ASES ON-CHAIN PROTOCOL

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BIODIVERSITY METHODOLOGY FOR SPECIES CONSERVATION CREDITS

Methodologies V1.0

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ases

On-Chain Protocol

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CONTEXT

The Kunming-Montreal Global Biodiversity Framework aims to trigger urgent and transformative action by governments and subnational and local authorities, the private sector, and civil society to halt and reverse biodiversity loss. The vision of the Kunming-Montreal Global Biodiversity Framework is a world living in harmony with nature where *"by 2050, biodiversity is valued, conserved, restored, and wisely used, maintaining ecosystem services, a healthy planet is maintained, and essential benefits are provided for all people."*

Under the Kunming-Montreal Global Biodiversity Framework, the global goals for protection and restoration include maintaining, improving, or restoring the integrity, connectivity, and resilience of all ecosystems, substantially increasing the area of natural ecosystems.

To achieve these global goals, it is necessary to have financial support from government, non-governmental, and business sources to carry out the necessary conservation and management actions. One way to access funding sources is through the voluntary nature market, in which, through a transparent, verifiable protocol with solid and updated scientific bases, it is ensured that the resources of the credits are used to achieve the proposed conservation and management objectives, avoiding "greenwashing", duplication and ensuring additionality.

The present methodology for the creation of Verified Biodiversity Credits for Species Conservation fully aligns with Goals 4, 14, 15, and 19 of the Kunming-Montreal Global Biodiversity Framework, with an emphasis on halting the extinction of known threatened species and promoting their recovery and conservation.

Biodiversity credits generated under the Ases On-Chain Protocol standard based on this methodology incentivize the conservation of natural ecosystems through reward mechanisms for those who protect and restore forests, wetlands, and other habitats of interest for biodiversity, fostering the active participation of local communities in biodiversity conservation.

In addition, the methodology presents a robust framework for quantifying the biodiversity conservation benefits of projects aligned with the practices and standards established by the initiatives: Corporate Sustainability Reporting Directive (CSRD), Enterprise Sustainability Reporting (ESRS) E4, and Science Based Targets Network (SBTN) for reporting and managing the environmental and social impact of companies.

The European Union's Corporate Sustainability Reporting Directive (CSRD) aims to standardize and improve the quality of companies' non-financial reporting information. It seeks to make companies more transparent about their environmental, social, and governance (ESG) performance to facilitate informed decision-making by investors, consumers, and other stakeholders.

The SBTN Science Based Targets Network is a global initiative that guides companies in defining greenhouse gas emissions reduction targets aligned with climate science to limit global warming to 1.5°C. SBTN provides methodologies and tools for companies to set ambitious and credible emissions reduction targets and contribute to effective climate action.

For its part, the Enterprise Sustainability Reporting Standard (ESRS) E4 focuses on measuring, evaluating, and reporting the impact of business activities on biodiversity and ecosystems by providing a framework for companies to identify, manage, and minimize their negative impacts on nature and contribute to the conservation of biodiversity.

By aligning themselves with these initiatives, companies contribute to the conservation of biodiversity, sustainable development, and the fight against climate change at a global level.

In addition, through its methodologies, the aOCP facilitates the identification and prioritization of degraded areas that require restoration, optimizing the use of resources and maximizing the positive impact on biodiversity. In addition to this, the standard promotes sustainable land management practices that protect the ecological integrity of ecosystems and contribute to the conservation of biological diversity, ensuring the permanence of the projects and thus the long-term health of ecosystems and the provision of essential ecosystem services.

INTRODUCTION

Species conservation credits are a financial instrument that allows companies, organizations, and individuals to invest in the protection and restoration of biodiversity. These credits represent conservation units of a particular target species, equivalent to 100 m^2.

Target species under the aOCP standard are those that, despite having relatively low abundance, have a disproportionate influence on the structure, function, and dynamics of the ecosystem of which they are a part. The importance of these species can be of the following types:

- **Species in a risk category:** Species classified as critically endangered, endangered, vulnerable, or near threatened according to the Red List of the International Union for Conservation of Nature (IUCN), or according to the applicable environmental regulations of each country;
- **Endemic species:** These species are those that are only found naturally in a limited geographical area and under specific conditions. The loss of an endemic species can have a disproportionate impact on the local ecosystem, as there is no similar species that can replace its ecological function;
- **Keystone species:** The disappearance of these species could trigger a series of negative events that will affect other species and the ecosystem as a whole;
- **Species with a strategic role in trophic chains:** These species control the populations of other species through predator-prey interactions, pollination, seed dispersal, etc.

Species conservation credits are generated from conservation projects promoted by non-governmental organizations, local communities, individuals, or government entities that implement measures aimed at protecting threatened, endemic, or species with a strategic role in the food chain.

To issue these credits, the aOCP conducts a rigorous evaluation of the positive impact that the conservation project/action is having on biodiversity and its safeguard. This evaluation determines the number of conservation credits that can be generated per unit of positive impact.

Species conservation credits are a crucial financing mechanism for biodiversity protection, allowing the implementation of large-scale projects. The incentives generated in addition to promoting conservation, help local communities and landowners to obtain income from the sale of credits.

To issue these credits, the aOCP needs to apply mechanisms that prevent double counting, ensuring that each credit represents a real unit of positive impact on biodiversity. Likewise, monitoring and follow-up are fundamental principles for measuring the long-term impact of the conservation project.

As part of the Ecosystem and Social Safeguards of the aOCP, the participation and involvement of local communities are essential, therefore, projects that apply for these credits must guarantee and verify the active and fair participation of local communities in the development and implementation of the project's activities, respecting their rights and traditional knowledge.

DEFINITIONS

- **Biodiversity:** Biodiversity refers to the variety of life forms present in an ecosystem, including species diversity, genetic variation within species, and ecological roles and interactions. This notion is frequently used to evaluate the complexity and health of an ecosystem. Entropy is a measure of the disorder and randomness of a system. Entropy can be thought of as the loss of biodiversity and complexity in ecosystems. When biodiversity is lost in an environment, the remaining species and interactions become more predictable and less robust. This can result in reduced ecosystem function and an increased risk of ecological collapse. Margalef's concept of the negative entropy of ecosystems implies that biodiversity functions as a buffer against entropy and that ecosystems with high biodiversity tend to be more resilient and stable over time. Consequently, biodiversity is essential for the long-term health and sustainability of ecosystems.
- **Ecosystem:** A defined area where organisms interact with each other and with their abiotic environment through processes such as predation, parasitism, competition, and symbiosis. The species in the ecosystem, including bacteria, fungi, plants, and animals, depend on each other. The relationships between the species and their environment result in the flow of matter and energy within the ecosystem (CONABIO, 2024).
- **Fragmentation:** The process by which large, continuous areas of habitat are reduced and divided into two or more smaller, isolated fragments or patches that become immersed in a matrix with conditions poorly suited to the species that inhabit them (ECOTONO, 1996).
- **Home range:** The home range of an animal is the area in which it lives and moves around periodically. Essentially, it is the animal's "territory" where it carries out its daily activities.
- **Habitat:** Defined as a terrestrial, freshwater, or marine geographical unit, or an aero-terrestrial environment that supports assemblages of living organisms and their interactions with the non-living environment. Habitats vary in their importance for conserving biodiversity which is important at the global, regional, and national levels, in their sensitivity to impacts, and in the importance that different stakeholders attribute to them (World Bank, 2015).
- **Mean species abundance (MSA):** The mean species abundance (MSA) metric is an indicator of the intactness of local biodiversity. MSA ranges from 0 to 1, where 1 means that the species assemblage is completely intact, and 0 means that all the original species are extirpated (locally extinct). The MSA is calculated based on the abundance of individual species under the influence of a given pressure, compared to their abundance in an undisturbed situation (natural/reference situation) (Global biodiversity model for policy support).
- **Conservation:** The management of the use of the biosphere by humans in such a way that it produces the greatest and most sustained benefit for present generations and yet maintains its potential to meet the needs and aspirations of future generations (IUCN, 1980).
- **Landscape connectivity:** Landscape connectivity in terms of structure can be understood as the spatial configuration of different habitat types and is known as the

degree of physical connection between the patches that make up a landscape, also defined by the number of functional links between patches of the same type, where each patch is connected or not based on a distance criterion (Bennett, 1999).

