Biodiversity Value Associated with FSC Forest Management Certification in Brazil

Final Report

Forest Stewardship Council®

CASA DA FLORESTA

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Teamwork

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Contents

Companies participating in the project

Company Name
4M Agroflorestal
Agrocortex
Arauco
Brasilwood
CENIBRA - Celulose Nipo-Brasileira S.A.
CMPC Celulose Riograndense
Dexco
Eldorado Brasil Celulose
Klabin S.A.
Mil Madeiras Preciosas – Precious Woods
Eucatex
Palmasola
Solufor Soluções Florestais
SR4 Soluções
Suzano S.A.
Sylvamo do Brasil
TTG Brasil
Veracel Celulose S.A.

1. Scope of the Project

Although the Ecosystem Services Procedure (FSC-PRO-30-006 V1-2 EN) makes possible that certified forest managements demonstrate and verify their impact on biodiversity voluntarily, this project intends to explore the possibilities to strengthen the monitoring, reporting and communication of biodiversity value as part of Forest Management (FM) certification, without using FSC-PRO-30-006. For this purpose, FSC International is conducting a project to improve the understanding of FSC value for biodiversity conservation. The project has two objectives:

1. Understand current monitoring efforts and value currently available data to assess biodiversity in FSC-certified forests; and

2. Advance the development of a globally consistent and robust monitoring framework for biodiversity in FSC-certified forests.

In this regard, the objective of the project conducted by Casa da Floresta Ambiental is focused on objective 1 and aim to explore biodiversity value at a country level, involving FSC Forest Managements Certificate Holders (FM CH) located in Brazilian territory. For this purpose, the project requires a representative sample of the whole certified area in Brazil, obtained through data acquisition from a maximum of certificate holders and/or from certificate holders with large forest area.

1.1 Scope of Work

The present project entails the following tasks:

1.1) Compile information about current monitoring efforts conducted in FSC-certified forests by FSC FM Certificate Holders;

2.1) Compile datasets and information from monitoring efforts related to biodiversity conducted by FSC FM CHs (from FM audit reports and direct engagement with CHs);

2.2) Identifying how FSC standards and national legislation differ and data sources;

2.3) Plan for data analysis;

2.4) Conduct analysis of biodiversity-related data;

2.5) Write report; and

2.6) Present results as part of workshops.

The tasks for the project are divided into the following deliverables (Table 1.1.1):

Table 1.1.1: Expected deliverables for the current project.

Deliverable Name	Description
1.1 Report on current monitoring efforts	A clean, well-structured and consistent **table** containing information on at least the following elements for each of the selected FSC FM certificate holders: - Description of data being collected. - Methodologies, approaches and tools used for monitoring and data collection (e.g., internal staff vs consultancy, interviews, traditional inventory methodologies (transects and plots), modern tools (remote sensing, drones, eDNA, camera traps, bioacoustics). - Costs estimates associated with monitoring and data collection (in man/day, money/year). - Reasons for monitoring (e.g., compliance with FSC P8, sustainability reporting, management plan, national legislation...).
2.1 Biodiversity datasets	Clean and curated **datasets** related to biodiversity offering potential for data analysis.
2.2 Summary table of FSC added value	A clear **table** summarizing: a. how FSC-certified forest management and its potential outcomes differ from that of uncertified forestry. Are FSC requirements different from national legislation? Where and how are FSC requirements likely to preserve biodiversity? b. Data sources that could be used to run actual comparisons.
2.3 Biodiversity data analysis	A clean, well-structured and FSC-agreed **description** of the data analysis to be conducted on the compiled datasets and their associated foreseen reporting visualizations (e.g., graphics).
2.4 Results of biodiversity data analysis	The **full set of raw data** used; results from analysis and associated data visualizations.
2.5 Final Report	A clean, well-structured and edited **final report** containing other deliverables and conclusions from data analysis pertaining to biodiversity conservation in FSC-certified forests.
2.6 Present main results and deliverables	The main results and learning associated with the deliverables will need to be presented to key stakeholders of the project. The meeting will be organized by FSC. Two **presentations** of each ca. 60min are foreseen.

1.2 Initial Considerations

To avoid misunderstandings throughout this report, it is important to emphasize some initial considerations:

- All analyses presented in this report were conducted using data willingly shared by the Certificate Holders (CHs) participating in this project. They do not represent the entire scenario of FSC-certified forests in Brazil, but rather a sample of it.
- All Certificate Holders are being treated anonymously, and that we cannot conduct direct comparisons with uncertified forests due to Brazilian law (Data Protection General Law), which prohibits the sharing of personal data.

1.3 Overview of Certificate Holders participating in the project

We consulted the FSC Public Certificate Search (FSC, 2024) to obtain a list with valid Forest Management Certificate Holders (FM CHs) in Brazil. After having contacted over than 50 CHs of 158 FM CH in Brazil, we received data from 30 of them.

The prioritization criteria for establishing contact with the Certificate Holders were determined based on:

i) planted forests;

ii) the longevity of the forest certifications;

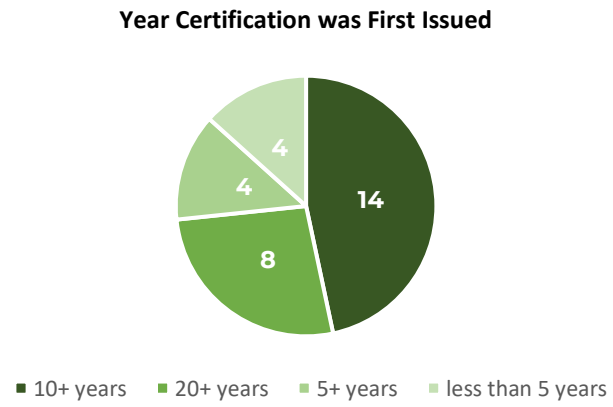
iii) large corporations with established market presence, and;

iv) facilitated communication with partner corporations for past biodiversity monitoring projects.

As an additional criterion, we contacted Native Forest Management CHs to enhance our understanding of practices on biodiversity monitoring in Brazil. Out of the 30 CHs, two belong to the Native Forest Management sector; however, one of these companies did not provide monitoring data, only raw biodiversity data, which is presented in Topic 3 (Deliverable 2.1).

The database of forest-based companies incorporated in this project was obtained by two distinct questionnaires. The first one refers to company-specific information about monitoring biodiversity and efforts (*Annex 1*), while the second one encompasses all the raw data obtained by biodiversity monitoring initiatives undertaken by the Certificate Holders (*Annex 2*).

Furthermore, most of the participants have held their certificates for over 10 years, as indicated in the graph below (Graph 1.3.11).



Graph 1.3.1: Number of Certificate Holders participating in the project related to the year their FSC FM Certificate was first issued.

Additionally, out of the 30 participating FM CHs, only 8 are certified for Ecosystem Services, all with over 10 years of certification — five with 20+ years and three with 10+ years.

All the analysis presented in this report were conducted using data shared by the 30 Certificate Holders (CHs) participating in this project.

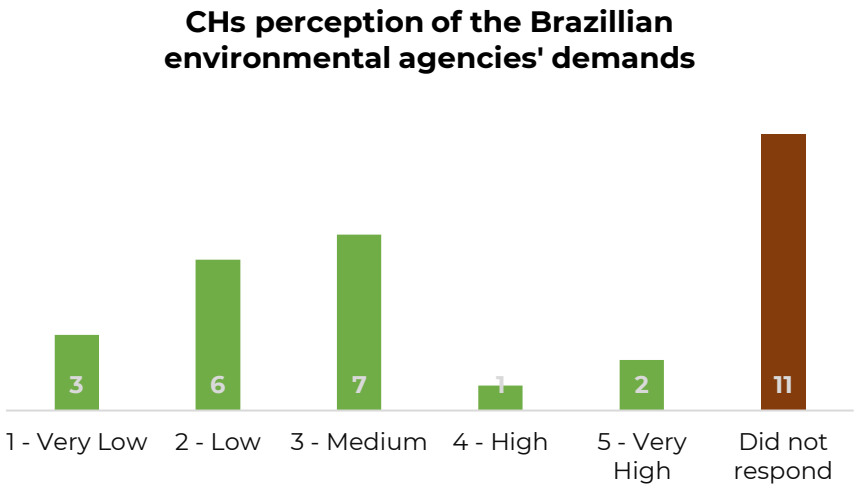
2. Overview of Deliverable 1.1

The Deliverable 1.1 focuses on the data acquired from the first questionnaire (*Annex 1*) and the "Monitoring methods" in the second one (*Annex 2*). We used the information from those questionnaires to estimate costs for monitoring efforts and to understand the CH interests and concerns related to monitoring biodiversity, as it will be described in the following topics.

2.1 Monitoring efforts

The table with all the summarized data was sent to FSC International as an xlsx file named "FSC_CDF_Deliverable1-1_Table." This data shows specificities of each CH along with their monitoring efforts, including what biological groups are studied, where, and what type of data is used.

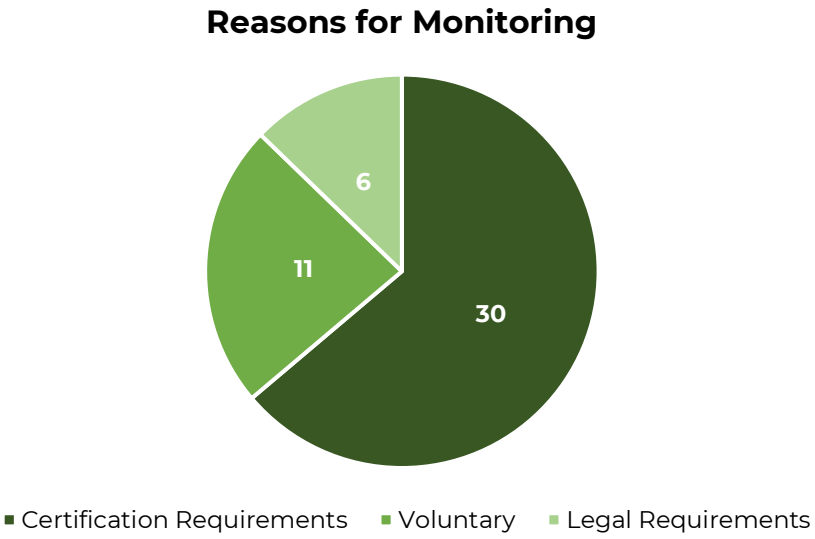
To have a better understanding of the CHs' efforts, we need to look at how Brazilian environmental laws match up with FSC standards. Understanding this connection is essential to identify the additional conservation benefits FSC certification offers, particularly in monitoring biodiversity, the focal point of this project. The following graph (Graph 2.1.1.2) illustrates the CHs perception of demands from Brazilian environmental agencies, offering initial insights into this discussion. It is worth noting that CHs operates across multiple states, leading to varied perceptions depending on their political and geographic scope.



Graph 2.1.1.2: Certificate Holders perception of demands from Brazilian environmental agencies.

Most of the Certificate Holders indicated that, overall, environmental agencies exhibit low levels of demand regarding biodiversity conservation and monitoring efforts, with 9 responses rating their demands as "very low" or "low." Additionally, a notable portion of CHs (11) chose not to respond to the question.

Unfortunately, although Brazilian legislation emphasizes the importance and obligation of biodiversity protection and conservation, there is a lack of effective legal mechanisms to ensure that companies are fulfilling their duty effectively. Moreover, the FSC Principle 8.2. requires regular monitoring and evaluation of environmental and social impacts of the activities carried out in the management units, and changes in its environmental condition, which includes biodiversity monitoring. The following graph (Graph 2.1.1.3) outlines the reasons for monitoring biodiversity described by the CHs participating in the project.



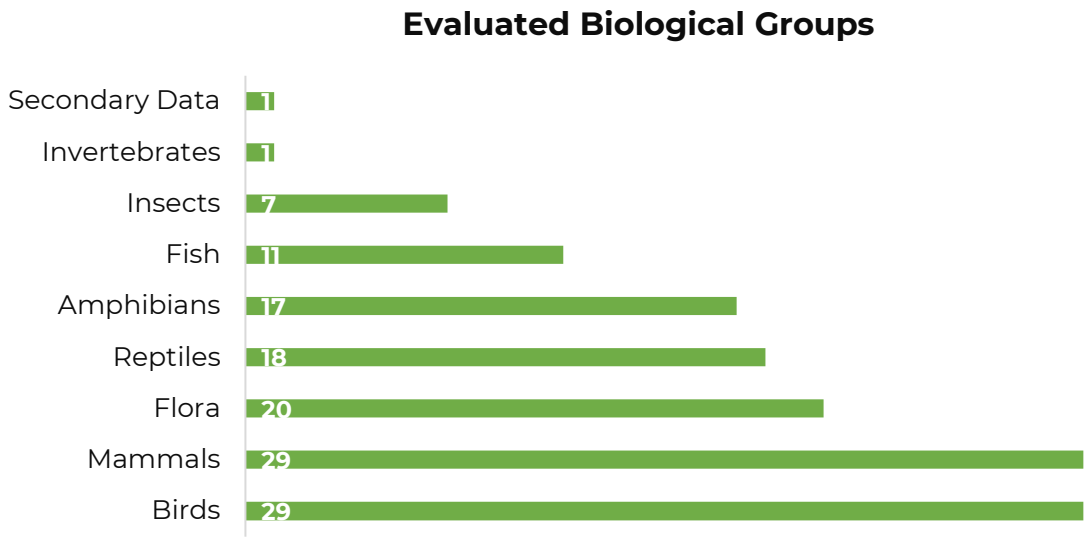
Graph 2.1.1.3: Reasons for Monitoring described by the Certificate Holders.

All participating CHs monitor their biodiversity as mandated by certification requirements. Some CHs voluntarily engage in monitoring activities, such as researches. Furthermore, six CHs conduct specific monitoring activities as mandated by legal requirements, particularly involving environmental licensing for activities or operations impacting environmental resources. Further discussion on legislation is provided in Topic 4 (Overview on Deliverable 2.2).

2.1.2 Overview on Monitoring efforts

The biodiversity monitoring efforts of the CHs primarily focus on groups such as birds, mammals, reptiles, amphibians, and flora. These groups face significant threats, are cost-effective for conducting monitoring activities, and are usually necessary to fulfill legal

requirements. However, some monitoring activities also includes fish, insects, and other invertebrate groups. The following graph (Graph 2.1.2.1) illustrates this categorization based on the responses of the CHs.



Graph 2.1.2.1: Evaluated Biological Groups by each Certificate Holder participating in the project.

Based on the information gathered from the first questionnaire (Annex 1), we observed that the monitoring activities of these CHs are primarily conducted by third-party entities (19), with many companies opting for environmental consultancy services. Some CHs conduct these activities using both their own team and third parties (8), while a minority solely rely on their own team for monitoring (3).

The methodologies, approaches, and tools utilized for monitoring and data collection, along with estimated associated costs, are detailed in the following topic.

2.2 Methods Database

The methods database consists in a table containing information on methodologies, approaches and tools used for monitoring and data collection, along with estimated costs associated. This table was build based on the responses gathered from one of the questionnaires provided to the CHs (Annex 2), specifically in the "Monitoring Methods" section. This table was submitted to FSC International in an xlsx file named “FSC_CDF_Deliverable1-1_Table”.

The methods employed by companies for monitoring biodiversity varied, although some methods are used more frequently than others. To summarize and standardize the methods employed by CH, descriptions were combined if they represented similar sample structure designs. To gain a better understanding of each method, descriptions are provided below.

Camera traps (CT)

These cameras have sensors that are triggered by motion and/or heat and are used to study many different species over long time periods, aiding in presence/absence, population estimation and behavior observation.

Transects (TRAN)

A designated path for standardized observations and measurements, walked to count species, by direct or indirect evidence (e.g., footprints, feces, burrows, carcass etc.), or assess habitat and landscape characteristics. It can be employed to monitor both animals and plants.

Visual Encounter Survey (VES)

A method that actively surveys the area, noting species, behavior and abundance. It can focus on specific habitats (e.g., for amphibians it is mainly used in reproduction sites), and in different periods to gather differences between day and night species.

Point Counts (PC)

Observers count species within predefined points or circles. This method is primarily used for birds, which can be detected by sight or sound by a single observer stationed at a fixed position for a specified period (e.g., 10 - 15 minutes). Counts are typically conducted in the morning, especially during the breeding season when birds are most vocal and territorial. However, it can also be performed at night to focus on specific nocturnal species.

Traps (TRAP)

Summarizes all the kinds of devices used to capture and/or collect animals with the propose of monitoring biodiversity. For birds, it is common the use of mist nets, rocket nets and Heligoland trap. For mammals, reptiles and amphibians it can be used for example box traps, funnel traps, pitfall traps and live traps (Tomahawk and Sherman). For fish and invertebrates, it is common the use of trawl nets, gill nets, standby nets, sieves and light traps.

MacKinnon Lists Technique (MACLIST)

A method that involves compiling a systematic inventory of bird species within a specific ecological region. It involves creating multiple list samples (e.g. 20 lists per study area), with each list containing the names of 10 species identified by sight or sound, without repetition. As each list is completed, another is initiated, offering valuable insights into the richness and abundance of species within the area.

Sand Plots (SP)

Areas with sand patches are monitored to track animal footprints and presence.

Permanent Plots (PP)

Fixed areas that are repeatedly measured or observed to track long-term changes in biodiversity, providing insights into forest development, succession, and/or carbon stock.

Temporary Plots (TP)

Temporary sampling areas that are established for short-term biodiversity assessments.

Casual Encounters (CE)

Sporadic observations of species made during regular activities or incidental encounters.

Unmanned Aerial Vehicle / Drone (UAV)

Remote-controlled aircraft equipped with cameras or sensors that capture aerial images for habitat mapping and species surveys. It is also being used for monitoring illegal activities (e.g., forest suppression, logging).

Light Detection and Ranging (LiDAR)

Laser-based technology that measures distances to generate high resolution and 3D maps for habitat assessment and forest structural analysis.

Ultrasonic Speakers (US)

Acoustic equipment used to capture quality ultrasonic bat vocalizations and conduct surveys.

Despite the fact they were not listed, some revolutionary methods are being used on biodiversity assessments during last years: eDNA and bioacoustics monitoring devices. Both methods are non-invasive and emerge as a cost-effective alternative for classic methods of biodiversity assessments or a strong tool to complement the understanding about the biota. In fact, a wide range of animal and plants can be detected using DNA dispersed in single samples of soil or water, processed, and analyzed in a relative short-term. The bioacoustics devices can capture birds, amphibians and other environmental sounds and has been highly used in innovative projects across the world. Depending on process costs and service availability, these, and other new methods, can be adapted and used on monitoring programs.

2.2.1 Overview on Methods Database

The Methods Database table provides comprehensive data on the monitoring efforts undertaken by each certificate holder. In total, the table documents 70 monitoring activities for birds, 70 for mammals, 31 for flora, 33 for herpetofauna (reptiles and amphibians, which are generally sampled together), 9 for ichthyofauna (fish), and 6 for entomofauna (insects).

The most frequent employed methods by biological group are presented in the table below (Table 2.2.1.1)

Table 2.2.1.1: Most frequent sample methods employed by the CHs participating in the project, by biological group.

Biological Group	Most Frequently Employed Method by Biological Group	
	Method	
	1st	2nd
Birds	Point Counts	Transects
Mammals	Camera Traps	Transects
Flora	Permanent Plots	Transects
Herpetofauna	Visual Encounter Survey	Transects
Ichthyofauna	Traps	-
Entomofauna	Traps	Visual Encounter Survey

It is interesting to note that transects are being used as a complementary method in the sample activities for most biological groups. Additionally, it is important to highlight that the methods database does not necessarily represent all the efforts employed by the Certificate Holders. It may have some gaps or alterations in the methods adopted over the years. Besides, some CHs did not brought clarity in some efforts (e.g., sample units, number

of sampled areas) and might carry inconsistencies. Our results shows that a standardized dataset should be useful for the Brazilian forestry sector to improve the understandings about biological data on certified forest managements.

2.2.2 Cost estimation

The cost estimation presented in the Deliverable 1.1 table "Methods Database" was formulated based on some premises and considering previous experience with monitoring projects that Casa da Floresta Ambiental developed. The premises are:

1. The total cost comprises all human resources used for fieldwork and other office activities (reports, databases, taxonomic identification, etc.);

2. The cost are estimated based on medium wages under Brazilian Work Legislation, estimated in January 2024;

3. Costs may vary depending on the distance between farmlands, tickets, equipment, materials, the necessity of 4x4 vehicles, local access conditions and other;

4. VAT is included in the values and can vary (municipalities and states have different percentages);

5. Considering a consulting company carrying on fieldworks - profit included;

6. Administrative costs are included (work safety, courses, office, tax, softwares, etc.);

7. Management and Administrative staff hours are included;

8. Some CH carry out fieldwork with their own staff or in partnership with universities - in these cases, the costs are significantly lower than this estimation;

9. The cost estimation was indirectly calculated based on workdays estimated by effort information provided by CH - some imprecisions are expected;

10. Airfares and transfers, when necessary, are not included.

The table below summarizes the average cost of monitoring each biological group annually considering all the Certificate Holders participating in the project.

Table 2.2.2.1. Average cost of monitoring activities documented by the CHs participating in the project.

Biological Group	Average cost (€/year/CH)	Monitoring activities documented
Flora	7.206,09 €	31
Birds	5.511,00 €	70
Mammals	5.032,31 €	69
Herpetofauna	4.535,78 €	33
Entomofauna	4.432,24 €	6
Ichthyofauna	3.990,72 €	9

2.3 Key Findings of Deliverable 1.1

Reasons for monitoring biodiversity

While Brazilian legislation mandates biodiversity protection and conservation, the enforcement mechanisms lack effectiveness. Additionally, Certificate Holders (CHs) tend to rate the demands of Brazilian environmental agencies as very low, low, or medium. In contrast, FSC Principles require CHs to regularly monitor and evaluate the environmental and social impacts of their activities, and the primary motivation for monitoring biodiversity, as identified by CHs, is to meet Certification Requirements. By mandating monitoring and evaluation processes, the FSC ensures that CHs are held accountable for their environmental stewardship beyond legal obligations.

Monitoring efforts

The monitoring methods employed by companies for monitoring biodiversity varied considerably, although some methods as camera traps, point counts, permanent plots, visual encounter survey, transects and traps are used more frequently than others. Considering the average cost of monitoring activities, those were estimated based on some premises, but we can conclude that Certificate Holders primarily focus their efforts and allocate most of their resources towards monitoring birds, mammals, and flora

3. Overview of Deliverable 2.1

The Deliverable 2.1 is related to the biodiversity data obtained in the questionnaire present in Annex 2. This dataset encompasses all the raw data obtained by biodiversity monitoring initiatives undertaken by the CHs and was submitted to FSC International in an xlsx file named "FSC_CDF_Deliverable2-1_BiodiversityDataset".

