *Accounting for Nature* model at a regional (sub-national) scale;
- provide a practical example of how a common currency for measuring the condition of environmental assets can be incorporated into an accounting framework;
- prepare standards on environmental accounting; and
- provide information and insights on the practical development of environmental accounts and inform international environmental accounting processes.

The trials will be conducted over three stages as depicted below. Stage 1 is the focus for these guidelines and is explained further in Section 2.4.

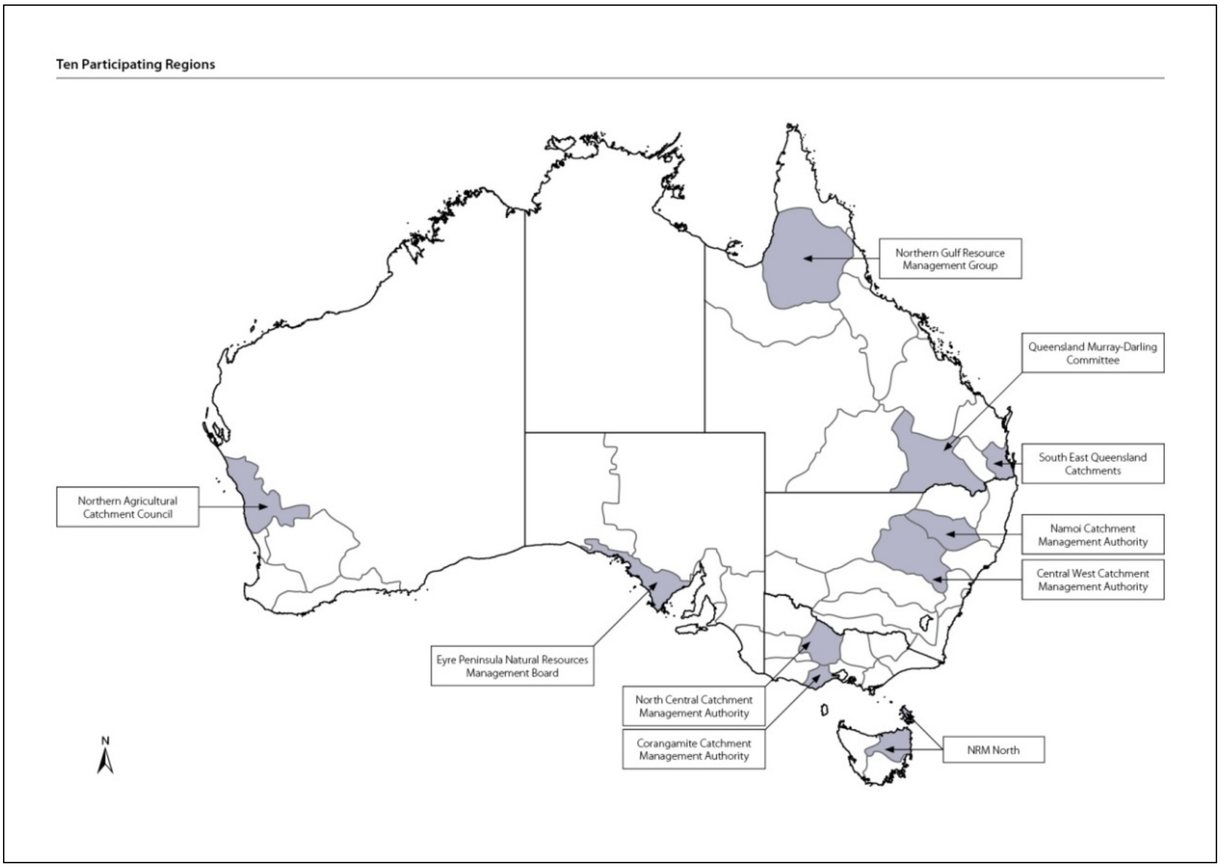

FIGURE 2 – Participating regions Stage 1 Regional Environmental Accounts Trial

2.2 Design Principles for the Trials

Design principles describe the foundational concepts that guide the design of the trials. These principles will provide reference points during the account development and define the scope of the work undertaken by all participants during the trial.

The Australian Regional Environmental Accounts trials are built on six design principles:

1. Environmental accounts should enable people to understand and track the status and direction of changes to their environmental assets.
2. From the environmental asset classes (land, water, coastal and marine, atmosphere), choose environmental assets and corresponding indicators that will measure condition of environmental assets and any change in their condition.
3. Establish a reference condition benchmark for each indicator against which change in the indicator can be measured and compared.
4. Indicators may vary from region to region according to agreed standards.
5. Existing data sets should be used wherever possible.
6. Measurements to be generated at a regional scale should be capable of aggregation to the national (and international) scale.

2.3 Organisational Structure

A *Regional Environmental Accounts Steering Group*, Chaired by Pam Green, will oversee the trial process as a whole.

The trials in each region will be managed by members of a *Regional Environmental Accounts Working Group,* who will be responsible for coordinating and implementing the Environmental Accounts trial in their region.

Two expert reference committees have also been established to provide scientific and technical expertise to the trial participants.

- A *Scientific Standards and Accreditation Committee:*

  Made up of experts from the scientific community. This committee's role is to establish scientific standards for the accreditation of the accounts and will provide assistance and feedback on scientific matters that arise during the trial; and

- A *Technical Environmental Accounting Standards Committee*

  Comprising professionals involved in environmental accounting.

  Its role is to advise on the development of the regional accounting framework and will ensure compatibility with national and international environmental accounts.

The Working Group and the committees will meet independently but have a high level of engagement from other committees. Findings from the ongoing trial process should feed into and inform each of the committees.

See Appendices 2 and 3 for group membership.

Figure 3 depicts the organisational structure.

FIGURE 3 - Organisational Structure 2011-2012

Regional Environmental Accounts Steering Committee

Role: Oversight of the regional trials and reporting on progress to the NRM Chairs and NRM Ministerial Council

Pam Green (Chair) Southern Rivers CMA, NSW	**Dr Sarah Ryan** ACT NRM Council
Kate Andrews Northern Territory NRM Board	**James McKee** NRM North, Tasmania
Niilo Gobius Northern Gulf RMG, Qld	**Danny O'Neill** National Chairs Working Group

Regional Environmental Accounts Working Group

Role: Management and Coordination of the regional trials

PARTICIPATING REGIONS	**MANAGEMENT COMMITTEE** ***Role:*** Co-ordination of Regions engaged in the trials.	**PARTICIPANT NETWORK** ***Role:*** Management of Trial in each region
	Pam Green - Chair	
VIC - Corangamite CMA	Chair Alice Knight CEO Gareth Smith	Cheryl Nagel
VIC - North Central CMA	Chair Geoff Williams CEO Damian Wells	Steve Jackson, Geoff Park
NSW - Namoi CMA	Chair Brian Tomalin GM Bruce Brown	Francesca Andreoni, Bronwyn Witts
NSW - Central West CMA	Chair Tom Gavel GM Carolyn Raine	Tracey Macdonald, Jen Shearing
WA - Northern Agricultural Catchment Council	Chair Chris King CEO Shelley Spriggs	Marieke Jansen
QLD - Northern Gulf RMG	Chair John Bethel CEO Noeline Ikin	Niilo Gobius
QLD - SEQ Catchments	Chair Robert Smith CEO Simon Warner	Noel Ainsworth, David Manning
QLD - Qld Murray Darling Committee	Chair Jeff Campbell CEO Geoff Panten	Roxane Blackley
SA - Eyre Peninsula NRM Board	Chair Heather Baldock CEO Annie Lane	Sophie Keen
TAS - NRM North	Chair Richard Ireland CEO James McKee	Andrew Baldwin
	Danny O'Neill - National Chairs Working Group	*Carla Sbrocchi - Wentworth Group*

Scientific Standards and Accreditation Committee

Role: Establish scientific standards, and accredit indicator selection, reference condition benchmarks, indices of ecosystem health, and data quality.

NAME	ROLE
Peter Cosier	*Chair*
Dr John Williams	Land (Agri Systems)
Prof Hugh Possingham	Land (Spatial Models)
Dr Denis Saunders	Land (Ecology)
Dr Mike Grundy	Land (Soil Science)
Dr Ronnie Harding	Environ. Indicators
Dr Richard Davis	Freshwater (Ecology)
Dr Terry Hillman	Freshwater (Metrics)
Dr Eva Abal	Freshwater (Monitoring)
Prof Bruce Thom	Coasts and SoE Reporting
Dr Tony Smith	Marine (Modelling)
Jane McDonald	Research Analyst
Carla Sbrocchi	Policy Analyst
Peter Greig	*Chair, Technical Committee*

Technical Environmental Accounting Standards Committee

Role: Develop the regional accounting framework and ensure compatibility with national and international environmental accounts.