I. APPLICABILITY CONDITIONS

The methodology is governed by the following conditions:

a) The project type is (see details Table 1):

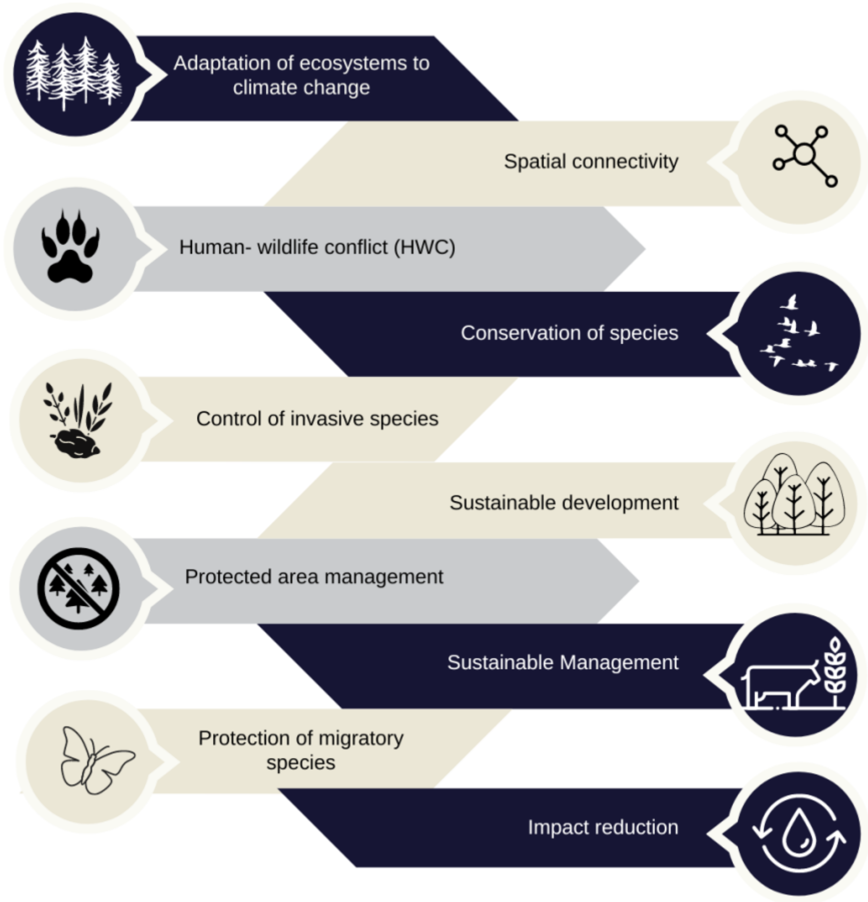


IMAGE 1. TYPES OF ELIGIBLE PROJECTS

b) The Project meets the eligibility criteria established in the document of *Project Procedures* aOCP version 2.3.

c) The Project was developed less than 10 years ago.

d) Project activities focus exclusively on biodiversity conservation, without conversion to non-native habitats/land uses (i.e. conversion of forests to agricultural land).

e) The project area has an MSA >= 80%.

f) The project engages local communities in its activities to ensure respect and application of cultural and traditional knowledge, ensuring compliance with the social safeguards of the aOCP.

g) The biodiversity of the project area is vulnerable to degradation or disturbance if not conserved.

h) The project will design and implement strategies to eliminate or manage invasive species in the project area (when applicable).

II.1. Eligible activities

The Ases On-Chain Protocol is a voluntary program of the Nature Market applicable on a global scale for the certification of biodiversity conservation and restoration projects. Activities eligible for certification can be applied by individuals, non-governmental organizations (NGOs), government organizations, private companies, and/or communities.

Identifying the project type from the list of eligible activities under the aOCP is crucial for the success of a biodiversity project. This main activity will be the core of the project, while other additional eligible activities may complement and strengthen its impact and mitigate the identified threats. It is important that all eligible activities, both the main and additional ones, comply with the certification guidelines of the standard presented in Table 1.

The classification by project type and activities is an essential element to determine the applicability of the Project to the aOCP certification, as well as for the correct quantification of biodiversity conservation credits, since the implemented activities or measures, as well as their geographical location and the habitat in which they are located, are determining factors in the evaluation process.

Table 1. Eligible activities

Type of project	ID	Eligible Activities	Elegible habitat											
			B	SE	S	M	P	H	D	MI	MN	AT	AA	VI
Adaptation of ecosystems to climate change	AD-1	Reforestation/restoration with Native species	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	AD-2	Promotion of natural regeneration	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
	AD-3	Wetland restoration						✓		✓	✓			
	AD-4	Green infrastructure					✓			✓	✓	✓	✓	✓
Spatial connectivity	CON-1	Establishment, improvement, or restoration of corridors ecological	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CON-2	Creation of wildlife passages	✓	✓	✓	✓	✓	✓				✓		
	WITH 3	Increased connectivity within urban environments										✓		✓
Human-wildlife conflict (HWC)	HWC-1	Actions to mitigate conflicts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	HWC-2	Improved coexistence between people and wildlife	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Conservation of species	CE-1	Reproduction programs for endangered species	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CE-2	Reintroduction of species to their natural habitat	✓	✓	✓	✓	✓	✓	✓	✓	✓			

Type of project	ID	Eligible Activities	Elegible habitat											
			B	SE	S	M	P	H	D	MI	MN	AT	AA	VI
	CE-3	Reintroduction and/or conservation of pollinators	✓	✓	✓	✓	✓	✓	✓			✓		✓
	CE-4	Reproduction of plant species	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
	CE-5	Fire control	✓	✓	✓	✓	✓		✓			✓	✓	✓
	CE-6	Creation of refuge areas and feeding	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CE-7	Other methods to safeguard the genetic diversity of species.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Control of invasive species	CONT-1	Elimination of exotic species	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	CONT-2	Disease and pest control introduced	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sustainable Development	DS-1	Ecotourism	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Protected area management	GES-1	Natural reserves	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	GES-2	Wildlife sanctuaries	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	GES-3	Marine protected areas								✓	✓			
	GES-4	Biological corridors	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	GES-5	Ecosystem maintenance natural	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
Sustainable Management	MS-1	Sustainable forestry	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
	MS-2	Sustainable fishing						✓		✓	✓		✓	
	MS-3	Regenerative/sustainable agriculture	✓	✓	✓	✓	✓		✓			✓	✓	✓
	MS-4	Sustainable grassland management					✓							✓
	MS-5	Sustainable livestock farming			✓	✓	✓		✓			✓		✓
Protection of migratory species	PRO-1	Hunting or fishing regulation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PRO-2	Creation of rest areas and feeding	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	PRO-3	Control of illegal trade in life wild	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Impact reduction	RI-1	Control of water and wind erosion	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
	RI-2	Contribution to water infiltration	✓	✓	✓	✓	✓	✓	✓			✓		✓
	RI-3	Improved water quality						✓		✓	✓		✓	

Habitat classification according to the Red List scheme, version 3.1

B: Forest; SE: Jungle; S: Savannah; M: Thicket; Q: Grasslands; H: Wetlands; C: Caves and underground (non-aquatic) habitats; D: Desert; MI: Intertidal Marine; MN: Neritic marine; MO: Oceanic marine: AT: Artificial – terrestrial; AA: Artificial – aquatic; VI: Introduced vegetation.

II.2. Ineligible activities

The Ases On-Chain Protocol does not recognize projects:

- Which simply protects existing biodiversity without generating additional benefits.
- Which only seeks to compensate for the negative impact on biodiversity.
- Which are required by law or regulation to protect or restore biodiversity.
- Which would have been carried out anyway without the prospect of generating biodiversity credits.
- That are based on public financing or subsidies that are not additional.
- That does not show their long-term permanence.
- That depends on ecologically or socially unsustainable practices.
- That they do not demonstrate in a real and quantifiable way the benefits to biodiversity.
- That involves the exploitation or displacement of local communities.
- That they do not have a transparent, corroborable, and accessible monitoring and evaluation system.

II. Retroactivity

The Ases On-Chain Protocol recognizes the efforts made for the conservation of biodiversity in the 10 years before the registration of the project. To obtain this recognition, project developers must demonstrate with concrete actions, data, and real and verifiable information that they have contributed significantly to the conservation of biological diversity.

This retroactive recognition opportunity not only rewards developers for their continued commitment to biodiversity conservation but also incentivizes them to continue working to protect biodiversity in the future.

III. Principles

The Nature Market is booming as a tool to finance biodiversity conservation and promote sustainable development. In this context, the aOCP is positioned as an instrument in the certification of conservation projects, ensuring that they meet the highest standards of quality and scientific rigor.

To obtain aOCP certification, biodiversity conservation projects must comply with five basic principles that are fundamental to guarantee the effectiveness and sustainability of conservation actions.

