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From Science to Policy 16

Sustainable finance and forest biodiversity criteria

Scoping for an EU Taxonomy

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Executive summary

What is the issue?

Forests play an important role in biodiversity maintenance, enhancement and conservation. In forests, biodiversity encompasses a wide range of animals, plants and fungi in complex interactions across spatial and temporal scales, their biodiversity shaped by the interplay of composition, structure, and functions.

Globally, the financial sector has been, mainly in an indirect way, one of the structural drivers of biodiversity loss by investing in economic activities or lending to companies that contribute to biodiversity loss. To divert the financial flows in a sustainable direction, and to meet its climate and environmental commitments, the EU launched its Sustainable Finance Strategy and developed related legislation.

The taxonomy for sustainable activities of the European Union, also called the "EU Taxonomy", aims to create a common set of indicators and criteria to classify sustainable economic activities. Its overarching Taxonomy Regulation (TR) establishes 6 environmental objectives: 1) climate change mitigation, 2) climate change adaptation, 3) sustainable use and protection of water and marine resources, 4) transition to a circular economy, 5) pollution prevention and control, as well as 6) protection and restoration of biodiversity and ecosystems.

To be considered environmentally sustainable, commercial activities and investments must meet certain minimum requirements and adhere to technical screening criteria based on scientific evidence. The EU Taxonomy Regulation does not specify these criteria, but the minimum requirements were defined later by the Climate and Environmental Delegated Acts. Forest-related activities have been addressed under the climate change mitigation and adaptation objectives in the Climate Delegated Act, but due to challenges in agreeing criteria have so far been excluded from the 'Protection and restoration of biodiversity and ecosystems' objective covered by the Environmental Delegated Act.

What are the objectives of the study?

This report aims to stimulate dialogue and help find consensus on how sustainable finance, with regard to forest-related biodiversity, can be encouraged and verified.

It provides guidance for biodiversity-oriented forest management, and proposes a set of 26 quantitative indicators and provides examples of thresholds, which would be applicable under the EU Taxonomy standard. The quantitative indicators are described with ranges in relation to the large variability of forest ecosystems at a global level, but also inside the EU. It also provides an overview of monitoring possibilities for forest biodiversity, and discusses the issue of compliance.

Key findings

Use a biogeographical-specific approach for indicators

Forest biomes in Europe vary over space and time, therefore indicators for biodiversity maintenance, conservation and enhancement and their thresholds can be defined best using a **biogeographical-specific approach**.

The complex nature of forest ecosystems and their diverse sustainable management options may not be adequately captured by one comprehensive list of indicators and standardised thresholds intended for global application, as proposed earlier by the Platform on Sustainable Finance. This **one-size-fits-all global approach should be avoided**, especially considering that biodiversity protection standards in other sectors are already well established in sustainable financial markets, such as renewable energy and agriculture, and are much less stringent and selective.

Avoid too-rigid thresholds or targets

The science today provides a sufficiently solid basis to state which measures in forest management are favourable for biodiversity and which are detrimental. Still, putting a natural system into a strict framework of management rules based on uniform and rigid thresholds or targets is challenging, as the carbon and biodiversity credit markets show. Too ambitious targets and thresholds may lead to a selective flow of donations only, and will discourage potential investors targeting a fair balance of financial profitability and biodiversity protection.

The threshold examples presented in this report should be seen as general guidelines to be approached with flexibility. This aims to balance supporting biodiversity protection while ensuring an attractive level of financial return on investments. The proposed threshold examples give a direction, realising that it may take (a long) time to achieve targets, with fluctuations in indicator values occurring over time and space.

New requirements can prove challenging

New requirements in development under the Taxonomy could exclude from sustainable finance the "early comers", namely those forest enterprises that have already integrated a high level of biodiversity protection into their management activities. Though the Taxonomy is about compliance, it needs to be specified whether financing biodiversity-friendly measures of a forest enterprise with an existing high level of biodiversity would be part of sustainable finance as defined by the Taxonomy.

Other strong policies are needed as well

Other strong policies are required as well alongside the Taxonomy to disincentivise financing deforestation and forest degradation. With recent developments in monitoring methods (e.g. remote sensing) and innovative financial instruments such as conservation bonds, biodiversity or carbon credits, the Taxonomy can provide an important stimulus, which European forests need to enhance biodiversity.

As the EU Taxonomy will be continuously updated, it is challenging to foresee the regulation's impact. Beyond financial impacts in terms of investments in forests, the Taxonomy might also have wider policy implications, as some definitions and criteria might be integrated into other fields of policy action. For example, these could be credits generated by carbon removal, certification of sustainable forest management and wood products labelling, non-financial reporting, and environmental claims.

Interpreting indicators and developing reporting processes

What is visible so far is that (financial) companies are facing difficulty in "correctly" interpreting existing forestry indicators for climate change mitigation and adaptation, and developing reporting procedures and processes. Next to monitoring challenges, the IT infrastructure to collect and process the required data, to understand the transition with its financial and forest management consequences, to foresee different EU disclosure requirements, as well as to apply the indicators that have been written by experts, does not necessarily match the accounting principles of (financial) companies.

These challenges might ease in the long term with further elaboration of the EU Taxonomy, its delegated acts and the experiences gained in reporting and implementation. However, it is still questionable whether the EU Taxonomy will eventually shift investments by providing information for disclosure. However, by moving towards "labelling and designations" through the Taxonomy, forest enterprises will have more options to attract needed investment funding and achieve positive ESG ratings.

1 Introduction: biodiversity crises, forests and sustainable finance

The rate of resource extraction and waste generation required for an increasing global population and that population's increasing welfare costs within the global economy exceeds the planet's capacity to replenish those resources (Figure 1). It risks destabilising the Earth's systems (Richardson et al, 2023). One of the major environmental consequences of the increasing pressure that is put on the planet continues to be biodiversity loss, though with variations spatially and temporally (Blowes et al, 2019; Leung et al, 2020; IPCC 2022).

The drivers of biodiversity loss are complex and diverse. The indirect drivers are an increasing world population and associated food consumption and demand, while the direct drivers are agriculture (IPBES, 2019), invasive alien species, urbanisation, modification of water regimes, forestry, poaching, illegal hunting and pollution (Jaureguiberry et al, 2022; EEA 2023).

The financial sector underpins these threats to biodiversity with the potential to play a role in indirectly mitigating them. One of the structural drivers of biodiversity loss is linked to decisions to invest in economic activities or to lend to companies that cause biodiversity loss, for example, by financing the conversion of natural ecosystems to other forms of human land use such as agriculture or infrastructure (Kedward et al, 2022a).

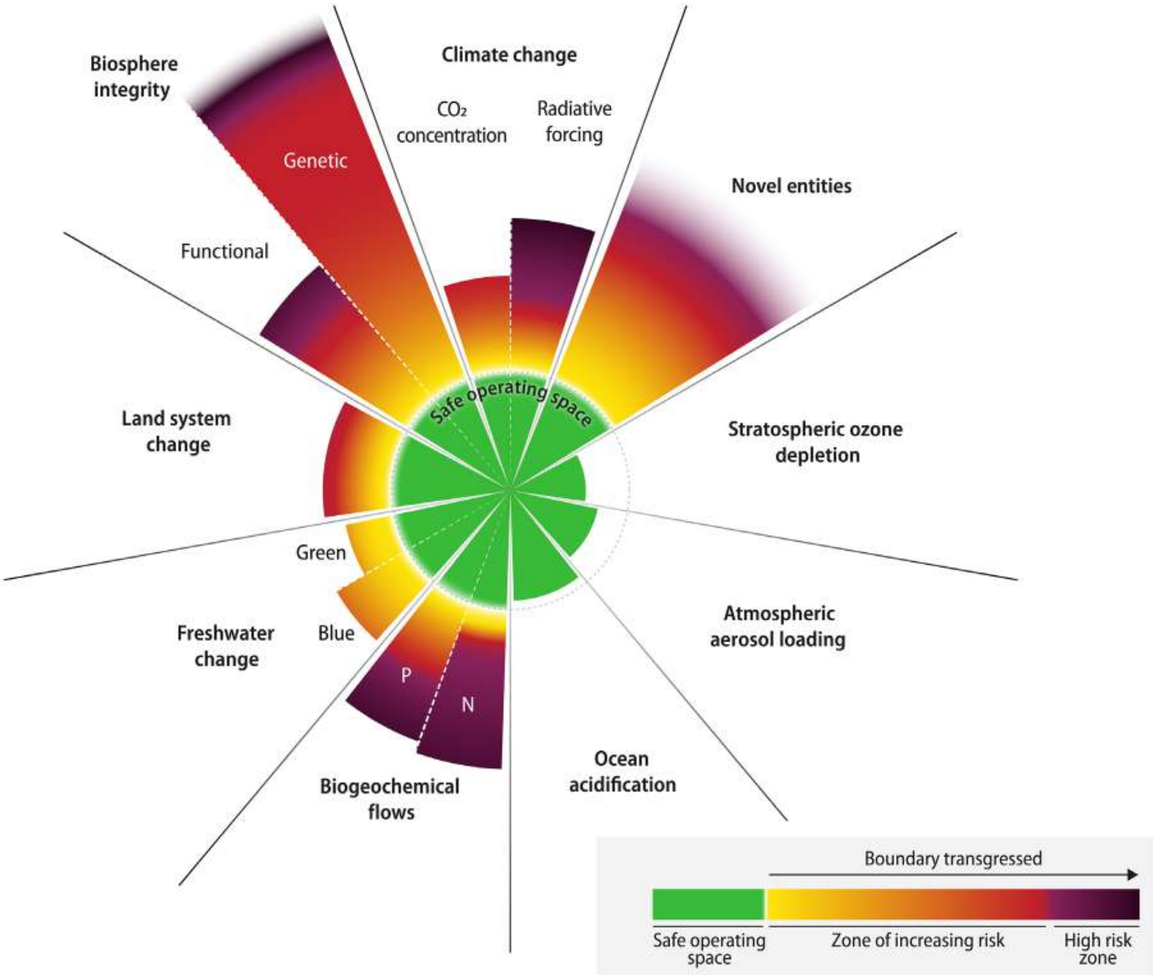

Figure 1. Current status of control variables for all nine planetary boundaries (Richardson et al, 2023)

Forests play an important role in biodiversity maintenance, enhancement and conservation. The state of biodiversity in forests in Europe is relatively good compared to other ecosystems, even though forests have been under human influence for thousands of years. The pressure on biodiversity (EEA, 2023) is not so much due to land use change in Europe but is related to forest cover change due to climate change and bark beetle attacks, forestry and pollution (EEA, 2023; Nabuurs et al, 2013; Turubanova et al, 2023; Bednar-Friedl et al, 2022).

The European Union addresses the above-mentioned challenges in its *Green Deal* to reverse biodiversity loss, coupled with the development of the bioeconomy and having economic growth decoupled from resource use. Accordingly, sustainable finance should aim to channel more private and public investment into the transition towards a climate-neutral, climate-resilient, resource-efficient and fair economy to fulfil the EU's climate and energy targets (EU, 2021a).

Sustainable finance in the EU is therefore referred to as "...the process of taking **environmental, social and governance (ESG) considerations into account when making investment decisions** in the financial sector, leading to more long-term investments in sustainable economic activities and projects" (EU, 2020a). Concerning this, the **EU Taxonomy** (for details see Chapter 3) sets out a classification system based on criteria for economic activities consistent with a net-zero profile by 2050 and broader environmental goals other than climate action.

A wide range of economic sectors, including agriculture, **forestry**, energy, transportation and buildings, among others, are covered. To be considered environmentally sustainable, economic activities and investments must meet certain minimum requirements and adhere to technical screening criteria based on scientific evidence, designed to ensure that economic activities are aligned with the objectives of the Paris Agreement and the UN Sustainable Development Goals (UNFCCC, 2015).

The EU Taxonomy Regulation (EU, 2020a) does not specify criteria, and these were defined later by delegated acts. For the **Climate Delegated Act** (EU, 2021) a list of criteria for 13 economic activities (including forestry) was drafted by a Technical Expert Group (TEG). For the **Environmental Delegated Act,** and due to considerable disagreement, the forest criteria about biodiversity were delayed at first. They were then published as part of a supplementary report in November 2022, including dissenting views on the 'forestry and logging' Technical Screening Criteria (TSC) for biodiversity and ecosystems. They were finally taken out from the Commission draft proposal in spring 2023 (Platform on Sustainable Finance, 2022b,c). These challenges in agreeing to criteria and indicators for forest biodiversity, and the current delay in proceeding, could subject investments to future non-compliance under those regulations.

This report aims to offer guidance to finance and investment in forestry aimed at biodiversity-oriented forest management, and its forest-related indicators and examples of thresholds, which would potentially be applicable under the EU Taxonomy standard. This report is set up in three parts.

Part I provides a background section and presents an overview of forest biodiversity characteristics, finance concepts and investments. Thereafter, it dives into the related EU decision-making process around the development of the Sustainable Finance Regulation and the Taxonomy.

Part II proposes operational guidance based on existing science through an overview of what biodiversity means in forests, and discusses related management options. It thereby introduces characteristics of indicators and presents a proposed list of quantitative indicators as well as examples of thresholds. Indicators and examples of thresholds for green finance in the forest sector, based on available knowledge, are provided. Chapter 5 presents an overview of monitoring possibilities for forest biodiversity and briefly discusses the issue of compliance.

Part III discusses challenges around green finance with respect to the specific characteristics of forests and forestry. To this end, Chapter 6 aims to disentangle different concepts around green finance and financing green. Chapter 7 provides some conclusions and recommendations.

Although the EU Taxonomy addresses a much broader scope than biodiversity alone, in the current report we stay at the level of the Technical Screening Criteria for forestry; i.e., the forestry criteria with regards to biodiversity as initially proposed under the Environmental Delegated Act.

Based on scientific references for forest management and biodiversity, a list of mostly quantitative forest biodiversity-related indicators is proposed, with some examples to support the concrete implementation of the investments under the EU Taxonomy Regulation. The quantitative indicators are described with ranges in relation to the large variability of the forest ecosystems at global level, but also inside the EU. The final chapter provides ideas on the way forward. This report cannot provide a definite list of forest-related biodiversity indicators nor thresholds for each indicator but should rather stimulate dialogue and help find consensus on how sustainable finance, with regard to biodiversity and forests, can be stimulated and verified. The report proposes some examples of thresholds, and how they can be implemented on a locally specific level.

Finally, this report is targeted primarily at those involved in developing the Delegated Acts at the European Commission. It is also aimed at investors who, in the future, must report under the Sustainable Finance Regulation, and those seeking to understand the complex relationships between profit generation through forest investments and biodiversity protection, maintenance and enhancement.

2 Background: forest biodiversity, defining finance and forest biodiversity investment

2.1 What is forest biodiversity?

According to the Convention on Biological Diversity, biodiversity comprises any form of living organism and encompasses genetic, taxonomic, habitat and landscape diversities (CBD, 1992). As such, biodiversity can be conserved and measured from the regional, national and local, to the forest management unit level, and at different internal (e.g. genetic) and external (e.g. individual, population) scales and grains. It is generally defined by three components (Bollmann and Braunisch, 2013), which is also reflected in Table 2:

- **composition** corresponds to the nature and number of the elements of biodiversity present in a given area (e.g. forest-related species in e.g. fungi and soil nematodes, herbs, mosses, shrubs, insects, birds, mammals);

- **structure** corresponds to the spatial arrangement and the dimensions of the elements that compose the ecosystem (e.g. tree species organisation, regeneration, spatial diversity from gaps to old growth);

- **function** corresponds to the role of each element in a given ecosystem (e.g. deadwood or damaging agents) and the way the system works (e.g. carbon sequestration).