NAME	INTEREST
Peter Greig	*Chair*
Neil Byron	Resource Economics
Mark Eigenraam	Information Systems
Tom Hatton	2011 Australian SoE Chair
Mark Lound	ABS
Richard Mount	BOM
Rob Sturgiss	DCCEE Carbon Accounts
Gary Stoneham	Environmental Markets
Michael Vardon	Intern'l SEEA Standards
Jane McDonald	Research Analyst
Carla Sbrocchi	Policy Analyst
Peter Cosier	*Chair, Scientific Committee*

2.4 Conducting the Trials – Stage 1

The purpose of Stage 1 of the trials is to develop and test guidelines and standards for constructing regional environmental accounts based on a common currency. At the end of Stage 1 the trials will be reviewed and the Accounting for Nature model modified (if appropriate).

Three parallel processes will be ongoing during Stage 1:

- the 10 participating regional NRM groups will:
  - determine the environmental assets that should comprise regional environmental accounts based on the vision and priorities for their region;
  - trial the development of a common environmental currency for each of these assets; and
  - construct a set of environmental accounts based on this information and have them accredited.
- the *Scientific Accreditation and Standards Committee* will:
  - develop (and with experience modify) Guidelines for Constructing Regional Environmental Accounts, and provide advice to the regional groups;

  - develop (and with experience modify) an Accreditation Manual for accrediting Regional Environmental Accounts;
  - and assess and accredit the accounts;
  - commission a peer review of the Stage 1 trials; and
  - review and modify, as appropriate, the Accounting for Nature model.
- the *Technical Accounting Standards Committee* will:
  - develop (and with experience modify) a set of environmental accounting tables;
  - assist in the development of a regional reporting structure that meets the needs of the regional groups; and
  - test the potential to aggregate these 10 regional accounts into a national environmental accounting framework.

The guidelines, standards and accreditation requirements will be developed and refined in a collegiate and adaptive (learning by doing) process as the trial progresses. The work of the NRM groups and committees will intersect and interact throughout the trial.

For the regional groups, constructing the regional environmental accounts involves the following steps:

1. Select the environmental assets to be measured;
2. Choose indicators;
3. Use data to measure selected indicators;
4. Define and calculate a reference condition benchmark for each asset;
5. Calculate an index of environmental health (Econd);
6. Create an account for each asset and prepare Regional Environmental Accounts; and

Figure 4 depicts the overall process for Stage 1 of the trials and how the steps of the different participants relate to each other. Figure 5 depicts the expected timeline for the Stage 1 trials during 2011-12.

2.5 Accreditation during the Trials

Each regional environmental account must go through an accreditation process to assure the users of the account that it is fit-for-purpose, scientifically robust, based on quality data, that it contains appropriate measures of environmental condition in the region, and that it can be aggregated to contribute to national- and international-scale environmental accounting.

To receive accreditation, a regional environmental account will need to be assessed as meeting a set of standards to a satisfactory degree. The *Scientific Standards and Accreditation Committee* is responsible for assessing and deciding whether an account can be accredited.

During this trial, different accounts may be accredited as meeting the standards to different degrees, reflecting the differences in capacity and constraints across the trial regions.

The Committee's accreditation assessment will determine whether the regional environmental account:

1. Contains an appropriate set of assets within each environmental asset class;
2. Is based on indicators that are suitable measures of environmental assets in that region;
3. Is based on quality data;
4. Contains reference condition benchmarks that are correctly defined and calculated;
5. Contains indices for each asset that are an appropriate description of the condition of the assets in that region;
6. Is able to be aggregated with environmental accounts from other regions.

Standards and accreditation criteria are being developed concurrently with the construction of the regional accounts (Figure 4).

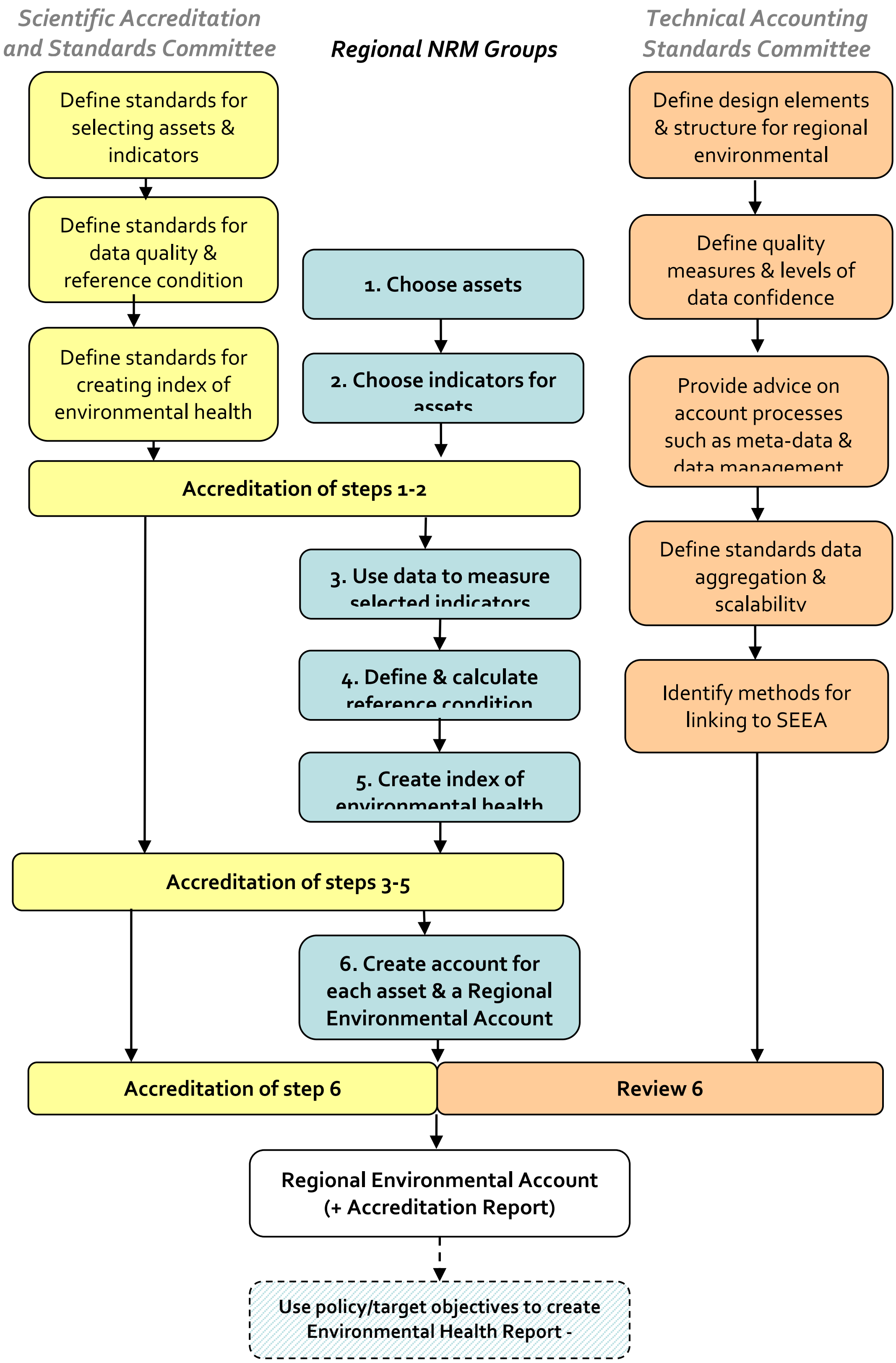

FIGURE 4 – Process diagram for trials

MONTH	ACTION #1	ACTION #2	ACTION #3	ACTION #4
September	Draft Accounting structure circulated			
October	Steps 1 and 2 submitted for accreditation	Accounting structure finalised		
November	Steps 1 and 2 accredited	National Workshop	Steps 3, 4 and 5 submitted for accreditation	Paper on structure of regional reports
December	Steps 3, 4 and 5 accredited			
January				
February	Step 6 submitted for accreditation	Regional Accounts accredited		
March	Regional reports produced	Aggregated accounts produced	Presentation to National NRM Chairs Conference	
April	Peer review of ‘Proof of Concept’ trial			

FIGURE 5 – Indicative timeline

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SECTION 3
GUIDELINES FOR CONSTRUCTING
A REGIONAL ENVIRONMENTAL ACCOUNT

3.1 How to use this Guide

This guide is a working document and is being developed on an ongoing manner as the trials progress. It will be reviewed and updated over time, as knowledge on how to conduct environmental accounts grows, and as the associated science improves.

