organization for biodiversity certificates

Towards biodiversity certificates: proposal for a methodological framework

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Produced by Carbone 4 and the Muséum national d'Histoire naturelle, for the Organization for Biodiversity Certificates, association created by aDryada and le Printemps des Terres.

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Purpose and content of this document

This report was commissioned by the Organization for Biodiversity Certificates (OBC). It was produced by Carbone 4 and the Museum National d'Histoire Naturelle (MNHN), in collaboration with the founding members of the OBC.

This document intends to propose a methodological framework for the development of a fair and operational financing mechanism to support the preservation, restoration, and sustainable use of ecosystems. It should be noted that:

- This document only presents a global approach for the design of a biodiversity certificate mechanism. The operational methodologies remain to be developed, and that will be the core of the future work to be conducted with the OBC and its members. At this stage, several aspects have been deliberately left open.

- This document is not definitive. The purpose of this publication is to gather feedback from stakeholders and experts, and some aspects may evolve accordingly.

Executive summary

There is an urgent need to act for biodiversity, and to find more funds for the restoration, preservation, and sustainable use of ecosystems. Today, various signals indicate that companies are willing to invest in such actions. One solution to facilitate the private sector's contribution to this global challenge is to develop a mechanism of **"biodiversity certificates" allowing the financing of field actions based on quantified and certified "biodiversity gains".**

This requires notably to:

I. Develop a methodology for assessing the biodiversity gains
II. Define a certification process for the generation of certificates
III. Design a market framework for the trade and use of certificates

Figure 1: three main challenges for the development of a biodiversity certificate mechanism

I. Assessment

Most assessment methods come up against the problem of measuring biodiversity *in situ*. In general, we do not know how to measure biodiversity satisfactorily because of its complexity. However, experts generally state that they *know*, for a given location, which actions are favorable to biodiversity.

What we propose is to quantify the gain from these actions based on a consensus between experts. To do so, we will not consider biodiversity as such, but the **Biodiversity Carrying Capacity** of a given area, which is the capacity of the ecosystem to host and support species.

The first step of the approach is to define categories of ecosystems, **"ecosystem types",** which are considered to be sufficiently homogeneous to allow, at first, the same approach to be applied to assess their biodiversity carrying capacity (e.g., intersection between a biogeographical category and a category of land use). For an ecosystem type, **a group of experts is formed**, i.e. individuals with established and recognized knowledge of biodiversity in that ecosystem type.

With the support of the experts, **we establish a set of "parameters",** that are identified as the main drivers of the biodiversity carrying capacity in the given ecosystem type.

These parameters can be **anthropic practices** (e.g., pesticide use) or **ecosystem characteristics** (e.g., species diversity in a forest), but should always be **assessable or measurable with reasonable complexity**.

The experts are then mobilized in a **participatory research protocol** that outputs a calculation rule for assessing the biodiversity carrying capacity based on the value on the parameters. The process is designed so that the **rule will be a synthesis and a generalization of the expert's collective knowledge**.

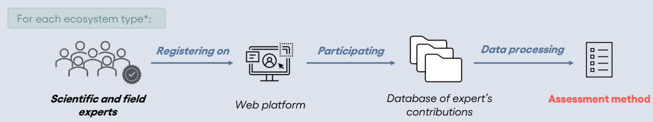

Figure 2: participatory research protocol

This evaluation rule can be used directly to provide an **evaluation over time of the biodiversity carrying capacity** from a measurement of the set of parameters.

It can also be used to derive an **evaluation grid** that will directly provide the biodiversity gains associated with certain changes of practices.

The evaluation may be refined in a second step to better account for local specificities. Overall, the method can be used to make ***ex-ante* projections** as well as ***ex-post* evaluations**. Importantly, it is designed to **be easily applicable on the field,** as the assessment relies only on the parameters that were selected according to their measurability.

II. Certification

For the certification mechanism, we recommend **seeking inspiration from the *best-in-class* carbon standards,** while taking care to adapt them to the biodiversity context.

A **general standard** should be defined, including rules and requirements regarding project management, additionality, as well as management of the main risks, such as non-permanence and leakage. We also recommend defining a **process of independent auditing**.

III. Market framework

Having a robust assessment methodology and certification process is necessary, yet not sufficient to ensure that the certificates mechanism promotes adequate action for biodiversity. Principles should be implemented so that the **purchase of certificates be part of a consistent global action for biodiversity** that is in line with the challenge we face.

In particular, we recommend **excluding the possibility of offsetting** for biodiversity. The concept already raises legitimate concerns in the climate field, and it seems even more problematic when applied to biodiversity, where impacts are essentially local and on non-substitutable ecosystems.

We rather recommend a **contribution approach,** where one distinguishes several types of actions, associated with distinct categories of certificates:

- When the actions generating the certificates are implemented **within the scope of the organization's biodiversity footprint,** certificates may be considered as **impact reduction,** provided a compatibility of the assessment methodologies. Importantly, certificates are only one of many ways to achieve impact reductions.
- When they are not, **certificates should not be used to "cancel" impacts** but considered as the **organization's contribution to collective strategies** for the preservation and restoration of ecosystems.
- In the contribution category, we recommend **distinguishing between contribution on a local scale**, linked to the organization's implantations, and contribution on a **global scale.**

Figure 3: three categories of certificates in a contribution approach

In a contribution approach, **each category of action is monitored separately**, and **impact reduction is set as a priority**. Also, each category has its **own logic and quantitative objectives**, which are **derived from global *biodiversity plans*,** issued by **institutions of reference** (ex. local authorities on the local scale, the IUCN, CBD or FAO[1] on the global scale), to define collective priorities and targets. Contribution projects are developed **in coordination with those institutions** and designed to be **aligned with the vision** they define for biodiversity action.

Overall, individual actions of organizations are carried out following a rationale **of "fair contribution" to the collective objectives**, and the communication around exchanged certificates (claims) is consistent with this perspective.

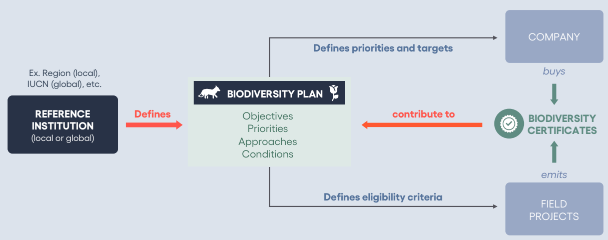

Figure 4: articulation with reference institutions and biodiversity plans

In addition, **rules for the trade of certificates** should be defined to ensure the global integrity of the market, and guarantee that **most of the funds are indeed used for biodiversity action.**

[1] International Union for the Conservation of Nature, Convention on Biological Diversity, Food and Agriculture Organization

This is only a first step, join us for the next ones

It is important to note that what is proposed here is **only a global approach**. The operational methodologies remain to be developed, and that will be **the core of the future work to be conducted with the OBC and its members.**

Stakeholders of the biodiversity certificates mechanism (companies, field actors, experts, NGOs, etc.) are **welcome to join us** to contribute to the methodological developments, so that we can collectively create a fair and robust mechanism that is up to the challenge.

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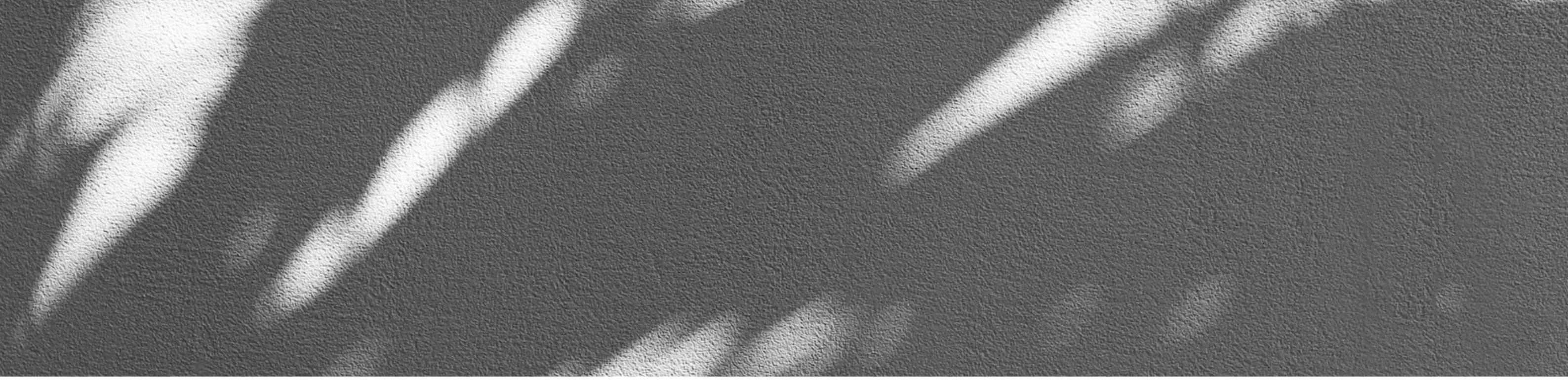

Introduction

General context

Experts and scientists agree on the fact that there is an **urgent need to act for biodiversity,** but various obstacles restrain the implementation of needed actions. One of these, probably among the most significant, is the **lack of funding.**
Today, various signals indicate that the private sector is willing to invest more in restoration, preservation, and sustainable use of ecosystems as part of its contribution to achieve broad collective social and environmental goals. And this could be a significant additional potential to bridge the gap.

However, beyond some regulatory systems that are generally limited in scope, **there is no global reference mechanism for biodiversity action**, and this hinders private sector funding. Preservation, restoration, and sustainable actions have long been carried out by NGOs and state nature protection institutions, often with the support of private actors, but without being part of a global reference mechanism to frame their financing and implementation. Various models coexist, as well as different approaches for the evaluation of biodiversity gains, but none of them constitute a global reference.

One reason for the lack of such a mechanism is that there **is no standard approach for the evaluation and monitoring of biodiversity gains.** Indeed, being able to associate funding with a quantifiable " amount of impact " in a standardized unit is a key asset for the development of such a mechanism. On the demand side (i.e. the financers), it brings confidence in the reality of the generated benefits – an essential element for the purchase of an intangible asset – and it guarantees the possibility to value it externally. On the supply side (i.e. field actors who implement restauration and preservation actions), it increases funding opportunities, facilitates *ex-ante* investments, and provides operational reference frameworks for the development of initiatives. It also reduces transaction costs by standardizing exchanges. **Overall, the development of a "standard unit" can be an important catalyst for scaling up biodiversity action.**

Some universal indicators have been developed for biodiversity, such as the MSA.km$_2$ [2] or the STAR [3] metrics. But the MSA may not be suitable for field action, notably because it involves a comparison with an "undisturbed" ecosystem - which can be difficult in practice and does not capture restoration efforts that are not part of the natural trajectory of an ecosystem, for example in the case of maintaining an open area in a formerly forested area, or in the case of agricultural parcels. Moreover, the existing methodologies for its calculation were generally designed to assess the negative footprint of an organization based on an overall view on its value chain and may not be suited for assessing field initiatives. As for the second, the IUCN STAR metric, it is well thought out for field action but focuses on species extinction risks, thus leaving out some aspects of ecosystem preservation and restoration.

Building an indicator that looks at ecosystems as a whole and is suitable for field measurement is a challenging task. First, biodiversity does not have a "canonical" unit, such as tCO_2e for climate. Furthermore, the diversity of ecosystems, their complexity and their non-substitutability make it even more difficult to combine them into a single value system. Thus, this unit of reference will necessarily be imperfect: the complexity of life cannot be summarized into a single dimension. However, it may be possible to develop a single unit approach that is, though imperfect, **sufficiently robust to adequately catalyze the preservation and restoration of ecosystems**, by directing funding towards actions that were identified as priorities for biodiversity.

The purpose of this document is to propose guidelines for the development of such a financing mechanism. It will be based on the generation and trade of "biodiversity certificates", corresponding to a certain "amount" of "biodiversity gains" generated on the ground and expressed in a "standard unit".

Many private actors wish to act for biodiversity. To address this interest, we can create a framework for the development of such actions by **introducing a standard unit for the evaluation of biodiversity gains: the biodiversity certificate**

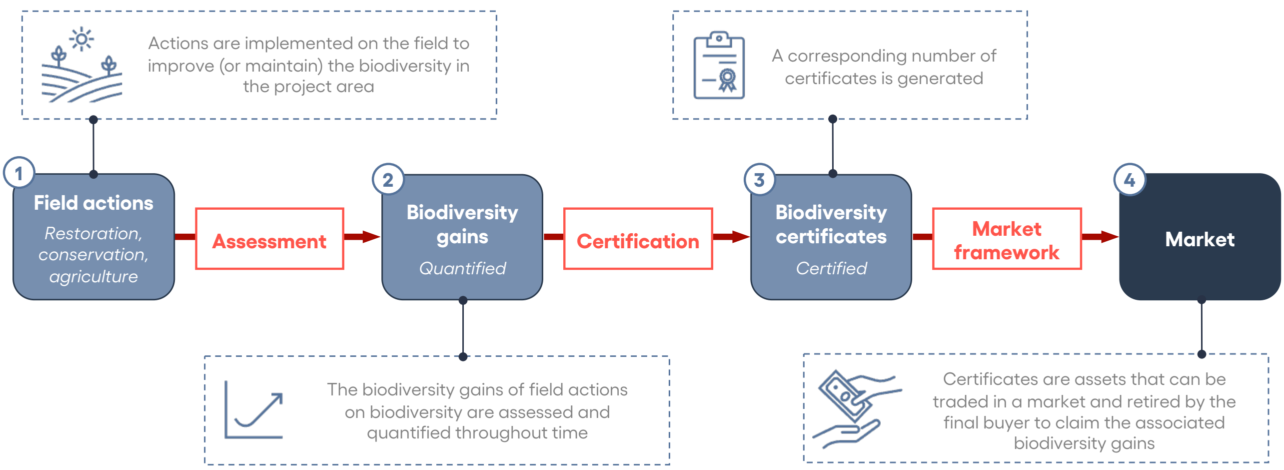

Figure 1: from field actions to tradeable biodiversity certificates

[2] Mean Species Abundance per km$_2$

[3] Species Threat Abatement and Restoration Metric, using the IUCN Red List of Threatened Species to estimate the potential reduction in species extinction risk

The climate example and the question of offsetting

Before exploring the development of this mechanism, it is important to have in mind the example of the **voluntary carbon market**. Since the mid-2000s, it has enabled to raise substantial funds to support climate action, notably in the forestry sector (REDD+, afforestation, reforestation, improved forest management); **but it has also generated some criticism.** First, the voluntary carbon markets have raised some issues related to the **integrity of the offer**, i.e. to the quality of the impacts generated in the projects. It includes concerns regarding the reliability of impact quantification methodologies, issues of permanence, additionality, or leakage. Some issues are also related to the **integrity of the demand,** i.e. the way in which credits are used by the final buyers and whether or not they promote an adequate and ambitious climate action overall. **By relying on the idea of offsetting,** the voluntary carbon market assumes that one carbon credit is equivalent to the emission of one ton of CO_2 and can therefore be used to *cancel* it. This raises some issues, as pointed out by many observers[4]. First, 1 tCO_2e of avoided emissions, 1 tCO_2e of carbon removals and an emission reduction of 1 **tCO2e correspond to different realities and are quantified with different methodologies.** For example, the assessment of avoided emissions involves the use of a reference scenario, and the assessment of carbon removals involves hypothesis for the consideration of various risks such as leakage or non-permanence. Then, as credits are generally traded at a cost that is below the social cost of carbon and the average cost of reducing emissions, **there is a risk that offsetting is done at the expense of an ambitious emission reduction policy,** though this is widely regarded as the undisputable priority to achieve global climate change mitigation objectives.