IV.1. Additionality

Projects seeking aOCP certification must demonstrate that the biodiversity conservation benefits they generate would not have occurred naturally or as a result of existing laws or regulations. Additionality ensures that projects are genuinely contributing to a net increase in species conservation.

Therefore, project developers must undergo the evaluation of additionality factors: financial, ecological, and regulatory stipulated by the aOCP during the selection stage.

IV.2. Permanence

The biodiversity conservation benefits produced by the projects must be enduring. This requires projects to have land use agreements in place, along with long-term monitoring and follow-up strategies. Additionally, mechanisms must be established to ensure the project's financial sustainability.

The aOCP supports the permanence of the benefits of each project through a *buffer pool*, which refers to the percentage of credits that during each issue will be allocated to a reserve (Table 2), which can be used in case of any unwanted eventuality. The percentage allocated to the buffer pool will be defined in each project based on its classification in the Nat5 Scoring (Image 2) as established in the aOCP V2.3 Project Procedures document.

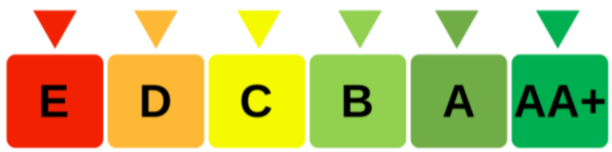


Image 2. NAT5 Scoring categories

Table 2. Provision of credits allocated to the buffer pool

Project classification in Nat5 Scoring	Percentage of credits allocated to the buffer pool
AA+	20%
A	25%
B	30%
C	35%
D	40%
E	50%

IV.3. No reversibility

The biodiversity conservation benefits generated by the projects must be irreversible or, at least, extremely difficult to reverse. This implies that projects must be carefully designed to minimize the risks of ecosystem loss or degradation.

IV.4. Transparency

Transparency stands as a fundamental element for the success of any project, especially those related to the conservation of biodiversity. Its implementation generates a series of benefits that have a positive impact in various aspects:

- **Strengthening credibility and accountability:** Transparency promotes trust between interested parties, as it allows open access to information about the project, its objectives, progress, challenges, and results. This creates an environment of accountability, where the project is responsible for its actions and decisions.
- **Fundraising Optimization:** Being a transparent project, it increases the trust and credibility of buyers, who feel more secure in allocating their resources to an initiative that manages their funds responsibly and ethically.
- **Promotion of learning and continuous improvement:** Transparency facilitates the exchange of knowledge and experiences between the parties involved in the project. This allows a continuous learning process, where opportunities for improvement are identified and more effective strategies for biodiversity conservation are implemented.
- **Stimulation of public participation:** Transparency promotes active community participation in the project. By having access to information, people feel more involved and motivated to contribute to the success of the initiative.

IV.5. Respect for ecosystem and social safeguards

Projects must respect the rights, well-being, and traditional customs of local communities and indigenous peoples who rely on the conserved ecosystems. They should avoid any negative impact on ecosystem goods and services and comply with the safeguards outlined in the aOCP standard document.

IV. Methodological considerations

V.1. Parameters of the methodology

The fundamental parameters and factors considered when applying the methodology are described in Table 3.

Table 3. Parameters of the methodology

Parameter	Index	Description
Biodiversity	(H) Habitat quality	Evaluates the quality, quantity and connectivity of the four habitat components: • Refuge areas • Space • Water availability • Food availability
	(HR) Home range	Determines the area an animal uses for its normal daily activities.
	(BI) Biodiversity index	Relationship between the observed diversity and the maximum expected diversity, which must be calculated for flora and fauna.
	(F) Fragmentation	Division or separation of natural habitats into smaller, more isolated units.
	(NDVI) Normalized Difference Vegetation Index	Index to evaluate the greenness, density, and health of vegetation.
	(K) Saturation coefficient	Indicator to evaluate the completeness of sampling and the potential presence of new species at a site.

V.2. Data collection

The biodiversity inventory is an essential element for certification in the aOCP and for project monitoring since through it the project developer will provide all the information and data necessary to evaluate and quantify the benefits of the project on the conservation of biodiversity.

Therefore, during the inventories the project developer must provide the information as established in the *Guide for biodiversity inventory in projects in the process of aOCP V1.0 certification*, covering the following parameters:

TABLE 4. DATA COLLECTION DURING INVENTORY IN THE PROJECT AREA

Inventoried component	Data collected	Format to use
Habitat quality	• Burrows • Caves • Hollow trees • Dense bushes • Human-made structures, such as nest boxes or artificial shelters • Forest areas of mature forests • Forest areas of young forests • Shrub forest areas • Areas with cliffs or caves • Areas of sustainable use / Productive • Areas where the implementation of works was carried out (water and soil) • Water bodies • Infrastructure (fences, power lines, roads, gaps, highways, buildings, etc.) • Grazing areas • Fruiting areas • Pollination areas • Carrion • Other resources of animal or plant origin • Nesting sites	Format for collecting habitat quality data *(Annex 1 of the Guide for biodiversity inventory in projects in the aOCP V1.0 certification process)*
Flora	• Landscape unit number • Sample plot number (1/10) • Geographical coordinates • Start date (day/month/year) • Responsible for collecting information • Physiography of the unit (valley, terrace, plain, plateau, hillside, hill) • Current land use • Record of individuals by species: arboreal, shrubby, and herbaceous stratum • Photographic record of the sampling plots.	Format for collecting flora data *(Annex 2 of the Guide for biodiversity inventory in projects in the aOCP V1.0 certification process)*
Fauna	• Landscape unit number • Transect number • Geographical coordinates • Start date (day/month/year) • Responsible for collecting information • Registration of individuals by species and by group: birds, mammals, reptiles and amphibians • Geographic coordinates of the location of the	Format for collecting fauna data *(Annex 3 of the Guide for biodiversity inventory in projects*

Inventoried component	Data collected	Format to use
	camera traps and acoustic sensors ● Evidence obtained from indirect methods (camera trapping, acoustics). Provide data for each sensor separately in folders, indicating the folder name and sensor/camera identifier.	*in the aOCP V1.0 certification process)*
Population of the target species	● Results of population censuses ● Evidence of trace tracking (footprints, feces or other indications of presence) ● Photographic evidence of indirect methods (photo trapping, acoustics).	

Carrying out flora and fauna inventories to adequately characterize a habitat requires considering the seasonal variability of the species and the ecosystem. Each season of the year presents specific environmental conditions and behavioral patterns that influence the presence, abundance, and visibility of species (Table 5).

TABLE 5. INVENTORIES AT DIFFERENT TIMES

Season	Behavior patterns	
	Flora	**Fauna**
Winter	Many plants are in a state of dormancy, with reduced or absent foliage, making their identification difficult. However, it is a good time to observe woody species, nuts, and reproductive structures such as cones or winter flowers.	Some animals hibernate or migrate, reducing observable diversity. However, it is a good time to detect tracks, burrows, and other signs of fauna presence.
Spring	Spring is the time of maximum flowering for many species, which makes it easier to identify and record them. It is an ideal time to observe flowering herbaceous plants, trees, and shrubs.	Wildlife activity increases with the arrival of spring, allowing for greater observation of birds, mammals, reptiles, and amphibians. It is a good time to carry out auditory and visual censuses.
Summer	When water availability allows, the vegetation reaches its maximum development in summer, which can make it difficult to observe some understory species. However, it is a good time to observe ripe fruits and seeds.	Wildlife activity remains high in summer, allowing for good observation of birds, mammals, reptiles, and amphibians. It is a good time to carry out direct censuses and trap sampling.

Season	Behavior patterns	
	Flora	Fauna
Autumn	Many plants begin to lose their leaves and fruits, making their identification difficult. However, it is a good time to observe fungi and lichens.	Wildlife activity decreases with the arrival of autumn, which reduces the observable diversity. However, it is a good time to observe migratory birds and mammals in preparation for hibernation.

The aOCP requests from project developers' inventories that allow obtaining complete records of flora and fauna to have a solid and robust database. Therefore, the inventories must adhere to the calendar established in Image 3, suggesting that they be carried out between April and July since it is the most favorable period that will allow for a general inventory of the flora and fauna of the project.