This section describes a 7 step process for constructing regional environmental accounts.

The steps for constructing a regional environmental account are as follows:

1. Define asset class and choose environmental assets;
2. Select environmental indicators;
3. Use data to measure selected indicators;
4. Define and calculate reference condition benchmarks;
5. Create index of environmental health;
6. Create an account for each asset and prepare a Regional Environmental Account; and
7. Use policy/target objectives and other information to interpret the accounts and to create a Regional Environmental Health report (optional).

For each step, guidelines and examples (and where appropriate recommended methods) should assist the participant in the development of their Regional Environmental Account.

All necessary information required to meet the criteria for accreditation will be provided under each step.

3.2 How to use the Committees

The role of the *Scientific Accreditation and Standards Committee* is to provide guidance and advice on scientific matters relating to environmental accounts, develop necessary scientific standards and to accredit the scientific process (see Appendix 2).

The accreditation process is iterative and flexible and is in development at the same time as the accounts are being developed. The purpose of accreditation is to encourage the maximum innovation and use of regionally unique data, whilst still being sufficiently scientifically robust and comparable to provide the foundation of National Environmental Accounts.

The regions may submit queries and seek advice and assistance from the Scientific Standards and Accreditation Committee at any point during the trial.

3.3 How to receive accreditation

To receive accreditation, a regional environmental account will need to be assessed as meeting a set of standards to a satisfactory degree.

Each regional environmental account must go through an accreditation process to assure the users of the account that it is fit-for-purpose, scientifically robust, based on quality data, that it contains appropriate measures of environmental health.

Due to the differences in capacity and constraints across the trial regions, different accounts may be accredited as meeting the standards to different degrees.

Prior to accreditation, participants can submit draft work and queries at any step of the process to gain feedback and advice.

As previously stated, the development of the accreditation process will occur in conjunction with the account development by the participants and the accreditation process should involve good communication between the participant and the committee.

A proposed process is below.

1. Submit draft workings (‘Steps’, as per pages following) that support the account to committee via email to Carla Sbrocchi.
2. Committee assesses Steps according to criteria.
3. Committee provides feedback.

   Feedback may include recommendations for improvement within the scope of the trial or goals for improvement in the longer term.
4. Participant can adapt account or respond to feedback.
5. Once all Steps of the account have been submitted for feedback, Participant submits Account and Committee makes final accreditation judgement (an Accreditation Report).

Step 1: Selecting Environmental Assets

Environmental accounts will describe both the condition and change in the condition of Australia's environment assets.

1. What are environmental assets?

For the purposes of this trial, environmental assets are defined as 'physical features in the landscape that can be measured in time and space'.

This definition was chosen as being the most commonly used in environmental asset classification.

Also called 'natural capital'[16], environmental assets comprise both natural resources (e.g. land and mineral deposits which have economic value) and ecosystems. An environmental asset can be large or small, degraded or pristine, localised or dispersed. Natural capital comprises both natural resources (eg land and mineral deposits which have an economic value)[17] and ecosystems.

An asset can be a discrete thing (such as a particular wetland), or it could be a collection of smaller assets (such as a particular soil type occurring in different locations across a region).

Measurements of these assets through indicators will reflect the state and condition of these assets.

2. Which environmental asset classes?

Environmental assets are categorised into broad environmental asset classes.

Stage 1 trials will aim to select a number of major asset classes described in Australia's State of the Environment reporting and measure the assets and indicators that describe these.

There are five broad asset classes used in Australia for most State of the Environment reporting processes:

1. Land
2. Water
3. Atmosphere
4. Coastal and Marine Resources
5. Towns and Cities

Biodiversity is often also given a separate classification. It will not be considered as a separate asset class in these trials, as biodiversity is considered by the *Scientific Standards and Accreditation Committee* to be an intrinsic part of all environmental asset classes.

Similarly, Towns and Cities (people) were thought by the participating regions to be part of all assets.

The *Scientific Standards and Accreditation Committee* recommends that the focus of the trials should be on 'Land' and 'Water' asset classes. Regions may choose to include 'Coastal and Marine' and 'Atmosphere' asset classes if time and resources permit.

3. How to select environmental assets for your region

Within each asset class there are a range of environmental assets – these are physical features in the landscape that can be measured in time and space. Table 2 identifies some of those assets, but it is not an exhaustive list.

Participants need to select the environmental assets that are **relevant in their region** and that also meet the definition of 'environmental asset'.

Relevant assets should be derived from an NRM plan or strategy that sets out the vision and NRM priorities for the region. This assumes that the plan was developed from a planning process that incorporated: best available science; consultation with stakeholders and communities; and government priorities (including environmental assets of state and national significance), to determine goals or targets for NRM in that region. Relevant or valued environmental assets would be defined as part of that process.

In some cases, the region's NRM plan may be out-of-date or in revision during these trials. In this case, participants should seek their Board's (or other governing body's) endorsement of the selected assets as being consistent with the region's vision, goals, and natural resource management priorities before constructing their accounts.

A Regional Environmental Account needs to account for all environmental assets in a region. An environmental asset's inclusion in an account is not dependent on whether a regional NRM body has responsibilities or powers of management over it or not. Environmental assets that are managed or influenced by others should also be included, provided they are considered as relevant assets in the region.

Each set of environmental assets chosen by the participant must be comprehensive enough to describe the condition of the each asset class in the region. For example, for a particular inland region, rivers, aquifers and wetlands would adequately represent the water asset class.

TABLE 2 - Environmental asset classes and examples of environmental assets

Environmental Asset Class	**Examples of Environmental Assets**
Land	1. Soil 2. Native vegetation 3. Native fauna 4. Agricultural soils 5. Sustainable forestry
Water	1. Rivers 2. Aquifers 3. Wetlands 4. Floodplains
Coastal and Marine	1. Estuaries 2. Tuna Fishery 3. Fisheries 4. Marine fauna
Atmosphere	If time and resources permit, some regions may choose to include assets within this class. The Scientific Committee will assist where possible.

In cases where environmental assets of interest do not meet the definition of an environmental asset or are beyond the scope of this trial, a working issues paper will be developed in an Appendix of this document (see Appendix 4). This will include alternative assets and indicators and other issues raised by the participants. These issues will be discussed and developed during the course of the trial and if unresolved will be highlighted as areas for further work beyond this one-year trial.

4. How will environmental assets be accredited?

Each regional account will be assessed against the extent to which the set of assets in the account is appropriate for that region.

The following criteria should be used as a checklist for your selected environmental assets.

- ☐ Does the account contain assets within each asset class?
- ☐ Does the selected asset meet the definition of an ‘environmental asset’?
- ☐ Is the selected set of assets relevant within your region?
  - ☐ Has the set of assets been determined in consultation with stakeholders and the community, and does it incorporate assets of state and national significance?
  - ☐ Has the NRM governing body endorsed the set of assets as being consistent with the region’s vision, goals, and NRM priorities? (required at a minimum)
- ☐ Does the selected set of assets adequately describe the condition of the asset class?
- ☐ If the account includes an asset not listed above, include a description as to why it is an appropriate asset for your region.
- ☐ Are there any gaps due to lack of information or capacity?

The *Scientific Standards and Accreditation Committee* will assess your selected assets against the above questions, and make a judgement on the extent to which the set of assets in the account is appropriate for your region. This will be ranked on a scale of 0 to 5: 0 is unacceptable, while a minimum ranking of 1 will allow that asset to be included in the Account.

The Committee may also seek additional information from you, for example, on the process that you undertook to select the assets.

5. What next?

Submit your list of asset classes and environmental assets to the committee for feedback or continue directly to Step 2.

Step 2: Selecting Environmental Indicators

1. What are environmental indicators?

The task of accounting for the complexity of ecosystems is made possible by using the science of environmental indicators.

Environmental indicators are quantifiable and transparent measures of the characteristics of the ecosystem that can be used to detect change. With careful selection, they are capable of providing a simple measure for a complex system.[18]

For the environmental accounts trials, indicators will measure the condition or state of the environment, and should be able to track changes in condition. They are not intended to cover pressures on environmental assets or management responses to pressures, other than when these are appropriate surrogates of condition (see Box below).