We received 882.020 records of monitoring activities across various federative units and biomes in the monitored areas. Further exploration of the dataset will follow in the sections below.

3.1 Geographic Coverage

The data gathered covers 13 Federative Units (UFs) comprising 367 Municipalities. However, 7.695 records lack information about the municipality. The following table (Table 3.1.1) and figure (Figure 3.1.1) displays information about the distribution of municipalities across each Federative Unit.

Table 3.1.1: Distribution of municipalities across each Federative Unit (UF) with biodiversity data recorded.

Federative Unit (UF)	Municipalities with biodiversity data recorded
São Paulo (SP)	86
Minas Gerais (MG)	59
Paraná (PR)	52
Rio Grande do Sul (RS)	51
Santa Catarina (SC)	41
Espírito Santo (ES)	30
Bahia (BA)	13
Mato Grosso do Sul (MS)	13
Maranhão (MA)	10
Amazonas (AM)	4
Mato Grosso (MT)	3
Pará (PA)	3
Tocantins (TO)	2
Total	**367**

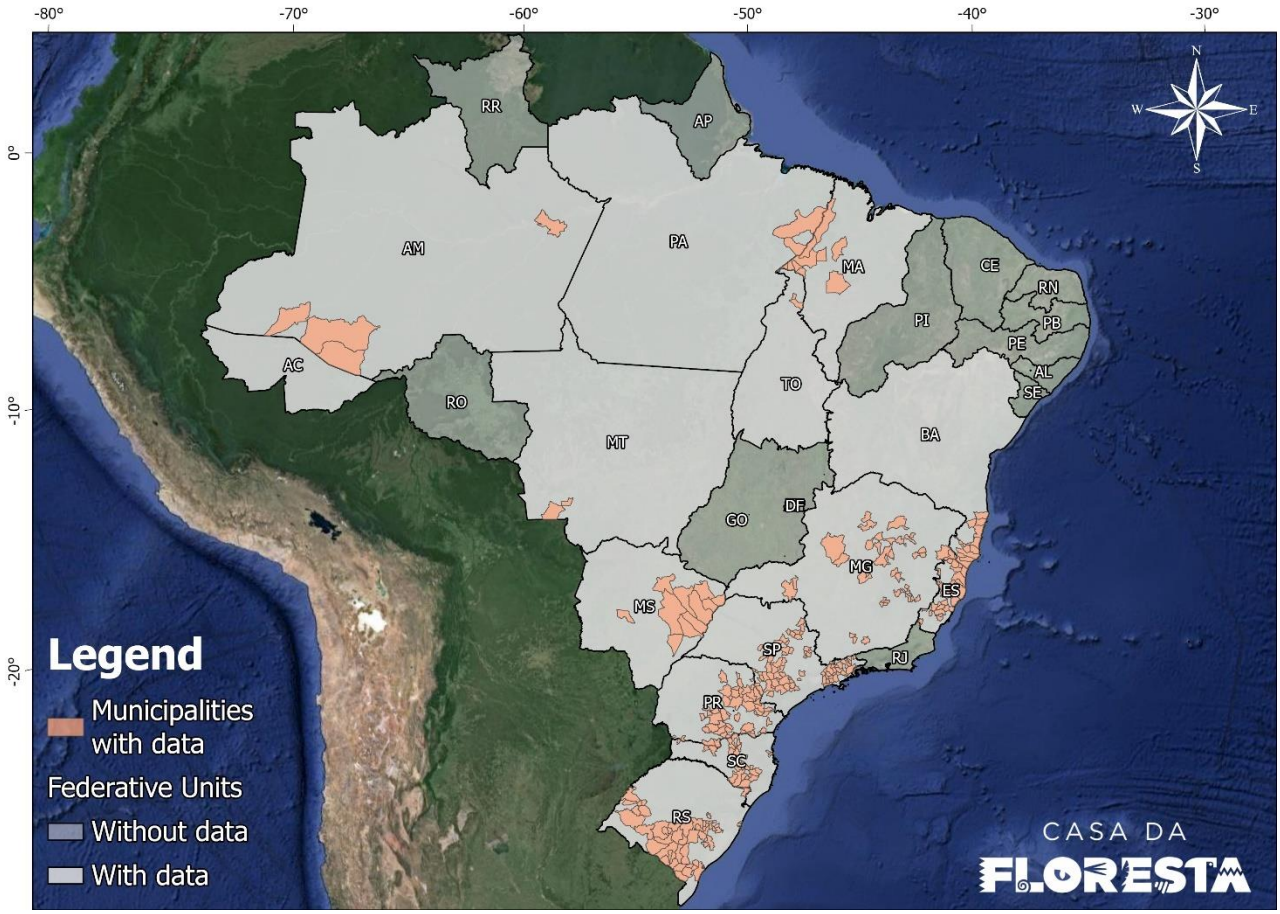


Figure 3.1.1: Distribution of municipalities across each Federative Unit with biodiversity data collected.

This Project covers the most representative regions of planted forests in Brazil. According to the Brazilian Industry Trees' 2023 Annual Report, planted forests are located mainly in the Southeast and West Central region, and the most representative states are: Minas Gerais (MG – 29%), Mato Grosso do Sul (MS – 15%) and São Paulo (SP – 13%). Besides, the South region leads the pines planted forests, especially the state of Paraná (PR; IBÁ. 2023).

Overall, out of a total of 8,87 million hectares of FSC-Certified forested area in Brazil, according to FSC Public Certificate Search (FSC, 2024), we obtained data from CHs covering 5,16 million hectares of certified forested area, representing nearly 58% of the national panorama for planted trees.

3.2 Overview on Biodiversity Dataset

We gathered a substantial amount of data of biodiversity records, totaling 882.020 lines (or records). Each record presents information about the species observed, including their name, location, biological group, and the method used to gather the data. For more information, see Annex 2.

In some cases, the record is not identified at species level, but for example at gender (5.032 records) or at biological group level (50.063 records).

Overall, our efforts resulted in 825.931 records, with a total of 7.158 species identified recorded. It is important to highlight that some subgroups from certain species were also recorded. Another cautious point is that, even passing all the raw data by a taxonomic update, some species may be duplicated, but not in a significant level, due to taxonomic synonyms.

The table below (Table 3.2.1) presents the distribution of the data according to their biological group.

Table 3.2.1: Distribution of data according to their biological group.

Biological Group	Total Obtained Data (species identified)	Number of Species Identified
Bird	514.392	1.217
Flora	226.470	4.967
Mammal	61.412	220
Amphibian	18.842	224
Reptile	3.466	184
Fish	937	118
Arthropod	374	190
Polypore	38	38
Total	**825.931**	**7.158**

The destruction of habitats poses a significant threat to Brazilian biodiversity, which is already highly vulnerable. In the data obtained we recorded a significant number of threatened species in different categories according to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. The following table (Table 3.2.2) presents the distribution of the species observed according to the IUCN Red List.

Table 3.2.2: Distribution of data according to the IUCN Red List Categories and Criteria.

IUCN Red List Categories and Criteria	Total Obtained Data (species identified)	Unique Species Identified
Extinct (EX)	2	1*
Extinct in the Wild (EW)	2	1**
Critically Endangered (CR)	1487	27
Endangered (EN)	4067	105
Vulnerable (VU)	22838	181
Near Threatened (NT)	11049	127
Least Concern (LC)	699486	3515
Lower Risk: Conservation Dependent (LR/cd)	254	6
Lower Risk: Near Threatened (LR/nt)	1446	22
Lower Risk: Least Concern (LR/lc)	837	3

Data Deficient (DD)	4330	36
Not Evaluated (NE)	80134	3135
Total	**825.931**	**7.161**

***Chrysophyllum januariense* - Classified as Extinct (EX) on IUCN Red List. However, since its last evaluation by the IUCN, other individuals have been recorded in the states of Bahia, Espírito Santo and Rio de Janeiro (Sossai & Alves-Araujo, 2017).
****Brugmansia arborea* – It is an exotic species from Brazil and probably it was found in a cultivated situation (Reflora, 2024).

The presence of species that have not undergone evaluation or classification (Not Evaluated) by the IUCN is evident. This situation arises from the IUCN's reliance on scientific data to determine the conservation status of species. In instances where a species is poorly known to the scientific community, has been recently discovered, or has undergone taxonomic updates, and in cases of limited resources to address the demands of extensive biological groups, such as in the plant kingdom, some species end up being excluded from the list (Table 3.2.3). Another exception to the IUCN classification occurred when the species is domesticated, as in the case of *Canis lupus familiaris, Bos taurus, Bubalus bubalis, Equus caballus, Felis catus domesticus, Pavo cristatus*, among others.

Table 3.2.3: Species of the phylum Chordata out of the IUCN list.

Biological Group	Species	Biological Group	Species
Bird	*Arremon polionotus*	Fish	*Trichomycterus ipatinga*
Bird	*Herpsilochmus frater*	Fish	*Trichomycterus melanopygius*
Bird	*Nystalus striatipectus*	Fish	*Trichomycterus tantalus*
Bird	*Pavo cristatus**	Mammal	*Bos taurus**
Bird	*Trogon chrysochloros*	Mammal	*Bubalus bubalis**
Fish	*Apistogramma acrensis*	Mammal	*Canis lupus familiaris**
Fish	*Austrolebias periodicus*	Mammal	*Equus asinus**
Fish	*Characidium krenak*	Mammal	*Equus caballus**
Fish	*Coptodon rendalli*	Mammal	*Felis catus domesticus**
Fish	*Cyphocharax spilotus*	Mammal	*Oligoryzomys mattogrossae*
Fish	*Cyprinus carpio**	Mammal	*Sylvilagus minensis*
Fish	*Melanorivulus ofaie*	Reptile	*Chelonoidis carbonarius*
Fish	*Neoplecostomus doceensis*	Reptile	*Hydromedusa tectifera*
Fish	*Steindachnerina biornata*	Reptile	*Trachemys dorbigni*
Fish	*Trichomycterus astromycterus*	Reptile	*Trachemys scripta*

* Domesticated species

However, in cases where it was possible to associate a species recently taxonomically updated, not found in the list, with its predecessor's name, the decision was made to assign it the classification belonging to its former name. Some examples of these situations are presented in the following table (Table 3.2.4).

Table 3.2.4: Species present on the IUCN list with their old names or synonym.

Biological Group	Species	Reference Species	IUCN
Bird	*Agelasticus atroolivaceus*	*Agelasticus cyanopus*	LC
Bird	*Attila spadiceus uropygiatus*	*Attila spadiceus*	LC
Bird	*Cyphorhinus modulator*	*Cyphorhinus arada*	LC
Bird	*Dendrexetastes devillei*	*Dendrexetastes rufigula*	LC
Bird	*Dendrexetastes paraensis*	*Dendrexetastes rufigula*	LC
Bird	*Dendrocolaptes juruanus*	*Dendrocolaptes certhia*	LC
Bird	*Dendrocolaptes medius*	*Dendrocolaptes certhia*	LC
Bird	*Hylopezus paraensis*	*Hylopezus macularius*	LC
Bird	*Lepidocolaptes layardi*	*Lepidocolaptes fuscicapillus*	LC
Bird	*Megascops ater*	*Megascops watsonii*	LC
Bird	*Megascops usta*	*Megascops watsonii*	LC
Bird	*Nystalus obamai*	*Nystalus striolatus*	LC
Bird	*Nystalus torridus*	*Nystalus striolatus*	LC
Bird	*Phaethornis maranhaoensis*	*Phaethornis nattereri*	LC
Bird	*Piculus laemostictus*	*Piculus chrysochloros*	LC
Bird	*Piculus paraensis*	*Piculus chrysochloros*	LC
Bird	*Piculus polyzonus*	*Piculus chrysochloros*	LC
Bird	*Picumnus buffonii*	*Picumnus exilis*	LC
Bird	*Polioptila atricapilla*	*Polioptila plumbea*	LC
Bird	*Polioptila parvirostris*	*Polioptila plumbea*	LC
Bird	*Thamnophilus capistratus*	*Thamnophilus doliatus*	LC
Bird	*Xiphocolaptes carajaensis*	*Xiphocolaptes promeropirhynchus*	LC
Mammal	*Aotus infulatus*	*Aotus azarae infulatus*	LC
Mammal	*Bradypus crinitus*	*Bradypus torquatus*	EN
Mammal	*Dasypus beniensis*	*Dasypus Kappleri*	LC
Mammal	*Guerlinguetus aestuans*	*Sciurus aestuans*	LC
Mammal	*Guerlinguetus brasiliensis*	*Guerlinguetus ingrami*	LC
Mammal	*Leopardus braccatus*	*Leopardus colocolo*	NT
Mammal	*Leopardus munoai*	*Leopardus colocolo*	NT
Mammal	*Mazama rufa*	*Mazama americana*	LC
Reptile	*Pseudablabes agassizii*	*Philodryas agassizii*	LC
Reptile	*Pseudablabes patagoniensis*	*Philodryas patagoniensis*	LC
Reptile	*Tropidurus lagunablanca*	*Tropidurus guarani*	LC
Flora	Acalypha brasiliensis	Acalypha fragilis	CR
Flora	Achyrocline alata	Achyrocline glandulosa	CR
Flora	Schizachyrium condensatum	Andropogon benthamianus	CR
Flora	Anemone decapetala	Anemone jamesonii	EN
Flora	Eugenia ligustrina	Eugenia ophthalmantha	EN
Flora	Eugenia pisiformis	Eugenia microcarpa	VU
Flora	Miconia cinerascens	Miconia lagunensis	EN
Flora	Myrcia eugenioides	Myrcia lineata	VU
Flora	Ocotea odorifera	Ocotea pretiosa	VU
Flora	Ouratea hexasperma	Ouratea boliviana	EN
Flora	Sloanea sinemariensis	Sloanea gracilis	VU
Flora	Acalypha brasiliensis	Acalypha fragilis	CR

Biological Group	Species	Reference Species	IUCN
Flora	Achyrocline alata	Achyrocline glandulosa	CR

The table containing all the information summarized in this topic was submitted to FSC International in an xlsx file named "FSC_CDF_Deliverable2-1_BiodiversityDataset".

3.3 Key Findings of Deliverable 2.1

Geographic range

There was an expressive amount of data received from the Certificate Holders across various federative units and biomes. The data encompasses the most significant regions of planted forests in Brazil and accounting for nearly 58% of the national landscape of FSC-certified forests.

Biodiversity Dataset

The most representative data obtained remains on the biological groups of birds, flora and mammals, respectively. These records consider a significant number of threatened species according to IUCN Red List.

4. Overview of Deliverable 2.2

The Deliverable 2.2 consists in a summary table of FSC added value in relation to non-certified forests, understanding how FSC requirements differs from national legislation and how these requirements promote the biodiversity conservation, including data sources that could be used to run actual comparisons.

To gain a deeper understanding of this subject, it's crucial to highlight key considerations regarding the actual impact of Brazilian law on ecosystem protection.

According to Brazilian Federal Law 12.651/2012, all rural property needs to maintain a riparian buffer intact and protected. This buffer, called as permanent preservation area (APP, the acronym in Portuguese) depends on the length of the river or lagoon but can vary between 30 to 500 meters in the area around watercourses depending on its width. There are also some specifications for springs when the minimal buffer is 50 meters.

The following figure (Figure 4.1) exemplifies the size of the riparian buffer (APP) according to the river width.

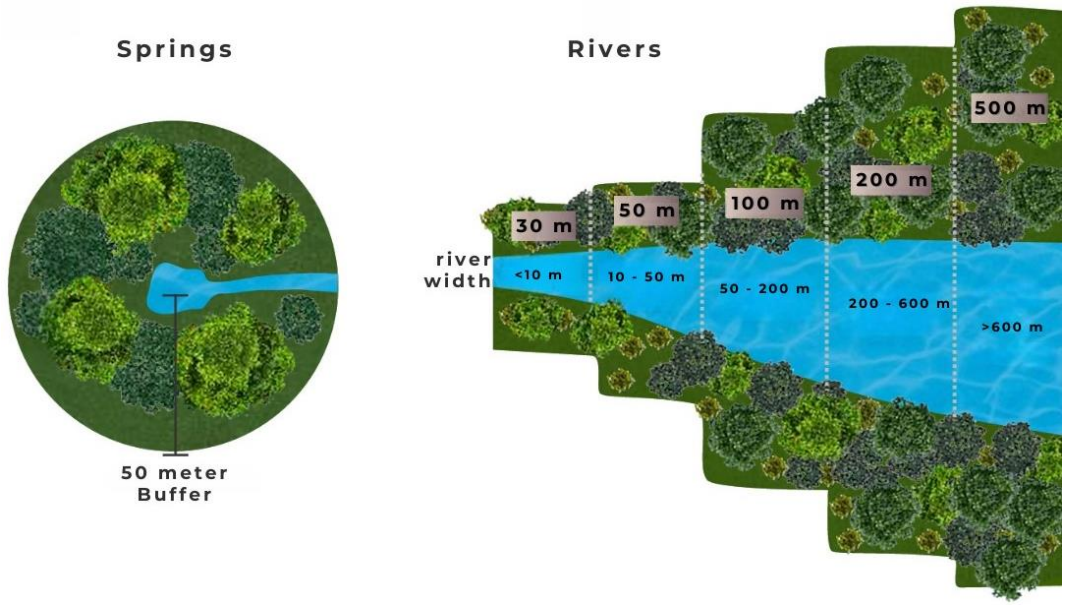


Figure 4.1: Permanent Preservation Area (APP) buffer zone according to the river's width.

Besides that, they also need to maintain the "Legal Reserve" (LR), a portion of a rural property that must be maintained with native vegetation to ensure environmental conservation and biodiversity. The specific requirements for the LR depends on factors such as the biome in which the property is located. In the forest area of the Legal Amazonia, which includes Amazon biome and partially the Cerrado biome, the percentage to be protected is 80%, in the Cerrado region without Legal Amazonia the percentage is 35% and for other biomes the percentage is 20%. This legislation strengthens the FSC's requirement that sets a minimum of 10% for the Conservation Areas Network (CAN).

Despite significant advancements in legislation over the past decade, as APP and LR are not considered legal protected areas (not included as a conservation unit). Besides, there remains a notable absence of effective inspection and enforcement mechanisms by governments to ensure the provision of ecosystem services and protection, including the preservation of Brazil's rich biodiversity.

In this subject, the FSC Principle 1 is a key solution to guarantee that the forest production is being sustainable, as it obligates the Certificate Holders to comply with national laws, which includes the conservation of set aside areas (APP and LR). Moreover, FSC-Certified forests go beyond national legislation, ensuring compliance with higher standards for biodiversity conservation and ecosystem protection (Principle 6). Uncertified forests only need to comply with minimum legal requirements, potentially leading to insufficient protection of biodiversity.

The following figure (Figure 4.2) illustrates the potential of the legal requirements for Permanent Preserved Areas (APP) and Legal Reserves (LR) in an FSC-Certified Forest plantation context considering the landscape connectivity. Additionally, it highlights further conservation criteria such as the inclusion of corridors between legal buffer zones and protected HCVs, showcasing the CHs' commitment to conservation beyond the law's minimum requirement due to FSC principles and criteria.

Figure 4.2: FSC-Certified Forest landscape highlighting legal requirements (Permanent Preservation Area), protected HCVs and landscape connectivity.

In this context, uncertified forests may lack systematic measures to conserve biodiversity and ecosystem services, leading to habitat degradation and loss of species diversity. Furthermore, FSC requires regular monitoring and reporting of biodiversity indicators, different from the Brazilian legislation, reaffirming that FSC requirements are likely to conserve biodiversity and ecosystem services.

It is interesting to notice that the Certificate Holders are concerned not only with structural connectivity in the landscape but also with functional connectivity, emphasizing their interest in both the physical arrangement of habitat patches and the ecological processes that facilitate species movement and interaction.

Another aspect of Brazilian legislation is environmental licensing, a process necessary to obtain authorization for activities or operations that utilize or interfere with environmental resources. In those cases, the federal law (n° 6.938/1981) establishes that "The construction, installation, expansion, and operation of establishments and activities that utilize environmental resources, whether effectively or potentially polluting, or capable, in any form, of causing environmental degradation, shall depend on prior environmental licensing".

This legal requirement complies with FSC Principle 8 in the means that the companies demonstrate the impacts of management activities and monitors their risks. However, as presented in Graph 2.1.1.3, only 6 out of 30 CHs affirmed that are conducting monitoring activities due to environmental licensing requirements.

Analyzing protected areas, these are one of the most important mechanisms to slow down biodiversity loss, and most of those areas in Brazil are created on public lands, following the Brazilian National Protected Area System Law (n° 9.985/2000 – SNUC). However, this legislation has two mechanisms to integrate private lands into the national protected area system. The first one combines public and private lands within their boundaries, and the second one enables the creation of Private Natural Heritage Reserves (RPPN, the acronym in Portuguese). The boundaries of the RPPN cannot be altered even when properties are sold or divided, and they can legally only be used for conservation, research, education and ecotourism. It is interesting to notice that some Certificate Holders in this project have created RPPNs and combined them to HCVAs which contributes to key habitats and species protection.

In this manner, the FSC Principle 1 “Compliance with Laws” is a key topic to biodiversity conservation and landscape connectivity and when integrated to Principle 6 “Environmental Values and Impacts” and 9 “High Conservation Values” it shows a great additional benefit, which may differ of uncertified forests and croplands or livestock, given that those activities may lack of systematic measures to conserve biodiversity and ecosystem services, leading to habitat degradation and loss of species diversity due to ineffective inspection and enforcement mechanisms in Brazil.

The figures below (Figures 4.3 and 4.4) elucidate FSC-Certified forests and their integrated landscape connected with preserved areas of natural forest and other land uses activities in Brazil. It is important to remind that all the Certificate Holders are being treated anonymously and that we cannot run actual comparisons with uncertified forests due to Brazilian law (Data Protection General Law) that do not permits personal data sharing.