For the development of the biodiversity mechanism, **our recommendation is to exclude the possibility of offsetting.** As presented above, the concept already raises some questions for the climate topic, for which we have a rather satisfactory canonical unit (in the sense that it allows to aggregate and summarize rather faithfully different contributions to climate change), the tCO_2e, and for which the impacts are global and generally equivalent (in the sense that an emitted tCO_2e will generally have the same contribution to climate change regardless of where it was emitted, with a few exceptions). **In the case of biodiversity, the impacts are essentially local,** the impacted ecosystems are **greatly diverse and non-substitutable,** and – this is related to the above – **the unit of impact will never be as efficient as the one used for climate.** This makes the concept of offsetting even more questionable for biodiversity action.

We consider that it is possible to create a universal unit for prioritizing and quantifying biodiversity gains and to support a robust and virtuous mechanism for financing actions based on quantified impacts. However, we consider that it is not desirable for these impact certificates to be used to "cancel" impacts generated elsewhere.

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[4] See for example the Net Zero Initiative: https://www.net-zero-initiative.com/en

We rather recommend a contribution approach, as presented in section III. Either one acts within one's scope of footprint, and then one may claim to reduce one's impact if the assessment methodologies are compatible. Or one acts outside the value chain, generating positive effects that will be accounted for separately. These two approaches should be developed in parallel, with distinct logics and objectives, determined with the help of methodologies that allow to connect the action of an organization with the collective objectives for the mitigation of the biodiversity crisis.

Scope of the certificate mechanism

General scope

To cover the largest possible range of actions that can contribute to the restoration, preservation, and sustainable use of ecosystems, we suggest that the **scope of this mechanism should be as large as possible.** In particular:

- In terms of **geography:** to cover all regions of the world
- In terms of **ecosystems:** to cover all types of ecosystems
- In terms of **types of actions:** to cover all types of initiatives

However, it does not seem possible to cover the entire diversity of geographies, ecosystems, and initiatives in a single impact quantification approach, therefore our goal is to develop a **general framework which allows the integration of context-specific methodologies,** as presented in Section I.

Project categories

From an operational point of view, we consider that the mechanism should cover three main project categories:

- First, **restoration projects,** whose main objective is to increase the biodiversity value of a given area. Examples include reforestation projects on degraded areas, the creation of ecological corridors to improve the connectivity of fragmented areas, savannah restoration projects, wetland depollution projects, etc.

- Secondly**, preservation (or conservation) projects,** whose main objective is to avoid future degradation. Examples include projects to reduce deforestation in tropical rainforests, to preserve natural grasslands, to prevent damage in coastal areas, etc.

- Finally, **agricultural and forestry practices projects**, whose main objective is to reduce the negative impacts of an agricultural or forestry activity on biodiversity, and more generally to enhance biodiversity in an agro-ecosystem. Examples include agroforestry projects on coffee parcels, improved forest management projects, projects to develop improved grasslands for cattle, projects to reduce the use of chemical inputs on cereal parcels, etc.

The projects should generate biodiversity gains, **but they may also deliver other benefits,** for example on climate, health, water resource, or for livelihoods. Moreover, the integration of non-biodiversity aspects in the project management should be an important criterion to ensure the global relevance of the certificate mechanism.

Each category may require specific methodological developments. For example, the conservation use case require to define a specific approach to value the avoided degradation of the biodiversity in a given area rather than its improvement, while the agricultural and forestry use case may require defining an approach to consider a change in yields. Both represent significant methodological challenges.

Overall, provided that a satisfactory approach is found to address the methodological challenges, we recommend that **the biodiversity certificate mechanism includes of all three types of projects,** as each of them constitute a major lever for mitigating biodiversity loss.

Link with climate projects

Many terrestrial and coastal ecosystems are also significant carbon sinks, due to the carbon contained in their biomass and soils. **Therefore, conservation and restoration of ecosystems can generate both biodiversity benefits** (the ecosystem considered as a habitat) **and climate benefits** (the ecosystem considered as a carbon sink). In practice, some climate projects already covered by the voluntary carbon market already offer significant potential for biodiversity benefits. This is notably the case for reforestation and afforestation projects (restoration), REDD+ avoided deforestation projects (conservation), or agroforestry projects (agriculture and forestry).

It would be valuable to be able to incorporate the biodiversity mechanism into existing voluntary carbon market mechanisms, either by enabling projects to generate biodiversity certificates in addition to the carbon credits, or by allowing carbon credits to be rated based on their biodiversity impact (e.g., an A to F rating). On the one hand, this will make it possible to value carbon projects that generate biodiversity gains, and, on the other hand, it could contribute to quickly provide concrete use cases for the biodiversity mechanism. However, the quantification of carbon impacts should not be mandatory, to allow the development of new project types in which biodiversity is the main focus.

Methodological developments

The objective of the mechanism is to create a market of biodiversity certificates based on the delivery of biodiversity gains through actions on the field. Its development poses three main challenges:

- The first challenge is to **develop a methodology for the assessment of biodiversity gains of field action.** The methodology should be robust enough to allow the proper quantification of biodiversity gains and thus create trust in the value of the certificates, while being adapted to the field project's context and applicable at a moderate operational cost. This implies defining a "standard unit" and designing an approach for valuing biodiversity gains in this "standard unit". This is the focus of section I.

- The second challenge is to **design a certification process** for the generation of biodiversity certificates. Again, it should be robust enough to create trust, while maintaining moderate complexity and operational costs. This is the focus of section II.

- The third challenge is the **definition of the market framework for the trade and use of certificates.** It should again ensure the reliability of the general mechanism but also promote a rigorous and ambitious vision of biodiversity action overall, beyond the initiatives financed under the mechanism, while remaining attractive to organizations. This implies framing the definition of biodiversity certificates and associated claims as well as their integration in the biodiversity strategies of organizations and defining market rules for the trade of certificates. This is the focus of section III.

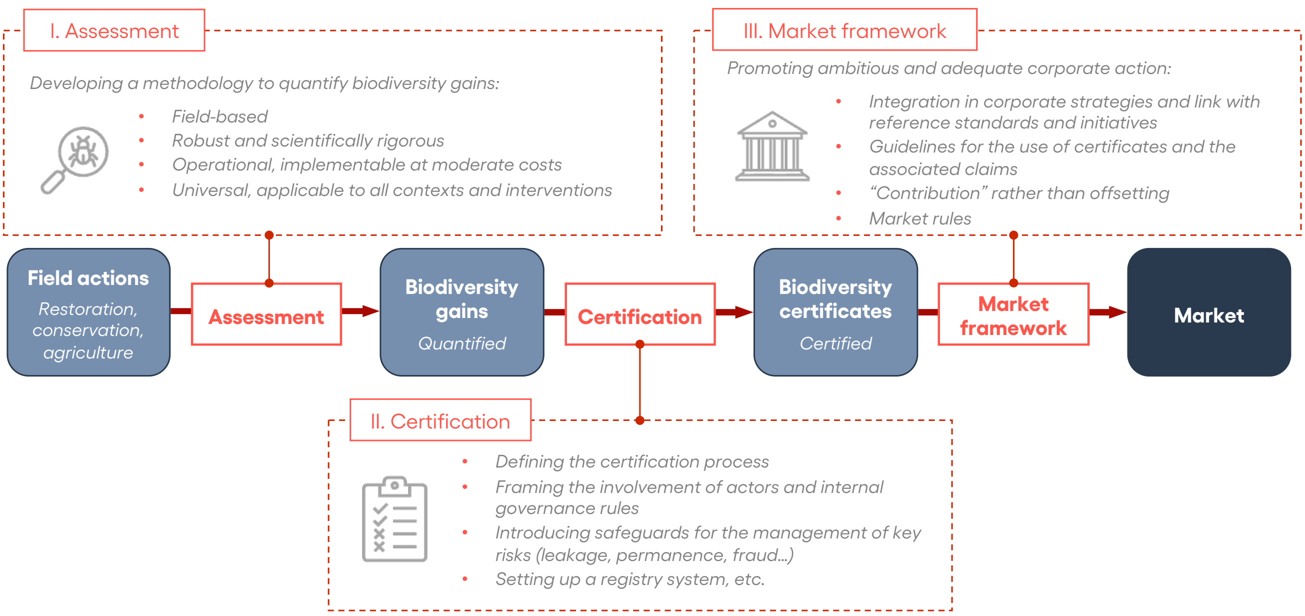

Figure 2: Three main challenges for the development of the biodiversity certificates mechanism

I - Assessment: quantifying biodiversity gains

To determine the number of certificates that will be generated by a given initiative, it is necessary to **develop a methodology for the quantification of biodiversity gains. This is the main challenge designing a global finance mechanism, and its cornerstone.**

To support such a mechanism, the methodology should notably fulfill the three following criteria. First, the methodology should be **robust and accurate** enough, so that the volume of generated certificates properly reflects the real biodiversity gains. It should also be **operational,** i.e. implementable on the field at a moderate cost and ensure that most of the funding effectively goes to the restoration and preservation of ecosystems. Finally, it should be as **universal** as possible, so that it can be applied to a wide variety of ecosystems and initiatives.

Commissioned by the OBC, and in collaboration with the founding members of the organization, Carbone 4 and the Museum National d'Histoire Naturelle have worked on the development of such a methodology, which we have entitled "Biodiversity Index Assessment Method" (BIAM).

As stated in the introduction, it should be noted that **the proposed version is not finalized,** and this for two reasons. First, what is proposed is a **global approach**, and developments are missing to make it fully operational. Some aspects have been explored in depth, some others have voluntarily been left open until further developments. Secondly, the elements presented are **not definitively settled**: one of the objectives for this publication is to collect feedback from the international community of experts, and to revise this first methodological proposition accordingly.

The proposed approach will have to be tested, first by developing biodiversity assessment methodologies for some selected contexts (or "ecosystem types", see definition in section I.2), then by testing the developed methodology on the field.

Importantly, **we do not consider that the presented approach is the only one that would be suitable for such a mechanism.** Other complementary or alternative approaches could fit the requirements of the biodiversity certificates mechanism. Moreover, it seems to us that it is preferable that several methodologies be developed in parallel so that several possibilities, potentially complementary, can be tested.

If no satisfactory method is found for a quantitative assessment of biodiversity gains, other approaches will have to be considered to frame the financing of biodiversity action on the field, for example qualitative approaches.

I-1 Context

A strong demand for a standard method

There is **a strong demand for a standard method of evaluating the positive effects of actions deemed to be favorable to biodiversity,** particularly from economic actors wishing to certify their actions or the effect of the funding dedicated to these actions.

We focus here on actions carried out in **explicitly delimited areas** and on the effects on the biodiversity of these areas. These actions can consist of habitat restoration (change of use), changes in agricultural or forestry practices, maintenance of conservation practices allowing the conservation of a socio-ecosystem, i.e. an ecosystem modified by anthropic activities (e.g. limestone grassland kept open by grazing).

The method must make it possible to **characterize the magnitude of the effects on biodiversity,** allowing as much as possible to compare different actions between them for one type of environment, and between different types of environments (common unit), anywhere on land or at sea. It must allow for an ***ex-ante* evaluation** (a given action should lead to a given gain in biodiversity) and an ***ex-post* evaluation** (actions favorable to biodiversity have been implemented and the positive gains can be verified).

Existing evaluation methods

Several quantitative methods have been developed to assess the negative impacts of an economic activity and are based on a gradient of degradation from an “undisturbed” ecosystem to a totally artificial area and aim to assess the level of degradation achieved, or to be achieved, along this axis (e.g. MSA[5], and assessment methods based on it such as the GBS[6]). These methods seek to estimate the proportion of nature destroyed by considering only the negative impacts of human activities. We note that the only positive action for biodiversity that fits perfectly on this gradient is "free evolution" (eliminating all uses and practices and letting nature take over). Other actions considered here may consist of changing (or maintaining) a socio-ecosystem, i.e. keeping the existing ecosystem out of or away from (at least temporarily) a trajectory towards an “undisturbed” ecosystem (in particular, this may result in socio-ecosystems that are radically different from the reference ecosystem and yet sometimes rich in biodiversity). This leads us to postulate that it must be possible to evaluate "biodiversity gains" (i.e. an improvement compared to an initial state) relative to a "reference state" which is not the intact state. **That said, we keep in mind the usefulness of a metric for measuring the biodiversity of a given place between 0 (no biodiversity) and 1 (“undisturbed” ecosystem),** assuming that no socio-ecosystem can exceed this value of 1, following the example of the MSA.