Indicators of environmental health reflect an ecosystem's vigour (level of ecological productivity), organisation (structure and interactions), or resilience (ability to rebound from a shock).[19]

Indicators of environmental asset condition are expressed as the divergence from a reference condition – a known measure of good condition for that indicator.

Box 1 - Threats as indicators of condition

Q: ***Can data on threats be used as an indicator of environmental health?***

A: Sometimes indicators on threats or pressures may be appropriate for use as surrogates of environmental condition, however this needs to be approached with care. There may be some cases where threats indicators are an appropriate measure for describing the condition of an environmental asset e.g. weeds as an inverse condition indicator of native vegetation. Participants should self-assess each of their proposed indicators against the Indicator Selection Principles (Box 2) and make their own judgement about whether it is a suitable measure. Although information on the status and trend of threats (along with other information, such as management interventions or progress against goals) is important in interpreting changes in condition, therefore threat indicators are best incorporated in environmental health reports as 'overlay' or interpretive information rather than for inclusion in the account itself.

2. How to select environmental indicators

Given design principle 5 that "*existing data sets should be used wherever possible*", it is recognised that the perfect set of indicators might not be produced. Below are some principles to guide selecting the best set of available indicators.

The indicators within an account should satisfy the following principles (Box 2). Where it is not possible to meet all six principles, select the indicators you believe, on balance, best meet these principles.

For example, a participant might select macroinvertebrates, fish and flow regime as indicators for their river asset, satisfying all the principles below.

Box 2 - Indicator Selection Principles

1. ***Relevant*** – the indicator is a measure or surrogate of the condition of an environmental asset or system
2. ***Simple*** – the indicator is easily interpreted, monitored, and appropriate for community use.
3. ***Sensitive*** – the indicator is able to detect change in the condition of the environmental asset.
4. ***Measurable*** – the indicator can be statistically verified, reproduced and compared.
5. ***Timely*** – the indicator shows trends over time, provides early warning of potential problems and highlights future needs or issues.
6. ***Aggregative*** – the indicator is amenable to combination with other indicators to produce more general information about environmental conditions. [2021]

Indicators recommended in scientific literature or on the advice of experts are advised for use in the account, however, may not be available or reasonably sourced in Stage 1. It is important to note that these indicators are relevant in documenting the condition of the chosen asset, even if they are not available. If a participant chooses not to use scientifically-recommended indicators, the decision must be documented as part of the accreditation process.

3. How will indicators be accredited?

Your set of indicators will be assessed against the extent to which the selected indicators are suitable measures of environmental assets in that region.

Use the following criteria as a checklist for selecting environmental asset condition indicators.

- ☐ Does the choice of indicators adequately satisfy the indicator selection principles (above)?
- ☐ Does the set of indicators adequately describe the condition of the relevant asset? – this is essential to avoid weighting indicators (see Step 5)
- ☐ Are there indicators you would like to use but are unavailable?

The *Scientific Standards and Accreditation Committee* will assess your selected indicators against the above questions, and make a judgement on the extent to which the indicators are suitable measures of environmental assets in your region. This will be ranked on a scale of 0 to 5: 0 is unacceptable, while a minimum ranking of 1 will allow that asset to be included in the Account. The Committee may also seek additional information from you in undertaking its assessment.

4. Examples of possible environmental indicators

Box 3 describes some commonly used indicators of environmental condition.

5. What next?

Submit your list of indicators for each environmental asset to the committee for feedback or continue directly to Step 3.

Box 3 – Examples of Indicators of Environmental Condition

Terrestrial Landscapes

The most commonly used indicators for environmental condition in terrestrial landscapes are vegetation extent, connectivity and condition. The simplest indicator is to measure the extent of native vegetation across a landscape.

Satellite technology makes it possible to produce simple, but comprehensive native vegetation stock accounts at catchment, landscape, national and international scale, by overlaying land cover data derived from this satellite imagery with vegetation association and land type maps.

It is a cost-effective measure of landscape health in many ecosystems, because the diversity and abundance of many native organisms correlates closely with the extent of native vegetation. [22,23]

Freshwater Ecosystems

Macroinvertebrates are perhaps the most commonly used indicator in Australia to assess inland water ecosystem condition. Macro-invertebrate information formed the basis for AusRivAS which is a nationally standardised and predictive approach to river assessment.

Macroinvertebrates are used because they show response to environmental stress, are common to different river habitats and act as continuous monitors of the water they inhabit.[24]

Flow regimes and fish are two other indicators that are used in river assessment in combination with macroinvertebrates.

Flow regimes (quantity and spatial and temporal distribution of water) is a natural driver of form and function of an aquatic ecosystem. Fish are at the top of the food chain and sensitive to environmental change.[25]

Physical form, vegetation, water quality (measured with physical and chemical parameters, ecosystems processes and nutrient cycles) are also important indicators for aquatic ecosystems.

Marine Ecosystems

Many global assessment of marine ecosystems are based on fish populations.[26,27,28,29.]

Fisheries management strategies which use an 'unfished biomass' benchmark to measure the current stock relative to that reference condition, set maximum sustainable yield levels and to identify thresholds of collapse.[30]

ASSET CLASS	ENVIRONMENTAL ASSET	INDICATOR
Land	Vegetation	Extent
		Condition
	Fauna	Species diversity
	Soils	Wind/Water Erosion
		Soil Carbon
		pH
		Salinity (secondary)
Water	Rivers	Flows
		Macro-invertebrate diversity
		Native fish diversity
		Riparian vegetation
		Physical Form
	Aquifers/Ground water	Water Quality (Salinity, Nitrogen)
	Wetlands	Seasonal extent
	Floodplains	Frequency of flooding, extent of flooding
Coastal and Marine	Fish stocks	
	Estuary	Water quality

Step 3: Data for measuring indicators

1. What is quality data?

The environmental accounts are only as good as the data that underpins them. Quality data maximises the reliability of the decisions made, which is why we need data quality standards for producing environmental accounts.

Data is of high quality if it is fit for its intended use and suits its context.[31]

Components of data quality include:

- adherence to relevant data quality standards;
- sampling program and data collection methods;
- data treatment, analysis and evaluation methods;
- whether data is statistically verifiable and reproducible; and
- data management methods.

Standards for data quality for the Regional Environmental Accounting trials are outlined in Box 4.

Box 4 – Data quality standards

The standards of data quality for the regional environmental accounts include:

1. *Field data should be collected under appropriately designed sampling programs that are: fit for the issue, question or hypothesis of interest; are of an acceptable spatial and temporal resolution; and detect change and do not pick up change that is not there.*
2. *Data sets should be suitably accurate and precise, statistically verifiable and reproducible.*
3. *Data sets should be treated and analysed to accepted standards (if available).*

Regions will use existing data where relevant and possible (Design Principle 5). Where any new data will be collected, the Scientific Committee can provide advice on methodologies.

2. Organising and managing data

Organising and managing data quality, using a metadata template, is a common and efficient way of tracking and storing records relating to data quality. Metadata describes data and provides a rapid way to assess that data's fitness for a specific purpose.

The *Technical Environmental Accounting Standards Committee* and the *Scientific Standards and Accreditation Committee* recommend the use of the *Australian and New Zealand Land Information Councils (ANZLIC) ANZMet Toolkit* for metadata creation and management.[32]

For access to the ANZLIC Metadata template (with comprehensive instructions and tutorials) follow this link:
http://www.osdm.gov.au/Metadata/ANZLIC+metadata+resources/ANZMet+Toolkit+(final+draft+-+07.2009)/default.aspx

All environmental accounts should at least contain information on categories included in the ANZLIC Metadata Profile (such as data name, purpose, jurisdictions, status, reference, scale, spatial representation, extent).

3. How will data quality be accredited?

Your account will be assessed against the extent to which the account is based on quality data and the level of confidence in the data and the inferences that can be made from it.

Use the following criteria as a checklist for assessing the quality of your data:

- ☐ Does the metadata and quality statement provided give sufficient detail to assess data quality? If not, what further information is needed?
- ☐ Have data been collected under an appropriately designed sampling regime (fitness for purpose, acceptable resolution, detection of change)?
- ☐ Are data suitably accurate, precise, verifiable and reproducible?
- ☐ Have data been treated and analysed to accepted standards?
- ☐ Are there datasets you would have liked to use but didn’t have access to?

The Committee will require additional information from you to undertake its assessment. Participants will need to prepare a Data Quality Statement to accompany the account. This will provide the information necessary for the *Scientific Standards and Accreditation Committee* to assess the quality of data underpinning the account.

