CRC TiME
Transformations in Mining Economies

CSIRO

Natural Capital and the Resources Sector

A practical guide for corporate natural capital accounting, assessment and disclosure

O'Grady A.P., Smith, G.S., Horner, C., Maybee B.

Citation

O'Grady A.P.[a], Smith, G.S.[a], Horner, C.[a], Maybee, B.[b] 2023 Natural Capital and the Resources Sector: A practical guide for corporate natural capital accounting, assessment and disclosure. CSIRO, Australia.

[a] CSIRO
[b] CRC TiME/Curtin University

Copyright

Important disclaimer

Foreword

The mining industry makes a significant contribution to the national economy, contributing in excess of 69% of export revenue and making a significant contribution to government taxes and royalties.

The mining industry's operational footprint in the landscape is less than 0.1% of the Australian land mass, but may have significant environmental impacts, particularly in a regional context. The industry has an important role to play in managing the land sustainably and protecting the environment.

This role is gaining greater prominence as the Australian government embraces a Nature Positive Plan and nature-specific goals and targets including the conservation and management of at least 30% of the nation's lands, coastal areas and oceans; restoring 30% of terrestrial and marine ecosystems; and reducing to near zero the loss of areas of high biodiversity importance and ecological integrity – all by 2030. The mining industry is embracing similar goals. Critical to the pathway for achieving these goals and targets is effective and transparent ways of monitoring and reporting on nature.

The emergence of natural capital accounting and nature-related risk disclosure as ways for industries to report on how they impact and depend on nature through their activities, is a significant opportunity for the mining industry. Key challenges lie in building the appropriate skills and practical methods and tools, to support the implementation of these types of frameworks.

An excellent recent example demonstrates the benefits of case studies to showcase natural capital accounting approaches. In May 2023, BHP published the first pilot case study on the application of natural capital accounting principles in the mining industry, for the Beenup Mineral Sands site in southern Western Australia. These accounts provide a measure of the amount, condition and value of the site's environmental assets, and help to describe changes in ecosystems over time and how they could impact wellbeing and economies. A key learning from this case study was that our capacity to develop natural capital accounts is hampered by low levels of understanding of key concepts, a dearth of practical methods, and lack of appropriate data.

Building on this base, a partnership between CSIRO, the CRC for Transformations in Mining Economies and its partners, and the Department of Climate Change, Energy, the Environment and Water has resulted in the first guidance material to support natural capital accounting and risk assessment for the mining industry.

This document is designed to build understanding of the concepts, methods and reporting structures for natural capital accounting and risk assessment, with a view to practical implementation.

It is hoped that it will help to empower mining companies to embed natural capital accounting and risk assessment into their businesses, and demonstrate to themselves, their investors and the broader community the value of sustainable management of nature.

Dr Libby Pinkard

Research Director, Living Landscapes
CSIRO Environment

Table of contents

Figures

Tables

Acknowledgements

The mining sector Environmental Economic Accounting project was supported by the Australian Government's Department of Climate Change, Energy, the Environment and Water.

The project has bought together industry, research providers and engaged stakeholders to promote the adoption and streamlining of natural capital accounting and disclosure in the mining sector.

The project team thanks our partners: Alcoa, BHP, Hanson Australia, CSIRO, CRC TiME, Murdoch University, Curtin University, University of South Australia, Syrinx Environmental PL, Minerals Council of Australia, Digital Finance CRC and the Western Australian Biodiversity Science Institute.

We also acknowledge the significant input of our colleagues Libby Pinkard, Francisco Ascui and Sue Ogilvy over many years of development, discussion and thinking.

Executive Summary

Executive Summary

Increasingly, organisations are being asked to account for their impacts and dependencies on nature and their stewardship of the natural capital under their ownership and or management. Growing concern about risks to economic stability associated with changing climates and declining biodiversity have generated calls for greater action from the private sector.

The prominence of natural capital accounting (NCA) and natural capital assessment in responding to these calls for improved disclosure has accelerated considerably over the last decade, which has seen the emergence of numerous initiatives, frameworks, metrics and targets, all aimed at improving the consistency and comparability of reporting in relation to natural capital.

ABOUT THIS PROJECT

The mining sector Environmental Economic Accounting project was initiated by the Australian Government's Department of Climate Change, Energy, the Environment and Water with the aim of increasing the preparedness of the resources sector for the changing reporting and disclosure regimes associated with rising expectations for disclosure of nature and climate-related risks.

The project was jointly led by CSIRO and CRC TiME and aimed to test the applicability of NCA in the mining sector, build capability, better understand the readiness of the industry for adoption and to provide guidance to promote consistent application and reporting of natural capital information. Key activities in the project included a series of mining-specific natural capital case studies.

The case studies were led by university research teams and partners (Curtin University, Murdoch University, Syrinx Environmental PL, The University of South Australia) working with industry partners (Alcoa, BHP, Hanson) to test the applicability of the processes on industry data.

Insights and lessons learnt from these case studies were used to inform an analysis of the business case and indicative roadmap for implementation and to produce guidance materials to assist with building capability and promoting broader adoption across the sector.

ABOUT THIS REPORT

This guidance material is aimed at organisations in the resources sector who are gearing up to respond to the growing demand for timely, repeatable and robust information on natural capital. It does not propose new or different approaches to NCA or assessment. Rather, its aim is to provide practical guidance on how the concepts of natural capital assessment and accounting work together in a corporate environment to provide a comprehensive and efficient approach to natural capital reporting and disclosure.

As such, it provides pointers to relevant resources and guidance, such as the United Nations System of Environmental Economic Accounting, and proposes approaches to the integration of NCA and assessment for a range of purposes including internal management, decision-making, target setting, natural capital risk assessment and external disclosure and reporting.

The report is structured into three sections:

- Section one provides a high-level introduction to the concepts of natural capital, natural capital assessment, risk assessment and NCA.
- Section two is targeted at an organisation's internal processes and introduces the concept of NCA and assessment for management purposes. It highlights the central role of the natural capital asset register as the foundation for the natural capital schedules that will be required to enable evidenced-based decision-making within the organisation. The focus of NCA and assessment for management purposes is to enhance strategic management and stewardship of natural capital. It recognises that acknowledging nature's contribution to the organisation's performance requires broader integration of the financial and environmental management systems.
- Section three is focussed on external disclosure of natural capital performance. It proposes an approach to natural capital disclosure that is closely aligned to the concepts of a general-purpose financial report, with which many reporting entities are already familiar, and extends this thinking to include emerging disclosure requirements associated with initiatives such as the Taskforce on Climate-related Financial Disclosures (TCFD) and the Taskforce on Nature-related Financial Disclosures (TNFD) and associated sustainability reporting standards.
- Appendix A provides an overview of the general accounting principles required to build trust and accountability underpinning the disclosure statements. These principles are essential for understanding and implementing the concepts in this guidance document.

Key features of this guidance material are:

- A clear differentiation between the concepts of NCA (the process of measuring the stock and flows of ecosystem assets and associated ecosystem services) and natural capital assessment (i.e., natural capital impact, dependency assessment and natural capital risk and opportunity assessment).
- The separation of NCA and assessment for internal management purposes from that required to support external disclosure.
- Identification of six key disclosure statements that, together, provide a comprehensive overview of an organisation's natural capital performance during the reporting period, including:
  - » Natural capital balance sheet, ecosystem change statement and natural capital income statement, deliberately designed to be analogues of existing financial statements, primarily targeted at organisations that directly own or control natural capital assets (i.e., most organisations in the resources sector), and,
  - » Natural capital impact and dependency statements and natural capital risk and opportunity statements to facilitate obligations under emerging sustainability standards and relevant to all organisations that will be required to disclose nature-related impacts and dependencies.

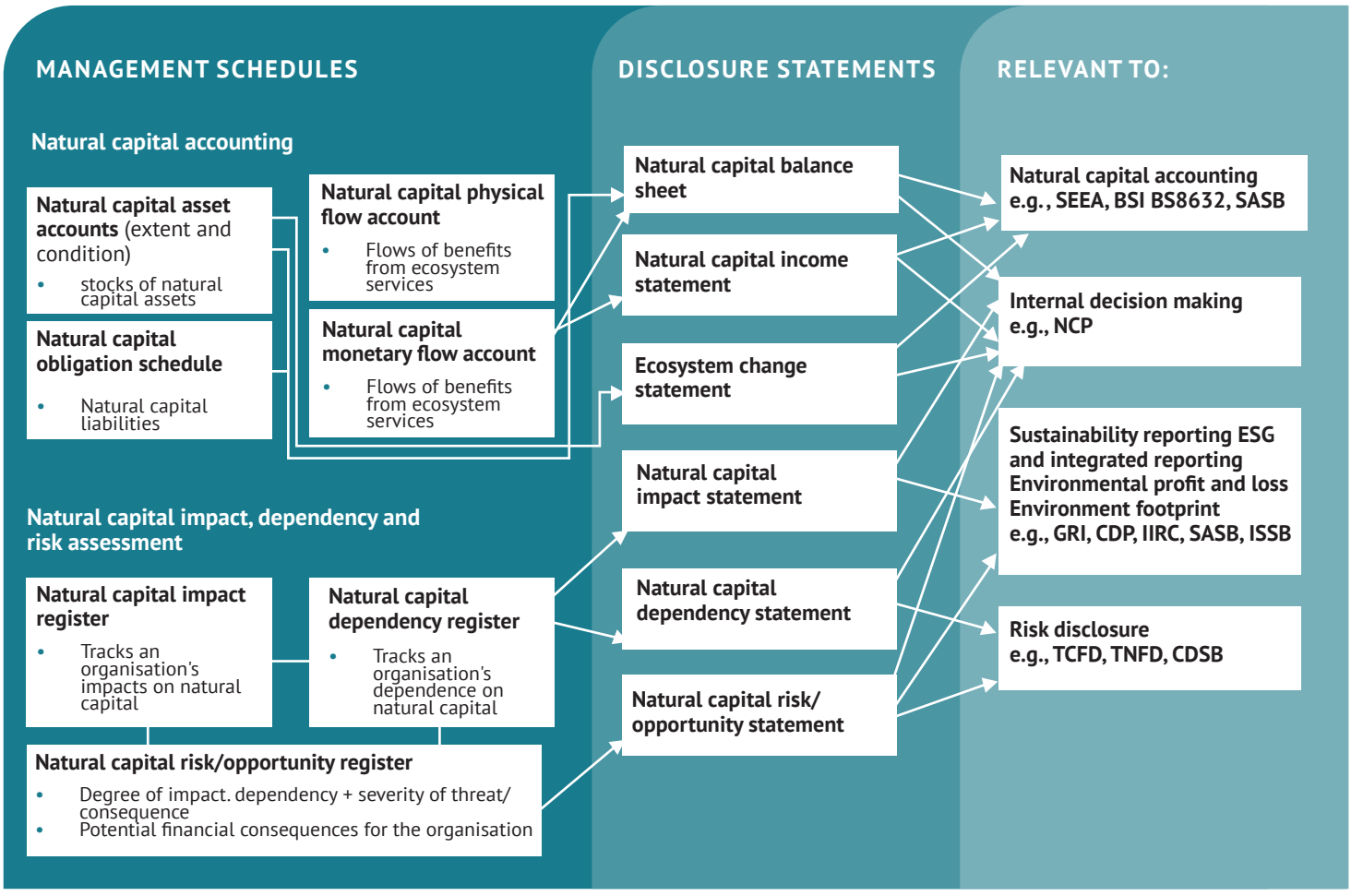


Figure 1 Relationships between corporate natural capital accounting, assessment and reporting (Adapted from Smith et al. 2023)

Part 1: Natural capital key concepts for the resources sector

PART 1

Natural capital key concepts for the resources sector

THE CONTEXT AND KEY CONCEPTS

Purpose:

This handbook provides guidance on natural capital accounting (NCA), assessing impacts and dependencies, natural capital risk assessment, and reporting for organisations within the resources sector.

It does not seek to replicate guidance that is already published elsewhere, but to provide a practical how-to guide that points towards other resources and helps to make sense of occasional differences in interpretation between different sources, so that organisations can make informed decisions about what approach will best suit their own needs.

Who is this report aimed at:

The intended audience for this guidance material are organisations that directly own, manage or control land devoted to the extraction of mineral resources and are seeking to conduct natural capital assessments or prepare natural capital reports, including natural capital accounts and/or conduct natural capital impact, dependency, and risk assessments, for internal or external use and disclosure.

There is a strong alignment between financial accounting and NCA proposed in this document. As such, it is strongly recommended that the organisation's environmental and accounting teams work together to pilot NCA.

1. INTRODUCTION TO NATURAL CAPITAL

Globally, there is rising concern associated with ongoing climate change, land degradation and biodiversity loss. Failure on climate action, extreme events and biodiversity loss have been highlighted as the three most important risks to the stability of global financial systems over the next decade (World Economic Forum 2022).

In response, there are growing calls for greater disclosure of individual organisations' dependencies and impacts on nature along with a clearer articulation of the associated risks and plans to adapt to and mitigate these changing environmental constraints (Capitals Coalition 2016, TEEB 2018, Dasgupta 2021).

Global agreements such as the Paris Agreement and the Convention on Biological Diversity have set clear operating boundaries with respect to carbon emissions and nature loss, and these are being enacted through initiatives such as the Taskforce on Climate-related Financial Disclosures (TCFD) and the Taskforce on Nature-related Financial Disclosures (TNFD) in collaboration with standards setters (e.g., IFRS) and prudential regulators around the globe.

1.1 NATURAL CAPITAL

All organisations rely on natural capital. Natural capital conceptualises nature as an input into economic activity and human wellbeing (Figure 2). Stocks of natural resources combine to produce flows of ecosystems services that create benefits for society.

The "invisibility" of natural capital in existing economic and financial reporting is believed to be a major contributor to the ongoing degradation of natural environments, and realisation that these resources are finite has been a major driver for new approaches to recognise and account for these as inputs into production.

1.2 NATURAL CAPITAL IMPACTS AND DEPENDENCIES

All organisations within the resources sector will have dependencies and impacts on nature (Figure 3). Natural capital impacts and natural capital dependencies help to describe an organisation's relationship with the environment and the renewable and non-renewable natural resources within the organisation's footprint.

The mining industry has a long history and good understanding of its impacts. Indeed, environmental impact assessments are an integral part of mining approvals processes. The recognition of dependencies on natural capital is less explicit, although they will potentially be indirectly acknowledged within mining environmental impact assessments.

This formalised approval process places mining organisations in a good position to respond to the growing calls for natural capital assessments and accounts.

1.3 THE NATURAL CAPITAL LANDSCAPE

The natural capital landscape is characterised by a number of standards, frameworks and initiatives. To simplify, Figure 4 maps these standards, frameworks and guidance materials, and provides a summary of their respective focal areas.

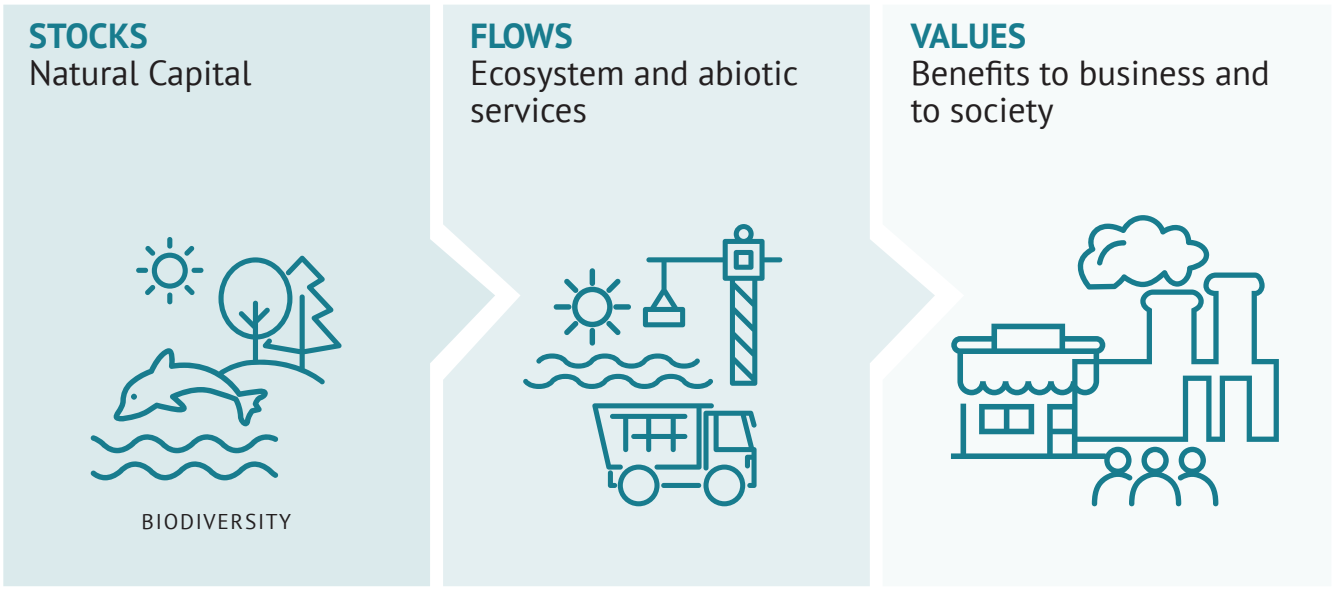


Figure 2 A conceptual model of the relationship between natural capital (the stock of natural resources), flows of ecosystem services (nature's functions) and the benefits that these generate for society (Adapted from Capitals Coalition 2016)

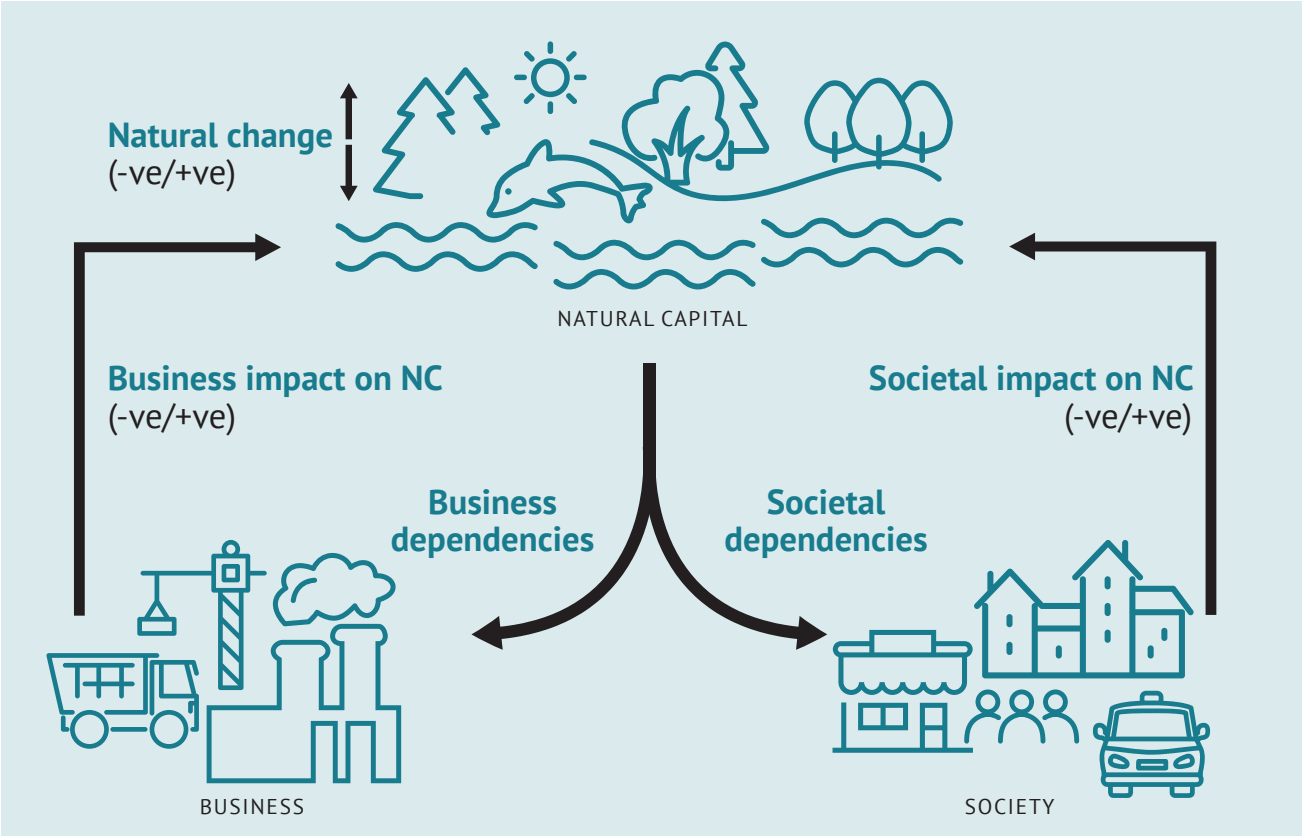


Figure 3 A conceptual model of the relationships between business entities and society with natural capital. Adapted from Capitals Coalition 2016.

The Natural Capital Landscape					
	Natural Capital Materiality Assessment	Natural Capital Impact & Dependencies	Natural Capital Risks & Opportunities	Natural Capital Accounting	External Disclosure and reporting
Standards					
SEEA - Central Framework SEEA - Ecosystem Accounting				✓	
The British Standards Institution (BSI) BS 8632: Natural Capital Accounting for Organisations; Monetary valuation of environmental impacts and related environment aspects	✓	✓	✓	✓	✓
Global Reporting Initiative (GRI)	✓	✓			✓
Frameworks					
Natural Capital Protocol	✓	✓	✓		✓
Taskforce on Climate, Financial, and Disclosures (TCFD), Taskforce on Nature-related Financial Disclosures (TNFD)	✓	✓	✓		✓
International <IR> Framework	✓	✓	✓		✓
Guidance					
The Natural Capital Forestry Handbook	✓	✓	✓	✓	✓
Natural Capital Finance Alliance (NCFA) Integrating Natural Capital in Risk Assessements, Exploring Natural Capital Opportunities, Risks and Exposure	✓		✓		

Figure 4 The natural capital landscape - natural capital standards, frameworks, and guidance.

1.4 NATURAL CAPITAL ASSESSMENT AND ACCOUNTING

Natural capital assessment and accounting are formalised processes designed to better understand an organisation's 'transactions' or interactions with the environment. While natural capital assessment and NCA are related conceptually and may share many characteristics in terms of scope, boundaries, data requirements and valuation approaches, there are important differences between the two processes.

A key difference is related to the frequency of natural capital assessments and natural capital accounts. Natural capital accounts are specifically designed to collate information on the stocks of environmental resources or ecosystem assets and the associated flows of ecosystem services at regular reporting periods, enabling the monitoring of the stocks and flows of natural capital through time.

Natural capital assessments on the other hand are the systematic analysis, reporting and valuation of an organisation's impacts and dependencies on natural capital. Natural capital assessments can be conducted as a once-off exercise, on a periodic basis or at a project-by-project level.

In many emerging natural capital assessment frameworks, there is a requirement to broaden the scope from the organisation's direct impacts and dependencies and to include impacts and dependencies in the upstream or downstream value chain.

Typically, natural capital accounts are suited to organisations that directly own or control ecosystems and environmental resources (e.g., a mining company). NCA is not mandated nor is there a recommended interval for it. However, a key feature of NCA is regularity, and an organisation may decide that natural capital accounts be aligned with the organisation's financial reporting periods, i.e., annually or to strategic planning cycles (1, 2 or 5 years).