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[5] Mean Species Abundance (MSA), originally developed to evaluate terrestrial biodiversity in GLOBIO models (*Alkemade et al. 2009*)
[6] Global Biodiversity Score, developed by CDC Biodiversité

The 5 pressures of IPBES

The assessment often uses the IPBES conceptual framework and, in particular, identifies **the five major pressures** (Land use change; pollution; exploitation; climate change; invasive species). Analyzing local actions favorable to biodiversity under this prism leads to the identification of two major families of effects: diffuse effects and localized effects on biodiversity. **Diffuse effects** (e.g. atmospheric pollution, greenhouse gases) are measured by their statistical contribution to pressures on a much larger scale than that of the action (e.g. global for greenhouse gases). **Localized effects** are directly attributable to the action under consideration, including at a certain distance from the action under consideration when the effects affect the circulation of organisms (connectivity) or are conveyed in a traceable manner by flows (e.g. restoration of a catchment area that improves the quality of the water downstream). The assessment of these two types of effects requires very different methods. **Here we seek to assess only locatable and attributable effects.**

Towards the notion of biodiversity carrying capacity

Most assessment methods come up against the problem of measuring biodiversity *in situ*. In general, we do not know how to measure biodiversity satisfactorily, because of its complexity. However, **most experts tell us that they know,** for a given location, which **actions are favorable to biodiversity.** We propose to **quantify the expected gain from these actions based on the consensus between experts** (see section I.3).

We also propose not to consider biodiversity as such, but the **Biodiversity Carrying Capacity (BCC)** of a given area, which is the capacity of the ecosystem to host and support species. This is implicitly what is meant when one says, "this action at this location is favorable to biodiversity", i.e. a notion based on experience and intuition that integrates the different dimensions of biodiversity without needing to make them explicit.

The relevance and robustness of this notion for the evaluation of biodiversity gains will have to be assessed and validated, particularly with regard to the strength of the consensus between different experts in attributing the same BCC gain to an action.

I-2 Overview of the Biodiversity Index Assessment Method (BIAM)

We call **Biodiversity Index Assessment Method (BIAM)** our proposed approach for the evaluation of the biodiversity carrying capacity (BCC) of a given ecosystem, expressed in a standardized unit, namely the **Biodiversity Index (BI).** The development of the BIAM is based on bringing out a scientific consensus.

The first step of the approach is to define categories of ecosystems, **"ecosystem types"**, which are considered to be sufficiently homogeneous to allow, at first, the same approach to be applied to assess their biodiversity carrying capacity (see section I.3.1). For an ecosystem type, a **group of experts** is formed, i.e. individuals with established and recognized knowledge of biodiversity in the ecosystem type in question. They are typically scientific ecologists, naturalists, or local (including native) field experts.

For a given ecosystem type, the first step is to identify **a set of parameters that are the main determinants of the biodiversity carrying capacity**. These parameters can be **practices** (e.g., pesticide use in agriculture, undergrowth management in a forest) or **ecosystem characteristics** (e.g., species diversity in a forest), but should always be assessable or measurable with a reasonable complexity.

To define those parameters, the coordinators of the methodological development compile an initial list from a review of the scientific literature, before soliciting the group of experts (through a participative protocol, see I.3.3) to review, correct and validate the list of parameters.

The next step is the construction of a **rule for assessing the biodiversity carrying capacity based on the value of these parameters**. It is based on contributions from the group of experts, that is solicited using the following **participatory protocol** (further presented in section I.3.3):

1. The **assumptions** underlying the proposed method for assessing carrying capacity are presented, including the ones regarding the definition of the reference unit for the biodiversity assessment, the Biodiversity Index (or BI, an indicator of biodiversity carrying capacity – see definition in section I.3.4)

2. **Each expert is presented with a series of "situations"** - which are possible states of the given ecosystem type, characterized by these parameters

3. They are asked to prioritize them in terms of biodiversity carrying capacity, to which they **assign a value of BI between 0 and 1** - in accordance with the underlying assumptions presented

The data generated is then **processed to derive a rule of correspondence** between a change in these parameters and a gain in biodiversity carrying capacity.

This evaluation rule can be **used directly** to provide an evaluation of the biodiversity carrying capacity using a set of parameter values and to monitor it over time. It can also be used to derive an **evaluation grid** that will directly provide the biodiversity gains associated with certain changes in practice.

The method can thus be used to make ***ex-ante*** **projections**, but also to make ***ex-post*** **evaluations** (see section II). The verifications then concern **the results on the evolution of the parameters:** changes in practices, changes in the characteristics of the environment.

If necessary, the value obtained can be refined by considering certain **local specificities** (see section I.4).

For a given type of ecosystem, the method allows for the rapid production of a first version, which will then be refined over time, notably through the integration of additional participations, and through the progressive integration of field data (see section 1.4).

I-3 The BIAM core methods per ecosystem type

In this section, we present the “core method” of our proposed approach, which enables a first assessment of the Biodiversity Index (BI). This first evaluation may be later refined as presented in section I.4, but it will be the main driver of the final value of the BI.

I-3.1 Framework of the BIAM core method

Definition of ecosystem type

Ecosystem types are *categories* within which ecosystems are considered to be homogenous enough so that the biodiversity carrying capacity may be, in first order[7], **evaluated with one single method.** Those *categories* should be specific enough to enable the design of a method that assesses carrying capacity with enough accuracy, but general enough so that the total number of methods to develop to cover most of the ecosystem restoration and conservation projects is reasonable. The ecosystem types will be an intersection between:

- **A biogeographical category[8].**
- **A category of land use** (eg. grassland, forest, annual crop, perennial crop, etc).

The categorization should create from a few dozen to a few hundred use cases, which is significant. However, **it is likely that a limited fraction of the total number of ecosystem types would allow to cover the greater share of projects.** Furthermore, the protocol for the development of the assessment method per ecosystem type makes it possible to develop them in a **decentralized** way, thus enabling several methods to be developed in parallel once the global framework will have been settled.

The categorization per ecosystem types will be further explored and specified in a later publication. For the following sections, we assume that a satisfying ecosystem type

[7] The assessment will be refined in another step to take into account the diversity within one single category, see section I.3
[8] For example: ecoregions in Europe

categorization has been performed and present the approach for assessing the biodiversity index for a given ecosystem type.

Core method for the evaluation of the biodiversity Index

For a given ecosystem type, the core method provides a first assessment of the Biodiversity Index (BI, see definition in section I.3.4) considering the main drivers of biodiversity carrying capacity. It is constituted of the three following elements.

1. **A set of parameters, identified as the main drivers of the biodiversity carrying capacity in the corresponding ecosystem type**

These parameters can be either **ecosystem characteristics** (evaluated through direct field measures or remote-sensing approaches) if adapted and feasible (ex. biomass density), or a characterization of an **anthropogenic practices** (ex. Intensity of pesticide use).

The list of parameters is first determined based on a **review of literature,** and then **reviewed and validated by experts** of the corresponding ecosystem type, as presented in section I.4.3.

The number of selected parameters may vary according to the ecosystem type but will typically be between 5 and 20.

2. **An evaluation for each parameter**

Parameters that are ecosystem characteristics are associated with a **measurable** indicator (ex. Biomass density in tdm/ha[9]).

Parameters that are anthropogenic practices are characterized **within a defined scale** (ex. Intensity of pesticide use rated from 0 to 5, where each rank is defined by a quantity of active substance per hectare)

Some evaluations may involve locally defined reference thresholds[10].

3. **A calculation rule, that establishes the correspondence between the evaluation on each parameter and the BI value of the evaluated area**

This calculation rule reflects **the relative weights and correlations between the different parameters.**

[9] Tons of dry matter per hectare
[10] The rating method is defined globally for each ecosystem type; however, it may involve the use of reference levels that are set locally to account for internal variability within ecosystem types. For example, biomass density (in tdm/ha) would be compared to the local maximum of biomass density, that may vary significantly within a given ecosystem type

The application of this core method outputs a $BI_{(1)}$ value. This $BI_{(1)}$ will be turned into the final BI value after additional refinements to take into account local specificities and additional factors of biodiversity carrying capacity that were not included in the core method, as presented in section I.4.2.

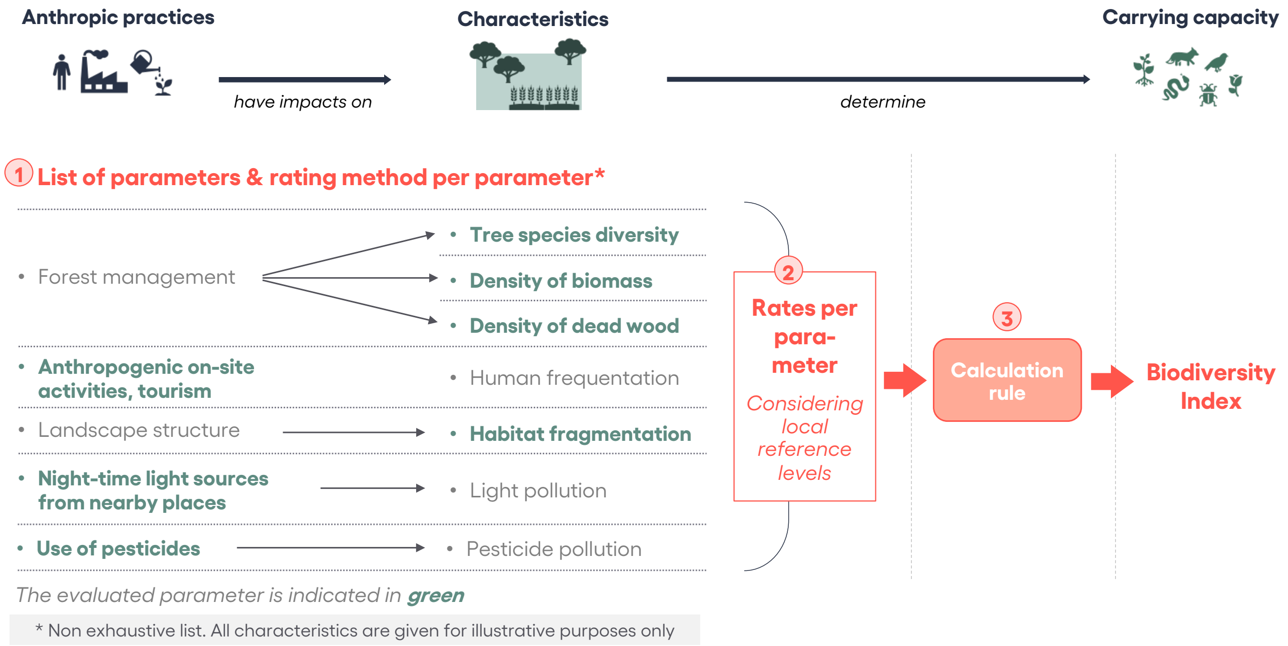


Figure 3: illustration of the approach of the BIAM core method per ecosystem type

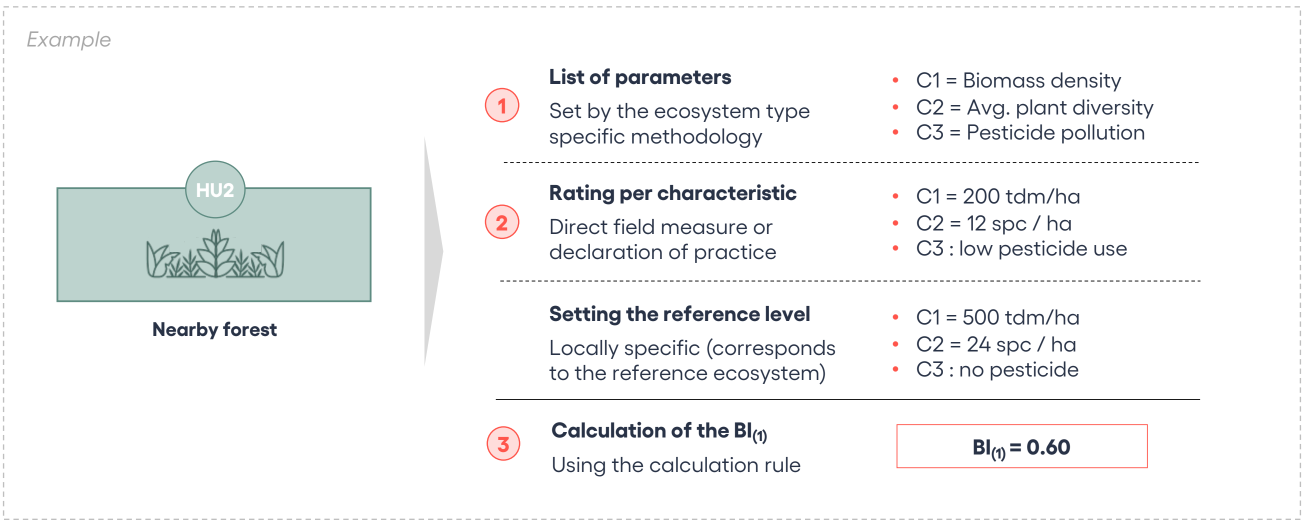


Figure 4: example with three parameters for a tropical forest – for illustrative purposes only

I-3.2 Bringing out a scientific consensus

To apply this framework, the key challenges lie in the **definition of the parameters** and, most importantly, of **the calculation rule**. The approach for this is presented in the following two sections.

These points **are difficult to address with a theoretical approach.** The biodiversity carrying capacity has been studied by research, but generally with an approach from which we cannot derive the kind of assessment that we are looking forward to developing. For this reason, **it does not seem possible to calibrate the assessment method only based on a literature review.**

We propose to adopt another approach to build the BIAM core methods, which aims to **bring out a scientific consensus**. In this approach, the elements of the assessment methodologies are defined and calibrated via a **participative process involving scientific experts.** This process would be centralized on a platform and overviewed by scientific coordinators, as explained below.

The approach would be designed to converge towards biodiversity assessment methods that **synthesize the scientific community's knowledge on the subject**. Thus, the objective would not be to reach theoretical perfection – which is probably impossible when evaluating biodiversity – but to **reflect as loyally as possible the view of the scientific community** on the quantification of biodiversity gains associated with a transition from a given state of the habitat to another.

Also, while the ultimate objective is to cover all ecosystem types worldwide, ecosystem type-specific methodologies will be developed progressively, starting with a few of the most frequent and requested cases.

I-3.3 Building BIAM core methods per ecosystem type through a scientific participative protocol

The proposal below is a possible implementation; many variants are possible, and it will be necessary to specify these choices at the effective start of the project.

We define a ***situation*** **as a possible state of the ecosystem** for the given ecosystem type, **characterized according to the defined set of parameters.**

The key principle of the protocol is to ask a group of selected experts to **attribute a Biodiversity Index between 0 and 1 to a set of *situations***, which are different states of an ecosystem for the given ecosystem type, characterized by a set of parameters. Then, the produced dataset is **analyzed to derive a calculation rule** that establishes the BI value from the rank of each parameter.

