CircHive

Descriptive report of the Biodiversity Databases

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Abbreviations

BD – Biodiversity

BD Protocol – Biological Diversity Protocol

BF – Biodiversity Footprint

CICES – Common International Classification of Ecosystem Services

CLC – CORINE Land Cover

CNCA – Corporate Natural Capital Accounting

CSRD – Corporate Social Responsibility Directive

DEBK – Double-Entry Bookkeeping

EA – Ecosystem Accounting

EAA – Ecosystem Accounting Area

EU – European Union

ES – Ecosystem Service

EMA – Environmental Management Accounting

ENCORE – Exploring Natural Capital Opportunities, Risks and Exposure

EP&L – Environmental Profit & Loss

EUNIS – European Nature Information System

FAO – Food and Agriculture Organization

FES – Final Ecosystem Services

GAAP – Generally Accepted Accounting Principles

GBS – Global Biodiversity Score

GET – Global Ecosystem Typology

GHG – Greenhouse Gases

GLOBIO – Global Biodiversity Model for Policy Support

IFRS – International Financial Reporting Standards

IPBES – Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

IUCN – International Union for Conservation of Nature

KBA – Key Biodiversity Area

KPI – Key Performance Indicator

LCA – Life Cycle Assessment

LULC – Land Use Land Cover

MAES – Mapping and Assessment of Ecosystem and their Services

MNHN – National Museum of Natural History of Paris

MVP – Minimum Viable Population

NASA – National Aeronautics and Space Administration

NBF – Negative Biodiversity Footprint

NC – Natural Capital

NCA- Natural Capital Accounting

NCP – Natural Capital Protocol

NESCS – National Ecosystem Services Classification System

PBF – Positive Biodiversity Footprint

PDF – Potentially Disappeared Fraction of Species

SEEA – The System of Environmental Economic Accounting

SEEA EA – The System of Environmental Economic Accounting Ecosystem Accounting

TBF – Total Biodiversity Footprint

TNC – The Nature Conservancy

TNFD – Taskforce on Nature-related Financial Disclosures

UN – United Nations

UNEP – United Nation Environment Program

UNEP-WCMC – United Nation Environment Program World Conservation Monitoring centre

WCS – World Conservation Society

WRI – World Resource Institute

WWF – Worldwide Fund for Nature

Introduction

Biodiversity (BD) and ecosystems (ES) are increasingly deteriorating across the world as there is an increasing demand for natural resources (IPBES 2019[1]). Businesses rely highly on BD and ecosystem services and have the power to impact overall BD positively or negatively. Due to the business risks' and opportunities' reliance on BD there is an increasing demand to measure and report the impact on BD, the negative as well as the positive. In addition, one of the objectives of the COP15 for 2030, that took place in Montréal in December 2022, requires transnational corporations and financial institutions to transparently monitor, assess and disclose the biodiversity risks and impacts of their operations, portfolios, supply, and value chains. At European level, the Corporate Sustainability Reporting Directive (CSRD), which will come into force on 1 January 2024, aims to harmonize and strengthen the non-financial reporting obligations of major European companies. These obligations will include precise reporting standards on BD and ES. As a result, many methods have been published to evaluate BD impacts, such as Global Biodiversity Score (GBS) or Exploring Natural Capital Opportunities, Risks and Exposure (ENCORE)[2], but there are neither standards, nor common approaches yet in use in a globally level.

In the light of the ongoing biodiversity loss as well as standardized methods that could support businesses to safeguard nature, European Union funded a project, *CircHive*. The five-year project aims to mainstream the use of biodiversity footprinting (BF) and natural capital accounting (NCA) in an integrated approach through methods, models, and guidance developed, improved, and piloted on field with case study partners from various sectors.

One of the projects objectives is to improve data availability and accessibility for life-cycle assessment (LCA) and NCA. In fact, "data, inventories, and monitoring on nature" has been identified by the 2019 IPBES global assessment report on BD as one of the key information needs. Data on BD impacts, dependencies and risks are required along the entire value chain to enable calculations of LCA or NCA. However, data can be scattered, collected, and analyzed with different kinds of observation scales or methodologies that can alter their reliability and usefulness. We need harmonization and standardization of data as well as facilitated access to make it easier to search, evaluate and compare accounts and data. This would improve integrity, accuracy, and consistency across databases. To do so, CircHive's first task (1.1) is to develop a screening process on available environmental data and database sources, availability, accessibility, quality, and needs, and further synthesize findings on regional and national level databases related to BD and natural capital (NC). The location and content of each data set, and the ability to update and export the data for external use will be specified, highlighting current gaps.

[1] IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (pp. XIV-LXI). Díaz, S., Settele, J., Brondízio, E. S., Ngo, H. T., Guèze, M., Agard, J., Arneth, A., Balvanera, P., Brauman, K. A., Butchart, S. H. M., Chan, K. M. A., Garibaldi, L. A., Ichii, K., Liu, J., Subramanian, S. M., Midgley, G. F., Miloslavich, P., Molnár, Z., Obura, D., Pfaff, A., Polasky, S., Purvis, A., Razzaque, J., Reyers, B., Roy Chowdhury, R., Shin, Y. J., Visseren-Hamakers, I. J., Willis, K. J., and Zayas C.N. (eds.). IPBES secretariat, Bonn, Germany. DOI: https://zenodo.org/records/3553579

[2] The most relevant existing methods are reviewed in Deliverable 2.1 report of CircHive-project: Synthesizing landscape of approaches for BF and NCA for private and public sectors.

Objectives

This report aims to:

1. Define important definitions and concepts around biodiversity.
2. Report on the existing data and databases of relevance for BD and NCA.
3. Provide guidance for use of the spreadsheet listing databases.
4. Synthesize findings on regional and national-level databases related to BD and NCA, specifying location, contents of datasets, etc. as well ability to export for external use, highlighting current gaps in data consistency and coverage, and describe successful and failed efforts to use and bring together data for corporate/private use.
5. Provide general guidance and recommendations.

Definitions and Concepts

Definitions

Baseline vs reference state

Reference state: Previous state or desired state (of nature) which a target aims to recover or achieve.

Each condition or integrity rating method will have a reference or pristine state embedded within it. This is different from the baseline chosen for an assessment.

Baseline: A minimum or starting point with which to compare other information (e.g., for comparisons between past and present or before and after an intervention). A baseline is a management decision and is usually dependent on a business and / or legal context. It is arbitrary in nature. The original state of biodiversity is often impossible to assess because losses have often occurred many years ago (i.e., accurate biodiversity state data is not available). Despite this, condition, or integrity rating methods all (attempt to) describe the reference or pristine state against which condition or integrity, at a given time, can be assessed. This is essential so that all condition rating assessments are standardized against the same benchmark. This is very different from a baseline, which typically refers to a date after which the responsibility for the biodiversity impacts that have or are likely to take place, has been recognized or accepted by management.

Biodiversity

Key definition: 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[3]. Key associated concepts: ecosystems, species, genetic diversity.

Biodiversity impact

Key definition: The BD Protocol defines a biodiversity impact (or impact on biodiversity) as a change in the state of biodiversity. This change can be positive or negative, or both, for instance a positive change for an ecosystem (e.g., increase in structural complexity of a forest as trees age and die) may be negative for a species (e.g., decrease in the population size of an herb shaded under the closed canopy) within the same spatial area.

Biodiversity measurement

Key definition: The process of determining the amounts, extent, and condition of biodiversity and associated ecosystem services, in physical terms.

[3] Convention on Biological Diversity (1992) Convention on Biological Diversity. Secretariat of the Convention on Biological Diversity, Montreal, Canada.

Impact measurement on biodiversity

Key definition: Biodiversity impact measurement is the process of assessing the scale of biodiversity impacts[4]. It provides the input data for organizational biodiversity accounting. Impact measurement assesses changes in the state of biodiversity that have already taken place or will / may occur in the future, for instance as per different scenarios.

Biodiversity impact measurement can be undertaken for any organizational focus (e.g., project, product, company as a whole) and value chain boundaries (i.e., direct operations, supply chains, clients).

For BD Protocol:

- For ecosystem impacts, it involves assessing both changes in their extent and condition / integrity.
- For impacts on species, it involves assessing changes in their population or habitat sizes.

Align argues there are two aspects to consider for individual species - population size and extinction risk.

Biodiversity indicator (Align): A measure, based on verifiable data, that conveys information about more than just itself. Indicators can be simple metrics (a system of standard of measurement), or more complex indices (numerical scales).

Ecosystem condition/ integrity (Align): 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.

Condition / integrity adjusted surface areas (Align / BD Protocol): A standard measurement framework for ecosystems is 'Extent × Condition', combining physical area or volume with a measure of its condition compared to the intact state (or reference state). Units may, for example, be expressed as quality-hectares or weighted hectares. 'Extent × Condition' is the framework adopted by the UN for ecosystem accounting and is widely used in corporate biodiversity assessments.

Dependency measurement

Dependency (in relation to biodiversity) (Align definition): Business reliance on or use of biodiversity and associated ecosystem services.

Biodiversity footprint (Total, Positive and Negative)

Biodiversity footprint: The impact of a commodity, company, or community on global biodiversity, measured in terms of biodiversity change as a result of production and consumption of particular goods and services. Can be negative or positive[5].

BD Protocol definition: A Biodiversity Footprint is the sum of positive and negative impacts of an organization on biodiversity over a given organizational and value chain boundary. The BD Protocol specifies that the Total

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[4] URL: https://407264.p3cdn1.secureserver.net/wp-content/uploads/2022/11/BDP-Quality-Biodiversity-Footprints.pdf

[5] IEEP (2021) Biodiversity footprints in policy and decision-making: Briefing on the state of play, needs and opportunities and future directions. Policy report. Institute for European Environmental Policy.