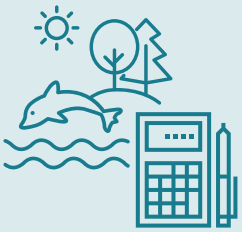
A natural capital assessment can be conducted by any organisation regardless of its position with respect to direct ownership or control of natural capital. As with NCA, natural capital assessments are not mandated.

However, recent legal opinion suggests that that risks associated with impacts and dependencies on nature are foreseeable and within the existing scope of the director's duties (Hartford-Davis and Bush 2023). The emergence of the International Sustainability Standards Board's (ISSB) S1 and S2 (based on the TCFD) and the related TNFD may lead to mandating of forms of natural capital assessment.

Organisations can use **natural capital assessments (impacts, dependencies, risks, and opportunities)** to understand their interactions with natural capital, regardless of ownership or location of that natural capital.

Organisations can use **natural capital accounts** to record the state and trends in the natural capital owned or controlled by the organisation.

Table 1 Natural capital accounting and assessment: key definitions and characteristics



Natural capital accounting

Natural capital accounting identifies and records consistent and comparable information on stocks of natural capital assets that organisations own or control and the ecosystem's goods and services generated by those natural capital assets.

Natural capital accounting can be seen as a logical extension to existing management and financial accounts, bringing the same structure and rigour that is already applied to manufactured and financial capital.

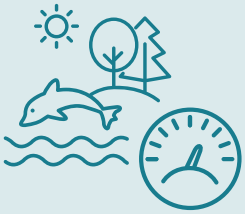
- **Natural capital assets** are the stock of natural resources, e.g., plants, animals, air, water, soils, minerals (NCP 2016 p. 2).
- **Ecosystem services** are the contributions of ecosystems to the benefits that are used in economic and other human activity (SEEA-EA 2021, s. 6.9, p. 121).

Natural capital impact and dependency assessment

Natural capital impact and dependency assessment identifies and records consistent and comparable information on the organisation's relevant (material) impacts and dependencies on natural capital, whether that natural capital is owned/controlled by the organisation, or not.

Natural capital impacts include negative impacts, such as land degradation, emissions or pollution, and positive impacts, such as carbon sequestration or ecological rehabilitation.[1] Natural capital dependencies include any material reliance on or use of natural capital, such as reliance on adequate rainfall or groundwater resources, or the services provided by insect pollinators.

In some cases, the relevant dependency might be the absence of conditions that would otherwise be unfavourable (such as extreme weather or pests and diseases).



Natural capital risk assessment

Natural capital risk assessment identifies and records consistent and comparable information on the material risks to the organisation arising from their natural capital impacts and dependencies and how these are projected to change in the future (e.g., through management changes, climate change or changes in social preferences and regulation).

- **Natural capital risks** are the risks to the organisation arising from their impacts and dependencies on natural capital. It is also important to note that reducing risks or increasing the organisation's resilience can provide **natural capital opportunities.**

1.5 THE RELATIONSHIP BETWEEN ENVIRONMENTAL ECONOMIC ACCOUNTING AND NATURAL CAPITAL ACCOUNTING

The terms environmental economic accounting (EEA) and natural capital accounting (NCA) are often used interchangeably; however, in this document we make a distinction between the two. Here, EEA refers specifically to accounting practices designed to complement the System of National Accounts (SNA) through the System of Environmental Economic Accounting (SEEA).

These are typically conducted by government to guide management/policies at regional to national scales. Whereas NCA refers to the internal and external accounting and reporting practices of organisations (sometimes referred to as corporate natural capital accounting) and is analogous to management and financial accounting. NCA is typically conducted by private sector organisations to assist management of the organisation.

Environmental Economic Accounting (EEA)

The SEEA Central Framework is an international statistical standard for measuring the environment and its relationship with the economy, with a particular focus on environmental flows, stocks of environmental assets and economic activity related to the environment (United Nations 2014).

The SEEA Ecosystem Accounting approach is an international statistical standard for tracking changes in ecosystem assets, measuring associated changes in ecosystem services and linking this information to economic and other human activity (United Nations 2021). A key distinction between the Central Framework and Ecosystem Accounting is that the former focuses on the measurement of natural resources or environmental assets (e.g., stocks of water, minerals), cultivated biological resources (e.g., fish stocks) and land, and the

[1] Here, we use the terms 'positive' and 'negative' for impacts that generally improve or degrade natural capital, respectively. However, this is a complex topic and impacts could be positive for some aspects of natural capital and negative for others, and/or viewed differently from different value perspectives or by different stakeholders. It is up to the organisation to clarify the basis on which any distinction between 'positive' and 'negative' impacts is made, particularly if using these concepts to report 'net' impacts.

> The System of Environmental-Economic Accounting (SEEA) is a framework that integrates economic and environmental data to provide a more comprehensive and multipurpose view of the interrelationships between the economy and the environment and the stocks and changes in stocks of environmental assets, as they bring benefits to humanity. It contains the internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics and accounts. The SEEA framework follows a similar accounting structure as the System of National Accounts (SNA). The framework uses concepts, definitions and classifications consistent with the SNA in order to facilitate the integration of environmental and economic statistics.[2]

latter focuses on ecosystems as assets and the associated flows of ecosystem services as inputs into the economy and human activity.

The two SEEA standards are complementary perspectives of the environmental contributions to the economy, and there is some overlap between the two approaches (Figure 5).

Natural Capital Accounting (NCA)

NCA has yielded several different assessment and accounting frameworks aimed at the integration of natural capital into corporate decision-making. In NCA, the primary focus is individual organisations, or a subset of the organisation, and the scale typically ranges from local to regional.

Despite the differences in focus between EEA and NCA, there is a growing body of evidence that supports the theory that many of the core statistical principles contained within SEEA are readily adapted to corporate applications (Stewart and O'Grady 2020, Ogilvy et al. 2022).

There are now several organisations starting to release natural capital reports based on principles and guidance contained within the SEEA statistical standard and presenting the natural capital information in a manner similar to general-purpose financial reports (Forico 2020, BHP 2023). Ultimately, the ambition of NCA is full integration of the organisation's environmental and financial transactions.

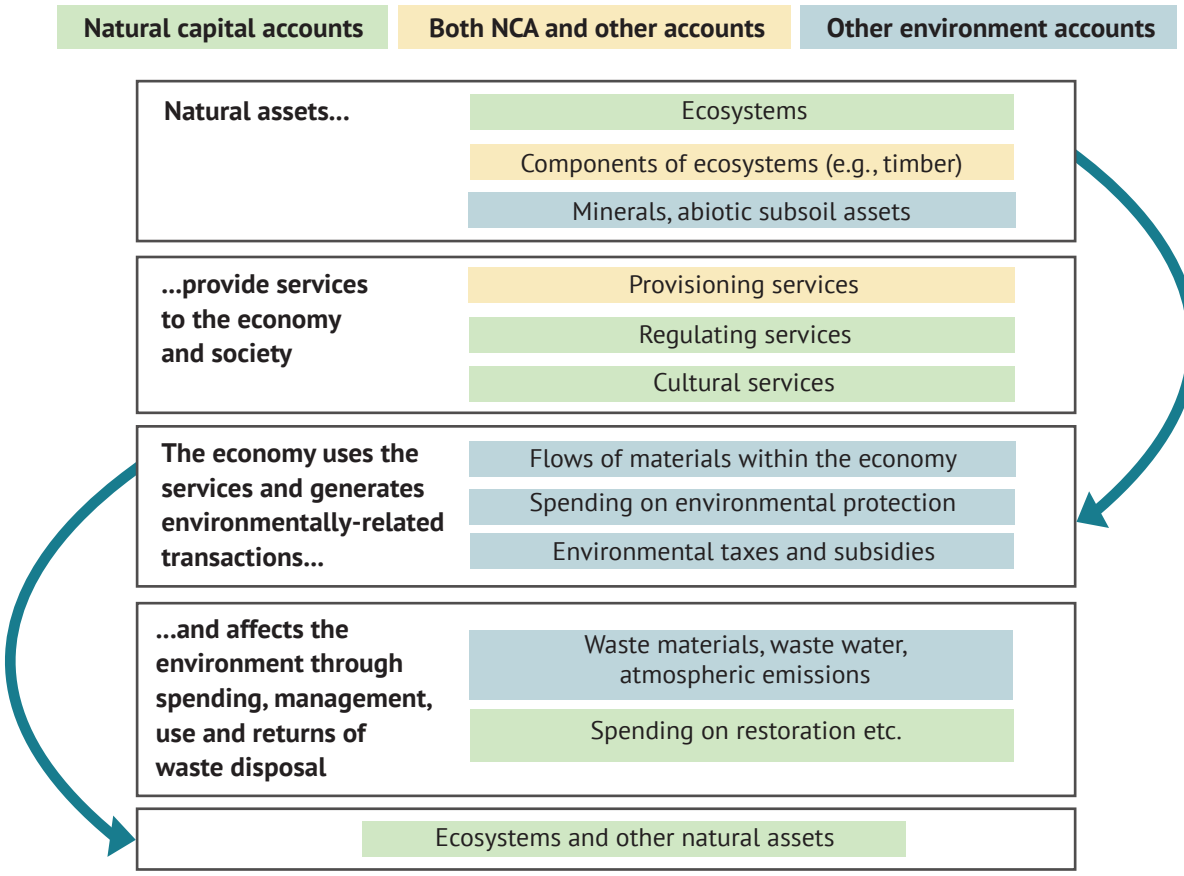


Figure 5 The relationships between ecosystems assets and environmental resources in environmental accounts (Adapted from Office for National Statistics 2017, Figure 2.)

[2] https://seea.un.org/

1.6 GENERALISED PROCESS FOR NATURAL CAPITAL ASSESSMENTS AND ACCOUNTS

Frameworks for natural capital assessments generally share similar characteristics. For example, the Natural Capital Protocol (Capitals Coalition 2016) provides a nine-step framework for conducting natural capital assessments based on the four building blocks of Frame, Scope, Measure and Value, and Apply. The Natural Capital Finance Alliance adapts the Natural Capital Protocol specifically to natural capital-related financial risk assessments. Similarly, the World Business Council for Sustainable Development lays out six building blocks for a Nature Positive business; Assess and prioritise, Commit, Measure and value, Act, Transform and disclose, and Report (WBCSD 2021). Regardless of the framework, the important characteristics of all natural capital assessments include (Figure 6):

- **Frame:** What are the internal and external business drivers?
- **Scope:** What is the purpose of the exercise? What aspects of natural capital are material to the business? What are the spatial and temporal boundaries of concern? Who are the target stakeholders? Define the relevant baselines and targets. Identify valuation approaches.
- **Measure and Value:** Collect and analyse relevant data, identify appropriate indicators on natural capital impacts, dependencies, risks and opportunities, ecosystem extent, ecosystem condition, and ecosystem services.
- **Apply, Assess and Act:** Measure performance against targets, identify strategies to address risks and opportunities, and implement.
- **Report and disclose:** Disclose and report environmental performance alongside financial performance.

1.7 KEY RESOURCES AND FURTHER READING

Capitals Coalition (2016). Natural Capital Protocol. https://naturalcapitalcoalition.org/wp-content/uploads/2018/05/NCC_Protocol_WEB_2016-07-12-1.pdf, accessed 21 April 2023

United Nations (2014). *System of Environmental and Economic Accounting 2012-Central Framework*. New York

United Nations (2021). *System of Environmental-Economic Accounting-Ecosystem Accounting (final draft)*. Department of Economic and Social Affairs-Statistics Division. https://seea.un.org/sites/seea.un.org/files/seea_eea_final_en_1.pdf, accessed 21 April 2023

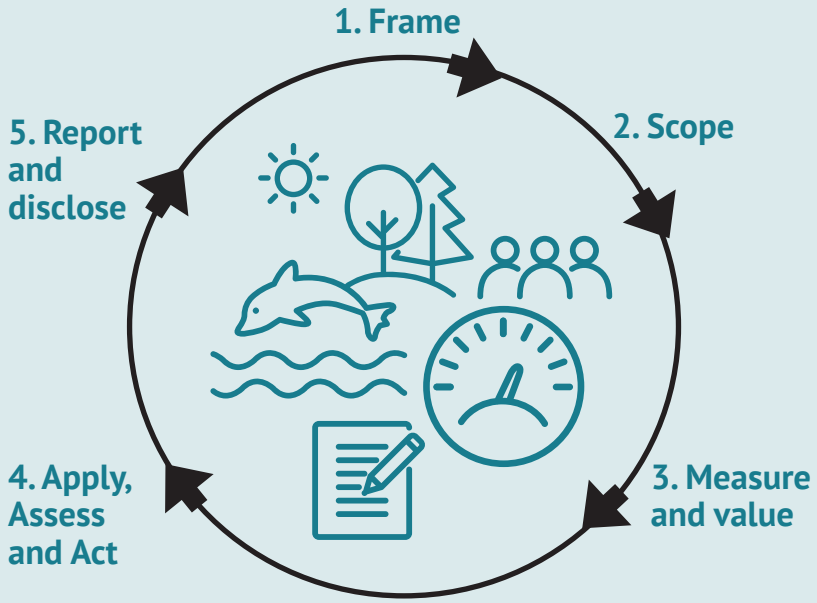


Figure 6 Generic process for natural capital assessment and accounting exercises

Part 2: Natural capital assessment and accounts for managerial purposes

PART 2

Natural capital assessment and accounts for managerial purposes

COMPILING RELEVANT AND MATERIAL NATURAL CAPITAL INFORMATION

Purpose:

This section of the guidance material unpacks the process of compiling relevant and material natural capital information for managerial purposes. It does not seek to replicate existing guidance, e.g., System of Environmental and Economic Accounting, rather, it provides an overview and examples of natural capital information relevant to the resources sector, with an emphasis on the ecosystem accounting approach outlined in SEEA-EA.

2 NATURAL CAPITAL ASSESSMENT AND ACCOUNTING FOR MANAGEMENT PURPOSES

The primary purpose of natural capital assessment and accounting for management purposes is to provide timely and useful information to the organisation's managers to facilitate organisational decision-making. As such, management-focused natural capital assessments and accounts should (Office for National Statistics 2017):

- monitor gains and losses in natural capital over time.
- identify priority areas for investment and inform resourcing and management decisions.
- highlight linkages between the organisation's activities and pressures on natural capital.

Natural capital accounting and assessment for management purposes facilitates decision-making in areas such as forecasting, planning and control, resource allocation, budgeting, and asset protection. It assists managers with internal performance evaluation and communication, as well as the evaluation of external effects, and developing policies for the achievement of objectives (IASB 2018a, Tuovila 2022, CIMA 2023, Tamplin 2023).

The collection and internal reporting of information regarding an organisation's natural capital risks, opportunities, impacts and dependencies, as well as enhancements and degradation of natural capital under its control, can facilitate organisational decision-making and evaluation regarding its environmental performance, but also provide additional information to support financial decision-making.

Natural capital assessments and accounts can be used to inform how organisations manage their operations, configure their supply chains, identify strategic risks and opportunities, and make investment decisions.

2.1 NATURAL CAPITAL REGISTERS AND ACCOUNTS FOR MANAGEMENT PURPOSES

Natural capital assessments and accounts for management purposes can be conceptualised as an information system that provides data, records, statements and reports to monitor the state of natural capital and the value of the benefits it supports (eftec 2015). The compilation and design of this information system should be tailored to meet organisational requirements, strategies and associated targets and goals. A conceptualisation of the natural capital information system outlining the required registers and schedules is shown in Figure 7.

Within this framing, natural capital accounts for management purposes are primarily focused on linking existing organisational information systems, such as the environmental management systems and the accounting and financial systems, to support a set of natural capital registers and schedules that facilitate broader adoption of natural capital accounting and assessment within an organisation.

These include:

- Natural capital assessment registers:
  - Impact and dependency registers
  - Risk and opportunity register
- Natural capital stock accounts:
  - Natural capital asset register
    - Ecosystem extent account
    - Ecosystem condition account
  - Environmental asset account
  - Natural capital monetary asset account
  - Natural capital obligation account
- Natural capital flow accounts:
  - Natural capital physical flow account
  - Natural capital monetary flow account

2.2 NATURAL CAPITAL ASSESSMENTS FOR MANAGEMENT PURPOSES (IMPACTS, DEPENDENCIES, RISK AND OPPORTUNITIES ASSESSMENT)

The following provides only a brief outline of natural capital assessment. Users should consult and be familiar with frameworks such as Natural Capital Protocol for further details. Most natural capital assessments follow a relatively similar process of (Capitals Coalition 2016):

- framing and scoping the assessment.
- identifying impacts and dependencies.
- assessing their materiality.
- measuring and valuing the impacts and dependencies.
- using this information to improve the stewardship of natural capital.

The TCFD and TNFD are two prominent examples of initiatives that fall within the scope of a natural capital assessment. Both seek to encourage broader disclosure of climate and nature-related impacts and dependencies and aim to improve the consistency of that disclosure regime through recommended reporting of metrics and indicators.

The generalised process for the development of a natural capital assessment is shown in Figure 8.

The core natural capital assessment registers to be maintained for management purposes are:

- Natural capital materiality assessment: section 2.2.1.
- Natural capital impact and dependency register: section 2.2.2.
- Natural capital risk and opportunity register: section 2.2.3.

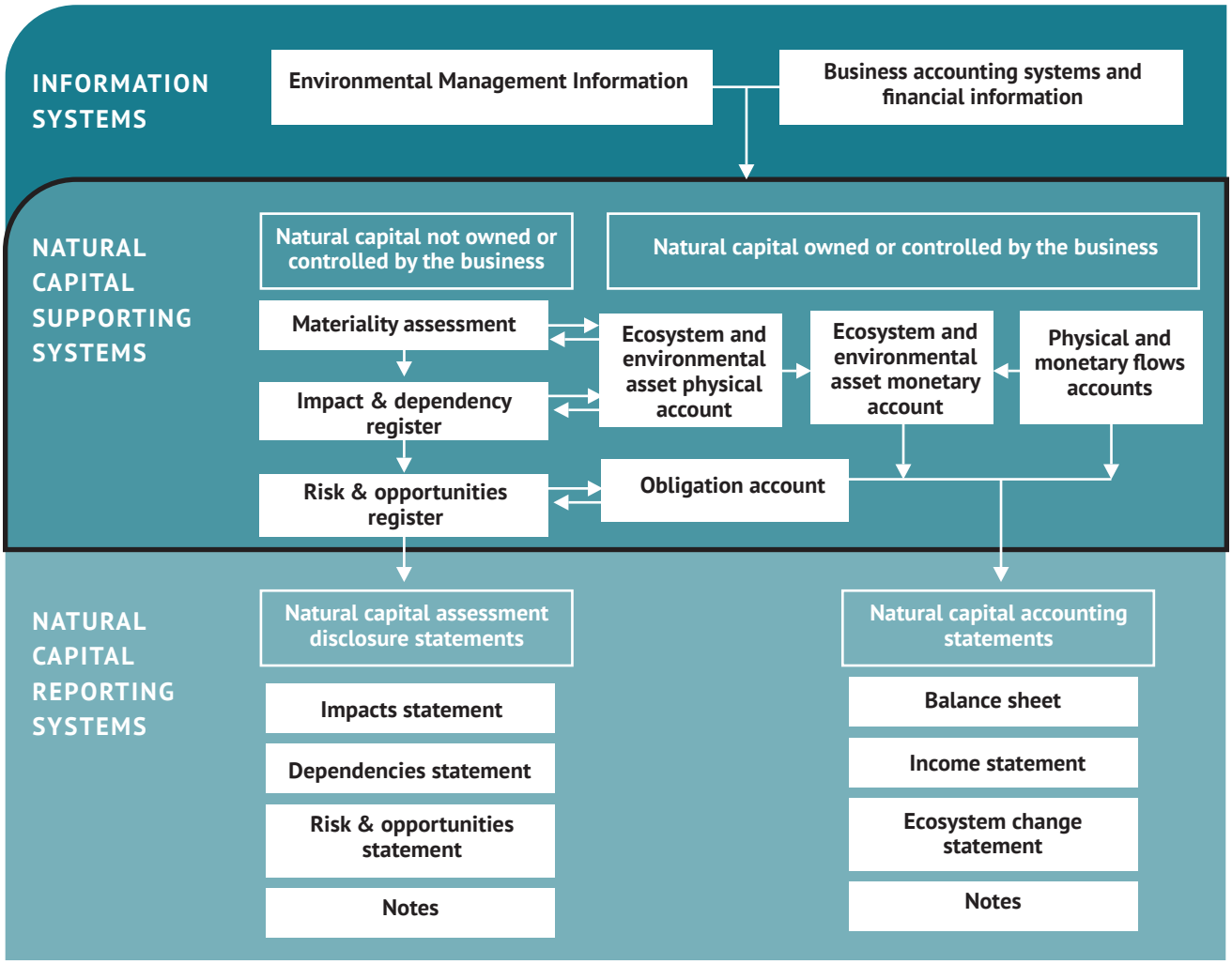


Figure 7 Conceptualisation of natural capital assessment and accounting (black box highlights the focus for management purposes). Adapted from eftec (2015)

STEP 1
Develop natural capital impacts, dependency and risk and opportunities registers

- identify impacts and dependencies
- assess materiality
- assess risk and opportunities
- act to mitigate risks, systems wide implementation of the mitigation hierarchy
- explore opportunities to transform practice and process

STEP 2
Develop natural capital impacts, dependency and risk and opportunities statements for external audience

- impacts and dependencies aligned to reporting standards
- metrics against targets
- disclose key risks and opportunities to address nature impacts

STEP 3
Incorporate into annual reporting statements

- annual reports
- sustainability report
- general purpose natural capital report

Figure 8 Natural capital assessment, impacts and dependencies, risks and opportunities and general disclosure (Adapted from Smith et al. 2023)

2.2.1 NATURAL CAPITAL MATERIALITY ASSESSMENT

A natural capital materiality assessment is "the process that involves identifying what is (or is potentially) material in relation to the natural capital assessment's objective and application" (Natural Capital Coalition, 2016, p. 43). It aims to develop a deep understanding of an organisation's impacts and dependencies on nature and to help identify the risks and opportunities associated with those impacts and dependencies.

Frame

A materiality assessment is designed to help an organisation decide what natural capital information is relevant to internal decision-making and what should be disclosed to the organisation's stakeholders. It can help an organisation prioritise its natural capital impacts and dependencies and identify natural capital risks and opportunities.

Scope

Depending on the purpose of the assessment, the natural capital materiality assessment should consider impacts and dependencies that may fall outside of the direct physical footprint of the organisation, i.e., to natural capital that is not owned or controlled by the organisation. In doing so, the organisation must also consider upstream and downstream impacts and dependencies. These 'scopes' are summarised in Table 5 and the key drivers of nature loss including changing land use and sea use, direct exploitation of nature, climate change, pollution and invasive species.

Measure and value

Additional guidance on a natural capital materiality assessment is provided in the TNFD (A4 of the "Assess" pillar) and this approach is closely aligned with the materiality assessment process outlined in step 4 of the Natural Capital Protocol (Capitals Coalition 2016):

- List the potentially material natural capital impacts and or dependencies.
- Identify criteria for your materiality assessment.
- Gather relevant information.
- Complete the materiality assessment.