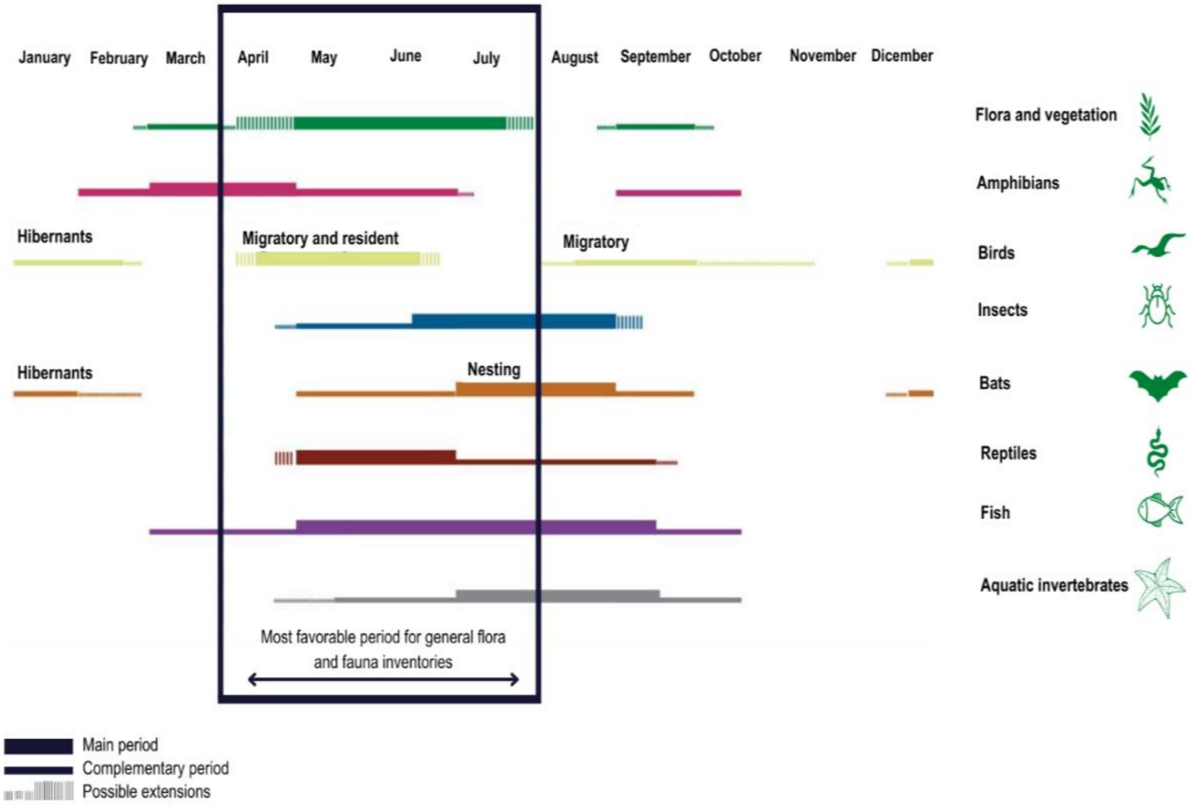


IMAGE 3. CALENDAR FOR CARRYING OUT INVENTORIES IN THE PROJECT AREA

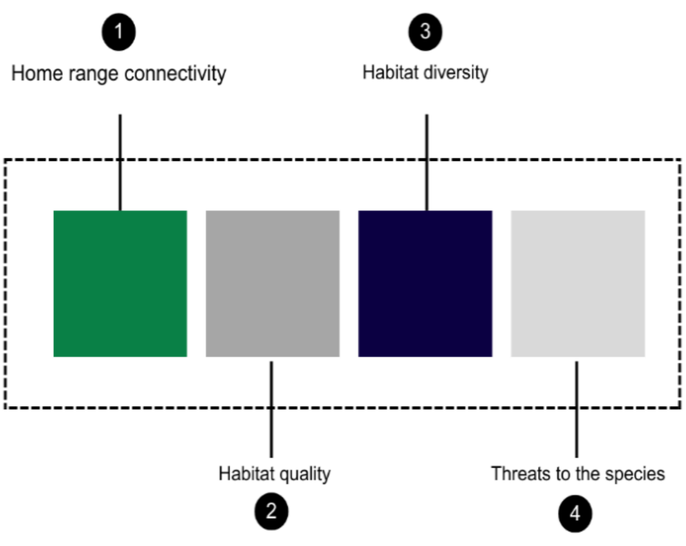
V. CALCULATION OF CREDITS

Global biodiversity is threatened by unprecedented and increasing anthropogenic pressures, such as the introduction of exotic species, habitat loss and fragmentation, overexploitation, climate change, and pollution (IPBES, 2019; Maxwell, Fuller, Brooks and Watson, 2016; Tilman et al., 2017). This has led to the development of initiatives that strive to halt biodiversity loss, and to achieve this, it must be supported by a strong understanding of the factors that threaten biodiversity, such as fragmentation, climate change, and land-use transformation.

The proposed method to calculate Biodiversity Credits for Species Conservation (BCSC) is an evaluation based on five main variables:

- **Habitat quality:** evaluates the quality, quantity, and connectivity of the four habitat components: water, food, shelter, and breeding space for the target species.
- **Home range of the species:** determines the geographic area required to maintain a viable population of the target species;
- **Shannon index:** calculates the biological diversity of the area using the Shannon Index to evaluate the richness and evenness of species present.
- **Landscape fragmentation index:** evaluates the degree of habitat fragmentation;
- **Target species monitoring:** allows for a baseline study to be carried out and changes to be evaluated using bioacoustics sensors and camera traps to document and provide evidence of the presence and abundance of the target species.

The proposed method to calculate the benefits of the project in the conservation of target species recognizes that biodiversity is a complex system and that the measures implemented for its conservation require the consideration of multiple variables: connectivity of the home range, quality of the habitat, habitat diversity, and threats to the species at the site.



To access the aOCP's Species Conservation Biodiversity Credits, the project area must demonstrate the presence of the target species through monitoring. Additionally, the area must have a biodiversity integrity value of greater than 0.80, which will be determined using the GLOBIO model, expressed by the Mean Species Abundance (MSA) metric. This model quantifies the impacts of infrastructure, climate change, land use (measured through habitat loss and fragmentation), and atmospheric nitrogen deposition on biodiversity integrity (Schipper et al., 2019). The MSA metric ranges from 0 to 1, where 0 indicates that all original species have been extirpated from the habitat, while a value of 1 means that the species assemblage is fully intact and, therefore, there is significant biodiversity to conserve.

Biodiversity Credits for Species Conservation are issued when the value of the scaled indices (see section VII) of the baseline (calculation of the initial state) is maintained at 100%, or in the case of fragmentation, a reduction is achieved over time. This should be evaluated annually during the project's lifetime to quantitatively compare the benefits of the activities carried out for biodiversity conservation. The evaluation will be carried out by applying the following formula:

$$\mathbf{BCSC} = \frac{(\mathrm{H} + \mathrm{HR} + \mathrm{BI} + \mathrm{FI}) \cdot (\mathrm{NDVI}) \cdot (1 - \mathrm{R} - \mathrm{L}) \cdot \mathrm{A} \cdot \mathrm{K}}{100 \ \ m^2}$$

Where:

H: Habitat quality for the target species (scale from 0 to 1)

HR: Home range area available for the target species (hectares)

BI: Biodiversity Index (Shannon)

FI: Landscape fragmentation index (scale from 0 to 1)

NDVI: Satellite monitoring of the Normalized Difference Vegetation Index (NDVI) (scale from 0 to 1)

R: Reversibility rate (scale from 0 to 1)

L: Leakage factor (scale from 0 to 1)

A: Additionality (scale from 0 to 1)

K: Saturation coefficient

Given that natural ecological fluctuations can occur at the site level, the aOCP allows the issuance of BCSC when the value obtained by applying the formula in the monitoring has remained at least 90% or more, in relation to the baseline scenario. If the BCSC value falls below 90% of the initial value, no credits can be issued. Therefore, the number of BCSCs that can be issued is determined by the area of the home range available to the target species and the state of the ecosystem.

BCSC issuance is determined with the following decision rule:

$$\frac{BCSC_{Ct}}{BCSC_{Ct0}} \geq 0.9 \quad \text{: issue BCSC}$$

$$\frac{BCSC_{Ct}}{BCSC_{Ct0}} < 0.9 \quad \text{: do not issue BCSC}$$

Where:

$BCSC_{ct0}$: Value of the relative indices at the beginning of the project, reported in the baseline evaluation.

$BCSC_{ct}$: Value of the relativized indices at the time of monitoring.

VI. REFERENCE SCENARIO

At the beginning of the project, the initial values of each index must be determined to apply the BCSC formula and objectively evaluate the outcomes of the conservation actions.