In forests, biodiversity encompasses a wide range of animals, plants and fungi. Conserving, enhancing and restoring biodiversity does not only rely on the protection of some species but include measures at the ecosystem level, applied at different management units (from stand to the level of the forest holding), that in turn favour groups of different species.

2.2 Defining finance – overview of concepts

The range of financial concepts can cause confusion among different stakeholder groups about what can be considered a sustainable investment. Therefore, Box 1 tries to disentangle sustainable finance from green, responsible and ethical finance.

The same confusion about what can be considered a sustainable investment applies to forests, further confused by greenwashing happening within sustainable finance markets (Azzouz and Merle, 2021; Begemann et al, 2023). To counteract this trend, and to find a common language, the EU is one of the first, but not the only, region worldwide to regulate sustainable investments (Climate Bonds Initiative, 2021).

Box 1. Sustainable, green, responsible and ethical finance

Sustainable finance is an umbrella term. It is the process of taking due account of environmental social and governance (ESG) considerations when making investment decisions in the financial sector, leading to more long-term investments into sustainable economic activities (EU, 2022). It aims to align financial markets with the sustainable development goals, such as reducing greenhouse gas emissions, promoting energy efficiency, and protecting biodiversity (EU, nd-a).

Green finance is almost synonymous with sustainable finance and is often used interchangeably. It aims at facilitating positive effects on the environment, yet often involves the deployment of financial capital mainly towards renewable energy, energy efficiency and clean transportation (Environmental Finance, 2023; Galaz et al, 2018).

Climate and biodiversity finance are related subcategories of green finance with a specific focus. Some examples of green finance products and services include *green bonds*, which are debt securities issued to finance environmentally friendly projects; *carbon credits*, which allow companies to offset their carbon emissions by investing in carbon-reducing projects; *Biodiversity offset credits,* which allow companies or landholders to implement activities that harm nature in one location by compensating for the loss elsewhere; and *green loans*, which provide financing for energy-efficient building retrofits.

Responsible finance has been a prominent topic since the 1980s and refers to a business management strategy aimed at a fair balance of interests between financial institutions, their customers, investors and other stakeholders. It implements the adoption of responsible investment practices, such as integrating ESG considerations into investment analysis and decision-making.

Ethical finance refers to financial products, services and investments that align with an individual's or organisation's ethical or moral values. Ethical finance can include considerations, such as avoiding investments in companies or industries that engage in activities that are considered morally or ethically objectionable, e.g. tobacco or weapons. In contrast to *sustainable finance* and *responsible finance*, it may include non-financial considerations such as human rights, animal welfare, or gender issues.

Impact investment refers to investments that prioritise social or ecological impacts alongside conventional financial returns. In practice, these sit on a spectrum from investors who are primarily interested in non-financial impacts and are willing to accept minimal returns, to those who are looking for market rates of return through investments that deliver co-benefits.

Conservation or biodiversity finance refers to funding and financing of biodiversity conservation activities. While the majority of investments in nature come from public funds (Seidl et al, 2021), there is an increasing focus on the creation of mechanisms for delivering investment returns for capturing the benefits of biodiversity enhancement, such as the through a method for commodifying biodiversity gains (e.g. biodiversity offset markets, biodiversity credits).

2.3 Forest investments and biodiversity

Forest investments, in all their variety, e.g. investing in short rotation eucalyptus to long rotation multi-functional forestry, can be part of diversification strategies for institutional investment portfolios of pension and/or insurance funds. However, investments in all types of forests have unique challenges compared to other forms of investment.

1) *Duration before the investment starts providing a return* is linked to the growth rhythm of trees, and the response times of biodiversity can frequently take many decades.

2) *Presence of generally positive environmental and social externalities* (e.g. reduction of erosion, biodiversity protection, recreational opportunities) can be negatively affected as well (e.g. in case of large clearcuts, soil damage, etc). Related pros and cons can alternate in time and space, making it a very complex sector (Mazziotta et al, 2022).

3) *Presence of disturbance factors* (e.g. storms, fires, pests, floods) creates risks of failure, exacerbated by the often long periods of investment.

4) *Presence of many local stakeholders and landowners with partly contradictory goals and visions* can increase transaction costs linked to the realisation of the investments (UNECE, 2019).

5) *Provision of a financially attractive rate of return* in the case of investing in mono species and fast-growing forests, for example in countries such as USA, Brazil, Portugal or Australia, is often linked with biodiversity trade-offs (Hua et al, 2022).

Still, for investors, there are several positive aspects that relate to forestry investments, which are recognised scientifically (Toppinen et al, 2012):

1. *Inflation hedging*, the rate of returns from forests is generally positively correlated to inflation[1];

2. *Low correlation with other asset classes,* as the rate of return on forest investments is less correlated with returns on other financial assets.

Green credentials, as forest investments, can improve the reputational value of investors, which is also the case through third-party certification where standards (e.g. FSC, PEFC) are available that show that forests are managed sustainably.

The finance and investment sectors have historically allocated very little capital towards activities that enhance or protect biodiversity, including in forests. This is largely because biodiversity is typically thought of as a non-rival, non-excludable public good, which would yield services with no appealing rate of return, or even negative returns. In contrast, donations are geared to biodiversity conservation. An informed civil society, coupled with a looming threat of potential erosion of reputational value, is emerging as a push for biodiversity protection.

This complexity of the management and the trade-offs regarding protection, restoration and management of forest biodiversity with lower rates of return, challenges investors' interest in forests.

1 More recent inflation rates may change this perspective.

3 The EU Taxonomy

3.1. Overview of the components of the EU Taxonomy Regulation and its application

The taxonomy for sustainable activities of the European Union, also called the "EU Taxonomy", aims to create a common set of criteria and indicators for investors, issuers, project promoters and policymakers to classify sustainable economic activities. Its overarching Taxonomy Regulation (TR) establishes six environmental objectives (EU, 2020a):

1) climate change mitigation
2) climate change adaptation
3) sustainable use and protection of water and marine resources
4) transition to a circular economy
5) pollution prevention and control
6) protection and restoration of biodiversity and ecosystems.

Forestry is one of 13 economic activities to be included and is addressed under the objectives of climate change mitigation, climate change adaptation and biodiversity protection and restoration (objectives 1, 2, 6, see Figure 2). In addition, forestry is indirectly mentioned under some so-called "do-no-significant-harm" (DNSH) criteria of other objectives such as objective 4 (transition to a circular economy). So far, the TR addresses only the "E" (environmental) in ESG; a social taxonomy has been postponed.

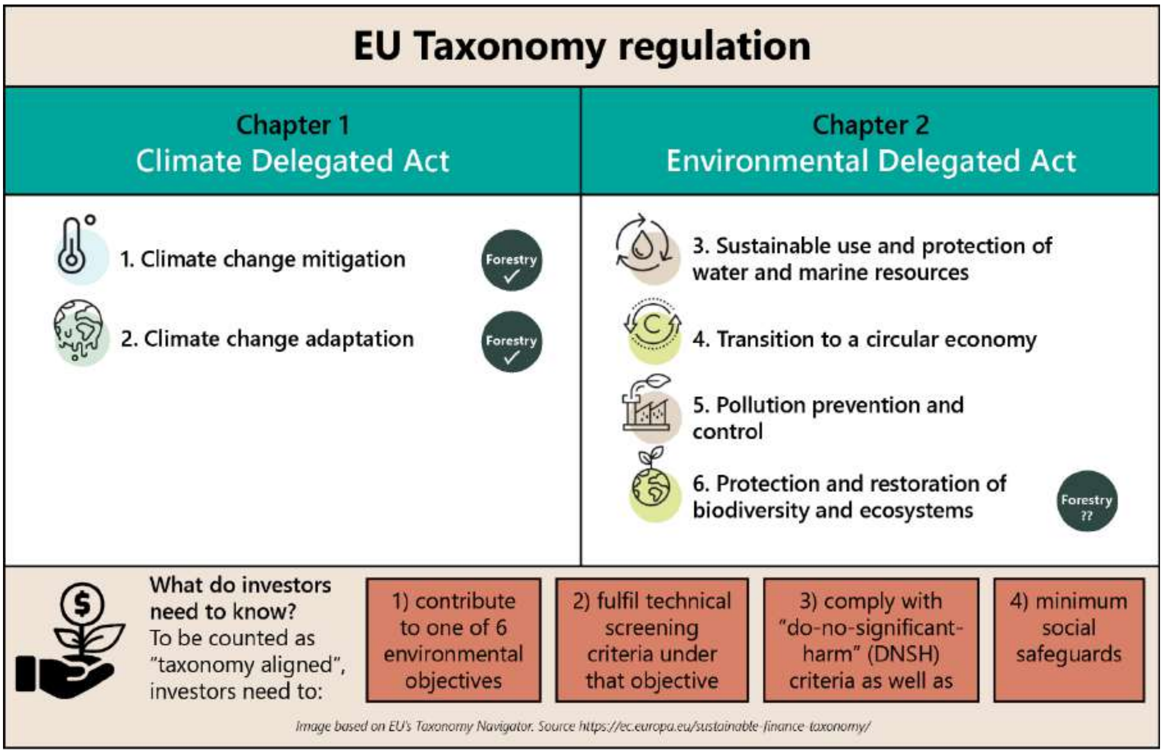

Figure 2. The components of the EU Taxonomy

Table 1. Overview of relevant sustainable finance documents of the European Union

Publi-cation date	Relevant policy/legislation	Description
Mar 2018	**Action Plan on Financing Sustainable Growth** (EU 2018) (COM/2018/097)	Includes 10 reforms in three areas: 1) reorient capital flows towards sustainable investments, 2) mainstreaming sustainability into risk management, 3) foster transparency and long-termism in financial and economic activity.
Dec 2019	**Sustainable Finance Disclosure Regulation (SFDR)** (EU 2019) (2019/2088)	Outlines disclosure requirements to enhance transparency in sustainable investment markets; additional Regulatory Technical Standards (RTS) specify the content, methodology and presentation of the information to be disclosed.
Jun 2020	**Taxonomy Regulation** (EU 2020a) (2020/852)	Presents overarching regulation to establish the taxonomy objectives, the roles and responsibilities within the development process.
Jul 2021	**Strategy for Financing the Transition to a Sustainable Economy** (EU 2021a) (COM/2021/390)	Builds on and refines measures proposed in the 2018 Action Plan and includes transition finance activities in an enlarged taxonomy.
Dec 2021	**Commission Delegated Regulation supplementing Article 8 of the Taxonomy Regulation** (EU 2021b) (2021/2178)	Specifies the content and presentation of disclosure required in accordance with the Article 8 of the Taxonomy Regulation.
Dec 2021	**First Delegated Act on sustainable activities for climate change adaptation and mitigation** (EU 2021c) (2021/2139)	Includes TS and DNSH for the first two TR objectives; see both Annexes: climate change mitigation (Annex I) and climate change adaptation (Annex II).
Dec 2022	**Corporate Sustainability Reporting Directive (CSRD)** (EU 2022) (2022/2464) Including European Sustainability Reporting Standards (ESRS)	Strengthens reporting requirements on social and environmental information that companies have to report and revises the requirements of the Non-Financial Reporting Directive (NFRD). With the publication of the EDA in June 2023, the EU COM has provided new reporting standards under the CSRD called the European Sustainability Reporting Standards (ESRS) that further elaborate disclosure requirements.
Jun 2023	**Environmental Delegated Act Regulation covering four environmental objectives** (EU 2023) (2023/3851)	Includes TS and DNSH for the remaining four TR objectives; the forestry criteria have been excluded from objective 6 (protection and restoration of biodiversity and ecosystems).

The Taxonomy Regulation mandates the EU Commission to adopt Delegated Acts to further define, in relation to these six objectives, technical screening criteria (TSC) as well as DNSH criteria (EU, 2020a; EU, 2021a). The so-called Climate Delegated Act (CDA), applicable from January 2022, targets the first two objectives on climate change mitigation and adaptation (EU, 2021b). The remaining four objectives are part of the so-called Environmental Delegated Act (EDA) (EU, nd-b), which will be applicable from January 2024.

In addition, further delegated and complementary acts have been adopted to define TR-related disclosure obligations and to include additional activities (see Table 1 for an overview).

Given that the Taxonomy Regulation does not specify the Taxonomy criteria, the European Commission (lead DG FISMA), with the support of an advisory body, developed them along with the six objectives for 13 economic activities (including forestry). A Technical Expert Group (TEG) was formed consisting of 35 experts mainly from the (sustainable) finance sector, as well as from civil society, academia and some additional members and observers from EU and international public bodies. The TEG made recommendations for the development of the Climate Delegated Act (EU, 2021c), targeting the first two objectives of climate change mitigation and adaptation (EU Commission, nd-c). For the Environmental Delegated Act, which targets the remaining four objectives, the "EU Platform on Sustainable Finance (PSF)" took over the work of the TEG (EU Commission, nd-d). Due to considerable disagreement among members of one of its subgroups that focused on agriculture, forestry and fishing, the forestry criteria with regard to biodiversity were delayed at first and then published as part of a supplementary report in November 2022, including dissenting views on the 'forestry and logging' TSC for biodiversity and ecosystems. They were finally taken out from the draft and final Environmental Delegated Act (Platform on Sustainable Finance 2022b, c).

With regards to the biodiversity objective, the Taxonomy Regulation (EU, 2020a) specifies in Article 15 how economic activities, such as forestry, shall qualify as

"contributing substantially to protecting, conserving or restoring biodiversity or to achieving the good condition of ecosystems, or to protecting ecosystems that are already in good condition, through: [...]

a) nature and biodiversity conservation, including achieving favourable conservation status of natural and semi-natural habitats and species, or preventing their deterioration where they already have favourable conservation status, and protecting and restoring terrestrial, marine and other aquatic ecosystems in order to improve their condition and enhance their capacity to provide ecosystem services;

b) sustainable land use and management, including adequate protection of soil biodiversity, land degradation neutrality and the remediation of contaminated sites;

c) sustainable agricultural practices, including those that contribute to enhancing biodiversity or to halting or preventing the degradation of soils and other ecosystems, deforestation and habitat loss; or

d) sustainable forest management, including practices and uses of forests and forest land that contribute to enhancing or to halting or preventing degradation of deforestation and habitat loss; or

e) enabling any of the activities listed in points (a) to (d) of this paragraph in accordance with Article 16."

TSC that further define the biodiversity objective, including for forestry, should be in accordance with relevant EU legislation and communications, such as the EU biodiversity strategy for 2030 (EU, 2020b). The final forestry TSC of the Climate Delegated Act comprise: (1) afforestation, (2) rehabilitation and restoration of forests, including reforestation and natural forest regeneration after an extreme event, (3) forest management, and (4) conservation forestry.

In addition, the Climate Delegated Act entails DNSH i.e., for forest management to not harm the protection and restoration of biodiversity and ecosystems under its two objectives (climate change mitigation and climate change adaptation) (see Box 2). Thus, even though it is called 'Climate Delegated Act', it has stringent criteria related to biodiversity, which set a basis i.e., to develop criteria under the Environmental Delegated Act.

At the beginning of 2022, the EC started a process to integrate the Taxonomy legislation with considerations of social aspects (Platform on Sustainable Finance, 2022a). In the future, with a broader and more comprehensive implementation of the sustainability concept, the Taxonomy Regulation will include Do-No-Significant-Harm (DNSH) criteria valid for both the environmental and social requirements. This integration and the presence of several trade-off between biodiversity protection and minimum social safeguards should suggest a more flexible approach in defining thresholds for the DNSH criteria.

Box 2. Do-no-significant-harm criteria for forest management to not harm the protection and restoration of biodiversity and ecosystems in the Climate Delegated Act (EU 2021c)

In areas designated by the national competent authority for conservation, or in habitats that are protected, the activity is in accordance with the conservation objectives for those areas.