A natural capital materiality assessment is likely to vary among organisations and standards on what should be disclosed are beginning to emerge. Thus, there is emerging consensus in the natural capital themes that are being disclosed by early adopters. These natural capital themes cover (van der Lugt et al. 2020):

- greenhouse gas emissions.
- energy use.
- water consumption.
- water and air pollution.
- waste generation.
- impacts on biodiversity and ecosystem services due to land use change.

ENCORE[3] provide a global multi-industry online natural capital materiality tool for organisations to begin understanding how they potentially impact and depend on nature and how this might lead to business risks. In addition, Science Based Targets Network[4] (SBTN) have also produced an Excel-based global sectoral materiality tool that includes information on upstream and downstream dependencies and impacts.

2.2.2 NATURAL CAPITAL IMPACT AND DEPENDENCY REGISTER

A natural capital impact and dependency register identifies and records consistent and comparable information on relevant impacts and dependencies on natural capital (whether those natural capital assets are owned/controlled by the organisation, or not).

- Natural capital impacts include negative impacts, such as land degradation, emissions or pollution, and positive impacts, such as carbon sequestration or ecological rehabilitation.
- Natural capital dependencies include any reliance on or use of natural capital, such as reliance on adequate rainfall or groundwater resources, or ecosystem services that are beneficial for the entity. However, an entity may have equally important dependencies on the absence (or relative infrequency) of natural resources, ecosystem disservices or environmental conditions that are harmful for the entity – e.g., an absence of pollutants in groundwater. These can be thought of as 'negative' dependencies.

Frame

The natural capital impact and dependency register provides information for organisations to internally track their natural capital impacts and dependencies over time, allowing trends or environmental performance to be monitored. It also facilitates the production of natural capital impact and dependency disclosure statements. A natural capital impact and dependency register can help an organisation better understand the risks and opportunities associated with their interactions with natural capital and to allocate resources in a manner that more effectively manages their impacts and dependencies on natural capital.

Scope

Natural capital impact and dependency assessments can either be limited in scope to the operations of the organisation or expanded to include those attributable to the organisation through its value chain. Depending on the purpose of the assessment, the organisation may consider impacts and dependencies of their value chain both upstream and downstream (recommended by the TNFD and IFRS S1 and S2). The potential 'scopes' for nature capital assessment are summarised in Table 2 alongside the equivalent carbon emissions scopes.

[3] https://encore.naturalcapital.finance/en
[4] https://sciencebasedtargetsnetwork.org/

Table 2 Scope definitions for carbon emissions and nature
Note: in the TNFD nature scopes, 2 and 3 are combined into Scope 3 upstream and Scope 3 downstream

SCOPE	CARBON EMMISSIONS	NATURE
Scope 1	Emissions released to the atmosphere as a direct result of an activity or series of activities at a facility level (Australian Government 2023)	Impacts and dependencies generated in the area controlled by the entity and other impacts and dependencies caused by the entity in the assessment period (Finance for Biodiversity 2022)
Scope 2	Emissions released to the atmosphere from indirect consumption of an energy commodity, e.g., emissions associated with burning coal for electricity generation (Australian Government 2023)	Impacts and dependencies associated with non-fuel energy (electricity, steam etc.) generation for onsite use including impacts from land use changes, fragmentation etc. (Finance for Biodiversity 2022)
Scope 3	Indirect GHG emissions other than Scope 2 emissions that are generated in the wider economy. They occur as a consequence of the activities of the organisation but from sources that are not owned or controlled by that facility's business (Australian Government 2023)	Upstream impacts and dependencies of the activities which are a consequence of the company but occur from sources not owned or controlled by the company in the upstream supply chain of its activities (Finance for Biodiversity 2022)
		Downstream impacts and dependencies which are a consequence of the activities of the company but arise from sources not owned or controlled by the company or its activities (consumption and waste) (Finance for Biodiversity 2022)

Measure and value

Guidance on how to measure and value natural capital impacts and dependencies is outlined in the TNFD and NCP frameworks, and ISO (2019) provides a standard for the valuation of environmental impacts:

- TNFD [E2] 'ID of dependencies and impacts' / NCP [Step 04] 'Determine the impacts and/or dependencies'.
- TNFD [E3] 'Dependency analysis' / NCP [Step 05 and 06] 'Measure impacts and/or dependencies' and 'Measure changes in the state of capitals'.
- TNFD [E4] 'Impact analysis' / NCP [Step 05 and 06 NCP] 'Measure impacts and/or dependencies' and 'Measure changes in the state of capitals'.

The development of a natural capital impact and dependency register is a five-stage process that involves:

1) Identification and prioritisation of the impacts and dependencies to be included in the natural capital impact and dependency register (this may be part of a natural capital materiality assessment (see the previous section on the natural capital materiality assessments).
2) Consideration of the appropriate qualitative and quantitative indicators and targets to measure each material natural capital impact.
3) Measurement of changes in the selected indicators between the previous and current reporting period and projection of future values where possible.
4) Consideration of the entity's mitigation and adaptation activities for each impact. This may include details such as the timing and costs of undertaking these activities and any monitoring of their effectiveness.
5) Decisions on the summarisation and presentation of the natural capital impact and dependency register.

Generalised structure of a natural capital impact and dependency register:

Examples of impacts and dependency registers are included in the Natural Capital Handbook (Smith et al. 2023). Key characteristics of an impact and dependency register include: a description of the impact or dependency; the location assessed; the qualitative and quantitative indicators and targets used to measure the state of each natural capital impact and dependency.

Notes:

The TNFD notes that impacts and dependencies can be measured in several different ways and each of these might be relevant for indicators included in an impact and dependency register. These are grouped under four broad categories:

- Measuring the activities or outputs caused by the entity that produce impacts (**impact drivers**); Measuring the amount of the relevant abiotic flows, ecosystem services or environmental conditions available to or received by the entity (**dependency availability**).
- Measuring the **state of nature** affected by the entity or the state of nature that provides the above dependencies (e.g., ecosystem condition).
- **Ecosystem service/dependencies:** Measuring the flows of ecosystem services or abiotic flows affected by the entity or those on which it depends.
- Measuring **responses** to any of the above, such as fines imposed by an environmental regulatory, or actions taken to prevent or mitigate impacts, or responses taken to ensure ongoing availability of critical dependencies.

The TNFD also emphasises that indicators should be considered alongside external trends, changes to the state of nature and ecosystem services, and contextual information regarding measurement techniques, limitations and assumptions.

An impact or dependency metric on its own is unlikely to provide sufficient information to understand how significant it is. This requires an understanding of the organisational and environmental context. It is recommended that impact and dependency metrics are recorded and reported together with targets that represent the desired maximum level for negative impacts or dependencies, or the desired minimum level for positive impacts or dependencies.

The basis for these targets (e.g., organisational commitments, regulatory requirements or environmental sensitivity thresholds) should be explained in notes.

2.2.3 NATURAL CAPITAL RISK AND OPPORTUNITY REGISTER

A natural capital risk and opportunity register tracks how the entity identifies, assesses and manages relevant natural capital risks and documents any associated natural capital opportunities. It also allows information to be recorded on how these risks and opportunities are projected to change in the future (e.g., through management changes, climate change or changes in social preferences and regulation).

- Natural capital risks can occur from changes in the availability of natural capital and the ecosystem services on which an organisation depends. Natural capital impacts can also affect the financial position of an organisation, for example, when society responds to natural capital impacts through regulation or changes in consumer acceptance.
- Nature-related opportunities can occur when organisations avoid, reduce, mitigate or manage nature-related risks, or through the strategic transformation of business models, products, services, markets and investments.

Frame

A natural capital risk and opportunity register provides a structured way for organisations to integrate natural capital risk and opportunity management into their decision-making, aligned with the entity's corporate risk assessments. A natural capital risk/opportunity register allows a reporting entity to monitor risks and/or opportunities for internal management purposes. It shows actions aligned with mitigating risks and/or exploiting opportunities. The risk and opportunity register should enable entities to identify and prioritise which natural capital impacts and dependencies could lead to potentially material risks and/or opportunities for the reporting entity.

Scope

A natural capital risk and opportunity register can either be limited in scope to the operations of the entity or expanded to include those attributable to the entity through its value chain. TNFD recommend the risk and opportunity register should be completed for each stage of the value chain (upstream, downstream and direct operations) but where this is not possible, the area of the value chain with the greatest potential dependencies and impacts on nature should be prioritised.

Measure and value

Guidance on how to measure and value natural capital risks and opportunities is outlined in the TNFD frameworks:

- TNFD [A1] 'Risk and Opportunity ID'.
- TNFD [A2] 'Existing risk mitigation and risk and opportunity management'.
- TNFD [A3] 'Additional risk mitigation and risk and opportunity management'.
- TNFD [A4] 'Risk and opportunity materiality assessment'.

The development of a natural risk and opportunity register is a seven-stage process that involves:

1) identification and prioritisation of the risks and opportunities to be included in the natural capital risk and opportunity register using a natural capital materiality assessment (see section 2.1.1).
2) consideration of the appropriate qualitative and quantitative indicators to measure the natural capital risks and opportunities.
3) measurement of changes in the selected indicators.
4) calculation of a natural capital risk materiality rating (see below).
5) documentation of the organisation's current and future mitigation and adaptation activities.
6) calculation of a residual risk materiality rating by adjusting for the adequacy of the organisation's mitigation and adaptation activities.
7) decisions on the summarisation and presentation of the natural capital impact and dependency register.

Natural capital risk materiality

The concept of materiality has been adopted from the field of accounting (Whitehead, 2017, Edgley et al., 2015). Broadly, something is 'material' if it has reasonable potential to significantly alter the decisions being taken by a user of the information being reported.

There are different interpretations of what this means in the context of natural capital risk- or opportunity-related information. At a minimum, in order for natural capital risk/opportunity disclosures to be consistent with the expectations of users of traditional corporate financial reports, entities should report on any natural capital risks or opportunities that have reasonable potential to affect enterprise value. Optionally, entities may also report on natural capital risks or opportunities that have reasonable potential to affect nature or society without affecting enterprise value (this is sometimes termed 'double materiality'). The approach taken to materiality should be disclosed (TNFD, 2023).

Guidance is provided under the "Assess" step A4 in the TNFD's approach (TNFD, 2023). The TNFD recommends nature-related risks and opportunities are assessed through the following components:

- **Magnitude** of risks or opportunities: a qualitative or quantitative assessment of financial impact.
- **Likelihood** of the risk or opportunity.

- **Vulnerability** of the entity, which refers to the susceptibility of an organisation to a risk/opportunity event in terms of its preparedness, agility and adaptability.
- **Speed of onset**, which refers to the time that elapses between the occurrence of an event and the point at which the organisation first feels its effects [e.g., short-term, medium-term or long-term] (TNFD, 2023).
- **Scale (temporal and spatial)** and **severity of impact on nature**.
- The **value of the impact on nature to society**.

Simplified risk materiality ratings can also be used to provide a summary of the understanding of the overall exposure and/or potential financial implications for the organisation of natural capital risks and opportunities. Smith et al. (2023) provide further guidance on how to calculate simple natural capital risk materiality ratings. In this approach, natural capital risks are viewed as being comprised of two key components:

- For impact risks, the degree of impact on nature caused by the reporting entity (which can also be thought of as including the scale and severity of impact on nature), and the severity of consequences for the reporting entity (which can also be thought of as reflecting the value of the impact on nature to society, insofar as society responds to the impact by imposing consequences on the reporting entity, such as fines, regulation, loss of market access, etc.).
- For dependency risks, the degree of dependency of the reporting entity on nature (which can also be thought of as the entity's vulnerability to unavailability of the dependency), and the severity of threats to the future availability of the dependency (which can also be thought of as a combination of the magnitude and likelihood of threats to the natural capital that provides the dependency).

Generalised structure of a natural capital risk and opportunity register:

Key characteristics of a risk and opportunity register include: a description of the risk or opportunity; the type of risk; the location assessed; the timeframe (short, medium or long-term); the qualitative and quantitative indicators used to measure each natural capital risk and opportunity; current and future mitigation and management actions; and risk materiality ratings and any associated opportunities.

Organisations should create a register of risks and opportunities most relevant to their business, and the TNFD provides several example templates (https://framework.tnfd.global/wp-content/uploads/2022/11/22-23032_TNFD_Risk-and-Opportunity-Registers_v2.pdf).

Notes:

Natural capital risks are risks arising from an entity's impacts and/or dependencies on natural capital. The TNFD calls these 'nature-related risks', defined as: "potential threats posed to an organisation linked to their and wider society's dependencies on nature and nature impacts. These can derive from physical, transition and systemic risks." (TNFD, 2023).

- **Nature-related physical risks** are a direct result of an organisation's dependence on nature. Physical risks arise when natural systems are compromised, due to the impact of climatic events (e.g,. extremes of weather such as a drought), geologic events (e.g., seismic events such as an earthquake), events or changes in ecosystem equilibria, such as soil quality or marine ecology, which affect the ecosystem services on which organisations depend.
- **Nature-related transition risks** are risks that result from a misalignment between an organisation's or investor's strategy and management and the changing regulatory, policy or societal landscape in which it operates.
- **Nature-related systemic risks** are risks arising from the breakdown of the entire system, rather than the failure of individual parts.[5]

TNFD recommends that organisations should consider both current and future risks and opportunities. The risk management process should identify long-term risks, as well as short- and medium-term risks (noting that some nature-related risks may have implications beyond the timeframes typically used by organisations).

A recent legal opinion has concluded that nature-related risks are likely to be considered as being foreseeable and that directors of companies have existing fiduciary duties to consider these as part of their broader risk management processes (Hartford-Davis and Bush 2023).

[5] https://framework.tnfd.global/concepts-and-definitions/definitions-of-risks/

2.3 NATURAL CAPITAL INDICATORS AND DISCLOSURE METRICS

The TNFD is moving towards a set of mandated disclosure metrics, with recommendations for additional metrics and sector specific metrics for a more comprehensive approach (TNFD 2023).

While not exhaustive, these provide a framing for some of the issues considered to be material from a nature-related impacts and dependencies perspective.

While these indicators and metrics are intended for disclosure, they are likely to be relevant for internal management purposes and could form a useful starting point for natural capital registers and accounts. Core and additional indicators as proposed by the TNFD and their relationship to the natural capital registers and accounts are presented in Table 3.

Table 3 Relationships between natural capital registers and accounts and proposed core and additional disclosure metrics in the TNFD. Based on the v0.4 TNFD draft beta release

DRIVER	TNFD INDICATOR	CORE/ADDITIONAL METRIC	REGISTER/ACCOUNT
Climate change	Scope 1,2,3 GHG emissions	Core	Impact/dependency register
Land/freshwater/ocean use change	Total extent of land/freshwater/ocean use change	Core	Extent and condition account
	Total spatial footprint	Core	Extent account
	Total extent of land/freshwater/ocean in prioritised ecosystems	Core	Natural capital asset register
	Extent of land/freshwater/ocean use changed that is sustainably managed by ecosystem type and business activity in the relevant time period	Additional	Natural capital asset register
	Extent of land/freshwater/ocean voluntarily conserved or restored by ecosystem type in the relevant time	Additional	Natural capital asset register
	For ecosystem services impacted, measurement on the change in the provision of the service	Additional	Ecosystem services supply and use account (physical)
	For ecosystem services depended on, measurement on the change in the provision of the service	Additional	Ecosystem services supply and use account (physical)
Pollution/pollution removal	Total pollutants released to soil split by type	Core	Impact/dependency register
	Volume of water discharges and concentrations of key pollutants in the wastewater discharge	Core	Impact/dependency register
	Total amount of hazardous waste generated	Core	Impact/dependency register
	Total non-greenhouse gas air pollutants	Core	Impact/dependency register
	Volume of pollutants removed from land, atmosphere, ocean and freshwater	Additional	Impact/dependency register
	Volume of plastic produced/consumed	Additional	Impact/dependency register
	Light and noise pollution	Additional	Impact/dependency register
Resource use / replenishment	Water withdrawal and consumption from areas of water stress	Core	Impact/dependency register
	Total water withdrawal and consumption	Additional	Impact/dependency register
	Volume of water loss mitigated and produced	Additional	Impact/dependency register
	Quantity of natural commodities sourced from priority ecosystems	Core	Ecosystem extent/abiotic flows accounts
	Extent of area that the organisation controls and/or manages that is used for the production of natural commodities from land/ocean/freshwater	Additional	Ecosystems asset register/ Extent and condition account
	Quantity of high-risk commodities sourced under a management or certification programme	Additional	Abiotic flow account
	Quantity of wild species extracted from natural habitats for commercial purposes	Additional	Ecosystem services supply and use account (physical)
Introduction of invasive species and other	Proportion of high-risk activities operated under appropriate measures to prevent unintentional introduction of IAS, or low-risk designed activities	Core (placeholder)	Impact register
	Number/extent of non-purposefully introduced species, varieties or strains in areas owned, operated, used or financed in priority areas	Additional	Impact/dependency register
State of Nature	Quantitative measurement of change to ecosystem condition and extent in priority locations the organisation depends or impacts on	Additional	Ecosystem extent and condition account
	Species Extinction risk	Core (placeholder)	Impact register

2.4 NATURAL CAPITAL ACCOUNTING FOR MANAGEMENT PURPOSES

Natural capital accounts for management purposes are built on a set of core stock and flow accounts.

- Stock account measures relate to a point in time, e.g., total area, total volume.
- Flow account measures relate to a unit of measurement per unit of time, e.g., cubic metres per year. The unit of time that is appropriate will depend on the selected length of the accounting period (United Nations 2021).

A generalised approach to the development of natural capital accounts for management purposes and to support broader disclosure is shown in Figure 9.

Natural capital accounts will support natural capital assessments and provide a deeper understanding of the state of nature under an organisation's stewardship. Core natural capital accounts and registers include:

Natural capital stock accounts for management purposes

- Natural capital asset register: section 2.4.1
- Ecosystem extent account: section 2.4.2
- Ecosystem condition account: section 2.4.3
- Environmental asset account: section 2.4.4
- Natural capital monetary asset account: section 2.4.5
- Natural capital obligation account: section 2.4.6

Natural capital flow accounts for management purposes

- Natural capital physical flow account: section 2.4.7
- Natural capital monetary flow account: section 2.4.8

The following section provides only a brief outline of the core natural capital accounts. Users should consult and be familiar with ecosystem accounting concepts as defined by the United Nations System of Environmental Economic Accounting statistical standards; the Central framework (United Nations 2014) and Ecosystem Accounting (United Nations 2021).

A comprehensive set of stylised example tables of the various ecosystem accounts are provided by SEEA (https://seea.un.org/ecosystem-accounting, accessed 26 April 2023). Acknowledging that impact and dependency assessments may surface issues that fall outside the scope of these accounts, the System of Environmental and Economic Accounting also provides for the production of 'thematic accounts' organised around specific materiality issues. These might include, for example:

- greenhouse gas accounts.
- discharge or production of pollutants.
- additional information on biodiversity.

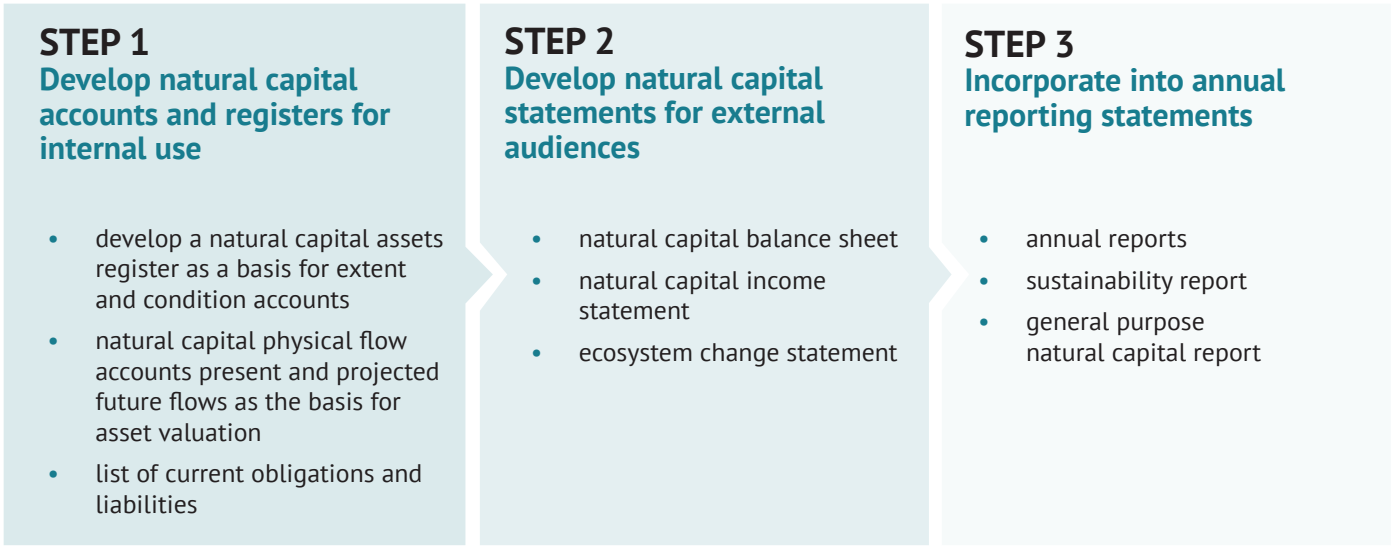


Figure 9 Natural capital accounts and statements for management and disclosure (Adapted from Smith et al. 2023)

2.4.1 NATURAL CAPITAL ASSET REGISTER

- The natural capital asset register is a foundation register for any organisation looking to implement NCA. The natural capital asset register enables ongoing tracking and monitoring of ecosystem assets within the ecosystem accounting area. Ecosystem assets are defined as contiguous spaces of a specific ecosystem type characterised by a distinct set of biotic and abiotic components and their interactions. Although ecosystem assets are spatially explicit, it should be noted that impacts and dependencies may extend beyond the boundaries of individual ecosystem assets. Furthermore, ecosystem assets are not restricted to ecosystems in a relatively natural state; highly modified ecosystems may also be delineated as ecosystem assets.
- Individual environmental assets comprise mineral and energy resources, land, soil resources, timber resources, aquatic resources, other biological resources and water resources. These assets are defined by their material content (e.g., the volume of timber or soil resources) without specific reference to their constituent elements (such as the carbon in timber and nutrients in soil resources) or to the ecosystem within which they are located. This focus reflects the material benefits from the direct use of environmental assets as natural inputs for the economy by enterprises and households.

Frame

A natural capital asset register is a comprehensive list of all the individual ecosystem and environmental assets in the ecosystem accounting area. Typically, an asset register would record attributes relevant to the management of the asset including location, type, extent, relevant management information, land use and condition. Its basic function is to give the organisation detailed information about each environmental and ecosystem asset under its management. The natural capital asset register provides the foundation of NCA.

Scope

The natural capital asset register should encompass all the ecosystem and environmental assets within the ecosystem accounting area.

Measure and value

Guidance on natural capital asset registers is outlined in the SEEA-EA Section 3.

The development of a natural capital asset register is a two-stage process that involves:

1) identification of all relevant ecosystem and environmental assets.
2) decisions on the summarisation and presentation of all relevant ecosystem assets and environmental assets in the natural capital asset register.

Generalised structure of an ecosystem asset register:

There is no defined approach for the development of the natural capital asset register. Ecosystem assets are spatially explicit and the maintenance of relevant spatial data in an appropriately maintained spatial database should facilitate the production of accounts derived from these data by the regular updating of accounts between accounting periods.