The experts are **conservation and biodiversity experts** of the given ecosystem type (scientific ecologists, naturalists, local – potentially native – field experts). They register on a platform to describe their competence and experience, and consent. These data will be **largely public** to authenticate the process and avoid multiple accounts, though safeguards will be implemented to avoid potential pressures on the experts.

Experts are selected by the coordinators of the program, based on transparent expertise criteria. **The study is then presented to them in detail.** In particular, the **underlying assumptions** for the evaluation of the biodiversity index (see section I.3.4) are explained in detail, to guarantee the homogeneity of the contributions.

A first proposal of a set of parameters for the assessment of the biodiversity carrying capacity and evaluation system for each parameter was carried out upstream by the coordinators of the program, from a literature review (see section I.3.1). The experts are presented with the parameters and asked to provide feedback on the selection. **The list of parameters is adjusted following this review.**

A series of *situations* is presented to the selected experts, with a detailed description. For example, for a cropland series: conventional, conservation agriculture, organic; each time detailing: intercrop management, nature of inputs, hedge management, water management, etc. The presented set of situations may depend on the declared competences of the experts.

The expert must first **identify the situations** which, in their opinion, establish the **minimum and maximum BI value** of the selection, **and assign them a score between 0 and 1** – according to underlying assumptions that have been presented to them in a previous step (see section I.3.4). Then, they **order the other situations on a quantitative axis** (with possible tie), affecting for each a **value of biodiversity carrying capacity expressed in BI.** They can indicate their level of confidence for each choice (1 = low, 2 = medium, 3 = high), as well as comment on their choice and indicate references (comments, reference papers, level of confidence on the series they order).

The expert can also submit **new versions of existing situations** and order them. If these situations are sufficiently well described, relevant and different from the existing situations, they will be proposed for scoring to other experts. The expert may agree to be notified for the reviewing of new situations.

During the entire survey period (with a clearly announced closing date), the experts can access and modify the data they have produced (all previous versions are archived). Thus, some experts may want to take time to prepare their proposal or to modify it when new situations appear. During the survey period, the database is not visible to experts. The only visible information is the number of experts and submissions.

Once the survey is closed, **an average BI value associated with each situation will be computed from all the submissions.** It will be possible to identify non-consensual contributors and check the possible reasons for these discrepancies (too little competence, poor understanding, etc.) and take them into account in the calculation. Additionally, this will enable to identify the situations with the most variation between experts, indicating a certain degree of uncertainty associated with the BI value of the assessed situation. **This database will be opened very quickly** (only the link between the real identity of the experts and their own participation will be protected): the raw data; their "cleaning" if necessary; the calculations leading to a grid of BI values. The access modalities (free download, on demand access...) and the license of the data must be specified (for example, some uses may require paying a fee access to the data).

The survey produces a dataset of situations, characterized according to each parameter, and associated with an average BI value derived from the assessment of the experts. This dataset is then processed by the coordination team to **establish a calculation rule that will output a BI value from a rank on each parameter.** The processing may involve artificial intelligence algorithms, or other forms of statistical analysis, so that the calculation rule is a **proper generalization of the evaluations conducted by the experts** on the series of situations.

There is one such method per ecosystem type. For each, there is at least **one referent scientific coordinator** for the duration of the survey (referee of the different situations listed on the platform, for the initial and complementary lists). Its **integrity** must be particularly well established. The different situations proposed for classification can ideally be written by stakeholder representatives (asking them not to participate in the scoring), to be as close as possible to "field reality", and under the supervision of the scientific coordinator. The recruitment of experts is done in the usual way for this type of system, by means of top-down communication from the heads of networks at different levels (Europe, nations, regions, etc.) and a more horizontal redirection by the experts to their community. The platform can be multilingual (English and local language of experts). It can be progressively extended depending on the recruitment of animators dedicated to each ecosystem type.

In the cases, presented in the section I.3.4, where the reference ecosystem will differ from the “undisturbed” ecosystem, the **same approach will be used to characterize the reference ecosystem and define its Biodiversity Index value $BI_{(ref)}$.**

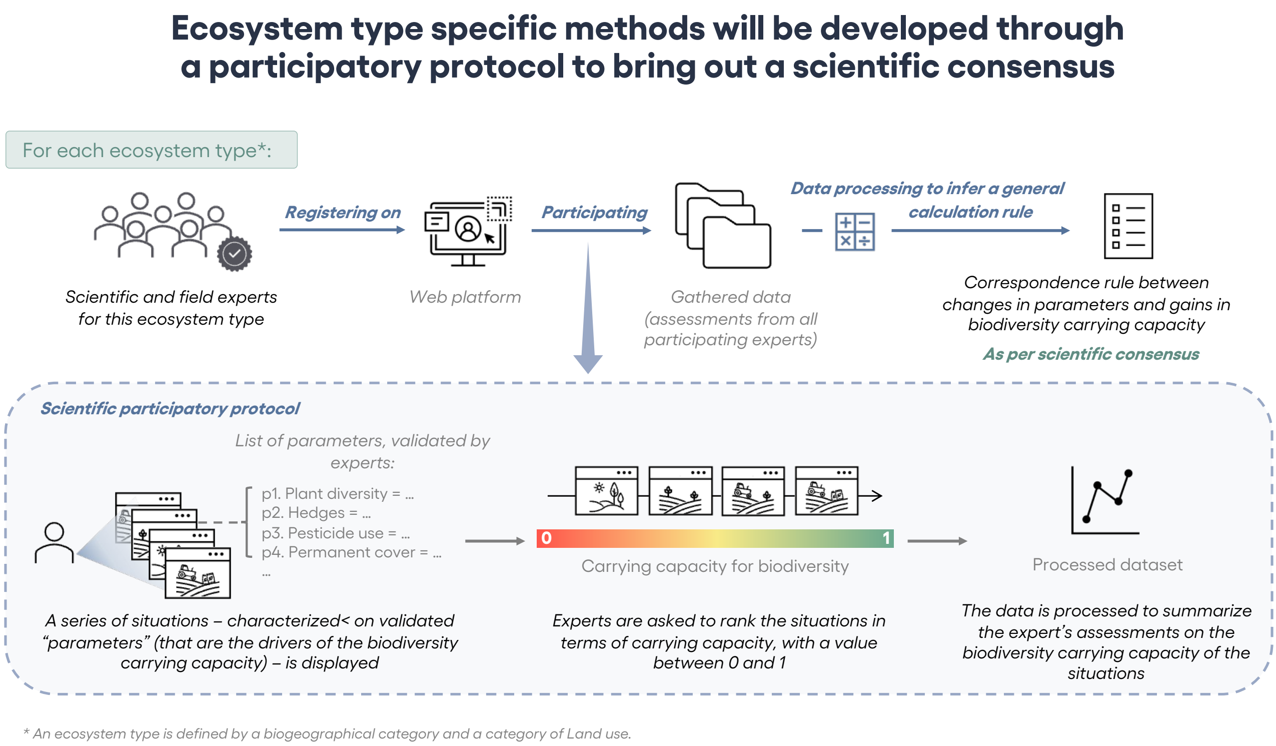


Figure 5: illustration of the scientific participatory protocol

I-3.4 Underlying assumptions for BI calculation

A biodiversity carrying capacity driven by a set of parameters

To evaluate the biodiversity carrying capacity, we assume that it can be **adequately described by a limited set of parameters.**

Some are **ecosystem characteristics**, i.e. tangible aspects of the ecosystem, and thus can be evaluated directly on the field. For example, in a forest, biomass density or tree species diversity, that can be assessed by conducting inventories on a sample of plots.
Others will reflect **anthropic practices**, i.e. human intervention on the area – such as its use (e.g. residential, agricultural, forestry, recreational, protected, etc.), management (tillage, management of plot edges, etc.), pressures (chemical pollution, hunting, etc.) as well as the history of these characteristics (how they have been linked in the past).

A quantification between 0 and 1: the Biodiversity Index (BI)

A given initial ecosystem can form, under the effect of human activities, different socio-ecosystems. We consider that these socio-ecosystems can be compared relatively to their biodiversity carrying capacity, and, therefore, that a value can be assigned to express this capacity.

We thus define a measurement unit, the Biodiversity Index (BI), ranging from 0 to 1. The BI value reflects the area's biodiversity carrying capacity relative to its level in an undisturbed state, i.e. without any anthropogenic pressure. This value is set to 0 in a state where biodiversity would have completely disappeared, and 1 in the state corresponding to the (potentially theoretical) absence of anthropogenic impact. This maximal value may not be exceeded.

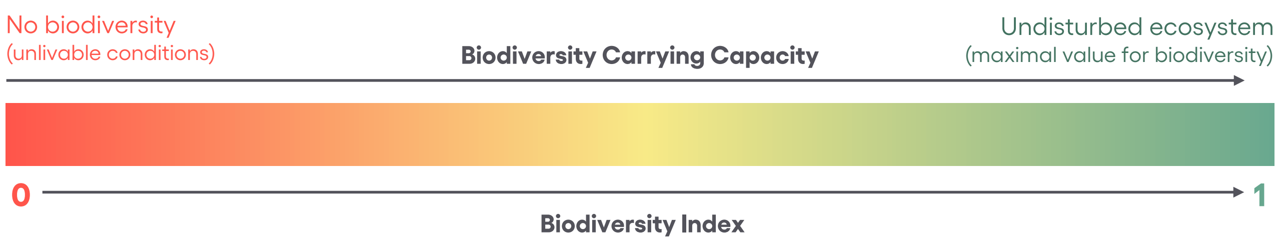


Figure 6: biodiversity carrying capacity and Biodiversity Index

The "undisturbed" state may be theoretical. First, their very existence is debated, as it seems that humans have had an influence on even the most remote ecosystems. Also, they may have entirely disappeared long ago – for example on most of the European continent.

Despite this inherent difficulty, we consider that using the "undisturbed" state as a theoretical reference for biodiversity remains relevant. Ecosystems are diverse and cannot be substituted, which is why it seems preferable, whenever possible, not to evaluate their capacity to host biodiversity in absolute terms. Instead, it appears more relevant to create a relative evaluation system, by comparing different states between each other[11]. This implies the definition of a maximum state; since it is now widely recognized that the driving causes for current biodiversity loss are anthropogenic activities, we consider this methodological choice as the most relevant. Further elements on the reference state are presented in the next sections.

Calculating the Biodiversity Index (BI): definition of the reference ecosystem

As introduced previously, the BI is defined relative to an "undisturbed" version of the ecosystem, which corresponds to a BI value of 1. However, **in practice, this "undisturbed" version may have disappeared long ago,** like it is the case in most of temperate Europe for example. Also, the nature of the ecosystem may have been so **deeply transformed** that we consider that **the "undisturbed" state does not constitute an adequate reference**. For example, in the case of a grassland that was established long ago in a former forested land and that will be maintained as grassland, we may want to compare it to "optimal grassland" rather than compare it to the original "undisturbed" forest, as some of the species that we want to see reinvesting the area are specific to grasslands and were not present in the original "undisturbed" forest.

Therefore, we propose to evaluate BI relative to a **"reference ecosystem", that may not be the "undisturbed" ecosystem and that is defined as follows.**

In regard to a specific area and its history and use, the reference ecosystem is defined as the ecosystem state with the highest biodiversity carrying capacity among the states:

1. which are of the **same category of land use** (forest, grassland, wetland, etc.)
2. and whose **characteristics,** on the parameters identified for the ecosystem type, **are known.**

In practice, that gives two cases for the definition of the reference ecosystem:

Case 1: reference = undisturbed

Whenever:

- The **characteristics of the "undisturbed" ecosystem are sufficiently** known to be used as a reference.
- And the **category of land use is the same** as in the evaluated ecosystem.

[11] As a result, all undisturbed natural ecosystems have a biodiversity index equal to 1: a desert, a savannah, and a forest, if not "deteriorated" by human activities, will have the same BI value.

Then the reference ecosystem is defined as the "undisturbed" ecosystem. This is the default case, and $\mathbf{BI_{(ref)} = BI_{(undisturbed)} = 1}$.

Case 2: reference ≠ undisturbed

If one of the two previous criteria is not met, **a reference ecosystem that is not the "undisturbed" state will be defined.**

It will correspond to the known ecosystem of same land use category that has the maximum biodiversity carrying capacity, according to the scientific community[12].

It may therefore **include species which were not present in the "undisturbed" ecosystem,** in particular when the category of land use is not the same as in the "undisturbed" state.

Among others, this case will cover all **agricultural ecosystems** as well as **grasslands established on former forest land,** whenever the land use category is maintained. However, in the case of a project that converts a grassland back into a forest in an area where we know the characteristics of the pristine forest, the "undisturbed" state will be used as a reference, as the biodiversity we want to assess corresponds to the forest land use category.

In this case, **the reference ecosystem is attributed with a biodiversity index value** $\mathbf{BI_{(ref)}}$**.**

Assignment of a $\mathbf{BI_{(ref)}}$ **when reference ≠ undisturbed**

The Biodiversity Index of the reference ecosystem ($BI_{(ref)}$) should correspond to **the ratio between its *gross* biodiversity carrying capacity and the one of the "*undisturbed*" ecosystem**. This is something that is difficult – if not impossible – to define theoretically, this is why we propose to define $BI_{(ref)}$ based on a scientific consensus, with the approach that is exposed in section I.3.3.

Furthermore, we consider that no anthropized state of an ecosystem should be considered of higher value than the "undisturbed" state, which imposes that $\mathbf{BI_{(ref)} \leq 1}$.

Following that principle $BI_{(ref)}$ will be equal:

- To 1, if the gross biodiversity carrying capacity of the reference ecosystem has been considered, following the scientific participative protocol, to be **equal or higher to the one of the "*undisturbed*" ecosystem.**

- To the evaluation, as per the scientific participative protocol, **of the ratio between the gross biodiversity carrying capacity of the reference ecosystem and the one of the "undisturbed" ecosystem,** if not. In this case $\mathbf{BI_{(ref)} < 1}$.

[12] The scientific consensus is determined through a participative process, as described in the section I.2.3

Note: to consider the effects of climate change, the definition of the reference ecosystem could also be adjusted to ensure that it still corresponds to the theoretical maximum state given the predicted evolution of the climate. This aspect will be explored in future developments.

Theoretical formula of the Biodiversity Index (BI)

It is important to note that the formula that will be presented is **theoretical**, and only defines the logic with which the BI evaluation should be performed, to ensure the homogeneity of contributions in the scientific participative process presented in section I.3.3. **It is not a formula which will be used in practice for the BI assessment. The** practical evaluation of the BI is based on an evaluation of practices and ecosystem characteristics, as described in the previous sections.

