PBAF Partnership for Biodiversity Accounting Financials

Taking biodiversity into account

PBAF Standard v2023 - Assessment of Dependencies on ecosystem services

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Assessment of Dependencies on ecosystem services

Through the PBAF Standard, we share the results of discussions with PBAF partners (financial institutions), data providers and other experts on biodiversity impact and dependency assessment. We encourage financial institutions to adopt biodiversity impact assessment and the assessment of dependencies on ecosystem services as a positive step towards a nature inclusive way of operating. We encourage methodology developers, data providers and financial institutions to align approaches, meeting the PBAF requirements and recommendations presented.

The PBAF Standard consists of four separate publications:
- PBAF Q&A – Introduction to biodiversity impact assessment
- PBAF Standard v2022 Biodiversity impact assessment – Overview of approaches
- PBAF Standard v2022 Biodiversity impact assessment – Footprinting
- PBAF Standard v2023 Assessment of Dependencies on ecosystem services

The PBAF Standard is periodically updated.

An overview of PBAF partners and supporters is available on the PBAF website (pbafglobal.com).

PBAF is an independent foundation based in the Netherlands and is co-funded by the PBAF partners, the IKEA Foundation and the Dutch government.

We welcome financial institutions to join the PBAF initiative. For more information, visit the PBAF website (www.pbafglobal.com) or contact us (info@pbafglobal.com).

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Foreword

In a time defined by unprecedented environmental challenges, it has become increasingly clear that our economic and financial systems are inextricably linked to the health and well-being of our planet. As the impacts of climate change and biodiversity loss continue to escalate, the need for collective action and responsible decision-making has never been more pressing. Investors and society at large face growing risks due to our reliance on nature and biodiversity and the depletion of natural resources, habitat destruction, and the loss of biodiversity pose not only ecological challenges but also financial and societal ones.

I am therefore excited to introduce an important addition to the PBAF Standard: the PBAF Standard v2023 Assessment of Dependencies on ecosystem services. Building on, among others, the pioneering work of the UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) and the ENCORE knowledge base, the PBAF Standard aims to contribute to a standardised, science based, robust and consistent assessment of dependencies on eco-system services that is both transparent and fit for purpose.

The standard complements the other parts of the PBAF Standard published in 2022, including a Q&A on biodiversity impact assessment, an Overview of impact assessment approaches and a module dedicated to Biodiversity footprinting. Developed in close cooperation with the PBAF partners, these modules offer practical guidance on impact & dependency assessment in the financial sector and contribute to standardisation and mainstreaming.

With the Dependencies standard, we hope to effectively support financial institutions in the assessment of dependency related risks and opportunities, the result of which can feed into the 'Evaluate' step of TNFD's LEAP approach and into CSRD and GRI disclosures. We encourage methodology developers, data providers and financial institutions to align with the PBAF requirements and recommendations presented.

Roel Nozeman
PBAF Programme Director

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1 Introduction

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All businesses depend on nature and the ecosystem services nature provides, either directly or indirectly through value chains. By assessing the dependencies on ecosystem services of the companies/assets in an investment portfolio or of a single investment, it becomes clear to what extent loans and investment may run a financial risk when the provision of ecosystem services is affected, e.g. by the loss of biodiversity. For example, research by the Dutch Central Bank and PBL Netherlands Environmental Assessment Agency[1] (PBL) has shown that the dependency on ecosystem services like pollination may pose a significant financial risk to the Dutch financial sector.

Biodiversity, natural capital and ecosystem services

The value of biodiversity is often explained through the services biodiversity underpins (see figure 1). Or, as described in the Natural Capital Protocol[2]: "Biodiversity is critical to the health and stability of natural capital as it provides resilience to shocks like floods and droughts, and it supports fundamental processes such as the carbon and water cycles as well as soil formation. Therefore, biodiversity is both a part of natural capital and also underpins ecosystem services."

Figure 1: Natural capital stocks, flows, and values (Natural Capital Protocol, 2016)

Figure 1 shows how biodiversity, natural capital, ecosystem services and benefits to business and society relate to each other. A loss of biodiversity may result in the loss of ecosystem services and benefits to business, including the financial sector.

Ecosystem services are defined as *'The contributions of ecosystems to the benefits that are used in economic and other human activity'*[3]. Ecosystem services can be classified in different ways. The Common International Classification of Ecosystem Services (CICES) distinguishes Provisioning services, Regulation & Maintenance services and Cultural services. Each of these types of services can be split into more specific ecosystem services. Examples of ecosystem services include (not a comprehensive overview): the provision of fresh water and raw materials (provisioning services), water regulation, erosion regulation and pollination (regulating services) and spiritual and religious values (cultural services). Note that a dependency assessment may only include a selection of ecosystem services (see also paragraph 3.3).

Impacts and dependencies may be linked

A company's impacts on biodiversity and dependencies on ecosystem services may be linked. For example, a company depending on the availability of water for its operations may contribute to water scarcity and impact on biodiversity through its water use. Through its impacts, a company may affect the provision of ecosystem services it depends on. It is important to realise that a company may also affect the ecosystem services other stakeholders depend on. Furthermore, the provision of ecosystem services to the company may also be affected by other stakeholders that impact on and maybe also depend on the same ecosystem services.

1 DNB, PBL, 'Indebted to nature; Exploring biodiversity risks for the Dutch financial sector', June 2020
2 Natural Capital Coalition, 'Natural Capital Protocol', 2016.
3 United Nations et al. (2021). System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA EA). White cover publication, pre-edited text subject to official editing. Available at: https://seea.un.org/ecosystem-accounting.

A financial institution's focus should be one of 'double materiality', both looking at the impacts of its loans and investments on nature (potentially also affecting society) and the financial impact of (the loss of) nature on the financial institution itself.

The ENCORE knowledge base

Experience with the assessment of dependencies in the financial sector is still limited, but growing. One of the first initiatives in this area is the ENCORE knowledge base (Exploring Natural Capital Opportunities, Risks and Exposure)[4]. ENCORE enables users to visualise how the economy depends on nature and how environmental change creates risks for businesses. Starting from a business sector, ecosystem service, or natural capital asset, ENCORE can be used to explore natural capital risks.[5] Like any other tool, ENCORE has certain limitations, some of which will be addressed in this document. An overview of limitations is also provided on the ENCORE website.[6]

The results of a dependency assessment can be used as an input to the identification of nature related financial risks, potentially following the 'LEAP process' of the TNFD Framework, and as an input to voluntary or mandatory disclosures, like the Global Reporting Initiative (GRI) and the Corporate Sustainability Reporting Directive (CSRD), see chapter 2. Moreover, Article 15 of the Global Biodiversity Framework[7], specifically refers to the fact that large and transnational companies and financial institutions should regularly monitor, assess, and transparently disclose their risks, dependencies and impacts on biodiversity.

NB: The assessment of dependencies discussed here is limited to the identification of physical risks resulting from the loss of ecosystem services *on which companies and production processes depend*. As mentioned, a company may also impact on ecosystem services that *other stakeholders depend on*, potentially resulting in transitional risks, like reputational damage and legal risks. An assessment of these risks will be covered in future updates of the PBAF Standard.

Similar to the assessment of biodiversity impacts (addressed in other parts of the PBAF Standard), it is important that a dependency assessment delivers information that is science based, robust, consistent and fit for purpose[8]. The limitations of a dependency assessment must be clear, as well as the interpretation and use of the results. This part of the PBAF Standard provides guidance on the assessment of dependencies and requirements and recommendations for data providers and financial institutions to comply with.

This document builds on guidance provided in the following publications and initiatives:

- ENCORE website: https://encore.naturalcapital.finance/en
- TNFD (March 2023), The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework Beta v0.4, Annex 4.5 Financial institutions metrics supplement'.
- UNEP-WCMC, Capitals Coalition, Arcadis, ICF, WCMC Europe (2022) Recommendations for a standard on corporate biodiversity measurement and valuation, Aligning accounting approaches for nature.

4 Natural Capital Finance Alliance (Global Canopy, UNEP FI, and UNEP-WCMC) (2023). ENCORE: Exploring Natural Capital Opportunities, Risks and Exposure. [On-line], 2023, Cambridge, UK: the Natural Capital Finance Alliance. Available at: https://encore.naturalcapital.finance. DOI: https://doi.org/10.34892/dz3x-y059.

5 It is important to note that ENCORE was designed to consider broader natural capital rather than biodiversity per se. Hence it considers components of biodiversity i.e. species and habitats, but not the connections between them. It is therefore a good starting point for analysis of nature related dependencies, but does not fully encompass biodiversity. ENCORE does include a 'Biodiversity module' focusing on portfolio alignment with biodiversity goals, focusing initially on mining and agriculture.

6 https://encore.naturalcapital.finance/en/data-and-methodology/limitations

7 Convention on Biological Diversity (CBD) (19 December 2022), Kunming-Montreal Global Biodiversity Framework

8 Also see paragraph 1.5 in the publication 'Recommendations for a standard on corporate biodiversity measurement and valuation, Aligning accounting approaches for nature', UNEP-WCMC, Capitals Coalition, Arcadis, ICF, WCMC Europe, 2022

- United Nations Environment Programme (2023), Nature Risk Profile: A methodology for profiling nature related dependencies and impacts. Cambridge, United Kingdom.
- PRé, CREM (2021), Biodiversity impact and ecosystem services dependencies; Integration of dependencies using the BFFI and ENCORE.
- WWF Biodiversity Risk Filter (2023). WWF Biodiversity Risk Filter Methodology Documentation.
- UN Environment Programme (2023). Towards a robust measurement of business dependencies on nature. UNEP–WCMC, Cambridge, UK.

Feedback on the draft Standard was provided by the PBAF Sounding Board, including civil society organisations, nature conservation organisations and experts on impact and dependency assessment. Even though this feedback was taken into account as much as possible, the Standard does not necessarily reflect the opinion of the members of the Sounding Board.

The guidance provided in this document is mainly based on the use of ENCORE[9], which is currently the main initiative offering a knowlegde base for conducting a dependency assessment. Tools like the WWF Biodiversity Risk Filter (WWF BRF or BRF) build on data from ENCORE in the assessment of ecosystem services dependencies[10]. Other tools may transform the data provided by ENCORE (e.g., by attributing a score to the different materiality levels) and combine the data with other information (e.g., information on the relevance of ecosystem services and the state of ecosystem services) to fit their purpose.

In the coming years, other databases providing dependency data may be developed, either or not based on the ENCORE data. For this reason, the requirements and recommendations presented in this section are formulated in such a way that they also apply to dependency assessments using other databases.

> *The target group of this PBAF Standard is not just financial institutions planning to conduct a dependencies assessment, but also data providers offering dependency data to financial institutions. Financial institutions can use the guidance offered in this Standard to gain a better understanding of the steps involved in a dependencies assessment, the potential challenges and the disclosure of results. Both data providers and financial institutions are invited to use the Standard to align their approaches with the PBAF Standard requirements and recommendations.*

The tools and databases focusing on an assessment of ecosystem services are developing fast. For example, a new version of ENCORE is already under development. This means that this standard will be updated on a regular basis.

Reader

Chapter 2 starts with an overview of the uses of a dependency assessment, including an explanation of where a dependency assessment fits within the LEAP process of the TNFD.

In chapter 3, a description is provided of the steps in a dependency assessment. For each step, PBAF Standard Requirements (R) and Recommendations (A = Advice) are presented.

Chapter 4 includes a few concluding remarks on the assessment of dependencies on ecosystem services.

An overview of ecosystem services included in the ENCORE knowledge base is provided in Annex 1.

A summary of PBAF Requirements and Recommendations is provided in Annex 2.