Biodiversity Footprint (TBF) is made of a Positive Biodiversity Footprint (PBF) and a Negative Biodiversity Footprint (NBF).

Total Biodiversity footprint (BD Protocol / Align; accounting definition): The sum of areas of all ecosystems within an asset inventory derived from individual statements of position for ecosystems.

Positive Biodiversity footprint (BD Protocol / Align; accounting definition): The sum of surface areas of all ecosystems identified within the asset register or inventory, adjusted according to their respective condition or integrity.

Negative Biodiversity footprint (BD Protocol / Align; accounting definition): Calculated based on the difference between the total and positive biodiversity footprint of the business, overall or for individual biodiversity assets.

Biodiversity net gain

Biodiversity Net Gain refers to the overarching principle of ensuring that any development or human activity results in a quantifiable and verifiable improvement in biodiversity, offsetting any biodiversity losses that may occur. It involves a measurable increase in the overall biodiversity value at a specific location or within a defined area as a direct outcome of a particular project or action. The aim is to leave the natural environment in a better ecological state than before the development took place. This concept is often applied in environmental policies and planning to promote sustainability and conservation efforts[6].

Data

Data is the fundamental block of any accounting system. In the case of BF and NCA, this could e.g. be data resulting from ecological monitoring programs (such as national or global surveys of ecosystems, habitats, species and/or communities) as well as data on pressures (e.g. land use or international trade). To be able to calculate biodiversity footprint and integrate it with Natural Capital Accounting, data needs to include biodiversity status, impacts, dependencies, and risks along the whole value chain. One current obstacle is the scattered availability from observation scales and documentation practices affecting the reliability and validity of the information used.

Database

A database is an organized collection of structured information and/or data.

Direct vs indirect impact

Direct impact

Simple definition: A change in the state of biodiversity caused by an impact driver or business activity with a direct causal link[7].

More complete definition: For BD Protocol, direct impacts constitute changes in the state of biodiversity which are caused directly by business activities. In other words, direct impacts involve business impact drivers which can be traced to specific, verifiable biodiversity features, that is direct causal link between your company's

[6] https://cieem.net/i-am/current-projects/biodiversity-net-gain/
[7] Align definition citing as source: Capitals Coalition (2016). Natural Capital Protocol. https://capitalscoalition.org/capitals-approach/natural-capital-protocol/

actions (e.g., land clearing or ecosystem restoration measures) and a change in the state of ecosystems or taxa (e.g., decrease/increase in ecosystem condition, habitat loss/gain for several species). These impacts may be temporary (short-term or long-term), recurrent (e.g., seasonal, every time a specific activity is undertaken) or permanent impacts (e.g., built-up properties, such as office buildings or parking areas). For instance, the direct land footprint of your business operations leads to verifiable, on the ground changes in biodiversity. Similarly, water emissions may lead to verifiable changes in the state of freshwater ecosystems which can be attributed solely to your company, for instance when streams or wetlands are wholly contained within its direct operations or where it is the only significant polluter within the catchment.

Indirect impact

Simple definition: A change in the state of biodiversity caused by an impact driver or business activity with an indirect causal link (for instance GHG emissions have indirect impacts on **biodiversity**)[8]**.**

More complete definition: For BD Protocol, indirect impacts are defined as changes in the state of biodiversity which cannot be traced to specific business activities. This implies that changes in biodiversity arising from indirect impacts can only be modelled (e.g., GLOBIO[9]). In other words, indirect impacts involve the various impact drivers to which no specific change in biodiversity (e.g., degradation of the condition of an ecosystem type/loss of taxa in a specific location) can be attributed. Indirect impacts can have very large negative consequences for biodiversity, for instance through biodiversity loss due to climate change or water pollution. Moreover, indirect impacts are often harder to manage than direct impacts since they extend beyond the physical or legal boundaries of your business and arise from the interactions of multiple factors and stakeholders. In greenfield projects, the combined effects of social (e.g., population growth) and economic (e.g., increased access to area) factors create the conditions for these impacts to arise (e.g., increased clearing of land caused, at least partially, by immigration to a new mining site).

Ecosystem

The Convention on Biological Diversity (CBD 1992) defines “ecosystem” as a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit. Ecosystems have four essential elements: a biotic complex (living components of the system); an abiotic environment (non-living, e.g., temperature and rock); the interactions within and between these two elements through energy flows; and a physical space in which to operate. Ecosystems may be terrestrial, freshwater, subterranean (e.g., caves) or marine systems. Different countries may have different classifications of ecosystem types.

Global: The International Union for Conservation of Nature (IUCN) has developed a Global Ecosystem Typology (GET) to support the development of its Red List of Ecosystems[10].

[8] Align definition.
[9] GLOBIO is a modelling framework to calculate the impact of environmental drivers on biodiversity for past, present and future. https://www.globio.info/
[10] URL: https://global-ecosystems.org/

European Union: The European Union has developed an EU ecosystem typology in its Mapping and Assessment of Ecosystems and their Services (MAES) initiative[11]. The ecosystems present in the EU are defined as (Maes et al 2020[12])M:

1. Urban areas
2. Agroecosystems (cropland and grassland)
3. Forest
4. Heathland and shrubland
5. Sparsely vegetated land
6. Wetlands (inland and coastal wetlands)
7. Freshwater (rivers and lakes)
8. Marine ecosystems

As this level of aggregation is too coarse for a detailed assessment of ecosystem condition, given the large heterogeneity that these broad ecosystem classes present the MAES ecosystem types are disaggregated into different ecosystem subtypes. Given the importance of the spatial component in the condition assessment under the EU-wide methodology, CORINE land cover (CLC) represents the most suitable dataset currently available to disaggregate broad ecosystem classes into land cover classes over time. Therefore, CLC data are used as proxies of ecosystem types, although this land cover classification presents important limitations in terms of thematic accuracy.

National / Regional: There are also classifications at national or regional level. The level of details is specific to each country or region.

Ecosystem extent

Ecosystem extent is the area of an ecosystem asset. The ecosystem extent describes the extent of the various ecosystem types presented in an accounting area and how the extent changes within the accounting period. The ecosystem types are based on the IUCN GET, which provides a top level of four realms, a second level of 24 biomes and a third level of 98 ecosystem functional groups. Depending on the application, alternative aggregations may be developed to align with the reporting requirements at the national and international level.

Ecosystem vs habitat

Habitat can be defined as "the resources and conditions present in an area that produce occupancy, including survival and reproduction, by a given organism"[13]. In other words, habitat is the sum of the specific resources

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[11] EU Mapping And Assessment of Ecosystems and their Services MAES initiative.

[12] Maes, J, A., T, Erhard, M, Condé, S, Vallecillo, S, Barredo, J I, Paracchini, M L, Abdul Malak, D, Trombetti, M, Vigiak, O, Zulian, G, Addamo, A M, Grizzetti, B, Somma, F, Hagyo, A, Vogt, P, Polce, C, Jones, A, Marin, A I, Ivits, E, Mauri, A, Rega, C, Czúcz, B, Ceccherini, G, Pisoni, E, Ceglar, A, De Palma, P, Cerrani, I, Meroni, M, Caudullo, G, Lugato, E, Vogt, J V, Spinoni, J, Cammalleri, C, Bastrup-Birk, A, San Miguel, J, San Román, S, Kristensen, P, Christiansen, T, Zal, N, de Roo, A, Cardoso, A C, Pistocchi, A, Del Barrio Alvarellos, I, Tsiamis, K, Gervasini, E, Deriu, I, La Notte, A, Abad Viñas, R, Vizzarri, M, Camia, A, Robert, N, Kakoulaki, G, Garcia Bendito, E, Panagos, P, Ballabio and C., S, S., Montanarella, L., Orgiazzi, A., Fernandez Ugalde, O., Santos-Martín, F (2020) *Mapping and Assessment of Ecosystems and their Services: An EU wide ecosystem assessment in support of the EU biodiversity strategy*. EUR 30161 EN, European Commission, Brussels.https://op.europa.eu/en-GB/publication-detail/-/publication/a84a0a68-0f65-11eb-bc07-01aa75ed71a1/language-en

[13] Krausman, P.R. (1999). Some basic principles of habitat use. In Launchbaugh, K.L., Sanders, K.D., Mosley, J.C. (Eds.). Grazing behavior of livestock and wildlife. Idaho Forest, Wildlife & Range Exp. Sta. Bull. 70: 85–90.

(e.g., food, water, material and sites for nesting, migration/dispersal corridors) that are needed by a given organism for survival and reproductive success.

Endemic taxon

It is a taxon that can be found in any specific area but nowhere else. This term is relative as a taxon can be endemic to a small island, to a country, or to a continent (IUCN 2012[14]).

Indicator / Metric

Indicators are quantifiable representations of a measurement focus, e.g., kg CO^2-equivalents for climate change. They may consist of a single measure or a group of measures a composite metric indicator, e.g., Potentially Disappeared Fraction of species (PDF). Below, some clarifications are listed:

- A measure could be an indicator but not all indicators are measures.
- A metric is a specific type of indicator. It is used to track and assess the status / trends of a specific process / outcome.
- A key performance indicator (KPI) is a type of metric. It tracks something significant.

Impact driver

Also called "pressures" in the Drivers, Pressures, State, Impact, Responses (DPSIR) framework, impact drivers (e.g., Land/sea use/use change, direct exploitation, climate change, pollution, invasive alien species) are caused by business activities that generate changes in the state of biodiversity, either directly or indirectly.