There is no conversion of habitats specifically sensitive to biodiversity loss, or with high conservation value, or of areas set aside for the restoration of such habitats in accordance with national law.

Detailed information referred to in point 1.2.(i)[1)] includes provisions for maintaining, and possibly enhancing, biodiversity in accordance with national and local provisions, including the following:

a) ensuring the good conservation status of habitat and species, maintenance of typical habitat species;
b) excluding the use or release of invasive alien species;
c) excluding the use of non-native species unless it can be demonstrated that:
    i) the use of the forest reproductive material leads to favourable and appropriate ecosystem condition (such as climate, soil criteria, and vegetation zone, forest fire resilience);
    i) the native species currently present on the site are not anymore adapted to projected climatic and pedo-hydrological conditions;
b) ensuring the maintenance and improvement of physical, chemical and biological quality of the soil;
c) promoting biodiversity-friendly practices that enhance forests' natural processes;
d) excluding the conversion of high-biodiverse ecosystems into less biodiverse ones;
e) ensuring the diversity of associated habitats and species linked to the forest;
f) ensuring the diversity of stand structures and maintenance or enhancing of mature stage stands and dead wood.

[1)] all DNSH criteria relevant to forest management

The Taxonomy Regulation makes no obligations to invest sustainably and will be further elaborated to update and extend the scope of activities (EU, 2020b). Hence, if an economic activity is not yet included in the Taxonomy Delegated Acts, it is not considered to be unsustainable (UNPRI, 2022). To shift financial markets in the long-term through enhanced transparency of corporate and financial information, the Taxonomy Regulation entails mandatory EU disclosure rules that are part of an EU disclosure regime consisting of three main pillars:

1) EU Taxonomy Regulation (including Delegated Act supplementing Article 8 of the TR)

2) Sustainable Finance Disclosure Regulation (SFDR) (including Delegated Act on Regulatory Technical Standards), and

3) Corporate Sustainability Reporting Directive (CSRD) to substitute the Non-Financial Reporting Directive (NFRD) (EU, 2021a).

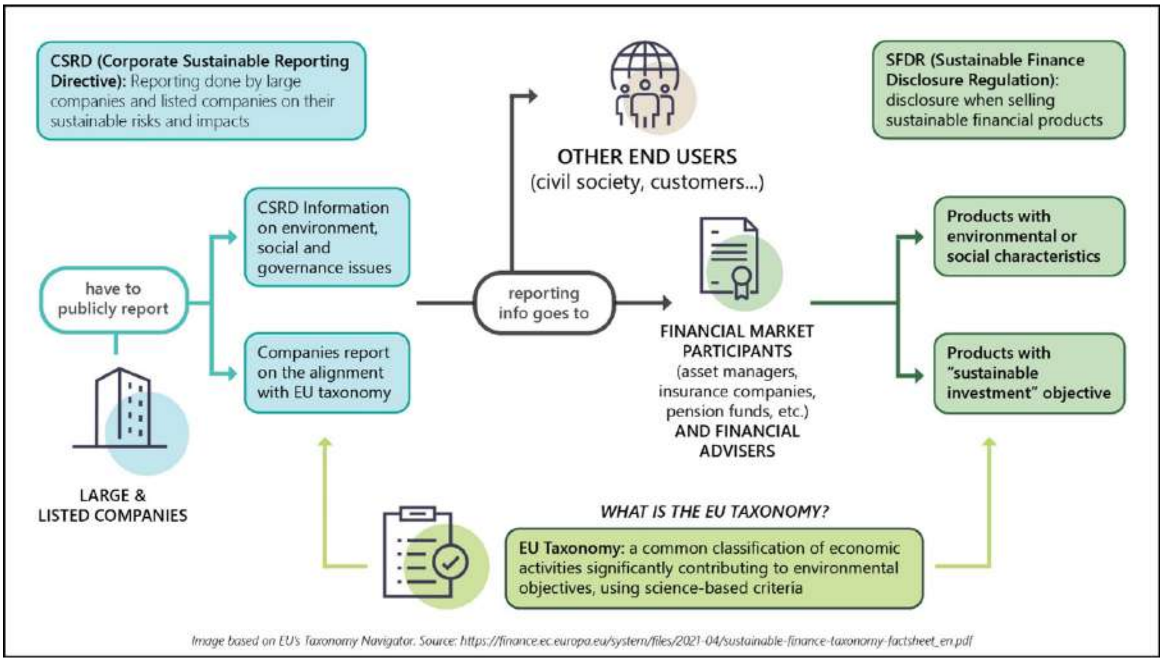

Figure 3. The EU disclosure regime. Source: EU Taxonomy Navigator

These pillars operate together (see Figure 3) and address (financial) companies' "double materiality", for which they report simultaneously on their impact on the environment and society (external impact), as well as financial risks faced due to their exposure to the environment and society (internal impact) (Loorbach et al, 2020).

4 Making the Taxonomy operational

According to the EU Taxonomy Regulation (EU, 2020), an economic activity qualifies if the following forest biodiversity objectives are met:

- protecting, conserving or restoring, or
- achieving the good condition of ecosystems, or
- protecting ecoystems that are already in good condition.

The above three objectives are the main goals to achieve. In addition to those, the first Climate Delegated Act implementing the EU Taxonomy Regulation already defined do-no-significant-harm criteria for forest management that must be taken into account in the management of forest biodiversity (see Box 2).

The application of forest-related biodiversity indicators can help align sustainable finance with the EU Biodiversity Strategy for 2030. Before diving into them, this chapter gives a brief overview of how forest management has an influence on biodiversity and what biodiversity-friendly measures can be applied. Employing existing criteria and indicator (C&I) sets as a backbone for the taxonomy assessment may ease the further development, design and acceptance of tailormade applications. In the following chapter, the conceptual foundations and applicability of C&I in the context of the EU Taxonomy Regulation are explored.

4.1 Forest management's influence on biodiversity and biodiversity-friendly measures

Forest management modifies the composition, structure and functional aspects of forests at the tree, stand and landscape scales. Indeed, many elements that support biodiversity are underrepresented in managed forests (e.g. deadwood, large trees, tree cavities), either at the tree scale or at the stand scale.

At larger scales, the spatial arrangements of these elements, as well as the composition and structure (continuity) of the forests, are modified by forest management (Muys et al, 2022, Figure 4). This is due to the cutting regimes that differ from the natural disturbances (Aszalos et al, 2022) and the creation of infrastructures that would not naturally occur in an unmanaged ecosystem, such as edges (Pellissier et al, 2013).

As a response, integrative forest management (Gustafsson et al, 2020) thus comprises set-aside areas, biodiversity-friendly measures within managed forests and eventually more intensively managed areas (Kraus and Krumm, 2013; Krumm et al, 2020; Bollmann and Braunisch, 2013). Closer-to-Nature Forest Management (Larsen et al, 2022), a new concept promoted by the EU Forest Strategy, aims to further improve forest conservation and climate resilience in multifunctional, managed forests (Figure 4).

Biodiversity-friendly practices may take different forms for forest managers and landscape planners. They take place at different levels and scales, are determined partly by ecosystem characteristics, local targets and objectives (see Figure 4), and may be controlled by different actors and stakeholders. Regulation EU 2020/852, Art. 31 requires "the protection and restoration of biodiversity and ecosystems, in several ways, including by protecting, conserving or restoring biodiversity". This implies that protection, conservation and restoration are not the exclusive means of protecting and restoring biodiversity, but that other, unspecified, approaches may also be acceptable measures.

There is a set of well-known measures favourable to biodiversity in different forest ecosystems, that can be applied at different management and biodiversity scales (landscape, habitat, species/population, and gene levels). These measures, based on Muys et al (2022), are summed up in Table 2 grouped by structure, function and composition.

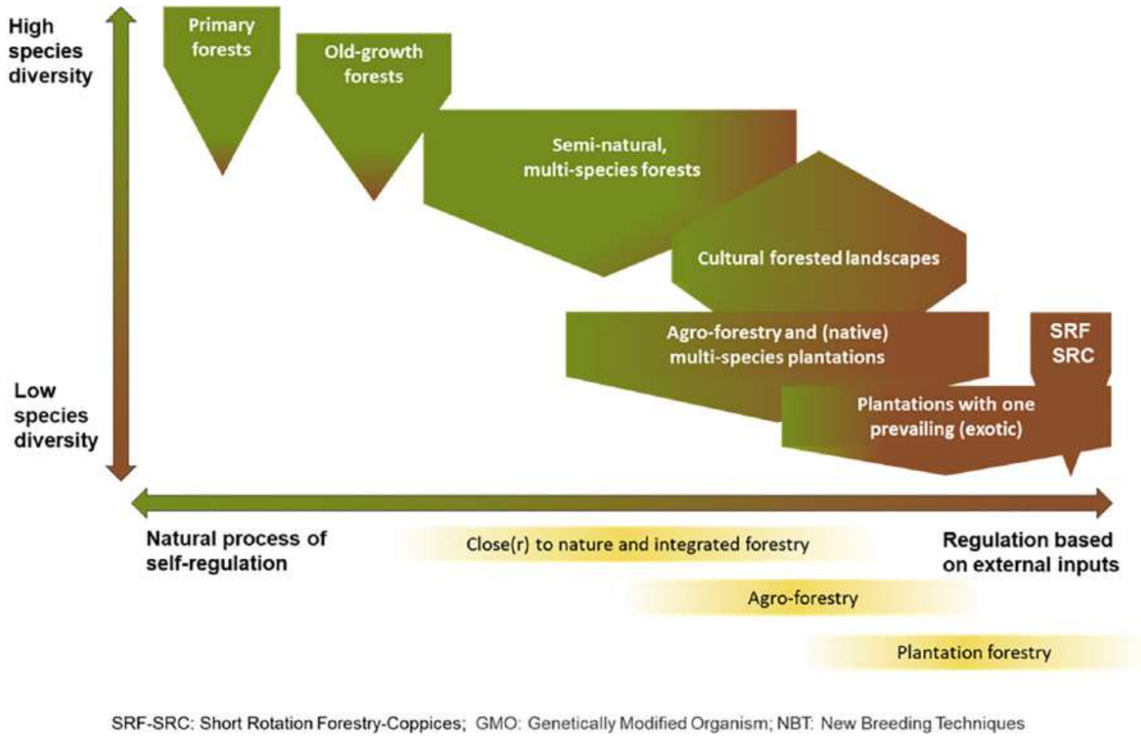

Figure 4. Indicative levels of species diversity in relation to types of forest management. Biodiversity levels overlap between management systems. Drawing by authors. There can always be exceptions in systems that reach e.g. higher biodiversity levels, e.g. some agroforestry systems can be rich in biodiversity.

To encompass and organise all the measures in space and time, *Close(r) to Nature* and other *forms of integrative forest management* is the overarching concept (Krumm et al, 2020; Larsen et al, 2022). It promotes long production cycles and low management intensities next to the inclusion of many elements of conservation management listed (Table 2) in addition to local requirements of species at stake (e.g. nesting and other sensitive periods).

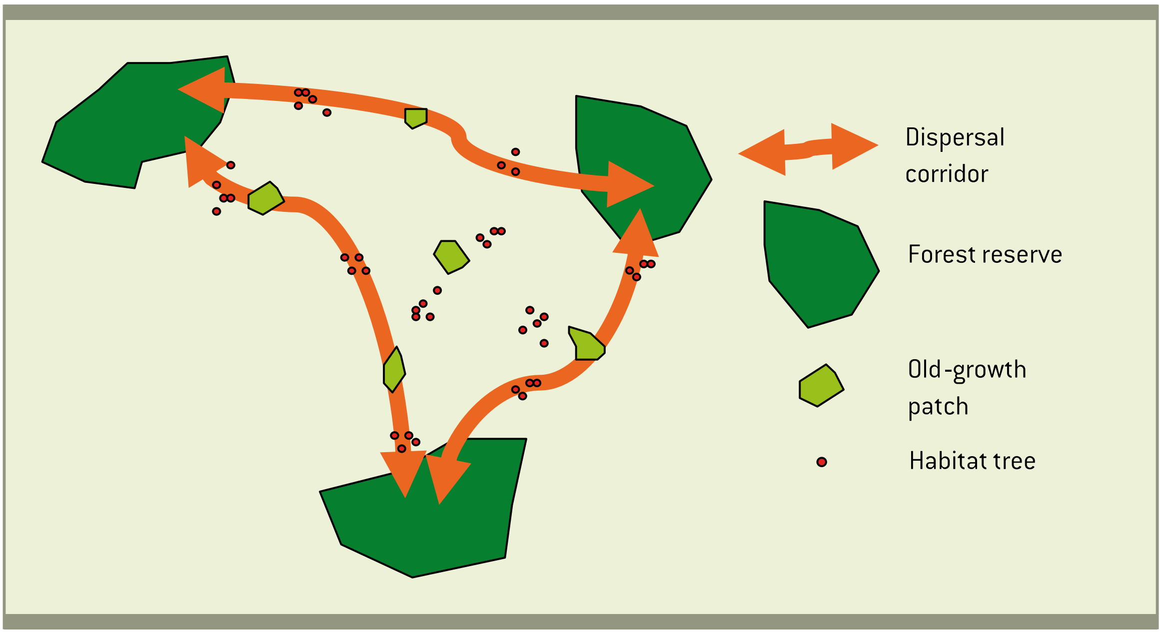

Figure 5. Schematic representation of a functional network of old-growth elements: larger set-asides (reserves, primeval and old growth forests) are interconnected through smaller set-aside patches and individual habitat trees. Areas with higher densities of habitat trees can form “corridors”, but a qualitative “matrix” can also be crossed by most target species. Figure from Vandekerkhove et al, 2013.