The Data Quality Statement should include information for each indicator, against each of the standards outlined in Box 4. The Statement should include an explanation on how the data was collected, treated, analysed and interpreted, as well as the group's own assessment of data quality for each indicator.

Some of this information is covered under the categories of the ANZLIC Metadata Profile (see above). In the future purpose-built metadata templates should be developed for Regional Environmental Accounting but for the purposes of the trial, the extra information can be provided in the form of a quality statement.

The *Scientific Standards and Accreditation Committee* will assess your datasets (informed by your Data Quality Statement) against the above questions, and make a judgement on its confidence in each dataset. This will be ranked on a scale of 0 to 5: 0 is unacceptable, while a minimum ranking of 1 will allow that asset to be included in the Account.

4. What next?

Submit your data quality statement and metadata template to the committee for feedback or continue directly to Step 4.

Step 4: Determining Reference Condition

1. What is Reference Condition?

Once indicators for each environmental asset have been selected and appropriate data sources identified, the next step is to use reference condition benchmarks to assess the current condition of the asset.

Reference condition is a scientific method for standardising the measurement of environmental assets so that we can assign a numerical (non-monetary) value to describe the relative condition of one asset to another, such that information at different scales and for different assets may be aggregated into a set of accounts.

No two rivers, or two bushland patches, nor two coastlines are the same. Defining a common point of reference for each system resolves these differences, because it puts all assets on a common scale.

Applying a reference condition benchmark performs the essential function of allowing different landscapes to be measured with indicators that are specifically suited to a particular location. This avoids having to use one set of indicators for distinctly different landscapes.

The reference condition is a scientific estimate of the natural or potential condition of an ecosystem in the absence of significant human alteration[33].

Reference condition based indicators are used extensively in the scientific literature to describe a standard or benchmark against which to compare the current condition of an environmental asset or an indicator of ecosystem health.[34] It can be a fixed point in time (for example, an estimate of its condition prior to industrial development),[35]observed at reference condition sites,[36] or a scientifically accredited model that estimates the naturalness of the biota in the absence of significant human alteration.[37]

Reference condition benchmarks stay the same over time and in doing so provide a reference point by which future changes in the condition of an environmental asset or ecosystem can be measured.

A reference condition score is created by comparing the current condition of an environmental asset or ecosystem relative to the reference condition benchmark. It is recorded as a number between 0 and 100, where 100 is the (reference) condition of an ecosystem as it would be had significant human intervention not occurred in the landscape, and 0 is where that ecosystem function is absent.

For example, one indicator of the condition of a terrestrial ecosystem is the extent of native vegetation cover. The change in percentage of native vegetation can be directly related to a change in biodiversity.[38] If there has been a decline in native vegetation in a region by 72% against a reference condition, that indicator would produce a 'condition score' of 28.

Reference condition metrics are used as a scientific benchmark for ecosystem management for several reasons:[39]

- ecosystems approaching conditions that prevailed prior to major periods of modification will generally better reflect the conditions to which persistent communities of native biota are adapted;[40]
- ecosystems are more resilient within their historical range of variation than ecosystems managed outside this range;[;41,42]
- it is a pragmatic approach for assessing and managing ecosystems where data for communities and species or processes are lacking, or such data cannot be collected within the constraints of rapid assessment;[43]and
- ecosystems are assessed in relative rather than absolute terms, thereby avoiding the perverse situation where ecosystems that are naturally more structurally diverse or species rich are always assessed as in higher condition than ecosystems that are naturally less structurally diverse or species rich.

Reference condition accounting does not imply or suggest that environmental assets should be returned to a pre-disturbance condition: it simply uses this information, in the same way national accounts are used, as a scientific standard to inform policy development through other processes and products that are derived from these accounts.

The advantages of such a benchmark metric are that:

- It creates a common environmental currency that allows us to evaluate the relative environmental improvement of one action over another from investments we are making; and
- They drive cost efficiencies in data collection, because they allow areas under intense environmental pressures to be measured with greater precision than areas under less pressure, without diminishing the ability to compare one asset or region with another.

To be accredited, an environmental account must contain reference condition benchmarks that are adequately defined, and calculated in accordance with the methods outlined below.

There are three stages in this process:

1. Select an appropriate reference condition *methodology* for each indicator;
2. Determine the reference condition benchmark for the indicator (in the same units as the indicator); and
3. Compare the current indicator measure with the reference condition benchmark to generate a score out of 100.

2. Select a reference condition *methodology*

The reference condition of an environmental asset can be:

- a fixed point in time (for example, an estimate of its condition prior to industrial development),
- observed at reference condition sites,[44]
- a scientifically accredited model that estimates the naturalness of the biota in the absence of significant human alteration.[45]
- based on expert opinion. This may be useful in the absence of reliable data and may be generated based on anecdotal observations, data from other

locations and/or incomplete data sets. This method can be used in combination with other methods or in the short-term while data are being collected

Modelling of reference condition should, wherever possible, incorporate landscape scale processes which impact on the condition and resilience of that asset, such as connectivity in terrestrial landscapes, or the timing and duration of environmental flows in freshwater ecosystems.

3. Determine the reference condition benchmark (RCB)

Measurements of reference condition can often be sourced from existing data sets. In many cases, this data will have been collected with this express purpose in mind (for example, existing pre-1750 vegetation mapping). In other cases it can be inferred (for example, reference condition under certain annual climatic conditions, ie. in a year of x mm of average rainfall).

Where there are no existing data sets explicitly for reference condition (for example, directly measuring abundance of fauna species) participants are encouraged to present novel approaches to these problems. In many cases, the data are not there because the question has not been asked, not because it is not possible to do.

It is important in measuring the reference condition benchmark (RCB) that:

- the units of measure are the same as the indicator (ie if you are measuring current vegetation extent in hectares then the reference condition is in hectares); and
- all reference condition data is adequately referenced.

Reference Condition Benchmarks may need to account for natural variation that may exist depending on the season, prevailing climatic conditions (such as rainfall) or temporal shifts (ie. Decadal shifts). It may be possible to measure an aspect of the asset at a specific time to reduce variability in the RCB. For example, if Estuaries was a chosen asset, and Fish Diversity the chosen indicator of the condition of that asset, the RCB might have different values for each season. Natural variation can be addressed by measuring aspects of an asset that change slowly and others that change quickly to provide an accurate measure of its overall condition.

Table 3 contains some examples of reference condition benchmarks.

TABLE 3 - Examples of reference condition benchmarks

ASSET CLASS	ENVIRONMENTAL ASSET	INDICATOR	REFERENCE CONDITION
Land	Vegetation	Extent	Pre-European Extent of vegetation
		Condition	Surveys of high order animals, such as birds
	Fauna	Species diversity	Using pre-European extent of native vegetation as a surrogate for species diversity
	Soils *Undisturbed RCB*	Wind Erosion	Measured at reference sites
		Water Erosion	Modelled from sediment export at bottom of catchment in an undisturbed catchment
		Soil Carbon	Levels of soil carbon in uncleared landscape
		pH	Levels of pH in an uncleared landscape
		Secondary Salinity	No areas of secondary salinity
Water	Rivers	Flows (volume, variability, flow events)	Modelled under assumption of no direct human influence on water management.
		Macro-invertebrate diversity	Species assemblage at sites with good condition (and similar environmental variables)
		Native fish diversity	Native species diversity at sites with good condition (and similar environmental variables)
		Riparian vegetation	Expert opinion on ideal width of buffer
	Wetlands	Extent and Type	Seasonal Pre-European extent by type
	Floodplains	Extent of flooding	Pre-European extent of flooding
Marine	Fish stocks	Maximum fish length	Early historical records
	Estuary	Seagrass extent	Modelled under assumption…
	Marine fauna – whales	Numbers within population	Pre-Whaling population numbers, using Indigenous knowledge

4. Calculate a condition score (C)

A condition score (C) is a number between 0 and 100, where 100 is the reference condition benchmark for each indicator, and 0 is where condition is degraded to the degree that ecosystem function is absent.[46]

C is calculated by measuring the current observed condition and expressing this as a ratio against the reference condition benchmark. It may or may not be a linear function. The condition score is represented as a percentage to generate a score out of 100.

The 'condition score equation' may vary depending on the indicator you using. The equation below many be used as a guide, but is an example only. Expert opinion should be sought when developing condition scores.