9 ENCORE, https://encore.naturalcapital.finance/en
10 WWF Biodiversity Risk Filter, https://riskfilter.org/biodiversity/home

Glossary

The definitions below are (partly) derived from the 'Align recommendations'[11], the TNFD Nature-related Risk & Opportunity Management and Disclosure Framework[12] and ENCORE[13].

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 part; this includes diversity within species, between species and of ecosystems.
Dependency	A business reliance on or use of biodiversity and associated ecosystem services.
Direct dependencies	Dependencies occurring in scope 1 or the direct operations of a company.
Indirect dependencies	Dependencies occurring upstream or downstream in the value chains of a. company
Ecosystem	A dynamic complex of plants, animals, and microorganisms, and their non-living environment, interacting as a functional unit (e.g. deserts, coral reefs, wetlands, and rainforests).
Ecosystem condition/integrity[14]	The quality of an ecosystem measured in terms of its abiotic and biotic characteristics. Condition is assessed with respect to an ecosystem's composition, structure and function which, in turn, underpin the ecological integrity of the ecosystem, and support its capacity to supply ecosystem services on an ongoing basis. Measures of ecosystem condition may reflect multiple values and may be undertaken across a range of temporal and spatial scales.
Ecosystem type	A distinct set of abiotic and biotic components and their interactions (UN SEEA. 2021. System of Environmental-Economic Accounting – Ecosystem Accounting: Final Draft). Note that countries may have different classifications of ecosystem types, which may have implications for adherence to the equivalency principle, notably in the context of no-net-loss requirements. The IUCN has developed a Global Ecosystem Typology (GET) to support the development of its Red List of Ecosystems, however a standardised, universal classification system for ecosystems does not currently exist.
Ecosystem services	The contributions of ecosystems to the benefits that are used in economic and other human activity.
Materiality	An impact or dependency on biodiversity is material if consideration of its value, as part of the set of information used for decision-making, has the potential to alter that decision.
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.
Natural capital assets	Natural capital assets are specific elements within nature that provide the goods and services that the economy depends on.

11 UNEP-WCMC, Capitals Coalition, Arcadis, ICF, WCMC Europe (2022) Recommendations for a standard on corporate biodiversity measurement and valuation, Aligning accounting approaches for nature

12 TNFD, The TNFD Nature-related Risk & Opportunity Management and Disclosure Framework, Beta v0.1 Release, March 2022. Annex 1 – Glossary of key terms.

13 https://encore.naturalcapital.finance/en

14 Ecosystem condition and ecosystem integrity are often used interchangeably. However, while ecosystem condition refers to the overall quality of an ecosystem in terms of its characteristics, ecosystem integrity looks at the extent to which composition, structure, and function of an ecosystem fall within their natural range of variation.

2 Use of the results of a dependency assessment

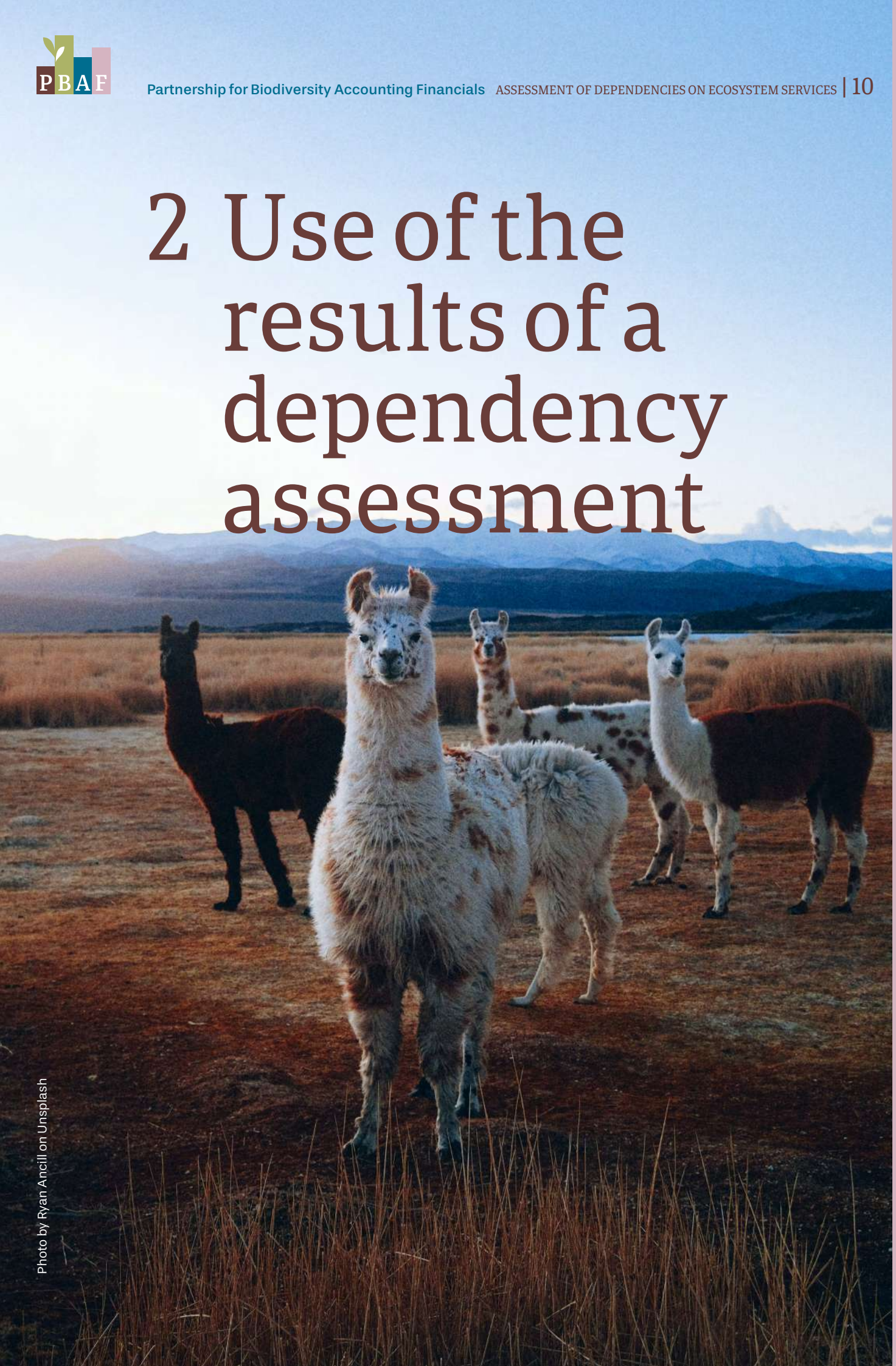


Photo by Ryan Ancill on Unsplash

Main uses of a dependency assessment include:

1. *To screen a loan and investment portfolio for potential direct (and possibly indirect) dependencies*
   To decide on the materiality of dependencies in a loan and investment portfolio, the number and the materiality of the dependencies per sector or sub-industry will need to be taken into account as well as the *financial exposure* to sectors or firms with material dependencies. This information can feed into a TNFD based assessment/disclosure of nature related financial risks (see point below) and other disclosures, like the (mandatory) Corporate Sustainability Reporting Directive (CSRD) or (voluntary) Global Reporting Initiative (GRI).

   Note that the focus of ENCORE is on potential *direct* dependencies, not yet on potential *indirect* (upstream, downstream) dependencies. Even when potential direct dependencies in a portfolio are limited, the indirect dependencies can still be significant.

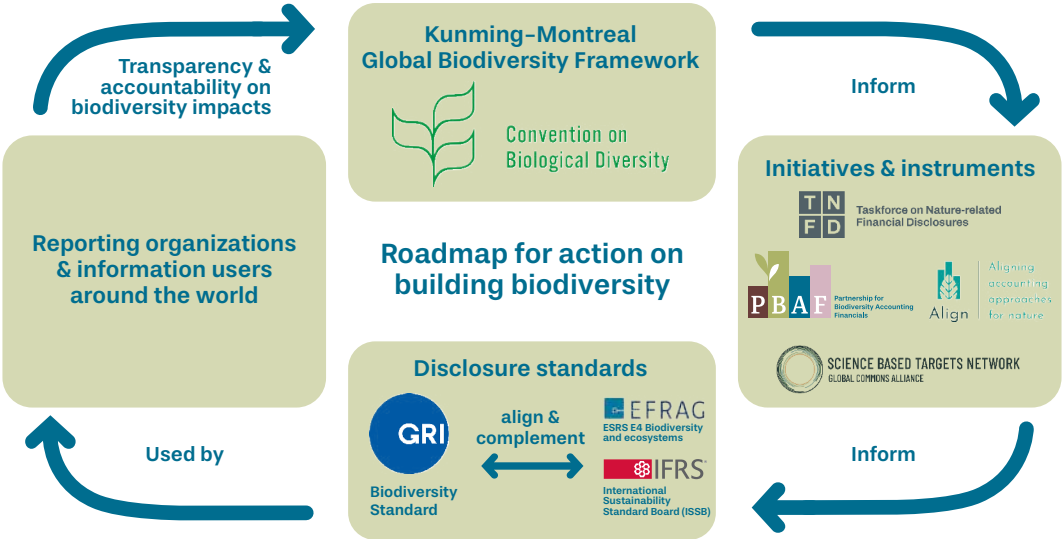


Figure 2: The disclosure landscape' (source: GRI website).

2. *To decide for which parts of a loan and investment portfolio more information should be gathered*
   For loans and investments with one or more highly material ecosystem services dependencies (level of materiality to be determined during the assessment), it is recommended to gather data on the location of the companies/assets involved and state of the ecosystem providing the ecosystem services (step 4 of the assessment). A dependency assessment (step 1-3) can be used as a prioritisation step, identifying potential hotspots in a portfolio in terms of sectors and companies to enable a deep dive into location specific data.

   Note that the need to gather more information is also true for portfolios which include financial corporates. The assessing financial institution should seek to understand what happens to the onward financial flows within those financial corporates. The direct dependency-based risk will be low, but the indirect dependency-based risk may be high.

3. *To assess potential financial risks as part of a TNFD assessment and disclosure*
   When the location of investees (and their production processes) is known, the information on dependencies can be combined with information on the state of the ecosystem and the provision of ecosystem services (step 4 of the assessment). This can be used to assess potential financial risks, e.g. what part of the investment portfolio (in value) is exposed to (material) dependencies on ecosystem services for which the provision is potentially at risk?

In this case the Locate step may follow the Evaluate step (Evaluate – Locate – Assess – Prepare: ELAP, instead of LEAP). More information can be found in the TNFD Framework v0.4 and the Annex 3.4 Illustrative Assessment and Disclosure Metrics for Financial Institutions[15].

THE USE OF DEPENDENCY METRICS IN TNFD

The results of the dependency assessment can be presented using different dependency metrics, reflecting the materiality of dependencies on a portfolio or asset level. The TNFD mentions the following illustrative dependency metrics for dependencies in the 'Beta v0.4 Annex 4.5 Financial institutions metrics supplement'[16]:

- **Exposure in millions (USD) to sectors or firms with high or medium dependency on ecosystem services**
- **Exposure as a percentage of total portfolio amount / value**
- **Top X firms in portfolio with high or medium dependency on ecosystem services**

These metrics can be broken down by ecosystem service, by sector and/or by geography, e.g. country or biome (at this point in time, breaking down by geography is less likely on a portfolio level, unless the availability of asset location data is improved).