Once the reference ecosystem is identified, we define the BI as the sum of the relative carrying capacities for each species, for all species present in the reference ecosystem, and weighted by the Biodiversity Index value of the reference ecosystem. In other terms:

$$BI = BI_{(ref)} \times \frac{1}{N_{reference\ species}} \times \sum_{s=1}^{N_{reference\ species}} \min\left(\frac{CC_{observed}(s)}{CC_{reference}(s)}, 1\right)$$

<u>Where</u>:

- BI = Biodiversity Index
- $BI_{(ref)}$ = Biodiversity Index of the reference ecosystem
- $N_{reference\ species}$ = Total number of species in the reference ecosystem
- $CC_{observed}(s)$ = Carrying capacity of species s in the assessed ecosystem
- $CC_{reference}(s)$ = Carrying capacity of species s in the reference ecosystem

Overall, the BI metric is close to an expression, in terms of biodiversity carrying capacity, of the **Mean Species Abundance (MSA)[13].** The main difference lies in the definition of the reference ecosystem: while the MSA indicator systematically uses the "undisturbed" state of any ecosystem as its reference, the BI may rely on a different reference ecosystem.

[13] Mean Species Abundance (MSA), originally developed to evaluate terrestrial biodiversity in GLOBIO models (*Alkemade et al. 2009*)

Calculating the Biodiversity Index (BI): the target ecosystem and a few examples

Overall, the reference corresponds to the best (in terms of biodiversity carrying capacity) known possible state of the ecosystem for a given category of land use. **It does not necessarily coincide with the ecosystem which the restoration project aims to reach, which we can refer to as the "target ecosystem".** This target ecosystem is defined by the project, which may choose to maintain a biodiversity carrying capacity below the theoretical maximum, for example to maintain certain activities on the project area.

Example 1 – Full regeneration of a forest

The project takes place in a degraded forest, in a region where there are still existing patches of primary forest. The objective is to transform the project location into a conservation area, and to fully regenerate the degraded forest. In this case, **the reference ecosystem, the undisturbed ecosystem, and the target ecosystem coincide.**

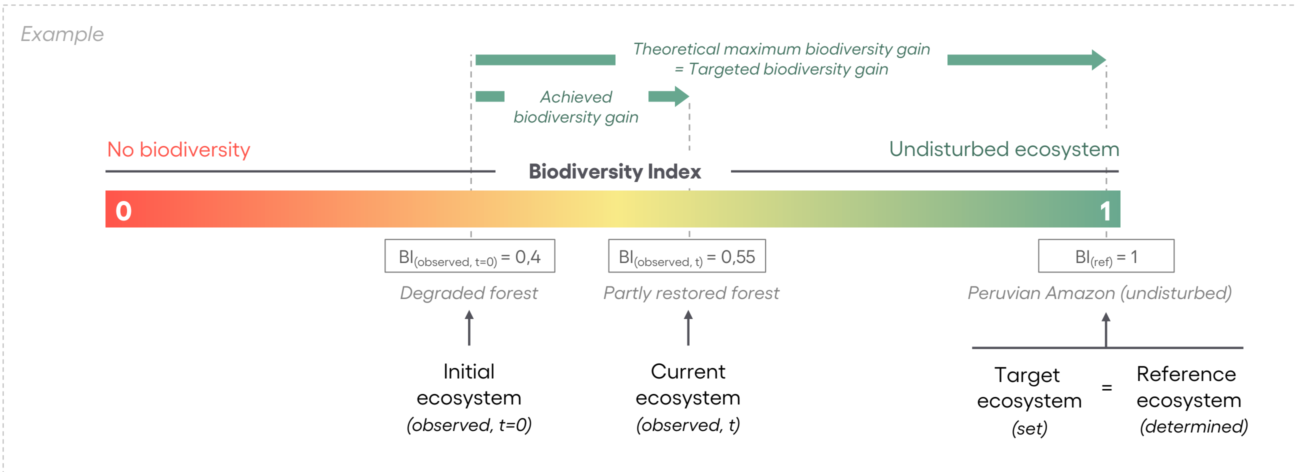


Figure 7: example 1 – full regeneration of a forest

Example 2 – Regeneration of a forest with maintained logging activities

The goal of the project is to improve local biodiversity of a forest plantation while maintaining logging activities, through an improvement of forest management practices. In this case, the **reference state corresponds to the "undisturbed" ecosystem** (primary forest), **but not the target ecosystem** which the project aims to reach (selective logging – best practices).

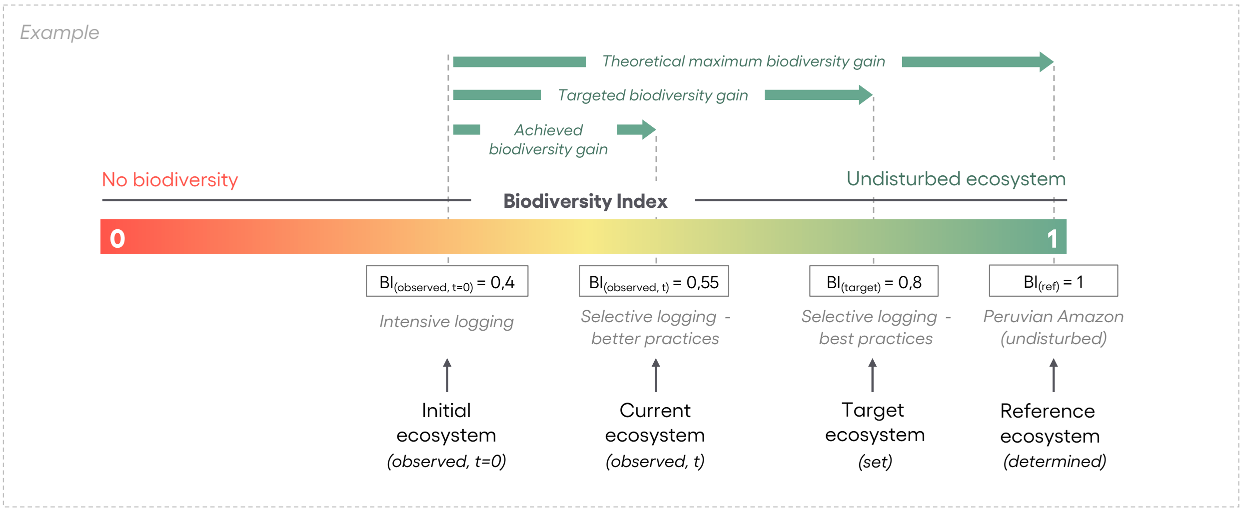


Figure 8: Example 2 – Regeneration of a forest with maintained logging activities

Example 3 – Improvement of a grassland

The initial ecosystem is a grassland whose biodiversity is sought to be increased, while maintaining this category of land use. **An "optimal grassland" state is defined by scientific consensus** and used as the **reference ecosystem,** and attributed with a $BI_{(ref)}$ value, through scientific consensus as well. In this case, some species present in the reference ecosystem and not in the "undisturbed" state are valued in the BI assessment. **The target ecosystem is this "optimal grassland".**

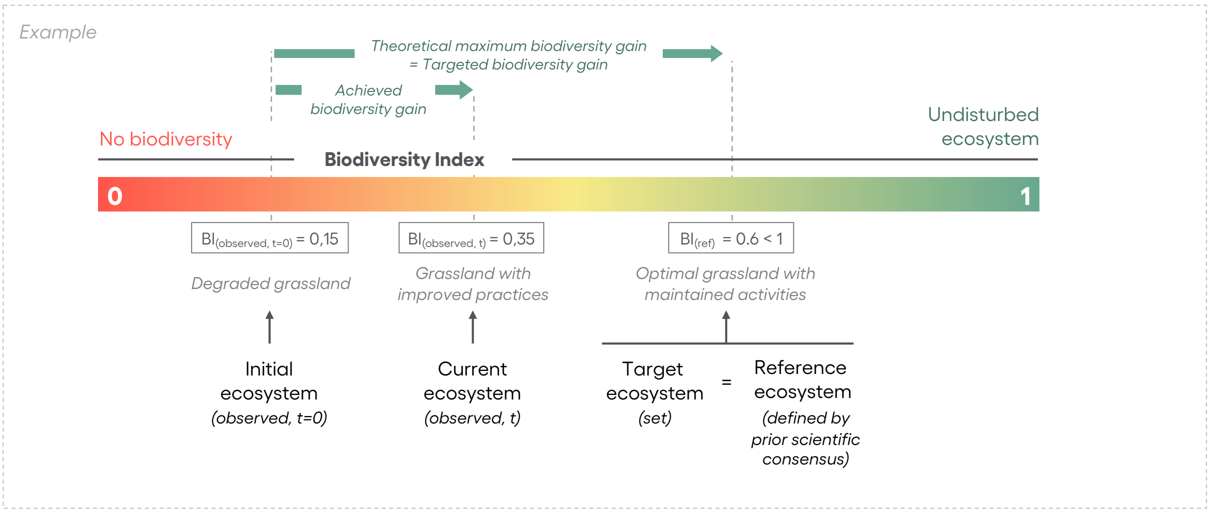


Figure 9: Example 3 – Improvement of a grassland

Example 4 – Reforestation of a cropland

This project consists in the transformation of a cropland into an old-growth forest, in an area where the primary forest has disappeared long ago. The initial value of the biodiversity index is evaluated using the **relevant cropland method,** including an “optimal cropland” reference ecosystem.

As the targeted land use category is a forest, the following Biodiversity Index assessments are performed using the relevant forest method. As the “undisturbed” state cannot be used as a reference, **an "optimal forest"** state is defined by scientific consensus to be used as the **reference ecosystem**, and attributed with **a $BI_{(ref)}$ value inferior or equal to 1,** through scientific consensus as well. **The target ecosystem is this “optimal forest”.**

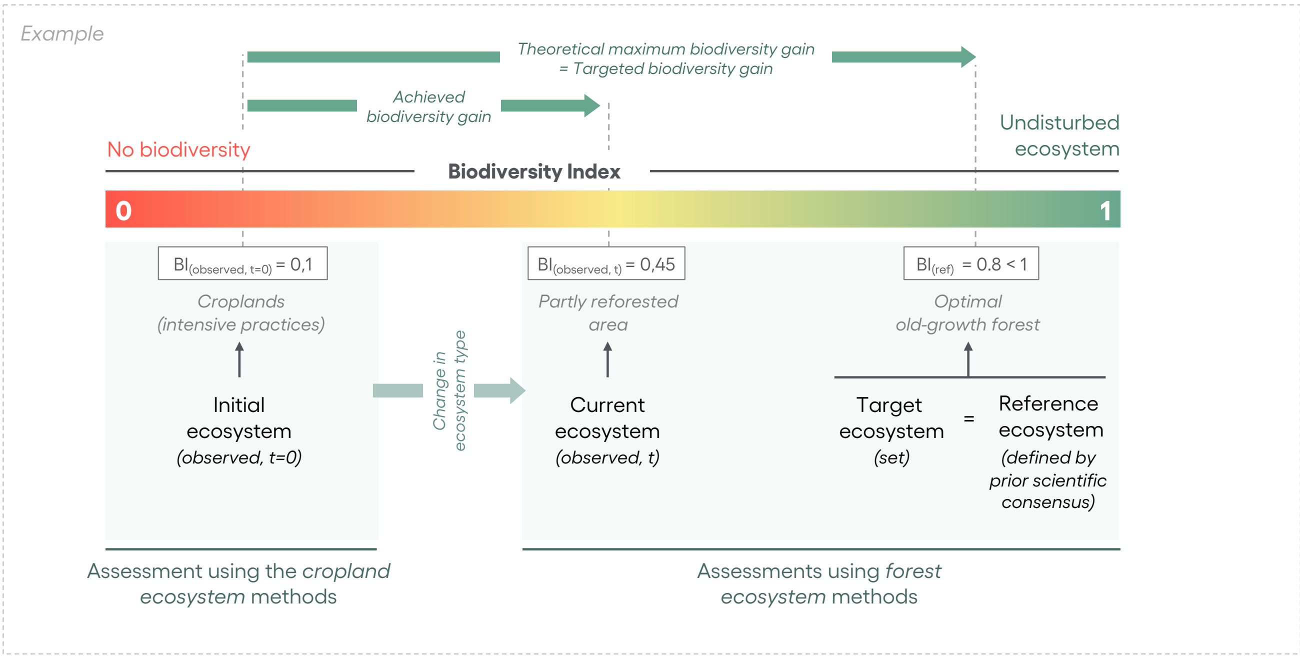


Figure 10: Example 4 – Reforestation of a cropland

I-4 Complements for the overall BI assessment

I-4.1 Upstream: Partition of the project into homogeneous units

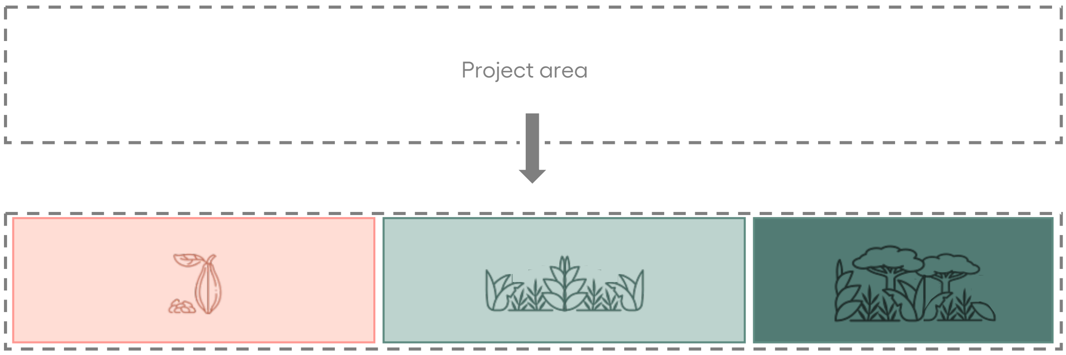
The BIAM core method allows to calculate the Biodiversity Index of delimited areas with homogeneous characteristics (i.e. same ecosystem type and homogenous values on the selected parameters for this ecosystem type). Consequently, **if the project area covers multiple subareas with different characteristics, it must be subdivided into homogeneous units beforehand.**

These homogeneous units (HUs) are defined relative to:

- **The ecosystem type**
- **The initial state**
- **The implemented actions and target state**

This prior partition into homogenous units is required to apply the BIAM core method.