Table 2. Biodiversity-friendly measures and scales of application

			Scales of intervention and influence			
	Biodiversity-friendly measure	**Meaning and aims**	**Land-scape**	**Habitat**	**Taxonomic (species)**	**Gene**
Composition	Conservation and restoration of rare biotopes within forests	Rocky outcrops, wetlands (e.g. swamps, streams, gullies) and forest clearings. They support a specific biodiversity that requires both forest and other ecosystems to live and reproduce such as Syrphidae, whose larvae live in deadwood and adults feed on flowers nectar (Speight, 1989)		X		
Composition	Enhancement of site-adapted tree species mixture wherever it is possible	Tree species mixture offers a variety of niches for different species and is not only beneficial to biodiversity but also to ecosystem functioning, since resource exploitation may be complementary between tree species. Species enrichment is particularly sensitive in artificial monocultures where species addition may provide benefits for biodiversity and tree growth (Baeten et al, 2019; Messier et al, 2019)		X		X
Composition	Promotion and preservation of genetic diversity by natural tree regeneration wherever it is possible, and use of locally adapted genetic provenances when planting or sowing.	Climate change adaptation may require the introduction of adapted provenances in certain cases which should use certified material all the time (Fady et al, 2016)				X
Composition	Proactive prevention and management of invasive species	Avoid their planting, expansion and concurrence of invasive species with native species, which is detrimental to biodiversity (Cuthbert et al, 2022; Essl et al, 2020)			X	
Structure	Conservation and restoration of standing and lying deadwood of multiple forms (form, tree species, dimensions, decay) in managed forests.	Deadwood supports about a quarter of forest biodiversity (Stokland et al, 2012). Species that depend on deadwood for at least a part of their living cycle are called saproxylic and are favoured by increased levels of deadwood, notably of large dimensions since they are lacking in managed forest ecosystems (e.g. Paillet et al, 2015)		X		
Structure	Conservation and promotion of habitat trees and tree-related microhabitats	Habitat trees are generally large, monumental and remarkable trees with considerable value for biodiversity due to their dimensions as well as their characteristics, they could also have an aesthetic or spiritual value for human beings (Butler et al, 2013). Habitat trees generally bear tree-related microhabitat, i.e. singularities not borne by all trees (e.g. cavities, dead branches, conks of fungi and cracks) and that support specific biodiversity (Larrieu et al, 2018)		X		

Table 2. continued

			Scales of intervention and influence			
	Biodiversity-friendly measure	**Meaning and aims**	**Land-scape**	**Habitat**	**Taxonomic (species)**	**Gene**
Function	Conservation of primary and old-growth forests	These forests have never or not been disturbed by direct human activities for a long period of time (e.g. Sabatini et al, 2018, 2020). Primary and old-growth forests in the landscape, even when small in surface, act as a refuge for sensitive species and as a source of colonisation of other favourable habitats	X	X		
	Conservation of ancient forests	These forests have remained forests for several centuries on that site (at least 150-200 years) but that can be managed today (e.g. Bergès and Dupouey, 2021). In this case, conservation means that conversion to other land-use forms (agriculture) is avoided	X			
	Conservation and maintenance of cultural landscapes	Such landscapes have known centuries of extensive use by humans and have maintained a high level of biodiversity thanks to a diversity of practices. Examples of cultural landscapes re dehesas and coppice forests (Muys et al, 2022; Angelstam et al, 2021).	X			
	Conservation and restoration of connectivity between forest patches and elements that benefit biodiversity	Connectivity ensures the circulation of species and genes between forest patches and is beneficial to genetic diversity and population viability	X	X		
	Restoration of disturbance regimes	Close to those observed in unmanaged forests (see Aszalos et al, 2022 for a comparison between natural and management-induced disturbances)	X			

In Europe, given the long history of human settlement and the current density of population as well as forest exploitation, (e.g. Angelstam et al, 2021) and the limited space to set aside large and numerous areas, the conservation of forest biodiversity has to rely on complementary measures integrated within managed areas (habitat trees and old-growth patches in addition to forest reserves, Figure 5) so as to create a connected network in which species and genes can flow without limitations (Muys et al, 2022, Figure 5).

Finally, the diversity of levels of biodiversity over time and space and of management approaches, as sketched in Figure 4, makes complying with one universal, globally applicable set of thresholds or targets impossible. However, classifying forest management in terms of complying with sustainable finance favouring biodiversity-friendly forest management or not, requires setting indicator values, i.e. a threshold when the management is compliant and when it is not (see Chapter 4.5). Regionally specific this seems feasible.

To sum up, forest biodiversity encompasses several dimensions as well as different species groups with different requirements regarding ecosystems, management and resources. Although biodiversity-friendly measures have proved to be useful in a variety of forest ecosystems (Gao et al, 2015; Zeller et al, 2023), they may not be beneficial to the whole spectrum of species, nor in all contexts of European forests.

Some measures may also have different effects regarding the context. Some measures may have adverse effects on different taxa, enhancing the diversity of some groups but detrimental for others, e.g. species that are specialised in monospecies stands may not be favoured by diversification of tree species (e.g. Leidinger et al, 2021; Paillet et al, 2018; Asbeck et al, 2021). The application of biodiversity-friendly measures should therefore be considered in the regional context and for certain components of biodiversity taxa.

4.2 Criteria and indicators for the EU Taxonomy

In EU documents and legal texts, the term “criteria” is used to describe a standard or principle.

For instance, in the Pan-European Criteria and Indicators for Sustainable Forest Management and its criterion “Maintenance, Conservation and Appropriate Enhancement of Biological Diversity in Forest Ecosystems”, the diversity of tree species or the area of protected forests are listed as indicators among others.

The approach of superior criteria and subordinate indicators has been used in various official documents (MCPFE, 1998; Forest Europe, 2015; ITTO, 2016) and in scientific publications related to the forest sector, usually at the national level (Boon and Helles, 1999; Linser and Wolfslehner, 2022; Linser et al, 2018; Neupane et al, 2020).

Other work focuses on a set of indicators or single parameters e.g. in ecologically oriented publications and species lists (IUCN, 2017; Asaad et al, 2017) or as assessed with new methods such as eDNA metabarcoding (Deiner et al, 2017). The current report adopted the prevailing terminology in the forestry sector to distinguish between a general principle (i.e. criteria) and its measurable quantities (i.e. indicators) (Box 3).

Box 3. Criteria and indicators (according to Linser and O'Hara 2019)

Criteria	Criteria relate to WHAT is important to measure. Criteria define the essential elements that should be assessed. In EU documents, the term 'criteria' is often used as an umbrella term for both criteria and indicators (e.g. 'Technical screening criteria', 'Do No Significant Harm Criteria').
Indicator	Indicators relate to HOW to measure the elements of a criterion. Indicators may be quantitative or qualitative. Indicators like deadwood (quantitative) and instruments to maintain, conserve and enhance biodiversity (qualitative) are widely applied forest biodiversity indicators.
Thresholds or targets for indicators	A threshold is an amount, level, or limit on a scale which should not be reached or exceeded in case of e.g. damage level, or which should be reached in case of a desired target (dead wood). Setting thresholds for forest related indicators is complex, as the ecological functioning of a forest depends on the local circumstances. Targets are (most often agreed) values which should be reached.

In the context of criteria and indicators, goals are often mentioned. Goals represent higher level policy objectives. They are usually qualitative, such as the Sustainable Development Goals or the Global Forest Goals (GFGs) (e.g. GFG 1: Reverse the loss of forest cover worldwide through sustainable forest management, including protection, restoration, afforestation and reforestation…).

In contrast, a target is a clear quantitative expression of a policy or management priority, setting out exactly what should be achieved, how, and by when. An example is the commitment in the EU Biodiversity Strategy for 2030 to planting at least three billion additional trees in the EU by 2030, or the target of the Nature Restoration Regulation that specifies that Member States should aim to bring a specific percentage of habitats into good state by a certain year.

In general, indicators are essential tools that help to measure success and progress towards achieving objectives (Linser and O'Hara, 2019). By measuring and tracking indicators (as in Table 3), forest owners/managers can identify areas for improvement, monitor their progress over time, and make evidence-based decisions to achieve their goals.

Selecting a range of easily comprehensible and meaningful indicators is crucial to ensure they are informative for the purposes of forest owners, forest managers and as an evidence-based overview for potential investors. To be meaningful, the indicators should fulfill the characteristics listed in Box 4: be quantifiable, feasible, easy to understand and communicate, scale specific and, in the best case, include a threshold or target to be reached.

Developing thresholds or targets for forest-related indicators across Europe, or even beyond, should reflect the wide variety of forest ecosystems and geographic differences. European forests encompass diverse climates, tree species, management practices, and ecological characteristics. What might be considered a threshold or target appropriate for one forest type or ecosystem may not necessarily be applicable to another.

Setting thresholds for forest-related biodiversity indicators shall be context-dependent (e.g. by habitat type, locality etc.) and based on the latest available science. In addition, related participatory stakeholder processes can help to further refine and create support in finding consensus on the thresholds and targets. Participatory processes can, of course, run the risk of not reaching an agreement, or result in weak compromises.

Box 4. Main characteristics of 'good' indicators (according to Linser, 2002)

Quantifiable	*Indicators should quantify information* so that their significance is apparent. The data should be available or obtainable with present technology.
Feasible	*Indicators should be measurable* at reasonable costs to allow repeated tracking of progress and performance over time.
Understandable / communicative	*Indicators need to be* easily *understandable* to ensure that they can be effectively communicated to the target audience.
Scale specific / representative for the chosen system	The *choice of scale at which biodiversity is measured can significantly affect the interpretation of results and the ability to detect changes* over time. For example, if biodiversity is measured at a fine scale, such as within a forest plot, the number of species observed is likely to be relatively high (e.g. five herb layer species may be detected), but at larger scales, these species numbers only gradually increase at a coarser scale, such as across an entire forest landscape. On the other hand, coarse-scale measurements may be better suited to detect large-scale changes in biodiversity that result from degradation, fragmentation, or climate change.
Include threshold degrees or targets	*Indicators should enable an assessment of a current situation with respect to a (sustainable) reference situation* (the ecological, economic or social goal), which has been optimally chosen in a participatory process. The indicator relevance to policymaking increases, if already politically decided threshold degrees or target levels exist to compare the indicator status. According to Braat (1991), the relevance and appropriateness of the threshold degree should be 'beyond doubt and dispute'. A target is different from a threshold. A target is a final aim and can be set higher than a threshold. A threshold is a minimum value that shall be achieved. However, when the aim is to reach the threshold, then the numeric value of threshold and target are the same.

According to article 19(c) of the EU Taxonomy Regulation (EU 2020), on the establishment of a framework to facilitate sustainable investment, "the technical screening criteria [indicators] shall be quantitative and contain thresholds to the extent possible, and otherwise be qualitative". Additionally, article 19(k) emphasises that the indicators should be easy to use and be set in a manner that facilitates the verification of their compliance. The set of indicators reported in Table 3 are all quantitative indicators. For most of them, directions can be defined further, even if many of the indicators are suited for assessing forest management systems and not for defining thresholds not to be exceeded or targets to be reached for all types of forests.

Traditional local knowledge, a relevant factor to be considered in biodiversity conservation (Parks and Tsioumani, 2023), has influenced the management of what can be defined as socio-cultural natural landscapes that need to be protected with their own biodiversity components (see Chapter 5). Therefore, a one-size-fits-all solution is not suitable for the maintenance, enhancement and protection of biodiversity.

However, directions and targets can also be set, in line with existing legislation, such as the Climate Delegated Act. Some flexibility is thus always needed. Examples on potential thresholds for some indicators, mentioned in Table 3, are detailed in Chapter 4.5.

4.3 Proposed quantitative biodiversity indicators

Many EU regulations move towards, or have already incorporated, lists of criteria and indicators. Table 3 provides a set of indicators with which the progress towards enhanced biodiversity levels can be filtered on compliance. Table 3 offers a workable set that is aligned with existing and already mentioned EU legal documents and Regulations, such as the Climate Delegated Act of the EU taxonomy, the REDIII, Nature Restoration Regulation (draft), Soil Health monitoring Regulation, LULUCF criteria, the Carbon Farming Certification Regulation, the Biodiversity Strategy for 2030, and the Regulation on deforestation-free supply chains.

It is recommended to choose a set of indicators with available data, or that could be acquired during daily management operations and monitoring in time series. The examples given in Table 3 are consistent with country-level reporting obligations to e.g. Forest Europe and consist also of indicators that are part of existing EU policies and tend towards what may be best from an ecological point of view. In this sense, many of these indicators help assess the performance of biodiversity-friendly methods described in Chapter 4 (Table 2).

The information on maintenance, enhancement restoration or protection of forest biodiversity on a forest holding level could be based on a range of the indicators presented in Table 3. The data for the indicators should be available at forest management planning level. Some data might also be available from remote sensing (Photo 3) or can be gap filled with additional modelling (Nabuurs et al, 2007).

The proposal for indicators, as given in Table 3, is structured according to the EU Taxonomy Compass[2], which addresses four areas for forestry (=criteria): (1) afforestation, (2) forest management, (3) rehabilitation and restoration of forests and (4) conservation forestry. Links to other international initiatives are provided as reference to acknowledge the importance of the indicator in other regulations. These proposed indicators can serve as a starting point for assessing and communicating the maintenance, enhancement, restoration or protection of forest biodiversity at the forest holding level. It is important to tailor indicators to the specific needs of the users. The table below follows the composition, structure and function groups of Table 2.

The indicators address biodiversity both at landscape scale, as well as more locally within the stand, and through management forms and in reaction to threats. They have been chosen in line with Forest Europe indicators, with EU regulations (REDIII, LULUCF, DNSH criteria, NRL), with certification instruments (see example Box 5), and with the Climate Delegated Act.

They were also linked to the measures introduced in Chapter 4.1, whenever possible (see Table 2 and Table 4). The below list of indicators is aimed specifically at biodiversity maintenance, protection and restoration, thus no socio-economic indicators are presented.

2 https://ec.europa.eu/sustainable-finance-taxonomy/taxonomy-compass

(1) Afforestation

Table 3a. Indicators for the topic *afforestation* to assess biodiversity-friendly measures

Indicator & measurement units	Monitoring options	Biodiversity-friendly direction	Links and alignments to international strategies, laws, goals, targets, indicators.
Forest area [ha]	Administrative documentation, part of management plan or remote sensing.	Maintain or enhance the forest area of forest holdings. Forest area is a basic indicator; on its own it does not indicate a state of biodiversity.	EU Forest Strat. for 2030, UNSPF target 1.1, SDG target 15.2, CGS Ind. 2, Forest Europe Ind. 1.1, EU Reg. on deforestation-free products, Indicator proposed by the EU Framework for Forest Monitoring,
Forest area by forest type [ha]	Forest types (conifer, broadleaved, mixed) or the EEA forest types, according to management plan inventory, or remote sensing.	Maintain or enhance the forest area per forest type, preferably in direction of forest types with high biodiversity values.	Part of Forest Europe Ind. 1.1, Indicator proposed by the EU Framework for Forest Monitoring.
Regeneration type (natural, seeded, planted, coppice) incl. share of site-resilient regeneration (better adapted to climate change) [%]	Management plan inventory.	Preference for natural regeneration but facing climate change, seeding and planting more site-adapted tree species is possible.	Part of Forest Europe Ind. 4.2, Proposal for a Regulation of the EP & Council on Nature Restoration. Climate Delegated Act 6e: promoting biodiversity-friendly practices that enhance forests' natural processes.
Diversity of regenerated tree species (Forest area with 1, 2-3, 4-5, ≥6 young tree species occurring (below 5m height) [ha], and diversity of tree species **in main stand** [%]	Management plan inventories, to some degree by remote sensing.	Maintain a high level of species diversity or increase species diversity to a higher level.	Part of Forest Europe Ind. 4.2 Proposal for a Regulation of the EP & Council on Nature Restoration. Act 6e: promoting biodiversity-friendly practices that enhance forests' natural processes; and 6g: ensuring the diversity of associated habitats and species linked to the forest. DNSH criteria 'promote biodiversity friendly practices'.

(2) Forest management

Table 3b. Indicators for the topic *forest management* to assess biodiversity-friendly measures

Indicator & measurement units	Monitoring options	Biodiversity-friendly direction	Links and alignments to international strategies, laws, goals, targets, indicators.
Retention trees left on clearcuts *[number/ha]*	Management plan inventories, remote sensing.	Trees that are not harvested during timber harvesting operations but remain on the land favouring the tree species most valuable for biodiversity.	Climate Delegated Act 6e: promoting biodiversity-friendly practices that enhance forests' natural processes; and 6g: ensuring the diversity of associated habitats and species linked to the forest. DNSH criteria: 'promote biodiversity friendly practices'.
Growing stock *[m³/ha]*	Management plan inventories, remote sensing.	Stable or slightly increasing (over holding areas) is preferable. Note that under a conversion forest management, growing stocks can decline temporarily	Part of Forest Europe Ind. 1.2., Part of the indicators proposed by the EU Framework for Forest Monitoring. Part of the LULUCF regulation in aiming at maintained Carbon sink.
Habitat trees (old, veteran) with tree-related microhabitats (e.g. cavities) *[number/ha]*	Management plan inventories.	Available / increasing	Proposal for a Regulation of the EP & Council on Nature Restoration: standing dead wood. DNSH criteria: 'ensure diversity of associated habitats...'.
Deadwood (lying, standing, decomposition stages) *[m³/ha]*	Management plan inventories.	Significant amounts characteristic for forest type and depending on risk assessment (e.g. likelihood of forest fires).	Forest Europe ind. 4.5, EEA SEBI 018, Proposal for a Regulation of the EP & Council on Nature Restoration, Part of the indicators proposed for the EU Framework for Forest Monitoring, Climate Delegated Act: 'Conservation and restoration of standing and lying deadwood of multiple forms'. DNSH criteria: 'ensure diversity of associated habitats'.
Stand and tree age structure *[years and diameter distributions]*	Management plan inventories.	Certain share of old growth forest stands, depending on forest type.	Part of Forest Europe Ind. 1.3. DNSH criteria: 'ensure diversity stand structure'.
Vertical diversity through uneven-aged trees and bushes *[No of layers]*	Management plan inventories, remote sensing.	Maintaining at high level or increasing.	Part of Forest Europe Ind. 1.3. Proposal for a Regulation of the EP & Council on Nature Restoration: share of forests with uneven-aged structure'. Climate Delegated Act 6h: ensuring the diversity of stand structures and maintenance or enhancing of mature stage stands and dead wood. DNSH criteria: 'ensure diversity stand structures'.