Similarly, the global core risk and opportunity disclosure metrics (organisational level) include nature related risk indicators that will (among others) require a dependency assessment, including[17]:

- **C 1.0 Proportion and total annual revenue exposed to 1) physical risks and 2) transition risks**
- **C 1.1 Proportion and value of assets exposed to nature-related 1) physical risks and 2) transition risks**
- **C 1.2 Proportion and value of assets/total annual revenue exposed to risks by risk ratings (high, medium, low).**
- **C 1.3 Proportion of and total revenue/value of assets with substantial dependence on ecosystem services or with a high impact on nature**

4. *To use the result in the due diligence of potential new investments and in engagement*
   The result of a dependencies assessment can be used for thematic engagement and sector engagement: to what extent are clients aware of their direct (and possibly indirect) dependencies on ecosystem services and are these dependencies being managed in an adequate way?

   By combining the result with a biodiversity impact assessment and knowledge about impact pathways (how can an impact on biodiversity lead to an impact on ecosystem services?), the question can be answered if clients (potentially) impact on the ecosystem services they depend on.

   NB: This standard does not (yet) go into the assessment of *impacts* on ecosystem services and the *valuation* or monetisation of dependencies. This is however also key information to consider in due diligence and engagement.

15 TNFD (November 2022), The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework Beta v0.3, Annex 3.4 Illustrative Assessment and Disclosure Metrics for Financial Institutions.
16 TNFD (March 2023), The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework; Beta v0.4, Annex 4.5 Financial institutions metrics supplement'.
17 TNFD (March 2023), The TNFD Nature-related Risk and Opportunity Management and Disclosure Framework; Beta v0.4, Annex 4.4 Additional draft disclosure guidance for financial institutions

IMPACTS ON ECOSYSTEM SERVICES AND THEIR VALUE

Assessing impacts on ecosystem services, the value of the ecosystem services affected and the stakeholders involved will be a key step to provide insight in the (local) consequences of economic activities financed. Not just from a transitional risk perspective (reputation, legislation, etc.), but also from the perspective of creating nature positive contributions and the involvement of and consequences for local stakeholders.

An example of a database that can provide valuable data on ecosystems services and their value at different locations is the Ecosystem Services Valuation Database (ESVD).[18] The database can be used to assess changes in ecosystem services and the value of these services resulting from land-use change. The assessment of impacts on ecosystem services and the value of these services will be part of future revisons of the PBAF Standard.

5. *To develop targets on ecosystem services dependencies*
   The assessment result can be used by financial institutions to set targets. These targets will differ, among others depending on the availability of location and value chain data. For example, targets may be developed to improve the availability of asset location data for sectors with critical dependencies on ecosystem services (dependencies with a high or very high materiality). Location data is needed to assess the risk of a potential decline in the loss of the ecosystem services involved. For companies located in ecosystems with a low integrity or condition (potentially affecting the provision of ecosystem services), targets could be developed to effectively manage dependencies on ecosystem services which are highly or very highly material.

   It must be realised that target setting (as well as financial decision making) requires multi-faceted input. Information on dependencies should be combined with other relevant information and analysis, like impact assessments and location-specific data. For more information on target setting, reference is made to the ongoing work of the Science Based Targets Network (SBTN), the Taskforce on Nature related Financial Disclosures (TNFD), UNEP-Finance Initiative and the Finance for Biodiversity Foundation.

18 See https://www.esvd.info/; access to the database: https://www.esvd.net/

3 General steps in a dependency assessment

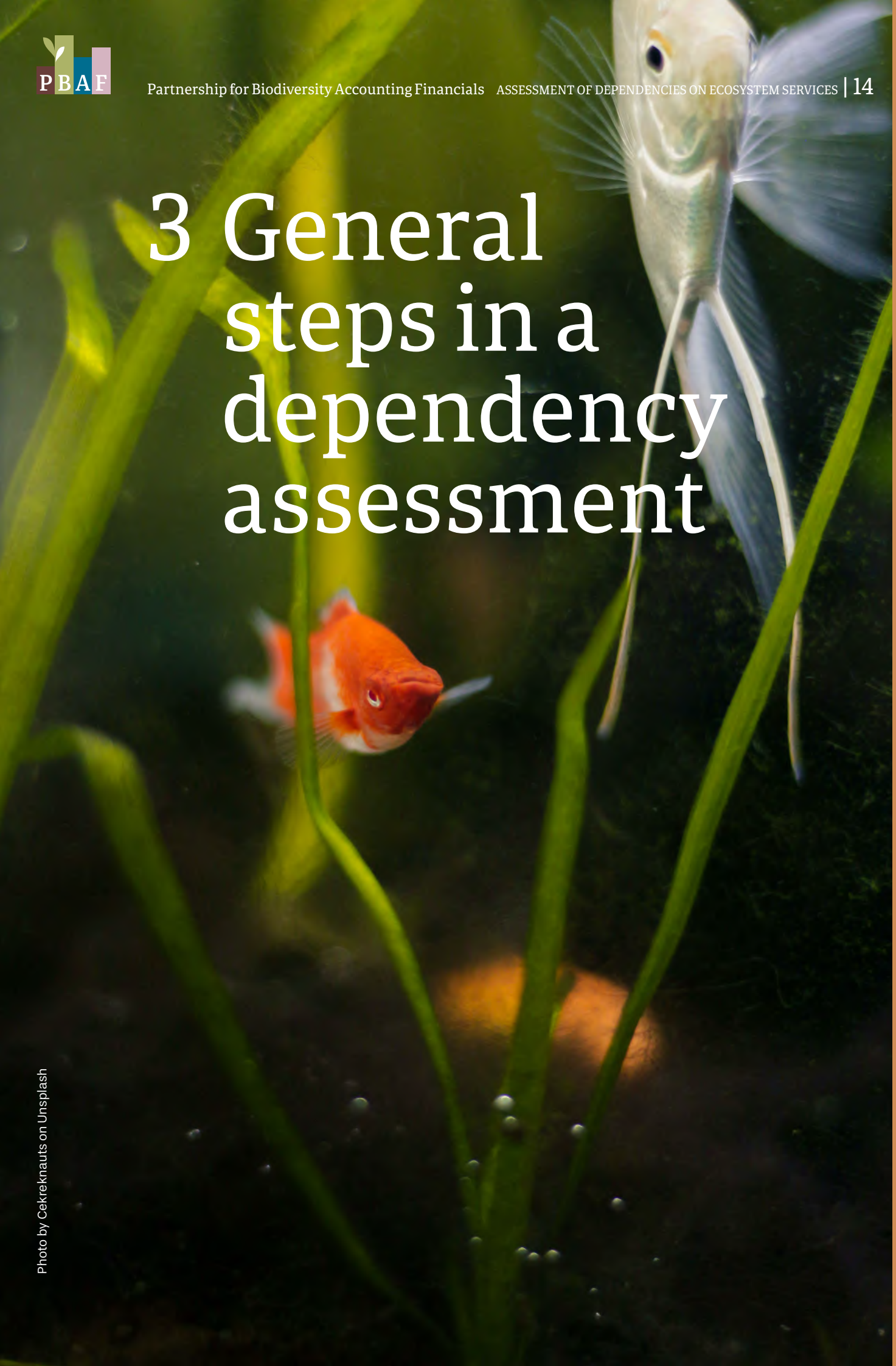
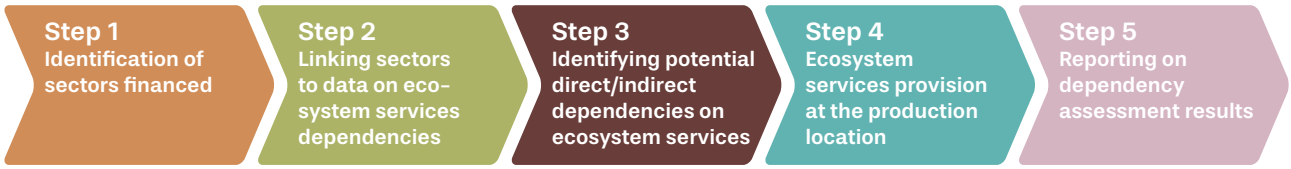


Photo by Cekreknauts on Unsplash

A dependency assessment consists of five main steps:



The steps are explained below and for each step an overview is provided of the challenges, PBAF Standard Requirements (R) and PBAF Standard Recommendations (A).

3.1 Step 1 Identification of sectors financed

To understand to what extent the economic activities financed depend on ecosystem services, it must be clear what economic activities are actually financed. The first step is therefore to identify the economic sectors[19] linked to a loan or investment in a portfolio, similar to the identification of economic activities in a biodiversity or carbon footprint. If a biodiversity or carbon footprint has been conducted, this information is already available.

Linking an investment to economic sectors can be rather straightforward in the case of investments in primary production (like mining, agriculture), but can be more challenging for companies with multiple business activities. For these companies, identifying the sectors these companies are involved in will require an analysis of information included in public reports or the use of revenue data, specified per sector, offered by data providers. Combinations of the two approaches are also possible. For those companies that span a variety of production processes, a decision can be made to focus on the 'dominant' industry or to use revenue data for each industry and production process to calculate the relative materiality of different ecosystem services (see textbox below and step 5). The criteria used to define the 'dominant' industry, e.g. more than 50% of total revenue, should be clear and should be disclosed in the result.

REVENUE BREAKDOWN BY PRODUCTION PROCESS TO CREATE A 'REVENUE WEIGHTED MATERIALITY SCORE'

Further detail can be provided in a dependency analysis if company revenue can be broken down by the products produced and production processes involved. If this information is available, revenue can be divided across ecosystem service dependencies. This can be combined in a 'revenue weighted materiality score' on a company level. See also step 5.

In order to link the sectors to the data provided in ENCORE or in the Biodiversity Risk Filter (BRF), activities should preferably be identified at the level of sub-industries and production processes (ENCORE, see the textbox below) and BRF industry sector. In some cases more granular data may be available, for example on the crops produced within agriculture. In this case, the level of granularity in the ecosystem services databases may constitute a limiting factor: they cannot (yet) distinguish between crops.

In ENCORE, economic sectors are classified according to the Global Industry Classification Standard (GICS) which comprises a four-level hierarchical structure with 11 sectors, 24 industry groups, 68 industries and 157 sub-industries. Sub-industries are further broken down by production processes to capture dependencies within each process which may not be captured at the sub-industry level. For example the chemicals sector includes a number of processes, such as fractional distillation, with potentially different ecosystem service dependencies.[20] Note that the GICS classification in ENCORE has not (yet) been updated to the newest GICS classification (March 2023).

19 Where sub(sectors) is mentioned, this includes sub industries and production processes, as defined by ENCORE
20 ENCORE, Data & Methodology, Sectors: https://encore.naturalcapital.finance/en/data-and-methodology/sectors

Result step 1

An overview of the sectors, sub-industries and production processes financed using a sector classification, like NACE, ICB, NAIC or GICS[21].

Challenges

- Limited accuracy of the result when the identification of economic activities is based on company revenue data with limited sector granularity.
- Sector granularity of revenue data differs between data providers, affecting consistency and comparability of the assessment results.
- Different data providers may have different ways of closing data gaps in revenue data, also affecting consistency and comparability of the assessment results.
- Changes in this first step will influence the rest of the dependency assessment.

Requirements (R) and Recommendations (A)

R1: The approach for identifying economic sectors (sectors, industries, sub-industries and production processes) shall be disclosed (by data providers) upon request (by clients), including underlying assumptions and databases used.

R2: When a selection is made of 'dominant' industries for companies that span a variety of industries and production processes, the criteria for this selection shall be disclosed.

A1: A sensitivity analysis and/or discussion/qualitative analysis of the dependency assessment results should be disclosed (by data providers) upon request (by clients) to show how changes in the assumptions underlying (sub)sector identification may influence the result of the dependency assessment.

A2: Where sectors are identified based on the product mix of companies, the use of primary data from the companies involved, e.g. data from annual reports, should be preferred over proxy data from databases.