IPBES

The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is an independent intergovernmental organization formed by member States. Its purpose is to enhance the collaboration between science and policy in the realms of biodiversity and ecosystem services, aiming to promote the conservation and sustainable utilization of biodiversity, as well as fostering long-term human well-being and sustainable development. Established in Panama City on April 21, 2012, by 94 Governments, it is important to note that IPBES is not a United Nations body. However, in 2013, with the approval of the UNEP Governing Council and at the request of the IPBES Plenary, the United Nations Environment Programme (UNEP) has been providing secretariat services to IPBES. For a more detailed history of IPBES, refer to this source.

Mitigation hierarchy and ecological equivalency

The mitigation hierarchy refers to the sequence of actions taken to (1) anticipate and avoid impacts on biodiversity; (2) minimize or reduce impacts where avoidance is not possible; (3) rehabilitate or restore when impacts have occurred; and (4) – as a last resort – compensate or offset significant residual impacts (Figure

[14] IUCN (2012). Guidelines for application of IUCN Red List criteria at regional and national levels: Version 4.0. Gland, Switzerland and Cambridge, UK: IUCN. iii + 41pp.

1). This concept is widely used throughout the world and is often embedded into national legislation as regards to environmental permitting. More specifically, the mitigation hierarchy calls for following the four steps when e.g., exploiting an area, with the aim to reach no net loss or biodiversity net gain (adapted from BBOP 2012[15]):

• First, avoidance measures to avoid generating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, to avoid impacts on natural capital as much as possible (e.g., locating a project outside a Key Biodiversity Area).

• Second, minimization measures to reduce duration, intensity and/or extent of impacts that cannot be completely avoided, as far as practically feasible (e.g., minimizing the spread of material and waste flows, scheduling of vegetation clearing at the appropriate time).

• Third, restoration / rehabilitation measures to assist recovery of an ecosystem type that has been degraded, damaged, or destroyed by business activities (e.g., rehabilitation of a mining site or quarry).

• As a last resort, offset measures to compensate for any residual significant, adverse impacts on natural capital that cannot be avoided, minimized and/or rehabilitated or restored, often implemented in order to achieve no-net-loss, or a net gain, of biodiversity. This may be achieved outside the immediate project area, through active biodiversity restoration or creation projects, or through averted risk/loss offsets which aim to prevent likely future risks of harm to (or losses of) biodiversity from occurring (Bull & Strange 2013[16]). The latter option requires the definition of an appropriate counterfactual, in other words determining what would have happened without the offset. Examples of averted-loss offsets include the expansion of a protected area network in areas under pressure from third parties.

Above and beyond, additional conservation measures may also be undertaken. These refer to voluntary pro-biodiversity measures that may be undertaken by companies. These are not linked to the company's negative impacts on biodiversity but may play an important role in its biodiversity strategy.

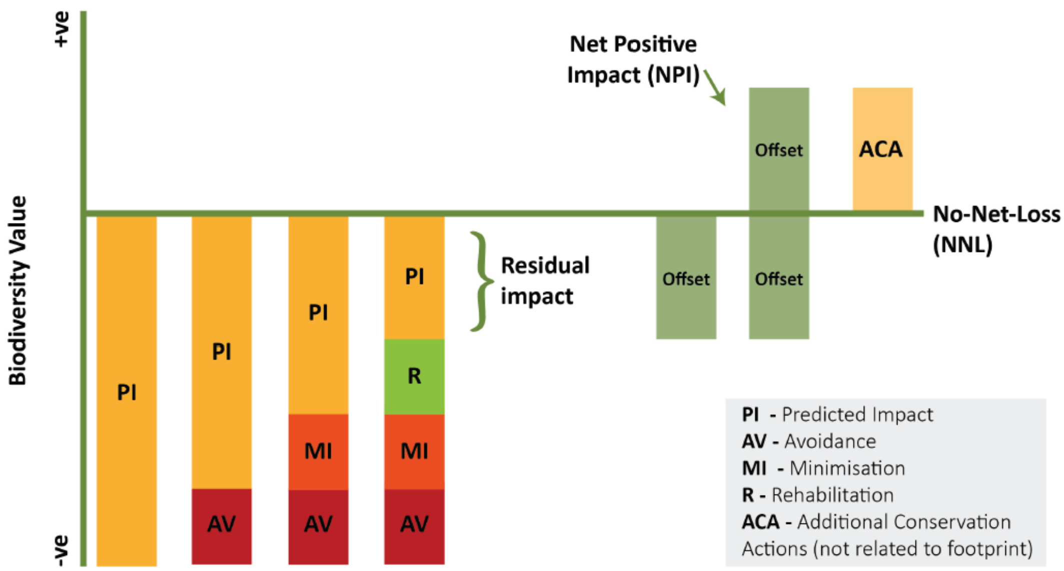

Figure 1. Applying the mitigation hierarchy for a greenfield project in the context of no-net-loss policy (adapted from the Business and Biodiversity Offset Program)

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[15] URL: https://www.forest-trends.org/bbop/bbop-key-concepts/biodiversity-offsets/

[16] Bull, J.W., Strange, N. (2018). The global extent of biodiversity offset implementation under no net loss policies. Nature Sustainability 1, 790–798.

Ecological equivalency[17]: It reflects the concept of 'like-for-like' when measuring the different components or aspects of biodiversity. When considering gains and losses within the mitigation hierarchy and / or developing a biodiversity account, one cannot sum changes in one species with another. That is, only the same types of ecosystems or taxa can be compared within an assessment.[18]

Metapopulation

A metapopulation is a collection of subpopulations of a species or taxon, "each occupying a suitable patch of habitat in a landscape of otherwise unsuitable habitat. The survival of the metapopulation is dependent on the rate of local extinctions of occupied patches and the rate of (re) colonization of empty patches." (IUCN 2012).

Method

A method is a particular procedure for accomplishing or approaching something, it can be a systematic or specific one. Method refers to the diverse principles, procedures, and practices that govern empirical research. Research method refers to the practical "how" of a research study. More specifically, it's about how a researcher systematically designs a study to ensure valid and reliable results that address the research objectives. It can be considered as a methodology combining variables to calculate a specific score or defining a model based on scientific work.

Minimum viable population

Minimum viable population (MVP) is a lower bound on the population of a species, such that it can survive in the wild.

Natural capital

Natural Capital Protocol definition: 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.

Renewable NC[19]: Natural resources that, despite consuming them, they will continuosly exist and/or replenish over time, such as water, air, plants, etc.

Non-renewable NC[20]: Natural resources that are finite, i.e. they do not replenish with the rate at which they are consumed, e.g., oil, gas, minerals, etc.

NB: Anthropocentric concept. These benefits may be cultural or economic, and can be valued in qualitative, quantitative and/or monetary terms. These benefits relate to the concept of ecosystem services, many of which are derived (to varying extents) from biodiversity. However, NC includes some abiotic services (e.g., the supply of minerals, metals, oil and gas, geothermal heat, wind, tides, and the annual seasons).

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[17] Equivalency is a BD Protocol principle: Ensures the notion of equity in the type of biodiversity (i.e. ecological equivalency or like-for-like principle) is integral to biodiversity impact inventory development and accounting. Undertake net impact accounting only for equivalent biodiversity losses (negative impacts) and gains (positive impacts).

[18] Align definition based on BD Protocol.

[19] These may be exploited indefinitely, provided the rate of exploitation does not exceed the rate of replacement, allowing stocks to recover (assuming no other significant disturbances). Renewable resources exploited faster than they can renew themselves may effectively become non-renewable, such as when over-harvesting drives species to extinction (UN 1997).

[20] These will not regenerate after exploitation within any useful time period. Non-renewable resources are sub-divided into reusable (e.g., most metals) and non-reusable (e.g., thermal coal).

NB2: Renewable NC (stock maintenance / renewal: e.g., ensuring a viable population of an exploited species via sustainable harvest rates) cannot be managed in same way as non-renewable NC (managing depletion rate).

Natural range of a species

The extent of a taxon, excluding any segment that arises from an introduction to a region or its adjacent areas (IUCN 2012).

No net loss

"No Net Loss" is a conservation and environmental policy concept that aims to ensure that the overall quantity or quality of a particular resource, such as biodiversity or ecosystem services, does not decrease as a result of human activities. The idea is to balance any negative impacts with equivalent positive actions, so that there is no net loss in the end (IUCN 2015).

In the context of biodiversity, for example, the "No Net Loss" principle might be applied to development projects. If a project is expected to result in the destruction or degradation of a certain habitat, proponents of the "No Net Loss" principle would advocate for measures to offset these losses by restoring or creating an equivalent or greater amount of habitat elsewhere. The goal is to achieve a neutral or positive balance in terms of the targeted resource (IUCN 2015).

This concept is often integrated into environmental regulations and policies to promote sustainable development and to mitigate the environmental impacts of human activities.

Population viability analysis

Population viability analysis is commonly used to describe both the process and the set of quantitative tools aimed at estimating the probability that a population, or collection of populations, will persist for some particular time in a particular environment (Beissinger & McCullough, 2002).

Species

A species is often defined as a group of individuals that actually or potentially interbreed and produce fertile offspring in nature.

Strong vs weak sustainability

Weak sustainability: assumes that natural capital and manufactured capital are essentially substitutable and considers that there are no essential differences between the kinds of well-being they[21]. The only thing that matters is the total value of the aggregate stock of capital, which should be at least maintained or ideally increased for the sake of future generations (Solow, 1993).