2.4.2 ECOSYSTEM ASSET EXTENT ACCOUNT

An ecosystem extent account measures changes in the stock of ecosystem assets over an accounting period. Ecosystem extent is "the spatial area of an ecosystem asset" (United Nations 2021 p. 27). Although usually measured in a two-dimensional area, ecosystem assets may be measured in one dimension (e.g., stream length) or three dimensions (e.g., water body volume).

Frame

Ecosystem extent accounts record the changes in spatial extent of ecosystem assets during the accounting period, aggregated to ecosystem types (United Nations 2021). A well-designed ecosystem extent account provides users of the account information on the key drivers of change (additions/reductions) in the stock of ecosystem assets. An ecosystem's asset extent is a factor in determining its capacity to provide flows of ecosystem services.

Scope

An ecosystem extent account is compiled for the total area of an ecosystem accounting area during a defined accounting period, e.g., one, two or five years (United Nations 2021).

Measure and value

Guidance on ecosystem extent accounts is outlined in the SEEA-EA, Section 4.

The development of an ecosystem extent account is a three-stage process that involves:

1) consideration of ecosystem classification systems to use. Using the IUCN Global Ecosystem Typology (IUCN GET), adopted by SEEA-EA, may promote comparability to other natural capital accounts. However, an organisation may wish to use more industry-relevant classifications.
2) measurement of an opening and closing ecosystem extent: the size of each ecosystem asset in terms of spatial area.
3) decisions on the summarisation and presentation of the ecosystem extent account.

Table 4 A worked example of a ecosystem extent account for the Beenup pilot accounts
Source: (BHP 2023), data are the ecosystem extent accounts for scenario 2, which is the operational mining phase of the project

REALM	TERRESTRIAL			FRESHWATER/TERRESTRIAL			
	T2 Temperate-boreal forests and woodlands		T8 Anthropogenic terrestrial systems*	TF1 Palustrine Wetlands			
Selected Ecosystem Functional Group	Temperate pyric sclerophyll forests and woodlands	Temperate pyric sclerophyll forests and woodlands	Locally native vegetation cover	Seasonal freshwater slopes	Seasonal freshwater basins	Seasonal freshwater plains	Seasonal freshwater plains (Endangered)
	T2.6	T2.6	T8.1	TF1.10**	TF1.8**	TF1.9**	TF1.9**
GEOMORPHIC UNITS (ha)	Dryland Plains	Dunes	Native Cover (MDSA)	Paluslopes	Sumplands	Palusplains	Ironstone Palusplains
OPENING EXTENT (Jul 1991) (ha)	86	28	0	60	27	13	45
ADDITIONS TO ECOSYSTEM EXTENT (ha)							
Managed expansion	0	0	0	0	0	0	0
Unmanaged expansion	0	0	0	0	0	0	0
REDUCTION TO ECOSYSTEM EXTENT (ha)							
Managed reduction	(58)	(20)	0	(54)	(19)	(10)	(38)
Unmanaged reduction	0	0	0	0	0	0	0
NET CHANGE IN ECOSYSTEM EXTENT (ADDITIONS - REDUCTION)	(58)	(20)	0	(54)	(19)	(10)	(38)
CLOSING EXTENT (Jun 1999) (ha)	28	8	0	6	8	4	7

*The T8 category is new and proposed to include the rehabilitated MDSA and waste dumps and similar manmade structures typical of other mines (not captured by existing classes)

**TF 1.8, 1.9, 1.10 are proposed to capture the diversity of wetland types (not captured by existing classes) and align with the global geomorphic wetland classification system.

Generalised structure of an ecosystem extent account:

The extent account summarises key information about the stocks of ecosystem assets under management. Key characteristics of an extent account include an opening balance, additions and reductions to ecosystem assets driven by changes in, for example, ownership, or conversion, and a closing balance at the end of the accounting period.

The total extent recorded in the ecosystem extent account should be equivalent to the ecosystem accounting area, thus additions or reductions in ecosystem extent should be matched with appropriate reductions or additions to other ecosystem assets.

The generalised form of an ecosystem extent account is shown in Table 4.1 of United Nations (2021), p. 76. An example of an ecosystem extent account from the BHP Beenup pilot is shown in Table 4. In this table, the extent of ecosystem assets within the ecosystem accounting area is summarised according to ecosystem type and changes in the stocks of ecosystem assets are recorded during the accounting period.

Notes:

The SEEA-EA recommends that ecosystem assets are aggregated to ecosystem types following the IUCN's Global Ecosystem Typology (Keith et al. 2020) but acknowledges that other ecosystem classifications may be more useful.

Australia does not have a nationally consistent ecosystem typology, which may be problematic where organisations have operations that span several Australian States and Territories and are looking to compile and disclose natural capital information at an organisational level.

Use of localised ecosystem typologies is acceptable, but

FRESHWATER		TOTAL NATIVE ECOSYSTEMS	TERRESTRIAL				TOTAL NON-NATIVE ECOSYSTEMS
F1 Rivers and Streams	F3 Artificial Wetlands		T7 Intensive land use systems				
Seasonal lowland rivers (streams)	Constructed lacustrine wetlands – Beaches and permanent lakes		Sown pastures and fields	Sown pastures and fields (Irrigated)	Plantations	Urban and Industrial Systems	
F1.5	F3.2		T7.2	T7.2	T7.3	T7.4	
Channels	Lakes/pools (including beaches)		Modified (Pasture) (ha)	Modified (Irrigated Pasture) (ha)	Modified (Plantation)	Artificial Surfaces & Associated Areas (ha)	
73	0	**332**	354	0	2	6	**361**
0	0	**0**	0	0	0	333	**333**
0	0	**0**	0	0	0	0	**0**
(37)	0	**(234)**	(97)	0	(1)	0	**(98)**
0	0	**0**	0	0	0	0	**0**
(37)	0	**(234)**	(97)	0	(1)	333	**235**
36	0	**98**	257	0	1	339	**596**

efforts should be made to adopt consistent approaches to ecosystem classification across the organisation's ecosystem assets.

2.4.3 ECOSYSTEM ASSET CONDITION ACCOUNT

Ecosystem condition is a central feature of ecosystem accounting. Ecosystem condition is the quality of an ecosystem measured in terms of its abiotic and biotic characteristics (United Nations 2021). The ecosystem condition account summarises relevant variables and indicators that describe the state of the ecosystem asset under consideration and changes in those metrics and indicators over the accounting period.

Assessment of ecosystem condition is probably one of the most challenging aspects of natural capital accounting (Czúcz et al. 2021) as ecosystem condition cannot be simply measured and usually requires compiling data on several ecosystem variables and indicators.

An ecosystem condition assessment considers metrics and variables related to its structure, function and composition. The process of variable and indicator selection will be dependent on identification of relevant data availability, but ecosystem condition accounts should support existing monitoring programs and the selection of variables and indicators should be focused metrics that show directional change over time (United Nations 2021). Key criteria for the selection of ecosystem characteristics and associated metrics are shown in Table 5.

The United Nations (2021) recommends that data related to ecosystem characteristics be organised following a standardised ecosystem condition typology. The typology's purpose is to organise ecosystem characteristics in a meaningful way, to provide a template

Table 5 Selection criteria for ecosystem characteristics and associated variables and indicators

CRITERION	SHORT DESCRIPTION
Conceptual criteria	
Intrinsic relevance	Characteristics and metrics should reflect the existing scientific understanding of ecosystem integrity, supported by appropriate literature
Instrumental relevance	Characteristics and metrics should be related to the availability of ecosystem services (characteristics that exert the strongest influence on the highest priority services should be favoured)
Directional meaning	Characteristics and metrics need to have potential for a consensual interpretation, i.e. it should be clear if a change is favourable or unfavourable with respect to ecosystem integrity
Sensitivity to human influence	Characteristics and metrics should be responsive to known socio-ecological leverage points (key pressures, management options)
Framework conformity	Characteristics and metrics should be differentiated from other components of the SEEA ecosystem accounting framework
Practical criteria	
Validity	Metrics should represent the characteristics they address in a credible and unbiased way
Reliability	Metrics need to be accurate, reliable and reproducible with potential sources of error explored and documented
Availability	Metrics covering the studied spatial and temporal extent with the required resolution need to be achievable in terms of the resources and time available
Simplicity	Metrics should be as simple as possible
Compatibility	The same characteristics should be measured with the same (compatible) metrics in different ecosystem types and/or different ecosystem accounting areas
Ensemble criteria (for the whole set of variables and indicators)	
Comprehensiveness	The final set of metrics, as a whole, should cover all of the relevant characteristics of the ecosystem, providing a complementary set of measures
Parsimony	The final set of ecosystem condition metrics should be free of redundant (correlated) variables

Table 6 The ecosystem condition typology (ECT) (United Nations 2021)
Source: United Nations (2021) Table 5.1, page 90

CRITERION	ECT GROUPS AND CLASSES
Group A: Abiotic ecosystem characteristics	
Class A1: Physical state characteristics:	Physical descriptors of the abiotic components of the ecosystem (e.g. soil structure, water availability)
Class A2: Chemical state characteristics:	Chemical composition if abiotic ecosystem compartments (e.g. soil nutrient levels, water quality, air pollutant concentrations
Group B: Biotic ecosystem characteristics	
Class B1: compositional state characteristics:	Composition/diversity of ecological communities at a given location and time (e.g. presence abundance of key species, diversity of relevant species groups).
Class B2: Structural state characteristics:	Aggregate properties (e.g. mass, density) of the whole ecosystem or its main biotic components (e.g. total biomass, canopy coverage, annual maximum normalised difference vegetation index (NDVI)).
Class B3: Functional state characteristics:	Summary statistics (e.g. frequency, intensity) of the biological, chemical and physical interactions between the main ecosystem compartments (e.g. primary productivity, community age, disturbance frequency).
Group C: Landscape level characteristics	
Class C1: Landscape and seascape characteristics:	Metrics describing mosaics of ecosystem types at coarse (landscape, seascape) spatial scales (e.g. landscape diversity, connectivity, fragmentation).

for variable and indicator selection and to provide a structure for the aggregation of ecosystem condition data.

The organisation of ecosystem condition data according to the suggested typology (Table 6) is designed to support comparability between ecosystem condition assessments, noting that interpretation of condition variables and indicators between ecosystem types can be problematic or, in some cases, may not be appropriate.

Frame

The primary purpose of an ecosystem condition account is to provide information on the directional changes in the characteristics of ecosystem assets during the accounting period (United Nations 2021). Ecosystem condition accounts provide information for tracking trends in the condition of ecosystem assets and should facilitate understanding the outcomes of management activities. An ecosystem's asset's condition is a factor in determining its capacity to provide flows of ecosystem services.

Scope

As for ecosystem extent, the basic accounting unit is the ecosystem asset. Ecosystem condition accounts summarise metrics and indicators related to the biotic, abiotic and landscape characteristics of ecosystem assets (United Nations 2021). Resourcing and time constraints are likely to constrain the assessment of ecosystem condition for each individual asset and sampling programs should be designed to provide a representative condition assessment of all the ecosystem assets within the ecosystem accounting area, or to provide relevant and useful information on the assets of particular concern.

Measure and value

Guidance on ecosystem condition accounts is outlined in the SEEA-EA, Section 5.

The development of an ecosystem condition account is a five-stage process that involves:

1) selection of relevant ecosystem condition variables.
2) identification of relevant baseline, reference conditions or management objectives for selected variables and indicators.
3) calculation of appropriate ecosystem condition indicators.
4) measurement of changes in the ecosystem condition indicators over the accounting period.
5) decisions on the summarisation and presentation of the condition account.

Generalised structure of ecosystem condition accounts:

The generalised structure for an ecosystem condition variable account, for an individual ecosystem asset or ecosystem type, is shown in Table 5.2 (United Nations 2021, pg. 93), and for ecosystem condition indicators in Table 5.4 (United Nations 2021, pg. 99).

The tables record changes in variables or indicators during the accounting period. Variables and indicators presented in Table 15 and Table 16 are neutral with respect to the relative importance of the individual values and, as such, cannot be interpreted as being high, medium or low. The focus of this presentation is the monitoring and reporting of relevant variables over time.

Organisation of ecosystem condition variables and indicators in this manner provides an approach for organising and reporting ecosystem characteristics for a specific ecosystem type. In many cases, an organisation will manage a range of ecosystem types and it may be important to present condition accounts for a range of ecosystem types. An example of an ecosystem condition account for the BHP Beenup pilot is shown in Table 9.

This table demonstrates how ecosystem condition variables and indicators might be summarised for the ecosystem accounting area for ecosystem types in a manner that is consistent with ecosystem extent.

Notes:

Condition of underlying assets is not normally accounted for in existing financial accounting practices, although measurement of and assumptions about an asset's condition are routine and assumed to be represented in the market price of the asset. Ecosystems rarely have an explicit market price, thus inclusion of condition accounts is considered to be an important extension of current accounting approaches (United Nations 2021).

The choice of ecosystem condition variables and indicators is likely to vary between ecotypes and for ecosystem services (see comment on instrumental relevance in Table 13). For example, the variables and indicators required to describe the capacity of an ecosystem to support biodiversity-related ecosystem services (e.g., pest and disease control) may be very different from the variables and indicators required to assess the condition of an ecosystem primarily focused on the growth of forage for livestock production.

Information on the condition of ecosystem assets should be recorded in the natural capital asset register.

There is not currently a nationally consistent approach to the assessment of ecosystem condition. Nor is there a nationally agreed set of ecosystem condition variables and indicators with defined ranges and benchmarks. Best practice in ecosystem accounting relies on measures of condition being expressed relative to an ecosystem's reference condition.

This reference condition is indicative of ecosystems with high ecological integrity and relatively little anthropogenic disturbance. In this framing, an ecosystem asset may have a low condition score but still provide important ecosystems services. For example, the ecological condition of a field managed predominately for fodder production may be relatively low, but its capacity to produce fodder may be high (high perennial cover etc.).

This distinction, i.e., condition relative to purpose, can create significant confusion in condition assessments and it is therefore important to define how condition is being measured and for what purpose.

It is also important to note, the reference condition (or state) provides a measurement reference point or baseline but may not necessarily be indicative of an organisation's target or management objective for the ecosystem asset being considered. The latter may be set

by processes governed by relevant legislation or through community engagement processes.

The choice of ecological integrity as the baseline enables consistency in reporting moving forward. However, in many cases, it will be neither desirable nor achievable to return an ecosystem to reference condition. Condition assessment should focus on clearly identifying appropriate reference baselines and fully consider relevant management objectives, indicators and targets. Many states have existing field-based approaches to the assessment of ecosystem condition, and these are largely focused on the ecosystems in a relatively natural state (e.g., Victoria's Habitat hectares assessment[6]). Some ecosystem condition assessment methodologies, e.g., Queensland's Biocondition framework (Eyre et al. 2015), have benchmarks for regional ecosystems.

Exactly how ecosystem condition is estimated is not dictated by the SEEA-EA. SEEA-EA is focussed on the compilation and presentation of indicators of ecosystem condition. The utility of its estimation should be the primary driver for its estimation.

Two broad approaches to the normative expression of ecosystem condition are emerging in Australia. Both are broadly consistent with the (United Nations 2021) approach for ecosystem condition accounting and allow for considerable flexibility in their implementation:

- Measuring the similarity of the ecosystem asset under consideration to its reference or historical state (e.g., The Environmental Condition Index-ECond, Butler 2020).
- Assigning a 'state' based on the ecosystem characteristics via the application of State and Transition models (Richards et al. 2020, Ogilvy et al. 2022).

An example of an ecosystem 'state' accounting table is shown in Table 7. In this presentation, ecosystem state is expressed nominally as 'Good', 'Fair' or 'Poor' enabling accounting for changes in the extent (stock) of ecosystems in a given condition and mirroring the ecosystem extent presentation.

Table 7 A worked example of a normalised ecosystem condition account

Source: BHP (2023), data are the ecosystem condition accounts for Scenario 2, which is the operational mining phase of the project. Data represent the ha of each ecosystem type in good, fair, poor condition.

REALM		TERRESTRIAL			FRESHWATER/TERRESTRIAL			
		T2 Temperate-boreal forests and woodlands		T8 Anthropogenic terrestrial systems*	TF1 Palustrine Wetlands			
	Selected Ecosystem Functional Group	Temperate pyric sclerophyll forests and woodlands	Temperate pyric sclerophyll forests and woodlands	Locally native vegetation cover	Seasonal freshwater slopes	Seasonal freshwater basins	Seasonal freshwater plains	Seasonal freshwater plains (Endangered)
		T2.6	T2.6	T8.1	TF1.10**	TF1.8**	TF1.9**	TF1.9**
GEOMORPHIC UNITS (ha)		Dryland Plains	Dunes	Native Cover (MDSA)	Paluslopes	Sumplands	Palusplains	Ironstone Palusplains
OPENING EXTENT	Good	0	37.29	0	0	28.32	123.18	147.72
	Fair	22.72	15.27	0	59.03	0	8.34	0
	Poor	0	0	0	0	0	0	0
Increases	Good	40.67	37		38.61	2.23		11.7
	Fair	3				8		7
	Poor							
Decreases	Good					28.35	67.12	36.45
	Fair		6.8		52.6		2.64	
	Poor							
Closing extent	Good	40.67	74.29	0	38.61	2.2	56.06	122.97
	Fair	25.72	8.47	0	6.43	8	5.7	7
	Poor	0	0	0	0	0	0	0

[6] https://www.environment.vic.gov.au/__data/assets/pdf_file/0023/48542/Habitat-Hectare-Assessment-fact-sheet_Feb-2016.pdf

2.4.4 ENVIRONMENTAL ASSET ACCOUNT

An environmental asset account records the opening and closing stock of environmental assets and the changes in the stock of these resources over the accounting period.

The focus of environmental asset accounts is on the individual resources, i.e., without considering the broader context or system in which those resources are located. For example, an environmental asset account would focus on minerals or water resources, whereas ecosystem asset accounts focus on the broader ecosystems that those resources are in and the range of services those ecosystems provide.

Frame

The purpose of accounting for environmental assets is to assess whether current patterns of economic activity are depleting and degrading the available environmental assets. Information from environmental asset accounts can be used to assist in the management of environmental assets, and valuations of natural resources and land can be combined with information about produced and financial assets (United Nations, 2014).

Scope

Generally, asset accounts are compiled for individual types of environmental assets.

Measure and value

Guidance on environmental asset accounts is outlined in the SEEA Central Framework, Section 5.

The development of an environmental asset account is a four-stage process that involves:

1) selection of relevant environmental assets.
2) measurement of an opening and closing environmental asset stock.
3) document changes between the beginning and the end of the accounting period as either additions to the stock or reductions in the stock and, wherever possible, the nature of the addition or reduction.
4) decisions on the summarisation and presentation of the environmental asset account.

The generalised structure of an environmental asset account is shown in Table 8. It starts with the opening stock of environmental assets and ends with the closing stock of environmental assets. In physical terms, the changes between the beginning and the end of the accounting period are recorded as either additions to the stock or reductions in the stock and, wherever possible, the nature of the addition or reduction is recorded.

In monetary terms, the same entries are made but an additional entry is included for the purpose of recording

FRESHWATER		TOTAL NATIVE ECOSYSTEMS	TERRESTRIAL				TOTAL NON-NATIVE ECOSYSTEMS
F1 Rivers and Streams	F3 Artificial Wetlands		T7 Intensive land use systems				
Seasonal lowland rivers (streams)	Constructed lacustrine wetlands – Beaches and permanent lakes		Sown pastures and fields	Sown pastures and fields (Irrigated)	Plantations	Urban and Industrial Systems	
F1.5	F3.2		T7.2	T7.2	T7.3	T7.4	
Channels	Lakes/pools (including beaches)		Modified (Pasture) (ha)	Modified (Irrigated Pasture) (ha)	Modified (Plantation)	Artificial Surfaces & Associated Areas (ha)	
13.31	0	**349.82**	0				**0**
57.32	0	**162.68**	0				**0**
512.5	0	**512.5**	802.29				**802.29**
11.9		**142.11**					**0**
		18					**0**
36.17		**36.17**	82.71				**82.71**
0		**131.92**					**0**
57.32		**119.36**					**0**
		0	0.74				**0.74**
25.21	0	**360.01**	0				**0**
0	0	**61.32**	0				**0**
548.67	0	**548.67**	884.26				**884.26**

Table 8 Generalised environmental asset account and example focused on minerals and energy

OPENING STOCK OF ENVIRONMENTAL ASSETS	TYPE OF MINERAL AND ENERGY RESOURCE (Class A: Commercially recoverable resources)				
	OIL RESOURCES (thousands of barrels)	NATURAL GAS RESOURCES (cubic metres)	COAL AND PEAT RESOURCES (thousands of tonnes)	NON METALLIC MINERALS (tonnes)	METALLIC MINERALS (thousand of tonnes)
Opening stock of minerals and energy resources	800	1200	600	150	60
Additions					
Discoveries					20
Upward reappraisals		200		40	
Reclassifications					
Total additions to stock		200		40	20
Reductions					
Extractions	40	50	60	10	4
Catastrophic losses					
Downward reappraisals			60		
Reclassifications					
Total reductions to stock	40	50	120	10	4
Closing stock of minerals and energy resources	760	1350	480	180	76
Additions to stock					
Growth in stock					
Discoveries of new stock					
Upward reappraisals					
Total additions of stock					
Reduction of stock					
Extractions					
Normal loss of stock					
Catastrophic losses					
Downward reappraisals					
Reclassifications					
Total reductions in stock					
Revaluation of the stock (monetary only)					
Closing stock of environmental assets					

Table 9 Types of environmental assets in the SEEA-CF

Environmental assets in the SEEA-CF	
1	**Mineral and energy resources**
1.1	Oil resources
1.2	Natural gas resources
1.3	Coal and peat resources
1.4	Non-metallic mineral resources (excluding coal and peat)
1.5	Metallic mineral resources
2	**Land**
3	**Soil resources**
4	**Timber resources**
4.1	Cultivated timber resources
4.2	Natural timber resources
5	**Aquatic resources**
5.1	Cultivated acquatic resources
5.2	Natrual aquatic resources
6	**Other biological resources (excluding timber and aquatic resources)**
7	**Water resources**
7.1	Surface water
7.2	Groundwater
7.3	Soil water

the revaluation of the stock of environmental assets. This entry accounts for the changes in the value of assets over an accounting period that are due to movements in the price of the assets.

Notes:

A list of the environmental assets covered by the central framework is shown in Table 9. Classes of environmental assets most likely to be material for the mining industry are denoted in bold. Many of the accounting concepts are similar between the Central Framework and the Ecosystem Accounting framework with the major difference being relation to the conceptualisation of the asset base.

2.4.5 NATURAL CAPITAL MONETARY ASSET ACCOUNT

Frame

The natural capital monetary asset account records the monetary value of all ecosystem assets and environmental assets within an accounting area at the beginning (opening) and at the end (closing) of each accounting period, as well as changes in the value of those assets over the defined accounting period. The natural capital asset account also records changes in the value of the ecosystem asset in response to ecosystem enhancement, ecosystem degradation, ecosystem conversions and revaluations (United Nations 2021).