Indicator & measurement units	Monitoring options	Biodiversity-friendly direction	Links and alignments to international strategies, laws, goals, targets, indicators.
Close(r)-to nature and other **forms of integrative forest management** *[ha, %]*	Management plan inventories.	Applied on certain share of the forest or on all or on increasing forest area.	Climate Delegated Act: Conservation and restoration of rare biotopes within forests. DNSH criteria: 'ensure diversity associated habitats', 'promote biodiversity friendly practices'.
Clear-cutting forest management *[ha]*	Management plan inventories, remote sensing.	Only certain share of total harvest from clearcuts. No clearcuts on steep slopes, no clearcuts in habitat type[3] forest. Aim for small clearcuts. In many EU countries the maximum size of clearcut is already under 1 ha.	EU regulatory framework for the certification of carbon removals, REDIII, Climate Delegated Act: 'Conservation and restoration of rare biotopes within forests', 'ensure maintenance and quality of the soil…', 'ensure diversity stand structures'.
Increment and fellings *[increment in m^3, fellings in m^3, share of increment and removals (%)]*	Management plan inventories, remote sensing.	Removals lower than increment. Some temporary (relatively local) fluctuations are allowed e.g. after calamities, storms or conversion to more resilient tree species.	Forest Europe Ind. 3.1 Climate Delegated Act: part of management plan or 'no conversion'.
Biodiversity valuable traditional forest management (e.g. Coppice) *ha, %]*	Management plan inventories, remote sensing.	Maintained.	Part of Forest Europe Ind. 4.2.
Monoculture plantations *[ha, %]*	Management plan inventories, remote sensing.	Decrease (through creation of mixed species forests instead of monoculture plantations).	Part of Forest Europe Ind. 4.3. Climate Delegated Act 6h: ensuring the diversity of stand structures and maintenance or enhancing of mature stage stands and dead wood. DNSH criteria: 'ensure good conservation status of habitats'.

3 Habitat reporting to EEA https://nature-art17.eionet.europa.eu/article17/habitat/progress/?period=5&group=Forests&conclusion=overall+assessment

(3) Rehabilitation and restoration of forests

Table 3c. Indicators for the topic *rehabilitation and restoration of forests* to assess biodiversity-friendly measures

Indicator & measurement units	Monitoring options	Biodiversity-friendly direction	Links and alignments to international strategies, laws, goals, targets, indicators.
Riparian buffer zones alongside seas, lakes, rivers and creeks/ brooks, peat. *[area (ha), length in m]*	Management plan inventories, other biodiversity volunteer networks, remote sensing.	Maintained or increasing at certain widths along streams.	Part of Forest Europe Ind. 5.1 (protective forest area). Climate Delegated Act: Conservation and restoration of rare biotopes within forests. DNSH criteria: 'ensure diversity associated habitats'.
Soil degradation [*Physical or chemical degradation through various indicators, area (ha) affected/ degraded for a certain time*]	Rutting (Management plan inventory or assessed by soil sampling and analysis).	To be minimised e.g. no soil rutting, minimise nutrient loss, reduce human induced degradation.	REDIII, LULUCF regulation, Soil Health Law. DNSH: 'ensure maintenance and improvement to physical, chemical and biological quality of the soil'.
Dominant invasive tree species [*area (ha), share of forest area (%)*]	Management plan inventories.	Decreasing or eliminated.	Forest Europe Ind. 4.4, EEA SEBI Ind. 010, EU Invasive Alien Species Regulation, Proposal for a Regulation of the EP & Council on Nature Restoration. DNSH: 'exclude use of non-native tree species'.
Forest fragmentation *[Size of forest patches (ha), Length of forest edges (m), Edge-to-area ratios]*	Management plan inventories, remote sensing.	No increase of fragmentation.	Forest Europe Ind. 4.7, EEA SEBI Ind. 013, UN Strategic Plan for Forests. Climate Delegated Act 6: exclude the conversion of high biodiverse ecosystems.
Forest connectivity: activities to connect isolated forest patches *[Size of isolated forest patches (ha), establishment of corridors (km) (afforestation) or game bridges (m)]*	Management plan inventories, remote sensing.	Increasing (if necessary).	Proposal for a Regulation of the EP & Council on Nature Restoration, Proposed EU Framework for Forest Monitoring. DNSH criteria: 'promote biodiversity friendly practices'.
Abundance of threatened forest species *[number assessed]*	Volunteer and professional networks, eDNA techniques.	Increase populations and reduce number of threatened species by improving habitats for endangered forest species.	Forest Europe Ind. 4.7, Part of SEBI Ind. 001-003, DNSH criteria: 'ensure diversity associated habitats', 'promote biodiversity friendly practices'.
Abundance of common forest bird species [*number assessed*]	Volunteer networks, acoustic recording.	Maintain or improve habitats for forest bird species.	Forest Europe Ind. 4.10, Part of EEA SEBI Ind 001, Proposed EU Framework for Forest Monitoring Proposal for a Regulation of the EP & Council on Nature Restoration.

(4) Conservation forestry

Table 3d. Indicators for the topic *conservation forestry* to assess biodiversity-friendly measures

Indicator & measurement units	Monitoring options	Biodiversity-friendly direction	Links and alignments to international strategies, laws, goals, targets, indicators.
Share of forest area undisturbed by man *[ha, %]*	Administrative documentation, part of management planning, remote sensing (lidar).	Stable or increase through active restoration towards old-growth, and set asides.	Part of Forest Europe Ind. 4.3, Part of the proposed EU Framework for Forest Monitoring, Climate Delegated Act: Management Plan and 6a: ensure good conservation status, DNSH criteria.
Share of forest area under a protection regime (not available for wood supply) *[% of forest area under MCPFE classes 1.1 and 1.2 or IUCN class I]*	Administrative documentation, part of management planning.	Increasing up to a certain share of ecologically valuable forest area.	Part of Forest Europe Ind. 4.9 (MCPFE Class 1.1. and 1.2)., Part of GCS Ind. 4, Part of EEA SEBI Ind. 007, Part of the indicators proposed by the EU Framework for Forest Monitoring, Global Forest Goal 3. Climate Delegated Act: Management Plan and 6a: ensure good conservation status. DNSH criteria: 'exclude the conversion…'. REDIII.
Change in area of primary forests *[ha, %]*	Administrative documentation, part of management planning,	No decrease, and measures aimed at some increase in long term (old growth, set asides).	GCS Ind. 5.

[1] United Nations strategic plan for forests, 2017-2030: https://www.un.org/esa/forests/wp-content/uploads/2016/12/UNSPF_AdvUnedited.pdf
[2] Sustainable Development Goals, target and indicators: https://unstats.un.org/sdgs/indicators/Global%20Indicator%20Framework%20after%202022%20refinement_Eng.pdf
[3] Global Core Set of forest-related indicators: https://www.fao.org/documents/card/en/c/cb9963en/ and https://www.fao.org/documents/card/en/c/cc2223en/
[4] EEA Indicators: https://biodiversity.europa.eu/track/streamlined-european-biodiversity-indicators

Subsequently, the indicators from Table 3a-3d are linked in Table 4 to the biodiversity measures, which were defined and outlined in Chapter 4.1.

The desired direction of change, indicated in Table 3, does not mean that a forest owner has to change his/her management in order to be eligible for sustainable finance. However, over a large region, investors (because of the Taxonomy) may finance management types that are already applied (biodiversity oriented, or integrated forest management) to improve the indicator. Thus, private sustainable finance is geared towards a specific type of forest management and, as a result, more owners may follow that type of management.

Table 4. Links between indicators (see Tables 3a-3d) and biodiversity friendly measures

EU Taxonomy Compass	Indicators	Composition: Conservation and restoration of rare biotopes within forests	Composition: Enhancement of site-adapted tree species mixture	Composition: Promotion & preservation of genetic diversity by natural tree regeneration	Composition: Proactive prevention & management of invasive species	Structure: Conservation & restoration of standing & lying deadwood of multiple forms	Structure: Conservation & promotion of habitat trees & tree-related microhabitats	Function: Conservation of primary and old-growth forests	Function: Conservation of ancient forests	Function: Conservation & maintenance of cultural landscapes	Function: Conservation & restoration of connectivity between forest patches & elements that benefit biodiversity	Function: Restoration of disturbance regimes
Afforestation	Forest area + by forest type											
	Regeneration type (natural, seeded, planted) incl. share of site-resilient regeneration (adapted to climate change)		X	X								
	Diversity of regenerated tree species and diversity of tree species in main stand		X									
Forest Management	Retention trees are left in the final harvesting site favouring the most valuable tree species for biodiversity						X					
	Growing stock											
	Habitat trees (old, veteran) and tree-related microhabitats (e.g. cavities)						X					
	Deadwood (lying, standing, decomposition stages)					X						
	Stand and tree age structure							X				
	Vertical diversity through uneven-aged trees and bushes											
	Close(r)-to nature and other forms of integrative forest management	X	X			X	X	X	X			X
	Clear-cutting forest management											X
	Increment and fellings (management intensity)					X	X					
	Biodiversity valuable traditional forest management (e.g. Coppice)									X		
	Monoculture plantations											

Table 4. continued

EU Taxonomy Compass		Conservation and restoration of rare biotopes within forests	Enhancement of site-adapted tree species mixture	Promotion & preservation of genetic diversity by natural tree regeneration	Proactive prevention & management of invasive species	Conservation & restoration of standing & lying deadwood of multiple forms	Conservation & promotion of habitat trees & tree-related microhabitats	Conservation of primary and old-growth forests	Conservation of ancient forests	Conservation & maintenance of cultural landscapes	Conservation & restoration of connectivity between forest patches & elements that benefit biodiversity	Restoration of disturbance regimes
	Indicators	**Composition**				**Structure**		**Function**				
Rehabilitation and restoration	Riparian buffer zones alongside seas, lakes, rivers and creeks/ brooks, peat.	X										
	Soil degradation											
	Dominant invasive tree species				X							
	Forest Fragmentation							X	X		X	
	Activities to connect isolated forest patches					X	X	X			X	
	Abundance of threatened forest species											
	Abundance of common forest bird species											
Conservation forestry	Share of forest area undisturbed by man				X			X			X	X
	Share of forest area under a protection regime							X	X	X		
	Change in area of primary forests				X			X			X	X

4.4 Qualitative indicators

Qualitative descriptive information, which includes policies, institutions, instruments, management regimes and traditional rights can provide additional insights that quantitative data alone may not capture (Forest Europe, 2020). Also, insights on forest holding's compliance with relevant laws, regulations and permits are of interest. Non-compliance can lead to legal and financial risks that may affect the investment's viability.

Qualitative descriptive information can be particularly valuable in situations where quantitative data may be limited or difficult to obtain, especially in remote forest areas. It can help fill knowledge gaps and guide management and conservation efforts based on a holistic understanding of the ecosystem.

The main sources of information are forest management plans or equivalent instruments, a pre-requisite of all standards for the certification schemes of sustainable forest management (e.g. FSC and PEFC, see Box 5), which are compulsory in many EU states for public forests and large private and community forest holdings.

Photo 1. Large dead standing trees (snags) like here in the beech forest of Fontainebleau (France) are important for many species, not only for those dependent on dead wood, but also for those that require forest structure variety and lighter conditions in the forest. Photo: Yoan Paillet

4.5 Exemplifying targets and thresholds in the European context

For several indicators presented in Tables 3 and 4 we present examples, based on scientific literature, for thresholds and targets (often used synonymously) for forests in Europe. Naturally, it is challenging to define these for diverse forest ecosystems across Europe and there is no one-size-fits-all solution.

Most of the examples given below are contextual and need further research and systematic reviews to be confirmed. However, regarding the lack of scientific grounds for all biodiversity indicators (Gao et al, 2015), some pragmatic (but still science based) thresholds or targets (Guntenspergen and Gross, 2014; Cook et al, 2016) may be discussed locally based on current scientific knowledge.

1. Forest area not available for wood supply

Unmanaged forests, old-growth and primeval stands provide refuges for a large range of species, and have proved to be richer than their managed counterpart (e.g. Paillet et al, 2010). Furthermore, since less than 1% of Europe's forests can be regarded as primeval (Sabatini et al, 2018), these forests host specific species that are often rare. However, due to the long history of human occupation and forest exploitation in Europe, not all protected forests show primeval or old-growth characteristics (see, for example, Paillet et al, 2015).

A strict protection status guarantees a slow recovery of these features (see Photo 2), and an increasing capacity to host biodiversity over time. However, the level to which a forest landscape should be protected to guarantee biodiversity conservation is still under debate, not to mention the spatial configuration of the reserves. Further, it should be noted that mosaic landscapes containing open forest patches can host specific species (Bouget and Parmain, 2016; Miklin et al, 2018). Forest area not available for wood supply is mostly assessed based on administrative and physical restrictions.

Photo 2. Strict reserve Galgenberg in the Netherlands. A larch plantation assigned as strict reserve 40 years ago in what was then a 30-year-old normally managed stand. Relatively young strict reserves do not always exhibit increased biodiversity values at short or medium term, although they may soon develop specific dark and undisturbed environments that benefits certain insect groups (Nijssen et al, 2020). Photo: GJ Nabuurs

Bouget and Parmain (2016) studied the influence of forest reserves area and configuration on the richness of saproxylic beetles in several landscapes in France and showed that, for lowland forests, the total beetle richness increased with increasing cover of forest reserves in the vicinity. They also show that 12%-20% of reserves within a total forest area increased richness and abundance in both managed forests and reserves. These results are in line with Schall et al (2020) who show, for different sites in Germany, that a certain share of unmanaged forest is necessary to preserve species but only affects specialist forest species of bats, birds, spiders, true bugs and vascular plants. These groups are favoured by 10% of unmanaged forests in the landscape.

Lastly, from a political point of view, these results tend to comply with the new EU Forest Strategy for 2030 to protect 30% of the land and sea, of which one third should be strictly protected with a special focus on remaining primeval and old-growth forests (EU, 2021e).

2. Tree species richness and mixture

The correlation between tree species richness and biodiversity is generally positive, though there are sites where one tree species tends to dominate. Increasing tree diversity is beneficial to a large set of species (Zeller et al, 2023; Ampoorter et al, 2012; Gamfeldt et al, 2013) and increases other crucial ecosystem services globally, such as productivity (e.g. Liang et al, 2016) and protection against pests and diseases (e.g. Jactel and Brockerhoff, 2007). The effects of increasing tree species numbers are not of the same magnitude (Hardenbol et al, 2020) depending on the ecosystem context:

- in a low tree species diversity ecosystems (like boreal or alpine forests), one additional species already makes a considerable difference in terms of biodiversity;
- in a high tree species diversity ecosystem (like Mediterranean or lowland alluvial forests) the expected effects would be higher only if a significant number of tree species are added.