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[21]https://sustainabledevelopment.un.org/content/documents/6569122-Pelenc-Weak%20Sustainability%20versus%20Strong%20Sustainability.pdf

Strong sustainability: assumes that the economic and environmental capital is complementary, but not interchangeable. Strong sustainability accepts that there are certain functions that the environment performs that cannot be duplicated by humans or human made capital. The proponents of strong sustainability invoke several reasons to demonstrate the non-substitutability of natural capital (reliance of all human-developed capitals on natural capital, qualitative difference between NC and human-derived capital, etc.).

This is practical implications on how we:

- Measure biodiversity impacts (recognition of incommensurable spatial elements vs modelling of potential impacts)
- Account for net biodiversity impacts (level of implementation of ecological equivalency between gains and losses)
- Value impacts, dependencies, and target setting => monetary / single integrative value (weak) vs pluralistic valuation approaches (stronger)

Subpopulation

Distinct groups within the global population, whether geographically separated or otherwise, exhibit limited demographic or genetic interchange. A subpopulation may or may not be confined to a specific geographic area (IUCN 2012).

Taxon (plural: taxa):

A taxon refers to any unit used in the science of biological classification (i.e., taxonomy). In the classification of plants and animals for instance, certain taxonomic categories are universally recognized and form a hierarchy: i.e., in descending order, kingdom, phylum (in plants, division), class, order, family, genus, species, and subspecies (or race). Rules for naming the various taxa are established in biological nomenclature.

Concepts

Accounting (national vs business)

Business accounting

Management (or cost) accounting[22]*:* The process of identification, measurement, accumulation, analysis, preparation, interpretation, and communication of information that used by management to plan, evaluate, and control within an entity and to assure appropriate use of an accountability for its resources. Managerial accounting reports are only used internally within the organization; so, they are not subject to the legal requirements that financial accounts are.

Environmental management accounting (EMA)[23] is the identification, collection, analysis, and use of two types of information for internal decision making. The first is physical information on the use, flows and rates of energy, water, and materials (including wastes). The second is monetary information on environment-related costs, earnings, and savings.

[22] URL : https://www.diffen.com/difference/Financial_Accounting_vs_Management_Accounting
[23] URL: https://www.cgma.org/resources/tools/cost-transformation-model/environmental-management-accounting.html#:~:text=Environmental%20management%20accounting%20(EMA)%

Financial accounting: Financial accounting is a specific branch of accounting involving a process of recording, summarizing, and reporting the myriad of transactions resulting from business operations over a period of time. Rules in financial accounting are prescribed by standards such as GAAP or IFRS. There are legal requirements for companies to follow financial accounting standards.

Environmental financial accounting[24] deals with accounting for and reporting on environmental transactions and events that affect, or are likely to affect, the financial position of an enterprise.

Double-Entry Bookkeeping (DEBK) is the core of financial accounting and was first popularized in the late 13th century by Luca Pacioli, who formalized the long-established accounting methods practiced by Venetian traders to keep track of their intricate web of transactions. With DEBK, every financial event involves recording each transaction in an account with an equal and opposite effect in at least one other account. These transactions are summarized in the preparation of financial statements, including the Statement of Financial Position (or Balance Sheet) and the Statement of Financial Performance (or Profit & Loss Statement), which are based on two inter-dependent equations. DEBK thus enables organizations to record both periodic and cumulative changes in transactions of a financial nature and to aggregate individual financial events at the organizational level. Because accounting journal entries must balance out, DEBK reduces the likelihood of errors and fraud and helps improve transparency and financial management (Trotman & Gibbins, 2003)[25].

Biodiversity accounting for organizations

BD Protocol: Biodiversity accounting for organizations can be defined as the systematic process of identifying, measuring, recording, summarizing, and reporting the biophysical state of biodiversity assets and the periodic and accumulated net changes to those assets. Biodiversity accounting must follow accounting rules:

1. An asset inventory or register of affected ecosystems and material species, organized in line with relevant international (e.g., IUCN Global Ecosystem Typology) and national classification systems (e.g., EUNIS Habitat Classification in Europe, South African ecosystem types, Terrestrial Ecological Systems of the United States),
2. Measurement techniques that use spatially explicit data, suitable to each asset category,
3. The assessment of net impacts for gains and losses of like-for-like assets (ecological equivalency principle) in line with the mitigation hierarchy,
4. Use of recording rules based on double-entry bookkeeping (DEBK) from financial accounting,
5. Compilation of asset-specific statements of performance and position, which can be aggregated for ecosystems but need to be kept separate for material species,
6. Time period assumption, and
7. The segregation of biodiversity state data per value chain boundary, as well as per type of impact (direct, indirect, future).

Double counting: Beyond the double counting of direct impacts, which would typically occur when different consolidation approaches are applied to a business interest or activity shared by two companies, double

[24] URL: https://unctad.org/system/files/official-document/iteeds4_en.pdf
[25] Trotman, K., Gibbins, M. (2003). Financial accounting: An integrated approach. 2nd edition, Thomson Nelson Australia.

counting may also arise when a company accounts for both direct and indirect biodiversity impacts. Indeed, many indirect biodiversity impacts cannot be verified on the ground. For instance, changes in the state of biodiversity due to climate change result from the cumulative impacts of all greenhouse gas emissions, not just the emissions of a single company. In other words, the underlying impact drivers (i.e., greenhouse gas emissions from your company) cannot be traced to identifiable, tangible ecosystem assets or taxa. This means that the same ecosystem assets could be impacted by the direct (e.g., land use of your operations) and indirect (e.g., greenhouse gases) impacts of your business (and indirect impacts of others), hence leading to the double counting of your biodiversity impacts. Accordingly, direct, and indirect biodiversity impact accounts should always be segregated. While double counting may hold lower risks for your business in the context of internal and/or voluntary external disclosure, legal requirements with respect to the implementation of the mitigation hierarchy warrant dealing explicitly with this issue, in partnership with the involved stakeholders, to avoid taking responsibility for another business' impacts.

Corporate natural capital accounting

Natural capital assessment methods can have different areas of focus (e.g., corporate sites, value chain, products), different target audiences (e.g., internal decision makers, external stakeholders); varying understandings of the relationships between corporations and natural capital (e.g., impact, dependence) and reflect contributions from experts from different disciplines (e.g., ecologists, economists). This development process has led to an array of methods which use data and generate results that are not consistent, difficult to compare and challenging to integrate with one another.

To address gaps in corporate natural capital assessment methods, corporate natural capital accounting has been emerging. It rests on a key principle, making nature visible in decision making. This visibility is compromised when positive and negative impacts of different natural capital assets (e.g., forest, grasslands) are considered equivalent. It is also compromised when nature, is indirectly measured, rather than being directly measured for the extent and quality of its stocks. Similarly, much is lost with an emphasis on annual monetary values over measuring changes to natural capital assets themselves.

Time to take stock report definition: corporate natural capital accounting (CNCA)

CNCA is the systematic process of identifying, measuring, recording, summarizing, and reporting the periodic and accumulated net changes to (a) the biophysical state of natural capital assets and (b) the associated values of natural capital to business and wider society. CNCA requires:

1. An asset inventory recognizing the biophysical properties and dynamics of each asset category.
2. Measurement techniques that use spatially explicit data and apply the principle of ecological equivalency (like-for-like)
3. Recording rules based on double-entry bookkeeping from financial accounting.
4. Asset-specific biophysical statements of performance and position.
5. A defined scope according to organizational and value chain boundaries.

Ecosystem services

Align definition: All goods and services provided by ecosystems to humans, often divided into four service types (1) provisioning (e.g., food, water, (2) regulating (e.g., flood control, (3) supportive (e.g., nutrient cycling, pollination) and cultural (e.g., recreational). An alternative term is “Nature's contribution to people”.

Final ecosystem services[26]: FES defines when an ecological end-product transitions from being predominately ecological to being either 1) a predominately economic input that will often be combined with manmade capital to produce an economic benefit, or 2) something directly used or appreciated. FES are therefore considered flows from ecosystems to economic units (e.g., private companies, households).

Millennium Assessment (2055) classification is widely considered as inadequate nowadays.

Scoping of natural capital / biodiversity assessment

Scoping a NC / biodiversity assessment involves going through three complementary aspects (apart from choosing biodiversity aspect): business application, organizational focus area and value chain boundaries.

The materiality perspective could be 4th aspect to consider.

Business applications

Align definition: The intended use of the results of a natural capital assessment, to help inform decision-making.

Three main groups identified by Align for biodiversity measurement applications:

1. Screening of risks related to potential impacts and dependencies, and opportunities for mitigation; it requires less detailed measurement approaches and might even have qualitative outcomes; outputs are indicative in nature but sufficient for prioritization purposes.
2. Measuring biodiversity impacts and performance: this requires more precise, quantified figures to understand the change in biodiversity state that is observed or predicted based on a company's activities.
3. Measuring changes in the state of biodiversity underpinning business dependencies: this requires quantitative measures of the state of biodiversity and the provision of ecosystem services on which the business activity depends.

Organizational focus area

Four main organizational focus areas (as defined by Natural Capital Protocol[27]) have been identified by Align:

1. Site or project level: site level usually refers to existing sites while project level usually refers to planned undertakings or initiatives at a specific location; site and project level impacts are directly related to the site or project activities, processes, and incidents and exclude supply chains delivering to the site or project.
2. Supply chain: focus is on the upstream parts of the value chain where primary sectors are active (e.g., extraction of raw materials, agriculture, fisheries, forestry).
3. Product level: goods and/or services, including the materials and services used to produce the product and the downstream activities.
4. Corporate level: assessment of a corporation or group, including all subsidiaries, business units, divisions, different geographies, or markets etc. This may require aggregation of information across the full value chain.