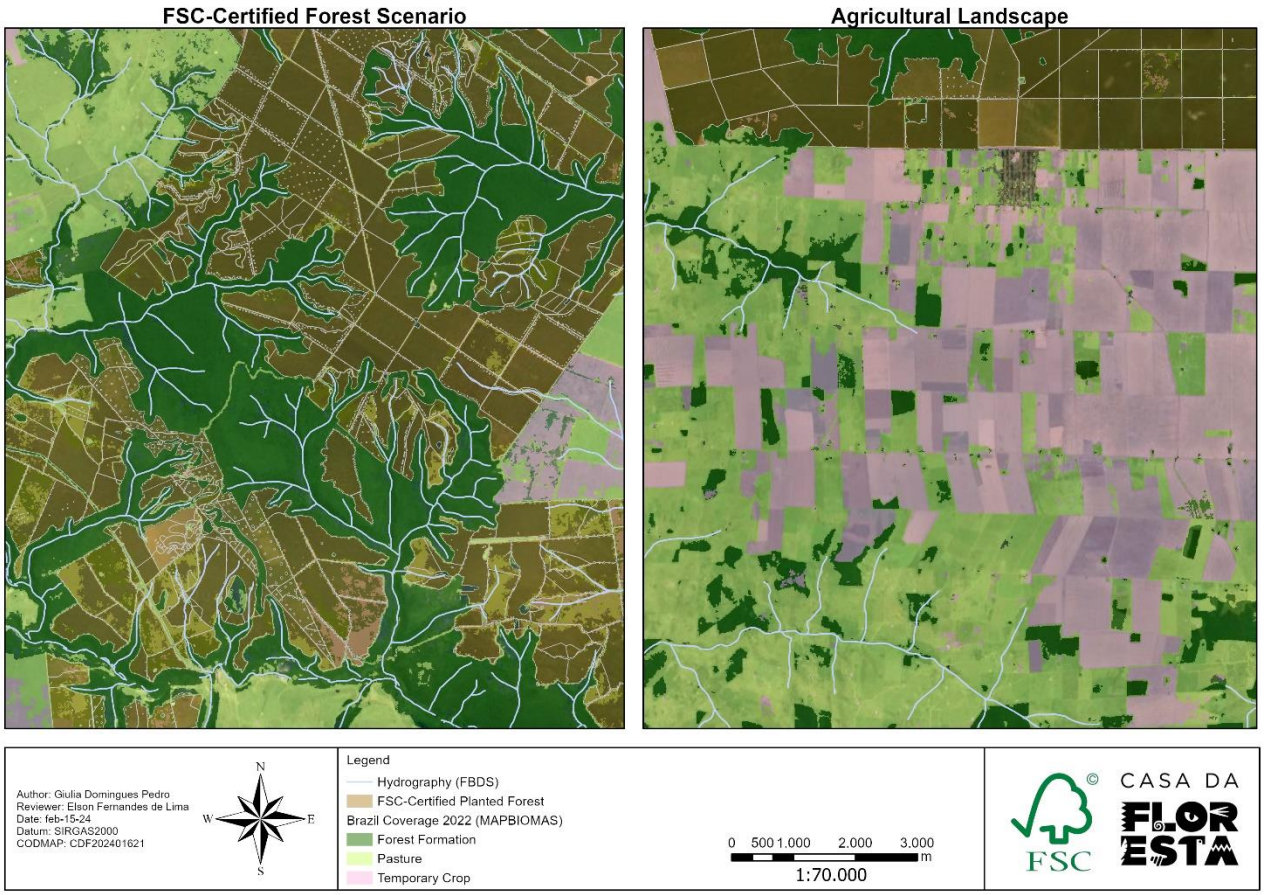


Figure 4.3: Comparison between FSC-Certified Planted Forest landscape and Agricultural landscape (nearby regions). **Sources:** MAPBIOMAS (for land use raster) and Brazilian Foundation for Sustainable Development – FBDS (for hydrography shapefile).

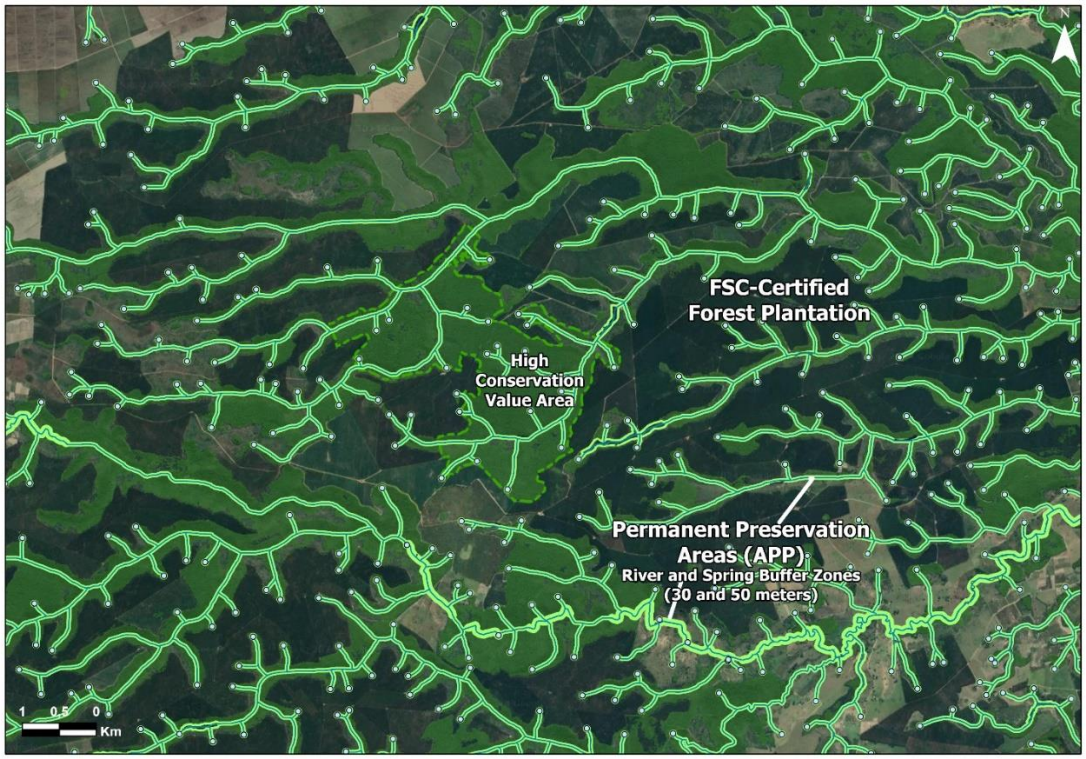


Figure 4.4. FSC-Certified Forest landscape example highlighting the connectivity between Permanent Preservation Areas (APP), set-aside areas and monoculture plantations.

4.1 Landscape connectivity

Tree plantations have the potential to contribute in a significant manner with biodiversity conservation as they emulate the structural complexity of natural forests closer than many other intensive land uses as agriculture and pasture.

Whilst some planted forests have been criticized as "green deserts", implying they are inhospitable to native species and lacking wildlife, analysis of existing data reveals that certain forest plantation systems can indeed offer complementary habitat for various species, including those facing threats of endangerment.

The following table (Table 4.1.1) highlights that a substantial number of species (considering only fauna) were recorded inside or in the border of tree plantations (mainly corresponding on pines or eucalyptus plantations). A considerable number of land uses categorized in the dataset as “unidentified,” or “others” were recorded but not included in this analysis.

Table 4.1.1: Distribution of species in the different land uses recorded by the Certificate Holders.

Land use	Total Obtained Data (fauna species identified)	Number of Species Identified	Data percentage relative to the total
Natural Forests	163.576	1.417	27%
Planted Forests	27.833	631	5%
Total	**191.409**	**1.437**	**32%**

In addition, the figure below (Figure 4.1.1) shows that a substantial number of species were documented in both Natural and Planted Forests (611 occurrences). Excluding these occurrences observed in both, 806 occurrences were found only in Natural Forests and 20 occurrences were only observed in Planted Forests.

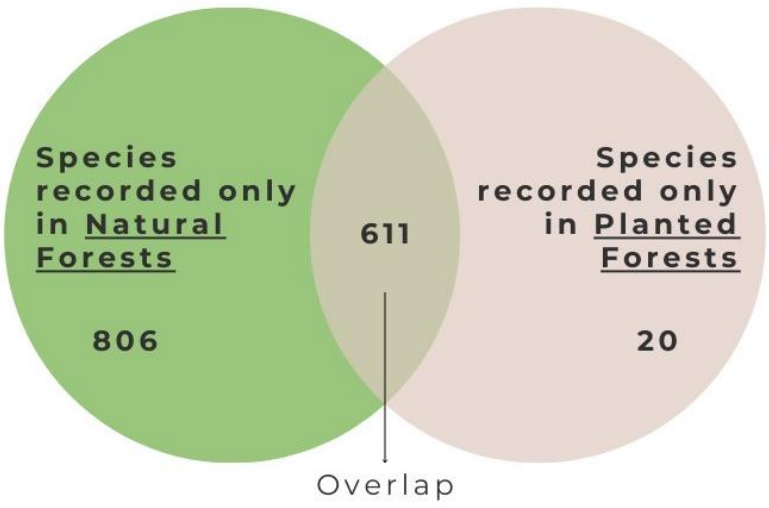


Figure 4.1.1: Distribution of species in Natural and Planted Forests according to data obtained by the CHs.

Although the efforts to monitoring biodiversity in natural and planted forests were different along the Certificate Holders, the following table (Table 4.1.2) indicates that threatened species may use planted forests to integrate their habitats. It is important to highlight that planted forests can be complementary to set aside areas for ecological maintenance of a significant number of native animal species, but they cannot substitute natural forests. This analysis will be further explored in Topic 6 (Deliverable 2.4).

Table 4.1.2: Distribution of species in natural and planted forests, according to IUCN Red List.

IUCN Red List Categories and Criteria	Fauna Species in Natural Forests	Fauna Species in Planted Forests
Critically Endangered (CR)	7	0
Endangered (EN)	14	4
Vulnerable (VU)	52	17
Near Threatened (NT)	61	25
Least Concern (LC)	1.224	573
Data Deficient (DD)	4	2
Not Evaluated (NE)	55	10
Total	**1.417**	**631**

4.2 Key Findings of Deliverable 2.2

Legal requirements and FSC Principles

Legal requirements in Brazil align with FSC Principles for certification. However, uncertified forests may lack systematic measures for conserving biodiversity and ecosystem services due to ineffective inspection and enforcement mechanisms, which may result in habitat degradation and loss of species diversity. Moreover, FSC mandates regular monitoring and reporting of biodiversity indicators, reaffirming that FSC requirements are likely to aid in conserving biodiversity and ecosystem services.

Landscape connectivity

While forest plantation systems can provide additional habitat for various species, including those endangered, they cannot fully replace natural forests set aside for conservation purposes.

4.3 FSC Added Value Table

The following table (Table 4.3.1) consists in the main product of Deliverable 2.2, which is a summary table of FSC added value in relation to non-certified forests, understanding how FSC requirements differs from national legislation and how are FSC requirements likely to support biodiversity conservation. This table was also submitted to FSC International in an xlsx file named "FSC_CDF_Deliverable2-2_FSCAddedValue".

Table 4.3.1: Summary table of FSC added value in relation to non-certified forests. X – Added Value in Biodiversity Conservation and Ecosystem Services due to FSC Certification. XX – Added Value in Relation to Brazilian Law.

FSC added value table	FSC-certified forest management	Source	Brazilian legislation	Source
Protection of ecosystems and watersheds	**XX**	**FSC Principles 1, 6 and 10**	**X**	**Brazilian Federal Law 12.651/2012**
Commitment to biodiversity conservation	**XX**	**FSC Principles 1, 6, 9 and 10**	**X**	**Brazilian Federal Law 12.651/2012 and 9.985/2000**
Evaluation of the impacts from management activities and mitigation actions	**XX**	**FSC Principles 8 and 10**	**X**	**Brazilian Federal Law 6.938/1981**
Effective inspection and enforcement mechanisms	**XX**	**FSC Principle 8**		
Actions to guarantee landscape connectivity	**XX**	**FSC Principles 6 and 9**		
Maintenance and Protection of High Conservation Value Forests	**XX**	**FSC Principles 6, 9 and 10**		

Law 6.938/1981 – National Environmental Policy – purposes, formulation and application mechanisms, and other measures.
Law 9.985/2000 – National System of Nature Conservation Units – definition of categories and criteria for Protected Area in Brazil.
Law 12.651/2012 – New Forest Code - general rules on vegetation protection, conservation and use.

It is noteworthy that Brazilian legislation is referenced for the first three rows. However, FSC requirements hold additional value, ensuring compliance with the law consistently under Principle 1 and conducting on-site inspections. Moreover, Principle 6

provides supplementary criteria for assessing ecosystem protection and the commitment to biodiversity preservation when compared to the law.

5. Overview of Deliverable 2.3

The present deliverable consists in a clean, well-structured and FSC-agreed description of the conducted data analysis on the compiled datasets and their associated foreseen reporting visualizations (e.g., graphics).

Considering the biodiversity dataset acquired from the CHs (Topic 3) and the importance to highlight the FSC-added value on biodiversity (Topic 4.2), we focused the analysis on the following topics:

i) **quantitative** – species occurrence, spatial distribution.

ii) **land use** – species observed in natural and planted forests; and

iii) **landscape** – case studies of FSC-Certified areas and their relationship with connectivity, legal requirements, FSC added value and Rare, Threatened or Endemic (RTE) species.

Initially we proposed other analyses, but due to the information available at the time of execution and some improvements on analysis objectives, alterations were necessary. The analyses altered from the scope previously sent to FSC are presented in the following table (Table 5.1)

Table 5.1: List of alterations on data analysis conducted on deliverable 2.4.

Alterations on data analysis conducted on deliverable 2.4			
Analysis topic	**Specific analysis**	**Action**	**Justification**
Quantitative	Invasive species	**Removed** from scope	Difficult to ascertain the invasive status of each species in specific areas. Such analysis would not yield relevant results for the objectives of this project
	Forest-dependent bird species	**Changed** to highly sensitive to habitat loss birds. **Moved** to Land Use analysis	Highly sensitive species are more indicative of the impacts of habitat alteration, such as those caused by planted forests. Their presence or absence can signal the effectiveness of forest management practices in maintaining biodiversity
	Threatened primates	**Moved** to Land Use analysis	Comparing their occurrence in natural versus planted forests can elucidate differences in habitat quality, resource availability, and ecological functionality
Temporal	All temporal analysis	**Removed** from scope	Insufficient systematic data collected over the years and the potential for misinterpretation. Without temporally contiguous data to provide coherent and continuous dataset for analysis, it is impossible to discern meaningful trends or patterns in the data

5.1 Materials and Methods

This section outlines the procedures and resources utilized in conducting the study. The main source of data for the analyses is the data acquired from the questionnaire described in Annex 2 and was shared with FSC International in a xlsx file titled "*FSC_CDF_Deliverable2-1_BiodiversityDataset*".

Additionally, terms commonly used throughout the results and discussions of this project are described below:

Records –

- **Certificate Holders' records** - Obtained and compiled by the participating CHs throughout their monitoring activities. Each record consists of one individual (animal or plant) observed and their spatial-temporal information (see Annex 2).
- **Public database records** – Obtained by official public databases and referring only to species through biomes, not including specific spatial-temporal information

Planted Forests (PF) – Monocultures of planted trees, usually referring to *Eucalyptus spp.* or *Pinus spp.* in the Brazilian context.

Natural Forests (NF) – Natural conserved forests with their native vegetation, also classified as "**set aside areas**". These forests are part of the landscape within the Management Unit of the CHs but are protected from exploitation to preserve their ecological integrity.

In the following sections, we detail the materials used and the methods implemented.

5.1.1 Quantitative analysis

We evaluated the number of species recorded by the Certificate Holders participating in the project to assess their representative value relative to the total number of identified species in Brazil. This was achieved by categorizing the data by biome and evaluating the percentage of total and threatened species being monitored in these regions.

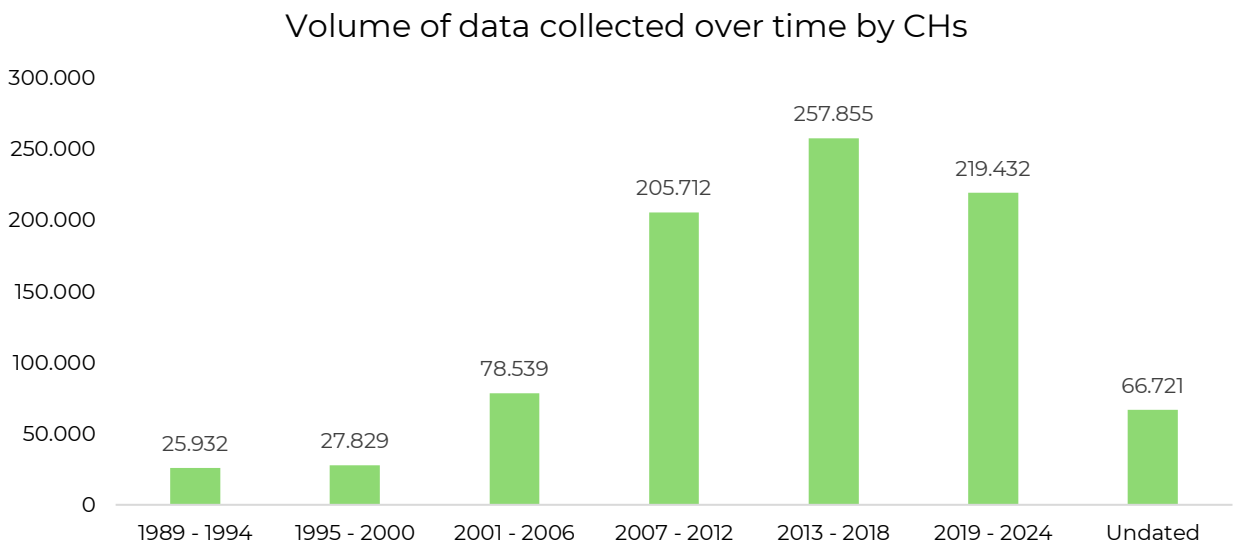
Additionally, we analyzed the proportional area of the CHs' certified forests in comparison to the total area of each biome. This quantitative analysis not only provides insights into biodiversity representation within certified areas but also underscores the effectiveness of monitoring efforts in capturing the presence of species and threatened species, for example. By evaluating these metrics, we can better understand the ecological impact and conservation value of certified forest areas across different biomes in Brazil.

For this analysis we focused on biological groups that are more representative considering taxonomic evaluation, endangered situation and volume of data acquired by the Certificate Holders described in Topic 3.2 – birds, mammals and flora. In this evaluation we used official public databases developed by Chico Mendes Institute for Biodiversity Conservation in the Biodiversity Extinction Risk Assessment System (ICMBIO/SALVE – salve.icmbio.gov.br) for fauna, accessed in 2024, and REFLORA Program version 393.399 (reflora.jbrj.gov.br/reflora/) for flora, last revised in 2024, to quantify the total number of species recorded in the country.

We highlighted those biological groups according to their threatened criteria (IUCN, 2023) in a quantitative form, understanding the total number of species in each biome by official public databases and the total number recorded by the CHs participating in this project.

For this analysis, we used data obtained from the CHs that was shared with FSC International in the xlsx file titled "*FSC_CDF_Deliverable2-1_BiodiversityDataset*". The analysis was conducted using the software programs RStudio, Excel and ArcGIS.

Data for the analyses was collected by the CHs from 1989 to 2024, with no missing years. As the number of Certificate Holders increased over time, as presented in Topic 1.3, the volume of data also grew, as illustrated in Graph 5.1.1.1 below. We obtained a total data of 882.020 records from the CHs. Each record contains the information of one individual (animal or plant) observed by the CHs during their monitoring activities.



Graph 5.1.1.1. Volume of data (records) collected over time by Certificate Holders participating in the project.

However, it is important to note that not all the data collected by the Certificate Holders over time was shared with us for analysis. Some Certificate Holders chose to share only a portion of their data, prioritizing data that was more organized and easier to share.

Additionally, the decrease in data volume from 2013-2018 to 2019-2024 may be attributed to the interruption or reduction of monitoring activities during the COVID-19 pandemic from 2020 to 2022. Additionally, most of the monitoring activities planned by the CHs for 2024 have not yet been implemented.

For the spatial analysis, only data with geographic information were used. In cases where CHs did not provide this information, coordinates were assumed based on the centroid of the Management Unit (MU) or the centroid of the Municipality. Out of a total of 880.250 records with geographic information, 61.016 were assumed based on the MU and 61.316 based on the Municipality. However, some data could not be assumed due to the lack of information provided by the CHs.

These records encompass all the 7.158 species observed in the biodiversity dataset described in Topic 3. It is important to underline that each of these records presents information about one individual observed, including their species, biological group, spatial-temporal information and method used to gather the data.

Furthermore, we conducted an examination of the concept of Essential Biodiversity Values (EBVs) as part of our discussion. EBVs serve to facilitate the collection, sharing, and utilization of biodiversity information (GEO BON, 2024; JETZ et al, 2019). This discussion aimed to evaluate the data provided by the Certificate Holders.

The associated foreseen reporting visualization for this analysis consist of maps (distribution and heat map), bar charts and tables.

5.1.2 Land use analysis

For the land use analysis, we compared species records provided by the CHs involved in this project across Natural and Planted Forest areas. Building on the findings discussed in Topic 4.1, which underscores the alignment of Brazilian legislation and FSC requirements with production and sustainability goals in the forest sector, this analysis aims to delve further into these aspects.

We wanted to understand at a finer scale the records of species in monoculture plantations and whether the same species were recorded in nearby conservated areas. This helps highlighting and gain a better understanding of landscape connectivity and how planted forests might function as a transitional region between natural fragments.

For this analysis, we selected specific groups that are more sensible to habitat loss and anthropic changes in land use, which are:

- **Highly sensitive species of birds**: Birds that exhibit a high degree of sensitivity to environmental changes or disturbances, often serving as indicators of ecosystem health and integrity due to their specific habitat requirements or susceptibility to habitat loss;
- **Forest species of mammals:** Mammals that primarily inhabit forested habitats, relying on the resources and conditions found within forests for shelter, food, and reproduction. These species are adapted to life in forest ecosystems and may have specific requirements for forest structure, vegetation types, and connectivity;
- **Threatened species of primates, mammals in general and birds:** Mammals and birds that are classified as threatened, endangered, or critically endangered according to their conservation status. These species face significant risks of extinction due to human activities, habitat destruction, climate change, and other factors, requiring urgent conservation efforts to prevent their decline and eventual disappearance from the wild.

The classification criteria for birds' sensitivity are based on the papers by Stotz et al. (1996) and Silva (1995), respectively. The criteria for mammals' preferred habitat are based on Reis et al. (2006) and ICMBio reports on the conservation of ungulates and carnivores (ICMBio, 2012; ICMBio, 2013). The threatened species were extracted by IUCN Red List (IUCN, 2023).

The analysis was conducted using the software program RStudio, with data from the biodiversity dataset, shared with FSC in a xlsx file named "*FSC_CDF_Deliverable2-1_BiodiversityDataset*". A total of 880.202 records were analyzed, considering that each record presents information about the species observed, their name, biological group, spatial-temporal information and method used to gather the data.

However, not all data, collected from the Certificate Holders participating in the project and shared for the biodiversity dataset, had the information about the specific land use where the individual were observed during monitoring activities. This lack of information prompted the implementation of specific filters, described below.

We removed for this analysis data that did not specify whether the species were observed in natural or planted forests, as well as records of unidentified species or those without taxonomic classification at the species level and alien species. Considering these data validation processes, the number of records available in Natural Forests and Planted Forests were, respectively, 280.361 and 28.601, collected by the Certificate Holders between 2002 and 2024 in the Amazon, Atlantic Forest and Cerrado biomes. For the "total" value bars

(T) presented in the land use analysis graphs by biome, all available information regarding the type of land use was considered, not only natural or planted forest.