VII.1. EVALUATION OF VARIABLES

VII.1.1. HABITAT QUALITY FOR THE TARGET SPECIES (H)

The habitat assessment for target species will be carried out using data from the Global Biodiversity Simulation Model (MSA GLOBIO).

The variables that will be used correspond to:

- **Habitat of the target species:** a physical place where a population of organisms lives and develops. This space provides the necessary environmental conditions for the species to grow, reproduce, and survive.
- **Quality of the type of habitat needed by the species on the site:** The MSA, which is a fundamental index for evaluating habitat quality by estimating the average abundance of species in a given area, will be utilized in this case. A high MSA value indicates a higher quality habitat, supporting a greater number of individuals per species, while a low value indicates a lower quality habitat with fewer individuals per species.
- **Diversity of habitats on the site:** Habitat diversity implies a variety of ecosystems, ecological niches, and environmental conditions that support a wide richness of biodiversity, which would translate into greater species richness and greater biological productivity.
- **Habitat fragmentation:** The division into small and isolated fragments of habitat is one of the greatest threats to biodiversity since it causes the decrease and loss of habitable surfaces for species, isolation of populations, alteration of ecological interactions, and, therefore, loss of species.

Once the variables described above have been generated, the following formula will be used to determine the quality of the habitat:

$$\boldsymbol{H} = C \cdot Q \cdot D \cdot F$$

Where:

C: Percent coverage within the site of the habitat necessary for the species (%)

Q: Value of the Average Species Abundance (MSA) index in the species' habitat

D: Habitat diversity at the site (scale from 0 to 1) (see Table 6)

FI: Habitat fragmentation index at the site (scale from 0 to 1) (see Table 9)

TABLE 6. HABITAT DIVERSITY CLASSIFICATION

Category	Classification	Scaled value
Very low diversity	>5 habitats	0.2
Low diversity	5 to 10 habitats	0.4
Moderate diversity	11 to 15 habitats	0.6
High diversity	16 to 20 habitats	0.8
Very high diversity	>20 habitats	1

VII.1.2. HOME RANGE AVAILABLE FOR THE TARGET SPECIES (HR)

The "home range" of a species is the minimum amount of land that an individual or group of individuals requires in their lifetime. It encompasses all areas within which an organism can move in search of food, water, shelter, mates, and other resources necessary for its survival and reproduction.

To determine the home range of each target species, the following factors must be considered:

- **Target species analyzed:** Each species has different home range sizes, often related to their body size, foraging strategies, and resource requirements.
- **Habitat:** The availability and distribution of resources within the habitat can significantly affect the size of the home range. Species that live in areas with abundant and dispersed resources may have smaller home ranges, while those in areas with scarce or fragmented resources may need larger home ranges to meet their needs.
- **Population density:** In areas with high population density, competition for resources can lead to greater overlap of home ranges and a reduction in the size of the individual home range.

Once the factors for each species have been analyzed based on official bibliographic information, a Kernel Density Estimation (KDE) will be performed. This will allow the creation of a probability density surface based on location data, indicating areas of higher and lower probability of the presence of the target species individuals within the project polygon.

VII.1.3. Biodiversity index (BI)

The result of the inventory of flora and fauna will be the base information for the calculation of biodiversity using the Shannon-Wiener index, which is one of the most used indices to quantify specific biodiversity, also known as Shannon-Weaver (Shannon and Weaver, 1949), derived from information theory as a measure of entropy. The index reflects the heterogeneity of a community based on two factors: the number of species present and their relative abundance. The maximum potential diversity (Hmax= ln S) depends on the number of species present in the community. The more species there are the greater the maximum potential diversity. It is achieved when all species are equally represented. An index of homogeneity, also called evenness, associated with this measure of diversity can be calculated as the quotient H/Hmax, which will be equal to 1 if all the species that make up the community have the same number of individuals.

The index is calculated using the following equation:

$$H = -\sum_{i=1}^{ps*} pi \cdot ln\,(pi)$$

Where:

H: Shannon-Wiener diversity index (nat)

Pi (p1, p2, p3... ps*): is the relative abundance of species in the collection.

Diversity is influenced by the distribution of relative abundance of species in the community. The equity index (J) is calculated as follows:

$$J = \frac{H}{Hmax}$$

Where:

H: Shannon-Wiener diversity index (nat)

Hmax: Maximum diversity that can be expressed through the sample (nat), which is calculated as:

$$Hmax = \; ln\;S$$

Where:

S: Species richness, i.e., number of species in the sample.

The results for species richness, the Shannon-Weaver diversity index, maximum diversity, and the evenness index of the tree, shrub, herbaceous, and fauna communities in the project area will be presented according to the format in Table 7, with separate tables for flora and fauna.

TABLE 7. FORMAT FOR THE PRESENTATION OF THE DIVERSITY INDEX

Parameters of the flora/fauna diversity index	Index
Richness	
Diversity (nats)	
Maximum potential diversity (Hmax)	
Equity index (J)	

When the diversity index value is 0, it indicates the presence of only one species, meaning there is no diversity. The index increases with the number of species or classes and becomes higher when the distribution of the occupied area among different ecosystems, species, or objects is more equitable.

The diversity index obtained for the project area will be interpreted according to the categories presented in Table 8.

TABLE 8. CATEGORIES OF INTERPRETATION OF THE SHANNON INDEX

Diversity	Shannon Index (nats)
Very low	<1.02
Low	1.03 – 1.53
Half	1.58 – 2.11
High	2.12 – 2.65
Very high	>2.65

Source: Qualitative interpretation of the index based on the interpretations expressed by Margalef (1975;1993).

VII.1.4. LANDSCAPE FRAGMENTATION INDEX

Given the complexity of the landscape and the necessity to consider various physical, ecological, and social factors, the analysis will include a 2 km buffer zone around the project area. This approach ensures that spatial variability is adequately accounted for.

The vegetation zones within this area of influence will be identified by digitizing satellite images using either supervised or unsupervised classification methods. The objective is to accurately map the vegetation patches at the analysis scale. Additionally, the information provided by the project developer in the habitat quality data collection format will be incorporated into the analysis.

The total landscape fragmentation will be estimated through the ratio between the forest area and the total area, represented by the following formula:

$$FI = \frac{Forest\ vegetation}{Total\ area}$$

The fragmentation index ranges from 0 to 1, with values below 0.5 indicating significant island fragmentation. This suggests a high level of ecological disruption within the landscape similar to the dispersion of islands in an ocean. A value of 1 represents a completely unfragmented landscape (Table 9).

TABLE 9. FRAGMENTATION RANGES

Fragmentation ranges	Level
<0.5	Insularized
0.5 – 0.7	Very fragmented
0.7 – 0.9	Moderately fragmented
1	No fragmentation

Source: Díaz, A. (2003).

- **Insularized:** It refers to a condition in which a geographic area resembles or behaves like an island, despite not being surrounded by water. An insular landscape can occur when a natural region or specific habitat is surrounded by a matrix of agricultural land, urbanized areas, or other intensive land uses. This landscape fragmentation can be the result of deforestation, uncontrolled urbanization, infrastructure construction, or agricultural expansion. Fragmentation causes the loss of habitats, the isolation of populations, the alteration of ecological processes, increased vulnerability to disturbances, and the reduction or loss of ecosystem services.
- **Fragmented:** Landscape that has been divided into multiple smaller fragments due to human or natural influence. This landscape fragmentation occurs when natural habitats and open areas are divided into smaller, more isolated fragments due to activities such as urbanization, infrastructure construction, deforestation, intensive agriculture, etc.
- **No fragmentation:** An area in which natural habitats and open areas are in a continuous state and have not been divided into smaller fragments. In a non-fragmented landscape, ecosystems and natural habitats are maintained in their original form, without significant alterations caused by human activities or natural phenomena.

VII.1.5. NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)

The Normalized Difference Vegetation Index is an indicator used to estimate the quantity, quality, and development of vegetation from satellite images. It is calculated as the difference between the reflectance in the red band (R) and the near-infrared band (NIR) of the electromagnetic spectrum, divided by the sum of both bands:

$$NDVI = \frac{NIR - R}{NIR + R}$$

NDVI values range from -1 to 1, with values near 1 indicating high vegetation density and values near -1 indicating low vegetation density or the absence of vegetation.

The results obtained will be classified according to the categories presented in Table 10.