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[26] See Finisdore et al. 2020. The 18 benefits of using ecosystem services classification systems Ecosystem Services 45 (2020) 101160. https://doi.org/10.1016/j.ecoser.2020.101160
[27] Capitals Coalition (2016). Natural Capital Protocol. https://capitalscoalition.org/capitals-approach/natural-capital-protocol/

Value chain boundaries

The Natural Capital Protocol (Natural Capital Coalition 2016) and the BD Protocol recognize three major parts of the value chain:

1. Direct operations (gate-to-gate), which cover activities over which your business holds ownership or control.
2. Upstream (cradle-to-gate), which covers the activities of suppliers.
3. Downstream (gate-to-grave), which covers activities linked to the purchase, use, re-use, recovery, recycling, and final disposal of your business' products and services.

Materiality perspective

TNFD definitions:

Single materiality focuses only on risk to the enterprise value of a business.

Double materiality or dual materiality, as advanced by European policy makers and regulators, incorporates a focus on impacts and risks to climate and nature as well as the business.

Societal materiality, used by the Science Based Targets Network (SBTN), emphasizes an obligation to contribute to social outcomes beyond what might be required by regulation.

Dynamic materiality emphasizes that material issues are dynamic and change over time.

Valuation

Natural Capital Protocol definitions:

Valuation: is the process of expressing the importance of things to people.

Value (noun): The importance, worth, or usefulness of something.

Economic value: The importance, worth, or usefulness of something to people—including all relevant market and non-market values. In more technical terms, the sum of individual preferences for a given level of provision of that good or service. Economic values are usually expressed in terms of marginal/incremental changes in the supply of a good or service, using money as the metric (e.g., $/unit).

Qualitative valuation techniques are used to inform the potential scale of costs and/or benefits expressed through qualitative, non-numerical terms (e.g., increase in air emissions, decrease in social benefits of recreation).

Quantitative valuation techniques, in turn, focus on numerical data which are used as indicators for these costs and/or benefits (e.g., changes in tons of pollutants, decrease in number of people benefitting from recreation).

Monetary valuation techniques translate quantitative estimates of costs and/or benefits into a single common currency.

Time to take stock report argues that at least three key valuation framing perspectives should be mentioned: (i) natural capital targets; (ii) natural capital dependencies; and (iii) natural capital impacts.

Intrinsic valuation: In the context of biodiversity accounting and the BD Protocol, it is important to highlight that biodiversity impact assessment is the key process by which the intrinsic value of biodiversity assets are identified and presented. This differs from an ecosystem service valuation which values biodiversity for its use by people. Typical intrinsic biodiversity valuation can involve:

1. Highlighting the threat level of each asset within the biodiversity asset register (e.g., IUCN Red List for species and ecosystems, protected species, ecosystem assets with no-net-loss or offset requirements), a form of qualitative valuation.
2. Highlighting the relative importance of individual elements of the biodiversity asset register compared to others (e.g., percentage of total biodiversity footprint of the organization which an ecosystem asset makes up within a site or across direct operations), a form of quantitative valuation.
3. Comparing the size of the total, positive and negative biodiversity footprints of (a) individual sites or operations and (b) individual biodiversity assets within the asset register, a form of quantitative valuation.
4. Comparing the size of the total, positive and negative biodiversity footprints across value chain boundaries or of different companies.

BD Protocol recommends the financial valuation of mitigation measures implemented for the various assets of the biodiversity asset register. This may include expenses (e.g., restoration measures) and liabilities (e.g., offset requirements within a given timeframe). Perhaps counter-intuitively, such monetary values help understand whether the intrinsic value of biodiversity is identified, recognized, and acted upon by the organization (e.g., how much money is spent conserving biodiversity assets for their intrinsic values). This can be embedded in cost-effectiveness approaches aimed at delivering the 30X30 target for protected areas and other effective area-based conservation measures.

Target setting

The use of the mitigation hierarchy is often linked to the concept of no-net-loss or a net gain for a whole project, which requires an assessment of the baseline or existing conditions to provide a starting point (e.g., pre-project condition of biodiversity) against which comparisons can be made (e.g., post-impact condition of biodiversity), allowing changes in biodiversity to be measured throughout the asset life-cycle. Offset measures, aimed at reaching no-net-loss or net gains, have been applied to a growing number of projects worldwide (e.g., property development, linear infrastructures, mines, typically in the context of project authorization processes.

In organizational biodiversity accounting (BD Protocol), target setting applies to each component of the biodiversity asset register or inventory. It may be influenced or dictated by specific procurement rules, standards and / or jurisdictional laws or regulations, for instance no-net-loss requirements for specific biodiversity assets (e.g., protected species and wetlands in many US States, threatened ecosystems in South Africa, protected habitats and species in the EU). The changes in the state of the biodiversity assets of offset sites should also be included in the accounting process (though separated from the core accounts, depending on their legal status), to ensure accountability and transparency regarding the implementation of mandatory biodiversity measures.

Furthermore, targets should be framed from two perspectives:

From a periodic impact perspective (Statement of Biodiversity Performance / EP&L or flow perspective), whereby targets are based on expected or desired positive (net positive / net gain), neutral (no net loss) or negative (net loss) changes in the state of individual biodiversity assets over one or several years from a chosen baseline.

From an accumulated impact perspective (Statement of Biodiversity Position / stock perspective), whereby targets are defined as the expected or desired share of the Total Biodiversity Footprint, per biodiversity asset category and overall, which is positive (Positive Biodiversity Footprint) or negative (Negative Biodiversity Footprint).

There is no neutrality possible for a total biodiversity footprint, no net positive impact possible for a company as a whole. However, for each company, the goal could be to set overall accumulated targets expressed as a Positive to Negative Biodiversity Footprints ratio (e.g., 30%:70%, in line with the 30X30 targets) and backed up by verifiable, on the ground periodic targets for each asset category.

Databases

1. Description.

The development of methodologies for LCA or NCA had not yet commenced during the production of this database. Consequently, there were no definitive guidelines regarding database types, localization, etc. that would be needed. The objective, instead, was to comprehensively document databases to offer a broad overview of accessible resources. The database aims to include as many databases as possible, potentially useful for LCA or NCA. This approach ensures that, when Task 2.2 of the second work package begins, there will already be an understanding of what is readily available or lacking, providing guidance on the required foundation for databases.

In the development of this Excel-based repository, we implemented a systematic categorization, organization, and description of the databases. This categorization encompasses a variety of parameters and for each entry there is a list with metadata that highlights key information for a comprehensive understanding of these databases. The spreadsheet contains approximately 170 biodiversity-related databases, described by several parameters:

Source Data ID: Unique identifier for the data source.

Database Name: Name of the database.

Website: URL or location of the database's website.

Type: Primary data (data measured *in situ*; example: direct population counts; direct and habitat and community surveys, etc.); Secondary data (modeled data, example: species threat assessment and range layers; spatial overlays with biodiversity data layers, etc.)

Category: The general subject or field the database covers, divided in: Pollution, Land use, Climate change/greenhouse gas emissions, Natural resource use and exploitation, Invasive & alien species, Ecosystem surface, Community composition, Species conservation status, Species trends, Ecosystem services, Area conservation status, Natural resources, Natural events, Industries/products, and Others.

Scope: Range or extent of data coverage, classified in six categories: Ecosystem extent, Ecosystem condition, Impact driver, Species, Ecosystem services, Socio-economic.

Private/Public: Whether the database is privately held and data not accessible and/or payable or publicly accessible and free.

Date of Creation: When the database was initially created.

Date of Last Update: Most recent update or revision date.

Geographic Coverage: General area(s) the data encompasses (worldwide, several countries, European Union, national, regional).

Geographic Coverage (details): Specific details about the geographic areas covered.

Scale of Data: Geographic scale of the available data (local to international scale).

Display of Data: How data is presented or visualized (visual data map, dashboard, spreadsheet tables, graphics, list of species, PDF, text, figures, and scientific papers).

Data Available for Download? Indicates if data can be downloaded.

Data Format: Format in which data is stored or can be downloaded (e.g., xlsx, xml, shp, csv, kml, etc.).

Link for Data Downloading: Direct URL for downloading the data.

User Conditions: Terms and conditions for users accessing the data (e.g. open source, private, public with license, authors citation, authors authorization, etc.).

Data Description: Detailed description of the data contents.

Methodology: The approach or methods used in data collection and processing.

Author: Creator or principal contributor to the database.

Comment: Additional remarks or notes regarding the database.

2. Methodology

The construction of this database was a collective work by CircHive partners from different sectors of the whole consortium engaged in task 1.1. As a first step, we created a list of the main biodiversity-related datasets based on IPBES, indexes and scores that form the basis of various tools and methodologies for risk and performance assessments, scientific research and policy-making tools. The datasets correspond to subjects related to the state of biodiversity, fragility of species, habitats, habitat quality, ecosystem services, threats to biodiversity, etc. This list was compiled based on the participators' expertise and an in-depth search of the relevant databases and literature (scientific and grey). The table was completed with the best available information, but in some cases the information was not found or did not exist. In these cases, we have therefore set the value N/A in the corresponding metadata fields.

The list was co-built by mapping environmental data and database availability to improve the utility of and access to global and European environmental datasets at different levels and ensure data coverage for the project development. Given the multitude of local databases that may exist, as part of this research and database characterization work, we have focused on databases with broad geographical coverage. We have therefore focused our search on databases covering the whole world, the European continent or European countries, and in particular the countries where the CircHive project's case study partners are located. Even so, stakeholders familiarized with BF (linked to NCA) and LCA methods fed the extensive screening process of the state of art of biodiversity databases. For the selection of the databases, there were criteria taken into account in regard with the content of datasets like the source, quality and needs from the public and private sector using them and the ability to update and export them for external use as well as geographical scales (e.g., national or regional databases).