Others specific filters were also applied to the analyses conducted, such as biological groups (birds, mammals, flora), species categorized as threatened by the IUCN (CR, EN and VU), biomes (Amazon, Atlantic Forest, and Cerrado) and management type (Planted forest management), aiming to achieve the desired results.

It is important to highlight that although we have the number of records in PF and NF, we do not have information regarding the monitored area for these observations.

It was decided to use only records from CHs managing planted forests for the land use analyses, as the intention of the analysis is to evaluate the difference in biodiversity observed in planted forest areas compared to natural forest areas (set asides). For natural forest management, a comparison is not possible since the entire monitored area consists solely of natural forest.

Additionally, we discussed the significance of High Conservation Value Areas (HCVAs) and the preservation of Natural Forests as they represent a significant added value of FSC requirements on conserving biodiversity.

The visualization of this results consists in bar charts highlighting the selected sensitive and restrict groups by Biome and at country level, along with Venn Diagram figures comparing records in natural and planted forests.

5.1.3 Landscape analysis

This topic involves integrating the results of the other analysis to evaluate landscape case studies of FSC-Certified areas and their relationship with connectivity, legal requirements, set-aside areas, RTE species and FSC's added value in biodiversity conservation, also discussed in Topic 4. In this analysis we used geographical data at coordinate point scale to elucidate some examples of positive outcomes from the environmental policy of the Certificate Holders, including monitoring activities. The data to be presented belongs to the forestry company Klabin S.A., which agreed to share some data for the conduct of these analyses.

With these examples we aim to showcase how conservation areas attributable to FSC increases the total conservation area in the landscape significantly and which species uses plantations and corridors. These results will be visualized in maps.

6. Overview of Deliverable 2.4

The present deliverable refers to the results from analysis and associated data visualizations.

6.1. Results of the Quantitative Analysis

This section presents the number of species recorded by the CHs and evaluates their distribution in a spatial analysis, comparing them to the total number of identified species in Brazil. This assessment is conducted by Biome and includes the percentage of threatened species being recorded during monitoring activities.

Brazil encompasses diverse biomes: the Amazon Rainforest, the world's largest tropical rainforest boasting rich biodiversity; the Cerrado, a savanna with diverse flora and fauna; the Pantanal, the largest tropical wetland area globally; the Caatinga, a semi-arid ecoregion marked specialized vegetation; the Atlantic Forest, a highly biodiverse biome along the eastern coast, home to numerous endemic species; and the Pampa, characterized by expansive grassy plains with distinct vegetation. Brazilian biomes differ due to a combination of factors, including climate variation, geological diversity, soil composition, topography, natural history, and human interference. These factors contribute to the unique characteristics of each biome, influencing the types of vegetation, fauna, climate, and landscape present.

The biodiversity database we acquired contains records encompassing four of the six biomes in Brazil: Amazon, Atlantic Forest, Cerrado and Pampa. Across these regions we gathered a total of 882.020 records documenting 7.158 observed species. This data was collected within the certified areas of the 30 CHs involved in the project, covering a combined area of 51.596 km² distributed among the biomes as detailed in Tables 6.1.1 and 6.1.2.

Table 6.1.1: Distribution of the CHs participating in the project over the biomes.

Biome	Certificate Holders participating in the project	CH (%)
Amazon	4	13%
Cerrado	12	40%
Atlantic forest	13	43%
Pampa	1	3%
Brazil	**30**	**100%**

Table 6.1.2: Comparison between total Biome area and total certified area from the CHs participating in the project, in each sampled Biome. **Sources:** IBGE, 2024; FSC Public Database (FSC, 2024).

Biome	Area		
	Biome (Km²)	CHs (Km²)	Relative
Amazon	4.196.943	9.622	0.23%
Cerrado	2.036.448	17.040	0.84%
Atlantic Forest	1.110.182	20.359	1.83%
Pampa	176.496	4.575	2.59%
Brazil	**8.514.877**	**51.596**	**0.61%**

Comparing the certified area of the participating CHs in this project with the total area of each Brazilian biome, we observe a significant amount of data collected in the project, as will be discussed further.

Figure 6.1.1 below illustrates the distribution of data given by the CHs with geographic information, by Biome.

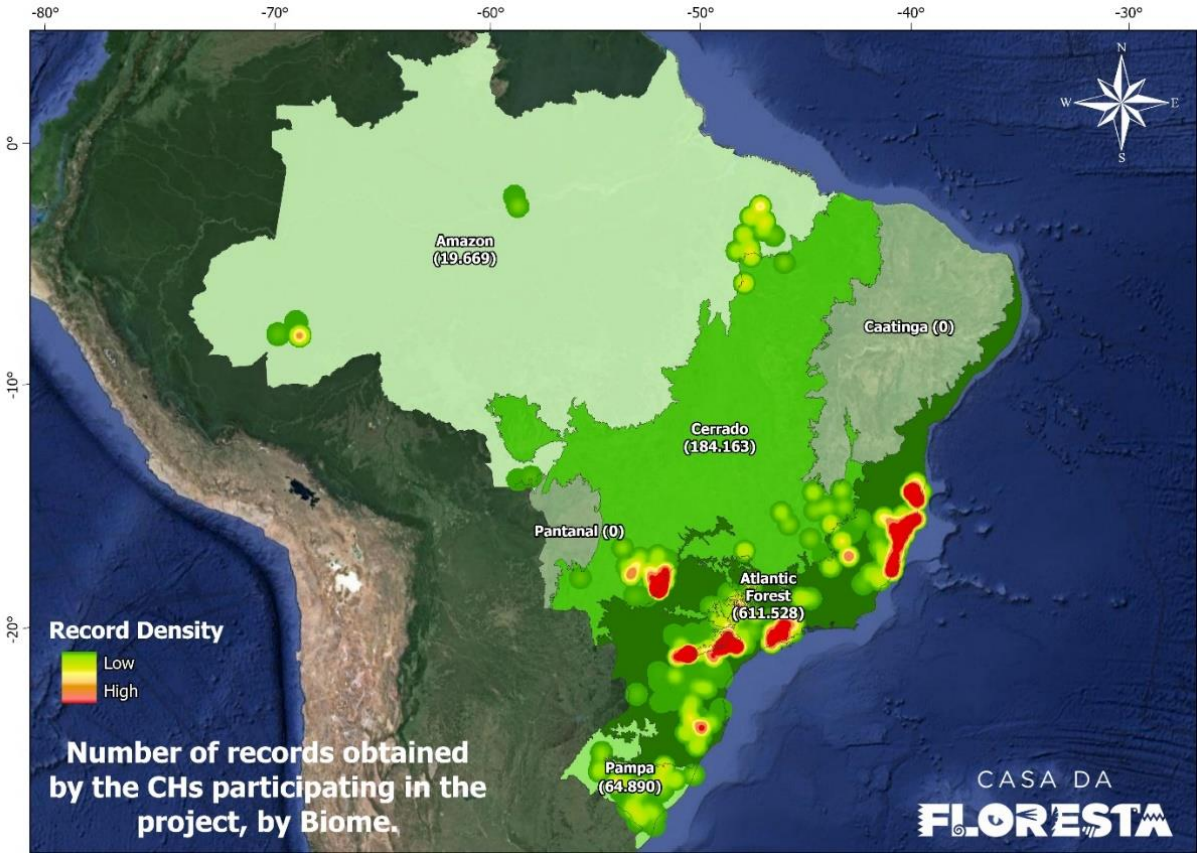


Figure 6.1.1. Number of biodiversity records (animals and flora) with available geographic coordinates, collected and shared by the participating CHs, categorized by Biome.

The acquired data covers the most significant regions of planted forests (monocultures of *Eucalyptus spp.* or *Pinus spp.*) in Brazil, particularly in the axis center-south. Additionally, it encompasses substantial areas of certified planted forests in the northeast region. Records in the north and northwest parts of Amazon refers to Natural Forest

Management companies, based on an additional criterion of CHs with whom we established contact, described in Topic 1.3.

Most of the acquired data are concentrated in Atlantic Forest and Cerrado biome. This reflects the sampling efforts, given that most participating CHs are situated in these biomes, as illustrated in Tables 6.1.1 and 6.1.2. Furthermore, data for the Pantanal and Caatinga biomes are absent due to the lack of CHs participating in the project in those regions.

Figure 6.1.1 highlights the significant density of records present in the Atlantic Forest biome, recognized as one of the global biodiversity hotspots, due to its vast biological diversity, harboring approximately 8,000 endemic species. This richness is at risk due to the historical territorial occupation resulting in currently 60% of Brazil's population, and the indiscriminate exploitation of natural resources. Given this scenario, with only about 7% of its remaining forests, the biome harbors approximately 530 threatened species, emphasizing the importance of monitoring and conserving natural forests within this biome (Pinto et al., 2006; Tabarelli et al., 2005; Myers et al., 2000).

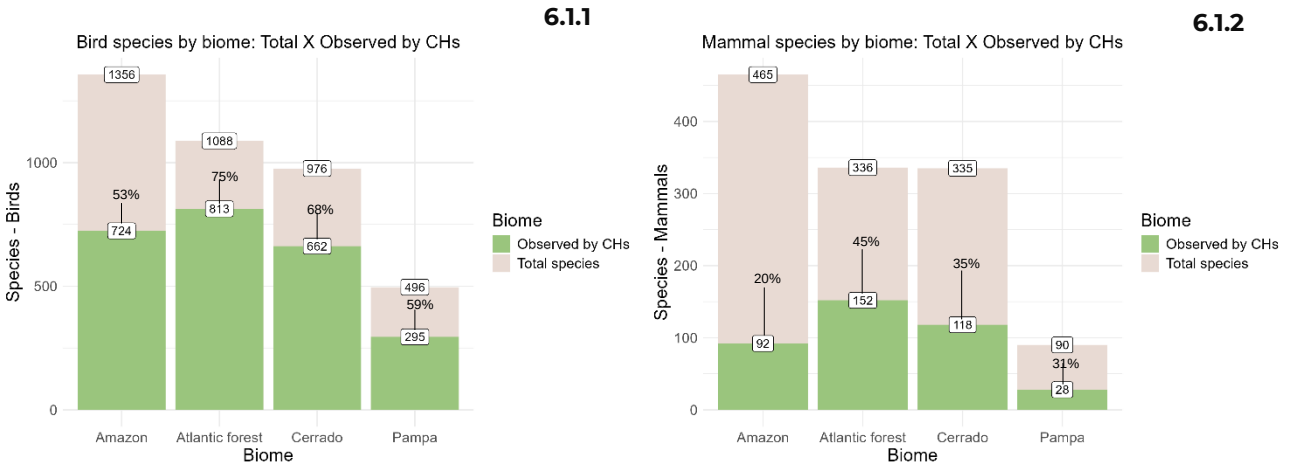
The second biome most sampled by the CHs participating in the project refers to the Cerrado biome, also recognized as a global biodiversity hotspot and, due to its significant heterogeneity, up to 5% of the world's fauna and approximately one-third of Brazil's fauna may be found in this biome (ICMBio, 2024).

This information underscores the critical importance of monitoring efforts in FSC-certified forests in Brazil, as they are essential for understanding the biodiversity within these threatened biomes and for proposing conservation actions aligned with the FSC requirements.

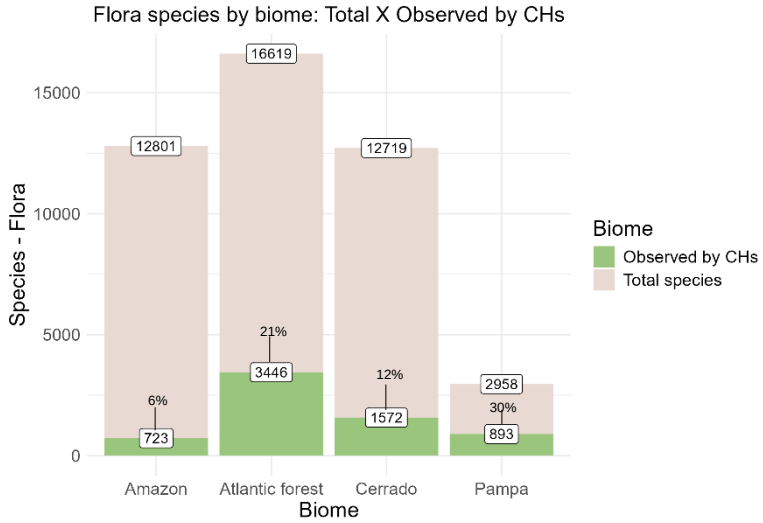
Furthermore, the participating CHs focus their efforts on collecting data related to species and their spatial-temporal distribution, which significantly contributes to ecological analysis. By systematically gathering biodiversity records, these efforts enhance the detection of changes in species populations, assessment of ecosystem health, and development of conservation strategies. It is important to highlight that, as discussed in Topics 2.1 and 4.3, most of the monitoring activities conducted by the CHs are motivated by FSC's certification requirements.

The following Graphs (Graphs 6.1.1, 6.1.2 and 6.1.3) depict the number of species observed by the CHs within each biome, compared to the total number of species known to exist in that biome. The focus relies on biological groups that are more prioritized in monitoring activities, also described in Topic 2.2, birds, mammals and flora.

These groups are commonly selected on monitoring activities due to their greater ease of sampling, being more cost-effective in effort, as well as presenting a high number of threatened species in Brazil, according to the IUCN (IUCN, 2023). The information of total species in Brazil divided by biome was acquired by the public databases from ICMBIO/SALVE and REFLORA Program.



Graphs 6.1.1 and 6.1.2: Number of observed species of birds (6.1.1) and mammals (6.1.2), by the CHs participating in the project, in comparison to the total of species in each biome. **Source:** ICMBIO/SALVE (2024) – salve.icmbio.gov.br.



Graph 6.1.3: Number of observed species of flora, by the CHs participating in the project, in comparison to the total of species in each biome. **Source:** REFLORA Program (2024) – reflora.jbrj.gov.br/reflora/.

Based on the efforts employed by the CHs, the graphs above indicate that the recorded species reflect the sampling efforts across different biomes, presented in Tables 6.1.1 and 6.1.2, with a higher number of species recorded in the Atlantic Forest and Cerrado biomes, which is also proportionate to the total number of species known to exist in these biomes.

It is important to highlight that although the number of recorded species of flora is expressive, the total number of species is even higher considering that there are some classes of vegetation that are generally not sampled in forest inventories, including for

example grasses and herbs. Except for monitoring activities conducted in the Pampa (grassland biome), these types of vegetation are often omitted from forest inventories. This is primarily due to the focus being on assessing tree species composition, structure, and timber volume.

Consequently, this approach results in 64%, 44%, and 44% of all plant species in the Amazon, Atlantic Forest, and Cerrado, respectively, being overlooked. Additionally, some monitoring activities for mammals conducted by the CHs generally only focus on sampling medium and large-sized animals - terrestrial animals with weight above one kilogram and including primates - which correspond to, approximately, only 25% of all mammal species in Brazil (PAGLIA et al., 2012; ABREU et al., 2023).

Another situation that can explain the difference between species observed and total species in the Biome is the relationship observed in the graphs 6.1.1, 6.1.2 and 6.1.3 that showcases that when there is a higher proportion of sampled area, there is a corresponding increase in the number of species recorded in the biome (Graph 6.1.4). This probably happens because the distribution area of species is not continuous throughout the biome and is often delimited by interfluves and natural barriers, causing many species to occur only in restricted areas where sampling did not occur (IUCN, 2023) (e.g., *Mico rondoni* - Figure 6.1.2).

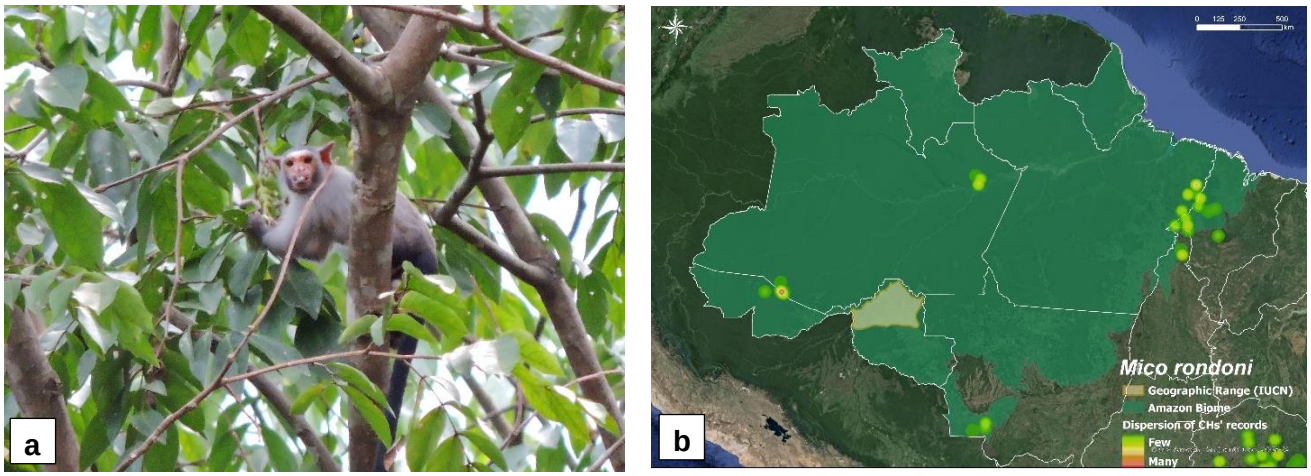
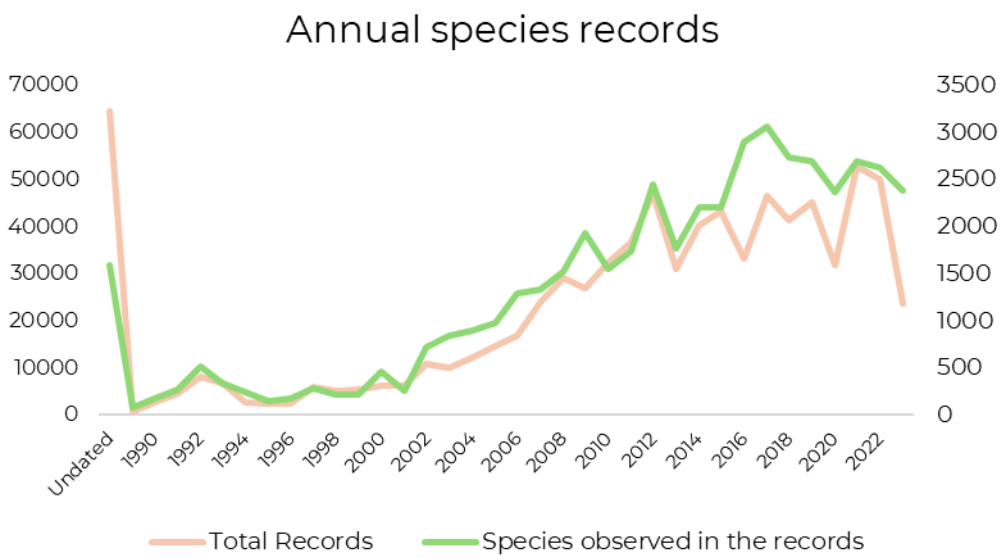


Figure 6.1.2. *Mico rondoni*. **a.** Photographic record, **b.** Species' geographical distribution. **Source:** IUCN, 2023.

Additionally, the graph below (Graph 6.1.4) illustrates that the expansion of certified forests over the years, considering the CHs participating in the project, has resulted in an increasing number of species observed. As certified forests expand, they provide more comprehensive data on species presence and distribution.



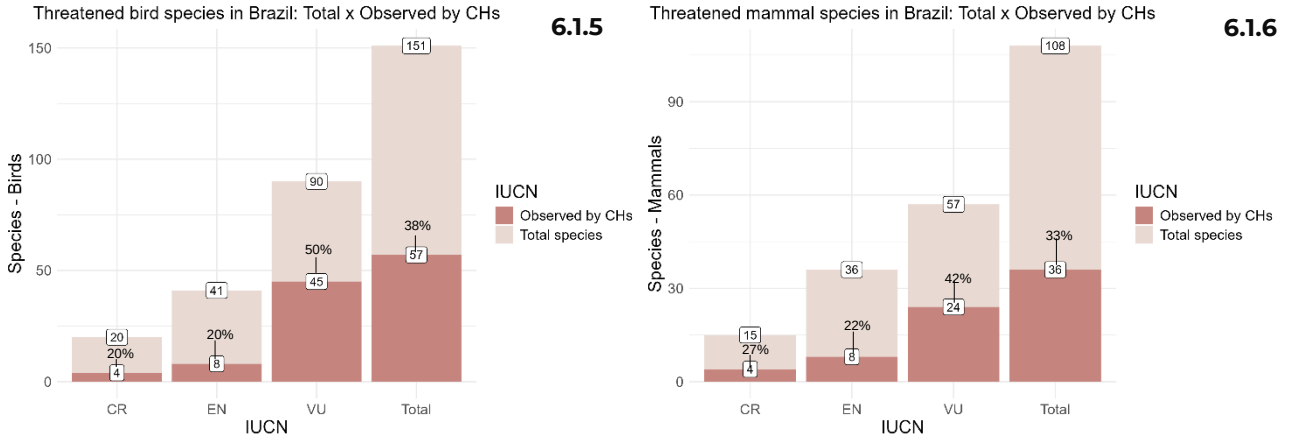
Graph 6.1.4. Number of species recorded each year during CH monitoring activities, considering the total number of records (main axis, in pink) and the total number of species documented in the records (secondary axis, in green).

Another conducted analysis considers the International Union for Conservation of Nature's Red List of Threatened Species (IUCN Red List) criteria, where we evaluated the number of threatened species recorded during monitoring activities from the CHs, considering the categories:

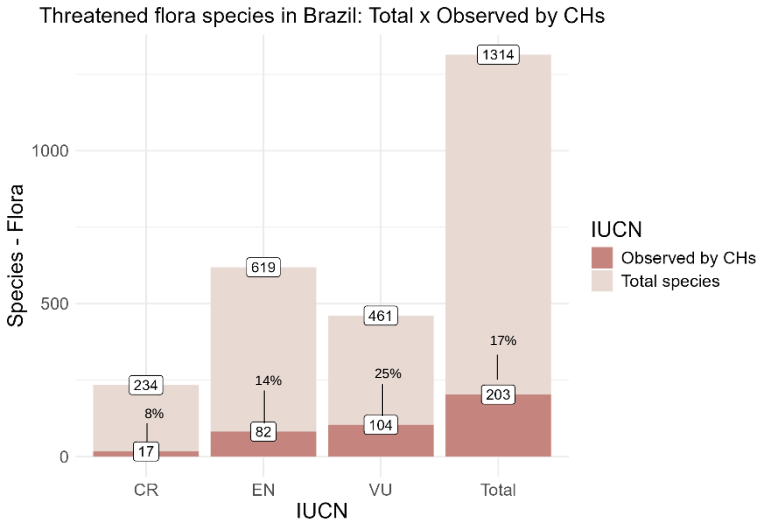
- Critically Endangered (CR): Extremely high risk of extinction in the wild;
- Endangered (EN): Very high risk of extinction in the wild; and
- Vulnerable (VU): High risk of extinction in the wild.