TABLE 10. NORMALIZED DIFFERENCE VEGETATION INDEX RANGES

NDVI	Interpretation
>0.8	Dense and vigorous vegetation
0.6 – 0.8	Moderately dense vegetation
0.3 – 0.5	Sparse or low-quality vegetation
0.1 – 0.2	Bare or sparsely vegetated soil
<0.1	water or snow

VII.1.6. REVERSIBILITY INDEX (R)

Reversibility risk is an assessment of the probability that a biodiversity credit, which represents a measurable unit of biodiversity conservation, may be lost or diminished due to future events or circumstances. This risk is crucial to assess the long-term value and reliability of credits as a tool for biodiversity conservation and impact offsetting.

Several factors can influence the reversal risk of a credit, including:

- **Permanence of conservation actions:** The risk is lower if the conservation actions that generated the credit are permanent and irreversible, such as the establishment of a protected area or the restoration of native habitat.
- **Climate change and natural disturbances:** Climate change and natural or climatic disturbances, such as wildfires, floods, or droughts, can pose threats to the persistence of the biodiversity gains represented by the credits.

The evaluation of the risk of reversibility will be carried out through the following equation:

$$\mathbf{R} = 1 - (P \cdot (HR \cdot C \cdot (H + D) / T) \cdot MC)$$

Where:

P: Probability that the species will remain present at the site in 2050 (scale from 0 to 1)

HR: Area of the species' home range (in hectares) (see section V.1.2.)

C: Home range connectivity (scale from 0 to 1)

H: Habitat quality for the target species (see section V.1.1)

D: Diversity of habitats at the site (scale from 0 to 1) (see Table 4)

T: Threats to the species at the site (scale from 0 to 1)

MC: Conservation measures implemented (scale 0 to 1)

In the reversibility equation (R), the probability that the species remains present is weighted by a factor that reflects the quality of the habitat it occupies, the threats it faces, and the conservation measures implemented. Size, home range, and connectivity are included in the habitat quality factor.

VII.1.6.1. Probability of presence of the species in 2050

Potential distribution models have taken on significant relevance in recent decades, especially due to the need to provide scientific methods and tools to evaluate the potential impacts that climate change has on the distribution of species or communities of species (Norberg, et al., 2019).

The probability of the presence of the target species by 2050 will be carried out using the Climpact Data Science CDS tool (Hinojos-Mendoza, et al., 2020). Climpact is an integrated model that allows the evaluation of the optimal areas for the distribution and presence of species, both in the current and future time horizons. The Climpact tool utilizes physical, environmental, and biological elements related to species and their distribution as its main input, enabling the spatial identification of potential optimal areas for species or communities to grow and sustain themselves within a specific territory.

CDS is grounded in the theory of ecological niches, defined as "the position of a species within an ecosystem, describing both the range of conditions necessary for the persistence of the species and its ecological role in the ecosystem" (Polechonvá and Storch, 2019). The habitat is the physical space where a species finds food, mating places, and shelter (Mitchell and Power, 2002). A source habitat exists when environmental conditions are sufficient to meet the needs of organisms, leading to the concept of the ecological field (Farina and Belgrano, 2004).

The model requires calibration to establish the relationship between the distribution of a species, or a group of species, and the spatial distribution of 27 essential variables for their development, such as climate, soil type(s), slope, and vegetation. This calibration is the first step in the Climpact Data Science process, involving the overlay of the spatial distribution of 19 environmental variables with species observation records. Among these environmental variables, seven are related to climatic elements crucial for the species' development and survival. The remaining three variables pertain directly to the biological environment, including vegetation or land use, the base flora of their diet, and species involved in biological interactions through competition.

It is important to consider that Climpact Data Science does not make assumptions about the relationship of a species with its environment. Instead, it only considers the occurrence of the species based on the values or category of each variable. During this process, all variables have the same weight, which avoids making conjectural assumptions. As with other potential distribution models, the accuracy of the calibration depends directly on the spatial resolution of the variables used and the number of observation records. The result of the first step, calibration, corresponds to the identification of the range of values of each variable that are considered significant to ensure the development and survival of the species. In other words, this step allows the establishment of the ecological niche of a species.

Climate variables acquire significant relevance since they greatly influence the survival and adaptation of species, especially in areas where climatic gradients are significant. This also allows a description of the climatic envelope of each species and can also be considered as a limiting factor (Woodward, 1987). Image 4 schematizes the first step, calibration, of the Climpact Data Science process.

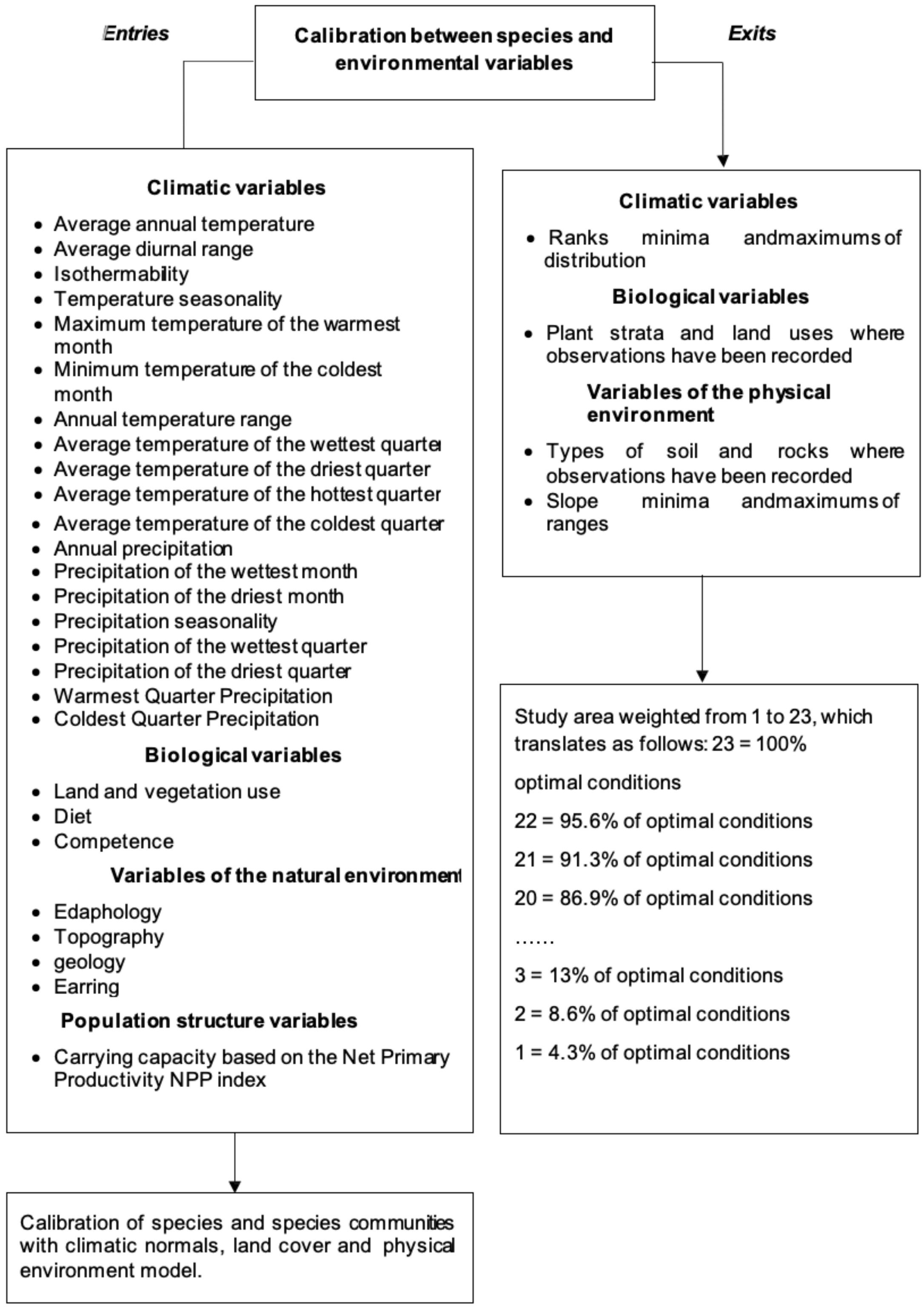


IMAGE 4. CLIMPACT DATA SCIENCE PROCESS

The Climpact methodology calculates the potential ecological distribution of species by identifying favorable conditions within a territory. The algorithm searches for areas where the reference characteristics match the sighting records of each species. It selects pixels with the same categories of nominal variables (land use, vegetation cover, soil type, and geology) and those within the range of quantitative variables (temperature, precipitation, and slope).

However, considering the uncertainty of finding similar environmental conditions for the species and their ability to adapt to environmental changes, the model considers three ecological scenarios:

1. The species or communities of species adapt slightly to the new environmental conditions, selecting areas where the characteristics are closest to the reference optimum, leading to a contraction in their population or community.
2. The species or communities of species adapt drastically to the new environmental conditions and can remain in the same areas.
3. The species or communities of species are unable to adapt to the changes and disappear locally.