After the description of databases, methodologies used in each one and availability, there was a selection process regarding the pertinence and usefulness. Afterwards, the harmonization and standardization of the value of the parameters describing the databases allowed us to evaluate and compare the listed databases. This standardization of datasets improved the integrity, accuracy and consistency of the whole set facilitating the compilation of data depending on needs and for exploring the possibilities that they give.

Results

This chapter presents an analytical synthesis of our findings (Biodiversity Database spreadsheet – Annex 1) segmented into five key scopes. These are: (1) Ecosystem Condition, referring to the biophysical parameters of various ecosystems; (2) Ecosystem Extent, focusing on the quantitative analysis of ecosystem spatial distribution and size metrics; (3) Ecosystem Services, examining the quantifiable benefits derived from ecosystems; (4) Impact Driver, related to the drivers affecting ecosystem transformations; and (5) Species, in the scope of species diversity metrics and their ecological roles within ecosystem structures.

Each section details the database sheet with an emphasis on Data Authors & Production to detail on the origin and methods of data collection. This is followed by Display of Data, highlighting how information is visualized. Access Specifications indicate the data's availability, distinguishing between private and public access. Finally, Limitations and Gaps examine any areas where the data may be lacking or incomplete, ensuring a comprehensive understanding of the database's scope.

1. Ecosystem condition

Description

Ecosystem condition refers to the quality of an ecosystem, measured through its abiotic and biotic characteristics. It encompasses functional condition, which focuses on the efficiency of ecological processes like nutrient cycling and energy flow; compositional condition, dealing with the biodiversity including the variety and abundance of species; and structural condition, involving the physical organization of the ecosystem, its species and habitats distribution, and their interrelations. These aspects collectively contribute to the ecosystem's ecological integrity and its ability to provide ecosystem services.

In our database spreadsheet of 170 databases, we have 38 databases (23% of the total) that are relevant to the ecosystem condition. Below we detail their main characteristics.

Data authors & production

In the database relevant for the scope of ecosystem conditions, there are a total of 30 unique authors represented in the dataset. The most cited contributors are the National Museum of Natural History of Paris (MNHN) and the World Wildlife Fund (WWF), with three databases each. The Food and Agriculture Organization (FAO) has two databases mentioned. The remaining authors have contributed to one each.

Our database reveals that 63.2% of the ecosystem condition databases are classified as secondary data sources, reflecting that most of the analyzed datasets are based on modeled data, such as spatial layers. Primary data sources, which involve direct collection from observations or experiments *in situ*, account for 31.6% of the types of data in the database. It is important to highlight that the constant collection and updates of field data is extremely necessary to best reflect the reality, especially when referring to biodiversity and ecosystems.

The datasets span a broad range of categories, with 'Land use' being the most prevalent, representing 26.3% of the total. This is followed by various other categories such as 'Area conservation status' and 'Natural resource use and exploitation'. These categories underscore the diverse factors that influence ecosystem health, however important aspects such as community composition, ecosystem surface, and species conservation status appear in a fewer database.

The creation dates of the databases extend from 1982 to 2022, covering a 40-year span that allows for historical comparisons and trend analysis. Also, approximately 70% of the databases listed had one or more updates in the last five years, which is crucial for long-term usage. Geographically, the coverage is predominantly worldwide in scope (65.8%), with 18.4% of the datasets focusing on national-level data.

Display of data

In examining the ecosystem condition databases, we find that the most common method of data presentation is through visual data maps, which are utilized in approximately 65.8% of the databases. In addition, a combination of visual data maps and dashboards is used in 18.4% of the cases, providing a more interactive interface experience. Other forms of data display, including dashboards, tables, and spreadsheets, are less commonly used.

Most of these datasets (86.8%) are available for download, in the shapefile format (.shp), used in geographic information system (GIS) software, and CSV files compatibility with numerous data analysis tools. Other formats, such as PDF, TIFF, and XLSX, are also available.

Access

In our dataset of ecosystem condition, 94.7% of the data sources are publicly available. Only a nominal 5.3% of the data remains private. Regarding the user conditions, there is a third of the databases requiring citation of the authors. Furthermore, 28.9% of the datasets are accessible under a public license, which provides users with clear guidelines on the utilization of the data while preserving the rights of the data providers. Open-source data, which allows for modification and redistribution, accounts for 15.8% of the 38 databases listed. Other specific conditions, including author authorization and tailored closure policies, are less common, collectively comprising under 10% of the user conditions.

Limitations and gaps

In the context of biodiversity footprint and natural capital accounting, accurately assessing ecosystem conditions presents several challenges, primarily due to gaps in data and representation. One major issue is the temporal and spatial bias in data collection. Data is often abundant for certain regions and time periods but lacking for others, leading to an incomplete understanding of ecosystem dynamics. Additionally, there is a significant bias in taxonomic representation, where data is predominantly available for certain groups like mammals and birds, while many other species, particularly invertebrates and fungi, are underrepresented. Moreover, data on the functional aspects of ecosystems, such as nutrient cycling and energy flow, is often scarce compared to compositional or structural data. This limited coverage can limit the understanding of biodiversity and ecosystem health.

Therefore, it is important to constantly update data with information from field studies and research. Regular, updated field data ensures that assessments reflect current conditions, capturing changes and trends over time. This ongoing data collection is essential for a more accurate and comprehensive understanding of natural capital and the true impact of human activities on biodiversity.

2. Ecosystem extent

Description

The concept of *ecosystem extent* covers the dimensions and geographical boundaries of diverse ecosystem types within a designated area, typically quantified by the spatial area they encompass. This parameter serves as a cornerstone of geo-spatial data, instrumental in estimating the potential flux of ecosystem services, and furnishes a structured schema facilitating the assessment of trade-offs among biodiversity, ecosystem services, and land usage[28].

Measurement of ecosystem extent is executed in a spatially precise manner, often denoted in hectares or square kilometers, and is pivotal in monitoring the temporal transitions in ecosystems' stock across a territory. A detailed comprehension of ecosystem extent empowers stakeholders to undertake well-informed conservation planning, land-use strategizing, environmental surveillance, and biodiversity evaluations.

The definition of an ecosystem extent for a given application may depend on:

- The typology of ecosystem defined, i.e., on where the specific typology used sets the cut-off value from one ecosystem to another. For instance, the difference between an open forest and a closed forest can be differently defined from one typology to the other, while other typology will simply define forests as an ecosystem of interest.
- The typical scale of the study area and the spatial resolution chosen for the analysis: it is important to choose a scale consistent with the analysis needed for the
- The method chosen to assess the nature of the ecosystem: field-based method, UAV-based, or remote sensing-based approaches or a mix of the former methods, may allow for more or less granularity in the definition of the typology.
- The temporal dynamics of the ecosystem which may transition or cycle through different stages corresponding to different types of ecosystems in a chosen typology.

While some of these criteria may be captured in the ecosystem condition, whereby, for example, a pioneer ecosystem may be considered as a degraded form a climactic one, it is not always the case, and the assumptions underlying the chosen typology should insofar as possible be explicitly highlighted in order to ensure that the typology chosen for ecosystem extents is consistent across time, and thus ensure period-to-period comparability of the ecosystem extent accounts. Depending on the goal of the account, the chosen typology may either be *de facto* "imposed" by the analysis framework chosen, in order to ensure cross-project comparability, or may be tailored to a specific project in order to ensure a better measure of performance in time for a specific project / bundle of projects.

Within our dataset, we identified a total of 38 databases that specifically target the scope of "Ecosystem extent". This subset, while being a significant portion, represents approximately 23.6% of the total 161 databases cataloged in the dataset. These databases play a crucial role in understanding, measuring, and

[28] Petersen, J.-E., Mancosu, E., King, S. (2022). Ecosystem extent accounts for Europe. *Ecosystem Services, 57*, 101457. https://doi.org/10.1016/j.ecoser.2022.101457

monitoring the spatial extent and boundaries of various ecosystems. For instance, the Ecoregions Prioritized for Conservation from the TNC, highlighting regions with a significant need for conservation efforts.

Data authors & production

In total, data has been contributed or curated by 21 unique authors or institutions.

Display of data

Ecosystem extent is generally derived from Land Use Land Cover (LULC) data or from natural habitat maps. Depending on the need a specific dataset could either be used in its original form or the data could be treated, through direct correspondence table between datasets or by improving it to fit a specific typology. The datasets gathered mainly enter in one of the two following categories:

1. Visual Data Maps: A significant portion (26 databases) employ visual data maps. These tools are instrumental in providing spatial insights.
2. Tables: Utilized in only 2 databases.

Access

All databases (37 in total) related to "Ecosystem extent" are publicly accessible. There are no private or mixed-access databases in this category.

Limitations and gaps

Practical challenges exist in defining ecosystems in practice in a way that is systematically relevant to understanding the impact of human activities such as, for example, a given resource extraction or exploitation activity on a given territory where it takes place.

Similarly, non-contiguous systems depending on keystone migratory species can be affected by the modification of stop-over habitats which are considered individually of marginal importance to the species but that may greatly affect ecosystems down the migratory routes (e.g., flyways or waterways) at breeding sites or feeding sites. This kind of complex trophic or functional interaction that extend beyond the scope of a studied EA, or EAA, are likely to not be captured through an ecosystem accounting approach.

Another difficulty may present itself when considering which typology of ecosystem to use. While available datasets generally propose a well-defined nomenclature, these are not necessarily consistent with one another and adapting the typology of ecosystem proposed in one dataset to another is not always feasible. For comparability between accounts, it is therefore important to choose dataset that are mutually consistent.