See example below - *Agroforestry in the Peruvian Amazon*



Homogeneous units	1 Cocoa farming	2 Nearby forest	3 Distant forest
Ecosystem type	Perennial crop	Tropical wet forest	Tropical wet forest
Initial state	Full sun intensive	Managed forest	Old growth forest
Target state	Agroforestry	Improved management	Old growth forest (preservation)

Figure 11: Partition in homogenous units

I-4.2 Downstream: BI refining through the integration of other impacts and local specificities

This aspect needs to be further studied. The elements presented below are only general principles that will be reviewed and refined in further developments.

The BIAM objective is to be universal – i.e. to cover the widest possible range of ecosystems – while **taking into account the local specificities** of assessed ecosystems.

Ecosystems within a given ecosystem type share a set of common characteristics, but they still differ one from another. In some cases, local elements which are not considered in the core method may have a significant influence on biodiversity. Furthermore, some pressures like invasive species or hunting can have a significant impact on biodiversity while being potentially difficult to include in the general method per ecosystem type. **The biodiversity assessment method should be flexible enough to address these points and provide a dedicated space for the integration of locally specific elements.** In concrete terms, the $BI_{(1)}$ assessed with the BIAM core method would be refined by integrating local specificities and additional pressures that were not already covered.

For local specificities, the method could provide **general guidelines on how to include specific local characteristics of the habitat** in the BI assessment, such as the presence of **key species or of other remarkable ecological elements**. The nature of those local characteristics and associated rating methods would then be determined and calibrated during the first validation audit, with the **participation of an expert of the local ecosystem.**

For other pressures that were potentially not considered in the core method, the objective would be to **develop generic pressure-specific methods** for evaluating their relative impact on the biodiversity carrying capacity. Some pressures may be excluded due to the impossibility of developing a satisfying method.

This step could also be the opportunity to integrate some aspects relative to specific species, and in particular **to endangered or emblematic species,** and **to value traditional skills and practices of local communities** that are beneficial to biodiversity.

Overall, this step would lead to a refinement of the $BI_{(1)}$ assessed with the core method, providing the final BI value.

Figure 12: BI refining through the integration of other impacts and local specificities (illustrative)

Additional checks could be conducted as **safeguards to validate the assessment.**

I-4.3 Species based complementary assessment biodiversity

This aspect needs to be further studied. The elements presented below are only general principles that will be reviewed and refined in further developments.

Several technological methods have been emerging in recent years to measure biodiversity, such as bioacoustics or DNA analyses, and they may provide valuable information on the presence and abundance of living organisms. But because of their relatively high implementation costs and the variability of such measures – which could be too substantial for the measurements to be reliable on a project scale, especially on short timeframes as in audits –, we preferred a method based on the biodiversity carrying capacity for the "core" of our biodiversity assessment method.

Nevertheless, **those tools bring valuable possibilities for reinforcing the assessment methodology.** Implemented in some selected projects, they could generate datasets of field biodiversity measures that would then be analyzed to **refine and improve the BIAM methods.** They might also provide valuable complementary information in specific cases, to demon**strate the reality of biodiversity gains.**

I-4.4 Quantification of biodiversity gains

This aspect needs to be further studied. The elements presented below are only general principles that will be reviewed and refined in further developments.

Biodiversity certificates attest to the biodiversity gains, expressed in terms of biodiversity carrying capacity, which arose from the implemented biodiversity project.

At a time *t*, we can define the **biodiversity gains as the difference between the BI assessed at that time and the BI of the baseline** - that is the BI that would have been measured if the project had not been implemented, - multiplied by the surface area of the project.

But defining a baseline raises various concerns, as it relies on scenarios that cannot be verified. For restoration, agriculture and forestry projects, a possibility would be to **set the initial state as the baseline,** while setting additional criteria in the standard to **ensure the additionality** of the generated gains as well as the management of other significant risks.

However, for conservation projects (i.e. for the quantification of avoided degradation), assumptions about the ecosystem degradation rate would have to be made to quantify the biodiversity gains of the project.

Those aspects will be further explored in a later publication.

Biodiversity gain unit	BI value.km^2
Biodiversity gain calculation	$$\sum_{\text{Homogeneous units}} \left(\underbrace{\textbf{\textit{additional BI}}}_{= BI\ (t)\ -\ BI\ (baseline)} \times \textbf{\textit{surface area}}\right)$$

Figure 13: calculation of the biodiversity gains

I-5 Safeguards et corrective components

This aspect needs to be further studied. The elements presented below are only general principles that will be reviewed and refined in further developments.

To ensure the reliability of the results and prevent the excessive or contentious generation of certificates, the **implementation of appropriate safeguards is recommended.**

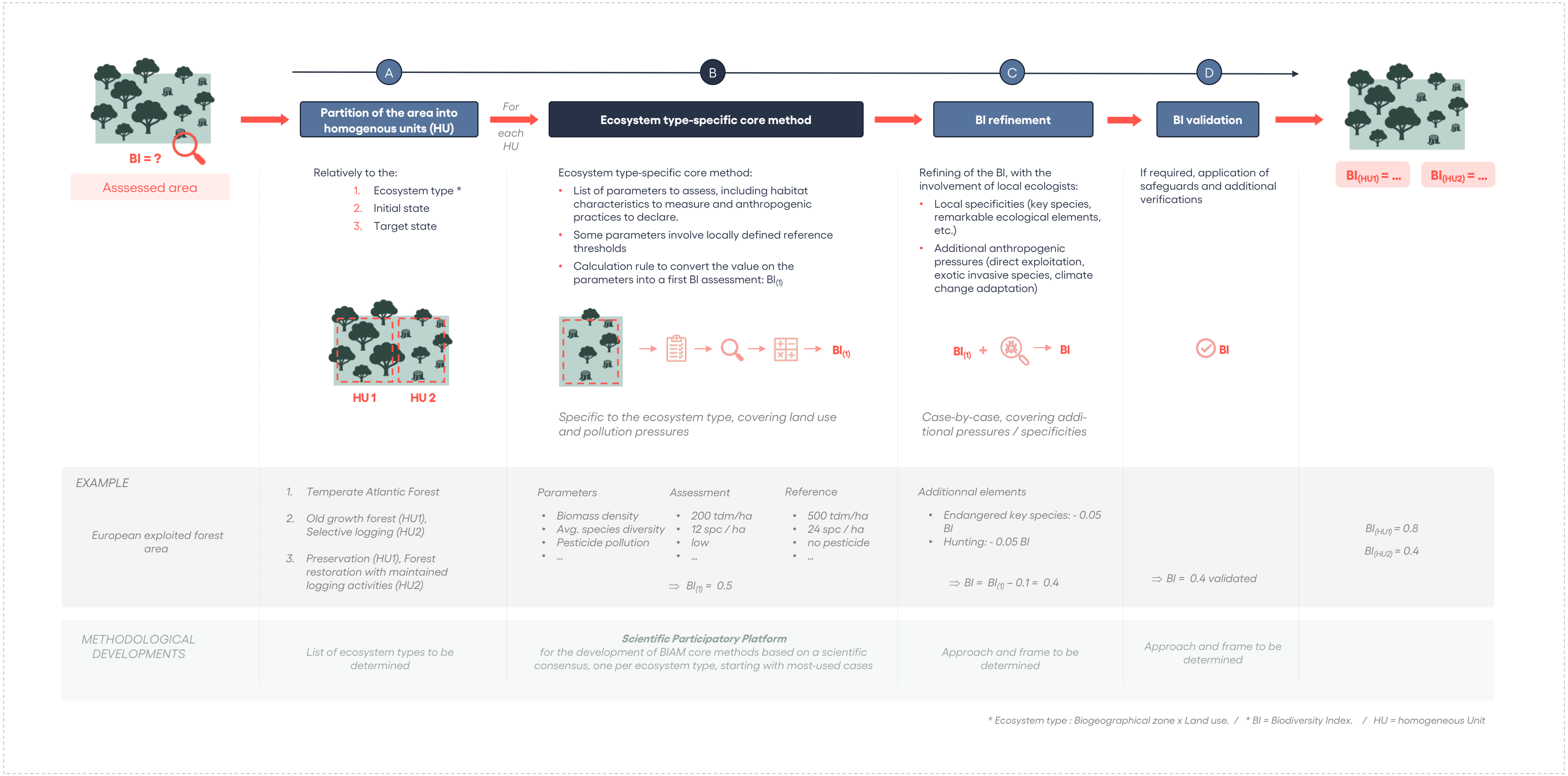


Figure 14: overview of the BIAM from a project's point of view

II – Certification: generation of certificates

To ensure the quality of certificates, we must define a **global standard** that goes beyond the quantification of biodiversity gains, and a **process of independent auditing** for the certificate generation. On those aspects, we overall recommend **seeking inspiration from the *best-in-class* carbon standards, while being careful to adapt them to the biodiversity context.**

Also, the development of the biodiversity certificates market could represent a good opportunity to explore what the **recent technologies** – specifically in the field of remote sensing and blockchain - **may bring to improve the efficiency and reliability of the certification process,** while lowering its costs. If so, the **environmental impact** of the use of such technologies should be carefully evaluated to ensure the overall relevance of including them in the process.

The following section presents general principles for the definition of a general standard, that will be refined in further developments.

II-1 A general standard

The biodiversity certificate mechanism needs to issue a **general standard that defines rules and requirements for a project to be certified and generate certificates.**

General eligibility criteria

As in the *best-in-class* carbon standards, it should include a set of **project management criteria** designed to make sure that **the project is viable and overall aligned with the mechanism's values.** In particular, the standard should include criteria regarding the project context, project duration, management and general framework, finance, transparency, respect of the legislation, social impact, and environmental impact beyond biodiversity.

For this category, we overall recommend seeking inspiration from the *best-in-class* carbon standards, while being careful to adapt them to the biodiversity context.

Management of key risks

Furthermore, as for carbon credits, biodiversity projects come with a wide range of **possible risks and biases in the assessment of biodiversity gains**: negative project impacts, non-additionality or non-permanence of biodiversity changes, leakage, misevaluation, etc.

To address these elements, **an additional set of rules and requirements should be included in the standard,** impacting when relevant the volume of certificates that will be delivered. For example, to address the risk of non-permanence, part of the generated certificates could be placed in a reserve (or "buffer") to be released in case of an event affecting the biodiversity gains generated in the past.

For this category, we overall recommend seeking inspiration from the *best-in-class* carbon standards, while being careful to adapt them to the biodiversity context.

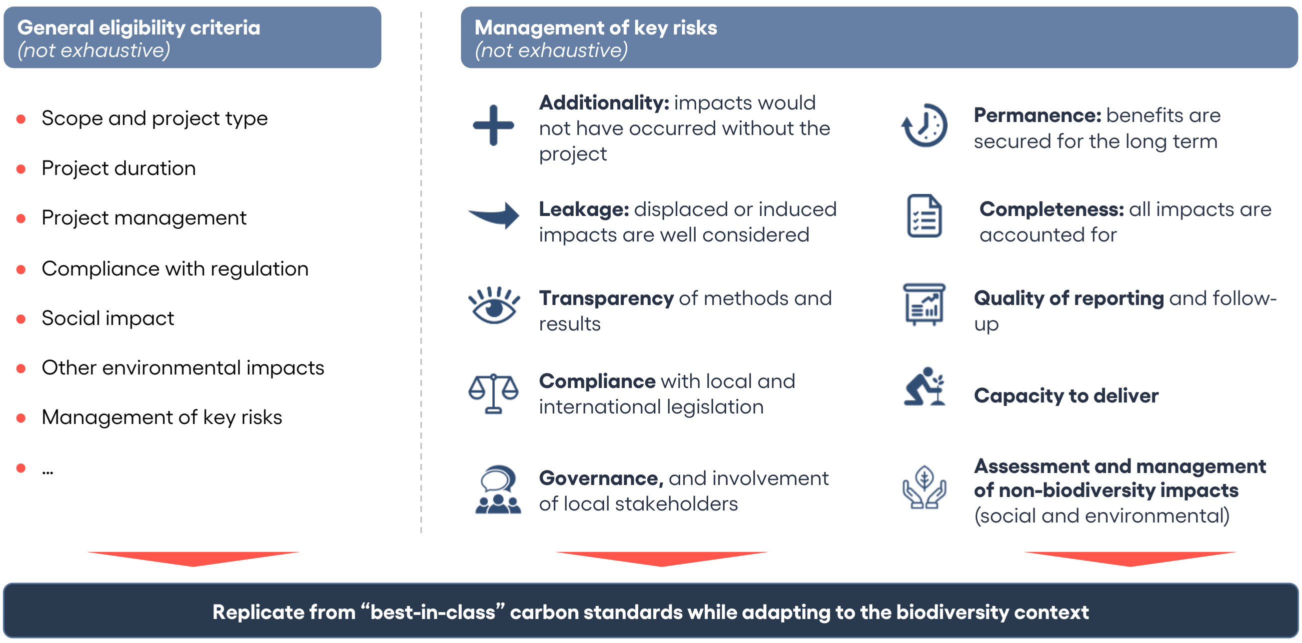


Figure 15: criteria for the general standards (illustrative)

Contribution criteria – alignment with local or global biodiversity strategies

In addition, as part as the contribution approach, we recommend including an **evaluation of the level of alignment of the project with the reference collective biodiversity plans,** as presented in the section III.2.

Projects would need to be above a minimum threshold to be validated. The results of the assessment could be publicly available, to value the projects that are the most aligned with the global vision for biodiversity.

II-2 Independent auditing

To ensure they are compliant with the standard, **all projects should be audited by accredited independent third parties.** The qualification of the auditors, and in particular their knowledge of the general standard and the Biodiversity Index Assessment Method (BIAM), should be well established.

As for the main carbon standards, we recommend a two steps process for the generation of certificates.

First, **a validation audit** to validate the general compliance of the project with the standard, the methodologies that will be employed, as well as the initial biodiversity assessment performed in the project area.

Then, **verification audits to be conducted periodically** (typically every 5 years, with possible adaptations depending on the project type) to **assess the biodiversity gains,** and thus determine the **number of certificates that will be generated.** The biodiversity gains assessment will be based on the Biodiversity Impact Assessment Method presented in section I. The verification audits will also verify the project continued compliance with the standard, and the correct management of key risks.