Still, it is sensible (Zeller et al, 2023; Ampoorter et al, 2012) to aim for an increased number of tree species. This does not mean that this has to happen in every management unit, but for larger forest holdings such aims can be set, complying to indicator requirements as given in Section 4.2.

Species richness can be assessed through field (management planning) inventories as well as through some satellite inventories, or drone-based assessments.

3. Deadwood

Deadwood volume is one of the most documented biodiversity indicators to date and is considered relevant when it comes to saproxylic beetles and wood-living fungi (Gao et al, 2015; Oettel et al, 2022) but also birds, bryophytes and vascular plants (Zeller et al, 2023). However, while the correlation between deadwood volume (or other metrics) and biodiversity is generally positive, very few studies report thresholds for optimal conservation for these species. In their review, Müller and Butler (2010) analysed thresholds for deadwood and found peak values for species richness of several groups at 20-30m^3/ha in boreal coniferous forests, 30-40m3/ha in mixed mountain forests and 30-50m^3/ha in lowland oak-beech forests. These are values above which the species richness does not increase very much anymore. Such values could be used as thresholds (allowing some variation) to qualify a forest holding, as in accordance with the Taxonomy Regulation.

While deadwood has positive effect on other ecosystem functions, such as soil fertility (wood decomposition) or forest resilience (grounds for natural regeneration and works as a water sponge), it should be noted that conserving deadwood for biodiversity in forests prone to wildfire may in rare cases increase this risk (see Larjavaara et al, 2023). The biodiversity-friendly measures adopted should then be chosen carefully (e.g. more oriented towards other measures, such as habitat trees), as well as the indicators used to assess forest management.

The amount of deadwood can be assessed through field (management planning) inventories.

Box 5. Examples of thresholds in PEFC Norway certification indicators

Indicators are used extensively in forest certification organisations. But thresholds are also set to assess whether a forest owner complies with the guidance and standards of a certification body. Below are a few examples of thresholds as applied by PEFC Norway[4]. Comparable thresholds are also applied by various other national versions of PEFC and FSC.

Retention trees. At harvesting, at least 10 retention trees per hectare of the harvested area should be set aside. Retention trees are left individually or in groups in the operational area in a way that contributes to tree stability. The requirement for number of retention trees applies as an average for the harvested area and may include several forest stands.

Foreign tree species. In the event of afforestation and regeneration after harvesting, Norwegian tree species shall be used. Foreign tree species can only be used on areas where foreign tree species have been planted for forestry purposes in the past.

Harvesting. As far as possible with regard to stability and regeneration, selective felling shall be used in swamp forests and wetland forests and in the transition zone to firm ground. Where ordinary selective felling is not possible, small-scale clear cutting can be used.

Buffer zones. For wetlands, the vegetation types and terrain form must be normative for the width of the buffer zones. Working on the basis of a buffer zone width of 10-15 m, adjustment should be made for the following: • Rich deciduous, tall-herb, tall-fern and swamp woodland – significantly wider buffer zone (25-30 metres) • Steep terrain around wetlands – narrower buffer zone • Dry vegetation and dry terrain around wetlands – narrower buffer zone • Single-layer pine forest – narrower buffer zone.

4. Management intensity

Management intensity is usually expressed for larger scale areas in terms of percentage of increment that is harvested. It cannot be expressed at the very small scale of a single stand, because harvest events take place at distinct points in time and thus at short intervals and, locally, the percentage changes a lot.

In the EU, as an average, it lies at ~75% (Forest Europe, 2020), but with national differences and increasing recently to some 90%-95% in some Nordic countries, and with over 100% in a country that faced bark beetle

4 https://cdn.pefc.org/pefc.org/media/2023-06/e70b99e3-6ce7-46ad-84ba-00a28987a942/dce9c550-7983-551b-918c-ddb3363e83be.pdf

damages (Forest Europe, 2020, Finnish NFI, Assikainen[5]). These high intensities will lead to decreasing stocks and thus the forest acting as a carbon source, often in line with biodiversity decline. Although Europe has built up large stocks of wood over the last seven decades, a very high level of harvesting and overharvesting can be seen as degradation. In combination with some set-asides, and given other increasing risks of natural disturbances, a 75% felling intensity is a defendable threshold for the whole forest area of a forest holding. This may vary locally. For instance, in cultural historical landscapes with coppice, when converting poor (bark beetle affected) stands, or after large disturbances. For example, some countries find a good standard for minimum utilisation of 75% of the increment[6].

Management intensity can be assessed through field (management planning) inventories as the ration between increment and fellings.

5. Close to nature management

Close(r)-to-nature forest management serves as a push towards biodiversity restoration, biodiversity maintenance and enhancement and resilience to climate change induced damages. It is based on two objectives: (i) increasing structural complexity; and (ii) promoting natural forest dynamics (Larsen et al, 2022).

In practice, it is based on a set of interventions (that are measurable, see Section 6.5): promote site-adapted natural tree regeneration and, where needed, complement the seeding or planting of climate change adapted species or assisted migration, ensure respectful harvest conditions (see next section on clearcuts), eliminate or minimise other management interventions (e.g. the use of herbicides), careful forest soils and water ecosystems management, avoiding rutting, avoiding soil erosion and leaving wide enough vegetation strips along water courses, protect specific minority species on-site, manage ungulate species, and a few more interventions that also come back in other indicators (Krumm et al, 2020).

Closer to nature management can be assessed in the field through indicators such as dead wood, structure, natural regeneration, habitat trees, etc.

6. Clearcut size

Clearcuts are defined as removing the (mature) trees from a contiguous area of usually more than 0.5 ha and can be up to 20 hectares in one event. In many European countries, clearcuts are restricted to a maximum size of 0.5 or 1 ha; Switzerland and Slovenia completely prohibit clear-cutting.

Clearcuts alter biodiversity via their specific characteristics, including severity and extent in the landscape, which act at different temporal and spatial scales. Biodiversity response to disturbance depends on the community characteristics and habitat requirements of species, i.e. pioneer species will benefit from a clearcut, but the often more rare species associated to old forests will not (Homyack and Haas, 2009; De Smedt et al, 2019; Kappes et al, 2009; De; Merckx et al, 2012; Godefroid et al, 2005; Hannerz and Hånell, 1997; Heilmann-Clausen and Christensen, 2003).

The impacts of clearcuts are also very much dependent on the soil type and slope of the terrain; large clearcuts on steep slopes will lead to higher erosion risk. In larger clearcuts, the regulating function of the canopy is lost; leading to stronger temperature fluctuations and heat extremes. An enhanced soil carbon loss has been measured after clearcut, depending on soil and size of the cut up to 20-25 tonnes carbon

5 https://www.luke.fi/en/news/removals-decreased-to-75-million-cubic-metres-in-2022
6 http://pisrs.si/Pis.web/pregledPredpisa?id=RESO56#

per hectare (CO_2 emission of 75-90 tonnes CO_2 per hectare), and often increased leaching of nutrients (Den Ouden and Mohren, 2020). Soil scarification and slash smashing will enhance this. Also noting that, in the past, under boreal natural circumstances, large fires occurred, we recommend that harvesting would need to be done as much as possible through thinnings or continuous cover forest management operations and should mimic the natural (intermediate) disturbance regime as shown in Aszalos et al (2021). Viljur et al (2022), from a large meta data study, concluded that, across all taxonomic groups, the highest local diversity in disturbed forest patches occurred under moderate disturbance severity, i.e. with approximately 55% of trees killed by disturbance.

Clearcut size can be monitored and is quantifiable both in field and remotely assessed as single size patches of cover changes. Given that most clearcuts in Europe are far under 5 ha per event (3.3 ha average in Sweden in 2021[7] with 30% of the clearcuts in northern Sweden over 20ha, a related quantitative biodiversity-friendly indicator threshold for sustainable finance should stay under 2 ha/ event, noting that national legislation may even provide a lower threshold.

7. Soil degradation

The quality and state of a soil can be characterised by biological, chemical and physical parameters, noting that soils occur in an enormous variety depending on mother material, climate and hydrology, slope, human influences and forest cover.

- Biological parameters express the variety of soil biota and fungi and the completeness of the soil food web (Turbe et al, 2010; Cortois et al, 2017).

- Chemical parameters are expressed by e.g. pH, cation exchange capacity etc.

- Physical by e.g. compaction by heavy machines, rutting and soil erosion (Ampoorter et al, 2012).

Human influence (notably here forest management choices as well as tree species choice) do affect all three, e.g. acidifying litter from pine needles will further acidify the soil chemistry and may have significant effects on an already poor acid soil (e.g. sandy Podzol).

Other physical effects of forest management can be soil rutting and compaction due to the use of machines under wet conditions and on soils of low bearing capacity e.g. peats. However, we also note that the use of machines is unavoidable, simply because logging with a manual chainsaw is dangerous and such labour is rarely available. In that case, the harvest should be planned and accompanied with mitigation measures (e.g. permanent harvesting tracks to avoid widespread soil compaction) or avoidance of wet season conditions. In some cases, soil compaction can provide some diversity with puddles of water (Müller and Bek, 2017).

Soil rutting, compaction and soil erosion can be monitored relatively easily, visually assessed in the field and nowadays also assessed for large areas remotely from satellites (erosion) or from airborne LIDAR[8] for compaction (see Photo 3).

7 https://www.skogsstyrelsen.se/statistik
8 LIDAR = Light Detection And Ranging: light pulses are sent from an airplane measuring the height of the soil surface very accurately. In this manner even soil compaction of 5-15 cm can be measured (see Photo 3).

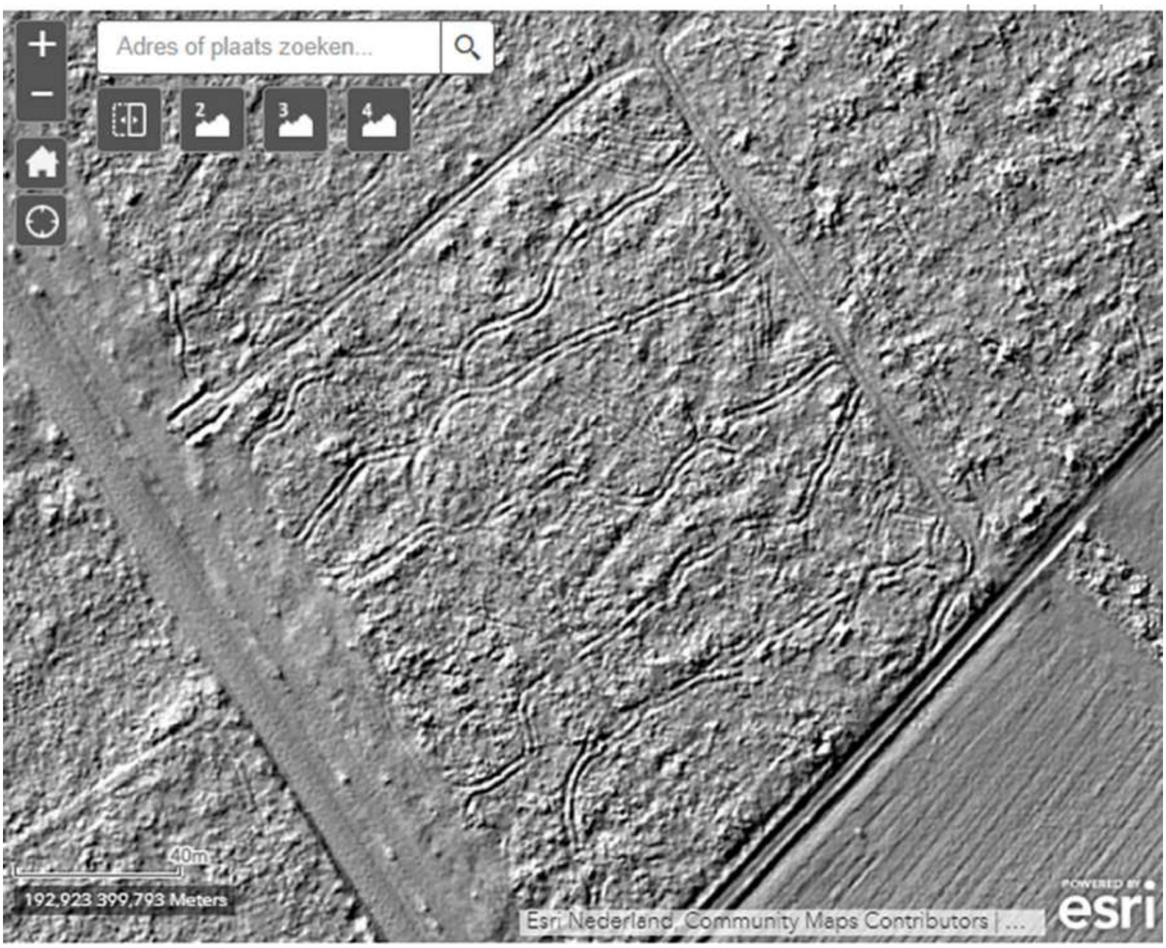

Photo 3. Tracks of a harvester leaving some compaction on the thinning tracks. The compaction is some 20cm but can easily be assessed through LIDAR for large areas. Using machines is unavoidable in commercial forestry, but planning these tracks carefully can avoid soil damage. Source: AHN4

8. Forest birds

Bird data is often used as the key biodiversity indicator because it is based on extensive data sources and benefits from skills among professionals and volunteer networks (e.g. Jiguet et al, 2012). However, birds' role as biodiversity indicator for other species is not evident (see e.g. Burrascano et al, 2018). They may be used as a direct indicator that would benefit from other measures, such as deadwood or tree-related microhabitats enrichment (Paillet et al, 2018). For birds, it makes no sense to define a threshold and the evolution towards higher diversity of forest species should be analysed carefully based on extensive monitoring networks.

In conclusion, developing thresholds for biodiversity indicators requires input from the latest science on the state of natural and forest management, and respective regular updates, since biodiversity and the impacts of forest management are very context specific. They need to be clearly linked to goals and objectives, which are themselves embedded into a socio-ecological system, i.e. a system where people and nature interact.

As a baseline, it has to be clear which direction and which range of development is desired, and where are the limits or culmination points.

If used for an assessment in the context of sustainable finance, criteria and indicators and thresholds have to be rooted in a clear methodology, where single parameters are not looked upon in isolation and without context to the actual and future forest management.

Ideally, indicators are responsive to management impacts, and can be used as operational guiding tools as well. In such a context, indicators have been shown to be a capable tool to safeguard common terminology and harmonised understanding of goals and objectives, and ways to achieve them. Thresholds can help to define the system boundaries in such a methodology but should not overstretch assessment procedures beyond their available scientific grounding and recognition of the specifics of sustainable forest management at different spatial dimensions.

5 Forest biodiversity monitoring and ensuring compliance

5.1 Monitoring biodiversity

Accompanying the implementation of management measures with biodiversity monitoring can prove efficient for biodiversity conservation and/or enhancement (Marchetti, 2004; Oettel and Lapin, 2020). This means that monitoring biodiversity indicators should help keep to and/or reorient forest management practices.

Consistently, monitoring forest biodiversity has long been, and still is, a major challenge (Muys et al, 2022). Quantifying the biodiversity of all species groups is hardly feasible and stating which type of measures will yield most results in terms of biodiversity, in short and long term, is context-dependant (e.g. Paillet et al, 2010).

In Europe, biodiversity reporting and its changes mainly rely on proxies and indirect indicators at the national level (e.g. dead wood age class distributions in Forest Europe 2020, or bird index, (Chirici et al, 2012)) that are based on either national forest inventories (NFIs) or extensive volunteer networks e.g. national breeding bird surveys, or local fungi inventories (see Photo 4). These networks and NFIs are complemented by extensive forest habitat inventories that are only reported to the European Environmental Agency for habitat forests,[9] which is mandatory for reporting on their state of conservation.