In other applications, the temporal resolution of the dataset used will be important. For instance, some datasets are produced on a year-to-year basis. Using such dataset to monitor the evolution on period less than the updating time step of the dataset will therefore be useless. In some cases, sudden changes linked to human activities will not be readily recorded until the next update of the dataset.

In addition, the accuracy and reliability of the georeferenced data used will depend on the method through which the dataset has been collated. Remote sensing data can generally lead to spatially consistent dataset in terms of resolution, but some details (e.g., exact nature of a forest stand) will not be available. Field-based data will usually be accurate in terms of habitat description, but may have some “blind spots”, as it is difficult to cover large swath of land. Finally, Unmanned Aerial Vehicle (UAV-based surveys) may strike an in-between, where relatively large areas can be covered at an improved resolution, however specific features of some habitats will be missing.

Moreover, the ecosystem map will differ depending on the base data used to compile it; for instance, LULC data would focuses more on general land-use types, while a map of natural habitats would be more focused on vegetal communities.

Finally, the representation of the data may influence the way the resolution of the dataset is defined. While for raster data the resolution of the pixel is always the proxy for the resolution of the dataset, things can be more complex for a polygon-based vector dataset , for instance if the resolution is defined by a minimal contiguous patch area, elongated narrow features (such as small streams), that may not appear in the raster dataset may be present in a vector dataset and conversely ecosystem patches present in a raster dataset may be absent from a vector dataset..

It seems therefore important that the limitations of the accounting framework are understood by the account users, and to stress that some applications may require tailored approach to assess biodiversity impacts in ways that are seemingly challenging to cover through the use of ecosystem accounting.

3. Ecosystem services

Description

While the intrinsic worth of the natural world cannot be quantified, the contributions derived from robust and thriving ecosystems in our midst are palpable. These advantages extend to bolstering our economic stability, cultivating a diverse array of food resources, and propelling breakthroughs in the realm of medical research, all attributable to the presence of wildlife and flourishing natural environments.

Humanity has long recognized the importance of attributing a value to nature, leading to the recent emergence of the concept of ecosystem services. This idea allows mankind to understand and appreciate the various ways in which wildlife and ecosystems impacts modern society. These contributions, which can be both direct and indirect, small, and significant, highlight the interconnected relationship between human societies and the natural world.

The Common International Classification of Ecosystem Services (CICES[29]) categorizes ecosystem benefits into three main types: provisioning, regulating, and cultural services. Provisioning services include tangible outputs like food and raw materials from ecosystems. Regulating services cover natural processes that maintain environmental balance, such as bioremediation and pollutant filtration. Cultural services encompass the non-material benefits from ecosystems, enhancing human culture, recreation, education, and spiritual life. These categories collectively illustrate the extensive ways ecosystems contribute to human survival, well-being, and cultural enrichment, highlighting the intricate and vital relationship between humans and the natural world.

The two key components of natural capital assessment and ecosystem accounting are stocks and flows. Stocks are defined as the natural capital which a company interacts with (water basins, forests, animals within a forest). Flows are the ecosystem services which a company depends on (or impacts). Understanding ecosystem services is essential for assessing the interaction between businesses and ecosystems.

[29] https://cices.eu/

Data authors & production

In the database we have a diverse range of datasets focusing on the ecosystem services. Of the six datasets available, the majority (66.7%) are classified as public sources, highlighting a significant reliance on governmental or publicly accessible information. The types of data vary, with an equal split between primary and secondary sources. Primary sources, which are directly collected through observations or experiments, and secondary sources, typically derived from existing data, each constitute 50% of our database.

The dates of creation range from 2014 to 2022, with the most recent dataset originating in 2022. Interestingly, half of the datasets have been updated in the last year (2023). Geographically, the coverage of these datasets is quite extensive and varied. One dataset includes a wide array of countries across multiple continents, such as Australia, Brazil, Canada, and more, emphasizing a global perspective. However, there's also a focus on more localized data, with datasets covering national data for countries like Bulgaria and regional data like coastal areas.

Display of data

Our database shows that a significant portion (83.3%) of our datasets is presented through Visual Data Maps or Dashboards. The formats of the data are varied, with datasets available as shapefiles (shp), xlsx and PDF format. Regarding the accessibility of the data, 66.7% of the datasets are available for download, enabling users to engage with the data more deeply.

Access

Of the six databases five are publicly available and one requires a license to access. User conditions are varied, often requiring some form of authorization from the authors.

Limitations and gaps

The database currently has a limited list of datasets on ecosystem services, a reflection of the work needed to find these databases. Gathering this data is a complex task that usually relies on the expertise of local specialists The challenge of scaling up these databases is high, as local expert assessments are fundamental not only for data collection but also for the modelling of ecosystem services. These models are essential for understanding the various ways in which ecosystems support human life, yet their development is constrained by the need for region-specific expertise, making the broader compilation and update of these datasets a long process.

4. Impact driver

Description

IPBES defines two broad types of impact drivers: direct and indirect:

Indirect drivers refer to drivers that bring about changes in a diffuse manner, impacting not only direct drivers but also other indirect drivers, often known as 'underlying causes'. Indirect drivers significantly impact the direct drivers of biodiversity and ecosystem change, while also exerting a substantial influence on other indirect drivers. Socio-economic and demographic patterns play a pivotal role in shaping consumption habits, thereby leading to significant environmental consequences.

Direct drivers, whether natural or anthropogenic, are unequivocal influencers of biodiversity and ecosystem processes, often termed as 'pressures.' Anthropogenic direct drivers largely stem from the previously mentioned indirect drivers. Operating at a more immediate level, these direct drivers often interact synergistically with other direct drivers, consequently contributing to the cycle of indirect drivers. Examples of direct drivers impacting biodiversity and ecosystems include land-use changes, climate fluctuations, pollution, the exploitation of natural resources, and the introduction of invasive species.

Following the IPBES[30] (2019) definitions, the five main drivers of biodiversity loss are:

Land-use change: The most significant human impact on habitats is land-use change, which encompasses activities such as altering land cover (e.g., deforestation or mining), modifying the management of ecosystems or agro-ecosystems (e.g., intensifying agricultural practices or harvesting forests), and reconfiguring the spatial layout of the landscape (e.g., fragmenting habitats).

Climate change: Climate change's direct driver pathways are linked to alterations in climate and weather patterns, impacting the functioning of ecosystems in their original locations and prompting the migration of species and entire ecosystems. Evidence suggests that the rise in global temperatures caused by climate change might endanger as many as one in six species worldwide. Elevated atmospheric CO2 concentrations, resulting in warmer ocean temperatures and increased ocean acidification, are anticipated to profoundly affect marine ecosystems, especially coral reefs and marine communities near the seafloor. Recent studies predicting reef shrinkage due to global warming unanimously underscore the adverse effects on marine biodiversity reliant on these ecosystems, although the specific impacts of ocean acidification vary significantly among different taxa.

Pollution: Pollution stands as a pivotal catalyst for biodiversity and ecosystem shifts across all biomes, inflicting particularly severe direct repercussions on freshwater and marine habitats. On a global scale, the atmospheric deposition of nitrogen has been acknowledged as one of the most significant menaces to the integrity of global biodiversity. Following nitrogen's deposition onto terrestrial ecosystems, a series of cascading effects may ensue, often resulting in overall biodiversity declines. In terrestrial biomes, nitrogen deposition from fossil fuels and fertilizer usage has been observed to hinder decomposition and retard microbial growth, thereby carrying several implications for terrestrial biodiversity. Mathematical representations of the most critical processes are employed to simulate changes in biotic or ecological characteristics in response to environmental drivers. While these process-based models are valuable for evaluating temporal trends and response times, they frequently necessitate a substantial amount of data for accurate model calibration.

Natural resource use and exploitation: Throughout human history, the human-driven exploitation of wildlife has resulted in biodiversity depletion and extinction. However, the current pace of loss has sharply accelerated. Among the most overexploited species are marine fish, invertebrates, trees, tropical vertebrates hunted for bushmeat, and species targeted for the medicinal and pet trade. Human activities have significantly impacted ocean health, primarily through overfishing, although substantial variations exist at the country level. The overexploitation of marine habitats has emerged as the primary cause of the decline in marine resources,

[30] IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio, H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. 56 pages. https://doi.org/10.5281/zenodo.3553579

leading to significant declines in commercially valuable species, as well as other species affected by bycatch and excessive fishing. The decision to abandon a declining fishery heavily relies on the socioeconomic status of the fishers, with disadvantaged households being less inclined to withdraw. Moreover, local evidence indicates that proximity to markets and market demand better predict overfishing than population density. Utilizing participatory modeling approaches with increased stakeholder involvement at the local level is highly pertinent for sustainable natural resource governance, particularly in the context of fisheries management.

Invasive species: Invasive species, whether indigenous or exotic/alien, are predominantly found in terrestrial and aquatic ecosystems (both marine and freshwater), causing disturbances in the ecological balance of natural systems. These invasive species often outcompete local and indigenous species for natural resources, leading to adverse consequences for biodiversity. Various regions worldwide have reported the presence of invasive species, weeds, or alien species, resulting in the depletion of biodiversity at local and regional levels and inflicting considerable economic harm.

Data authors & production

Behind the 23 databases about impact drivers were different authors. Some were based on a scientific article or a method and some put together and updated by National Institutes or International actors like UNEP-WCMC, FAO, World Resources Institute.

Display of data

Regarding the five main impact drivers for biodiversity loss, data on pollution was most common (8), natural resource use/exploitation (6), and land use (5). Climate change related databases were only three and none of the databases contained specifically information about invasive species. In addition, there were few databases on other related topics.