A3: Financial institutions and their data providers should engage companies for primary data on revenue, sectors, industries, sub-industries, production processes and production locations.

3.2 Step 2 Linking sectors to data on ecosystem services dependencies

In the second step, the sectors identified need to be linked to a database with data on sectors (and sub-industries, production processes) and dependencies on ecosystem services, like ENCORE. ENCORE uses GICS classification[22] to differentiate between (11) sectors and (157) sub-industries. Each sub-industry is then linked to one or more production processes. To link the sectoral classification used to identify sectors in step 1 to ENCORE, a conversion to GICS sectors and sub-industries is needed. A selection of one or more production processes per sub-industry will result in a more specific result.

The preferred option for this step is to use an agreed 'crosswalk table' (also called 'concordance table') between the sector classification used in step 1 and GICS classifications. If a crosswalk table is not available the conversion needs to be completed manually. The SBTN 'Sectoral Materiality Tool' provides a crosswalk table for ISIC-NACE-GICS[23]. The EC has published a crosswalk table linking NACE codes used by the EU Taxonomy to other classifications.[24] Note that the

21 NACE: Nomenclature statistique des Activités économiques dans la Communauté Européenne; ICB: Industry Classification Benchmark; NAIC: North American Industry Classification System; GICS: Global Industry Classification Standard
22 The Global Industry Classification Standard, https://www.msci.com/our-solutions/indexes/gics
23 SBTN (2021),SBTN Sectoral Materiality Tool for Step 1a (version 2 - July 2021) - Overview
24 https://finance.ec.europa.eu/system/files/2022-03/sustainable-finance-taxonomy-nace-alternate-classification-mapping_en.xlsx

underlying methodology for the creation of these crosswalk tables should be made available to understand how the connections were made.

EXAMPLE OF SECTORS – SUB-INDUSTRIES – PRODUCTION PROCESSES FOR AGRICULTURAL PRODUCTION

Sector: Consumer staples
Sub-industry: Agricultural products
Production processes:

- **Aquaculture**
- **Freshwater wild-caught fish**
- **Large-scale irrigated arable crops**
- **Large-scale livestock (beef and dairy)**
- **Large-scale rainfed arable crops**
- **Saltwater wild-caught fish**
- **Small-scale irrigated arable crops**
- **Small-scale livestock (beef and dairy)**
- **Small-scale rainfed arable crops**

Annex 1 provides an overview of the sectors and ecosystem services included in ENCORE.

Sometimes the level of granularity of the industries identified is not as granular as the data in ENCORE (e.g., when using data from background databases like EXIOBASE[25]). In this case a link has to be provided between the data available and the more granular data in ENCORE (the same is true for the BRF). Two options are available to make this link:

- Use of average dependencies for an industry: an average dependency score is calculated for an industry, where the dependency of each production process has the same weight within the industry.
- A focus on critical dependencies: An EXIOBASE/NACE/GICS industry is considered to be critically dependent if at least one of the ENCORE processes included in this industry is critically dependent (has a high or very high dependency).

The methodology used to link the data on activities financed to dependencies data needs to be transparent to enable a correct interpretation of the result.

Result step 2

The sectors/sub-industries/production processes identified in step 1 are linked to the sectors, industries, sub-industries and production processes used by ENCORE.

25 https://www.exiobase.eu/

EXAMPLE: LINKING SECTOR CLASSIFICATIONS

Company A, a Euronext listed, steel producing company is involved in the following activities:

- Production of iron ore and coal
- Steel products and processing, distribution and trading

The Industry Classification Benchmark (ICB) is linked to the Global Industry Classification Standard (GICS):

Company A	ICB (Euronext)		
Sector	Industrial Metals and Mining		
Subsector	Iron and Steel		

Company A	GICS (ENCORE)		
GICS Sector	Materials		Energy
GICS Sub-industry	Steel	Iron	Coal & Consumable Fuels
ENCORE Production process	Steel production	Iron extraction	Mining

Source: PRé, CREM (2021), Biodiversity impact and ecosystem services dependencies; Integration of dependencies using the BFFI and ENCORE.

Challenges

- The granularity of the sectors, sub-industries and production processes covered by the ENCORE database is limited, which limits the possibilities for identifying differences in dependencies between more granular production processes (e.g., specific crops within 'large-scale rainfed arable crops').
- The granularity of the economic activities (industries) identified may be lower than the level of granularity of the dependency data available. In this case a link must be made between these different levels of granularity, e.g. by using an average dependency score for an industry.
- Internationally agreed crosswalk or concordance tables are not always available. Manual conversions are subject to interpretation, affecting consistency and comparability of the assessment results.

Requirements (R) and Recommendations (A)

R3: Crosswalk/concordance tables and/or manual conversions used to link sectors identified to the data on ecosystem services dependencies shall be disclosed (by data providers) upon request (by clients).

R4: The methodology used to link the data on sectors/sub-industries financed to dependencies data, like the use of an industry average dependency score, shall be disclosed (by data providers) upon request (by clients) to enable a correct interpretation of the results.

A4: A sensitivity analysis and/or discussion/qualitative analysis of the dependency assessment results should be disclosed (by data providers) upon request (by clients) to show how changes in the conversion may influence the result of the dependency assessment.

3.3 Step 3 Identifying potential direct/indirect dependencies on ecosystem services

In this step, the sector information collated in Steps 1 and 2 is used to identify the associated potential ecosystem service direct dependencies, including their materiality (very low to very high materiality) of those dependencies[26].

Categorization of ecosystem services

ENCORE categorizes the ecosystem services according to their function (an overview of the ecosystem services in ENCORE is included in Annex 1):

- Direct physical input (e.g. animal-based energy, fibres and other materials)
- Protection from disruption (e.g. climate regulation, flood and storm protection)
- Mitigates direct impacts (e.g. dilution by atmosphere and ecosystems, filtration)
- Enables production process (e.g. pollination, water quality)

Please note that ENCORE follows the Common International Classification of Ecosystem Services, CICES, and does not cover all ecosystem services. The TNFD aligns with the UN System of Environmental-Economic Accounting Ecosystem Accounting (UN SEEA EA).

Assessment of the importance of ecosystem service(s):

To assess the importance of an ecosystem service to a production process and the materiality of the impact if this service is disrupted, two aspects are considered by ENCORE:

1. How significant is the loss of functionality in the production process if the ecosystem service is disrupted? Limited, moderate, or severe?
2. How significant is the financial loss due to the loss of functionality in the production process? Limited, moderate, or severe?

The materiality assessment in ENCORE reflects both considerations. A very high materiality rating means that the loss of functionality is severe and that the expected financial impact is also severe.

Note that this does not necessarily mean that a medium or low materiality cannot lead to a significant financial impact. A dependency on a number of ecosystem services with a medium materiality can still represent a financial risk when these services are declining at a production location. A dependency assessment is therefore not necessarily limited to highly and very highly material ecosystem services (see also the use of scoring approaches in step 5).

Assessment of dependencies upstream or downstream

ENCORE does not yet include a value chain view. This means that it is not possible to automatically identify dependencies that may occur upstream or downstream of a company (often referred to as 'indirect' dependencies). However, since the dependencies of suppliers can also be assessed using ENCORE, it is possible to also include dependencies upstream in the assessment. The SUSTAIN project (see textbox below) aims to incorporate not only potential direct dependencies but also potential indirect dependencies associated with different economic activities through their upstream and downstream value chains.

By using input/output databases that provide data on the trade between sectors and countries (like the EXIOBASE database, often used in biodiversity footprinting) supply chains can be modelled. When this data is linked to ENCORE (which will again require a conversion of one sector classification into another, see step 2), it is possible to generate an overview of indirect dependencies. The WWF Biodiversity Risk Filter also explains that the assessment of biodiversity-

26 ENCORE speaks of 'potential' dependencies since the ecosystem service dependencies were not developed based on location-specific information and the materiality of ecosystem services to production processes may show some variance across contexts or over time.

related risks throughout the supply chain is conceptually not different from assessing 'first-order risks'. The additional layer of information is the importance of each supplier-customer relationship. When information on the (relative) importance of each supplier is available, a supply chain risk score can be calculated by adding up the risk scores of each supplier weighted for importance.

A similar approach towards indirect/upstream dependencies was taken in the analysis by Banque de France (Annex 2.C in 'A "Silent Spring" for the Financial System? Exploring Biodiversity-Related Financial Risks in France', August 2021[27]).

> *The assessment and use of indirect dependencies will be covered in more detail, including requirements and recommendations, in future revisions of the PBAF Standard when more experience has been gained in the market with such an assessment.*

UPDATING ENCORE DEPENDENCIES AND IMPACTS KNOWLEDGE BASE: THE SUSTAIN PROJECT

SUSTAIN (Strengthening Understanding and Strategies of Business to Assess and Integrate Nature) will bring together a multi-stakeholder and multi-disciplinary team to strengthen understanding and awareness of how all economic activities depend and impact on biodiversity. The 3-year EU funded project will build on existing work within the business and biodiversity space. Among other activities, it will improve, update and validate the ENCORE dependencies and impacts knowledge base. ENCORE was developed by Global Canopy, the UNEP Finance Initiative, and UNEP-WCMC with funding from the Swiss State Secretariat for Economic Affairs (SECO) and the MAVA Foundation. A further phase of work was funded by the Swiss Federal Office for the Environment (FOEN), which resulted in the creation of the ENCORE biodiversity module.

SUSTAIN aims to bring the following improvements to how potential dependencies are reflected in ENCORE:

- **Update information on potential dependencies of different economic activities, drawing on latest scientific and empirical research;**
- **Update dependency materiality ratings to ratings based on quantitative data and comparable across sectors, to the extent possible with existing data. The current version of ENCORE offers materiality ratings that are based on a qualitative assessment only;**
- **Incorporate not only potential direct dependencies but also potential indirect dependencies associated with different economic activities through their upstream and downstream value chains.**

Materiality levels covered

Assessments may vary in the materiality levels included in the analysis. For example, the focus of the study by the Dutch Central bank 'Indebted to Nature' was limited to dependencies with a 'high' and 'very high' level of materiality. However, excluding ecosystem services with a lower materiality rating poses a risk of missing out on potentially material ecosystem services at specific production locations.

Relevance of ecosystem services

The relevance of ecosystems services can vary depending on the asset location. For example, although many industries and production processes may depend on the ecosystem service 'flood protection', this service will only be relevant at locations where the risk of flooding is a real risk. Companies located inland may not be at risk of flooding. Location specific relevance is not yet included in ENCORE because the database is not yet spatially explicit. Other data providers and the WWF Biodiversity Risk Filter do already take into account location, either by applying a 'relevance score' (see the example of UNEP and S&P Global in step 5) or by showing the state of ecosystem services on a map (WWF BRF).

27 https://publications.banque-france.fr/sites/default/files/medias/documents/wp826_0.pdf

Result step 3

The result of this step is an overview of potential direct (and in some assessments also indirect) ecosystem service dependencies and their materiality for the production processes of a company and/or on a portfolio level.

EXAMPLE: DIRECT DEPENDENCIES OF COMPANY A

The direct dependencies of company A are assessed for each production process, using the ENCORE knowledge base. The result, including the materiality of each ecosystem service, is shown in the table below.