While independent auditing is an essential element to ensure the robustness of the mechanism, **the aim should be to minimize its overall weight in the process** so that the greater part of the effort and resources are allocated to generating biodiversity gains on the field.

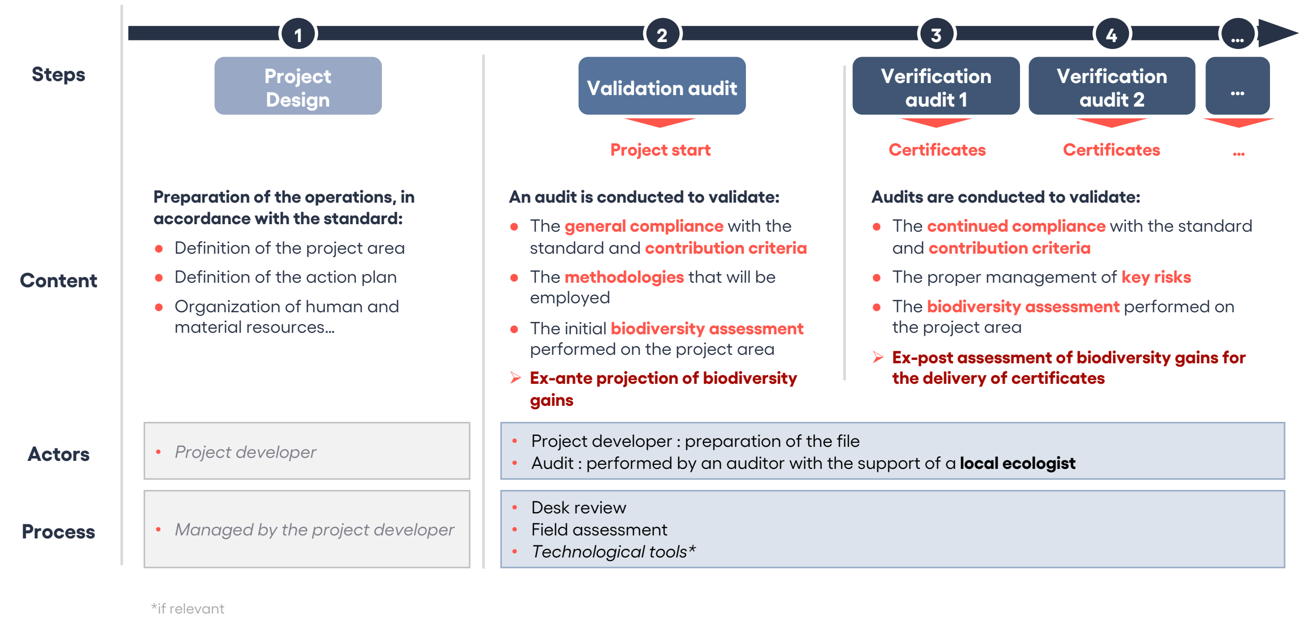
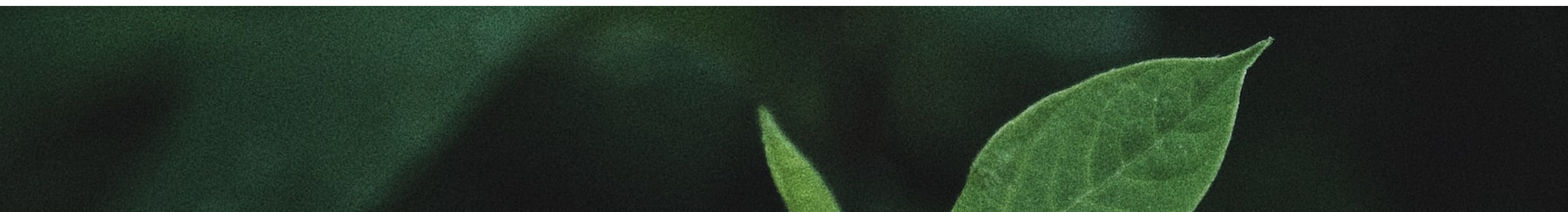


Figure 16: certification process (illustrative)



III - Market: Use and trade of certificates

III-1 Introduction

Some of the risks related to the introduction of a biodiversity certificates mechanism are not related to the **intrinsic quality of the certificates** generated, i.e. the method of quantifying the biodiversity gains, **but rather to the potentially indirect effects that they could have more globally on the biodiversity action of organizations in general.** For example, the voluntary carbon market has been criticized for the fact that the purchase of offset credits may, in some cases, have been to the detriment of emission reductions by companies, which is essential and a priority in order to achieve collective neutrality. This is an effect that is independent of the quality of the projects or the impact measurement methodologies and is essentially due to the way in which the credits were used by the companies.

Just as participation in the voluntary carbon market is far from being the only modality for climate action, **the purchase of certificates is far from being the only modality for biodiversity action.** Thus, in order to develop a virtuous biodiversity certificate mechanism, it is not enough to develop a robust quantification methodology; it is also necessary to work to **ensure that the purchase of certificates is articulated with other commitments, and is part of a *solid* overall approach to biodiversity action.** Each of these two elements is essential, and we recommend that they are worked on together to guarantee the quality of the mechanism.

In addition, we must also consider how the certificates will be **issued and traded**, and the role of the various intermediaries in the market.

These two points are the subject of the following section.

III-2 Use of certificates: a contribution approach

III-2.1 A global strategy for biodiversity

A certificate scheme will not determine the overall biodiversity action of its stakeholders, but it can prevent some bad practices through the way it defines its certificates and regulates their use and the claims associated with them. It can also more generally promote good practices that go beyond the use of certificates.
This requires the mechanism to first position itself on **what a *solid* global action for biodiversity is,** and then define the place that certificates can occupy in it, and to define them accordingly.

To have an objective and scientific basis, we consider that the adequate approach to define **a *solid* global action for biodiversity is to do so in relation to collective action.** From this point of view, a *solid* action is one that, by its approach and its level of action, is **aligned with the global issues and objectives of the biodiversity transition, as set out by scientific literature and reference institutions,** local and/or international. The approach encompasses the **qualitative dimension,** i.e. the nature of the actions that are carried out, their prioritization and operational declination. The level of action encompasses the **quantitative dimension,** i.e. the quantified targets that are set for the various components.

This approach is for example that of the Science Based Target Network, which popularized the notion of science-based targets in the field of climate and is now also working on biodiversity. A first document for the definition of **Science Based Targets for Nature** was published in 2020 (initial guidance), and another publication is planned for early 2023. Actors who develop impact measurement indicators, such as **the CDC Biodiversité,** are also publishing on this topic. As for the global objectives for biodiversity, this is notably the content of the work of the **Convention on Biological Diversity (CBD),** which is preparing its post 2020 biodiversity framework, which should be presented at the COP15 in Montreal. Other institutions and initiatives are also working on these issues. **The certificate mechanism will have to coordinate with this work to fit into the vision they define.**

This topic will be further explored in upcoming publications.

III-2.2 Project categories based on their link with the supply chain

Even without the details of global biodiversity goals and strategies, or a standard definition of what constitutes a *solid* biodiversity action, it is already possible **to propose a vision of how the biodiversity certificates could be articulated** with these elements. To this end, and to reflect the fundamentally non-substitutable nature of the different ecosystems, we consider that it is useful to distinguish between different cases, depending on the position of the certificate issuing area in relation to the end-user value chain.

In the following, we assume that, for the organization retiring the certificates, **a scope of biodiversity footprint** has been defined, i.e. that there is a method allowing to assign a set of biodiversity impacts to the organization based on its activity. This method is not necessarily standard, and several indicators could correspond to it.

For example, CDC Biodiversité's Global Diversity Score (GBS) defines a scope of footprint inspired by the one defined for climate by the GHG Protocol, comprising 3 scopes:

- **Scope 1:** impacts generated within the perimeter controlled by the entity and other impacts directly caused by the entity during the assessment period.
- **Scope 2:** impacts resulting from the production of purchased non-fuel energy (electricity, steam, heat, and cooling), including impacts resulting from land use changes, fragmentation, etc.
- **Scope 3:** impacts resulting from the company's activities but from sources not owned or controlled by the company, upstream and downstream of its activities.

Thus, we can begin to distinguish two cases for the generation of certificates. Either they are generated **within its scope of footprint**, or they are generated **outside the scope of footprint.**

Footprint reduction

Certificates can be generated within an organization's scope of footprint. For example, in the case of a company that buys cocoa, the biodiversity impact of the cocoa production in its suppliers' parcels is generally accounted for in its footprint (e.g., in scope 3 upstream as defined by the GBS or GHG Protocol). However, the implementation of some footprint reduction actions within those parcels (e.g. conversion to agroforestry, reduction of chemical pollution) could be eligible for the generation of certificates.

In this case, **if the methodology for accounting for the biodiversity footprint is compatible with the methodology for evaluating biodiversity gains for the generation of certificates,** then it seems rigorous to consider that **these certificates can be considered as a footprint reduction.** For it is literally a matter of quantifying and verifying a reduction in the biodiversity footprint, as defined by the methodology in question. The certificates are then used to value actions in the field that have reduced the organization's impact on biodiversity.

Of course, **the generation of certificates is far from being the only way to generate or quantify footprint reductions,** nor even the main one in most cases. However, it can be used in cases where the footprint reduction is the result of field initiatives that are covered by the certificate mechanism, in an articulated way with the approach used for footprint measurement.

These certificates are not intended to be exchanged, except possibly between different actors in the same value chain (e.g. cocoa producer and cocoa buyer). In this case, they become a tool for formalizing, quantifying, and valuing the co-financing of actions to reduce the biodiversity footprint between different actors in the same value chain.

In the case where there is no exchange, it is also possible to consider that the assessment methodology could be used to quantify the positive effects and take them into account in the footprint calculation, but **without involving an external audit, and therefore without generating certificates.**

Overall, biodiversity impact assessment methodologies are mostly designed to be used in a "top-down" approach, based on aggregate data on an organization's activity. **The BIAM could complement these methodologies** by allowing the results to be refined when precise field data are available. In the long run, the results provided by BIAM could **enrich footprint assessment methodologies** by allowing them to model more finely the impact of changes in practices or land management that were not considered in the initial models - provided, of course, that the evaluation methodologies are compatible.

Contribution

In an **offsetting** approach, positive impacts generated anywhere can **« cancel out » negative impacts** generated in the scope of footprint. As presented in the introduction, **we consider that such an approach is not suitable for biodiversity, and recommend excluding the possibility of biodiversity offsets,** i.e. that funding an action outside the scope of an organization’s biodiversity footprint should not allow it to reduce its biodiversity footprint.

Instead, we recommend that the financing of actions for biodiversity should be part of a **contribution approach, where the individual action of organizations is valued as a participation in collective strategies for the preservation, restoration, and sustainable use of ecosystems.** Furthermore, to take into account the fundamentally local nature of the biodiversity issue, we recommend going further by distinguishing between two cases of contribution: **contribution on a local scale,** linked to the locations where the company is implanted, and **contribution on a global scale,** without any correlation with the locations where the company is located.

This contribution approach is presented in the following section.

III-2.3 Contribution: setting the approach and targets

In an offsetting approach, different categories of impacts are merged into a single indicator that is monitored alone for the management of the whole strategy.

In a contribution approach, different categories of actions are related to different indicators, which can be expressed in the same unit. These indicators are **driven separately:** each has its own **approach** - that is, its own logic for prioritizing the actions to be implemented - and its own **quantitative targets**, which define the level of ambition. These objectives and this approach are **defined in relation to collective strategies** that are the reference for the category of actions in question, and which are determined from **scientific literature by reference institutions.** Thus, in a contribution approach, **an organization contributes through its individual action to the collective action** and positions itself in relation to it. Its performance is defined by its **level of alignment** with the strategies in question.

In the vision that we propose for biodiversity, certificates enable action on **three categories of impact: footprint reduction, local contribution, and global contribution.**

Footprint reduction project

For footprint reduction, the logic is to target the organization's impacts and reduce them, and more broadly to **contribute to the transformation of the sector** by implementing practices that are favorable to biodiversity. These actions can also increase the **resilience** of activities by identifying **biodiversity dependencies** and **preserving the ecosystem services they rely on.**

The approach and objectives are defined in relation to **global biodiversity conservation objectives,** which are to be applied at the level of organizations and their footprint, for example by using the guidelines provided by the Science Based Target Network (SBTN). Sector-specific methods can be useful to define more precisely the right level of contribution, as well as the actions to prioritize. Preferably, these actions should be **coordinated with other actors** in the same sector who share the footprint.

Local contribution project

In the case of local contribution, certificates are generated **within a territorial unit that overlaps with the organization's footprint,** but outside of it. The territory is governed by a **territorial authority** (region, department, group of municipalities), which has developed a **biodiversity plan** defining priorities and targets for biodiversity action. Actors in the field can generate **local contribution certificates** by implementing **actions for biodiversity**, under the condition that they are **in line with this local biodiversity plan** – which is concretely translated into validation criteria, verified during the first audit of the project (see section II). An organization can **contribute to the territorial biodiversity plan** by purchasing these certificates, within a **local market developed in coordination with local authorities.** It can then **trade them with other local actors** through this same market.

In this impact category, the organization's objective is to **go beyond its footprint,** within which the potential for restoration and preservation may be limited, **while acting in line with its impacts,** as it acts on ecosystems on which it exerts local pressures (land use, direct pollution, etc.). The objective is also to **preserve the ecosystems on which the organization depends,** and therefore a certain number of **ecosystem services from which it benefits**, and to contribute to the **transition of the territory.**

The approach and objectives are defined **in relation to the global objectives of preserving biodiversity,** which are to be applied at the level of the organizations. They are also defined in relation to **local biodiversity plans and policies,** which define priority actions and the level of ambition in the territory in question.

These actions should be **coordinated with the local authorities** in charge of the biodiversity plan, to ensure that they are **in line with its policy**. The latter can also **play a role in the governance** of the mechanism, for example by taking on the supervision, by providing criteria for the validation of projects, or by having a right of review. It is also possible that they will take on a centralizing role, acting as an intermediary between actors who generate impacts on the territory and others who generate certificates.

Global contribution project

In the case of global contribution, the certificates are generated in areas that are not linked to the organization's value chain, and on which it does not exert pressure, except through its contribution to global pressures (climate change, global pollution, etc.). It receives global contribution certificates, which can be **traded globally.**

Reference institutions (e.g. IUCN, CBD, FAO[14]) have developed **global plans for biodiversity** that define priorities and targets. Actors in the field can generate **certificates** by implementing actions for biodiversity, under the condition that they are **in line with these global plans** - which is concretely translated by validation criteria, verified during the first audit of the project (see section II). An organization can **contribute to global biodiversity plans** by purchasing these certificates, within a global market developed **in coordination with the reference institutions**. It can then resell them to other actors through the same market.