Box 5 - Formula for calculating a condition score

Formula:

$C = (I_i / I_0)*100$

where: I_i = *Environmental indicator measure at any given point in time*

I_0 = *the reference condition benchmark for that indicator*

C = Condition Score for an indicator of an asset

Example:

The current area of a type of native vegetation (I_i) *is 10,000 ha.*

The RCB (I_0) *of this type of vegetation (in this case pre-European) is 100,000 ha.*

*The calculation is 10,000 / 100,000 * 100 = 10*

C for this type of native vegetation in this area is 10.

The raw data used in calculating the condition score would be presented in the environmental account.

There are many cases where condition scores for a number of environmental assets are already embedded in pre-defined metrics. Examples include river health metrics in catchments in the Murray-Darling Basin that have already been calculated in the Sustainable Rivers Audit; and fish stock in marine ecosystems off southern Australia. Where available, participants are encouraged to use these metrics where they can be defined for their region.

5. How will reference condition be accredited?

Your account will be assessed against the extent to which the set of reference condition benchmarks and Condition Scores are correctly determined and calculated.

Use the following criteria as a checklist for managing data quality.

- ☐ Do the methods for determining reference conditions in the account comply with one of the methods mentioned earlier, and are they the most appropriate methods?
- ☐ Are the datasets used for reference condition benchmarks satisfactory and do they comply with the data quality measures in Step 3?
- ☐ Are the reference condition benchmarks measured in the same units as the relevant environmental indictors?
- ☐ Are the condition scores (C) calculated correctly?
- ☐ If the account includes reference condition methods or benchmarks other than those above, is this 'alternative' method acceptable?'

The *Scientific Standards and Accreditation Committee* will assess your set of reference condition benchmarks and Condition Scores against the above questions, and make a judgement on the extent to which they are correctly determined and calculated. This will be ranked on a scale of 1 to 5. The Committee may also seek additional information from you in undertaking its assessment.

6. What next?

Submit your reference conditions and condition scores to the committee for feedback or continue directly to Step 5.

Step 5: Creating a Common Environmental Currency

In order to describe the complexity of an ecosystem in numerical values, several indicators may need to be integrated to generate a single measure that best describes the condition of that environmental asset.[47]

This allows every asset to be compared relative to that same asset at any scale and it allows us to compare the rate of change not only within each asset class, but between different assets. It allows us to compare the relative condition of a sand dune with a eucalypt forest, or one local creek with another.

These environmental health indices will be used to create the common environmental currency for each environmental asset, which can then aggregated to produce environmental accounts at a range of spatial scales.

To avoid confusion with the condition score of each individual indicator, each environmental health index will be referred to as an "*Econd*".

An *Econd* is defined as:

> *"an accredited measure, metric or model that reflects the health of an environmental asset, that is created by combining (where appropriate) condition scores of environmental indicators based on a reference condition benchmark."*

An *Econd* describes the common environmental currency, in the same way the dollar ($) describes our economic currency.

To be accredited, a regional environmental account must contain environmental health indices for each asset class that are an appropriate description of the health of that environmental asset in that region.

There are three stages in this process:

1. Select the indicator(s) that are to form the environmental health index (*Econd*) for each environmental asset;
2. Choose the method for integrating the indicators to create the environmental health index; and
3. Where appropriate, spatially aggregate sub-regional environmental health indices to create an *Econd* for each environmental asset in the region.

1. Select indicators for integration

An environmental health index can be generated by selecting a range of appropriate condition scores that, when combined, best describe the condition of that environmental asset in that location.

In the cases where there are limited indicators of environmental assets, a single environmental health indicator (or surrogate) may be used as the final metric for environmental health.

For example, in the case of native vegetation, it is likely that in many regions during stage 1 of the trials, the percentage remaining of native vegetation will be sufficient to describe the

Econd. Over time, as more indicators such as vegetation structure become available, they would be incorporated into this index.

2. Choosing the method for combining indicators

An environmental health index can be generated by either summing a number of condition scores, taking the median or average expressed as a percentage;[48] or where deemed necessary, by combining scientifically accredited weighted indicators.[49,50]

The formula for combining a set of condition scores into an environmental health index (*Econd*) is described in Box 7. Averaging the condition scores will produce a number between 0-100 for the environmental asset.

Box 7 - Formula for calculating an Econd for each asset

Formula:

$$E = \frac{C_1 + C_2 + \ldots C_n}{n}$$

where: E = the environmental health index for each asset (Econd)

C = Condition score for each individual indicator within each asset

n = the total number of indicators used for each asset

3. Spatially aggregating information

The numerical representation of the condition of environmental assets enables the spatial aggregation from site scale information to create property, catchment (sub-regional), and whole region accounts. The procedure for spatial aggregation of environmental health indices (*Econds*) is as follows.

1. Select the asset you wish to aggregate (for example: a river or a forest).
2. Calculate the Econd for that environmental asset (0-100).

   Where there are a large number of sampling sites, it is scientific best practice to take the median score of indices. [51]

   In the case of rivers, there may be several indices for a river or stream due to multiple sampling sites and taking the median of these for calculating the environmental health index (Econd) for a particular asset (ie a river) is the preferred option.

   Where remotely sensed data is used or there are less sample sites, it will be appropriate to use the average. This will be the case, for example, where terrestrial vegetation scores are based on native vegetation extent data. If there is a case where a large number of sites are surveyed for condition or vegetation structure, then it may be appropriate to use the median.
3. Define the scale to which it will be spatially aggregated (for example: sub-catchment, catchment, or regional).
4. Weight the scores according the size of the asset (for example: the length of each river, the area of each forest).

5. Average the scores by the size of the aggregation area (see calculation in Box 8).

Box 8 - Formula for aggregating environmental health indices for environmental assets (Econd)

Formula:

$$E_x = \frac{(C_1*A_1)+(C_2*A_2)+\ldots(C_n*A_n)}{A_{TOTAL}}$$

where: E_x *= the spatially aggregated environmental health index (Econd) for an asset*

C = the condition score of an indicator of an asset

A = area occupied by the indicator of an asset

Example:

*In sub-catchment A of **100,000** ha there are 3 vegetation communities:*

*Community 1 is 80, 000ha and has a calculated condition score of **10**.*

*Community 2 is 10,000ha and has a calculated condition score of **90**.*

*Community 3 is 10,000ha and has a calculated condition score of **80.***

To produce a score for sub-catchment A use the following equation:

Econd for vegetation in subcatchment A equals

$$= \frac{(\mathbf{10}*80{,}000) + (\mathbf{90}*10{,}000) + (\mathbf{80}*10{,}000)}{\mathbf{100{,}000}} = 25$$

Step 6: Creating the Regional Environmental Account

This step outlines how to build environmental asset accounts and construct a Regional Environmental Account for your region.

The following tables, designed by the *Technical Environmental Accounting Standards Committee*, are a way to house, compute and present information for your accounts.

There are 3 levels of tables. All are designed and linked so that users can drill downwards through the cells to increasing levels of detail. The results can also be aggregated upwards. All show change over time.

1. The uppermost is the SUMMARY table in the calculated Econd for each asset is presented.
2. The next sets of tables are ASSET tables. For each asset, measures of indicators and reference condition benchmarks are placed, and Condition Scores and Econds are calculated.
3. The DATA tables contain the raw data which underpin the ASSET tables.

The SUMMARY table should be linked to an ASSET table and the measures within the ASSET tables should be linked to a DATA table.

The tables depicted below are examples only. Population of the tables should be completed in Excel or a similar program (an Excel template is available). The empty tables do not have equations embedded in them. This will be up to the participant to fill in (the Excel tables have examples of linked cells for demonstration).

TABLE A - Environmental Account SUMMARY table

Environmental Asset Class	Environmental Asset	Econd		
		2008	2009	2010
LAND	Vegetation	40		
	Soils	60		
	Fauna	80		
WATER	Rivers	60		
	Wetlands	54		
	Floodplain	75		
	Groundwater	68		

Note: Colours and example Econds derived from ASSET tables

TABLE B – Native Vegetation ASSET table

Native vegetation				Year 1		Year 2	
	Indicator*	Unit of Measure	Reference Condition Benchmark	Year 1 measure	Condition Score	Year 2 measure	Condition Score
Econd TOTAL				40			
VA1 Econd							
	Vegetation extent						
VA1	Structure						
	Connectivity						
VA2 Econd							
	Vegetation extent						
VA2	Structure						
	Connectivity						
VA3 Econd							
	Vegetation extent						
VA3	Structure						
	Connectivity						
VA4 Econd							
	Vegetation extent						
VA4	Structure						
	Connectivity						

Notes: VA = vegetation association; summarised in Table A. Indicators are examples only.