In the biodiversity dataset, we gathered a total of 30.524 records of threatened species, encompassing 328 different species observed, including 25 critically endangered species, 112 endangered species and 190 vulnerable species.

The results related to the percentage of threatened species from the most monitored groups (birds, mammals and plants) are presented in the graphs below (Graphs 6.1.5, 6.1.6 and 6.1.7).



Graphs 6.1.5 and 6.1.6: Number of threatened species observed by the CHs of birds (6.1.4) and mammals (6.1.5) in comparison to the total of threatened species in Brazil. **Sources:** ICMBIO/SALVE (2024) – salve.icmbio.gov.br; IUCN –https://www.iucnredlist.org/.



Graph 6.1.7: Number of threatened species observed by the CHs of flora in comparison to the total of threatened species in Brazil. **Source:** REFLORA Program (2024) – reflora.jbrj.gov.br/reflora/; IUCN – https://www.iucnredlist.org/.

The graphs above illustrate the monitoring efforts of the participating CHs regarding observed threatened species. While the proportion of threatened species is notably lower compared to the total recorded, this pattern isn't concerning, as it's typical for species most vulnerable to extinction to have either restricted distribution ranges or small populations. In this manner, it would be impossible for the CHs to detect many threatened species with a small monitored area when compared to the whole country, as shown in Table 6.1.2.

The following table (Table 6.1.3) presents the species observed by the CHs that are in a critically endangered (CR) situation.

Table 6.1.3: Critically endangered (CR) species observed by the CHs participating in the project. **Source:** IUCN (2023).

Species	Common name (IUCN)	Biological group
Cotinga maculata	Banded cotinga	Birds
Formicivora paludicola	Marsh Antwren	Birds
Mergus octosetaceus	Brazilian Merganser	Birds
Psophia obscura	Black-winged Trumpeter	Birds
Acalypha brasiliensis	-	Flora
Achyrocline alata	-	Flora
Araucaria angustifolia	Parana Pine	Flora
Chloroleucon tortum	-	Flora
Couratari asterophora	Embirema	Flora
Couratari asterotricha	Imbirema	Flora
Homalolepis floribunda	-	Flora
Mezilaurus microphylla	-	Flora
Mollinedia lamprophylla	-	Flora
Myrcia gilsoniana	-	Flora
Myrcia neoestrellensis	Araça-rei	Flora
Oxandra unibracteata	-	Flora
Pouteria pachycalyx	-	Flora
Schizachyrium condensatum	-	Flora
Sorocea longipedicellata	-	Flora
Tapura follii	-	Flora
Toulicia stans	-	Flora
Alouatta guariba guariba	Northern Brown Howler Monkey	Mammals
Brachyteles arachnoides	Southern Muriqui	Mammals
Callithrix flaviceps	Buffy-headed Marmoset	Mammals
Sapajus xanthosternos	Buff-headed Capuchin	Mammals

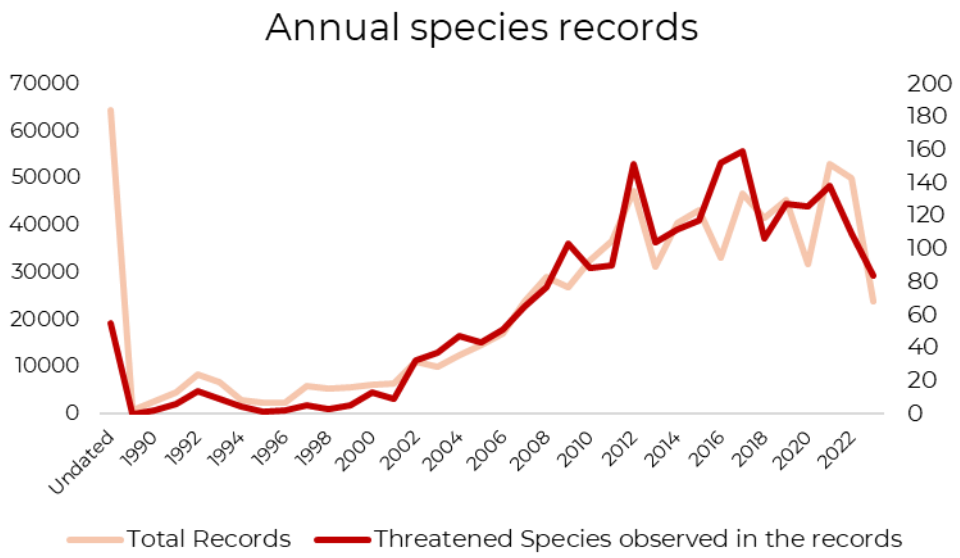
Due to habitat loss caused by anthropogenic disturbances, restricted occurrence areas, and small populations, species classified as RTE show greater susceptibility to local threats and are considered crucial for biodiversity conservation. These species indicate the need for special attention to ensure their survival. According to the IUCN's threat degree classifications for wild species, the Critically Endangered (CR) category represents the highest risk. It refers to species facing an extremely high risk of extinction in the wild, with a probability of at least 50% within 10 years or three generations (whichever is longer, up to 100 years in the future) (IUCN, 2012).

The monitoring activities conducted by the Certificate Holders is not necessarily focused on evaluating threatened species, however the presence of these species is valuable as they might be indicators of the ecosystem's health, it helps prioritizing conservation efforts and it is an important criterion for identifying High Conservation Value Areas (HCVAs), which is also a certification requirement from FSC, differing from national legislation, as discussed in Topics 4.2 and 4.3.

The observation of threatened species by Certificate Holders aids in identifying critical habitats requiring protection and establishes priorities for restoration activities and resource allocation within these areas. Moreover, these species can serve as indicators of a conserved

landscape, a topic to be further explored in land use and landscape analysis (Topics 6.2 and 6.3).

Additionally, there was an increasing number of threatened species observed over the years, associated with the expansion of certificated forests, also discussed in Graph 6.1.4, as presented below (Graph 5.1.8)



Graph 6.1.8. Number of threatened species observed each year during CH monitoring activities, considering the total number of records (main axis, in pink) and the total number of threatened species observed in the records (secondary axis, in red).

Considering that there is a higher concentration of CHs that initiated their FSC certifications from 2013 onwards, i.e., with FSC certificates for over 10 years, as discussed in Topic 1.3, Graphs 6.1.4 and 6.1.8 support the idea that the more areas monitored by certified forests, the higher the number of species recorded, including threatened species. Table 6.1.2 further emphasizes that even in a small area, the CHs participating in the project manage to find a high number of species at biome level.

6.1.1 Discussion

The Certificate Holders (CHs) involved in this project gathers a significant amount of data through species records. It is noteworthy that most monitoring activities conducted by the CHs are primarily aimed at meeting certification requirements, as presented in the report from Deliverable 1.1 (Topic 2). This underscores the added value of FSC certification in biodiversity monitoring in Brazil. However, these monitoring efforts remain limited, not necessarily in terms of effort, but in how the data is utilized to inform decision-making policies of the companies. This specific information was not collected during the present study.

Studies from Jetz et al. 2019 conceptualize the term "essential biodiversity variables" (EBVs) to facilitate the mapping and monitoring of species populations, aiming to inform global policy and decision-making regarding biodiversity conservation. These EBVs are expected to meet four key criteria:

1. Comprehensive Representation: Encompass a diverse and representative set of species within a given taxonomic scope;
2. Global Coverage: Ideally have a near-global scope or cover the full spatial extent of a given taxonomic scope to ensure comprehensive coverage of national stewardship responsibilities;
3. Geographical and Temporal Continuity: Be geographically and temporally contiguous to provide coherent and continuous datasets for analysis and decision-making; and
4. Practical Utility: Offer information at spatial and temporal resolutions that are practical and useful for decision-makers and policymakers, facilitating effective policy creation and conservation efforts.

Based on the data acquired from the CHs, they demonstrate commendable performance in fulfilling the first criterion by maintaining a diverse and representative set of species, particularly focusing on taxonomically important and endangered groups such as birds, mammals and flora. However, an analysis of the received data reveals systematic deficiencies in meeting the third and fourth criteria. There is a lack of coherence and continuity in the datasets, hindering effective analysis and decision-making processes.

This could be occurring for several reasons. For instance, the ongoing expansion of Management Units (MUs) and FSC-Certified areas is not uniform. Additionally, monitoring practices vary among Certificate Holders, including methods and effort, influenced by the size of companies and their management strategies.

Furthermore, the data obtained does not enable us to determine whether the Certificate Holders (CHs) are effectively utilizing the collected data for practical purposes, nor can we discern the specific actions undertaken to promote biodiversity and habitat conservation. However, since some companies are clients of Casa da Floresta, we are aware of certain actions being implemented, facilitated by field monitoring. These actions include providing practical recommendations throughout forest management activities, ranging from construction of roads and infrastructure to timber harvesting and storage.

Moreover, certain companies indicated in Deliverable 1.1 that the gathered data is also used for research purposes, for establishing ecological corridors across the landscape, for identifying High Conservation Value Areas, among other applications.

Additionally, the CHs are effectively concentrating their efforts on important groups in Brazil, such as mammals, birds and flora, as they are sensitive to management impacts, concentrates a highly number of threatened species and are cost-efficient to sample. Records including reptiles, amphibians and fishes are generally associated with environmental licensing, which is a process required by law to obtain authorization for activities or operations that utilize or interfere with environmental resources.

It is important to highlight threatened species being monitored in Brazil because they often serve as indicators of the overall health and integrity of ecosystems. However, while monitoring threatened species is crucial, it may not always be the focus of monitoring efforts for several reasons, considering resource constraints, ecological context and long-term goals, for example.

Prioritizing the resolution of these identified gaps in data coverage should ideally be a focus for future data collection endeavors. Implementing a basic standardization of the type of data recommended for the Certificate Holders (CHs) could enhance their monitoring activities while still allowing companies to maintain autonomy in the process. This approach has the potential to enhance the practical value of biodiversity data collection and to shape future conservation planning initiatives.

6.1.2 Key Findings on Quantitative Analysis

Comprehensive geographical range

The data acquired from the Certificate Holders (CHs) covers the most significant regions of planted forests in the country, particularly in the axis center-south, highlighting critical biodiversity hotspots such as the Atlantic Forest and Cerrado biomes. These regions are globally recognized for their rich biodiversity, yet they face significant threats due to historical territorial occupation. This reality underscores the necessity of diligent monitoring within these areas.

Monitoring efforts

The requirement for FSC certification has been a driving force behind most of the monitoring efforts observed. In Brazil, FSC-CHs are focusing on collecting data related to species and their spatial-temporal distribution. Such data collection is pivotal, as it contributes substantially to ecological analysis and the formulation of effective conservation strategies, also required by FSC Certification.

The monitoring activities conducted by the CHs provide a thorough representation of local species within their certified areas. As certified forests expand, the breadth and depth of data on species presence and distribution also grow, enhancing our understanding and analysis of local biodiversity and Rare, Threatened or Endemic (RTE) species.

These outcomes collectively contribute to the preservation and enhancement of biodiversity in some of Brazil's most critical and threatened ecosystems. Establishing a basic standard for the type of data recommended to Certificate Holders (CHs) could improve their monitoring activities while ensuring companies retain autonomy in the process.

Total and Threatened Species observed by the CHs

The analysis underscores the prioritization of monitoring efforts on key biological groups, notably birds, mammals, and flora. While initial analysis may suggest a disparity between observed and total species over the biomes, it is essential to note that certain taxa, such as grasses and herbs among plants, or small mammals, typically fall outside the primary focus of monitoring activities conducted by the Certificate Holders (CHs).

This disparity is further illuminated by the relationship between sampled area and species recorded in a biome, as the distribution of species are non-continuous and often constrained by natural barriers, resulting in many species being confined to unsampled areas. Furthermore, as certified forests expand in Brazil, they provide more comprehensive data on species presence and distribution.

Considering the records related to threatened species, despite the lower proportion of them when compared to the total threatened species in each biome, it is important to recognize the importance of these records as they serve as valuable indicators of ecosystem health and aids in prioritizing conservation initiatives.

Overall, the increasing area of FSC-certified forests over time underscores the positive impact of requiring biodiversity monitoring for conservation efforts.

6.2 Results of the Land Use Analysis

The land use analysis aims to compare records provided by the CHs of species in Planted Forests (PF) and Natural Forests (NF) to understand at a finer scale the species recorded in set aside areas and whether the same species were recorded in nearby plantation forests (monocultures of *Eucalyptus spp.* or *Pinus spp.*, mainly).

In the discussion section of this analysis (Topic 6.2.1.1), we also evaluate the importance of High Conservation Value Areas (HCVAs) within the certification framework for conserving biodiversity

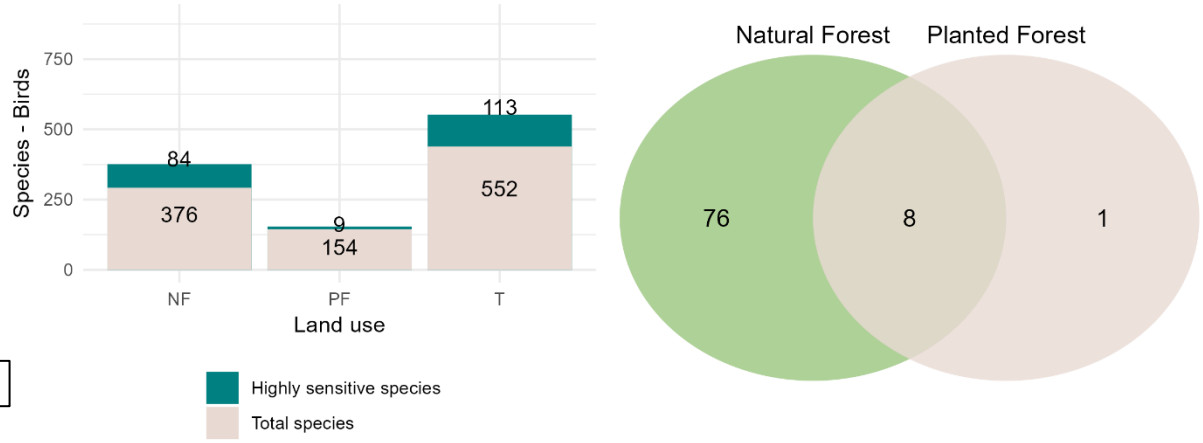
The figures below (Figures 6.2.1, 6.2.2, 6.2.3, 6.2.4) represent the total of species recorded by the CHs in Planted Forests (PF) and Natural Forests (NF), as well as the biological groups of interest evaluated, as described in Topic 5.1.2. It is important to remember that this analysis is focusing only on the CHs that provided data on land use and considering all the years of records provided with this information (from 2002 to 2024), which represents 40% of the total data gathered. Out of this 40%, 11% are related to records in planted forests and 89% in natural forests.

On the figures 6.2.1, 6.2.2 and 6.2.3, bar charts are presented side by side with Venn diagrams with information regarding the records of highly sensible to habitat loss birds (a), mammals with forests as their preferential habitat (b), threatened species of primates (c), threatened species of birds (d) and mammals (e), differing the land use in Natural Forests (NF), Planted Forests (PF) and Total (T), which encompasses records from both NF and PF, as well as records from other land uses. On the last line, a Venn Diagram is illustrating the total number of species recorded in NF, PF and both (f). Each figure presents one biome in records where CHs provided information on land use, respectively: Amazon (Figure 6.2.1), Atlantic Forest (Figure 6.2.2) and Cerrado (Figure 6.2.3). Additionally, a land use analysis at country level was also included (Figure 6.2.4). This analysis excludes data from flora species.

The bar charts on the left side of the figure show the number of species observed and recorded by the CHs in Natural Forests (NF) and Planted Forests (PF), as well as the total number of records (T) encompassing all land uses. The Venn diagrams on the right highlights which species were found exclusively in NF, PF, or both (in the overlapping section). In the case of all species observed in Planted Forests (PF) also being observed in Natural Forests (NF), the PF circle is placed entirely over the NF circle.

Amazon biome

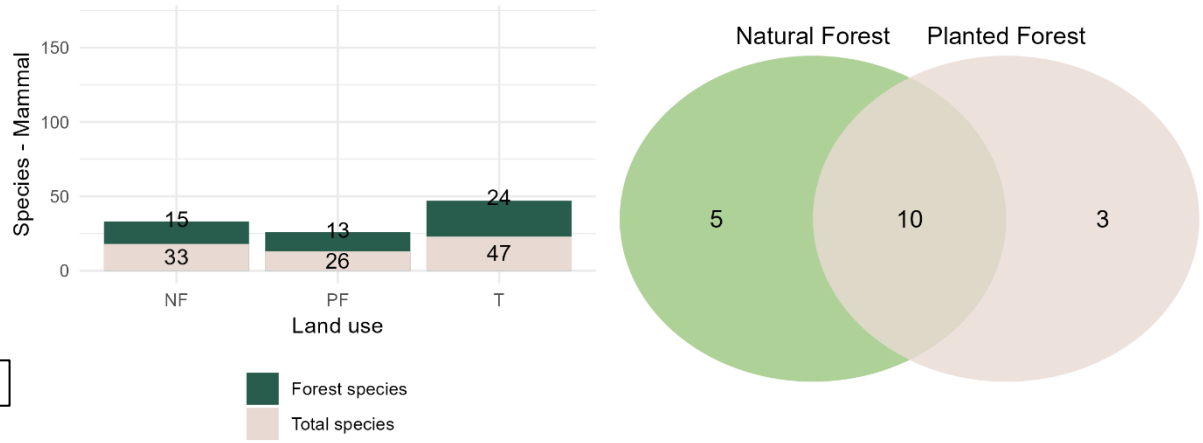
Number of highly sensitive species of birds observed by CHs



a

Highly sensitive species
Total species

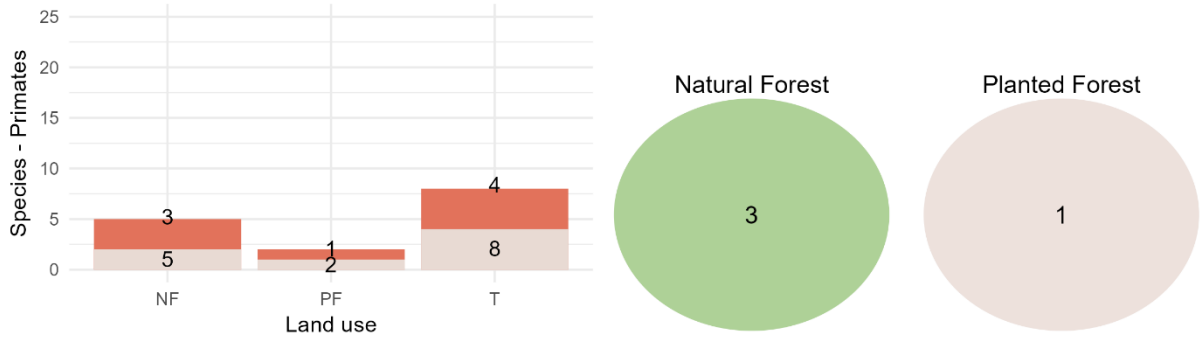
Number of forest species of mammals observed by CHs



b

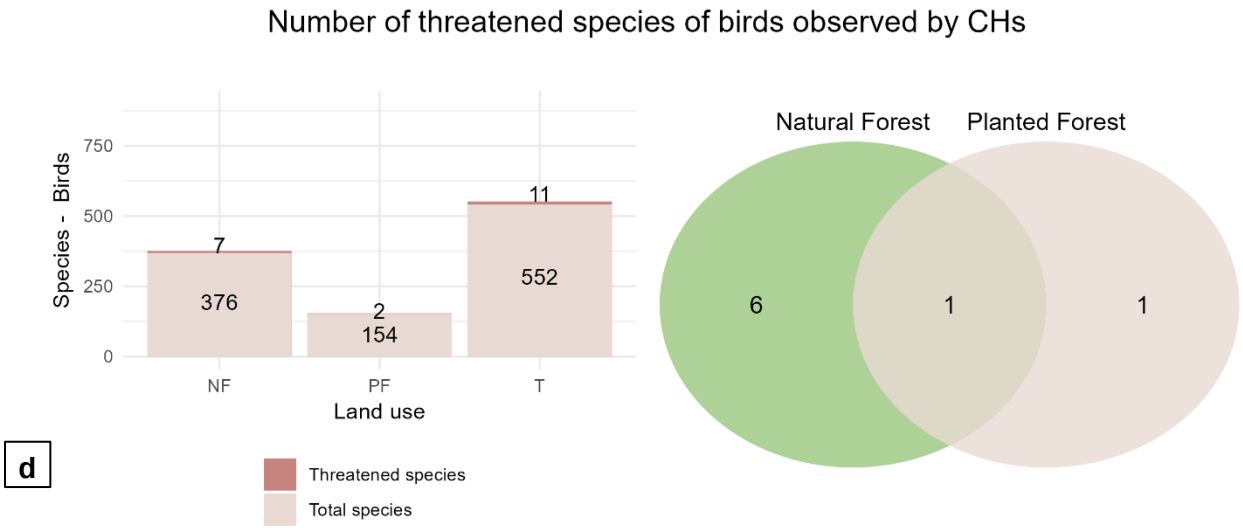
Forest species
Total species

Number of threatened species of primates observed by CHs

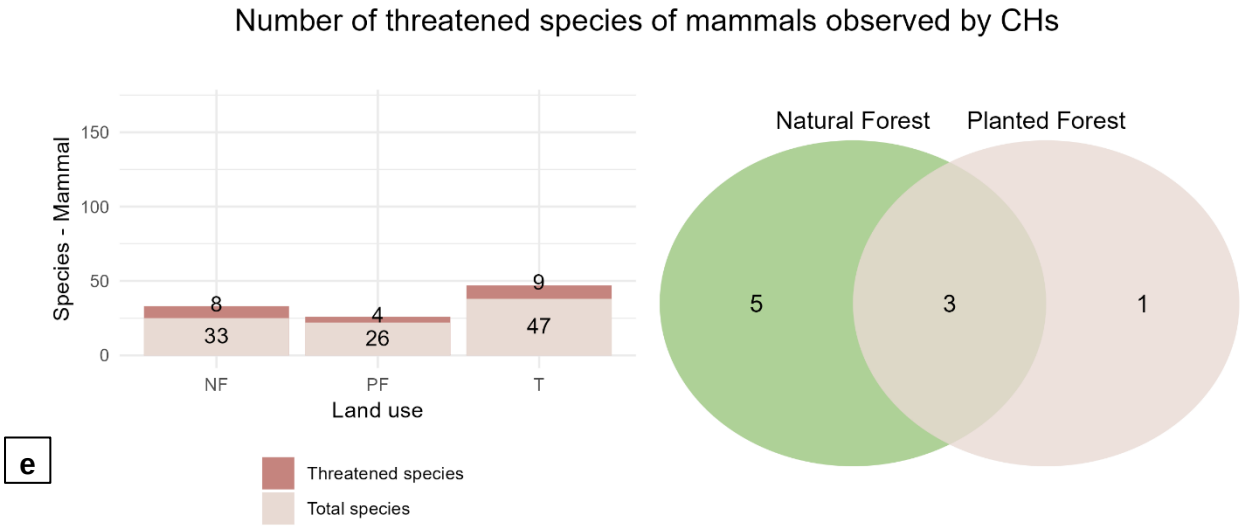


c

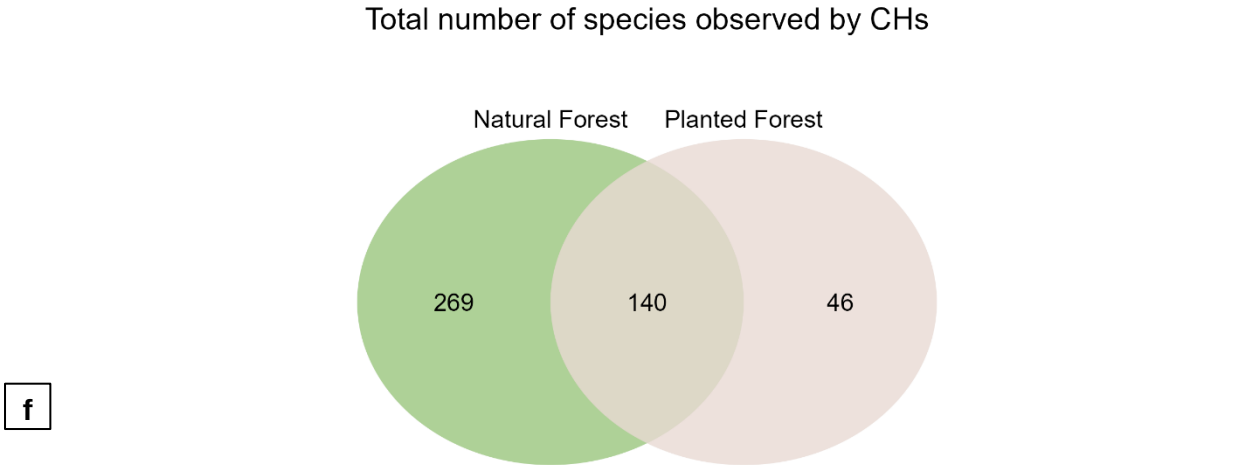
Threatened species
Total species



d



e



f

Figure 6.2.1: Bar charts and Venn diagrams revealing the records of **a.** highly sensitive species of birds, **b.** forest species of mammals, **c.** threatened species of primates, **d.** birds and **e.** mammals, along with a **f.** Venn Diagram illustrating the number of animal species recorded by the CHs in Natural Forest (NF) and Planted Forest (PF) land uses in Amazon Biome.