The approach to valuing both ecosystem and environmental assets follows the guidance for other assets set out in the SNA. As such the preferred approach is to use market values. For many ecosystem and environmental assets however, there are few markets that exist, and several alternative valuation methods can be used. It is recommended that valuation of ecosystem and environment assets be undertaken using the net present value (NPV) approach, which uses estimates of the expected economic benefits that can be attributed to an asset — for example, positive and negative cashflows from the sale of mineral resources are discounted to give them a value in the current period.

Scope

For ecosystem assets, the primary scope for this account is an individual ecosystem asset that is able to be valued as a single entity and reflects the net present value of the bundle of ecosystem services, as recorded in the natural capital flow account (United Nations 2021). Natural capital monetary asset accounts can be compiled for individual ecosystem assets, for all ecosystem assets of a single ecosystem type or for various types of ecosystem accounting areas (United Nations 2021).

For environmental assets, the scope of this account is similar to the physical asset account in that, generally, the asset accounts are compiled for individual types of environmental assets. In monetary terms, there may be interest in aggregating the values of all environmental assets at the beginning and the end of the accounting period.

Measure and value

Guidance on natural capital monetary asset accounts is outlined in the SEEA-EA, Section 10 and SEEA-CF Section 5:

- Detailed guidance on the approach to the valuation of ecosystem assets is outlined in SEEA section 10.3 (United Nations 2021).
- Detailed guidance on the approach to the valuation of environmental assets (for mineral and energy resources) is outlined in SEEA-CF Section 5.5.4.

Here, we focus on ecosystem assets. As each ecosystem asset generates bundles of ecosystem services, each service is valued separately, i.e., the net present value approach is applied at the level of individual ecosystem service and the resultant discounted values aggregated to derive the monetary value of the ecosystem asset (United Nations 2021).

The value of a single ecosystem asset at the end of an accounting period (*VEA*) is given as:

$$VEA_t = \sum_{i=1}^{i=S} \sum_{j=t+1}^{j=t+N} \frac{ES_t^{ij}}{(1+r_j)^{(j-t)}}$$

Where ES_t^{ij} is the value of the ecosystem service *i* in year *j* as expected in period *t* generated by a specific ecosystem asset. *S* is the total number of ecosystem services, r_j the discount rate (in year *j*) and *N* is the lifetime of the asset.

The development of a natural capital monetary asset account is a three-stage process that involves:

1) consideration of the appropriate natural capital asset lifetimes and discount rates.
2) calculation of the net present value of each natural capital asset using the sum of discounted future monetary flows from the natural capital monetary flow account.
3) decisions on the summarisation and presentation of the natural capital monetary asset account.

Generalised structure of a natural capital monetary asset account:

The generalised structure of the natural capital monetary asset account for ecosystem assets is presented in SEEA-EA, table 10.1, pg. 210 (United Nations 2021). The structure of the monetary asset accounts for environmental assets largely parallels the structure of the environmental asset account.

Notes:

Discounting: The selection of a discount rate is required to derive net present value estimates.

For individual environmental assets such as mineral and energy resources, the SEEA Central Framework recommends that for the purpose of alignment with the concept of exchange values in the SNA, it is necessary to use private, market-based discount rates.

For ecosystem assets, the SEEA-EA recommends that private, market-based discount rates should be used for ecosystem services that benefit private economic units, and social discount rates should be used for ecosystem services that benefit wider society. The social discount rates should be based on relevant government guidelines or those commonly used in government decision-making.

2.4.6 NATURAL CAPITAL OBLIGATION SCHEDULE

The natural capital obligation schedule documents the obligations the entity has to restore or rehabilitate ecosystem assets. Natural capital obligations in the obligation schedule have a specific link to the liabilities in the natural capital balance sheet.

This is particularly relevant for the mining sector, with the International Council on Mining and Metals (ICMM) requiring member companies to commit to a nature positive future (ICMM 2024). By tracking their natural capital obligations and recognising them as natural capital liabilities, entities and their stakeholders can easily monitor their progress towards meeting broader nature-positive commitments or objectives.

Frame

The primary purpose of a natural capital obligation schedule is to provide information for tracking the organisation's ecosystem obligations.

Scope

Natural capital obligations are incurred through degradation to the ecosystem assets due to the operating activities of the entity. Degradation to ecosystem assets due to activities beyond the entity's control (e.g., extreme weather events) do not give rise to a natural capital obligation.

Measure and value

The development of a natural capital obligation schedule is a four-stage process that involves:

1) consideration of any natural capital obligations (degradation of ecosystem assets).
2) measurement of the physical quantities of each obligation.
3) estimation of the restoration, rehabilitation or recovery quantities required to meet each obligation.
4) decisions on the summarisation and presentation of the natural capital obligation schedule.

Notes:

It is likely that the financial value of an organisation's obligations to restore or rehabilitate mining and exploration sites is already represented in the financial accounts, and care must be taken to ensure that where natural capital obligations are monetised, this does not result in double counting. The natural capital obligation schedule extends beyond the costs of rehabilitation to recognise the physical quantities of the ecosystem assets degraded.

The loss of nature recorded in the obligation schedule is conceptualised as a natural capital liability in the natural capital balance sheet. This ensures that the loss of nature is tracked and recorded in a manner consistent with the treatment of the nature-related assets and current accounting practice.

However, recognition of 'natural capital liabilities' may also have implications for the financial balance sheet. According to IAS 37 Provisions, Contingent Liabilities and Contingent Assets (International Accounting Standards Board 2022), a liability is "a present obligation of the entity arising from past events, the settlement of which is expected to result in an outflow from the entity of resources embodying economic benefits."

A natural capital liability may lead to a financial liability when the entity recognises it is not able to meet commitments to restore nature agreed to as part of the approval conditions, or in cases where public statements would otherwise lead stakeholders to believe that that the company will act to restore to a certain standard (e.g., a constructive obligation).

Horner et al. (2022) found that where an organisation makes a public statement or has a policy commitment to no net loss of biodiversity, this creates a valid expectation that the company will discharge its responsibilities to achieve this position. The loss of biodiversity or nature and the costs associated with restoration thus give rise to a constructive obligation, which should appear in the financial balance sheet as a provisional liability.

According to IAS 37, the need to recognise a provision arises when (International Accounting Standards Board 2022):

- the entity has a present obligation (legal or constructive) as a result of a past event.
- it is probable that an outflow of resources embodying economic benefits will be required to settle the obligations.
- a reliable estimate can be made of the amount of the obligation.

Horner et al. (2022)'s treatment of commitments to no net loss of biodiversity as a constructive obligation is consistent with recent advice from the IFRS that identifies commitments to offset greenhouse gas emissions as potential constructive obligations (IFRS Foundation 2023).

2.4.7 NATURAL CAPITAL PHYSICAL FLOW ACCOUNT

Natural capital assets supply one or more (bundles of) **ecosystem services** (Table 10). In some cases (in the resources sector, in particular), many of the flows derived from natural capital are **abiotic flows**, i.e., the benefits derived from these flows are not dependent on ecosystem characteristics and are non-renewable.

In NCA, ecosystem services and abiotic flows are recorded as flows between ecosystem assets and economic units. The natural capital physical flow account records those flows over time, to the organisation and (if desired) to society. It includes information on historical actual flows, and a separate schedule could also be used to forecast expected future flows.

Frame

A natural capital physical flow account provides information for tracking ecosystem services flows and abiotic flows from the natural capital assets in the ecosystem accounting area. It underpins valuation of ecosystem services in the monetary flow account that, in

Table 10 Reference list of provisioning, regulating and cultural ecosystem services

SELECTED ECOSYSTEM SERVICES		
Provisioning service	Biomass provisioning	Crop provisioning services
		Grazed biomass provisioning services
		Livestock provisioning services
		Aquaculture provisioning services
		Wood provisioning services
		Wildfish and other natural aquatic biomass provisioning services
	Genetic material services	
	Water supply	
	Other provisioning services	
Regulating and maintenance services	Global climate regulation services	
	Rainfall pattern regulation services	
	Local (micro and meso) climate regulation services	
	Air filtration services	
	Soil quality regulation services	
	Soil and sediment retention services	
	Solid waste remediation services	
	Water purification services	
	Water flow regulation services	
	Flood control services	
	Storm mitigation services	
	Noise attenuation services	
	Pollination services	
	Biological control services	
	Nursery population and habitat maintenance services	
	Other regulating and maintenance services	
Cultural services	Recreation related services	
	Visual amenity services	
	Education, scientific and research services	
	Spiritual, artistic and symbolic services	
	Other cultural services	

turn, provides a key input to the values reported in the natural capital balance sheet and natural capital income statement.

Scope

The measurement scope of a natural capital physical flow account is based on a range of ecosystem services and abiotic flows supplied by natural capital assets in the ecosystem accounting area. In practice, it is unlikely that any organisation would seek to quantify the full range of ecosystem services specified, as they might not be material or there is a lack of data.

Measure and value

Guidance on natural capital physical flow accounts is outlined in the SEEA-EA, Section 8. Additional guidance on physical flow accounts is also available in the British Standard on natural capital accounting for organisations (BSI 8632:2021).

The development of a natural capital physical flow account is a three-stage process that involves:

1) consideration of which ecosystem services and abiotic flows are most material to the organisation, what data exists, and what are the appropriate biophysical units of measurement.
2) measurement of the actual flows of each ecosystem service and abiotic flow in the most relevant biophysical units of measurement. There is also an option to estimate the future flows, where future flows should incorporate any management and natural changes.
3) decisions on the summarisation and presentation of the natural capital physical flow account, including consideration of whether to present as a supply and use table.

Table 11 A worked example of a natural capital physical flow account

REALM		TERRESTRIAL			FRESHWATER/TERRESTRIAL			
		T2 Temperate-boreal forests and woodlands		T8 Anthropogenic terrestrial systems*	TF1 Palustrine Wetlands			
Selected Ecosystem Functional Group		Temperate pyric sclerophyll forests and woodlands	Temperate pyric sclerophyll forests and woodlands	Locally native vegetation cover	Seasonal freshwater slopes	Seasonal freshwater basins	Seasonal freshwater plains	Seasonal freshwater plains (Endangered)
		T2.6	T2.6	T8.1	TF1.10**	TF1.8**	TF1.9**	TF1.9**
GEOMORPHIC UNITS		Dryland Plains	Dunes	Native Cover (MDSA)	Paluslopes	Sumplands	Palusplains	Ironstone Palusplains
	Unit							
PROVISIONING SERVICES								
Seed for rehabilitation	Tonnes	200						
Fodder production to support grazing	t DM							
REGULATING SERVICES								
Carbon sequestration (AGB)	t CO2-e	617	201	0	430	194	93	323
Carbon sequestration (BGB)	t CO2-e	17,901	5,828	0	12,489	5,620	2,706	9,367
Water qulaity regulation	Tonnes sediment retained						97	
CULTURAL SERVICES								
Maintenance of MNES	no. of MNES							1
Site visits for education	# visitors	366						33

Generalised structure of a natural capital physical flow account:

- The ecosystem service supply table records the flows of different ecosystem services supplied by different ecosystems assets under the organisation's control.
- The ecosystem service use table records the use of ecosystem services by the organisation or society (final ecosystem services). It can also be used to show the intermediate ecosystem service flows – intermediate services are those ecosystem services in which the user of the ecosystem services is an ecosystem asset and where there is a connection to the supply of final ecosystem services (United Nations 2021).

An example of a natural capital physical flow account is presented in Table 11. Other examples are presented in Smith et al. (2023).

2.4.8 NATURAL CAPITAL MONETARY FLOW ACCOUNT

The natural capital monetary flow account records the monetary value of ecosystem and abiotic flows over time, to the organisation and (if desired) to society. It includes information on historical actual flows, and a separate schedule could also be used to document expected future flows.

Monetary value

In natural capital accounting the primary motivation for monetary valuation is the adoption of a common unit (e.g., dollars) to facilitate comparisons across different ecosystem services and assets, and to ensure consistency with products and assets recorded in the System of National Accounts (United Nations 2008). The adoption of monetisation in natural capital accounts should involve careful consideration of its purpose and the implications associated with potential differences in interpretation of the account.

FRESHWATER		TERRESTRIAL				TOTAL ECOSYSTEMS
F1 Rivers and Streams	F3 Artificial Wetlands	T7 Intensive land use systems				
Seasonal lowland rivers (streams)	Constructed lacustrine wetlands – Beaches and permanent lakes	Sown pastures and fields	Sown pastures and fields (Irrigated)	Plantations	Urban and Industrial Systems	
F1.5	F3.2	T7.2	T7.2	T7.3	T7.4	
Channels	Lakes/pools (including beaches)	Modified (Pasture) (ha)	Modified (Irrigated Pasture) (ha)	Modified (Plantation)	Artificial Surfaces & Associated Areas (ha)	
						200
		333	4,330	0	0	4,663
				523		2,380
				15,197		69,107
						97
						1
						399

Monetary valuation may not be needed or will not be appropriate in all decision-making situations. In all cases, it will be important to use associated biophysical data on stocks and flows (United Nations 2021).

Monetary valuation of ecosystem stocks and flows is contentious to some stakeholders due to:

- differences in views for the underlying framing of the valuation of stocks and flows.
- uncertainty associated with the capacity of existing valuation approaches to support decision making.
- the ability to produce reliable estimates of the value of ecosystem services in monetary terms.
- it is important that compilers of monetary accounts document the scope of the conceptual basis of the valuation, and that users recognise that not all values are substitutable (United Nations 2021).

Frame

A natural capital monetary flow account provides information for tracking the monetary value of ecosystem and abiotic flows. It underpins the monetary values reported in the natural capital balance sheet and the natural capital income statement.

Scope

The measurement scope of a natural capital monetary flow account is based on the ecosystem service and abiotic flows supplied by natural capital assets in the ecosystem accounting area. As such, the natural capital flow account in monetary terms should be closely aligned to the set of ecosystem services and abiotic flows recorded in the natural capital physical flow account. However, given the difficulty associated with the valuation of ecosystem services, it may be the case that the set of ecosystem services represented in the monetary flow account is smaller.

Measure and value

Guidance on natural capital monetary flow accounts is outlined in the SEEA-EA, Section 9. Additional guidance on monetary flow accounts is available in the British Standard on natural capital accounting for organisations (BS 8632:2021).

The development of a natural capital monetary flow account is a four-stage process that involves:

- consideration of the appropriate value concepts to be used.
- measurement of the actual flows of each ecosystem service and abiotic flow in monetary terms. There is also an option to estimate the future flows, where future flows should incorporate any management and natural changes.
- measurement of the ecosystem service production costs ("the costs that are necessary to incur to realise the flow of benefits at a point in time" (BS 8632:2021, section 6.7.1.5, p22)).
- decisions on the summarisation and presentation of the natural capital monetary flow account, including consideration of whether to present as a supply and use table.

Generalised structure of a natural capital monetary flow account:

The structure and layout of the ecosystem services monetary flow account is similar to that for the ecosystem services supply and use tables in physical terms (e.g., Table 13). Instead of physical units being recorded, monetary units are presented.

Notes:

Chapter 8 of the United Nations (2021) provides more detail on the principles of monetary valuation for ecosystem accounting.

To be consistent with SEEA, entries within the natural capital monetary flow accounts should be based on exchange values, apply a common currency, and pertain to a single accounting period (United Nations 2021). The values presented in a natural capital monetary flow account should also be net of any ecosystem service production costs incurred to realise the flow of benefits.

2.5 APPLY, ASSESS AND ACT

Measure performance against targets, identify strategies to address risks and opportunities, and implement.

Natural capital impact, dependency, risk, and opportunity registers, combined with ecosystem accounts, can help organisations assess their performance against a range of internally or externally set targets, and to allocate resources in a manner that more effectively manages their impacts and dependencies on natural capital.

They can also inform a range of activities for organisations such as options appraisal, performance assessment and corporate risk assessment. It can allow an organisation to better align their strategy and management to the changing regulatory and consumer preference landscape in which it operates.

2.6 KEY RESOURCES AND FURTHER READING

Capitals Coalition (2016). Na*tural Capital Protocol*. https://naturalcapitalcoalition.org/wp-content/uploads/2018/05/NCC_Protocol_WEB_2016-07-12-1.pdf, viewed 4 May 2023

CICES 2017 *Towards a common classification of ecosystem services*. https://cices.eu/resources/, accessed 21 April 2023

Dasgupta, P. (2021). *The economics of biodiversity: the Dasgupta Review*. London: HM Treasury

eftec (2015). *Developing corporate natural capital accounts. London: EFTEC*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/516968/ncc-research-cnca-final-report.pdf, viewed 4 May 2023

Finance for Biodiversity (2022). *Guide for biodiversity measurement approaches; annex on Assessing Impact to Pledge Guidance*. https://www.financeforbiodiversity.org/publications/guide-on-biodiversity-measurement-approaches/, viewed 4 May 2023

Hein, L., Bagstad, K., Edens, B., Obst, C., De Jong, R. and Lesschen, J. P. (2016). *Defining Ecosystem Assets for Natural Capital Accounting*. PLOS ONE, 11, e0164460

ISO (2019). *Monetary valuation of environmental impacts and related environment aspects*. International standards Organisation

Keith, D. A., Ferrer-Paris, J. R., Nicholson, E. and Kingsford, R. (2020). *IUCN Global Ecosystem Typology 2.0: Descriptive Profiles for Biomes and ecosystem function groups*. Gland, Switzerland: International Union for Conservation of Nature and Natural Resources

NCAVES and MAIA (2022). *Monetary valuation of ecosystem services and assets for ecosystem accounting; Interim Version 1st edition*. United Nations Department of Economic and Social Affairs Statistics Division

Natural Capital Finance Alliance (2023) (ENCORE) *Exploring Natural Capital Opportunities, Risks and Exposure*. https://encore.naturalcapital.finance/en, viewed 17 May 2023

Obst, C., Hein, L. and Edens, B. (2015). *National Accounting and the Valuation of Ecosystem Assets and Their Services*. Environmental Resource Economics,, 64, 1-23

SBTN (2020) *Science-Based Targets for Nature: Initial Guidance for Business*. Science Based Targets Network

Smith, G. S., Ascui, F. A., O'Grady, A. P., & Pinkard, E. A. (2023). *The Natural capital handbook: A practical guide to corporate natural capital accounting, assessment, risk assessment and reporting*

TNFD (2023). *The TNFD Nature-related risk and opportunity Management and Disclosure Framework Neta v0.4 Annex 4.3 Disclosure Metrics Annexes*. Taskforce on Nature-related Financial Disclosures

United Nations (2008). *System of National Accounts*. New York: United Nations

United Nations (2014). Syste*m of Environmental and Economic Accounting 2012-Central Framework*. New York: United Nations

United Nations (2021). *System of Environmental-Economic Accounting-Ecosystem Accounting (final draft)*. Department of Economic and Social Affairs-Statistics Division

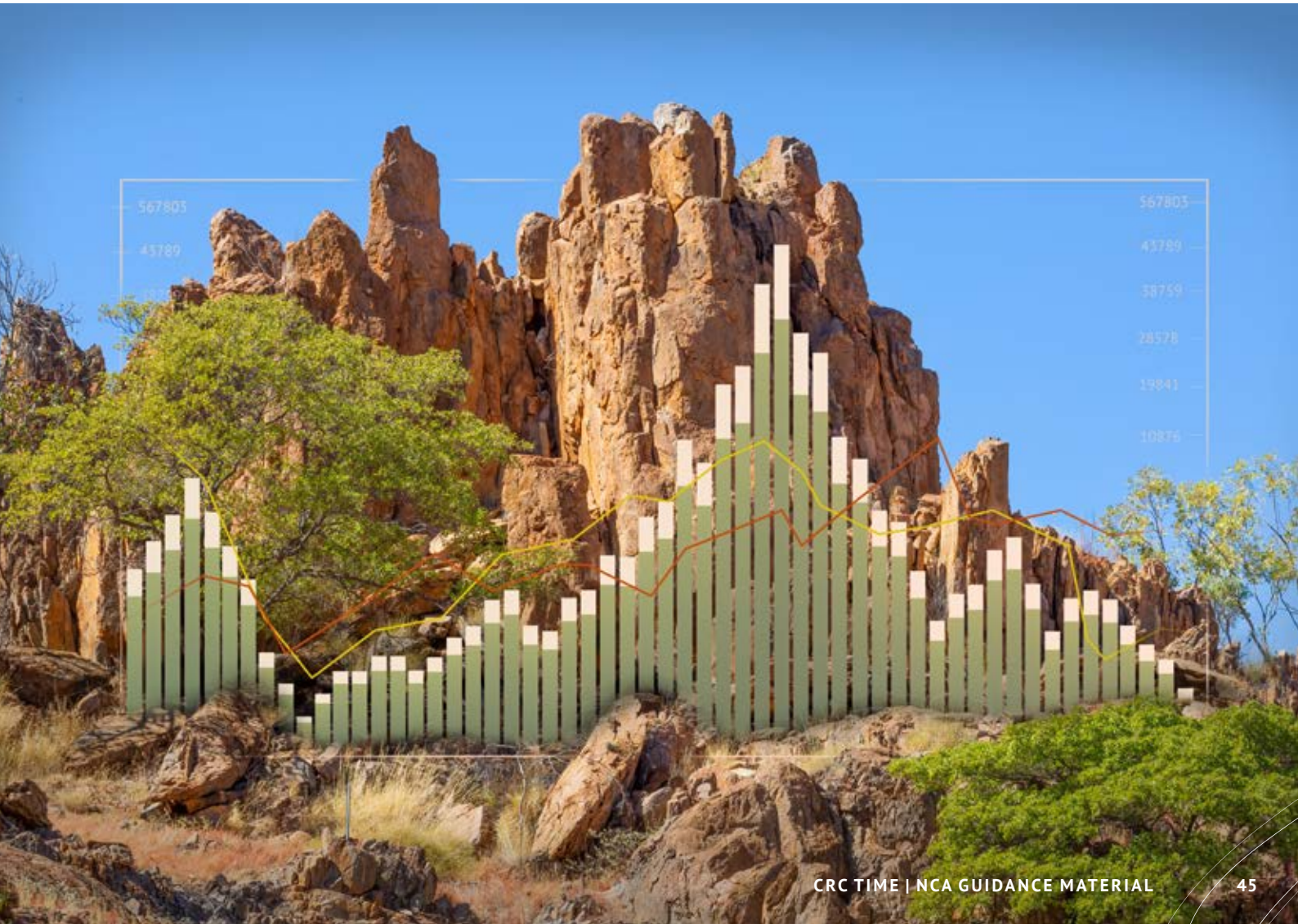
Part 3: Natural capital reporting and disclosure

PART 3
Natural capital reporting and disclosure

A PROPOSED PRESENTATION OF GENERAL-PURPOSE NATURAL CAPITAL REPORTS FOR EXTERNAL STAKEHOLDERS

Purpose:

This section focusses on the presentation of natural capital information for external stakeholders and proposes a series of natural capital statements to supplement financial statements presented in annual reports. Preparers of external natural capital reports are referred to as 'reporting entities'. "A reporting entity is an entity that is required, or chooses, to prepare financial statements. A reporting entity can be a single entity or a portion of an entity or can comprise more than one entity. A reporting entity is not necessarily a legal entity" (IASB 2018a) para 3.10.