New techniques with satellites or drones, or through eDNA and bioacoustics, are developing rapidly (e.g. Deiner et al, 2017; Valbuena et al, 2020). However, to date, no network of monitoring both forest biodiversity (taxa) and forest habitats has been set up in Europe (ICP-forest plots have limited biodiversity sampling, see http://icp-forests.net/).

Monitoring biodiversity is a challenge not only because of the very large number of species, but also because natural dynamics, along with dynamics due to climate change, cause the numbers of species to fluctuate in space and time. Linking the monitored changes in biodiversity to causes is often difficult (Oettel and Lapin, 2020).

In general, factors that favour biodiversity are relatively well known, although the state of evidence still needs progress (e.g. Gao et al, 2015; Zeller et al, 2023). Forest management methods that integrate such factors and measures are then considered beneficial to biodiversity (Figure 4), despite the fact that local conditions (context) may influence the effects of different management methods on biodiversity (Kraus and Krumm, 2013; Krumm et al, 2020; Paillet et al, 2010).

The proxies are useful since they are easier to measure than species occurrence per se. Otherwise, strong species-related expertise, depending on the taxa targeted, is required (see Burrascano et al, 2021, for an overview of the methods). However, complementary inventories of forest structure (e.g. tree measurement), management types and species do help for better insights and to better adapt measures to targets (e.g. Burrascano et al, 2023).

At the management scales (stand, holding), the same problem is evident, since species inventories are hampered by the lack of taxonomic expertise and the financial resources to evaluate the effects of biodiversity-friendly measures. However, forest inventory staff and managers have strong experience of forest

9 https://nature-art17.eionet.europa.eu/article17/habitat/progress/?period=5&group=Forests&conclusion=overall+assessment

structure monitoring and observation and may also use indirect indicators of biodiversity for monitoring the effects of forest management. For example, deadwood measures or tree-related microhabitat inventories may be added to plots that are already used for monitoring tree growth and effects of silviculture. Numerous examples of such monitoring integration at the management scale can be found in e.g. Krumm et al (2020), notably Boutteaux et al (2020) and Mergner and Kraus (2020).

5.2 Ensuring compliance with the EU Taxonomy in forests

While the intention behind the EU Taxonomy is to direct finance towards economic activities that satisfy sustainability criteria, a major question is how to ensure that institutions who claim that activities are compliant (see Box 6) with the EU Taxonomy are, in fact, achieving this. For example, the criteria for forestry in the Climate Delegated Act include specific ecological outcomes, which require detailed monitoring and reporting to validate.

Photo 4. Some fungi only thrive in old growth forest with large-sized dead wood. The photo shows the rare Hericium coralloides in the Ebrach forest reserve. In monitoring biodiversity there is not always a need to count all species throughout all seasons or years; there are other indicators that together give an indirect picture of the state of biodiversity and its changes. This set of indicators makes it cheaper and easier to reflect the state of biodiversity (see Table 3). Photo: GJ Nabuurs

In the absence of appropriate governance systems (monitoring, auditing, communication, processes for acting on non-compliances, enforcement) for ensuring that activities are actually compliant, there is a risk that activities will be labelled as sustainable or non-sustainable without the associated management measures being implemented in reality. It is recognised that complying with the informational requirements of such policies can be burdensome, especially for small or mid-scale providers and investors.

On the other hand, extensive monitoring data is usually available, either from National Forest Inventories, remotely sensed information, forest holding-level management planning inventories, or biodiversity monitoring networks. There is sufficient ecological understanding to generally state which measures will benefit biodiversity and which ones not (Muys et al, 2022; Larsen et al, 2022). Local ecological research may also help. Still, showing compliance with the Taxonomy will require additional effort in terms of monitoring and reporting.

Monitoring outcomes and ensuring compliance is also made more complex by the large variety of forest types and management systems. This means that monitoring compliance using a one-size-fits-all, low-cost approach, such as remote sensing, remains a challenge. It is therefore essential to design appropriate governance mechanisms that find a balance between feasibility, robustness and equity.

However, the challenges do not mean that detecting and enforcing compliance is impossible, and approaches have been proposed in other environmental financial instruments for allocating monitoring efforts and compliance checks in an efficient manner (e.g. for biodiversity credits; Biodiversity Consultancy, 2022). These include identifying which specific financial flows are associated with the most significant environmental impacts (positive or negative) and allocating effort towards these particularly consequential cases.

In the context of forestry in Europe, this would mean conducting compliance checks on forests receiving financing, because they are of particularly high biodiversity value, in ecologically important locations, or implemented over unusually large areas. Monitoring methods could include remote sensing coupled with other on-the-ground checks by qualified foresters. Such monitoring methods could potentially be coupled with other forms of remotely collected biodiversity data, such as bioacoustics and environmental DNA.

Box 6. Key concepts in sustainable finance

Compliance refers to adhering to a set of rules or standards, often established by regulatory bodies or laws. In the context of environmental regulations, compliance refers to an organisation meeting the requirements set forth by those regulations to minimise negative impacts on the environment.

Investment refers to the allocation of money or capital to an asset or project with the expectation of earning a financial return. The goal of investment is to grow wealth over time by earning a return on the initial investment, either through interest, dividends, or appreciation in value (e.g. Lombard Odier bank, or the APG pension fund).

A ***donation***, in contrast to investments, yields no financial return to the investor but is only focused on, in this case, biodiversity conservation (e.g. Bezos Earth Fund, see https://www.gozdnispecialisti.si/en/).

Photo 5. Danube floodplain forest restoration in progress by the Public Enterprise "Vojvodinašume" and supported by Institute of Lowland Forestry and Environment from Novi Sad within the SUPERB EU Horizon 2020 project (photo: GJ Nabuurs). Here, conversion forestry is carried out: from poplar plantation to the more natural oak floodplains. At first glance, a large clearcut appears with a few retention oaks that may not comply to the proposed indicators. But assessing compliance with the Taxonomy requires considering multiple quantitative indicators over larger areas and longer time frames, e.g. for a whole forest holding. Other indicators that apply here are, for example, closer to nature forest management, retention trees, riparian buffers etc. Together this can qualify as compatible with the Taxonomy. Just looking at one stand and one point in time can thus give the wrong impression.

Despite these challenges, there are multiple lessons from other domains of sustainability finance that suggest that compliance is a critical issue. The effectiveness of the Taxonomy at transitioning the economy towards sustainable activities will also be highly dependent on key aspects of the governance architecture. For example, in biodiversity offsetting systems, a typical design would be for landowners to commit to implementing a specific form of conservation management on their land for a given contract length (like the kinds of actions stipulated in the EU Taxonomy). They are then able to use a metric approved by the government for estimating the gains in biodiversity that arise from those management measures, and then convert those predicted biodiversity gains into credits, which can then be sold into the biodiversity market.

However, many follow-up studies have demonstrated that compliance with delivering the improvements in biodiversity, stipulated in the offset contracts, is low. This is largely because of the limited threat of enforcement or legal action (Theis et al, 2020; zu Ermgassen et al, 2019). These systemic compliance failures have, in some EU jurisdictions, deeply undermined the biodiversity outcomes of the system (e.g. Bezombes et al, 2019).

The studies of systemic compliance failure have helped spark a lively debate about designing appropriate governance systems for ensuring compliance in biodiversity offsetting systems (Damiens et al, 2021). An equivalent conversation is needed for ensuring the compliance of agents claiming they satisfy the criteria of the EU Taxonomy.

Even though the taxonomy is aimed at forest holding level, we can learn from compliance mechanisms at the national level as well. For example, in the context of the Framework Convention on Climate Change (UNFCCC), compliance refers to measures that lead to improvement, namely the reduction of greenhouse gas emissions or enhancement of sinks. Examples are, at project scale, the Clean Development Mechanism or the Reducing Emissions from Deforestation and Forest Degradation (REDD+) investments and, a broader scale, the plans related to the Nationally Determined Commitments under the Paris Agreement. Monitoring and reporting compliance in all these processes is a complex process.

Another example of compliance at holding level are the sustainability criteria, also a major item in the biomass for bioenergy area, applicable at enterprise level. Here biomass suppliers need to comply with sustainability criteria that can be proven, such as by private accredited certifiers (see, for example, the Dutch process[10]).

Unlike projects that focus on generating carbon certificates where additionality is essential, within the EU Taxonomy Regulation and the Climate Delegated Act additionality criteria *must not be met* by sustainable finance compliant with the EU framework. On the contrary, the requirement for additionality has been excluded during related negotiations.

The aim is not only to qualify forest holdings that aim to increase biodiversity, but also those that have already achieved a high level of biodiversity through the management methods practiced. The EU Taxonomy thus considers the Ecosystem Approach of the Convention on Biological Diversity (CBD), which is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. This consideration of the CBD Ecosystem Approach is also called for in the Climate Delegated Act.[11] Thus, a realistic consideration of biodiversity protection must also include balancing with other co-benefits of forest management.

Another challenge of the EU Taxonomy in forests is the inherent complexity of forests resulting from the diversity between forest ecosystems in Europe. Financial systems call for uniform assessment systems based on mechanistic and simplistic approaches to biodiversity conservation and enhancement. In this tense field, the question arises whether compliance with the EU Taxonomy aims at getting the big picture roughly right, instead of focusing on local conditions and risking misvaluing them to the detriment of biodiversity and other forest functions (Crona et al, 2021).

Against this background, measures for compliance have to be investigated for verification and to assess the sustainability of taxonomy requirements. Developing such instruments is a time-consuming and non-trivial task since it demands a triangulation of technical, contextual and participatory elements to reach a comprehensive and comprehensible outcome. Criteria and indicators (C&I) have a particularly long record over more than 25 years as proven tools in evaluating sustainability of forest management and are widely recognised as flexible, multi-purpose tools to address different dimensions of sustainable forest management (Linser et al, 2018).

10 https://adviescommissiedbe.nl/cms/view/b62e71d2-36ff-4bc6-9778-1454222111f8/advisory-commission-on-sustainability-of-biomass-for-energy-applications

11 *Additionality* means that a project should result in an environmental benefit that would not have occurred had the project or action not been implemented. It is a way to ensure that projects make an additional contribution to improvement, rather than simply displacing negative spillover effects to another location or time.

6 Going beyond the EU Taxonomy: greening finance in the land-use sector

6.1 Financing green – initiatives for increasing private investment into biodiversity conservation in the EU

Estimates of the global 'biodiversity funding gap' demonstrate that global conservation funding is approximately five to seven times lower than is required to halt and reverse biodiversity loss (Deutz et al, 2020). The two main strategies for altering the flow of finance into projects that affect biodiversity are 'financing green', and 'greening finance' (WWF, 2023). Financing green captures a range of efforts to increase the opportunities for investments to generate profitable returns from investing in projects that improve biodiversity in some way. We are currently experiencing a time of rapid innovation in the creation of innovative financial mechanisms for increasing the flow of return-seeking capital into nature conservation and restoration. This can be seen through emerging mechanisms such as conservation bonds and biodiversity credits (e.g. Thompson, 2023).

While widely recognised to underpin all economic activity, underinvestment in biodiversity remains widespread, in part because it is a complex, intangible public good and the rate of commercial return is low or often negative, even when there are substantial net benefits to society (Bradbury et al, 2021). Therefore, there is a severely limited number of investment opportunities available. Governments are, and have historically been, the main funders of biodiversity conservation, with the majority of conservation investments coming from public spending, funded via general taxation. However, within EU countries, changes in public spending on conservation are not increasing at anywhere near the rate required to meet the funding gap (Seidl et al, 2021). Conservation spending in some countries in Europe has even declined as a percentage of gross domestic product (GDP) over the last 15 years (zu Ermgassen et al, 2021). There is still huge potential for states to take on a larger role in addressing biodiversity funding shortfalls, both through increasing direct investment and reducing ecologically damaging subsidies (Deutz et al, 2020; Figure 6).

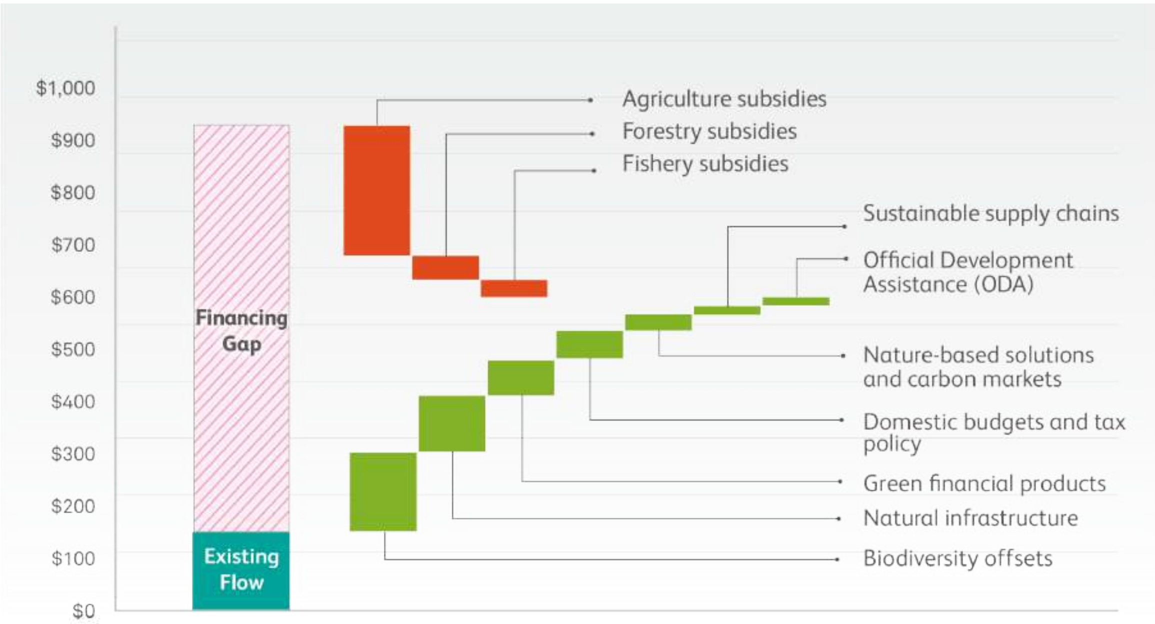

Figure 6. Schematic of the global biodiversity funding gap and a strategy for addressing the gap proposed in Deutz et al, 2020 (million US$/y). Red bars: required reduction of financial flows that harm biodiversity. Green: additional flows needed and their capacity to upscale

Photo 6. Stag beetles are indicators for old oak forests with large-sized dead wood. Without having to inventory all beetle populations, the volume of dead wood can be inventoried and used as a widely accepted proxy for beetle habitat. Photo: GJ Nabuurs

Recognising that governments are unlikely to be able to address biodiversity funding shortfalls on their own without substantial changes in taxation and spending regimes, an increasing area of focus currently is the role of upscaling private investments in nature to address global biodiversity funding shortfalls. Under the Kunming-Montreal agreement, high-income countries agreed to increase public biodiversity-related spending in low-income countries to USD $30bn/year by 2030, while 'mobilising' at least USD $200bn/year primarily through various mechanisms for commodifying and increasing the investment appeal of biodiversity such as: "leveraging private finance, promoting blended finance… [and] stimulating innovative schemes such as… green bonds, biodiversity and credits" (CBD, 2022).

In the EU, most initiatives for drawing private investment into biodiversity are still in pilot phases and questions remain about their capacity to scale up while consistently delivering benefits for ecosystems (Kedward et al, 2023). The most commonly applied market-like mechanisms for utilising private funding to address biodiversity loss are biodiversity offsets, which have achieved mixed outcomes to date (zu Ermgassen et al, 2019). For example, evaluations of Australian offset markets demonstrated that such investments delivered little biodiversity improvement in reality because of poor spatial targeting and/or weak compliance (Gibbons et al, 2018; zu Ermgassen et al, 2021).