TABLE C – Soil ASSET Table

Soil				Year 1		Year 2	
	Indicator*	Unit of Measure	Reference Condition Benchmark	Year 1 Measure	Condition Score	Year 2 measure	Condition Score
Econd TOTAL				60			
Soil type 1 Econd							
	pH						
Soil type 1	Carbon						
Soil type 2 Econd							
	pH						
Soil type 2	Carbon						
Soil type 3 Econd							
	pH						
Soil type 3	Carbon						
Soil type 4 Econd							
	pH						
Soil type 4	Carbon						

Notes: summarised in Table A; indicators are examples only.

TABLE D - Native Fauna ASSET table

Native fauna				Year 1		Year 2	
	Indicator*	Unit of Measure	Reference Condition Benchmark	Year 1 Measure	Condition Score	Year 2 measure	Condition Score
Econd TOTAL				**80**			
Birds Econd							
	Diversity						
	Abundance						
	# threatened species						
Mammals Econd							
	Diversity						
	Abundance						
	# threatened species						
Amphibians Econd							
	Diversity						
	Abundance						
	# threatened species						
Reptiles Econd							
	Diversity						
	Abundance						
	# threatened species						

Notes: summarised in Table A; indicators are examples only

TABLE E – River ASSET table

Rivers				Year 1		Year 2	
	Indicator*	Unit of Measure	Reference Condition Benchmark	Year 1 Measure	Condition Score	Year 2 Measure	Condition Score
Econd TOTAL				60			
Creek 1 Econd							
	Macroinverts						
Creek 1	Water flow						
	Riparian						
Creek 2 Econd							
	Macroinverts						
Creek 2	Water flow						
	Riparian						
Creek 3 Econd							
	Macroinverts						
Creek 3	Water flow						
	Riparian						
Creek 4 Econd							
	Macroinverts						
Creek 4	Water flow						
	Riparian						

Notes: summarised in Table A; indicators are examples only

TABLE F - Wetland ASSET table

Wetlands				Year 1		Year 2	
	Indicator*	Unit of Measure	Reference Condition Benchmark	Year 1 measure	Condition score	Year 2 measure	Condition score
Econd TOTAL				54			
Wetland 1 Econd							
	Macroinverts						
Wetland 1	Water flow						
	Riparian						
Wetland 2 Econd							
	Macroinverts						
Wetland 2	Water flow						
	Riparian						
Wetland 3 Econd							
	Macroinverts						
Wetland 3	Water flow						
	Riparian						
Wetland 4 Econd							
	Macroinverts						
Wetland 4	Water flow						
	Riparian						

Notes: summarised in Table A; indicators are examples only

TABLE G - Floodplain ASSET table

Floodplains				Year 1		Year 2	
	Indicator*	Unit of Measure	Reference Condition Benchmark	Year 1 Measure	Condition score	Year 2 Measure	Condition score
Econd TOTAL				75			
Floodplain 1 Econd							
	Vegetation						
Floodplain 1	Water flow						
	Water quality						
Floodplain 2 Econd							
	Vegetation						
Floodplain 2	Water flow						
	Water quality						
Floodplain 3 Econd							
	Vegetation						
Floodplain 3	Water flow						
	Water quality						
Floodplain 4 Econd							
	Vegetation						
Floodplain 4	Water flow						
	Water quality						

Notes: summarised in Table A; indicators are examples only

TABLE H - Groundwater ASSET table

Groundwater				Year 1		Year 2	
	Indicator*	Unit of Measure	Reference Condition Benchmark	Year 1 Measure	Condition score	Year 2 Measure	Condition score
Econd TOTAL				68			
Aquifer 1 Econd							
Aquifer 1							
Aquifer 2 Econd							
Aquifer 2							
Aquifer 3 Econd							
Aquifer 3							
Aquifer 4 Econd							
Aquifer 4							

Notes: summarised in Table A; indicators are examples only

TABLE I – River Asset – Macroinvertebrate indicators for Creek 1 - DATA table

Creek 1	**Year 1**
Indicator	**Year 1 measure**
Macroinverts	**20**
Sample 1	**10**
Sample 2	**20**
Sample 3	**20**
Sample 4	**40**
Sample 5	**16**
Sample 6	**20**
Sample 7	**18**
Sample 8	**18**
Sample 9	**18**

Notes: Linked to Table E

Appendix 1:
Regional Environmental Accounts Working Group

Pam Green (Convenor): Chair of Southern Rivers Catchment Management Authority in NSW, member of NSW Natural Resources Advisory Council, founding member National NRM Regions Working Group. Pam has provided leadership in many NRM committees including the Natural Heritage Trust Advisory Committee, Envirofund National Panel, Land and Water Australia SIRP and is a former Mayor of Eurobodalla Shire Council.

Kate Andrews: Chair of the NT NRM Board, and the 2010 Chair of the National NRM Regions Working Group. She was the Knowledge and Adoption Manager for Land & Water Australia and has assisted the Lake Eyre Basin community design a multi-state natural resource management organisation.

Dr Sarah Ryan: Chair of ACT Natural Resource Management Council and the current Chair of the National Working Group. Dr Sarah Ryan has a PhD in agriculture and 30 years research experience spanning agriculture, international development, ecology and water research. She is currently an Honorary Fellow at CSIRO Sustainable Ecosystems and working on ecosystem governance research.

James McKee: Chief Executive Officer of NRM North in Tasmania. James previously worked as the Operations Manager at NRM North and in the Queensland Murray Darling Basin in regional NRM planning and investment planning, monitoring and evaluation, project management and reporting.

Niilo Gobius: Resource Evaluations Officer for Northern Gulf, Queensland, developing a regional accounting scheme to monitor environmental trends in the regions land, water, coastal and marine environment, air and atmosphere, indigenous resource management and Northern Gulf community. He also works in Cape York running grazing management workshops and mapping grazing properties.

Danny O'Neill (Executive Officer): Danny is the Executive Officer to the National NRM Regions' Working Group and to Victoria's CMA Chairs and CEOs Groups. He has worked in the natural resource management sector for over 25 years.

Regional NRM Group Trial Participants 2011-2012

Corangamite Catchment Management Authority, VIC

- Alice Knight (Chair), Gareth Smith (CEO), Cheryl Nagel

Central West Catchment Management Authority, NSW

- Tom Gavel (Chair), Carolyn Raine (GM), Jen Shearing , Tracey Macdonald

Eyre Peninsula Natural Resources Management Board, SA

- Heather Baldock (Chair), Annie Lane (Regional Manager), Sophie Keen

Namoi Catchment Management Authority, NSW

- Brian Tomalin (Chair)), Bruce Brown (GM), Francesca Andreoni and Bronwyn Witts

North Central Catchment Management Authority, VIC

- David Clark (Chair), Damian Wells (CEO), Steve Jackson, Geoff Park

Northern Agricultural Catchment Council, WA

- Chris King (Chair), Shelley Spriggs (CEO), Marieke Jansen

Northern Gulf Resource Management Group, QLD

- John Bethel (Chair), Noeline Ikin (CEO), Niilo Gobius

NRM North, TAS

- Richard Ireland (Chair), James McKee (General Manager), Andrew Baldwin

Queensland Murray-Darling Committee, QLD

- Jeff Campbell (Chair), Geoff Penton (CEO), Roxane Blackley

South East Queensland Catchments, QLD

- Robert Smith (Chair), Simon Warner (CEO), Noel Ainsworth, David Manning

Appendix 2:
Scientific Standards and Accreditation Committee

Purpose:

1. To establish which scientific standards apply to regional environmental accounting;
2. Accredit indicator selection, reference condition benchmarks, indices of environmental health, and data quality;
3. Provide a consultative forum that can effectively address scientific matters arising during the trial.

Terms of Reference:

1. To establish standards and criteria for:
    1. Selection of environmental assets and their indicators;
    2. Data quality;
    3. Selection of reference condition benchmarks; and
    4. Development of indices of environmental health.
2. To develop guidelines for the trial participants on the methods and procedures for undertaking 1-4 above to meet accreditation criteria.
3. To accredit accounts from each trial region against standards and criteria for indicator selection, reference condition benchmarks, indices of environmental health and data quality.
4. To provide access to scientific advice to the trial participants in response to matters as they arise.
5. To prepare issues papers and progress reports for the Technical Environmental Accounting Standards Committee with reference to matters that affect both the scientific and accounting aspects of the trial, and review issues papers produced from this committee.