Sector	Sub-industry	Production process	Direct Ecosystem Service Dependencies	Materility
Energy	Coal & Consumable Fuels	Mining	Mass stabilisation and erosion control	Medium
Energy	Coal & Consumable Fuels	Mining	Surface water	High
Energy	Coal & Consumable Fuels	Mining	Water flow maintenance	High
Energy	Coal & Consumable Fuels	Mining	Ground water	High
Energy	Coal & Consumable Fuels	Mining	Climate regulation	High
Materials	Steel	Steel production	Ground water	Medium
Materials	Steel	Steel production	Surface water	Medium
Materials	Steel	Steel production	Water flow maintenance	Medium
Materials	Steel	Steel production	Climate regulation	Very Low
Materials	Steel	Steel production	Mass stabilisation and erosion control	Low
Materials	Iron	Iron extraction	Mass stabilisation and erosion control	Medium
Materials	Iron	Iron extraction	Ground water	High
Materials	Iron	Iron extraction	Surface water	High
Materials	Iron	Iron extraction	Water flow maintenance	Medium
Materials	Iron	Iron extraction	Climate regulation	Medium

Source: PRé, CREM (2021), Biodiversity impact and ecosystem services dependencies; Integration of dependencies using the BFFI and ENCORE.

Challenges

- In order to avoid double-counting, ENCORE only lists direct potential dependencies of production processes on ecosystem services, excluding dependencies that occur through the supply chain (see discussion above).
- The granularity of the sectors, sub-industries and production processes covered by the ENCORE database is limited, which limits the possibilities to identify differences in dependencies between more granular subsectors and production processes.
- The ENCORE database dependencies do not take the location of companies/production processes into account (not spatially explicit). However, for some ecosystem services, the location of the production process does play an important role, like the ecosystem service 'flood protection'.
- The materiality ratings consider present-day technologies and industry norms, and do not account for potential future developments by industries to reduce dependencies. Moreover, companies may have robust measures in place to avoid or reduce actual dependencies.
- The materiality level of dependencies is based on qualitative information, which may limit the comparability across different sectors.

  For an overview of limitations of ENCORE, also visit the ENCORE website.

- Ecosystem services covered in different dependency tools and databases can differ. It is therefore important to know what ecosystem services were covered in the assessment.

Requirements (R) and Recommendations (A)

R5: The scope of the assessment, direct dependencies, indirect dependencies or both shall be disclosed.

R6: The list of ecosystem services included in the dependency assessment shall be disclosed.

R7: The way the materiality level of dependencies is defined shall be explained and disclosed, as well as the materiality levels included in the dependency assessment.

> *The PBAF Standard does not yet set any requirements on how to define materiality ratings of dependencies. Current ratings in ENCORE will likely change based on the SUSTAIN project (see textbox above) and further experience with dependency assessments is needed to understand the pros and cons of the ratings used.*

R8: If dependencies with a lower materiality level are not included in the assessment, the potential consequences shall be explained in the discussion of the dependency assessment results.

A5: All materiality levels are included in the dependency assessment.

A6: A qualitative analysis is used to identify likely differences in dependencies between sub-sectors and production processes not (yet) covered by the ENCORE database or other databases used.

3.4 Step 4 Ecosystem services provision at the production location

The need to focus on production locations

While the previous step provides an overview of potential direct/indirect ecosystem service dependencies and their materiality for the production processes of a company or on a portfolio level, this is not yet a financial risk. A financial risk arises when the ecosystem services are at risk at the production location. This means that information on dependencies needs to be combined with information on (1) the production location and (2) the ability of the ecosystems in which a business operates to sustain a continued flow of those services to that business.

This step of combining dependency data with location data and data on the state of the ecosystem is sometimes not included in a dependency assessment, e.g. due to a lack of asset location data. Because identifying the location of companies/assets can be a challenge, financial institutions may decide to look at the exposure to ecosystem services dependencies first (step 1–3), and use the result to zoom in on part of the portfolio (instead of the whole portfolio) to identify production locations, the state of the ecosystem and the provision of ecosystem services (step 4). In terms of the TNFD LEAP approach: Evaluate – Locate – Assess – Prepare (ELAP).

WWF BIODIVERSITY RISK FILTER GUIDANCE ON IDENTIFYING THE LOCATION OF COMPANIES/ASSETS

The WWF Biodiversity Risk Filter has developed guidance on the collection of location-specific (proxy) data in the absence of corporate disclosure data.[28] The following options are identified:

- **Asset-level data**
  Data about physical assets, including attributes such as coordinates, asset type, production capacity, productivity and age, tied to ownership information. Offered by commercial and open-source data providers.
- **Corporate structure data**
  Linking the ultimate parent company to its subsidiaries, affiliates and assets, including information on their industry classification and location. Often a by-product of commercial data providers.
- **City of headquarters data**
  Location-specific information on a company's headquarters (i.e., location and industry classification), available in commercial data sets.
- **Disaggregated revenue data**
  Revenue reporting by country (e.g., Firm A generates 20 per cent of its revenue in country X) and by industry (e.g., Firm A generates 10 per cent of its revenue in industry Y). This data is provided by commercial data providers.
- **Hybrid approaches**
  Combining multiple data sources rather than relying on only one to use each data source's advantage and increase coverage of location specific company information.

A discussion of the *value and limitations* of the different options can be found in the WWF Biodiversity Risk Filter Methodology Documentation.

Ideally, the provision of ecosystem services at a production location is measured and monitored. The publication 'Towards a robust measurement of business dependencies on nature' (UNEP, 2023)[29] states: "To account for the full scope of dependency-related risks and opportunities, measurement of business dependencies on nature at a location should cover the following components:

1. Reliance on the ecosystem service
   The benefit derived from the ecosystem service (volume and quality of the ecosystem service consumed or the amount of business assets that would be affected by a loss of the service.
2. Impact drivers resulting from the business's own activities
   The impact drivers resulting from the business activities, including consumption of environmental assets as a result of a dependency on a provisioning ecosystem service.
3. External drivers of change
   External drivers of change (impact of other businesses, natural processes, impact of society) and estimated future trends.
4. State of nature supporting the ecosystem service
   The extent and condition of the relevant ecosystem as a proxy for ecosystem capacity to provide the ecosystem service.
5. Ecosystem service
   The availability and quality of the ecosystem service (e.g. availability and quality of water, level of pest control, level of river flood control)."

Although measuring each of these components would provide a good overview of the dependency related risks and opportunities, for many financial institutions this will not (yet) be

28 WWF Biodiversity Risk Filter (2023). WWF Biodiversity Risk Filter Methodology Documentation. January 2023.
29 UN Environment Programme (2023). Towards a robust measurement of business dependencies on nature. UNEP-WCMC, Cambridge, UK

feasible, or only for a selection of loans and investments. As a first step, focus will often be on the first component (step 1–3 in this document) and the fourth component (the step described below). An exception to this rule is the inclusion of component 5 for those ecosystems services for which more data is already available, like the availability and quality of water (e.g., by using the WWF Water risk filter[30]). However, this fifth component, as well as components 2 and 3, are not yet addressed in this version of the PBAF Standard, and may be added in a future revision.

DIFFERENT ECOSYSTEM TYPES SUPPORT DIFFERENT ECOSYSTEM SERVICES

Different ecosystem types support different ecosystem services to varying extents, because of variations in their compositional, structural and functional characteristics (see the publication referenced below for more information on composition, structure and function). Structured ecosystem services frameworks list common ecosystem types that support different ecosystem services. These can be used to identify the ecosystems that are most likely to support the ecosystem services business depend on. For example, mangrove ecosystems are linked to the service of coastal flood protection.
(adapted from 'Recommendations for a standard on corporate biodiversity measurement and valuation')[31]

Indicators for the provision of ecosystem services

A growing number of initiatives provide information (indicators, proxies) on the ability of ecosystems to provide ecosystem services. One example is the use of the 'Ecosystem Integrity Index' by UNEP and S&P Global (see text box in paragraph 3.5) as an indicator of 'the resilience of the ecosystems providing the services'. Another example is use of the Mean Species Abundance (MSA), quantifying the abundance of native species at a given site in its current state compared to their abundance in an undisturbed reference state. The MSA is also used by some data providers as an indicator of ecosystem intactness. See the textbox below.

ECOSYSTEM SERVICE PROVISION AND THE MSA LAYER

Mean Species Abundance, or MSA, is a dimensionless metric between 0 and 1, quantifying the abundance of native species at a given site in its current state compared to their abundance in an undisturbed reference state. It is an indicator of ecosystem intactness. Since integrity of natural ecosystems is positively connected with provision of a number of ecosystem services, this indicator can also be a good proxy to measure resilience of ecosystem services.

MSA was assessed at the global level using the GLOBIO model (Global Biodiversity Model for Policy Support), developed by PBL Netherlands Environmental Assessment Agency, combined with the 'IMAGE model'. The most recent version of the model, GLOBIO 4, quantifies the impacts of five pressures on terrestrial plants, mammals and birds: climate change, land use, roads, atmospheric nitrogen deposition and hunting. Impacts are quantified based on meta-analytical pressure-impact relationships that link the levels of each of these pressures to an impact on biodiversity expressed in MSA. The impact for each pressure at each location is combined to obtain an overall global map of ecosystem intactness, expressed in MSA, at a 10-arc-second resolution (approximately 300m). The global map of MSA values is publicly available.[32]

Both ENCORE and the WWF Biodiversity Risk Filter also provide indicators for the delivery of ecosystem services. The approaches are briefly explained below.

30 WWF Water Risk Filter, https://riskfilter.org/water/home
31 UNEP-WCMC, Capitals Coalition, Arcadis, ICF, WCMC Europe (2022) Recommendations for a standard on corporate biodiversity measurement and valuation, Aligning accounting approaches for nature
32 https://www.globio.info/globio-data-downloads

3.4.1 Ecosystem services provision in ENCORE and the Ecosystem Integrity Index

ENCORE offers two ways to identify if ecosystem provision might be at risk:

1. By explaining what natural capital assets underpin the ecosystem services and what drivers of environmental change may affect these assets;
2. By showing 'hotspots of natural capital depletion' on a world map.

Moreover, the 'Ecosystem Integrity Index' (EII) can be used as a proxy, as shown in the 'Nature Risk Profile' methodology (see paragraph 3.5). How the EII will be made available, through ENCORE or in another way, was not decided yet at the time of writing of this standard (June 2023).

The three options are briefly explained below.

Ad 1. Natural capital assets underpinning ecosystem services

ENCORE offers information on natural capital assets underpinning the different ecosystem services. For example, for 'Fibres and other materials' it is stated that this service depends on 'Habitats' and 'Species'. One or more indicators are used to show the state of these natural capital assets on a world map. For example, 'Habitats' is characterised by 'habitat intactness, the 'modelled average abundance of originally-present species relative to their abundance in an intact ecosystem'.

In turn, these assets are influenced by 'Drivers of environmental change'. For example, 'Habitats' are vulnerable to, among others, droughts, fire, flooding and landslides. Again, each driver is shown on a world map to explore location-specific risks.

Finally, contextual information is provided for each driver of change and the effects it can have on natural capital assets and ecosystem service provision. Factsheets are available for each ecosystem service, describing the ecosystem service-natural capital asset system, the main drivers of environmental change influencing or impacting the system and the mechanism by which these impact ecosystem service provision. The importance of natural capital assets to ecosystem services and the influence of drivers of environmental change on natural capital assets is characterized by a red, amber or green colour[33].

> *Identifying location-specific risks resulting from drivers of environmental change that influence the natural capital assets underpinning ecosystem services can be challenging for financial institutions. Different sources of information need to be combined, with data sometimes not fully complete (e.g., data on some of the drivers of environmental change is not yet available).*

Ad 2. Hotspots of natural capital depletion as an indicator for ecosystem services delivery

A feature included in 2021 in ENCORE is the overview of hotspots of 'natural capital depletion' (including the assets 'atmosphere', 'water', 'soil and sediments' and 'biodiversity') using maps. These maps were developed by UNEP-WCMC in collaboration with the UN Principles for Responsible Investment (PRI). The maps can show overlapping hotspots of depletion of natural capital in terrestrial environments, and the potential depletion of natural capital in marine environments. When a large proportion of an ecoregion or habitat overlaps with a hotspot of natural capital depletion, it threatens the ecological balance and the ecosystems' ability to deliver services.[34]

33 See the ENCORE website: https://encore.naturalcapital.finance/en/data-and-methodology/methodology

34 UNEP-WCMC (2021) Mapping global hotspots of natural capital depletion: Using ENCORE to identify natural capital risks and opportunities and focus investor engagement, Cambridge, UK

For each natural capital asset, one or more indicators of depletion are used. For example, for 'Biodiversity' the indicator is 'Loss of biodiversity intactness', using the 'Biodiversity Intactness Index (BII). The BII is a modelled average abundance of originally present species (species found in such an ecosystem in an intact state), relative to their abundance in an intact ecosystem (a pristine baseline).