The Amazon biome is a vast tropical rainforest renowned for its exceptional biodiversity, with dense forests teeming with countless plant and animal species. However, the Certificate Holders (CHs) with planted forest management participating in the project occupy only a small portion of this biome, primarily near the border with the Cerrado biome. Additionally, monitoring data in the Amazon biome are relatively limited compared to the Atlantic Forest and Cerrado biomes, because only a few Certificate Holders in the project are located within the Amazon biome, as detailed in Topic 6.1.

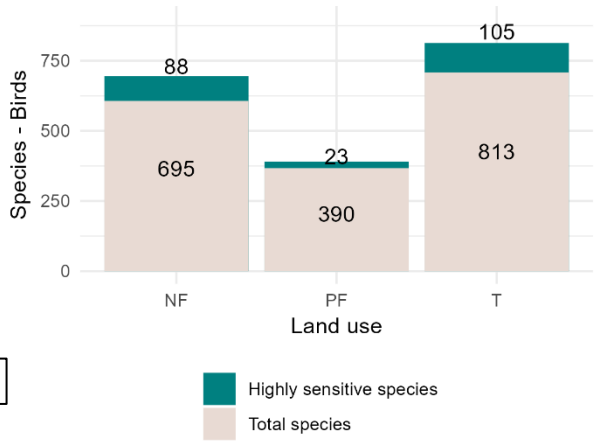
Examining Figure 6.2.1, we observe a considerable number of bird species documented by the CHs within Amazon biome (552), totaling 113 highly sensitive species (a). However, of this total, 76 were exclusively observed in Natural Forests (NF), while 1 was found solely in Planted Forests (PF), and 8 were recorded in both. The higher number of sensitive bird species exclusively observed in Natural Forests (NF) suggests that these birds prefer or rely heavily on undisturbed, natural forest habitats for their survival and ecological functions. Additionally, this indicates that certain sensitive bird species may have specific habitat requirements that are not met by planted forest environments. This underscores the importance of maintaining diverse habitat types to support a wide range of species.

Regarding threatened species of primates, birds, and mammals, the consistent pattern observed across records indicates a concentration of records in Natural Forests (NF), with outliers sporadically recorded only in Planted Forests (PF), likely due to limited sampling efforts in the Amazon biome. Notably, the vulnerable primate species, *Sapajus cay* (Azara's Capuchin), was exclusively documented in Planted Forests (PF), highlighting a potential gap in sampling coverage within Natural Forests (NF). This absence in NF could be attributed to fewer recorded instances with land use information, as this species is highly dependent on natural forested habitats for ecological maintenance.

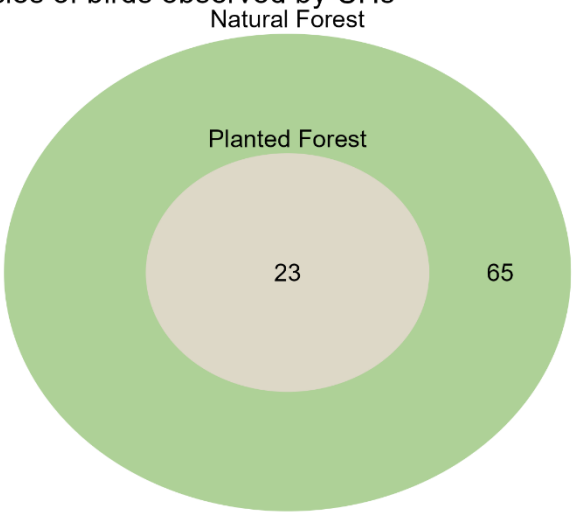
Figure 6.2.2 below illustrates the results of the land use analysis related to the Atlantic Forest biome.

Atlantic forest biome

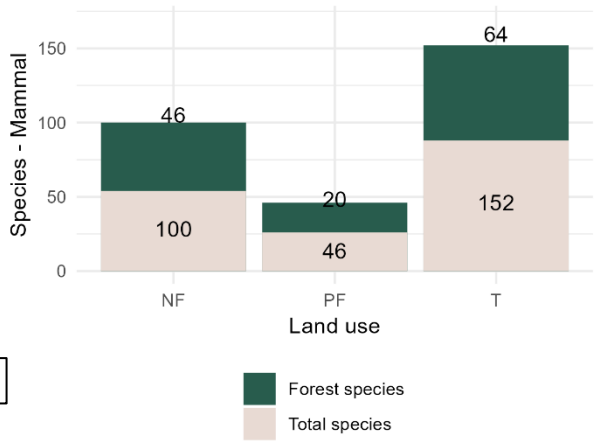
Number of highly sensitive species of birds observed by CHs



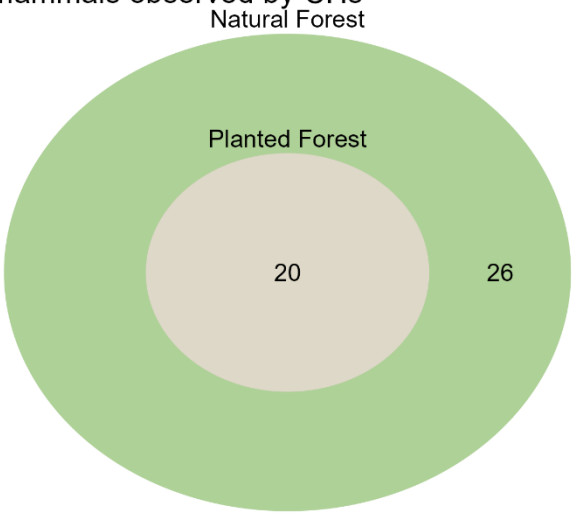
a



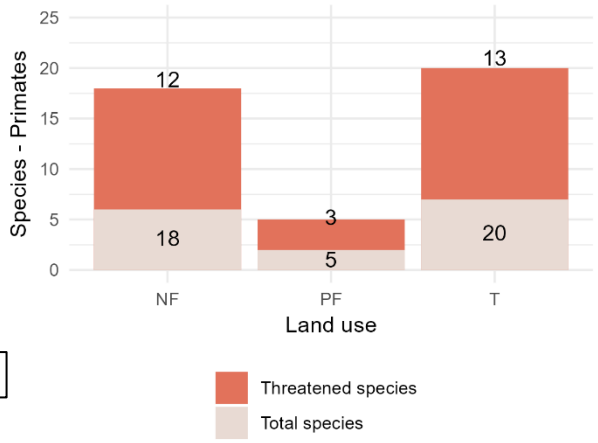
Number of forest species of mammals observed by CHs



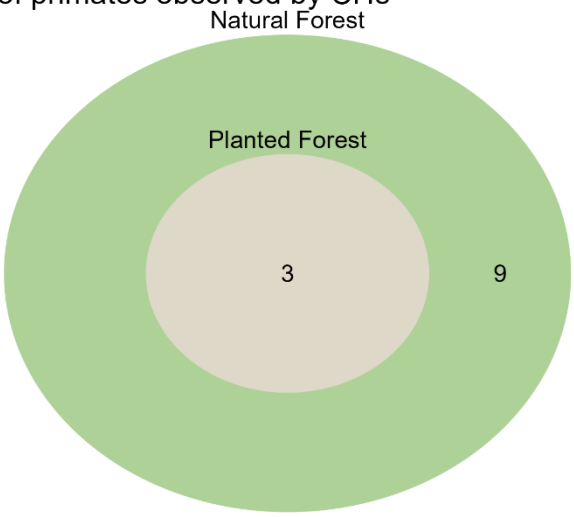
b



Number of threatened species of primates observed by CHs



c



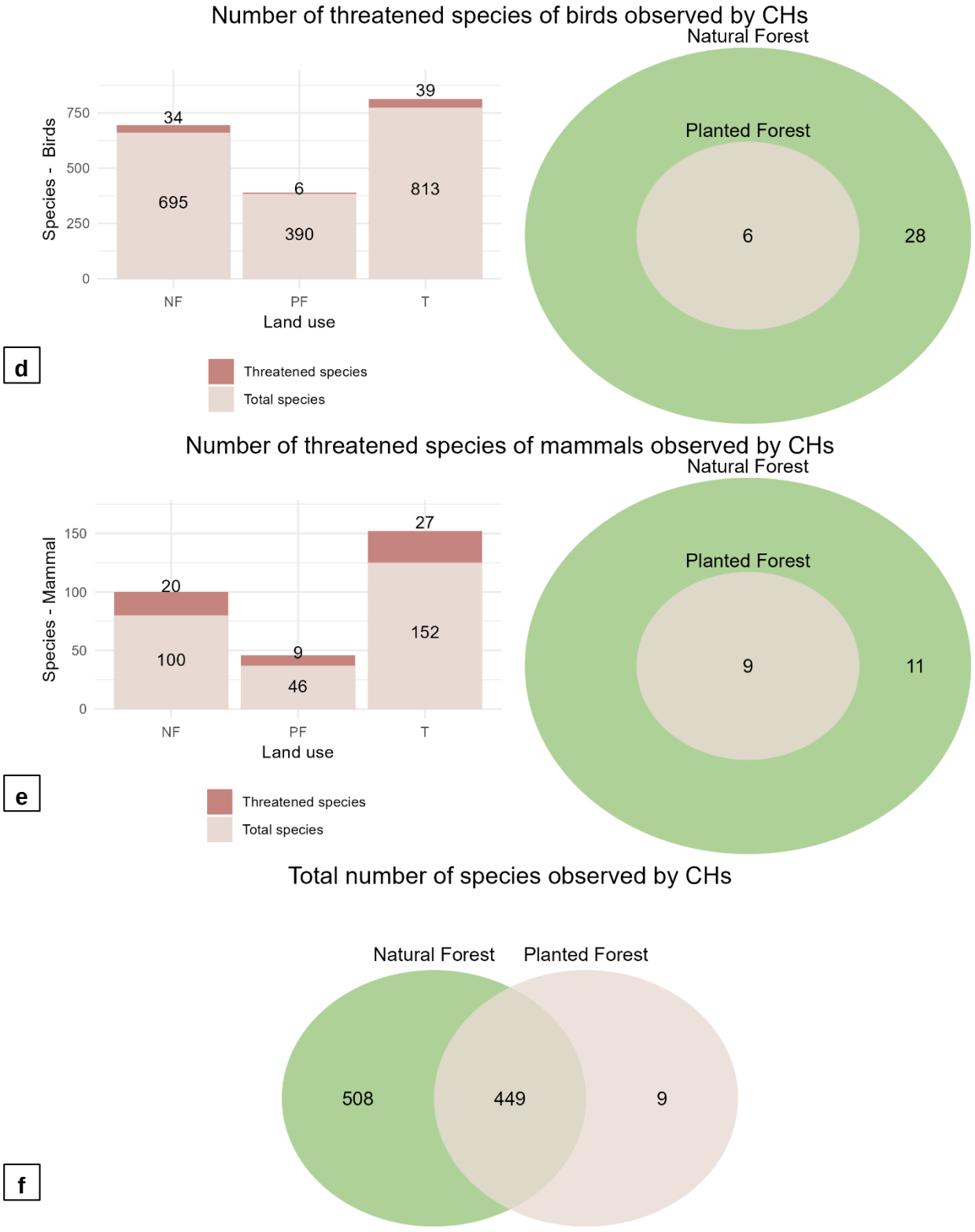


Figure 6.2.2: Bar charts and venn diagram revealing the records of **a.** highly sensitive species of birds, **b.** forest species of mammals, **c.** threatened species of primates, **d.** birds and **e.** mammals, along with a **f.** Venn Diagram illustrating the number of animal species recorded by the CHs in Natural Forest (NF) and Planted Forest (PF) land uses in Atlantic Forest Biome.

Considering the highly sensitive bird species recorded (a), 23 were found in both land uses (NF and PF), while 65 were observed only in NF. These birds are more sensible to habitat loss and are commonly more restricted to natural fragments where they can exercise their ecological functions.

This scenario is not different when analyzing forest mammals, which are mammals that primarily inhabit forested habitats, with 20 species observed in both NF and PF but 26 species observed exclusively in NF. From these 26, there are 13 primates, 1 sloth, 6 rodents, 1 bat, 4 marsupials and 1 wild dog. The absence of a diverse range of mammals in planted forests, compared to their exclusive presence in natural forests (set aside areas), indicates that planted forests are not suitable for their ecological maintenance, such as denning, breeding, or feeding. This pattern is consistent across all selected groups (a, b, c, d, e) and reflects a prevailing trend among the total animal species observed in the biome (f).

Notably, the Atlantic Forest, which has the highest amount of data collected by the CHs participating in the project, demonstrates a clear trend: a higher number of species are recorded in Natural Forests (NF) with no species exclusively inhabiting Planted Forests (PF). This indicates that PF is primarily used by species as corridors rather than primary habitats.

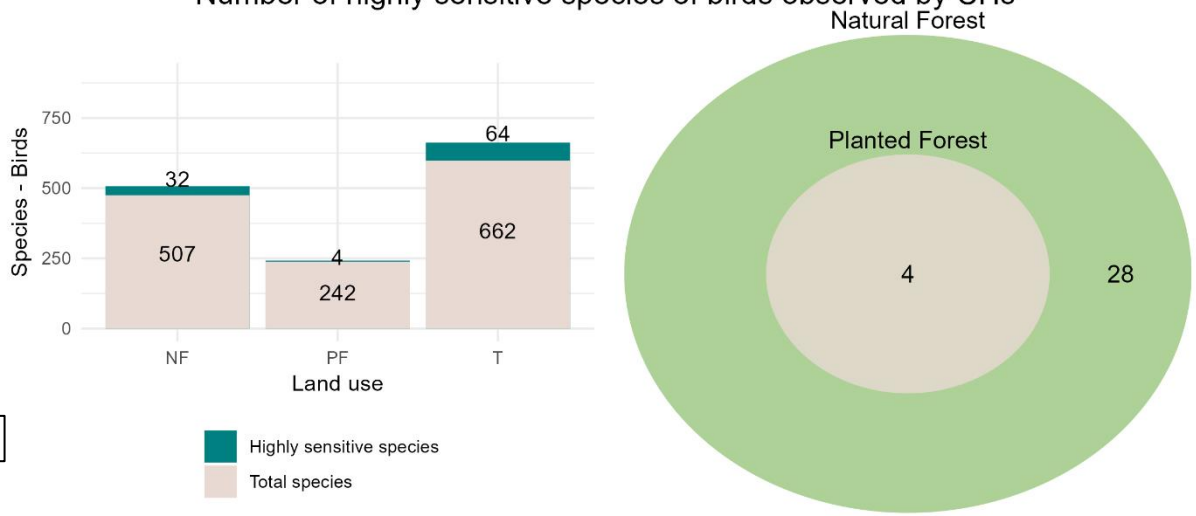
The Atlantic Forest biome, characterized as a predominantly arboreal tropical rainforest, presents an opportunity for tree plantations to contribute significantly to biodiversity conservation. While such plantations may mimic the structural complexity of natural forests better than other intensive land uses like agriculture and pasture, it is evident that biodiversity conservation within FSC-certified forests is not solely contingent on the presence of planted forests. Instead, the integrated landscape, incorporating protected natural areas and set asides, plays a pivotal role in effective forest management.

While some species, such as insectivorous birds, may use planted forests for feeding or breeding, these areas primarily function as corridors. They facilitate species movement between different natural forest fragments, enhancing connectivity and supporting biodiversity, as also discussed in Topic 4.

The Figure below presents the Cerrado biome panorama of land use analysis (Figure 6.2.3).

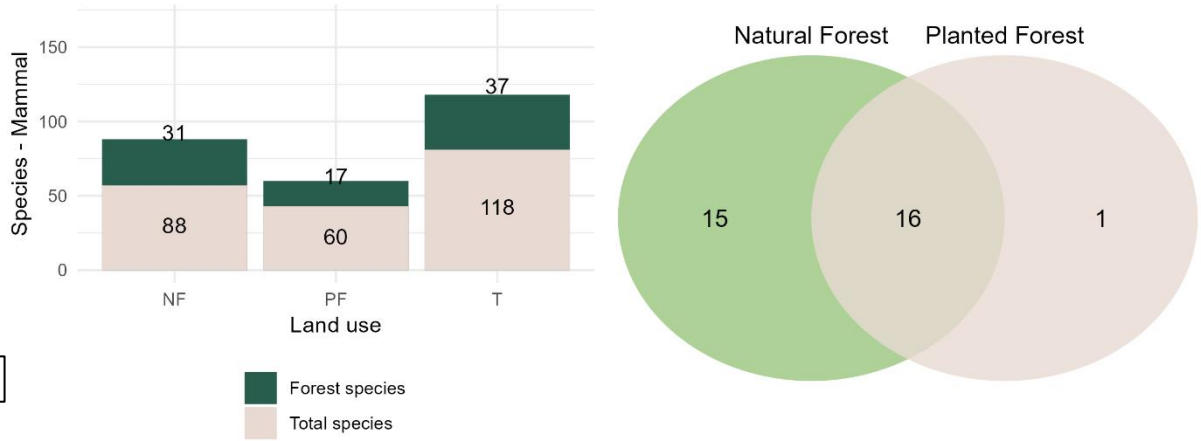
Cerrado biome

Number of highly sensitive species of birds observed by CHs



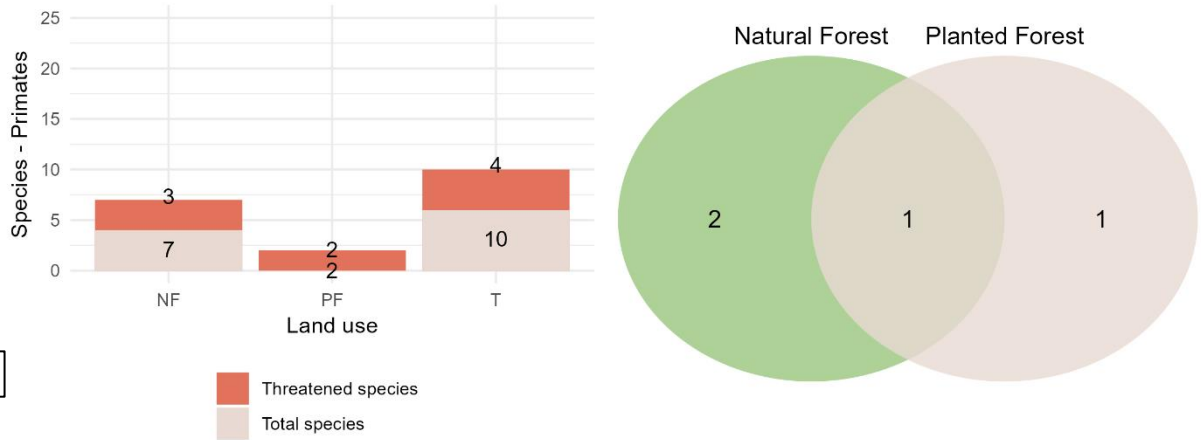
a

Number of forest species of mammals observed by CHs

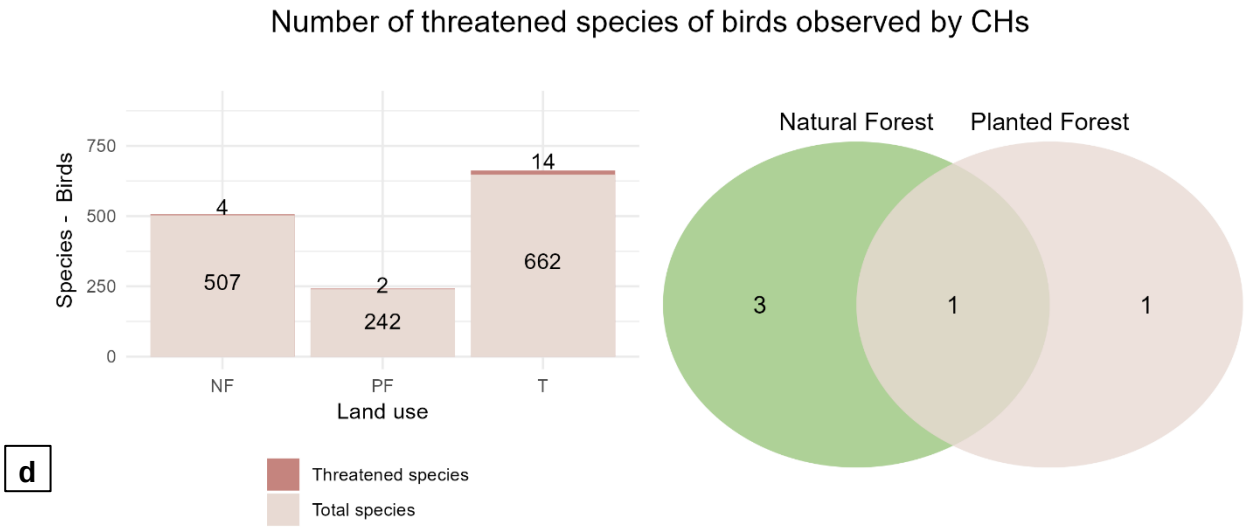


b

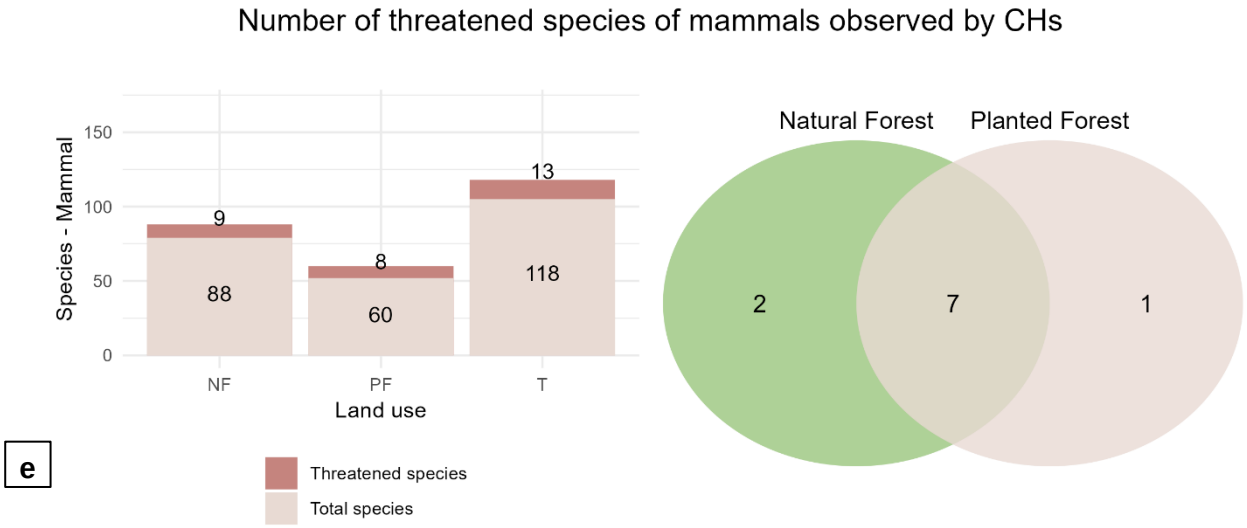
Number of threatened species of primates observed by CHs