The results obtained, particularly the comparison between the current situation and future possibilities, enable the identification of spatial dynamic trends for the species. Table 11 provides the interpretation of the previously presented decision criteria.

TABLE 11. DECISION CRITERIA, WEIGHTING, AND PERCENTAGES OF GLOBAL SIMILARITY

Weighting range	Interpretation
100-1199	When a pixel has global similarity values between 1 and 52.17% (weighting between 100 and 1200), the area can be considered unsuitable for the development of the species or community of species. The possibility of adaptation of species to new future conditions decreases significantly.
1200-1899	When a pixel has global similarity values between 52.17 and 82.6% (with a weight between 1200 and 1800), the pixels represent an area where the species must adapt to new conditions, showing some mild periods of stress. In this case, the uncertainty for the adaptation of species to the new ecological situation is of greater importance than in the other ranges of global similarity values.
1900-2299	When a pixel has global similarity values between 82.6 and 100% (weighting = 1900, 2000, 2100 or 2200), it indicates that the environmental conditions for the species are slightly similar to its ecological niche. The potential impact of climate change should not be significant on the life and development of species, and their adaptation to future environmental conditions should be appropriate.

Weighting range	Interpretation
2300	When a pixel has 100% global similarity (weight = 2300) it means that the pixel has 100% fitness for the distribution of species or communities of species. In this area, the environmental parameters correspond to the ecological niche of the species or community of species (decision criterion = equal, which means equality of environmental parameters). In the case of the evaluation of the potential impact of climate change on the distribution of the species, 100% global similarity means that the species would not encounter problems in their life and development.

Modeling the current and future potential distribution (up to 2050) must be conducted for each target species to identify the behavioral pattern resulting from climate change. This pattern may show that the area remains the same, reduces, or increases, with scaling as follows (Table 12):

TABLE 12. CLASSIFICATION OF THE POTENTIAL DISTRIBUTION AREA BY 2050

Potential distribution area to 2050	Scaled value
The potential distribution area of the species showed an increase by 2050	1
The potential range of the species remained the same as today.	0.85
The potential range of the species decreased from 10% to 20%	0.70
The potential range of the species decreased from 20% to 40%	0.55
The potential distribution area of the species decreased from 40% to 70%	0.40
The potential distribution area of the species decreased from 70% to 99%	0.25
The species' potential distribution area will disappear by 2050.	0.1

VII.1.6.2. Connectivity of the home range

To evaluate the spatial continuity of the home range, the Volgelmann Index (FCI) applied to the scale of the project area will be used. The formula is composed as follows:

$$FCl = \ln\left(\frac{\Sigma A}{\Sigma P}\right)$$

Where:

FCI: Vogelmann index of spatial continuity

Σ A: Total surface area of forest patches in the landscape (m^2)

Σ P: Total perimeter of forest patches in the landscape (m)

Values less than zero indicate a landscape with spatial continuity, while values higher represent areas of greater discontinuity and fragmentation of the patches.

TABLE 13. VALUES OF THE SPATIAL CONNECTIVITY OF THE VITAL AREA

Index value	Spatial continuity	Scaled value
< 0	Continuous	1
0.10 - 5	Discontinuous	0.5
> 5	Highly discontinuous	0.1

VII.1.6.3. Threats to the species at the site

The assessment of threats faced by species is a fundamental step for biodiversity conservation. This information makes it possible to identify the factors that put the survival of a species at risk in a given area, and consequently, assist in the development of appropriate management strategies for its protection.

Biodiversity conservation depends largely on understanding and effectively managing the threats that species face in their habitats. A systematic assessment of these threats is crucial to developing sound conservation strategies and ensuring long-term species survival. To evaluate threats to the target species, a prediction and assessment methodology will be used.

Threat prediction: Estimates the probability of the occurrence of the identified threats. This prediction must be made based on a comparative analysis of the impacts identified in the baseline.

To determine the prediction of the threat, the following measurement parameters must be considered:

TABLE 14. MEASUREMENT PARAMETERS FOR THREAT PREDICTION

Value	Description
1	Improbable
2	Unlikely
3	Likely
4	Very likely

Threat assessment: Assign a quantitative value to the threats identified in the project area that put at risk or compromise the presence and habitat of the target species. The identified impacts must be assessed in accordance with their nature by applying a rating scale for each of the following minimum attributes:

- **Temporality:** It defines the duration of any threat over time and can range from short-term to permanent, be reversible or irreversible, and its occurrence can vary.

- **Space:** It defines the spatial extent of any identified threat and can extend from a local to a regional/international level.
- **Gravity:** Defines the level of intensity of the threats and their impacts.

For the assessment of each threat, the results will be integrated into the rating scale to assign a score to each range into which it is divided and contrasted using the significance classification, as shown in Table 15.

TABLE 15. MEASUREMENT PARAMETERS FOR THREATS ASSESSMENT

Threat assessment	Description		Value
Temporality	Short term	<5 years	1
	Medium term	From 5 to 20 years	2
	Long term	From 20 to 40 years	3
	Permanent	> 40 years	4
Spatiality	Habitat		1
	Project area		2
	Area of influence		3
	Location		4
	Municipality		5
	State		6
	National/Regional		7
	International		8
Gravity	Potential	The threat exists, but there is no evidence that it is affecting the habitat or the species.	1
	Low	The threat is affecting the habitat or the species, but the impact is minimal. Monitoring and management measures can be implemented to prevent the threat from escalating.	2
	Moderate	The threat is affecting the habitat or species significantly. More intensive management measures are required to mitigate the impact of the threat.	4

Threat assessment	Description		Value
	Serious	The threat is endangering the survival of the habitat or the species. Urgent conservation measures are required to avoid total or partial loss.	6
	Imminent	The threat is imminent and there is a high risk of total loss of habitat or species. Immediate, large-scale action is required to save them.	8

Below are the threats that, at a minimum, should be considered for the analysis of each species (Table 16).

TABLE 16. EVALUATED THREATS

Threat	P	T	E	G	**Scoring** Sum of P+T+E+G
Habitat loss due to conversion to agricultural or livestock land					
Habitat loss due to urbanization					
Loss of habitat due to the installation of any infrastructure other than urbanization					
Increase in fragmentation or barriers that prevent the movement of species					
Water and soil pollution					
Introduction of harmful chemical substances into the environment (pesticides, fertilizers, oil spills, and/or industrial waste)					
Deforestation					
Forest fires					
Illegal wildlife trafficking					
Illegal extraction of the species for own consumption					
Unregulated tourism / inadequately regulated tourism					
Illegal hunting					
Invasion of exotic species					

Threat	P	T	E	G	**Scoring** Sum of P+T+E+G
Competition with other species for resources or space					
Spread of diseases or pests					
Droughts					
Floods					
Cyclones/storms					
Earthquakes/earthquakes					
Volcanic eruptions					
				Summation	

Probability (P); Temporality (T); Spatiality (E); Gravity (G)

Finally, based on the assessment and characterization of the threats, the significance will be determined, and they will be classified and weighted from low to very high, following the values and criteria established in Table 17.

TABLE 17. VALORIZATION OF THE SIGNIFICANCE OF THE THREAT

Description	Scoring	Level
• The threat has no significant impact on the habitat or the species. • The threat is unlikely to cause long-term damage.	4 - 7	Very low
• The threat has little impact on the habitat or the species. • It is possible that the threat will cause some long-term damage. • Monitoring measures can be implemented to assess the impact of the threat.	8 - 11	Low
• The threat has a moderate impact on the habitat or the species. • The threat is likely to cause medium to long-term damage. • Management measures are required to mitigate the impact of the threat.	12 - 15	Average
• The threat has a significant impact on the habitat or the species. • The threat is likely to cause serious damage in the short to medium term. • Urgent conservation measures are required to address the threat.	16 - 19	High

Description	Scoring	Level
• The threat has a critical impact on the habitat or the species. • There is a high risk of total loss if immediate action is not taken. • Large-scale conservation actions are required to save the habitat or the species.	20 - 24	Very high / Critical

To scale the value of the threats (Table 18), the total sum of the scores must be made and the general value will be classified as follows:

TABLE 18. SCALE OF THREATS

Total score	Scaled value
80 to 140	1
141 to 220	0.8
221 to 300	0.5
301 to 380	0.3
381 to 480	0.1

VII.1.6.4. Effectiveness of the conservation measures implemented (CM)

To evaluate the measures implemented for conservation, the threats that have been identified in the previous section (VII.1.6.3) and the effectiveness of the activities carried out by the project developer based on the list of eligible activities will be used. from Table 1.