3. NATURAL CAPITAL ASSESSMENT AND ACCOUNTING FOR DISCLOSURE PURPOSES

3.1 PROPOSED FRAMING OF A GENERAL-PURPOSE NATURAL CAPITAL REPORT

The presentation of a reporting entity's financial performance over an accounting period is dictated under accounting standard IAS 1 Presentation of Financial Statements. The objectives associated with standardisation of the presentation of financial information are to:

- ensure comparability of an entity's financial statements with previous reporting periods.
- ensure comparability of the information of an entity's financial statements with other entities.

On the characteristics of useful natural capital information

The IASB lays out a Conceptual Framework (IASB, 2018a) that characterises the qualitative characteristics of useful financial information that can be (and is being) easily adapted to natural capital thinking. Useful natural capital information is information that is relevant and a faithful representation of the underlying natural capital.

Relevant natural capital information: Information has predictive or confirmatory value, i.e., it can help the users of the accounts predict the trajectory of natural capital under the organisation's management or can confirm or refute previous observations.

Faithful representation: Information is complete, neutral and free from error:

Completeness: all the information that a user needs to understand the state of the natural capital is included.

Neutrality: information is unbiased, it is neither overly optimistic nor overly pessimistic.

Freedom from error: there are no errors in the depiction that would make a difference to a resource allocation decision.

Secondary characteristics that enhance the usefulness of the information include:

Comparability: good quality information allows users to compare the natural capital position of a business over time, and of different businesses with each other.

Verifiability: different observers are able to agree on what the information means, and that it provides a faithful representation.

Understandability: information should be understandable to users with a reasonable level of knowledge.

Timeliness: information tends to be more useful if it is more current.

Currently, there are no international standards on the presentation of natural capital reports specifically targeted at external users, although an NCA standard for organisations was released by the British Standards Institution in 2021 (British Standards Institution 2021).

The growing demand for information on natural capital performance from a range of stakeholders suggests a need for a natural capital equivalent of the general-purpose financial report – a general-purpose natural capital report.

Consistent with the requirements of a general-purpose financial report, a general-purpose natural capital report would be targeted at external stakeholders and should present natural capital information in a format that enables comparison between accounting periods for an entity and ensures that the information that is contained within is comparable between entities.

Unlike financial reporting, which specifically limits the users of such information to those with a financial interest in the organisation, general-purpose natural capital reports should consider the information needs of a broader group of stakeholders. An important motivation for adoption of general-purpose natural capital reporting is to provide increased visibility of a reporting entity's environmental management and performance as a result of its economic activities.

General-purpose natural capital reports should provide information on the state and management of natural capital presented in a consistent format, which is understandable to a user with a reasonable understanding of the concepts of natural capital and its reporting practices, and which facilitates comparisons with previous reporting periods and other entities.

As such there is growing interest in the adoption of natural capital reporting in a format that mirrors general purpose financial reporting (Ogilvy 2020, Forico 2020, BHP 2023).

Here, we propose a structure and the associated statements of a general-purpose natural capital report that is aligned to current financial reporting conventions and emerging natural capital disclosure requirements that aims to provide consistent, robust and comparable information on the state of natural capital. The purpose of a general-purpose natural capital report is to facilitate an assessment of a reporting entity's management of natural capital. The presentation of natural capital information proposed here builds on existing guidance developed for the forestry industry (Smith et al. 2022) and is an adaptation of the British Standard on Natural Capital Reporting for organisations (British Standards Institution 2021).

Figure 10 proposes six natural capital statements that would provide a comprehensive assessment of a reporting entity's interactions with natural capital. The six proposed statements are:

- A statement of natural capital impacts: section 3.2.1.
- A statement of natural capital dependencies: section 3.2.2.
- A statement of natural capital risks and opportunities: section 3.2.3.
- A natural capital balance sheet: section 3.3.1.
- A natural capital income statement: section 3.3.2.
- A natural capital ecosystem change statement: section 3.3.3.

The proposed natural capital statements are designed to structure natural capital information in a manner that facilitates an assessment of the reporting entity's management and stewardship of natural capital.

The natural capital assessment statements provide information about a reporting entity's:

- natural capital impacts, dependencies, risks, and opportunities.
- natural capital & environmental assets.
- natural capital liabilities.
- natural capital income in the form of ecosystems services received.
- natural capital losses and disservices.
- changes in ecosystems as a result of the reporting entity's activities.

The statements are designed to mirror the format of financial statements as required under IAS 1 (IASB 2018b). Equivalence with financial statements is listed in Table 12. The proposed structure of the natural capital accounts reporting statements is presented in Figure 11.

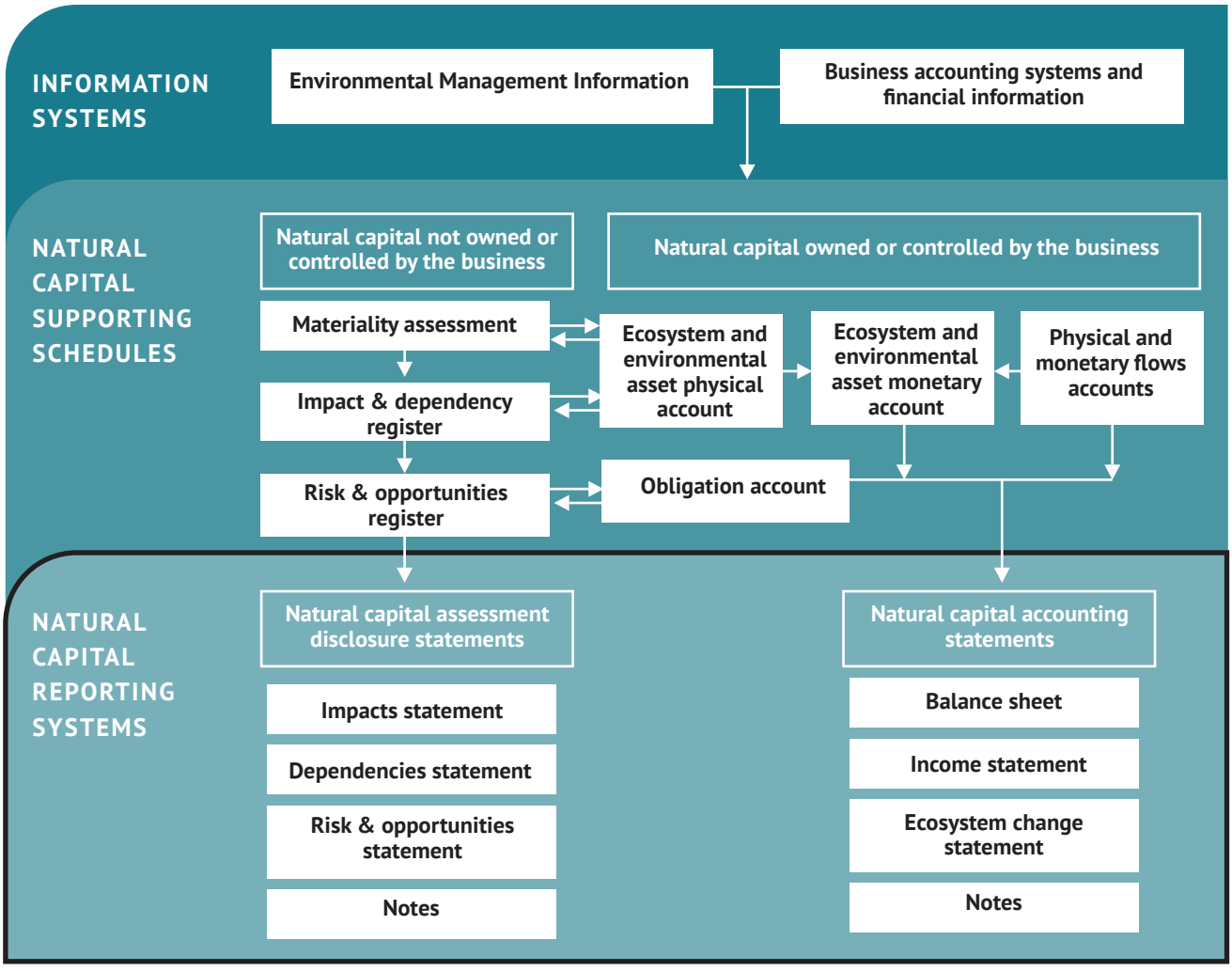


Figure 10 Conceptualisation of natural capital assessment and accounting (black box highlights the focus for disclosure)

Table 12 Relationship between proposed natural capital statements and existing disclosure requirements

NATURAL CAPITAL STATEMENT	EXISTING FINANCIAL ANALOGUE
Natural capital impact statement	No equivalent financial statement, aligned to the expanding NC disclosure environment such as the TNFD and IFRS S1 and S2
Natural capital dependency statement	No equivalent financial statement, aligned to the expanding NC disclosure environment such as the TNFD and IFRS S1 and S2
Natural capital risk and opportunity statement	No equivalent financial statement, aligned to the expanding NC disclosure environment such as the TNFD and IFRS S1 and S2
Natural capital income statement	A statement of profit and loss and other comprehensive income for the period
Natural capital balance sheet	A statement of financial position at reporting date
Ecosystem change statement	A statement of cashflows for the period
Natural capital notes	Notes to the financial statements

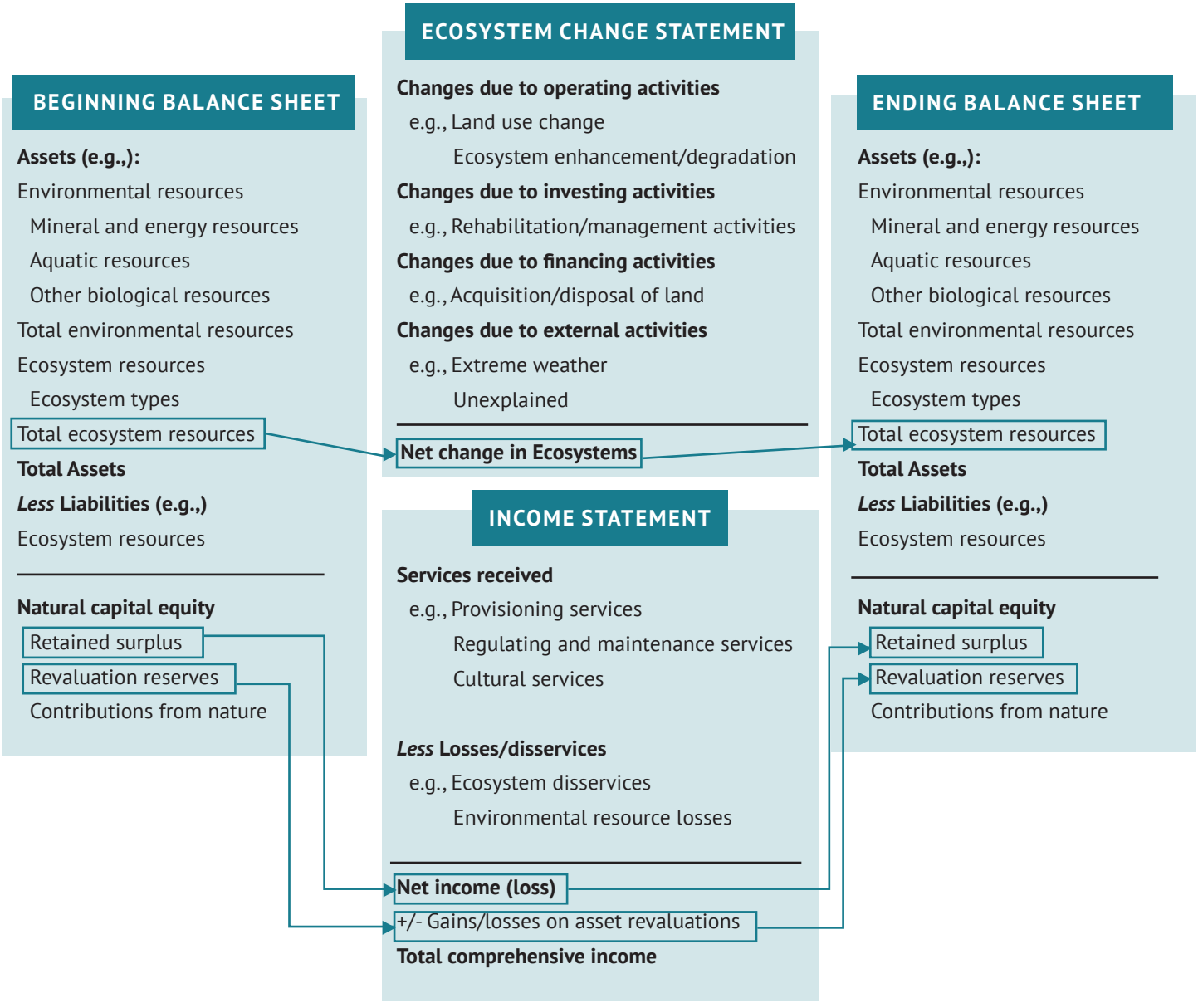


Figure 11 The relationship between the general-purpose natural capital reports

The ecosystem change statement explains why the closing balance of the ecosystem assets differs to the opening balance and, like a cash flow statement, explains whether this difference is due to operating, investing or financing activities, with the additional category of external activities (as ecosystem assets may be affected by events outside the reporting entity's control, such as extreme weather events).

As with the cash flow statement, the ecosystem change statement provides important information to external users regarding the activities causing changes in ecosystem asset balances. Like the statement of profit and loss and other comprehensive income in financial reporting, the natural capital income statement explains the increase or decrease in retained earnings over the period, as well as any differences in the balances of revaluation reserves, which fluctuate due to changes in the market values of assets. The natural capital balance sheet provides a snapshot of the reporting entity's natural capital at a point in time.

3.2 NATURAL CAPITAL ASSESSMENT DISCLOSURE STATEMENTS

3.2.1 NATURAL CAPITAL IMPACT STATEMENT

A natural capital impact statement provides information for a reporting entity to externally report on the positive and negative impacts of their operations on natural capital over time, allowing trends or performance to be monitored by stakeholders. It provides a summary of information from the natural capital impact register for the current period, compared with the previous reporting period.

The natural capital impact statement is focussed on the reporting entity's broader relationship with natural capital. The impact statement should encompass all of the positive and negative natural capital impacts identified within the natural capital impact register that are deemed to be relevant to external stakeholders. It can be aligned with the reporting entity's sustainability reporting, Environmental, Social, and Governance (ESG), or integrated report.

Report and disclose

Guidance on how to disclose natural capital impacts is outlined in the TNFD framework.

The TNFD is moving towards a set of mandated disclosure metrics, with recommendations for additional metrics and sector specific metrics for a more comprehensive approach (TNFD 2023). If reporting entities do not report against any of the core global indicators and metrics, they should provide a short explanatory statement as to why they have not reported, or a statement of why it is not material.

The development of a natural capital impact statement is a three-stage process that involves:

1) consideration of the natural capital impacts from the natural capital impact register that are to be disclosed.
2) calculation of the % change from previous reporting period or baseline (baselines could include historical baselines and reference states and/or industry averages for trend analysis).
3) decisions on the summarisation and presentation of the natural capital impact statement.

Supporting schedules

Supporting schedules for the natural capital impact statement are the natural capital asset register, the natural capital impact and dependency register, and the natural capital risks and opportunities register.

Generalised structure of a natural capital impact statement:

The TNFD recommends that for each indicator, reporting entities should state the measurement baseline by showing the previous reporting period, and indicate the percentage change between the previous and current reporting period. Where possible, it may also be useful to estimate future measures. Finally, it is recommended that in the impact and dependency register the reporting entity separates their direct operations, upstream activities and downstream activities (where possible). Table 13 presents some examples of indicators that might be reported based on the suggested presentation of the impact and dependency statement. This example was developed based on data presented in BHP's Sustainability and ESG Navigators and Databook 2022 and BHP Annual Report 2022.

Notes:

There are a number of frameworks currently being deployed to report an entity's natural capital impacts, e.g., Global Reportioning Initiative, particularly in relation to environmental, social and governance (ESG) and sustainable development goals (SDG) reporting. There is also emerging guidance specifically linked to initiatives such as the TNFD. The aim of the impact statement is to align with these reporting objectives.

The impact statement is broadly comparable with what some organisations have called an 'environmental profit and loss' statement, e.g., Kering and PUMA.

3.2.2 NATURAL CAPITAL DEPENDENCY STATEMENT

A natural capital dependency statement provides information on the nature of natural capital dependencies that are relevant to the reporting entity's stakeholders allowing trends and performance to be assessed over time. It provides a summary of information from the natural capital dependency register for the current period, compared with the previous reporting period.

The natural capital dependency statement is focussed on the natural capital on which a reporting entity is dependent. The natural capital dependency statement should encompass all the natural capital dependencies identified within the natural capital dependency register that are deemed to be relevant to external stakeholders.

Report and disclose

Guidance on how to disclose natural capital dependencies is outlined in the TNFD framework. The TNFD is moving towards a set of mandated disclosure

Table 13 A worked example of a mining sector natural capital impact statement

Driver of nature change	Indicator	Location	TNFD	Units	Target	Current reporting period	Previous reporting period	% change	Notes
Climate change	Scope 1 GHG emissions	Western Australia (Beenup)	Core (C1.0)	MtCO2-e	Maintain operational GHG emissions at or below FY2017 levels	0.04	0.05	(5.6)	
		Whole of business				9.2	10.1	(9)	
	Scope 2 GHG emissions	Western Australia (Beenup)				0.01	0.01	(5.6)	
		Whole of business				3.1	6.2	(50)	
	Scope 3 GHG emissions	Western Australia (Beenup)				NA	NA		Data not available
		Whole of business				3.2	3.1	3	
Landuse	Total extent of landuse change	Western Australia (Beenup)	Core (C2.0)	km2	-	628	0		
	Landuse in prioritised ecosystems		Core (C2.1)			3.35	3.35	-	
Pollution/ pollution removal	Total pollutants released to soil split by soil type	Whole of business	Core (C3.0)			NA	NA		Data not available
	Volume of waste water discharged and concentration of key pollutants in the wasterwater discharged		Core (C3.1)			NA	NA		Data not available
	Number of days of exceedance of water qulity thresholds		Def. by Org.			12	21	(43)	
	Accidental discharges of water and tailings		Def. by Org.			0	0	-	
	Total amount of hazardous waste generated		Core (C3.2)			NA	NA		Data not available
	Total non GHG air pollutants		Core (C3.3)			NA	NA		Data not available
Resource use / replenishment	Water withdrawal and consumption from areas of water stress		Core (C4.0)	ML	<10,000	18000	25000	(28)	
	Quantity of high risk natural commodities sourced from land	Western Australia (Beenup)	Core (C4.1)	Mineral sands are not listed as a high impact commodity					
	Quantity of natural commidities sourced from high priority ecosystems		Core (C4.2)	t (seed)		200	0		
Invasive species	Area of weed infestation in adjacent estate		Def. by Org.			0.1	0.15	(33)	

Metrics contained in Table 13 are for indicative purposes only and contain a mixture of examples from the Beenup pilot study and impacts taken from the BHP Sustainability and ESG navigators and Databook 2022 and BHP Annual Report 2022 (denoted as "Whole of business"). Entities reporting on impacts would normally be reporting at a whole of business scale. Where metrics are directly related to core metrics proposed by the TNFD, these are denoted as Core. Other metrics may be defined by the organisation, denoted as "Def. by Org", where the materiality assessment identifies these as material

metrics, with recommendations for additional metrics and sector-specific metrics for a more comprehensive approach (TNFD 2023). If entities do not report against any of the core global indicators and metrics, they should provide a short explanatory statement as to why they have not reported or a statement of why it is not material.

The development of a natural capital dependency statement is a three-stage process that involves:

1) consideration of the natural capital dependencies from the natural capital dependency register that are to be disclosed.
2) calculation of the % change from previous reporting period or baseline (baselines could include historical baselines and reference states and/or industry averages for trend analysis).
3) decisions on the summarisation and presentation of the natural capital dependency statement.

Supporting schedules

Supporting schedules for the natural capital dependency statement are the natural capital asset register, the natural capital impact and dependency register and the natural capital risks and opportunities register.

Generalised structure of a natural capital dependency statement:

A natural capital dependency statement should be similar in structure to a natural capital impact statement.

A worked example of a natural capital dependency statement is shown in Table 14 based on data extracted from BHP's Sustainability and ESG Navigators and Databook 2022 and BHP Annual Report 2022. Data in Table 30 represent an aggregated view of BHP's scope 1 dependencies.

Notes:

Most reporting entities are well versed in assessing impacts that the entity has on natural capital. Natural capital dependency thinking is relatively new and existing precedents sparse, although frameworks such as the Natural Capital Protocol have been around for some time (Capitals Coalition 2016). The TNFD is pushing for greater disclosure of natural capital on the back the influential Dasgupta Review (Dasgupta 2021).

3.2.3 NATURAL CAPITAL RISKS AND OPPORTUNITIES STATEMENT

A natural capital risk and opportunities statement provides a structured way for reporting entities to disclose their relevant natural capital risks and opportunities and to consistently integrate with disclosure frameworks and Standards such as the Taskforce on Nature-related Financial Disclosures (TNFD) and IFRS S1 and S2. It provides a summary of information from the natural capital risk/opportunity register for the current period, compared with the previous reporting period.

Report and disclose

Guidance on how to disclose natural capital risks and opportunities is outlined in the TNFD framework.

The TNFD is moving towards a set of mandated disclosure metrics, with recommendations for additional metrics and sector-specific metrics for a more comprehensive approach (TNFD 2023). Specific guidance for the resources sector is anticipated, but not yet released.

If entities do not report against any of the core global indicators and metrics, they should provide a short explanatory statement as to why they have not reported or a statement of why it is not material. IFRS S1 requires organisations to adhere to the industry-specific Sustainability Accounting Standards Board (SASB) Standards (ISSB 2023), with the latest version of the Metals and Mining Sustainability Accounting Standard for the Extractives and Minerals Processing Sector released in 2023.

The development of a natural capital risk and opportunity statement is a two-stage process that involves:

1) consideration of the natural capital risks and opportunities from the natural capital risk and opportunity register that are to be disclosed.
2) decisions on the summarisation and presentation of the natural capital risk and opportunity statement.

Supporting schedules

Supporting schedules for the natural capital risk and opportunity statement are the natural capital asset register, the natural capital impact register, the natural capital dependency register, and the natural capital risk and opportunity register.

Table 14 A worked example of a mining sector natural capital dependency statement

Nature of dependency	Nature of dependency	Location	TNFD metric	Unit	Target	Current reporting period	Previous reporting period	% Change	Notes
Climate change	Absence of destructive bushfire	Western Australia (Beenup)		% of estate affected by destructive bushfire	2%	4%	5%	(20%)	Dependency defined as the absence of extreme weather events
Landuse	Extent of land that the organisation controls that is used for the production of natural resources	Western Australia (Beenup)	Additional (A3.1)	km^2		363	0		Change not recorded due to change from zero
	Adequate pollination services to maintain plant and seed production	Western Australia (Beenup)	Additional (A3.4)	#Hives	120	108	102	5.6	
Resource use / replenishment	Adequate rainfall to meet growth requirements	Western Australia (Beenup)		mm	>550	461	468	(1.5)	Operation is in a drying climate
	Total water consumption in water stressed areas	Whole of business	Core (4.0)	Ml		115,400	106,950	7.9	
	Operational energy consumption	Whole of business		PJ		149	155	(3.9)	

Metrics contained in Table 14 are for indicative purposes only and contain a mixture of examples of dependency metrics from the Beenup pilot study and the BHP Sustainability and ESG Navigators and Databook 2022 and BHP Annual Report 2022 (denoted as "Whole of business"). Entities reporting on dependencies would normally be reporting at a whole of business scale. Where metrics are directly related to core metrics proposed by the TNFD, these are denoted as Core. Metrics denoted as additional are additional metrics proposed by the TNFD. Other metrics may be defined by the organisation, denoted as "Def. by Org", where the materiality assessment identifies these as material.