> *This means that if the location of investees is known, these maps provide an indication whether the provision of ecosystem services might be at risk.*

More information on these hotspots of natural capital depletion can be found on the ENCORE website and in the publication 'Mapping global hotspots of natural capital depletion. Using ENCORE to identify natural capital risks and opportunities and focus investor engagement'. A (hypothetical) case study on the use of ENCORE and the hotspots of natural capital depletion for engagement purposes is provided in the PRI/UNEP–WCMC publication 'Identifying natural capital risks and opportunities as part of designing an investor engagement strategy'[35].

Ad 3. The 'Ecosystem Integrity Index
The Ecosystem Integrity Index (EII) is developed by UNEP–WCMC and is formed of three components, structure, composition, and function and measured against a natural (current potential) baseline on a scale of 0 to 1. Natural areas containing ecosystems with higher integrity have greater potential to provide services such as carbon sequestration, maintenance of water quality, climate regulation, pest control, and pollination, as well as supporting higher levels of biodiversity.[36]

The Ecosystem Integrity Index will be made publicly available once it has completed final peer review and can be used as an extra data layer in both impact assessments and dependency assessments.

3.4.2 Ecosystem services provision in the WWF Risk Filter

Another tool providing location specific information on the state of ecosystem services is the WWF Biodiversity Risk Filter (WWF BRF)[37]. The tool combines information on ecosystem services dependencies from ENCORE with indicators for the status of ecosystem services. The WWF BRF allows users to use a world map showing *physical risks*, which account for the status of the ecosystem services that companies, or their suppliers, rely on.

This includes the following 'risk categories', each including a number of indicators:
1) Provisioning Services
2) Regulating & Supporting Services – Enabling
3) Regulating Services – Mitigating
4) Cultural Services
5) Pressures on Biodiversity

The information on these indicators, like water scarcity, soil condition, pollination (see the example below) and fire hazards is combined with information on the dependencies of a specific sector and the location of assets financed. In this way, the WWF BRF is able to produce a risk analysis for loans and investments with a known location.

35 https://www.unpri.org/download?ac=13450
36 Samantha L.L. Hill et al,The Ecosystem Integrity Index: a novel measure of terrestrial ecosystem integrity with global Coverage, United Nations Environment Programme World Conservation Monitoring Centre (UNEP–WCMC), August 22, 2022.
37 See the WWF Biodiversity Risk Filter: https://riskfilter.org/biodiversity/home

POLLINATION IN THE WWF BIODIVERSITY RISK FILTER

An example of an indicator providing information on the state of ecosystem services is the indicator for the ecosystem service 'pollination'. For this ecosystem service the metric 'Crop pollination' is used. This metric is based on 'the average equivalent number of people fed by pollination-dependent crops, attributed to nearby ecosystems based on the area of pollinator habitat within pollinator flight distance of crops'. It measures 'how much nutrition is produced on fields that are dependent on the surrounding natural habitat to sustain pollination'.

Simply put: the presence of habitat sustaining pollinators is used as an indicator for the state of the ecosystem service 'pollination'.

More detailed information on the indicators used by the WWF Biodiversity Risk Filter can be found in the publication 'WWF Biodiversity Risk Filter (2023). WWF Biodiversity Risk Filter Methodology Documentation, January 2023'.

The WWF BRF allows the user to have a look at different maps for different indicators relevant to physical risks. One of these indicators is 'Ecosystem condition'. This ecosystem condition indicator has been calculated separately for terrestrial, freshwater and marine areas. For terrestrial ecosystem condition, the 'Biodiversity Intactness Index' and 'Functional Connectivity of the Worlds Protected Areas' are used to assess condition. Areas of very high risk are estimated to have low levels of ecosystem intactness (below 70% for terrestrial areas) and low levels of connectivity.

> *Together with ENCORE's map of 'Natural capital depletion' and the 'Ecosystem Integrity Index', the map on 'Ecosystem condition' by the WWF BRF offers a proxy for the ability of an ecosystem to deliver ecosystem services. This proxy can be used for ecosystem services for which a more direct link with ecosystem characteristics (like the level of water scarcity for the provision of water) is lacking.*

Like any other tool used to assess the provision of ecosystem services, the WWF BRF risk analysis has a few limitations. The indicators for the ecosystem services included in the WWF BRF only provide an indication of the status of ecosystem services and the geospatial granularity (which is aligned with the Water Risk Filter, the so-called 'HydroBASINS level 7') may limit the ability to differentiate between locations in the same region. Moreover, the approach considers a selection of 16 ecosystem services (ENCORE includes 21 ecosystem services, see Annex 1).

NB: It is important to realise that the condition of some ecosystem assets can reach tipping points or thresholds beyond which their capacity to provide ecosystem services is significantly reduced or destroyed[38]. As these tipping points are reached, dependency-related risk to businesses can rapidly increase.

Result step 4

The result of this step is an overview of the potential risk (e.g. by means of a risk score) that potential direct ecosystem service dependencies may result in a financial risk due to the state of or trend in the provision of ecosystem services at a specific location.

Challenges step 4

- Identifying the location of investees can be a challenge. When a financial institution has a direct relation with companies invested in, location data will be available. However, this could still be data on a company's headquarters instead of data on the assets location(s) where

38 UN Environment Programme (2023). Towards a robust measurement of business dependencies on nature. UNEP-WCMC, Cambridge, UK

actual production takes place. Proxies and multiple data sources may be needed to come up with location data that can be used to identify potential ecosystem services provision risks.
- The relations between the state of an ecosystem and the ability to provide services ecosystem are not yet fully understood. This means that indicators like Ecosystem Integrity only provide a first indication of ecosystem services provision.
- Spatial granularity of the data available on the state of ecosystems or the characteristics of an ecosystem directly relevant to specific ecosystem services (like vegetation supporting pollination) may be limited, limiting the level of insight for specific production locations. The same is true for the age of the data used.
- The data sources described are static in nature and do not account for trends. What are the regional threats and how will they change over time? An additional scenario analysis (quantitative or qualitative) will be needed to capture these trends.
- Analysis may not yet be very granular and risk based on location does not account for any mitigation activities a company undertakes. This means that further steps will be required, like overlaying company action (the 'Assess' stage in LEAP).

Requirements (R) and Recommendations (A)

R9: The approach used to identify asset locations, including the use of proxies and multiple data sources, shall be disclosed (by data providers) upon request (by clients) to enable a correct interpretation of the assessment results.

R10: The approach used to assess the state of or trend in ecosystem services shall be disclosed to enable a correct interpretation of the assessment results.

R11: The limitations of the dependency assessment results resulting from step 1–4 shall be disclosed and discussed by financial institutions and data providers to enable a correct interpretation of the assessment results. This includes, but is not limited to the spatial granularity and quality of the data used to assess the provision of ecosystem services at a company/asset location.

A7: The importance of location specific data in the assessment of dependency related (financial) risks stresses the need to ask clients/investees for such data and maybe even set targets for 'asset location transparency' and 'supply chains transparency' on the level of a loan and investment portfolio.

3.5 Step 5 Reporting on dependency assessment results

In the fifth step, the information gathered in steps 1 to 3 or 1 to 4 is processed and presented (or downloaded in case of an online tool) in a report. Reporting on dependencies can take different forms, including (not a comprehensive overview):

A. *Portfolio exposure to sectors or companies depending on one or more ecosystem services with a specified level of materiality*
   For example, the total value of loans and investments in a portfolio (or the percentage of total portfolio value) exposed to companies that depend on one or more ecosystem services with a high or very high materiality (or other level of materiality selected).

In practice, data providers may also speak of a 'high or very high dependency' or 'critical dependency'. For example, '50% of the portfolio is critically dependent on at least one ecosystem service', where 'critically dependent' refers to ecosystem services of high or very high materiality. Further insight can be provided by reporting on the level of exposure to each ecosystem service with a high or very high level of materiality. For example, 60% of total portfolio value has a critical dependency on pollination'. Of course, it must be made clear what 'critically dependent' or 'highly dependent' refers to (one or more ecosystem services with what level of materiality?).

EXAMPLE: DEPENDENCIES DUTCH FINANCIAL INSTITUTIONS

In 2020, the Dutch Central Bank and PBL Netherlands Environmental Assessment Agency conducted the study 'Indebted to nature; Exploring biodiversity risks for the Dutch financial sector'[39]. Part of this study focused on the dependency of Dutch financial institutions on ecosystem services, using the ENCORE knowledge base. The study showed:

"Dutch financial institutions have provided worldwide EUR 510 billion in finance to companies that are highly or very highly dependent on one or more ecosystem services. One of these ecosystem services is animal pollination. The financial sector is exposed to the amount of EUR 28 billion to products that depend on pollination."

B. *Combining dependency data with other data in one score*
By assigning weight scores to different materiality levels (e.g., between 0 and 100%, 100% being a very high materiality, or between 0 and 5, with very low materiality = 1, very high materiality = 5), dependencies can also be combined with other information in a combined score. For example:

- *Dependencies of a company weighted by materiality*
All the dependencies of a company's production processes can be combined in one score, taking into account the materiality for each production process.

EXAMPLE: COMBINING DEPENDENCIES IN ONE SCORE, WEIGHTED BY MATERIALITY

Company X has two production process, A and B. Production process A depends on ground water (materiality 'high') and on pollination (materiality 'low'). Production process B depends on ground water (materiality 'very high') and surface water (materiality 'very high').

When the materiality levels of the dependencies are given a score (very low = 1, low =2, medium = 3, high = 4 and very high = 5), this can be used to calculate a weighted materiality score for each ecosystem service (and shown in a graph for company X):

- Groundwater: 1 process A * materiality 4 + 1 process B * materiality 5 = dependency score 9
- Pollination: 1 process A * materiality 2 = dependency score 2
- Surface water: 1 process B * materiality 5 = dependency score 5

This example also shows that it is important to understand the data behind the calculation. For example, it will not be clear from the final score that two processes depend on groundwater with a high and very high dependency respectively.

- *Dependencies of a company weighted by materiality of the dependency and the revenue associated with the production processes involved*
Information of a company's dependencies weighted by materiality can be combined with information on the revenue associated with the production processes that depend on these services.

39 DNB, PBL, 'Indebted to nature; Exploring biodiversity risks for the Dutch financial sector', June 2020.

EXAMPLE: DEPENDENCIES WEIGHTED BY MATERIALITY AND REVENUE

Using again the example of company X with production processes A and B. Production process A is responsible for 70% of the company's total revenue, production process B for 30%. This means that the following scores can be calculated (and shown in a graph for company X), weighted by materiality and revenue:

- Groundwater: 1 process A * materiality 4 * 70% of total revenue+ 1 process B * materiality 5 * 30% of total revenue = dependency score 4,3
- Pollination: 1 process A * materiality 2 * 30% of total revenue = dependency score 0,6
- Surface water: 1 process B * materiality 5 * 30% of total revenue = dependency score 1,5

Similar to the previous example, it is important to understand the calculation of the scores and what the result means. While adding revenue data provides new insights, it also limits insight in the materiality of dependencies not weighted for revenue.