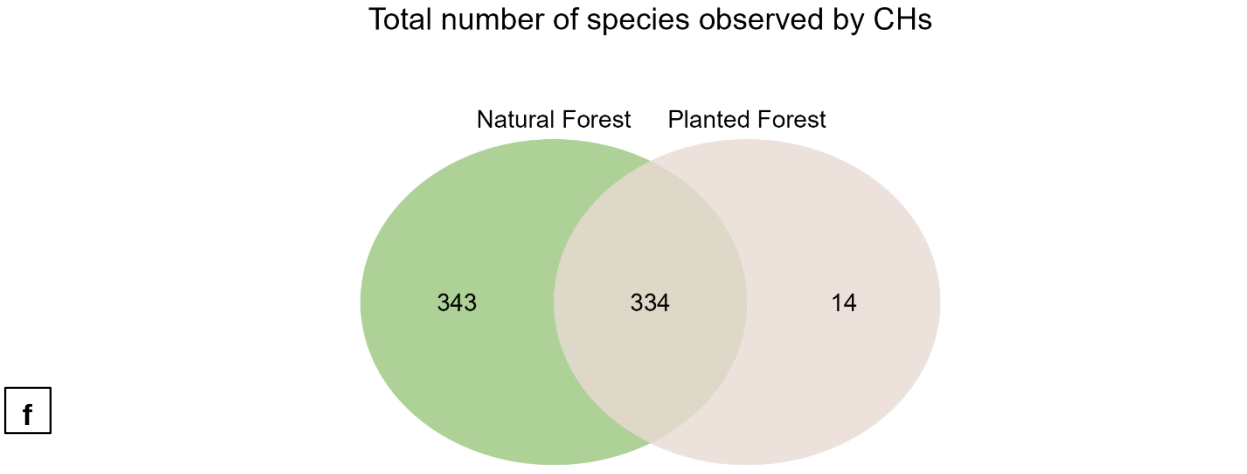
c



d



e



f

Figure 6.2.3: Bar charts and venn diagram revealing the records of **a.** highly sensitive species of birds, **b.** forest species of mammals, **c.** threatened species of primates, **d.** birds and **e.** mammals, along with a **f.** Venn Diagram illustrating the number of animal species recorded by the CHs in Natural Forest (NF) and Planted Forest (PF) land uses in Cerrado Biome.

The Cerrado biome is characterized by a variety of phytophysiognomies, including savanna grasslands, taller and denser vegetations ("cerradão"), gallery forests along watercourses, and cerrado *stricto sensu*, which features short and twisted trees with dense ground cover. These phytophysiognomies vary according to factors such as soil type, drainage, and fire regime, contributing to the high biodiversity and ecological resilience of the Cerrado biome (Ribeiro, et al. 2008).

Upon analyzing the findings concerning highly sensitive bird species, all 32 species were recorded within Natural Forests (NF), and only 4 were also observed in Planted Forests (PF). The limited occurrence of sensitive bird species in PF suggests that these habitats may not fully meet the ecological needs of these species.

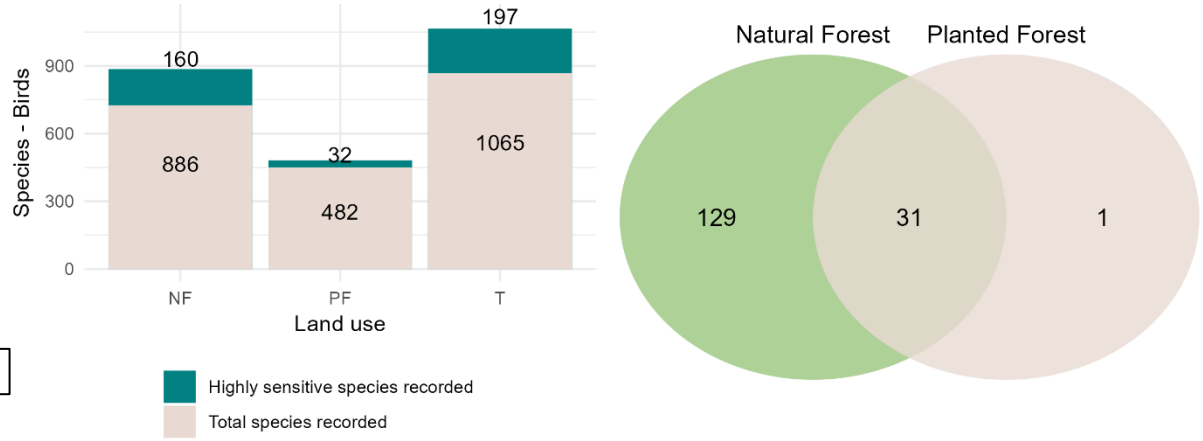
The observed pattern extends to forest mammal species (b), threatened primates (c) and mammals (e), with the *Alouatta guariba clamitans* (Southern Brown Howler Monkey) being the only species exclusively recorded in planted forests, with only one individual observed in the biodiversity database. However, this finding may be considered an outlier, given that it is a vulnerable species with a strong dependence on natural forest habitats. It is likely that the limited monitoring efforts available for analysis in this topic contributed to the absence of this species in NF.

It is noteworthy that this biome is not predominantly forested (Ribeiro et al., 2008), resulting in a lower diversity of primates and forest species recorded. In this context, planted forests, typically monocultures of *Eucalyptus spp*. or *Pinus spp*., might act as ecological barriers for species that are not dependent on forested habitats. On the one hand, during the initial stages of their growth cycle when trees are small and the canopy is less dense, planted forests can attract species that primarily inhabit open areas. This is particularly relevant considering that the Cerrado is characterized by a mosaic of habitats, including savannas, grasslands, and shrublands, alongside forested areas. As such, these forests can serve as ecological corridors, facilitating the movement of species between fragmented natural habitats and enhancing connectivity across the landscape.

Figure 6.2.4 below presents the panorama of the whole country for the land use analysis.

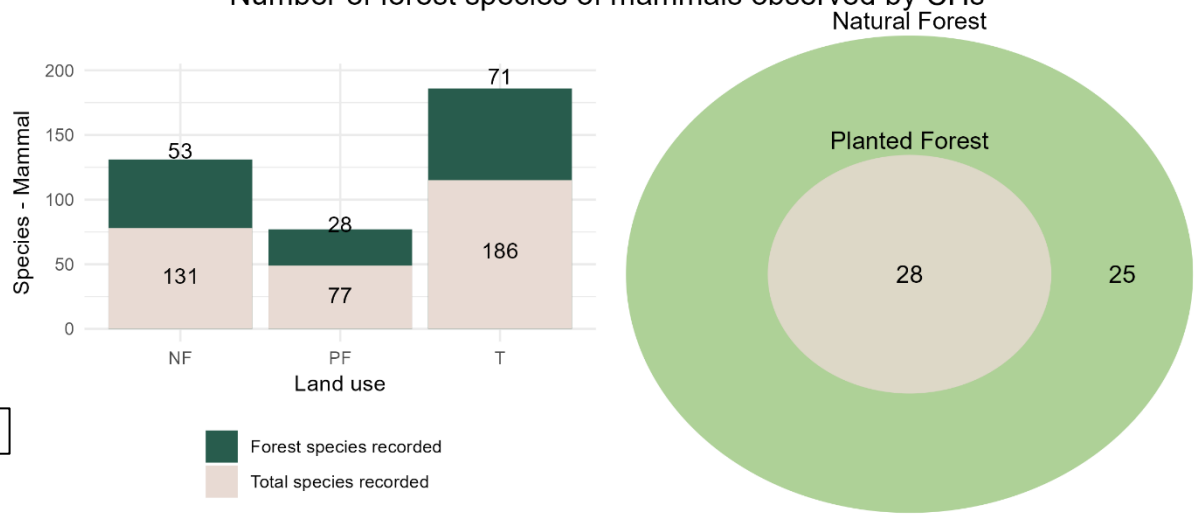
Brazil

Number of highly sensitive species of birds observed by CHs



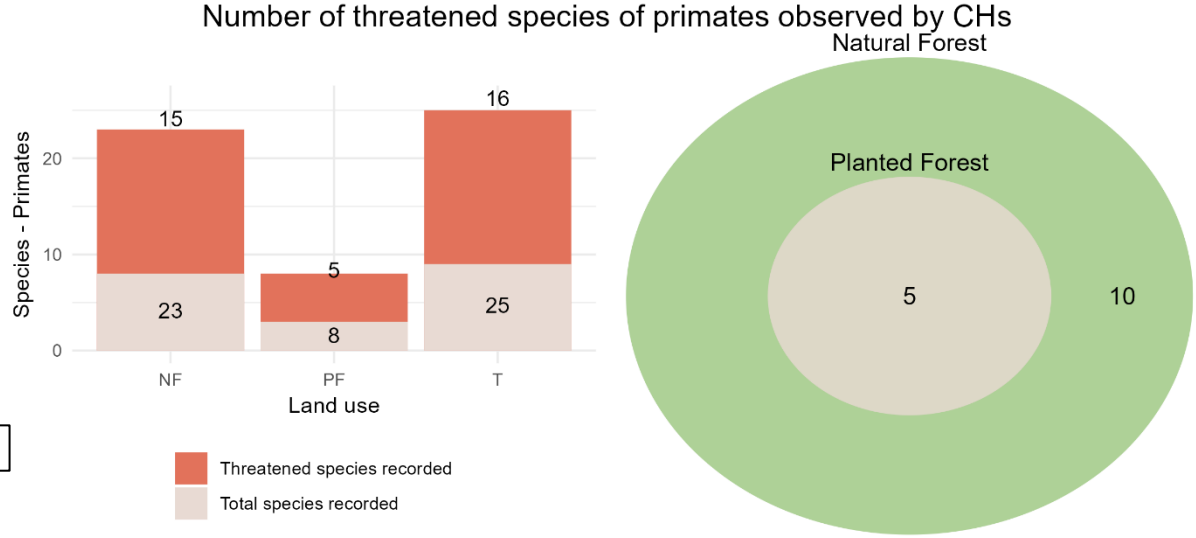
a

Number of forest species of mammals observed by CHs



b

Number of threatened species of primates observed by CHs



c

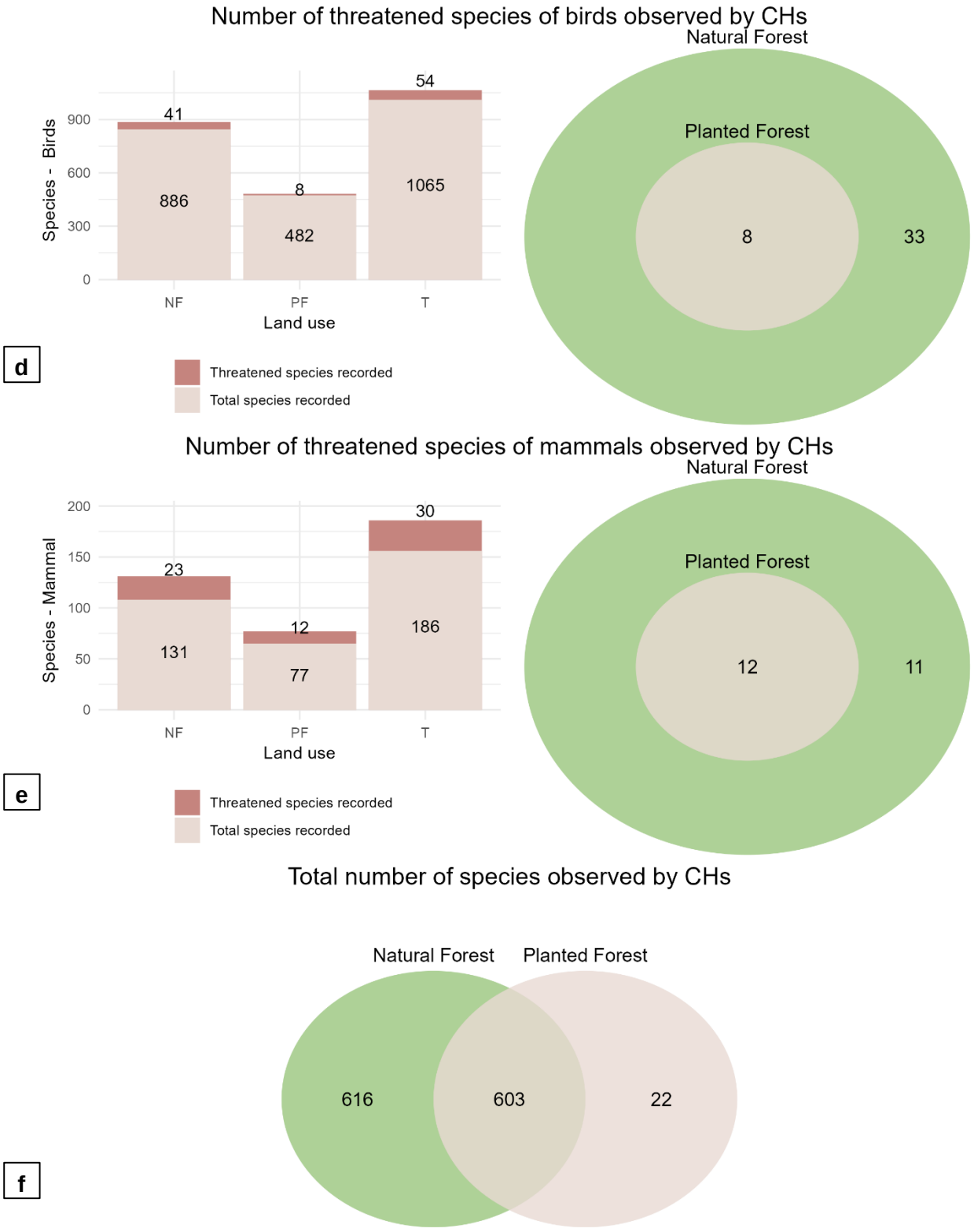


Figure 6.2.4: Bar charts and venn diagram revealing the records of **a.** highly sensitive species of birds, **b.** forest species of mammals, **c.** threatened species of primates, **d.** birds and **e.** mammals, along with a **f.** Venn Diagram illustrating the number of animal species recorded by the CHs in Natural Forest (NF) and Planted Forest (PF) land uses at country level.

It is important to highlight that the monitoring efforts among the Certificate Holders in planted and natural forests vary considerably. However, the results remain intriguing, revealing a pattern where a greater number of species are concentrated in natural forests. Nonetheless, a significant number of species also utilizes planted forests as part of their habitats, but not exclusively.

Similarly, the differences in species numbers observed across biomes can be explained by variations in the monitoring efforts dedicated to each (Table 6.1.1), but they are also influenced by the inherent biodiversity within each biome (Graphs 6.1.1 and 6.1.2).

6.2.1 Discussion

Ecological disturbance indicator species plays a vital role in connecting the immediate impacts of forest management to the underlying ecological condition and integrity of the ecosystem (Gardner, 2010). In this manner, highly sensitive species of birds, forest-dependent mammals and threatened species, along with the total number of species recorded were used to understand how planted forests and set aside areas might be connected in a functional manner, facilitating species movement and interaction. However, based on the data obtained, we can only ascertain that a considerable number of species, including those sensitive to environmental changes, may inhabit planted forests for structural purposes, connecting the landscape with set aside areas, but we can't affirm planted forests are being used for ecological maintenance (e.g. breeding, feeding or nesting). This reaffirms that planted forests can be complementary to set aside areas, but they cannot substitute natural forests.

Many variables influence bird and mammal communities in planted forests, especially the landscape in which the matrix is embedded, as many species only use it as a transit area (Jacoboski et al., 2016; Biz et al., 2017; Homem et al., 2020; Dotta and Verdade, 2011). Furthermore, conditions within the forest plots, such as height and age, the amount of understory, and the presence of scattered native trees within them, can directly influence the composition and abundance of birds for example (Volpato et al., 2010; Lopes et al., 2015; Millan et al., 2015).

When evaluating primates, those are rarely found in planted forests, where despite using trees for locomotion, they restrict their occurrence in native forests due to their ecological requirements. Planted forests never fully meet the needs of these species; however, species with greater environmental plasticity, such as omnivores, may incorporate forest plantations to obtain some resources.

On the other hand, there are few studies that encompass the entire faunal community, which are long-term, and that assess community dynamics more accurately to generate conservation guidelines (Jacoboski et al., 2016).

Additionally, commercial planted forests in mosaics, when well-managed and interspersed with remnants of natural forest, as shown in figures (4.2, 4.3 and 4.4), can function as temporary ecological corridors that connect fragments of natural vegetation, allowing animals to move between the set aside areas.

Furthermore, the monitoring activities carried out by the Certificate Holders involved in this project primarily focus on assessing biodiversity in set aside areas. However, it is important to consider increasing efforts in monitoring planted forests to evaluate the impact of the forest sector more effectively on biodiversity in Brazil, including the FSC added value in certificated plantations.

6.2.1.1. High Conservation Values

The behavior of species observed in Planted Forests and Natural Forests underscores the fundamental differences in habitat quality and ecological value between these two types of forested areas. Planted Forests, characterized by monocultures of species like Eucalyptus or Pinus, often lack the structural complexity and biodiversity found in Natural Forests.

This result highlights the role of identifying High Conservation Value Areas (HCVAs) within the context of FSC-Certification, as described in Topic 4.3, as this is an important added-value when compared to legal requirements in Brazil.

The six HCVs categories are:

- **HCV 1: Species Diversity –** Concentration of biological diversity including endemic species, and rare, threatened or endangered (RTE) species, that are significant at global, regional or national levels;
- **HCV 2: Landscape-level ecosystems, ecosystem mosaics and IFL –** Large landscape-level ecosystems, ecosystems mosaics and Intact Forest Landscapes (IFL) that are significant at global, regional or national levels, and that contain viable populations of the great majority of the naturally occurring species in natural patterns of distribution and abundance;
- **HCV 3: Ecosystems & Habitats –** Rare, Threatened or Endangered (RTE) ecosystems, habitats or refugia;

- **HCV 4: Ecosystem Services –** Basic ecosystem services in critical situations, including protection of water catchments and control of erosion of vulnerable soils and slopes;
- **HCV 5: Community Needs –** Sites and resources fundamental for satisfying the basic necessities of local communities or indigenous peoples;
- **HCV 6: Cultural Values –** Sites, resources, habitats and landscapes of global or national cultural, archaeological or historical significance, and/or of critical cultural, ecological, economic or religious/sacred importance for the traditional cultures of local communities or indigenous peoples.

Within the project's context, the High Conservation Values (HCVs) that could be associated with monitoring and conserving biodiversity are those categorized as HCVs 1, 2, and 3.

These categories are designated within Natural Forests due to their exceptional ecological significance. These areas represent ecosystems with high biodiversity, complex habitat structures, and crucial ecological functions. By evaluating these areas, FSC certification ensures the conservation of critical habitats and ecological corridors necessary for the survival and movement of various species. Moreover, these areas serve as reservoirs of biodiversity, safeguarding species diversity and ecosystem resilience in the face of ongoing environmental challenges.

Furthermore, the presence of HCVAs within FSC-certified forests demonstrates a commitment to sustainable forest management practices of the Certificate Holders. By designating and preserving these areas, FSC-certified forests contribute to broader landscape-level conservation efforts, promoting connectivity between natural habitats and supporting regional biodiversity conservation goals. These benefits are crucial for bolstering biodiversity conservation efforts in Brazil, particularly in light of the absence of legal mandates compelling companies to adhere to such high standards.