Threats: Those that have obtained a level of significance from low to very high will be selected, which will be weighted according to the following values (Table 19):

TABLE 19. WEIGHTING OF THREATS

Threat level	Weighting
Low	0.25
Average	0.50
High	0.75
Very high	1

Effectiveness of the measures: For each threat, the specific conservation measures implemented to address it will be identified. The effectiveness of each measure will be determined and classified based on its response to the impact: very low (0.1), low (0.25), medium (0.50), high (0.75), and very high (1).

Subsequently, the level of threat will be compared against the effectiveness of the measures using the criteria outlined in Table 20.

TABLE 20. MATRIX TO EVALUATE THE EFFECTIVENESS OF MEASURES

Threat	Threat level (NA) (Low: 0.25) (Average: 0.50) (High: 0.75) (Very high: 1)	Measurement effectiveness (ME) (Very low: 0.1) (Low: 0.25) (Average: 0.50) (High: 0.75) (Very high: 1)	Unaddressed risks: (NA – ME) * 0.90
1.			
2.			
…			
		Total sum of unaddressed risks	

It is important to highlight that, although the measures implemented play a fundamental role in protecting biodiversity and reducing the negative impacts of human activities or extreme climate events, no conservation work can completely eliminate anthropogenic risk or climate change. As such, there will always be a certain level of residual risk since threats to biodiversity are complex, dynamic, and interconnected, and it is not always possible to fully control or mitigate them. Therefore, said residual risk is generally considered to be 10%, so in the unaddressed risk formula, the value obtained is multiplied by 0.90.

Once the analysis is completed, the following formula must be applied to obtain the effectiveness of the conservation measures implemented:

$$\mathbf{MC} = \frac{\Sigma \text{ RA}}{\Sigma \text{ TA}}$$

Where:

RA: Risks addressed, which will be the difference in the total number of threats minus the total sum of risks not addressed.

TA: Total threats, which will be the total sum of the threat levels (NA).

VII.1.7. Leakage factor (L)

The leakage factor in biodiversity assessment will be made using the species that are identified in the project area and that have any national or Red List protection status, or that are endemic, called "protected species" since their presence will be an indicator of the ecological conditions of the site.

To evaluate the leak factor, the following formula will be considered:

$$\boldsymbol{L} = \frac{(EP)(TAD)}{(TE)(TAP)}$$

Where:

EP: The number of protected species that were no longer found during inventories after project implementation and monitoring.

TE: The total number of protected species that were inventoried in the baseline or reference information.

TAD: The average size of the distribution area of protected species in the project area.

TAP: The size of the project area.

VII.1.8 Additionality (A)

Additionality refers to ecological benefits or improvements in the conservation of species that would not have occurred without the implementation of the Project. Additionality (A) in the projects will be measured from the following equation:

$$\boldsymbol{A} = (H\_pre - H\_post + MC) \cdot (1 - L)$$

Where:

H_pre: Habitat quality before the project

H_post: Post-project habitat quality

MC: Conservation measures implemented (see section VII.1.6.4)

L: Leakage factor

VII.1.9. Saturation coefficient (K)

The species accumulation curve (SAC) represents the relationship between sampling effort and the number of species recorded in a given area. The parameter K of the SAC, known as the saturation coefficient, is a useful indicator for evaluating the completeness of sampling and the potential presence of new species at a site.

Biodiversity finite represents the total number of species present in an area. By comparing the value of K over time, it is possible to evaluate the effectiveness of conservation measures implemented in terms of increasing species richness or population recovery; an increase in the value of K could indicate a positive impact of conservation measures.

During each monitoring and data collection in the field, the SAC will be prepared (see example Image 5) to evaluate the behavior of the curve based on the number of species recorded in each inventory.

The coefficient K will be calculated from the Chao 2 estimator, applying the following formula:

$$\boldsymbol{K} = \frac{\mathrm{S(n)} \cdot (\mathrm{S(n-1)} - 1)}{\mathrm{f(n-1)} - \mathrm{f(n-2)}}$$

Where:

S(n): Total number of species recorded in n units of sampling effort.

f(n): Number of species captured for the first time in n units of sampling effort.

A high K (greater than 1) will indicate that you are approaching a horizontal asymptote, showing that most species have been discovered and the additional sampling effort is unlikely to result in a large increase in the number of species recorded.

While a low K (less than 1) presents a steep slope, suggesting that many species remain to be discovered.

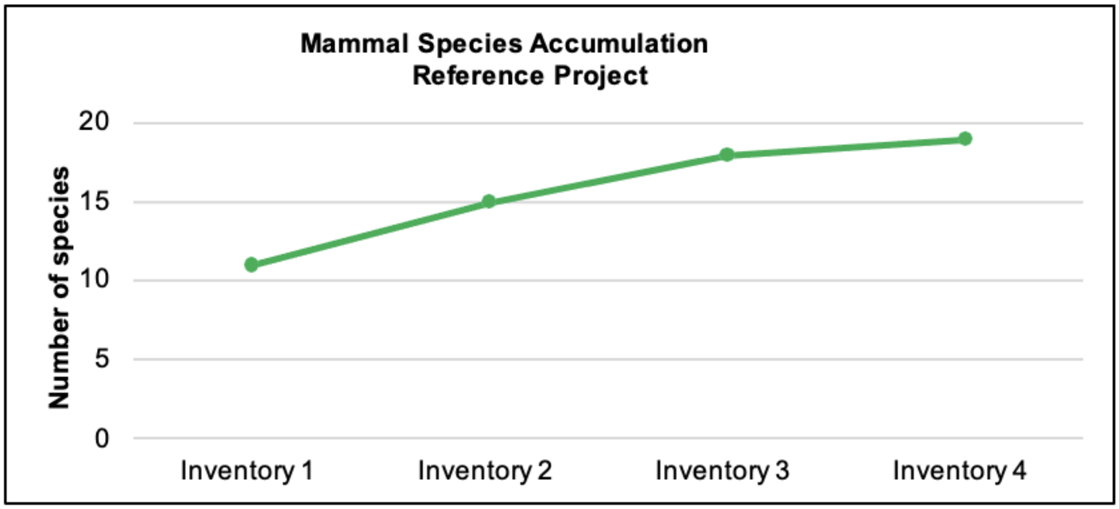


IMAGE 5. EXAMPLE OF THE SAC

VII. MONITORING

The monitoring of the biodiversity of each project must be carried out within the timeframe indicated in the Schedule in Image 3. Following each inventory, the number of credits issued for the benefits generated will be determined based on the baseline results. Using the baseline as a reference, the project should not exhibit any declines over its duration.

Consequently, monitoring must assess each parameter analyzed in the baseline to ensure the project is achieving the expected outcomes.

TABLE 21. PARAMETERS CONSIDERED IN MONITORING

Parameter: Habitat quality (H)	
Description	The habitat quality index should show an increase due to Project activities.
Equation	$\boldsymbol{H} = C \cdot Q \cdot D \cdot F$
Source of information	Information collected during inventories.
Parameter: Area of vital area of the target species (HR)	
Description	The surface area of the vital area should show an increase due to Project activities.
Equation	Area (ha)
Source of information	Information generated through the analysis of the species' habitat based on the information collected during on-site inventories and geographic information.
Parameter: Diversity Index (BI)	
Description	The biodiversity index should show an increase due to Project activities.
Equation	$H = -\sum_{i=1}^{S} pi \cdot \ln(pi)$
Source of information	Information collected during inventories.
Parameter: Fragmentation (F)	
Description	The fragmentation index should show a decrease due to Project activities.

Equation	$$Fragmentation = \frac{Forest\ area}{Total\ area}$$
Source of information	Information generated through the analysis of the species' habitat based on the information collected during on-site inventories and geographic information.
Parameter: Normalized Difference Vegetation Index (NDVI)	
Description	The normalized difference vegetation index should show an increase due to Project activities.
Equation	$$NDVI = \frac{NIR - R}{NIR + R}$$
Source of information	Information generated through satellite images.
Parameter: Saturation coefficient (K)	
Description	The K coefficient greater than 1 will indicate that it is approaching a horizontal asymptote, indicating that most species have been discovered.
Equation	$$\boldsymbol{K} = \frac{\mathrm{S(n)} \cdot (\mathrm{S(n-1)} - 1)}{\mathrm{f(n-1)} - \mathrm{f(n-2)}}$$
Source of information	Information collected during inventories.

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