- *Combining dependencies identified with the relevance of services and resilience of ecosystems*
  In the UNEP publication 'Nature Risk Profile: A methodology for profiling nature related dependencies and impacts'[40], in collaboration with S&P Global, the materiality of the dependencies is combined with a *relevance score* for the ecosystem services at a specific location of operation and the *resilience of the ecosystems* providing the services. To do this, the location of operation must of course be known.

DEPENDENCY SCORING APPROACH UNEP AND S&P GLOBAL

The dependency scoring approach presented in the publication 'Nature Risk Profile: A methodology for profiling nature related dependencies and impacts', consists of the following parts:

1. **A given business or asset's dependencies on each of 21 ecosystem services is first assessed by combining scores of (formula are provided to combine the scores):**
   a) **The materiality of the dependency on that service**
   b) **The relevance of that service based on the locations operated in**
      > **a + b leads to a reliance score, adjusted for relevance**
   c) **The resilience of the ecosystems providing the services**
      Either based on the state of individual services (e.g. the availability of water) or using the integrity of the ecosystem as a proxy using the 'Ecosystem Integrity Index'
      > **c leads to a resilience score; the reliance score and resilience score are then combined in a dependency (risk) score**

2. **The scores of the 21 service dependencies are combined using a logarithmic function. This results in one dependency score for each sector. The logarithmic function is used to capture the decreasing marginal contribution effect of additional ecosystem services.**

3. **Company or asset-level turnover data is then used to produce an overall company-level, or asset-level dependency score, based on the distribution of turnover within different sub-sectors**

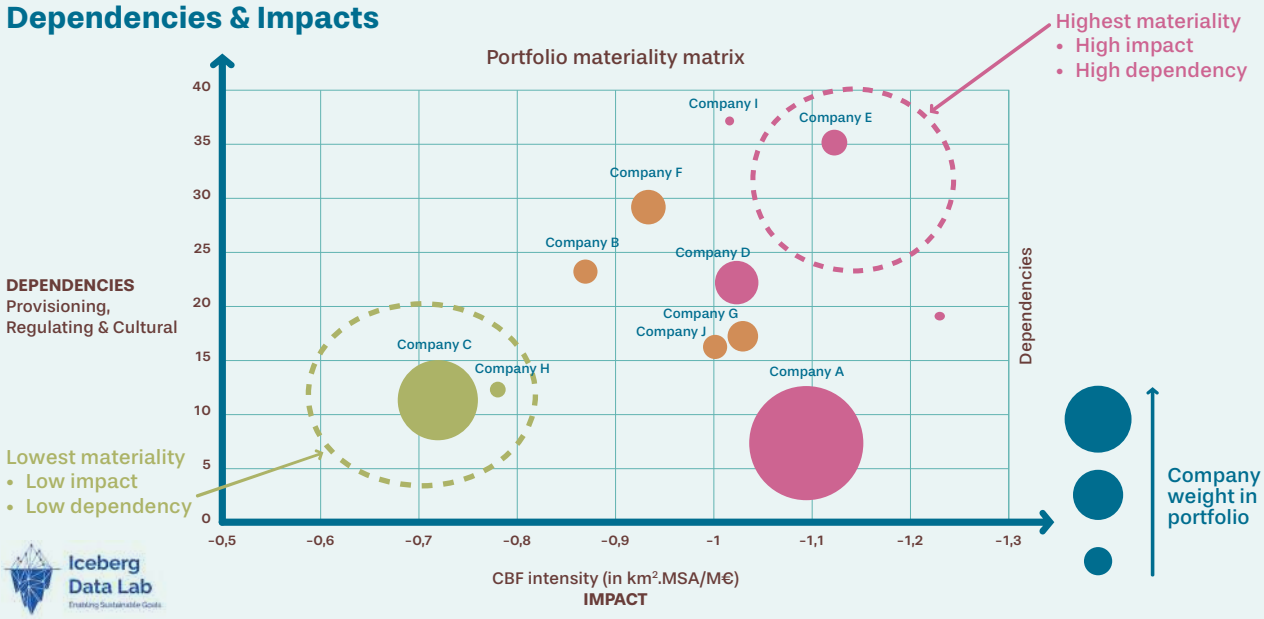
The methodology is currently limited to direct dependencies, not yet including indirect, supply chain dependencies.

40 United Nations Environment Programme (2023), Nature Risk Profile: A methodology for profiling nature related dependencies and impacts. Cambridge, United Kingdom.

The results of a dependency assessment can also be combined with the results of an impact assessment to identify priorities, see the example below.

EXAMPLE: REPORTING ON DEPENDENCY ASSESSMENT RESULTS

An example of how the results of a dependency assessment can be presented, is provide below for a hypothetical (small) portfolio (Iceberg Data Lab, 2023).



In this example, the results of a dependencies assessment have been combined with the results of a biodiversity impact assessment. For each company in the portfolio the sum invested/financed (the 'company weight in the portfolio') is reflected by the size of the circle.

The y-axis shows the dependency on ecosystem services, including regulating, provisioning and cultural services, totalling 26 ecosystem services (note that cultural services have been added to the ecosystem services covered by ENCORE). It covers the *direct* dependencies of the companies and the dependencies have been scored to calculate an average dependency score for each company. The dependencies were weighted for materiality and revenue and the resulting dependency scores were averaged at ecosystem service level. Indirect dependencies and the geographical locations of the companies have not yet been included.

On the x-axis, the impact intensity (in this case the impact divided by revenue) of the companies is presented in km^2.MSA/M€, using the Corporate Biodiversity Footprint (CBF). The impact is calculated for scope 1, scope 2 and scope 3 upstream and downstream.

The green circles at the bottom left of the graph represent the companies with the most moderate impacts and dependencies. The companies at the top right of the graph have the highest biodiversity impact in the portfolio and a high dependence on one or more ecosystem services. They are shown in red.

Result

A report of the dependency assessment indicating the potential direct/indirect dependencies of the sectors or companies in a portfolio, including their materiality (either or not including the use of a relevance score), potentially weighted by the revenue associated with the production processes and expressed in dependency metrics.

Challenges

- Combining information in one score can provide valuable additional insights but can also introduce extra layers of inaccuracy and limit the view on the underlying information.
- Not enough data may be available to link revenue to production processes, preventing the calculation of a revenue/sales-weighted dependency score.

Requirements (R) and Recommendations (A)

R12: The approach used to calculate and present the dependency assessment results shall be disclosed to enable correct interpretation, including, but not limited to, the use of terms like 'critical' or 'high' dependency, the scopes included in the assessment (only direct dependencies or also dependencies upstream or downstream), the ecosystem services covered in the assessment, the assessment of ecosystem service materiality (ENCORE approach or other) and the use of other scores, like relevance and resilience.

R13: The limitations of the dependency assessment result resulting from step 1–5 shall be disclosed and discussed in the dependency assessment report.

A8: The dependencies identified in step 3 (sectors, sub-industries, production processes, potential direct dependencies and their materiality) are also disclosed separately (by data providers) upon request (by clients) to enable a view of the data used for further calculations.

A9: It is strongly advised to link the results of the dependency assessment (step 1–3) with data on the ability of the ecosystems at the location of operation to provide the services identified (step 4), either or not focusing on the dependency 'hotspots' in a portfolio.

Use of the assessment results

The results of the dependency assessment can be used by financial institutions to decide on the materiality of dependencies on ecosystem services in a portfolio and for indivdual loans and investments, and the need to zoom in. To answer the question if dependencies are material, a financial institution may look at the financial exposure to loans and investments in companies with a high or very high dependency on one or more ecosystem services. On a company level, a revenue-weighted materiality score will offer additonal insights in the potential financial riks a company is exposed to. Zooming in on company/asset location will be necessary to gain insight in the relevance of the ecosystem services identified and the risk of a (future) decline in ecosystem services provision. The latter can be based on information regarding the state of the ecosystem providing the services identified, and/or information on the ecosystem services themselves (e.g., for water quality and quantity). Depending on the result, engagement with investees on risk mitigation could be a next step.

More information on different uses of a dependency assessment is provided in chapter 2.

4 Concluding remarks

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Current tools and data available already allow for an assessment of potential dependencies on ecosystem services and, if location data is available, the potential physical risks associated with such dependencies. The level of granularity of the industries, sub–industries and production processes covered in current tools is still limited, but does enable the identification of priority sectors from a dependency perspective (dependency hotspots), which can be used for thematic and sector engagement purposes and zooming on location specific data.

More detailed assessments will be possible when more data become available and tools become more sophisticated. First steps towards more accurate assessments are already taken by, for example, including 'relevance' scores to ecosystem services dependencies.

For some ecosystem services, like water ((scarcity, quality), detailed data on the provision of these services is already available and can be used as a source of information to more accurately identify dependency risks. Continuing work on trends in the provision of ecosystem services and on scenarios will hopefully also enable future looking assessments.

Financial institutions can contribute to the availability of data by engaging with companies on the provision of data on sub–industries, production processes, production locations, supply chains and the state of ecosystems.

Transparency by data providers and tool developers on the methodologies and data used is key to enable a correct interpretation of the dependency data provided. By aligning with the requirements and recommendations presented in this PBAF Standard, assessments will benefit from becoming more harmonised, more transparent and more consistent enabling correct interpretation and comparison of results.

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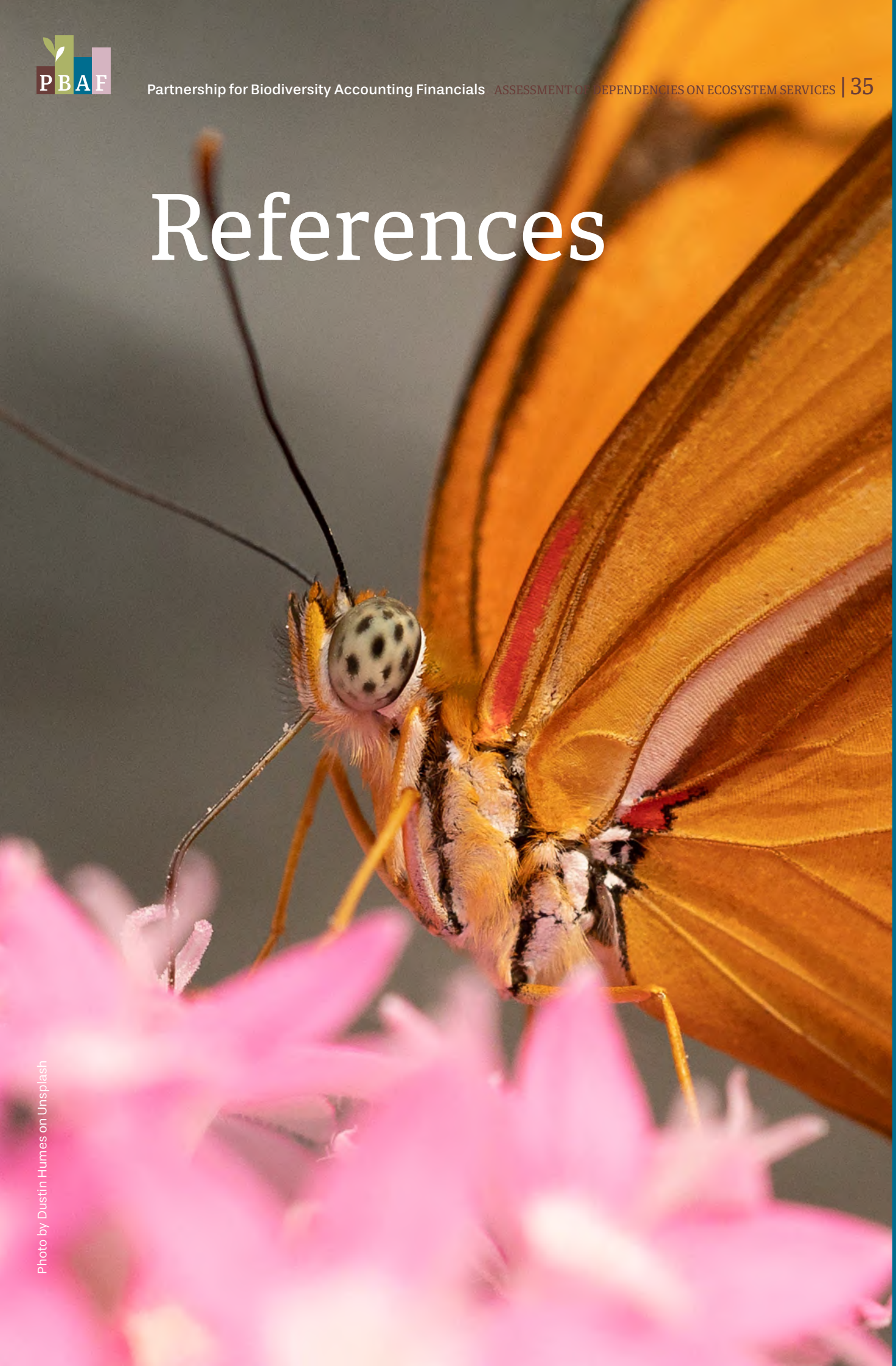