Generalised structure of a natural capital risk and opportunity statement:

A natural capital risk and opportunity statement could be similar in structure to the natural capital risk and opportunity register used for management purposes. Here, we show an example of a generalised structure of a risk and opportunity statement in Table 16.

Notes:

The nature of disclosures for risks and opportunities associated with natural capital are still emerging. For assessments of nature-related risks and opportunities to be practically useful, disclosed information must be relevant, complete and comparable, thereby enabling evaluation of performance across businesses, industries and sectors. The TNFD will provide sector- and biome-specific disclosure metrics that should provide the basis for this comparability.

Table 15 A worked example of a potential hypothetical risk and opportunities statement for the mining sector.
Risks, opportunities and mitigation actions are taken from the BHP Annual Report 2022; risk ratings are for indicative purposes only

Date 30 June 2023

Risk	Type of risk	Location	Time frame	Risk Rating	Mitigation and management)	Residual Risk Rating	Opportunities
Water shortages impacting production, associated activities and reputation due to changes in average rainfall and temperature / evaporation	Physical risk	Minerals Australia, Minerals Americas	Short-Medium term	High	A range of risk management measures for water-related risks, including consideration of climate change projections as relevant	Moderate	Identifying the potential for weather, climate variability or climate change to disrupt delivery of products and implementing management measures may increase the resilience of operations and value chain.
Flooding of mine and/ or key production infrastructure (e.g. plants, conveyor belts etc.) due to extreme precipitation	Physical risk	Minerals Australia, Minerals Americas	Short-Medium term	High	Developed internal guidance on incorporating climate change projections into mine water planning, hydrologic assessment and infrastructure design.	Moderate	
Disruption and/ or damage to port and coastal infrastructure and operations due to higher sea levels, cyclones, storm surge and changes in marine ecosystems	Physical risk	Minerals Australia, Minerals Americas	Short-Medium term	High	Stockpile and capacity management and use of weather forecasts to minimise operational disruption at ports from weather / climate-related events.	Moderate	
Changing environmental restrictions or regulations, including measures with respect to carbon-intensive industries or imports)	Physical risk	Minerals Australia, Minerals Americas	Short-Medium term	Moderate	Monitoring geopolitical and macroeconomic developments and trends, to provide an early indication of events that could impact our ability to access key markets	Low	Monitoring macroeconomic, societal, geopolitical and policy developments and trends may reveal new markets or commodities, or identify opportunities to strengthen secondary markets for existing products

3.3 NATURAL CAPITAL ACCOUNTING STATEMENTS

3.3.1 NATURAL CAPITAL BALANCE SHEET

The natural capital balance sheet provides a statement of a reporting entity's natural capital assets, liabilities and equity at a point in time. In this respect, the natural capital balance sheet is analogous to the financial balance sheet. The balance sheet addresses a fundamental concept in accounting where an entity's assets are equal to its liabilities plus its equity:

Assets = Liabilities + Equity

The natural capital balance sheet reports on the physical and monetary (where possible) value of the natural capital assets and liabilities, calculated as the sum of discounted future benefit flows and the sum of future discounted obligations (liabilities). The difference between the value of the natural capital assets and the natural capital liabilities is represented as natural capital equity.

Report and disclose

The development of a natural capital balance sheet is a four-stage process that involves:

1) compilation of information on the net present value of each natural capital asset using the sum of discounted future monetary flows from the natural capital monetary flow account.
2) compilation of information on net present value of any natural capital liabilities using the sum of discounted future obligation costs from the natural capital obligation schedule.
3) compilation of summary information on physical extent and condition of natural capital assets using the extent and condition accounts.
4) completion of the natural capital balance sheet.

Supporting schedules

Supporting schedules for the natural capital balance sheet are the natural capital physical and monetary flow account, natural capital obligation account, natural capital asset account.

Generalised structure of the natural capital balance sheet:

The natural capital balance sheet is a statement of the reporting entity's natural capital under its stewardship. It is a statement of its natural capital assets, as well as the natural capital liabilities, for which the organisation is responsible. A worked example of a natural capital balance sheet is shown in Table 16.

Notes:

It is unlikely that it will be possible to represent completely the NPV of all ecosystem services that natural capital assets are providing. Thus, the natural capital balance sheet is likely to be an underestimate of the 'value' of the natural capital equity under the reporting entity's management.

Reporting entities should try to avoid presenting only information in monetary terms, as this is easily misinterpreted and potentially contentious. It is recommended that physical values also be presented, noting that this creates problems for constructing a balance. The monetisation of the ecosystem services is simply designed to provide an approach to aggregating the value and to provide an estimate of natural capital equity.

As per the SEEA, natural capital assets may be classified as being either 'environmental assets' or 'ecosystem assets'. This choice is a matter of professional judgement, depending on whether the value of the resource is limited to its use as an input to economic activity and human consumption, in which case it would be classified as an 'environmental asset'.

To avoid double-counting it is important that that the value of an environmental asset (e.g., water resources) is deducted from the value of the ecosystem asset (e.g., freshwater ecosystems – excluding the value of water resources). Reporting entities should have clear policies around how such classifications are determined, and these policies should be disclosed in the notes to the general-purpose natural capital reports.

The natural capital balance sheet should contain reference notes to help users of the statement better understand the approaches to the measurement of the ecosystem service, valuation approaches and the assumptions and limitations associated with the preparation of the statement. As natural capital accounting is still relatively new, close attention to the assumptions and limitations of the data presentation will be an important component of providing users of the statement information relevant to its interpretation.

3.3.2 NATURAL CAPITAL INCOME STATEMENT

The natural capital income statement summarises information on the flows generated by ecosystem and environmental assets owned and controlled by the reporting entity. This includes flows of services (or income) received from assets owned or controlled by an entity, ecosystem disservices, and gains and losses from fluctuations in the value of assets.

The statement's structure is designed to be analogous to the financial income statement and explains the changes in the equity accounts in the natural capital balance sheet between two reporting periods.

For the natural capital income statement, it is recommended that relevant physical flows be presented alongside the monetary valuations of ecosystem services to avoid problems associated with the misinterpretation of natural capital monetary accounts.

Ecosystem disservices and environmental resource losses

Ecosystem disservices describe interactions between economic units and ecosystem assets that are negative from the perspective of the economic units (SEEA-EA 2021, para. 6.75). Ecosystem disservices can be thought of as providing negative benefits, or disbenefits to human wellbeing. Examples might include the provision of habitat for pests or vectors of disease, or the production of pollen that causes asthma. Ecosystem disservices are excluded from SEEA because it is assumed that ecosystem accounting (consistent with the general accounting treatment of transactions) should only record ecosystem services as positive exchanges between

Table 16 A worked example of a mining sector natural capital balance sheet
Source: The natural capital balance sheet shown [here] represents Scenario 2, the period of operational mining scenario, from the Beenup pilot accounts (BHP 2023)

			DATE 30 JUNE 1999		DATE 30 JUNE 1991	
	Indicator	Units	Quantity (CondHa)	Value from natural capital	Quantity (CondHa)	Value from natural capital
Natural capital assets						
Environmental assets	Mineral sands reserves					20,000
Ecosystem assets	Pasture ecosystems		89	8,330	80	7,532
	Native ecosystems		69	13,618	129	18,237
	Aquatic ecosystems		137	2,595	269	2,666
Total ecosystem assets		CondHa	295		478	
Total natural capital assets				24,544		48,435
Natural capital liabilities						
Native ecosystem liabilities		ha		13,124		8,505
Aquatic ecosystem liabilities		ML		71		
Total natural capital liabilities				13,195		8,505
Natural capital equity						
Asset revaluation reserve				799		
Environmental resource valuation reserve				20,000		20,000
Retained surplus/(Accumulated losses)				(8,505)		
Current year surplus/(deficit)				(19,201)		(8,505)
Returns due to nature				(10,178)		
Contributions from nature				28,435		28,435
Total natural capital equity				11,350		39,930
Total Natural Capital Liabilities and Equity				24,544		48,435

ecosystem assets and economic units that contribute to benefits. However, there may be contexts in which recording flows of ecosystem disservices might be relevant for reporting entities.

Environmental resource losses occur when an entity extracts environmental resources (e.g., minerals) and converts them to inventory. Having previously been recognised as environmental resource assets on the natural capital balance sheet, the loss of these assets is recognised on the natural capital income statement as they are transferred to an economic resource that is recognised as an asset (inventory) on the reporting entity's financial statements. There may also be losses (or gains) associated with the revaluation of environmental resource assets due to fluctuations in the expected market value of these assets.

Report and disclose

The development of a natural capital income statement is a five-stage process that involves:

1) compilation of information on the current monetary flows from the natural capital monetary flow account for each ecosystem service.
2) compilation of information on the current physical flows from the natural capital physical flow account for each ecosystem service.
3) compilation of information on ecosystem disservices associated with the reporting entity's assets.
4) calculation of gains or losses from fluctuations in the value of assets.
5) completion of the natural capital income statement.

Supporting schedules

Supporting schedules for the natural capital income statement are natural capital physical and monetary flow accounts.

Generalised structure of a natural capital income statement:

A worked example for the mining sector is shown in Table 17.

Notes:

In order to be comprehensive, the natural capital income statement should include:

- the flows of positive benefits from owned/controlled natural capital assets over the reporting year.
- if relevant, the flows of negative disbenefits from owned/controlled natural capital assets over the reporting year (also known ecosystem disservices, e.g., health impacts from pollen).
- losses resulting from the extraction of environmental resources.
- gains or losses resulting from fluctuations in the value of the reporting entity's assets. The gains or losses on natural capital assets describe the fluctuations in the value of the entity's natural capital assets. These gains or losses are calculated through revaluation of the natural capital assets. with the change in value recognised in the natural capital income statement as the revaluation increment (decrement) of future estimated value.

Table 17 A worked example of a natural capital income statement for the mining sector

Source: The natural capital income statement shown [here] represents Scenario 2, the period of operational mining scenario, from the Beenup pilot accounts (BHP 2023)

NATURAL CAPITAL INCOME STATEMENT 30 JUNE 1999						DATE 30 JUNE 1991	
		Units	Quantity	Value to reporting entity ($'000's)	Value to rest of society ($ '000's)	Value to reporting entity ($'000's)	Value to rest of society ($ '000's)
Natural Capital Income Received from Ecosystem Assets							
Provisioning services	Grazing support	ha	886		1,248		1,275
	Habitat provision	no. of MNES	1		112		504
Regulating services	Carbon sequestration	t CO2eq	71,487		1,358		1,825
	Water flow	ML	31,292		3,129		2,666
Cultural services							
Natural Capital Income received from Environmental Assets							
Total natural capital income received					5,847		6,270
Less Natural capital services expended							
Ecosystem disservices							
Environmental resource losses		tonnes	400,000	20,000			
Total natural capital services expended				20,000	0	0	
Net Natural Capital Profit/(Loss)				(20,000)	5,847	0	6,270
***Plus* Other comprehensive income**							
Gains(losses) on asset valuations, Gains on asset revaluations	Gains on asset revaluations			799			10,901
Total other comprehensive income				799			
Total Comprehensive Natural Capital Income				**(19,201)**	**5,847**	**0**	**17,171**

3.3.3 ECOSYSTEM CHANGE STATEMENT

The ecosystem change statement provides aggregated changes to ecosystem assets over the accounting period. A reporting entity may be operating profitably by liquidating its ecosystem assets, thus the ecosystem change statement is designed to provide a synthesis of the changes to ecosystem assets associated with the entity's activities.

The ecosystem change statement provides an aggregated view of the management of the natural capital assets owned or controlled by the reporting entity. It provides data on ecosystem enhancement, degradation and conversion or other changes to ecosystems associated with the entity's activities. It also allows for reporting of changes to the entity's ecosystem assets driven by activities outside of the entity's control.

The scope of the ecosystem change statement is restricted to ecosystem assets owned and controlled by the organisation and encompasses changes driven by both management and natural causes (e.g., stochastic impacts on ecosystems such as cyclones) and reports changes in ecosystem assets during the accounting period.

Report and disclose

The development of an ecosystem change statement is a six-step process that involves:

1) determining the starting balance of the ecosystems.
2) calculating changes in ecosystem extent and condition due to operating activities. These are defined as activities directly related to the exploitation of the mineral resources and include loss due to land use change, degradation associated with mining activities and enhancements to rehabilitation or restoration associated with mining operations.
3) calculating the changes in ecosystem extent and condition due to investing activities. This might also include actions conducted by the organisation directly targeted at enhancing ecosystem condition that are not related to operations (e.g., pest and weed control).
4) calculating the changes to ecosystem extent and condition due to financing activities. This includes changes to ecosystem extent due to acquisitions or disposals of ecosystems through formal transfer agreements.
5) calculating the changes to ecosystem extent and condition due to external activities. Changes due to external activities would include losses to ecosystem extent or condition as a result of disturbances such as fire, flood, cyclones etc.
6) calculating the final balance, which corresponds with the difference between the opening and closing balances of the total ecosystem assets on the natural capital balance sheet.

Table 18 A worked example of a ecosystem change statement for the mining sector

Source: The ecosystem change statement shown here represents Scenario 2, the period of operational mining scenario, from the Beenup pilot accounts (BHP 2023).

ECOSYSTEM CHANGE STATEMENT (Year ended 30 June 1999)		
Changes due to operating activities	**Ha**	**CondHa**
Land use change (extent) due to operating activities		
Terrestrial ecosystems	(250)	(61)
Aquatic ecosystems	(112)	(87)
Condition change due to operating activities		
Terrestrial ecosystems	(79)	(24)
Aquatic ecosystems	(159)	(54)
Gains and losses due to reappraisals	-	-
Total	**(600)**	**(227)**
Ecosystem enhancements due to rehabilitation activities		
Ecosystem enhancements due to management activities (e.g. weed control)		
Total		
Changes due to financing activities		
Ecosystem gains due to acquisitions		
Terrestrial ecosystems	510	77
Aquatic ecosystems	152	67
Ecosystem losses due to disposals/transfers		
Terrestrial ecosystems	(194)	(43)
Aquatic ecosystems	(73)	(57)
Total	**395**	**44**
Total changes due to internal activities	**(205)**	**(183)**
Changes due to external activities		
Ecosystem degradation due to extreme weather events		
Unexplained changes to condition		
Total		
Net change in ecosystem resources		
Terrestrial ecosystems	66	(51)
Aquatic ecosystems	(164)	(131)
Total	**(98)**	**(183)**

Supporting schedules

Supporting schedules for the ecosystem change statement are the natural capital asset register, ecosystem extent and condition, natural capital monetary asset account.

Generalised structure of the ecosystem change statement:

A worked example for the mining sector is shown in Table 18.

Notes:

The role of the ecosystem change statement is to explain changes in the value of the entity's ecosystem assets as a result of normal operating activities during the reporting period, as compared to changes resulting from activities outside of normal operating activities and activities outside of the reporting entity's control.

The intent of the ecosystem change statement is to report on changes in the extent and condition of the organisation's ecosystem assets (and their associated value). The statement provides users of the statement additional information on the reasons for changes to ecosystems under their control.

3.3.4 NOTES TO THE GENERAL-PURPOSE NATURAL CAPITAL ACCOUNTS

Consistent with the International Financial Reporting Standards, the notes should present information about the basis of the preparation of the general-purpose natural capital accounts, the specific accounting policies used, and any additional information that is relevant to understanding the accounts. The notes should be presented in a systematic manner with consideration given to the understandability and comparability of the

natural capital accounts. Items in the natural capital accounts should be cross-referenced to any related items in the notes.

Specific items that should be disclosed are as follows:

- Material accounting policy information, with materiality relating to accounting policy information that, when considered alongside other information in the natural capital statements, could reasonably be expected to influence the decisions of the users of the natural capital statements.
- Any judgements made in applying the entity's accounting policies that have had a significant effect on the amounts recognised in the natural capital accounts.
- Information about assumptions made about the future, and other main sources of estimation uncertainty, including details regarding the nature and amount of the assets and liabilities potentially affected by the uncertainty (IASB 2018b).

3.4 ASSUMPTIONS AND LIMITATIONS

There is likely to be substantial evolution of the NCA concepts that have been presented in this guidance material. Internationally, there are several initiatives focussed on driving consistency and transparency in NCA.

While this guidance does not represent a standard, the intent is to drive consistency in natural capital reporting between reporting periods and across different sectors of the economy; however, we cannot guarantee that the approach proposed here would be adopted more broadly.

To the best of our knowledge, only a very limited number of organisations are regularly reporting on their natural capital (e.g., Forestry England and Forico). These and the recent BHP pilot (Beenup) have all adopted approaches that mirror financial statements.

Furthermore, the British Standard on natural capital accounting suggests a similar approach. This guidance also supports that approach but recognises that there will remain relatively high barriers to entry during the early phases of implementation. It also presupposes regular reporting on natural capital, many of the existing examples representing one-off case studies.

Considerable work is required to extend existing accounting approaches and to streamline the collation of the required spatial data to facilitate regular natural capital reporting cycles.

The treatment of 'losses/disservices' in the Natural Capital Income Statement and 'liabilities' in the Balance Sheet differs somewhat from those presented in previous examples (e.g., BHP 2023) or even proposed by the British Standard (British Standards Institution 2021b). Here, we recommend that losses are recognised as being due to environmental resources consumed (e.g., through resource extraction), or to ecosystem disservices.

Other approaches have advocated that the expenses should represent the actual monetary expenses associated with the costs of maintaining the ecosystems and their services.

This approach is not ideal for two reasons:

- The value of the ecosystem services should already be estimated net of production costs (United Nations 2021).
- These are expenses that would typically be captured on an entity's financial statements, thus future integration of natural capital and financial statements runs the risk of double counting these expenses.

Despite this, the approach advocated in this guidance is potentially difficult to apply as it would require modelling changes in the ecosystem services due to the entity's activities. It is unlikely that any organisation would have the capacity to adequately represent all of the ecosystem services on the income statement.

Thus, the natural capital income statement is likely to underestimate the quantum of the entity's natural capital income and losses/disservices. It should be noted that the concept and treatment of natural capital liabilities is a matter of ongoing discussion.

There is considerable future work required to better identify ecosystem services that should be presented in the natural capital income statement, and to develop approaches that adequately represent changes in these ecosystem services that are associated with changes in the extent or condition of the underlying ecosystem assets.

There are also limitations around measurement uncertainty. However, a degree of measurement uncertainty is already accepted in financial accounting, with the IASB stating that there may be trade-offs between characteristics of information such as 'relevance' and 'faithful representation', noting that:

> *The use of reasonable estimates is an essential part of the preparation of financial information and does not undermine the usefulness of the information if the estimates are clearly and accurately described and explained. Even a high level of measurement uncertainty does not necessarily prevent such an estimate from providing useful information. (IASB 2018a) para 2.19.*

The Ecosystem change statement introduced in this guidance material has no precedent in existing corporate natural capital reports (Forico 2020, Forestry England 2021, BHP 2023).

However, we believe a statement that summarises the information on the changes in ecosystem assets is particularly useful, as it helps to explain changes in the ecosystem extent and condition as a result of the entity's activities over the reporting period.

Both the Forestry England Natural Capital Report and BHP's Beenup do summarise changes to ecosystem assets in an 'Asset Register' table; however, this lacks the explanatory power to attribute changes in natural capital to either the entities' activities or the other changes to natural capital that are beyond the organisation's control.

The utility of this presentation of natural capital both within organisations and to their stakeholders requires further testing. Future work should be focussed on conducting an integrated assessment and accounting statement, which is tested with standard setters, investors and the community more broadly.

Anecdotally, the natural capital reports that have been already released have been well received. In the mining sector, BHP's Beenup report is a world first; however, it was a retrospective exercise that portrays a generally nature-positive position over the whole of operating life.

For operating assets, it is likely that natural capital accounts will present a picture of natural capital in decline. To some extent this is inevitable, and while natural capital reporting is not mandated, this may discourage organisations from trialling and disclosing their natural capital position, which could stifle the field's development.

While natural capital risk disclosure is likely to be mandated through initiatives such as the TNFD, it remains unclear if a broader statement of natural capital performance would be mandated, although this may improve efficiency in environmental and sustainability reporting in organisations.