Membership:

Peter Cosier	*Chair*
Dr John Williams	Land (Agricultural Systems)
Prof Hugh Possingham	Land (Spatial Models)
Dr Denis Saunders	Land (Ecology)
Mr Mike Grundy	Land (Soil Science)
Dr Ronnie Harding	Environmental Indicators
Dr Richard Davis	Water Resources Policy
Dr Terry Hillman	Freshwater (Metrics)
Dr Eva Abal	Waterways (Monitoring)
Prof Bruce Thom	Coasts and SoE Reporting
Dr Tony Smith	Marine Science
Jane McDonald	Research Analyst – University of Queensland
Carla Sbrocchi	Policy Analyst – Wentworth Group
Dr Peter Greig	*Chair, Technical Committee*

Appendix 3: Technical Environmental Accounting Standards Committee

Purpose:

1. To develop an accounting framework fit for purpose at multiple scales;
2. Ensure compatibility with national and international environmental accounts; and
3. Provide a consultative forum that can effectively address accounting matters arising by the Regional Groups during the trials.

Terms of Reference:

1. To develop standards for:
    1. Design of the regional accounting framework;
    2. Quality measures;
    3. Data aggregation;
    4. Linking regional accounts to national and international environmental accounting standards.
2. To develop templates and guidelines for the trial participants on the methods and procedures for building a regional environmental account according.
3. To provide advice to the trial participants in response to matters as they arise.
4. To prepare issues papers and progress reports for the Scientific Standards and Accreditation Committee with reference to matters that affect both the scientific and accounting aspects of the trial, and review issues papers produced from this committee.

Membership

Dr Peter Greig	*Chair*
Dr Neil Byron	Resource Economics
Mark Eigenraam	Information Systems
Dr Richard Mount	Australian Bureau of Meteorology
Dr Tom Hatton	2011 Chair, Australian State of the Environment Committee
Mark Lound	Australian Bureau of Statistics
Dr Rob Sturgiss	Dept Climate Change - Carbon Accounts
Gary Stoneham	Environmental Markets
Dr Michael Vardon	International Standards
Jane McDonald	Research Analyst – University of Queensland
Carla Sbrocchi	Policy Analyst – Wentworth Group
Peter Cosier	*Chair, Scientific Committee*

Appendix 4: Issues raised by the regions

Issue	Region of origin	Status of Response	Where to find information
How do we use birds Australia data?	Eyre Peninsula, Northern Gulf and QLD Murray-Darling	Addressed by Scientific Committee, 21/10/11. Further work being undertaken.	See Issues Paper 1, point 2.3 for further information.
Could measurement of threats be used as an indicator of env. health (eg extent of weed infestation, pest animal pop'n)?	Eyre Peninsula	Resolved	Section 2 of the Guidelines amended accordingly
We thought the concept of Accounting for Nature was about including negatives in the equation. We might be improving health where we are working but other areas might be going backwards.	Eyre Peninsula	Resolved	Section 1 of the Guidelines
Our data is usually specific to sites where investment is made. How do we account for/extrapolate across the entire region?	Eyre Peninsula	Addressed by Scientific Committee, 21/10/11. Principles established. Further work is being undertaken.	See Issues Paper 1, point 4.1 for further information.
With some Metrics, the current state divided by the reference conditions will become toxic and therefore bad for the environment eg. The river flows (way too much over normal has bad consequences) or mineral levels (eg P over 100mg/kg becomes toxic). The health becomes better up to a particular threshold then starts to diminish again. How do we deal with this in the accounting?, we should have some sort of equation that can deal with this.	Northern Gulf	Addressed by Scientific Committee, 21/10/11. Principles established. Further work is being undertaken.	See Issues Paper 1, point 4.2 for further information.
Different regions selecting different indicators can create very different outcomes especially if we have only 3 to 4 indicators in a particular asset sub-theme or asset theme. The average for a theme is impacted more by only a few indicators compared to if you have	Northern Gulf	Addressed by Scientific Committee, 21/10/11. Resolved.	Refer to Steps 1 and 2 in Guidelines. See also Issues Paper 1, point 2.2 for further discussion.

heaps.			
landform and community views of land - a sense of place as additional "assets".	Corangamite	For the purposes of this trial assets are limited to physical features. To be reviewed after Stage 1.	See Section 3 of the Guidelines
An issue - diversity of landscapes are important for biodiversity – but landscapes do not change much…	Corangamite	Beyond scope of Stage 1. To be reviewed after Stage 1.	
What is the reference condition of fire-dominated savannas when we don't know the true ideal or pre-European state?	Northern Gulf	Addressed by Scientific Committee, 21/10/11. Further work is being undertaken.	See Issues Paper 1, point 4.3 for further information.
What is the reference condition when we use annual fish catch as an indicator?	Northern Gulf	Addressed by Scientific Committee, 21/10/11. Further work is being undertaken.	See Issues Paper 1, point 4.4 for further information.
How can we take into account large annual fluctuations in condition when determining the reference condition for seagrass as an indicator?	Northern Gulf	Addressed by Scientific Committee, 21/10/11. Further work is being undertaken.	See Issues Paper 1, point 4.5 for further information.
If Groundcover is not a suitable indicator for Soil Condition, what is?	Most groups	Work is being undertaken.	
What are suitable Wetlands Indicators	Eyre Peninsula	Work is being undertaken	
What are suitable Floodplains indicators?	Namoi, Central-West	Work is being undertaken	
How do we account annually for some indicators that are only measured periodically ie every 3-5 years?	SEQ	Work is being undertaken	
What are suitable 'coastal' indicators for potential sea level rise?	SEQ	Work is being undertaken	

Appendix 5: Glossary

Account

Asset

Common currency

Condition

Econd – see definition of 'environmental health index'??

Ecosystem -

Ecosystem condition –

Ecosystem health – see definition of 'environmental health' below

Environmental asset - a physical feature in the landscape that is measurable in space and time.

Environmental asset class – overarching themes, such as Land and Water, to describe the environment that incorporates sets of environmental assets.

Environmental health – the level of health relates to an ecosystem's vigour (level of productivity), organisation (structure and interactions) and resilience (ability to rebound from a shock). In general, a healthy ecosystem has high rather than low productivity, is more complex than simple, and is more able to bounce back after a disturbance. 'Health' is a judgement.

Environmental health index – An aggregation of indicators that when combined, best describes the function of ecosystem.

Environmental health indices are can be represented as a percentage between 0-100. For example, an indicator for the condition of vegetation is tree cover. The indicator can be expressed in appropriate units such as 10,000ha. When the indicator is measured against a known reference condition (the original extent was 100,000ha) then the indicator of environmental health is expressed as 10%.

Environmental heath indicators are predisposed to aggregation because they are already measured against a common benchmark and can be expressed between 0-100.

Indicators need to be measured in the same units in order to be aggregated. The typical method for combining indicators into a single unit or score is the 'distance to reference point'. That is, each indicator is compared to a common reference condition and can be expressed as a percentage in relation to that point. The indicators are then amendable to combination to give a single number because the indicators are measured on the same scale (0-100).

Environmental stock -

Goal – see 'target' and 'vision'.

Goods and services

Index (indices)

Indicator – Environmental indicators help track changes in the environment by measuring key measures – which may be physical, chemical, biological – which provide useful information about the whole system.

Using indicators, it is possible to evaluate the fundamental condition of the environment without having to capture the full complexity of the system (adapted from ANZECC State of the Environment Reporting Task Force). Indicators of environmental condition measure components of an ecosystem, which reflects vigour, organisation, structure and interaction or resilience.

Indicators of condition and function are expressed as the divergence from a reference condition.

Metric

Natural capital

Natural resource

Reference condition - For the purpose of these trials reference condition is defined as a reference point where "the status of an ecosystem's components as they would be had significant post-industrial intervention had not occurred in the landscape".

The reference condition enables the generation of environmental health indices (see 'Environmental health index') and normalisation of indicators for aggregation and comparison.

Reference condition benchmark

Report

Service

State – the current status or condition of an environmental asset.

Stocks and flows

Surrogate – A representative indicator that provides information on other (or a range) of parameters.

Target – A policy objective set by government or environmental managers.

The target is a level to which managers are aiming for, set with consideration for a number of factors such as environmental prioritisation, achievability, and social and economic values and priorities.

Vision – A description of how the landscape could be, or is desired to be, understanding landscape health and taking into account the people and activities that rely on those landscapes.

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