Biodiversity offsetting policies have been adopted in various EU member states (and around the world; Droste et al, 2022), which aim to ensure that regulated sectors develop in a way that leaves nature, as a minimum, in the same state as before development. For example, in the Netherlands, a deforested area (i.e. change of forest land use to something else), needs to be compensated through forest area expansion elsewhere. In reality, there are large delays with executing these compensations or they consistently fall short of their biodiversity goals (zu Ermgassen et al, 2019). In several jurisdictions, there are biodiversity offsetting systems whereby developers are responsible for delivering compensation for the harms caused by their developments, with compensation sites and management measures often implemented by third-party organisations delivering these offsets in practice (e.g. France; Gelot and Bigard, 2021). England is, from late 2023 onwards, introducing a new policy mandating that all new infrastructure developments leave biodiversity in a measurably better state after construction than beforehand. If developers are unable to achieve this within their site boundary, they will need to purchase additional 'biodiversity units' from a new compensation market, with biodiversity largely produced through the implementation of habitat enhancements on private land (zu Ermgassen et al, 2021). There is widespread interest in how this nascent biodiversity market will function and its ecological effectiveness.

In the EU, slightly more established mechanisms for drawing private finance into forest biodiversity build on payments for carbon storage and sequestration, such as through voluntary carbon markets. Some national voluntary carbon markets are emerging, such as the Woodland Carbon Code in the UK, now a decade old, while other schemes, such as "Label Bas Carbone" in France, are established and slowly growing.[12] In November 2023, the European Parliament adopted its position regarding a regulation proposal on Carbon Removal Certification with the aim of defining a framework of common rules for an EU voluntary carbon market, including forest investments, and including long-term storage (i.e. for at least 50 years) in wood products. The EU Regulation is now in the phase of final approval by the Council, but many questions remain, especially on formation of the baseline, the certifiable methodologies or how co-benefits, such as an increase in biodiversity, can increase the value of carbon removals. Detailed guidance for the carbon removal certification is being developed and drafted in a handbook (COWI, 2021), although it shows that even certifying something seemingly as simple as carbon results in many technical issues. Biodiversity offsets will most likely be much more complex.

Despite plenty of commitments around scaling up efforts, including those embedded in the Kunming-Montreal agreement (Kedward et al, 2023), biodiversity markets remain small in the context of global capital flows. Despite years of economic growth, the largest market remains the voluntary carbon market, which was assessed by the IPCC in the Sixth Assessment Report at a value of 569 million USD/yr. This is far short of what would be needed to make a significant mitigation effect (Nabuurs et al, 2022). Although some figures for 2021 (Forest Trends, 2022) estimate the value of forest carbon credits, transacted at the global level, to be double that amount at 1.3 billion US$, this is still a small sum. Also, these carbon markets are often not transparent, sometimes foster unsustainable management practice and greenwashing, and their CO_2 calculations are sometimes arbitrarily assessed (Battocletti et al, 2023).

Considering that investments in forest carbon credit generation in the voluntary market are not always associated with biodiversity protection, the most important pillar of a coherent strategy to improve the biodiversity outcomes of finance is 'greening finance': changing the underlying incentives in the financial system to alter the allocation of resources away from ecologically damaging activities, through various regulatory and information-based approaches.

6.2 Greening finance – approaches to altering financial flows throughout the economy

The key focus of greening finance is to alter the balance of economic incentives in the economy so that investors modify their patterns of investment and ultimately allocate less capital towards ecologically damaging activities, to enhance their long-term returns. These approaches include risk-based approaches, such as encouraging firms to report on their exposure to nature-related risks (e.g. the Taskforce for Nature-related Financial Disclosure). The aim is to unlock information flows so that investors can accurately gauge their exposure to previously under-recognised nature-related risks. Information from these disclosures can act as inputs into firms' environmental, social and governance (ESG) scores, as derived by ESG ratings agencies, which have also been seen as a mechanism for helping inform the allocation of capital, both within and across sectors. However, there is also widespread agreement that these risk-based approaches are insufficient to systematically transform capital allocation processes on their own (Xin et al, 2023), and so such efforts also need to be coupled with other policy levers, including direct regulation targeting ecologically damaging or polluting processes. There have also been calls for central banks to take a more 'precautionary' approach to monetary policy in order to address climate- and nature-related risk (Kedward et al, 2022b). Other approaches, such as the EU Taxonomy, focus on classifying economic activities to make it easier for investors to gauge the sustainability of their investments, and assist their reporting on progress towards sustainable investment goals.

12 See, for example, https://label-bas-carbone.ecologie.gouv.fr/ and Stichting Nationale Koolstofmarkt in Netherlands https://nationaleco2markt.nl/

Failing to address biodiversity loss exposes society to a wide variety of risks. The World Economic Forum (WEF)'s 2022 Global Risks Report ranks nature loss and ecosystem collapse as the third most severe global risk over the next 10 years. This is preceded by climate-related risks, to which nature loss and land use change are also strong contributors (WEF, 2022). Some of the key risks are clear threats to financial institutions (De Nederlandsche Bank, 2020).

Assets of financial institutions are exposed to physical risks from nature loss and disturbances in contexts where investments are dependent on the ecosystem services that underpin their potential returns. For example, agricultural productivity is dependent on pollination services provided by pollinator communities and forest resources are vulnerable to bark beetle infestations and tree mortality.

Financing activities that harm nature have always exposed financial institutions to reputational risk and these risks are intensifying with increasing public awareness. Increasingly, financial institutions are concerned with the very material risks of financing assets that could become stranded following the adoption of more stringent environmental legislation or changes in society's preferences (Cahen-Fourot et al, 2021). In extreme cases, this could increase the probability of defaulting on loans and necessitate write-downs. Given that these risks are systemic (i.e. likely to be correlated between investments rather than independent), these risks can in turn threaten the viability of related bundles of investments, which might ultimately have impacts on a financial institutions' creditworthiness or viability.

Interconnections between various forms of risk are explored in Figure 7. A key concept here is the idea of double materiality. The concept of materiality is the idea that firms should report publicly on those aspects of their operations of material interest to stakeholders. This would mean reporting on their exposure to nature-related risk, which has the potential to be a liability that investors and other stakeholders should be aware of and potentially factor into their decision-making. Double materiality extends this concept and implies that firms should not just report on the way nature affects their businesses, but also the way their businesses affect nature – as, arguably, such information is also material to stakeholders who might be interested in evaluating the company's exposure to specific forms of risk that relate to company impacts such as reputational risks (BFN, 2023).

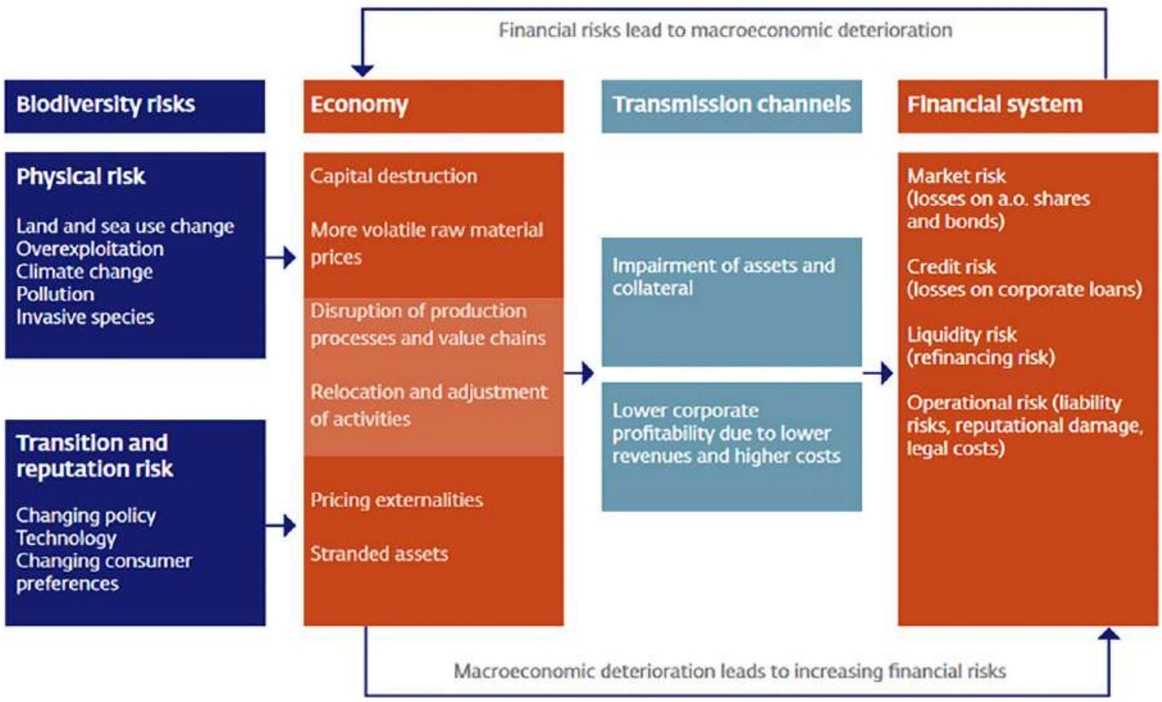

Figure 7. An exploration of the interconnected risks between nature loss and the financial system. From Indebted to Nature: exploring nature-related risks for the Dutch financial sector (De Nederlandsche Bank, 2020)

Sustainable finance has emerged as an important topic in a number of countries, including the European Union. Given that it is a broadly categorised concept with no universal definition existing so far (Cunha et al, 2021), a plethora of voluntary initiatives and terminologies exist in parallel (see Box 1).

7. Conclusions and recommendations

Forests play an important role in biodiversity maintenance, enhancement and conservation. In forests, biodiversity encompasses a wide range of animals, plants and fungi in complex interactions across spatial and temporal scales, their biodiversity shaped by the interplay of composition, structure and functions.

Currently, the state of biodiversity in forests in Europe is relatively good compared to other ecosystems. However, Europe's forest biodiversity is also under pressure as forests are becoming more exposed **to disease, pests, fires and other factors**. Only 26% of forest species and 15% of forest habitats of European interest were in 'favourable conservation status' according to EEA (2023). This is mainly due to forest cover change caused by climate change, bark beetle attacks, forestry and pollution. The financial sector has been, mainly in an indirect way, one of the structural drivers of biodiversity loss by investing in economic activities or lending to companies that contribute to biodiversity loss. To divert the financial flows in a more sustainable direction, and to meet its climate and environmental commitments, the EU launched its Sustainable Finance Strategy and developed related legislation.

The EU Taxonomy for Sustainable Activities defines technical screening criteria and preventive measures, including so-called "Do-No-Significant-Harm" criteria, along six environmental objectives. Two major Delegated Acts, which further elaborate these objectives, the so-called Climate and Environmental Delegated Acts, have been adopted to date. Forestry activities have been addressed under the climate change mitigation and adaptation objectives but were excluded from the 'Protection and restoration of biodiversity and ecosystems' objective.

Given the challenges of designing biodiversity indicators and thresholds for forest-based sustainable finance, this report aims to give guidance on how to select and set thresholds by providing a basic set of indicators and examples of their threshold or target values. Considering that forest biomes in Europe vary over space and time, we argue that indicators for forest biodiversity conservation and their thresholds can be defined best using a biogeographical-specific approach. The complex nature of forest ecosystems and their diverse sustainable management options may not be adequately captured by a comprehensive list of indicators and standardised thresholds intended for global application, as proposed earlier by the Platform on Sustainable Finance. This one-size-fits-all global approach should be avoided, especially considering that biodiversity protection standards in other sectors are already well established in sustainable financial markets, such as renewable energy and agriculture, and are much less stringent and selective.

The science today provides a sufficiently solid basis to state which measures in forest management are favourable for biodiversity and which are less favourable. Still, putting a natural system into a strict framework of management rules based on uniform and rigid set of thresholds or targets is challenging, as the carbon and biodiversity credit markets show. **Too ambitious targets and thresholds may lead to a selective flow of donations** but may discourage potential investors interested in forest finance based on balanced criteria of financial profitability and biodiversity protection.

Furthermore, **the additionality and durability of sustainable forest finance, as well as its leakage effects, pose additional challenges**. Additionality requirements could exclude from sustainable finance the "early comers", namely those forest enterprises that have already integrated a high level of biodiversity protection into their management activities. Though the Taxonomy is about compliance, it needs to be specified whether financing biodiversity-friendly measures of a forest enterprise with an existing high level of biodiversity would be part of sustainable finance as defined by the Taxonomy.

This report presents a set of quantifiable indicators, that together cover the composition, structure and function of forests, to be assessed at the level of a forest enterprise.

The 26 indicators are grouped according to the criteria defined in the Climate Delegated Act for the four typologies for forest finance: afforestation, forest management, rehabilitation and restoration and conservation forestry:

1. Afforestation:
   Forest area, forest area by forest type, Regeneration type, Diversity of regenerated tree species and diversity of tree species in main stand

2. Forest management:
   Retention trees left on clearcuts, Growing stock , Habitat trees, Deadwood, Stand and tree age structure, vertical diversity, Close(r) to nature and other forms of integrative forest management, Clear-cutting forest management, Increment and fellings, Biodiversity valuable traditional forest management, monoculture plantations

3. Rehabilitation and restoration of forests
   Riparian buffer zones, Soil degradation, dominant invasive tree species, forest fragmentation, forest connectivity, abundance of threatened forest species, abundance of common forest bird species

4. Conservation forestry
   Share of forest area undisturbed by man, share of forest area under protection regime, change in area of primary forests

The thresholds and targets examples presented as general guidelines to be approached with flexibility, are established at an intermediate level. This aims to define a balance, supporting biodiversity protection while ensuring an attractive level of financial return on investments. The proposed threshold examples give a direction, realising that it may take a long time to achieve some targets, and with fluctuations in indicator values occurring over time and space.

Due to time constraints in preparing this report, a participatory process for defining the thresholds and targets could not be conducted, although these processes have their own challenges. However, we view this as an option for future consideration, particularly in light of the necessity to incorporate social criteria into the Taxonomy.

Apart from the Taxonomy and its indicators and thresholds, other strong policies are required to disincentivise financing deforestation and forest degradation. With recent developments in monitoring methods and innovative financial instruments such as conservation bonds, biodiversity or carbon credits, the Taxonomy can provide an important stimulus, which European forests need to enhance biodiversity.

As the EU Taxonomy will be continuously updated, it is challenging to foresee the regulation's impact. Beyond financial impacts in terms of investments in forests, the Taxonomy might also have wider policy implications, as some definitions and criteria might be integrated into other fields of policy action. For example, these could be credits generated by carbon removal, certification of sustainable forest management and wood products labelling, non-financial reporting, and environmental claims.

What is visible so far is that **(financial) companies are facing difficulty in "correctly" interpreting existing forestry criteria for climate change mitigation and adaptation**, and developing reporting procedures and processes. Next to monitoring challenges, the IT infrastructure to collect and process the required data, to understand the transition and interplay between different EU disclosure requirements, as well as to apply the criteria that have been written by experts, does not necessarily match the accounting principles of (financial) companies.

These challenges might ease in the long term with further elaboration of the EU Taxonomy, its delegated acts and the experiences gained in reporting and implementation. However, it is still questionable whether the EU Taxonomy will eventually shift investments by providing information for disclosure and new investment tools. However, by moving towards “labelling and designations” through the Taxonomy, forest enterprises might have more options to attract needed investment funding and achieve positive ESG ratings.

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