3.5 KEY RESOURCES AND FURTHER READING

AASB (2022). *Presentation of Financial Statements*. Australian Government Australian Accounting Standards Board

British Standards Institution (2021). *Natural capital accounting for organisations - specification*. The British Standards Institution Standards Publication

International Accounting Standards Board (2018) *Conceptual Framework for Financial Reporting*

ISO (2019). *Monetary valuation of environmental impacts and related environment aspects*. International standards Organisation

Ogilvy, S. (2018). *Standards-compliant accounting valuations of ecosystems*. Sustainability Accounting, Management and Policy Journal, 9, 98-117

Ogilvy, S., Burritt, R., Walsh, D., Obst, C., Meadows, P., Muradzikwa, P. and Eigenraam, M. (2018). *Accounting for liabilities related to ecosystem degradation.* Ecosystem Health and Sustainability, 4, 261-276

Glossary

TERM	DEFINITION
Abiotic flows	Contributions to the benefits from the environment that are not underpinned by, or reliant on, ecological characteristics and processes (United Nations 2021)
Assessment metrics	Metrics used within an integrated internal assessment process for nature-related risk and opportunity management (e.g., TNFD LEAP). These would not be required for disclosure (TNFD 2023)
Benefits	The advantages or profits gained by an entity or society from ecosystem services generated from natural capital (Authors' definition)
	The goods and services that are ultimately used and enjoyed by people and society (United Nations 2021)
Biodiversity	The variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems (Secretariat of the Convention on Biological Diversity 2020)
Chart of accounts	An index of all accounts in the general ledger of a company
Critical habitat	Any area of the planet with high biodiversity conservation significance, based on the existence of habitat of significant importance to critically endangered or endangered species, restricted range or endemic species, globally significant concentrations of migratory and/or congregatory species, highly threatened and/or unique ecosystems and key evolutionary processes (International Finance Corporation 2019)
Cultural services	The experiential and intangible service related to the perceived or actual qualities of ecosystems whose existence and functioning contributes to a range of cultural benefits (United Nations 2021)
Disbenefits	The disadvantages or losses to an entity or society from ecosystem services generated by natural capital (Authors' definition)
Disclosure metrics	Metrics required to be disclosed to market participants in line with the TNFD's disclosure recommendations (TNFD 2023)
Ecosystem accounting area	The geographical territory for which an ecosystem account is compiled (United Nations 2021)
Ecosystem asset	Contiguous spaces of a specific ecosystem type characterised by a distinct set of biotic and abiotic components and their interactions (United Nations 2021)
Ecosystem condition	The quality of an ecosystem measured in terms of its abiotic and biotic characteristics (United Nations 2021)
Ecosystem degradation	The decrease in the value of an ecosystem asset over an accounting period that is associated with a decline in the condition of an ecosystem asset during that period (United Nations 2021)
Ecosystem enhancement	The increase in value of an ecosystem asset over an accounting period that is associated with an improvement in the condition of the ecosystem asset during that accounting period (United Nations 2021)
Ecosystem services	The contributions of ecosystems to the benefits are used in economic and other human activity (United Nations 2021)
Exchange values	The values at which goods, services, labour or assets are in fact exchanged or else could be exchanged for cash (United Nations 2021)
Final ecosystem services	Those ecosystem services in the user of the service is an economic unit (United Nations 2021)
General ledger	A ledger in which accounting data are posted from journals and aggregated from subledgers

TERM	DEFINITION
Impact drivers	A measurable quantity of a natural resource that is used as an input to production (e.g., volume of sand and gravel used in construction) or a measurable non-product output of business activity (e.g., a kilogram of NOx emissions released into the atmosphere by a manufacturing facility). (Capital Coalition 2016).
Indicator	Rescaled version of variables, where variables are rescaled relative to reference values of the variable (Czúcz et al. 2021)
Intermediate ecosystem services	Those ecosystem services in which the user of the ecosystem service is an ecosystem asset and there is a connection to the supply of final ecosystem services (United Nations 2021)
Liability	A present obligation of the entity arising from past events, the settlement of which is expected to result in an outflow from the entity of resources embodying economic benefits (IAS 37)
Ledger	A book to which debits and credits are posted. A ledger is created for each account in a chart of accounts
Materiality assessment	The process that involves identifying what is (or is potentially) material in relation to a natural capital assessment's objective and application
Natural capital	The stock of renewable and non-renewable natural resources (e.g., plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people (Capitals Coalition 2016)
Natural capital dependency	A business reliance on or use of natural capital (Capital Coalition 2016)
Natural capital impact	The negative or positive effect of a business activity on natural capital (Capital Coalition 2016)
Nature-related risks	Potential threats posed to an organisation linked to their wider societies' dependencies on nature and nature impacts (TNFD 2023)
Physical risks	Risks that arise as a direct result of an organisation's dependence on nature. Physical risks arise when natural systems are compromised, due to the impact of climatic events (e.g., extremes of weather such as a drought), geologic events (e.g., seismic events such as an earthquake) events or changes in ecosystem equilibria, such as soil quality or marine ecology, which affect the ecosystem services organisations depend on (TNFD 2023)
Transition risks	Risks that result from a misalignment between an organisation's or investor's strategy and management and the changing regulatory, policy or societal landscape in which it operates (TNFD 2023)
Systemic risks	Risks arising from the breakdown of the entire system, rather than the failure of individual parts (TNFD 2023)
Nature-related opportunities	Activities that create positive outcomes for organisations and nature by creating positive impact on nature or mitigating negative impacts on nature (TNFD 2023)
Non-renewable resources	Materials provided by nature that can be used for production or consumption. Non-renewable resources will not regenerate within timeframes useful for economic activity. Adapted from (Capitals Coalition 2016)
Provisioning services	Those ecosystem services representing the contributions to benefits that are extracted or harvested from ecosystems (United Nations 2021)
Regulating and maintenance services	Those ecosystem services resulting the ability of ecosystems to regulate biological processes and to influence climate, hydrological and biochemical cycles and thereby maintain environmental conditions beneficial individuals and society (United Nations 2021)
Renewable resources	Materials provided by nature that can be used for production or consumption. Renewable resources may be used indefinitely provided the rate of use does not exceed the rate of exploitation. Adapted from (Capitals Coalition 2016)
Revaluations	Changes in the value of ecosystem assets over an accounting period that are due solely to movements in the units process of ecosystem services that underpin the derivation of the net present value of ecosystem assets (United Nations 2021)
Variable	Quantitative metrics describing individual characteristics of an ecosystem asset (Czúcz et al. 2021)
Welfare value	The contribution of an asset or service to human wellbeing, regardless of its contribution to the economy

References

Australian Government. 2023. *Greenhouse gases and energy*. Clean Energy Regulator

BHP. 2023. *Natural capital accounting for the mining sector; beenup site pilot case study.* BHP, Perth, Western Australia

British Standards Institution. 2021a. *Natural capital accounting for organisations - Specification*. The British Standards Institution Standards Publication

British Standards Institution. 2021b. *Natural capital accounting for organsations: specification*. BSI Standards Ltd

Butler, D. 2020. *Land Restoration Fund (LRF) Native Vegetation monitoring method*. Accounting for Nature

Capitals Coalition. 2016. *Natural Capital Protocol*

CIMA. 2023. *Management Accountant: Roles, Functions, Qualifications, & Careers*. American Council of Professional Accountants

Czúcz, B., H. Keith, J. Maes, A. Driver, B. Jackson, E. Nicholson, M. Kiss, and C. Obst. 2021. *Selection criteria for ecosystem condition indicators*. Ecological Indicators 133:108376

Dasgupta, P. 2021. *The economics of biodiversity: the Dasgupta Review*. HM Treasury, London

eftec. 2015. *Developing corporate natural capital accounts*. EFTEC, London

Eyre, T. J., A. L. Kelly, V. J. Nelder, B. A. Wilson, D. J. ferguson, M. J. Laidlaw, and A. J. Franks. 2015. *A condition assessment framework for terrestrial biodiversity in Queensland*. Queensland Herbarium, Queensland Australia

Finance for Biodiversity. 2022. *Guide for biodiversity measurement approaches; annex on Assessing Impact to Pledge Guidance*

Forestry England. 2021. *Natural capital accounts for the nations forests 2020-21*. Forestry England, United Kingdom

Forico. 2020. *Natural Capital Report 2020 of the Tasmanian Forest trust for the year ended 30 June 2020*. Forico Pty Ltd, Launceston, Tasmania

Hartford-Davis, S., and Z. Bush. 2023. *Nature-related risks and directors duties: Joint Memorandum of Opinion 24th October 2023*. Pollination in collaboration with the Commonwealth Climate and Law Institute

Hayes, A. 2021. *Double Entry: What It Means in Accounting and How It's Used*. Investopedia

Horner, C., A. O'Grady, S. Ogilvy, H. Mayadunne, and T. M. Zhao. 2022. *Accounting and Accountability for No Net Loss of Biodiversity.* AASB Research Centre Working Paper 4

IASB. 2018a. *Conceptual Framework for Financial Reporting*. International Accounting Standards Board

IASB. 2018b. *IAS 1 Presentation of Financial Statement*s. IFRS Foundation

ICMM. 2024. *Supporting a Nature Positive Future*

IFRS Foundation. 2023. Climate-related Commitments (IAS 37)

International Accounting Standards Board. 2022. *IAS 37-Provisions, Contingent Liabilities and Contingent Assets*. IFRS

International Finance Corporation. 2019. *Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources*. Page 251. World Bank Group

ISO. 2019. *Monetary valuation of environmental impacts and related environment aspects*. International standards Organisation

ISSB. 2023. IFRS S1 *General Requirements for disclosure of Sustainability-related Financial Information.* International Sustainability Standards Board

Keith, D. A., J. R. Ferrer-Paris, E. Nicholson, and R. Kingsford. 2020. *IUCN Global Ecosystem Typology 2.0: Descriptive profiles for biomes and ecosystem functional groups*. International Union for Conservation of Nature and Natural Resources, Gland, Switzerland

Liberto, D. 2022. *Chart of Accounts (COA) Definition: Examples and How It Works*. Investopedia

NYU STERN. 2019. *Sustainbility materilaity matrices explained*. Centre for Sustainable Business

O'Grady, A. P., E. A. Pinkard, R. Mount, B. Schmidt, I. Cresswell, and S. Stewart. 2020. *Conceptual modelling to support natural capital accounting of a forestry enterprise*. CSIRO Land and Water, Hobart, Australia

Office for National Statistics. 2017. *Principles of Natural Capital Accounting: A background paper for those wanting to undertsand the concepts and methodology unedrlying Natural capital accounts being developed by ONS and Defra*. Office of National Statistics, United Kingdom

Ogilvy, S. 2020. *Toward a methodology for incorporating ecological capital into the acounts of indivdual entitiies*. Australian National University, Canberra

Ogilvy, S., D. O'Brien, R. Lawrence, and M. Gardner. 2022. *A natural capital accounting framework to communicate the environmental credentials of individual wool-producing businesses.* Sustainability Accounting, Management and Policy Journal 13:765-802

Peters, R. M., and D. R. Emery. 1978. *The role of negative numbers in the development of double entry bookkeeping*. Journal of Accounting Research 16:424-426

Richards, A. E., F. Dickson, K. J. Williams, G. D. Cook, S. Roxburgh, H. Murphy, M. Doherty, A. Warnick, D. Metcalfe, and S. M. Prober. 2020. T*he Australian Ecosystem models Framework project: a conceptual framework*. CSIRO, Australia

Secretariat of the Convention on Biological Diversity. 2020. *Global Biodiversity Outlook 5-summary for policy makers*. Montreal

Smith, G. S., F. Ascui, A. P. O'Grady, and E. A. Pinkard. 2022. *Handbook for natural capital accounting, reporting and risk assessment: Forestry*. National Institute for Forest Products Innovation, Hobart

Smith, G. S., F. A. Ascui, A. P. O'Grady, and E. A. Pinkard. 2023. *The Natural capital handbook: A practical guide to corporate natural capital accounting, assessment, risk assessment and reporting*. CSIRO Environment

Stewart, S., and A. P. O'Grady. 2020. *Experimental natural capital accounts for the forestry sector in the Green Triangle*. CSIRO Land and Water

Tamplin, T. 2023. *Management Accounting*. Finance Strategists

TEEB. 2018. *TEEB for Agriculture and Food: Scientific and Economic Foundations*. UN Environment, Geneva

TNFD. 2023. *The TNFD Nature-related risk and opportunity Management and Disclosure Framework Neta v0.4 Annex 4.3 Disclosure Metrics Annexes*. Taskfore on Nature-related Financial Disclosures

Tuovila, A. 2022. *Managerial Accounting: Meaning, Pillars and Types.* Investopedia

United Nations. 2008. *System of National Accounts*. United Nations, New York

United Nations. 2014. *System of Environmental and Economic Accounting 2012-Central Framework*. United Nations, New York

United Nations. 2021. *System of Environmental-Economic Accounting-Ecosystem Accounting (final draft)*. Department of Economic and Social Affairs-Statistics Division

Appendix 1 General Principles

MATERIALITY

Materiality is already well-established in financial and sustainability reporting and disclosure and is equally relevant to natural capital. Definitions of materiality are provided in Table 19. A common theme in all these definitions is that materiality is grounded in the concepts of relevance, importance, and consequence.

Materiality assessments are focused on identifying, collating and presenting relevant information in a manner that would help an internal or external stakeholder assess the information to inform their decision-making. As such, assessments of materiality should involve engagement with relevant stakeholders. Relevant stakeholders are any group or individual relying on the information provided for decision-making purposes.

Table 19 Definitions of materiality used in financial, sustainability and natural capital reporting

FINANCIAL	SUSTAINABILITY	NATURAL CAPITAL
Information is material if omitting, misstating or obscuring it could be reasonably expected to influence decisions that the primary users of general purpose financial reports make on the basis of those reports (IASB 2018b)	A material sustainability issue is an economic, environmental or social issue on which a company has an impact or may be impacted by. It may also be one that significantly influences the assessments and decisions of stakeholders. (NYU STERN 2019)	An impact or dependency on natural capital is material if consideration of its value, as part of a set of information used for the decision, has the potential to alter that decision (Capitals Coalition 2016)
	Materiality refers to an organisation's significant economic, environmental or social impacts, or to issues that substantively influence the assessment and decisions of stakeholders (GRI cited in (NYU STERN 2019))	
	An issue is material if it could substantively affect the organisation's ability to create value in the short medium and long-term (IIRC cited in (NYU STERN 2019))	

MANAGEMENT ACCOUNTS

The purpose of accounting for management purposes is to provide information that facilitates organisational decision-making. As such, management accounting differs to financial accounting in that management accounting is directed towards an internal audience (managers), whereas the intended audience of financial accounting are external users who have a financial interest in the organisation, namely investors, lenders and creditors.

Given the internal focus, the preparation of management accounts is not subject to any regulation, and the accounts may be presented in the form that best suits the organisation to help achieve their specific objectives. Conversely, general-purpose financial reports must meet the needs of a wide range of users with disparate needs and varying levels of expertise, in order to provide information that is useful for decision-making with respect to the allocation of financial resources (IASB 2018a, Tuovila 2022, Tamplin 2023).

The practice of accounting is based on the double-entry bookkeeping system, which states that every transaction has an equal and opposite effect in at least two different accounts. The double entry system ensures that the accounting equation (Assets = Liabilities + Equity) always holds true, as assets are recognised as having a debit balance, while liabilities and equity are credit balances (Hayes 2021).

Debits and credits are used to denote increases and decreases, because the earliest written work on the double-entry bookkeeping system (published in 1494) predates the use of negative numbers in mathematical theory (Peters and Emery 1978). Debits and credits offset each other when recorded in the general ledger (Hayes 2021).

For NCA to be truly effective in a corporate setting, it will need to move towards these general accounting principles, which will involve the development of a chart of natural capital accounts to support a double-entry NCA system. Just as financial activities are recorded, environmental activities would be recorded as debits and credits in a general ledger, which would then enable reports to be prepared for both internal management accounting purposes, as well as external natural capital reporting.

> "Management accounting systems and related forms should be used only as long as they serve a useful purpose[7]"

While management accounts can be tailored to be in any form that is useful for internal users, external general-purpose natural capital reports should move towards a consistent format that external users are familiar with and can understand, with 'understandability' being one of the enhancing characteristics that information should possess to be useful for decision-making.

One way to do this is to make the format of general-purpose natural capital reports as similar as possible to general-purpose financial reports, which will involve the production of a balance sheet and income statement at the least.

Presentation of accounts

The compilation of ecosystem accounts is an undertaking that generates significant amounts of information on the underlying ecosystem assets. Ecosystem accounts can be presented in tabular forms, as graphs, as maps, and various combinations of the three (Stewart and O'Grady 2020).

The generated accounts should provide management relevant information with due consideration of the organisation's targets or benchmarks. In this guidance, the recommended framing for natural capital accounts draws largely of the System of Environmental and Economic Accounting (United Nations 2021), which provides formats for the presentation of accounts. These formatting conventions are adopted in this guidance.

Towards a natural capital chart of accounts

A chart of accounts is an index of all the accounts in an organisation's general ledger. The chart of accounts lists the accounts according to whether they are classified as 'assets', 'liabilities', 'equity', 'income', or 'expenses', with the sub-accounts varying according to the specific nature of the business (Liberto 2022).

Development of a natural capital chart of accounts will be important for any organisation looking to commit to ongoing NCA. Figure 12 provides an example of what a chart of natural capital accounts may look like.

The suggested asset account names and account codes for environmental resources are consistent with the SEEA-CF classifications of environmental asset types. Note that not all accounts displayed in Figure 12 will be relevant for all organisations, and it will be up to individual organisations to determine which accounts best represent their interactions or transactions with the natural environment.

As noted above, assets have a debit balance, while liabilities and equity, on the other side of the accounting equation, have credit balances. Thus, an asset is increased by debit entry in the general ledger and decreased by a credit entry. Conversely, liabilities and equity are increased by a credit entry, and decreased by a debit entry. The purpose of ecosystem assets is to generate ecosystem services (or natural capital 'income'), which increases natural capital equity. Accordingly, income is recognised with a credit entry, while expenses (which decrease equity) are recognised as a debit entry. These effects are displayed in Figure 13.

MONETARY VALUATION

The terms 'value', 'price' and 'cost' are commonly used interchangeably. However, they are not in fact equivalent. Nature is clearly a source of great value, yet many of the services that come from nature are not bought or sold in markets and therefore do not have market prices.

The value of a natural asset may therefore be quite different from its market price, if one exists. Similarly, the value produced by a natural asset may be quite different to the costs associated with maintaining or enhancing the asset.

- **Exchange values** represent the contribution of an asset or service to the economy, regardless of its impact on human welfare. The exchange value does not capture the total value provided by ecosystem goods and services, but rather accounts more pragmatically for the values of those goods or services as if traded. For most market goods, exchange value data is readily available. However, for natural capital and ecosystem services, most of which are not traded in markets, it is impossible to observe an exchange value and instead exchange values need to be imputed.

Exchange values should be used in national and financial accounting. However, there may be other policy or business reasons behind the decision to create natural capital accounts (some of which might require a broader concept of value) and therefore the use of exchange values may be less essential.

Using concepts such as welfare values within natural capital accounts is possible; however, it is important to note that in such cases there may not be consistency between the valuation of services valued at market rates and other non-market services, and this should be made clear in the accounts.

ECOSYSTEM ACCOUNTING AREA

The **ecosystem accounting area** is the defined geographical area for which an ecosystem account is compiled. It needs to be defined by the reporting entity as part of the framing stage of the natural capital accounts.

Typically, the ecosystem accounting area might represent the physical footprint (as defined by tenure boundaries) of the organisation. However, depending on the purpose of the assessment, the ecosystem accounting area may include areas outside of the organisation's tenure, for example, some defined area of influence.

[7] https://accountlearning.com/principles-management-accounting/

Assets NCA1-0000 (DR)	
Account Code	***Suggested Account Name***
NCA1-0000	Assets
NCA1-1000	Environmental resources
NCA1-1100	Mineral and energy resources
NCA1-1110	Oil resources
NCA1-1120	Natural gas resources
NCA1-1130	Coal and peat resources
NCA1-1140	Non-metallic mineral resources
NCA1-1141	Mineral sands reserves
NCA1-1150	Metallic mineral resources
NCA1-1200	Land
NCA1-1300	Soil resources
NCA1-1400	Timber resources
NCA1-1410	Cultivated timber resources
NCA1-1420	Natural timber resources
NCA1-1500	Aquatic resources
NCA1-1510	Cultivated aquatic resources
NCA1-1520	Natural aquatic resources
NCA1-1600	Other biological resources
NCA1-1610	Seed reserves
NCA1-2000	Ecosystem resources
NCA1-2100	Terrestrial ecosystems
NCA1-2110	Pasture ecosystems
NCA1-2120	Native ecosystems
NCA1-2200	Aquatic ecosystems
NCA1-2300	Marine ecosystems

=

Liabilities NCA2-0000 (CR)	
Account Code	***Suggested Account Name***
NCA2-0000	Liabilities
NCA2-1000	Environmental Liabilities
NCA2-2000	Ecosystem Liabilities
NCA2-2100	Terrestrial ecosystems
NCA2-2110	Pasture ecosystems
NCA2-2120	Native ecosystems
NCA2-2200	Aquatic ecosystems
NCA2-2300	Marine ecosystems

+

Equity NCA3-0000 (CR)	
Account Code	***Suggested Account Name***
NCA3-0000	Equity
NCA3-1000	Contributions from nature
NCA3-2000	Retained surplus/ (Accumulated losses)
NCA3-3000	Current year surplus/ (Deficit)
NCA3-4000	Reserves
NCA3-4100	Asset revaluation reserve
NCA3-4200	Asset reappraisal reserve
NCA3-4300	Asset enhancement reserve
NCA3-4400	Environmental resource valuation reserve

Current year surplus/(deficit) =

Services income NCA4-0000 (CR)	
Account Code	***Suggested Account Name***
NCA4-0000	Services required
NCA4-1000	Provisioning services
NCA4-1100	Water supply
NCA4-1200	Seed supply
NCA4-1300	Grazing support
NCA4-2000	Regulating and maintenance services
NCA4-2100	Soil and sediment retention
NCA4-2200	Water purification
NCA4-3000	Cultural services
NCA4-3100	Recreation
NCA4-3200	Education, science and research
NCA4-4000	Other comprehensive income
NCA4-4100	Gains on revaluations

-

Services expended NCA5-0000 (DR)	
Account Code	***Suggested Account Name***
NCA5-0000	Services expended
NCA5-1000	Ecosystem disservices
NCA5-2000	Environmental resources losses
NCA5-2100	Mineral resource losses
NCA5-3000	Ecosystem losses
NCA5-3100	Losses due to operating activities
NCA5-3200	Losses due to external activities
NCA5-3300	Losses due to changes in market values
NCA5-4000	Ecosystems services foregone
NCA5-4100	Foregone due to operations
NCA5-4200	Foregone due to external events

Figure 12 An example chart of natural capital accounts

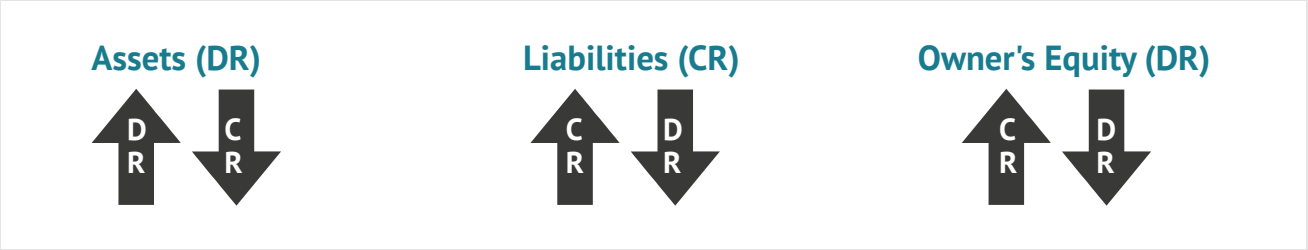


Figure 13 The effect of debit and credit entries on account balances

The ecosystem accounting area should be clearly defined to avoid the potential of double counting when aggregating different accounting areas under the organisation's control or in regional and national accounting exercises.

For mining operations, defining the ecosystem accounting area may be a challenge due to the frequent changes to land tenure associated with expansion and contraction of the mining lease area, lands purchased or leased for buffers or future expansion, and transfers to third parties.

A solution would be to include the full area owned or controlled (including leased) by the entity, and which would normally appear on the company's financial accounts.

ECOSYSTEM AND ENVIRONMENTAL ASSETS

Natural capital assets are defined as "the naturally occurring living and non-living components of the Earth, together constituting the biophysical environment, which may provide benefits to humanity" (SEEA-CF 2014, para. 2.17).

The SEEA standards draw a distinction between **ecosystem assets** (areas of specific ecosystem types, covered in SEEA-EA) and other individual components of the environment – **environmental assets** such as mineral deposits, land, water and energy resources (covered in the SEEA-CF). Many environmental assets are generally already accounted for within corporate financial accounting standards.

Overlap between environmental and ecosystem assets can exist (e.g., water resources can be considered an individual environmental asset but also that those water resources are part of an aquatic ecosystem asset providing a number of ecosystem services).

Where this occurs, then care should be taken to avoid double counting, especially when different accounting methods are used for individual components versus the ecosystem.

In general, ecosystem assets are usually valued using the net present value of future ecosystem service flows (see natural capital monetary flow account), whereas individual environmental assets are more often valued on their market value.

If transparently described the difference between values for ecosystem assets and individual environment assets may be instructive, for example, in highlighting that the market for water resources does not currently capture the value of other ecosystem services provided by aquatic ecosystems.

CRC TiME
Transformations in Mining Economies

E hello@crctime.com.au
T +61 (08) 9263 9805
W www.crctime.com.au

Part of the Australian Government's flagship CRC Program, the Cooperative Research Centre for Transformations in Mining Economies (CRC TiME), brings together diverse stakeholders to help re-imagine and transform mine closure and transitions for the better. It is the world's only dedicated research focused on what happens after mining ends.

Australian Government
Department of Industry, Science and Resources

Cooperative Research Centres Program