For the global contribution, **the objective is to go beyond the local scale,** within which the potential for restoration and preservation may be limited. The objective is also to **preserve and restore ecosystems that are considered "priority" by reference institutions**, for example because of their specific richness (hotspots of biodiversity), their rarity or level of degradation, the strong dependence of human activities on these ecosystems, or the presence of emblematic or endangered species. Moreover, these ecosystems identified

[14] International Union for Conservation of Nature, Convention on Biological Diversity, Food and Agriculture Organization

as "priority" may be poorly connected to the value chains of organizations likely to take ambitious action for biodiversity.
The approach and objectives are defined in relation to global biodiversity preservation objectives, which are to be applied at the level of organizations for the overall contribution. Global biodiversity plans also define **priority actions.**

These actions should be **coordinated with the global reference institutions for biodiversity,** to ensure that they are in line with their vision. The latter can take a **role in the governance of** the mechanism, for example by assuming the supervision, by providing criteria for the validation of projects, or by having a right of review. It is also possible that they will take on a centralizing role, acting as an intermediary between certificates buyers and sellers.

In addition to (and separately from) the reduction of their own impacts, **companies can contribute to local or global biodiversity objectives by buying "contribution certificates" outside of their value chain.**

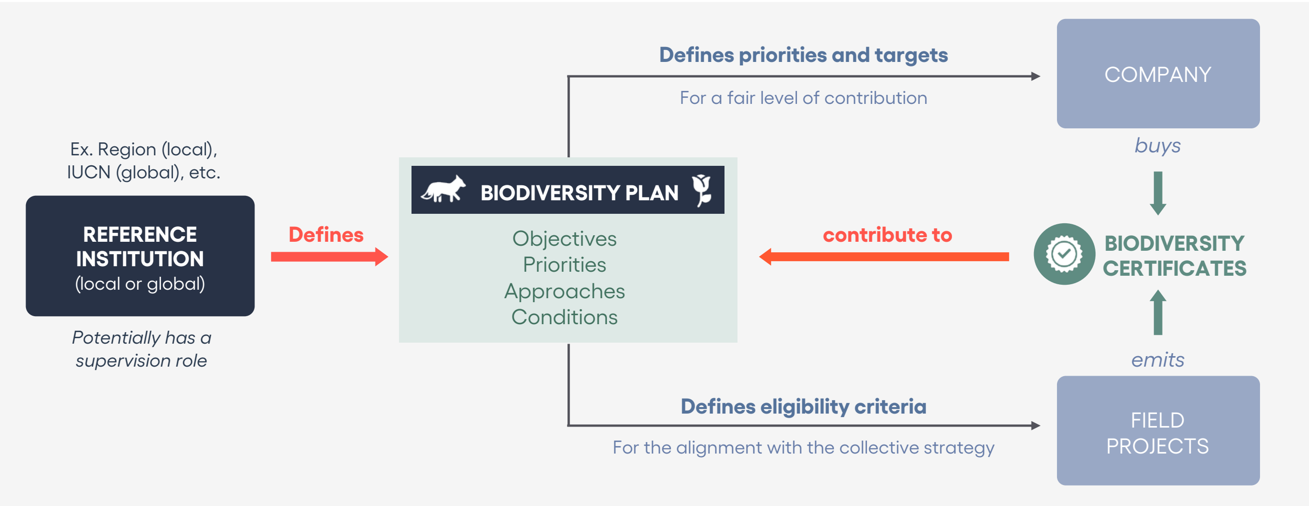


Figure 17: Articulation with reference institutions and biodiversity plans

Three levels of action

The table below summarizes the overall logic proposed for the three categories of certificates. In the long term, the objective is to have **operational methodologies for defining the approach and quantitative targets for each of the three components,** based on the work produced by reference institutions on global objectives for biodiversity (IUCN, FAO, CBD) and on the definition of corporate standards (SBTN). These are points that will be further explored in a future publication.

	Reduction	Contribution	
Within the scope of footprint?	Yes	No	No
Connected with value chain?	Yes	Yes	No
Category	**Reduction**	**Contribution**	
Certificates delivered	**Certificates of footprint reduction**	**Certificates of local contribution**	**Certificates of global contribution**
Rationale	• Target impacts of the activity • Transform the sector • Improve resilience	• Target ecosystems connected with the activity • Preserve ecosystems the activity depends upon	• Target global conservation and restoration priorities
Reference documents For targets and approach	• Corporate standards derived from global goals (SBTN...) • Sector-specific standards	• Corporate standards derived from global goals (SBTN...) • Local biodiversity plans and policies	• Corporate standards derived from global goals • Global biodiversity plans and policies (CBD, SDG…)
In coordination with	• Stakeholders of the supply chain	• Local authorities	• Global institutions for biodiversity (IUCN, FAO…)
Tradability	• Only between stakeholders of the supply chain	• Only between local actors	• Global

Figure 18: three scopes of action delivering three types of certificates

III-2.4 Further distinctions in the type of certificates?

This distinction results in three distinct types of certificates. They are expressed in the same unit but differ in their meaning and in the way they can be used by companies. They are therefore **not substitutable** and must be accounted for and managed separately.

It may also be possible to further distinguish between different certificates, depending on the method of quantification and the ecosystem concerned. As discussed in the introduction, restoration, conservation, and agricultural and forestry projects use different methodologies for quantifying biodiversity gains, which may justify a distinction between the certificates generated. Similarly, because different ecosystems are fundamentally different and non-substitutable, it may be preferable for certificates to be specific to the ecosystem in which they were generated.

The objective should be to **find the right balance between distinction and standardization.** As discussed in the introduction, expressing different biodiversity gains in the same unit brings different advantages, and in particular it facilitates scaling up of action by creating a reference and a standard. At the same time, it brings the risk of confusing these gains, which are fundamentally different because they are achieved through different actions, on different ecosystems, and may have different links with the value chain of the organization that finances them.

It is therefore necessary to find the right level of distinction, as well as the tools to ensure that it is respected by companies.

Overall, we consider that the expression of different impacts in the same unit does not necessarily imply the fungibility of all impacts, but it does bring a risk that the certificate mechanism must anticipate and manage adequately.

III-2.4 Contribution criteria on the demand side

To further guarantee that the use of certificates is integrated in a *solid* global biodiversity action, the biodiversity certificate mechanism could **set additional criteria on the demand side,** in particular to **ensure that the organization retiring the certificates have engaged in a biodiversity impact reduction process.** An option would be to require having set and validated SBTN biodiversity impact reduction targets.

III-3 Market rules

The objective is to define **a market that is sufficiently agile and efficient to properly catalyze investments in biodiversity, while also safeguarding the mechanism's principles and purposes.** In particular, it should be reliable, transparent, and guarantee that the greater part of the resources is used for the implementation of valuable restauration and conservation activities. In that regard, there is a **trade-off to be found between a fully liberal approach** allowing a maximum efficiency in the transaction of certificates and **the implementation of rules and safeguards** to avoid some flaws in the market.

The following section explores some possibilities for structuring the market.

III-3.1 Registry

As it is the norm for voluntary carbon markets, **a transparent registry system** should be developed to centralize the data on the generated biodiversity certificates, and secure and track all the operations: generation, trade, and retirement. It should also publicly display information regarding the existing projects, to ensure the **global transparence** of the mechanism.

The registry could be inspired from the registries that have been implemented for the voluntary carbon market. Alternatively, the development of a new mechanism leveraging the blockchain technology could also be considered.

The options should be compared in terms of efficiency, environmental impact, reliability, and transparency to define which is the most adapted.

III-3.2 Trade of certificates

This is a major aspect of the certificate mechanism, which is only briefly addressed in this section, and will need to be further developed in the future.

Regarding the trade of certificates, **the right balance should be found between a liberal approach allowing a maximum efficiency** in the transaction of certificates and the

implementation of rules and safeguards designed to avoid some flaws in the market, such as excessive speculation that would divert the funding away from the field.

Between field actors that generate the certificates, and final users that retire them to claim the biodiversity gains, there may be one or several **intermediaries,** especially for global projects where there is no restriction on the kind of actors that may buy the certificates.

Intermediaries have an important role in this kind of mechanism. They facilitate the link between supply and demand, bring investment potential, and overall, provide an agility that is necessary for the scale up of the mechanism. One of the goals behind the creation of this mechanism is precisely to enable the development of such intermediaries to support its development. However, the main objective of the mechanism is to finance ecosystem preservation and restauration, and that means **that the greater share of the price of the certificates should be employed for preservation and restoration actions.** Therefore, we want to avoid a situation where intermediaries would take a too significant share of the global turnover of the certificate market.

A first possibility for this is to create an **accreditation system for intermediaries.** Intermediaries would be selected and would commit to respect a set of principles it the trade of certificates. This would allow to limit the total number of intermediaries and promote good trading practices but could deteriorate the efficiency of the market.

Another possibility would be to **limit the number of possible transactions** per certificate, so as to avoid excessive speculation.

Another possibility is to **set rules on the price of certificates.** A strict approach would be to **impose that the percentage** of the final price of the certificate that was used for field restoration and conservation operations must be above a given level. Another would be to only **impose transparency** on the share of the final price that was used for field restoration and conservation operations, without imposing a threshold.

The options should be compared to define which is the most adapted considering the stated objectives.

III-3.3 Control and sanction

Attempts to defraud and fraud are observed in emerging markets. The certificate mechanism will have to design **a sanction system in case of fraud or non-compliance** with the charter, the requirements, or the prerequisites, to guarantee their enforcement.

Glossary

Anthropogenic practices:

Human activities – notably related to agriculture or forestry – which are carried out in (or near to) the assessed area. These practices impact the ecosystem characteristics, which can lead to (more or less) detrimental repercussions on the biodiversity of the assessed area.

Examples of anthropogenic practices include: use of pesticides, use of fertilizers, tillage, undergrowth management, harvesting, use of light sources, use of motorized vehicles, tourism and human presence, hunting, etc.

Biodiversity Index (BI):

Unit of measurement of the biodiversity carrying capacity of a given area. The BI value ranges from 0 to 1, where 0 corresponds to a state where biodiversity would have completely disappeared, and 1 to a (potentially theoretical) "undisturbed" state of the ecosystem. The process to assess the BI is described in the "Biodiversity Index Assessment Method" (BIAM).

Biodiversity Index assessment Method (BIAM):

The Biodiversity Index Assessment Method (BIAM) is the proposed methodology for assessing biodiversity gains resulting from the implementation of actions on the field for the restauration, preservation, and sustainable use of ecosystems. It is based on the estimation of the Biodiversity Carrying Capacity of the evaluated area. The BIAM includes a general framework and multiple ecosystem type-specific core methods, which enable the calculation of a Biodiversity Index (BI) using information on a set of parameters (ecosystem characteristics and anthropogenic practices). Core methods of the BIAM are to be developed through a participatory protocol involving experts of each ecosystem type to bring out a scientific consensus.

Biodiversity Carrying Capacity (BCC):

The term "Biodiversity Carrying Capacity" is used to describe the general capacity of an ecosystem to host and support local species. If the area's living conditions are favorable to the establishment and development of local species, the BCC of the ecosystem is high; on the opposite, the BCC is low if the characteristics of the ecosystem have made the area unfriendly or unlivable for local species, ie. have degraded their capacity to live in this ecosystem.

Using this biodiversity carrying capacity to estimate biodiversity levels relies on the underlying postulate that life is resilient: that living organisms spontaneously reinvest favorable habitats up to their maximum capacity, and that an improvement in habitat conditions results in a gain in biodiversity. The Biodiversity Index Assessment Method is based on the assessment of the Biodiversity Carrying Capacity.

Biodiversity experts (for the methodological developments of the BIAM):

The BIAM core methods (and potential appendices) will be developed via a participatory platform involving biodiversity experts of the associated ecosystem type. The goal is to reflect current scientific consensus on the impacts of specific anthropogenic practices on the environment. Experts will be defined as individuals with established and recognized knowledge of biodiversity for the ecosystem type in question: typically, scientific ecologists, naturalists, or local (including native) field experts.

Biodiversity gains:

Biodiversity gains refer to a net overall improvement of the state of biodiversity in a given area, without direct or indirect biodiversity deterioration in other areas. The volume of generated certificates depends on the additional biodiversity gains delivered by the project.

Ecosystem type:

Ecosystem types are categories within which ecosystems are considered to be homogeneous enough so that the biodiversity carrying capacity can be, in a first instance, evaluated with one single “BIAM core method”. Ecosystem types could be defined as the intersection between a biogeographical category (for instance, ecoregions in Europe) and a category of land use (grasslands, forests, annual crops, perennial crops, etc). A specific core method for $BI_{(1)}$ assessment in the Biodiversity Index Assessment Method will be developed for each ecosystem type.
The classification in ecosystem types will be further explored and specified in later publications.

Ecosystem characteristics:

Ecosystem characteristics are biotic and abiotic information that characterizes the state of an ecosystem. They may concern both the living organisms that forms it and the (non-living) chemical and physical aspects of the environment.
Examples of ecosystem characteristics include number and nature of species, vegetal biomass density, dead wood density, topography, light, soil composition, local humidity, pollution, etc.
Some ecosystem characteristics, when relevant and easily measurable, may be parameters for the assessment method. Other are indirectly and implicitly considered through an evaluation of anthropogenic practices, which are known to affect these ecosystem characteristics.

(BIAM) **Parameters:**

Core methods of the Biodiversity Index Assessment Method (BIAM) enable to compute a Biodiversity Index (BI) value from a set of evaluated parameters. These parameters can either be ecosystem characteristics which are easily measurable through direct field measures or remote-sensing approaches (ex. tree biomass density inf tdm/ha) or characterizations of anthropogenic practices (ex. pesticide use intensity). For each ecosystem type-specific method, chosen parameters were identified as the main drivers of the Biodiversity Carrying Capacity in the corresponding ecosystem type. Their number may vary depending on the ecosystem type but will typically range from 5 to 20.

Situation:

In the scientific participative protocol for building the BIAM core methods per ecosystem type, we define a *situation* as a possible state of the ecosystem for the given ecosystem type, characterized according to the defined set of parameters.

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