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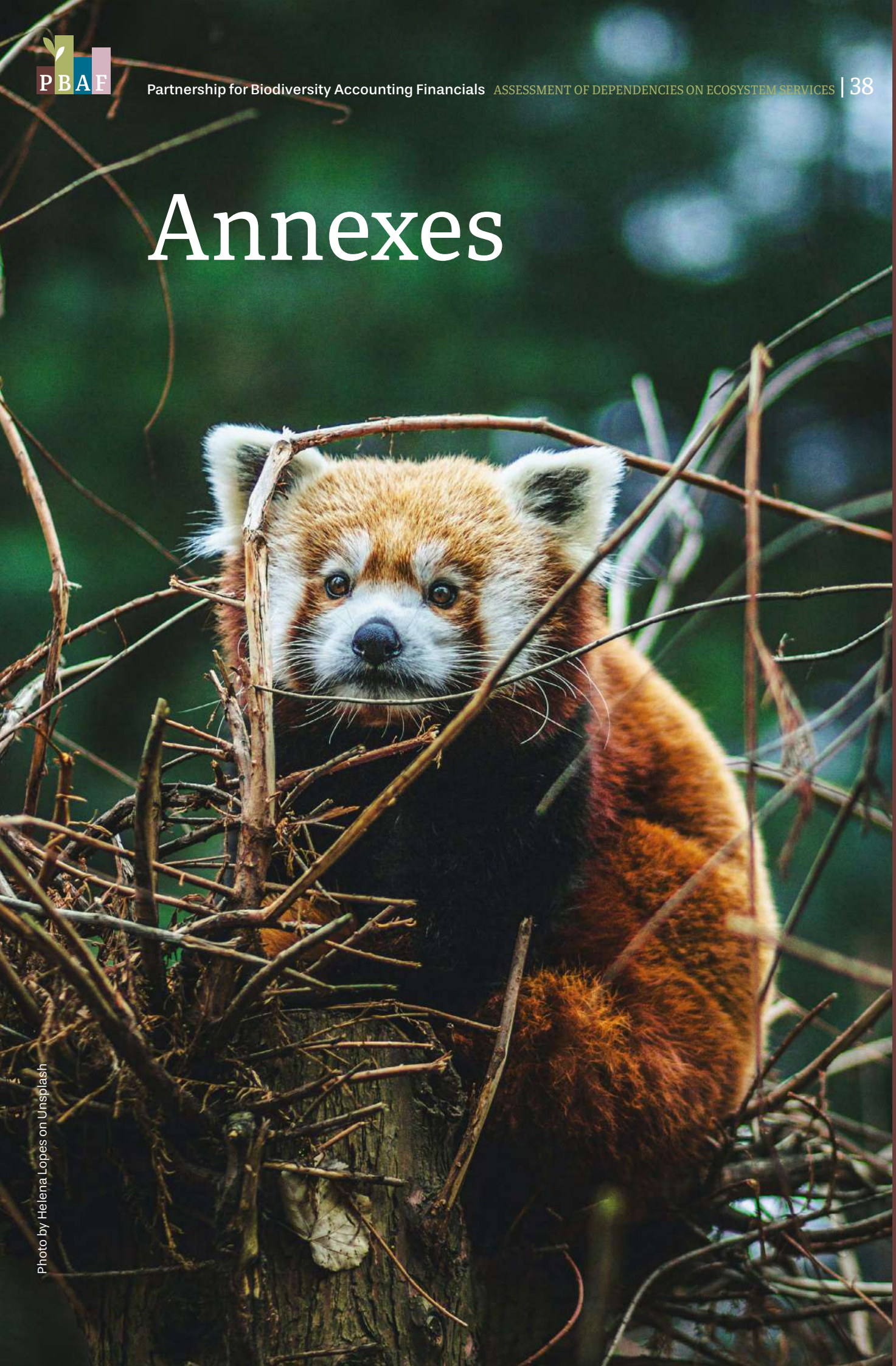
Annexes



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Annex 1 Economic sectors and ecosystem services in ENCORE

ENCORE classifies sectors, using the Global Industry Classification Standard (GICS):

1. Consumer Discretionary (e.g. footwear, apparel retail, etc.)
2. Consumer Staples (e.g. agricultural products, brewers)
3. Energy
4. Financials (e.g. investment banking & brokerage, asset management & custody banks, consumer finance)
5. Health Care
6. Industrials
7. Information Technology
8. Materials (e.g. commodity chemicals, construction materials)
9. Real Estate
10. Telecommunication Services
11. Utilities (e.g. renewable electricity)

Each sector is divided into sub-industries from GICS and each sub-industry (total 157) is linked to one or more production processes (total 86). The list of production processes is not part of GICS and was created when ENCORE was developed. For example, the sub-industry 'agricultural products' (part of the sector 'consumer staples') is divided into the following production processes:

- Aquaculture
- Freshwater wild-caught fish
- Large-scale irrigated arable crops
- Large-scale livestock (beef and dairy)
- Large-scale rainfed arable crops
- Saltwater wild-caught fish
- Small-scale irrigated arable crops
- Small-scale livestock (beef and dairy)
- Small-scale rainfed arable crops

ENCORE covers the following ecosystem services, based on the Common International Classification of Ecosystem Services, CICES (note that this overview is slightly different from the overview provided by the TNFD, which is aligned with the UN System of Environmental-Economic Accounting Ecosystem Accounting (UN SEEA EA):

1. Animal-based energy
2. Bio-remediation
3. Buffering and attenuation of mass flows
4. Climate regulation
5. Dilution by atmosphere and ecosystems
6. Disease control
7. Fibres and other materials
8. Filtration
9. Flood and storm protection
10. Genetic materials
11. Ground water
12. Maintain nursery habitats
13. Mass stabilisation and erosion control

14. Mediation of sensory impacts
15. Pest control
16. Pollination
17. Soil quality
18. Surface water
19. Ventilation
20. Water flow maintenance
21. Water quality

For each of these ecosystem services a description is provided. The ecosystem services are categorized according to their function:

- Direct physical input (e.g. animal–based energy, fibres and other materials)
- Protection from disruption (e.g. climate regulation, flood and storm protection)
- Mitigates direct impacts (e.g. dilution by atmosphere and ecosystems, filtration)
- Enables product process (e.g. pollination, water quality)

Annex 2 Overview of PBAF requirements and recommendations

Step 1 Identification of sectors financed

R1: The approach for identifying economic sectors (sectors, industries, sub-industries and production processes) shall be disclosed (by data providers) upon request (by clients), including underlying assumptions and databases used.

R2: When a selection is made of 'dominant' industries for companies that span a variety of industries and production processes, the criteria for this selection shall be disclosed.

A1: A sensitivity analysis and/or discussion/qualitative analysis of the dependency assessment results should be disclosed (by data providers) upon request (by clients) to show how changes in the assumptions underlying (sub)sector identification may influence the result of the dependency assessment.

A2: Where sectors are identified based on the product mix of companies, the use of primary data from the companies involved, e.g. data from annual reports, should be preferred over proxy data from databases.

A3: Financial institutions and their data providers should engage companies for primary data on revenue, sectors, industries, sub-industries, production processes and production locations.

Step 2 Linking sectors to data on ecosystem services dependencies

R3: Crosswalk/concordance tables and/or manual conversions used to link sectors identified to the data on ecosystem services dependencies shall be disclosed (by data providers) upon request (by clients).

R4: The methodology used to link the data on sectors/sub-industries financed to dependencies data, like the use of an industry average dependency score, shall be disclosed (by data providers) upon request (by clients) to enable a correct interpretation of the results.

A4: A sensitivity analysis and/or discussion/qualitative analysis of the dependency assessment results should be disclosed (by data providers) upon request (by clients) to show how changes in the conversion may influence the result of the dependency assessment.

Step 3 Identifying potential direct/indirect dependencies on ecosystem services

R5: The scope of the assessment, direct dependencies, indirect dependencies or both shall be disclosed.

R6: The list of ecosystem services included in the dependency assessment shall be disclosed.

R7: The way the materiality level of dependencies is defined shall be explained and disclosed, as well as the materiality levels included in the dependency assessment.

R8: If dependencies with a lower materiality level are not included in the assessment, the potential consequences shall be explained in the discussion of the dependency assessment results.

A5: All materiality levels are included in the dependency assessment.

A6: A qualitative analysis is used to identify likely differences in dependencies between sub-sectors and production processes not (yet) covered by the ENCORE database or other databases used.

Step 4 Ecosystem services provision at the production location

R9: The approach used to identify asset locations, including the use of proxies and multiple data sources, shall be disclosed (by data providers) upon request (by clients) to enable a correct interpretation of the assessment results.

R10: The approach used to assess the state of or trend in ecosystem services shall be disclosed to enable a correct interpretation of the assessment results.

R11: The limitations of the dependency assessment results resulting from step 1–4 shall be disclosed and discussed by financial institutions and data providers to enable a correct interpretation of the assessment results. This includes, but is not limited to the spatial granularity and quality of the data used to assess the provision of ecosystem services at a company/asset location.

A7: The importance of location specific data in the assessment of dependency related (financial) risks stresses the need to ask clients/investees for such data and maybe even set targets for 'asset location transparency' and 'supply chains transparency' on the level of a loan and investment portfolio.

Step 5 Reporting on dependency assessment results

R12: The approach used to calculate and present the dependency assessment results shall be disclosed to enable correct interpretation, including, but not limited to, the use of terms like 'critical' or 'high' dependency, the scopes included in the assessment (only direct dependencies or also dependencies upstream or downstream), the ecosystem services covered in the assessment, the assessment of ecosystem service materiality (ENCORE approach or other) and the use of other scores, like relevance and resilience.

R13: The limitations of the dependency assessment result resulting from step 1–5 shall be disclosed and discussed in the dependency assessment report.

A8: The dependencies identified in step 3 (sectors, sub-industries, production processes, potential direct dependencies and their materiality) are also disclosed separately (by data providers) upon request (by clients) to enable a view of the data used for further calculations.

A9: It is strongly advised to link the results of the dependency assessment (step 1–3) with data on the ability of the ecosystems at the location of operation to provide the services identified (step 4), either or not focusing on the dependency 'hotspots' in a portfolio.