Almost all data were secondary data, with only two exceptions being primary data. Likewise, almost all data was public data, with only one exception of private data. Most of the data sets were worldwide, with few national (5) and regional (1) data sets. Scale of data was mostly national (11) or regional (7), but in few also local (4). Majority of data sources were presented as visual data maps or dashboards with few exceptions in excel or pdf.

Access

Almost all of the data sources listed here were public (24) and only one private (1). From the public databases, 9 needed licenses, 7 asked to user citate the author, 3 were open source and 1 open access.

Limitations and gaps

Although only 25 data sources were listed here, it seems that a large share of impact driver related data is gathered behind some databases needing a license. Regarding the scale of the data, most data was either national or regional with very little local data included. When the CircHive-project continues, more databases will be searched according to the need. Currently no database having data about invasive species was included, but this type of data is very much linked to the geographical site and application. Such data may be included in species occurrences databases such as GBIF database. But regional lists of alien invasive species are required to highlight the occurrences of invasive species in a particular area. Maybe this type of data will be needed during the piloting, but the focus needs to be set first.

5. Species

Description

As stipulated by The Convention of Biological Diversity, the term "biodiversity" is plural and encompasses a wide range of biological features with distinct attributes, this means 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 (i.e., genetic, behavioral, and cultural diversity), between species and of ecosystems. Due to its multi-level complexity the integration of biodiversity into Natural Capital Accounting is challenging. In the past, accounting has been compiled by using spatial data and information about ecosystem assets or services (e.g., ecosystem extent or condition). For understanding ecosystem condition, data on species can be used as a proxy. For instance, compositional state can be described by species-based indicators (e.g., bird species richness for tropical – subtropical forests) (SEEA-EA, 2021). Spatially linked tools elucidate the importance of habitat loss linking accounting to land use practices and indicators such as Species-Area Relationship models for biodiversity loss (Curran et al., 2016).

Moreover, approaches can model a potentially disappeared fraction and aggregate results to a global landscape which are able to scale biodiversity impacts in terms of species extinctions (Marques et al., 2021). Other approaches have tried to adopt novel metrics reflecting non-compositional attributes of biodiversity (e.g., functional), such as indicators of ecosystem resources (e.g., dead wood) and functional trait diversity (e.g., diversity of pollinators).

Even though species indicators are somehow considered while evaluating ecosystems condition (e.g., composition, function, and structure), it has been difficult to link species assessments as a separate relevant aspect on biodiversity footprint which can go beyond these variables. Accounting for species assets can include species status of conservation, species stocks and distribution (SEEA-EA; 2021). Approaches capturing biodiversity impacts in terms of ecosystem functionality give clear information on ecosystem's health (e.g., biomass or abundance; Grime, 1998).

In addition, species accounting may reflect provisioning services (e.g., pollination or rates of extraction) and at the same time can go beyond ecosystem services accounting by exploring aspects like tendencies of populations, global irreversible species extinctions, value in reintroduction or translocation procedures and/or monitoring programs (Bogaart et al., 2020).

Throughout the compiled database (167 databases) there is a total of 41 databases that have species as their scope or measurement target. This, as stated before, accounts for species-based or target measurements. Databases of species can take many forms, going from inventories, as well as distribution, stocks, and risk of extinction. It was observed that for the whole set of species-scoped databases there are almost 20 that contain primary source data. This means that 24.6% of the databases analyzed are in situ, direct population counts, direct field data collected, including richness, occurrence, or abundance records and/or community surveys. So, there is 75.4% that corresponds to modelled data, species threat assessments, range layers, or analysis of spatial overlays with biodiversity data layers.

The scale of the data corresponds to the level of measurement, in this case we can find that there are 21 databases holding national scaled data, 4 that have regional data (e.g., Pan-European Common Bird Monitoring Scheme) and 17 describing local data (e.g., GBIF Database describing local occurrences of species).

For the geographical coverage, meaning the surface or territory that has been assessed, we can observe 16 databases that have worldwide data, including 20 that have national information and 5 corresponding to regional data and 3 regarding the European Union (e.g., EUNIS – European level).

Data authors & production

Most of the worldwide databases have been developed by UNEP in collaboration to international actors like WCS, TNC, IUCN, GBIF, WRI or NASA. Databases with narrower geographic coverage are usually developed by national or regional institutions.

Display of data

Through this selection, 18 of the databases correspond to Visual Data Maps included in Dashboards where the user can observe spatial distribution of species or risks of extinction. Most of these databases have the available data in csv or shapefiles for usage. There are eight databases that are lists of species, two that are indexes described in scientific papers which are not available for download and 10 that correspond to text, tables, or spreadsheets georeferenced.

Thirteen of them can be linked to the species conservation status directly and 25 are focused on species trends, like abundance, occurrence data, distribution, or area of range.

Access

There are three databases, from the whole selection 41, that are private, and the rest are publicly available for consultation. Some of them, seven, are open source, and there are 20 that can be used but published under authors authorizations or citation. Different databases have certain use conditions which depend on the level of exploitation of the data from the user. In some cases, there are specifications on the type of license Creative Commons By 4.0 International license for open datasets. Specifically, from the public data, 29 databases have data available for download and 20 have a sort of condition (depending on each database some need registration like the GBIF or some need authors citation like the Species Habitat Index), two others can be downloaded but upon request (e.g., Sweden national bird monitoring program).

Limitations and gaps

Species data are commonly based on existing assessments from experts, IUCN Red List or monitoring programs. A vast majority is highly dependent on the IUCN Red List of Threatened Species which is a comprehensive set of data considering assessments with temporal and spatially coherent measurements. This database is restricted as ranges are not publicly available. It only allows to have an approach informed by sample surveys (e.g., biomonitoring or national surveys), stock assessments for commercially valuable species, or area focused efforts (e.g., census of protected areas and nature reserves).

Species data are complicated to obtain at large geographical coverage and fine scale measurements on these databases. They often come from citizen science and are non-exhaustive and often concentrated in already well-known interesting areas for biodiversity such as natural protected areas. Incorporating a quality threshold is essential, as there may be inaccuracies in species identification and geographical locations within the data. Outside these areas, inventory pressure and, consequently, the distribution of species occurrence data are much more random. They can be used to confirm the presence of certain species at a specific time and place. However, they do not allow us to rule on the absence of species.

In addition, it is rather easy to find data on mammals, birds, or plants, as most people are more familiar with these taxa. It becomes more complicated to find information on insects, freshwater invertebrates, or lichens.

In a context of extremely rapid climate and ecosystem change, where continuous monitoring is not in place, data that are one- or two-year-old could already be outdated and may not accurately reflect current conditions.

Therefore, it is deeply recommended to make an in-situ assessment of species by experts to complement the databases when using this type of data when making an analysis. Furthermore, only the implementation of standardized inventory protocols, repeated at regular intervals, will enable to assess the evolution of local species populations, and use species data as a proxy to measure changes in the ecosystems condition.

Conclusions

The number of databases per scope ranges evenly, varying from 15 to 23 databases per scope. However, ecosystem services stand out with only three databases, and no database for invasive species. The lack of data for ecosystem services and invasive species are limited due to the requirement for expert determination.

Several databases listed are also websites that host multiple databases, necessitating distinct considerations regarding accessibility, the timing of the last update, and methodology. Furthermore, a significant portion of primary data is not accessible through open channels. It is particularly true for impact driver data, though highly significant, is mostly unavailable to the public.

Challenges in identifying local and up-to-date data persist across scopes, with the complexity of defining ecosystems adding to measurement difficulties. About 60% of the data is secondary, with only 19% being local, highlighting a deficiency in local and primary data.

The assessment of ecosystem conditions, extent, services, impact drivers, and species in natural capital accounting is complex. Identified issues, such as biases and representation gaps, reveal the multifaceted nature of the task. Continuous data updates through field studies are imperative for accurate biodiversity accounting.

Some of the definitions and concepts listed in the so-called section could be controversial and may need further discussions in the project's future.

The data gathering in CircHive-project Task 1.1 provides an overview of biodiversity data availability. It serves as a starting point for method development and piloting. As knowledge on methods grows, it will aid in filling gaps in the current dataset. Ongoing piloting with project case-study entities ensures data gathering aligns with practical applications. The non-exhaustive list of databases in this deliverable should complement WP2 progression.

Recommendations

For the next steps we recommend:

1. Expert-Driven In-Situ Assessments: The role of expert-driven in-situ assessments and standardized inventory protocols is critical. Recognize their significance, particularly in the face of rapidly changing climates and ecosystems, as these measures are deemed essential for accurately gauging local species populations and using species data as a reliable indicator for assessing the evolving condition of ecosystems.
2. Database continuous update: As the CircHive project progresses, especially in the context of WP2, it is essential to continually augment and redirect efforts toward the completion of this database.
3. Controversial definitions and concepts: continue discussion on definitions and concepts in the project's future where necessary.
4. Promote data sharing within the consortium and beyond, particularly in the private sector, to address gaps in public data (e.g., ecosystem services).
5. In order to facilitate the use and updating of existing data useful for LF and NCA in the subsequent stages of the project and beyond, we recommend setting up a web application for entering and querying the database. In this context, we feel it would be advisable to develop a relational database to provide a link between the data that can be mobilized, the metrics and the BF and NCA methods.

Annex I - Biodiversity Database spreadsheet

CircHive_Deliverable_
D.1.1-Biodiversity data

Project Partners

CircHive is a five-year, €11.5 million project with 15 research and 10 case-study partners.

The project will develop rigorous and standardised methods for combining two approaches to valuing nature: biodiversity footprinting and natural capital accounting. These two approaches are being used by an increasing number of organisations to understand and value the nature that underpins their operations.

By combining these methods, the project will provide a more comprehensive approach to valuing nature and improving biodiversity performance.

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