6.2.2 Key Findings on Land Use Analysis

Biodiversity dynamics in Natural and Planted Forests

A significant number of sensible and/or threatened species are exclusively observed in Natural Forests (NF), indicating their preference for undisturbed habitats where they can fulfill their ecological functions. This underscores the vulnerability of these species to habitat loss.

This also highlights the importance of Natural Forests as primary habitats for maintaining biodiversity and suggests that Planted Forests serves mostly as structural corridors, emphasizing the importance of integrated landscape management.

Monitoring efforts vary across biomes and between Natural and Planted Forests, with 89% of the available data for land use analysis originating from Natural Forests, while only 11% is derived from Planted Forests. This underscores the importance of stimulating monitoring efforts in planted forests to evaluate the impact of the forest sector more effectively on biodiversity in Brazil, including the FSC added value in certificated plantations.

Importance of High Conservation Value Areas

Identifying High Conservation Value Areas (HCVAs) within FSC-Certification, particularly focusing on HCVs 1, 2, and 3, becomes crucial in the context of the importance of Natural Forests on conservating biodiversity. By evaluating and preserving these areas, FSC-certified forests contribute to landscape-level conservation efforts, promoting connectivity between habitats and supporting regional biodiversity goals. Such practices are pivotal for enhancing biodiversity conservation in Brazil, especially since there are no laws requiring companies to follow such high standards.

6.3 Results of the Landscape Analysis

This topic aims to evaluate landscape examples of FSC-Certified areas and their relationship with connectivity, legal requirements, set-asides and RTE species.

During the reports for deliverables 2.1 and 2.2, we analyzed the differences between FSC requirements and national legislation, as well as how FSC requirements promote biodiversity conservation. In general, although Brazilian environmental legislation is considered one of the most robust and advanced in the world, we discussed that uncertified forests may lack systematic measures to conserve biodiversity and ecosystem services caused by the notable absence of effective inspection and enforcement mechanisms by the government.

In this manner, the FSC Principle 1 “Compliance with Laws” is a key topic to biodiversity conservation and landscape connectivity and when integrated to Principle 6 “Environmental Values and Impacts”, Principle 9 “High Conservation Values” and Principle 10 “Implementation of Management Activities” it shows a great additional benefit, which may differ of uncertified forests and croplands or livestock.

In the following sequence, we will present some landscape case studies from one of the companies participating in the project that authorized the use of their data (Klabin S.A) to gain a better understanding of how the FSC principles are applied in the Brazilian context.

6.3.1 Black Lion Tamarin (*Leontopithecus chrysopygus*)

The following figure (Figure 6.3.1.1) illustrates a situation where an endangered species (*Leontopithecus chrysopygus*) was recorded during monitoring activities conducted by Klabin S.A. The Figure 6.3.1.1-a points out where the records were located, and the Figure 6.3.1.1-b shows the geographical range and population information according to IUCN (2023).

Figure 6.3.1.1: ***a.*** records of the endangered primate species *Leontopithecus chrysopygus* during monitoring activities conducted by a Certificate Holder participating in the project (Klabin S.A.); **b.** Geographic Range of the species according to IUCN.

Leontopithecus chrysopygus, commonly known as the Black Lion Tamarin, is listed as "Endangered" on the IUCN Red List. The primary criteria for this classification include a significant reduction in population size, limited geographic range, and continuing decline in the extent and quality of its habitat. The main threats are habitat loss due to deforestation for agriculture and urbanization, as well as habitat fragmentation which limits the tamarins' ability to find food, mates, and establish territories (IUCN, 2023). The Black Lion Tamarin is found in a small area of the Atlantic Forest biome in the southern region of São Paulo State. It prefers forests with dense canopies and plays a crucial role in the ecosystem as a seed disperser (Valladares-Padua et al, 1994).

The Black Lion Tamarin is a key focus of the Emergency Plan for the Conservation of Primates in São Paulo State, developed since 2014 by the official Commission for the Protection of Primates ("Pró-Primatas"), coordinated by the São Paulo State Secretary for Environment.

Monitoring activities in FSC certified forests are crucial for the conservation and protection of species like *Leontopithecus chrysopygus*. The landscape connectivity shown in Figure 6.3.1.1, along with other key aspects of FSC, highlight the added value of FSC certification compared to legal obligations in Brazil. This is evident through the following points:

Habitat Protection: FSC-certified forests implement measures to protect and restore habitats crucial for endangered species like the Black Lion Tamarin. This includes maintaining and connecting natural forest patches, as observed in Figure 6.3.1.1 and reaffirmed in Figures 4.2, 4.3, and 4.4.

Biodiversity Monitoring: Regular biodiversity monitoring helps assess conservation efforts and guides adaptive management strategies. In Topic 2.1, we discussed how most of the monitoring efforts conducted by the CHs is driven by certification requirements. Additionally, the Quantitative and Land Use analyses (Topics 6.1 and 6.2) highlight significant monitoring efforts in threatened species recorded across their areas, primarily in Natural Forests but also in Planted Forests.

6.3.2 Atlantic Royal Flycatcher (*Onychorhynchus swainsoni*)

The following figure (Figure 6.3.2.1) showcases a situation where a vulnerable and highly sensible to habitat loss bird species (*Onychorhynchus swainsoni*) was recorded during monitoring activities conducted by Klabin S.A.

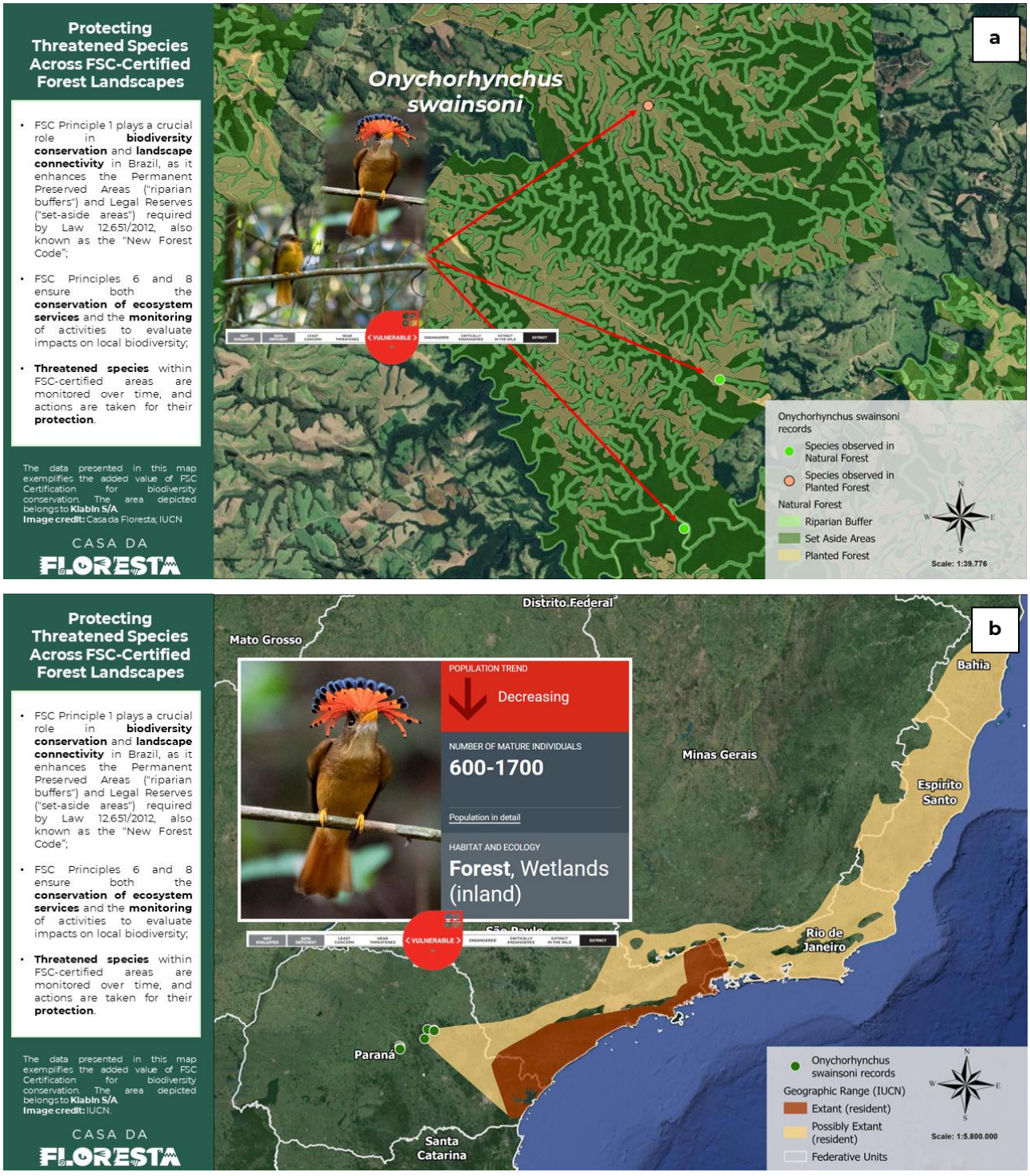


Figure 6.3.2.1: ***a.*** records of the vulnerable and highly sensible to habitat loss bird species *Onychorhynchus swainsoni* during monitoring activities conducted by a Certificate Holder participating in the project (Klabin S.A.); **b.** Geographic Range of the species according to IUCN.

The Atlantic Royal Flycatcher (*Onychorhynchus swainsoni*) is categorized as "Vulnerable" on the IUCN Red List, indicating its heightened risk of extinction. This classification stems from several factors, including a declining population trend exacerbated by habitat loss and fragmentation.

This species is endemic to the southeastern Brazil, in the Atlantic Forest biome. This biome is characterized by high biodiversity and endemism but is also one of the most threatened due to extensive deforestation and fragmentation. The species prefers lowland and montane evergreen forests, typically in areas with dense undergrowth and proximity to water sources (Mikchi & Bérnils, 2004).

It is noteworthy that the records obtained by the CH extend beyond the current geographic range evaluated by IUCN. This highlights the importance of monitoring due to FSC certification, as it enables the detection of species occurrences beyond known boundaries, contributing to a more comprehensive understanding of their distribution and conservation status. Additionally, FSC monitoring activities offer valuable data that support other conservation programs and research initiatives, as noted by the CHs in the questionnaire presented in Deliverable 1.1 (Topic 2.1).

The records obtained by the Certificate Holders also underscore the potential for vulnerable and sensitive species to utilize Planted Forests as corridors between Natural Forest fragments. This is confirmed by the presence of records of this and other species, as discussed in Topic 6.2, across both land uses.

6.3.3 Vulnerable and Forest-dependent Mammals

The following figure (Figure 6.3.3.1) demonstrates other situation where threatened species were recorded during monitoring activities conducted by Klabin S.A, highlighting the land use and the connectivity of the landscape.

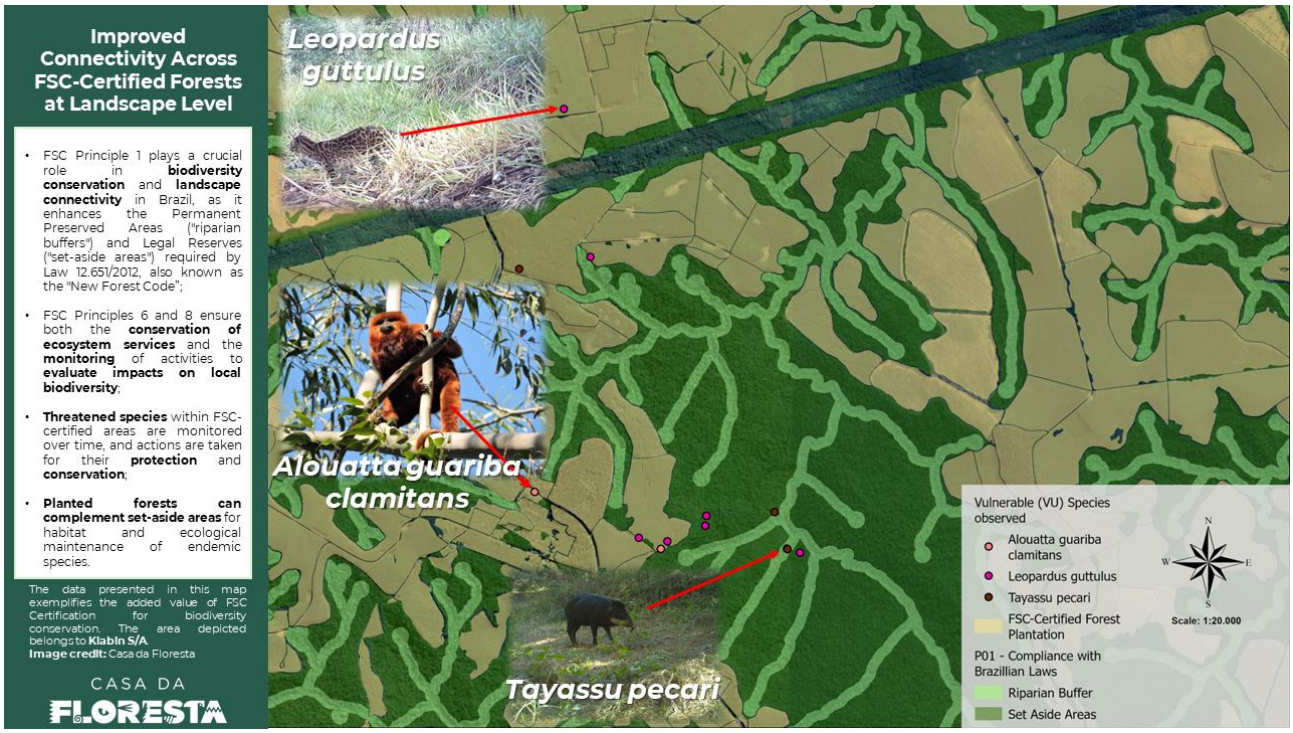


Figure 6.3.3.1: Vulnerable and forest-dependent mammal species (*Alouatta guariba clamitans*, *Leopardus guttulus*, and *Tayassu pecari*) in a Management Unit of Klabin S.A.

The three mammal species presented above, *Alouatta guariba clamitans* (Southern Brown Howler Monkey), *Leopardus guttulus* (Southern Tiger Cat), and *Tayassu pecari* (White-lipped Peccary), are classified as Vulnerable (VU) according to the IUCN. These species have a broad distribution within Brazil, inhabiting various biomes such as the Amazon, Atlantic Forest, and Cerrado (ICMBio, 2024).

Another common characteristic among these species is their preference for forested habitats. Their home ranges in these habitats vary from 2 km to 25 km (*Leopardus guttulus*), 21 km to 121 km (*Tayassu pecari*), and 1.8 to 33 hectares (*Alouatta guariba clamitans*) (Fragoso, 2004; Keuroghlian et al., 2004; Oliveira et al., 2010; Fortes et al., 2015). The Southern Tiger Cat and White-lipped Peccary can also occur near agricultural fields, provided there is natural vegetation cover, often found in mosaics of forests or Cerrado alongside small agricultural areas (Oliveira et al., 2008; Altrichter & Boaglio, 2004). Within their forest habitats, these species play vital roles: the White-lipped Peccary serves as prey for large top carnivores, the Southern Tiger Cat preys on small mammals, birds, and lizards, and the Southern Brown Howler Monkey acts as a seed disperser (Oliveira et al., 2008; Cavalcanti & Gese, 2010).

The primary factors contributing to the decline of these species, classifying them as vulnerable to extinction, includes illegal and unsustainable hunting for fur, food, and due to conflicts with rural properties, continuous and widespread deforestation leading to habitat loss and fragmentation, which also increases hunting pressure, agriculture, livestock farming, urban growth, and vulnerability to epidemics (IUCN, 2023).

The data provided by the CHs, along with the review of the mentioned species, indicate that those species can use planted forest areas to move around and find suitable habitats. However, they are only present in these areas due to the mosaic promoted by the conservation of natural areas like Legal Reserves (RL), Permanent Preservation Areas (APP), and High Conservation Value Areas (AAVCs), together with the FSC-certified plantations. These natural areas are crucial for the ecological maintenance of these species.

Thus, it is possible to observe a significant contribution of the FSC to biodiversity by enabling knowledge of the species in the areas through monitoring, as well as by requiring the maintenance of natural areas. This allows species, like those discussed here, to be present in the certified companies' areas. The interaction between planted forests and conserved natural areas creates a more favorable environment for the survival and movement of these species, highlighting the importance of certification for biodiversity preservation.

6.3.4 Vinaceous-breasted Amazon (*Amazona vinacea*)

The following figure (Figure 6.3.4.1) showcases a situation where an endangered and highly sensible to habitat loss bird species (*Amazona vinacea*) was recorded during monitoring activities conducted by Klabin S.A.

Figure 6.3.4.1: Endangered and highly sensible to habitat degradation bird species (*Amazona vinacea*) in a Management Unit of Klabin S.A.

The Vinaceous-breasted Amazon (*Amazona vinacea*) is a species native to Brazil, Paraguay, and Argentina. In Brazil, its range extends from Bahia (where its subpopulation is quite reduced) to Rio Grande do Sul, where the largest subpopulation is found. It predominantly inhabits areas located in the Atlantic Forest biome and ecotones with the Cerrado and Campos (ICMBio, 2024). This species has a strong association with Araucaria angustifolia, which will also be discussed in the next section (Topic 6.3.5).

Among the main factors threatening the species, habitat loss stands out, with the suppression of Araucaria forests in the south of the country causing a worrying population decline, including local extinctions. Hunting to eliminate individuals from agricultural areas and capturing for smuggling are very common activities in the regions where the species occurs most numerously (Urben-Filho et al., 2008; Lombardi et al., 2012). Such actions have led the species to be classified as Endangered by the IUCN, with a 20% chance of becoming extinct in the next five generations (IUCN, 2013).

In the case of the Vinaceous-breasted Amazon (*Amazona vinacea*), the main contribution of the FSC for identifying this species in its certified forests, beyond the

monitoring that allowed individuals to be found, is the conservation of natural forests, particularly the araucaria forests. The *Amazona vinacea*, being highly sensitive to disturbances, shows a significant dependence on this type of forest for the maintenance of its species, both in terms of feeding and reproduction. This makes it unlikely for its individuals to utilize planted forests in any way, unless they are planted forests of araucaria (Araucaria angustifolia). Therefore, the protection and conservation of araucaria forests are essential for the survival of this species.

6.3.5 Critically Endangered Tree: Parana Pine (*Araucaria angustifolia*)

Figure 6.3.5.1 below illustrates the situation of a critically endangered (CR) tree species recorded during monitoring activities conducted by Klabin S.A., emphasizing the importance of conserving natural forests (set-asides) to ensure the protection of threatened flora species.

Figure 6.3.5.1: Critically Endangered tree species (*Araucaria angustifolia*) being conserved in set-aside areas belonging to Klabin S.A.

Araucaria angustifolia, commonly known as Paraná Pine, is a conifer species native to southeastern Brazil (particularly in the states of Paraná, Santa Catarina, Rio Grande do Sul, and parts of São Paulo, Minas Gerais, and Rio de Janeiro) and adjacent regions of Argentina (Misiones) and Paraguay (IUCN, 2023). Over the past century, Paraná Pine forests in southern Brazil have nearly vanished due to logging and agricultural expansion. Today, the species exists in pristine conditions only in a few locations, with most populations found as fragmented and isolated trees from formerly continuous forests. The species' future is at risk unless effective restoration plans are developed and implemented (Bittencourt, 2007).

Araucaria angustifolia features a straight, cylindrical trunk that can reach heights of 25 to 50 meters, with a trunk diameter of 1 to 2 meters at breast height (Klein, 1960). It takes about 150 years for a tree to reach a diameter of 75 cm (Voltolini, 2000). Animals such as jays, rodents, domestic pigs, and peccaries disperse its seeds, which have a longevity of no more than six weeks (Ntima, 1968).

This species was the most commercially important native conifer in Brazil, and possibly all of South America, until the late 1970s (Guerra et al., 2002). *Araucaria angustifolia* played a significant role in social and economic development, providing high-quality timber for construction, furniture, and long-fibre cellulose (Carvalho, 1994). Additionally, the buds are used in traditional medicine, and the seeds, known as "pinhão," are consumed as food. The forest thus offers wood, medicinal leaves, food, and various fruits (Carvalho, 1994; IUCN, 2023).

In 2001, harvesting of Araucaria was prohibited by law after surveys revealed that less than 3% of the original forest cover remained as fragmented land (Castella and Britez, 2004). The conversion of most native Araucaria forests into pasture and agricultural land has led to the extinction of many natural populations.

The FSC certification plays a crucial role in conserving threatened tree species like *Araucaria angustifolia*, even in FSC-certified planted forests, as one critical aspect of FSC certification is the establishment of set-asides.

Additionally, FSC Principle 1 ensures that forest management in Brazil aligns with national laws, such as the National Environmental Policy (Law 6.938/1981), guaranteeing that any potential environmental and biodiversity impacts, including those on threatened species like *Araucaria angustifolia*, are thoroughly assessed and mitigated. Additionally, Law 12.651/2012, known as the New Forest Code, mandates the maintenance of Legal Reserves and Permanent Preservation Areas (APPs) on rural properties to conserve native vegetation.

7. General Conclusions

Based on the presented results, we conclude that FSC-certified companies in Brazil are actively monitoring biodiversity and providing valuable data on species, including rare, threatened, and endangered (RTE) species observed within their Management Units. This data is essential for evaluating forest management practices and consolidating species-specific information for their regions. The companies are focusing their efforts on key groups such as mammals, birds, and plants, which are cost-efficient to sample and sensitive to environmental changes. The methods and efforts among the Certificate Holders (CHs) vary considerably, influenced by the size of the companies and their management strategies.

However, improvements are needed to consolidate monitoring records into a robust database. This will ensure comprehensive species representation, geographical and temporal continuity, and practical utility for decision-makers, thereby facilitating effective conservation efforts. Addressing these data coverage gaps should become a focal point for future data collection efforts. Introducing a basic standardization of data types for CHs could enhance their monitoring activities while still granting companies autonomy in the process.

Another key conclusion highlights the importance of including planted forest areas and borders between planted and natural forests in monitoring activities. The data reveals that many species, including those sensitive to environmental changes, may inhabit planted forests for structural purposes. Monitoring these forests provides insights into the landscape of certified forests, encompassing both tree plantations and set-aside areas, and helps identify potential conservation needs and opportunities.

The table below (Table 7.1) summarizes the main conclusions related to CHs' efforts in conserving biodiversity, linked to the FSC added-value table presented in Deliverable 2.2 (Topic 4.3).

Table 7.1. Added value of FSC for monitoring, conservation, and landscape connectivity in Brazil.

Biodiversity Conservation	FSC Requirements	Brazilian legislation	Findings from the Analyses
Protection of ecosystems and watersheds	FSC Principles 1, 6 and 10	Brazilian Federal Law 12.651/2012	Protection Required by Law on Permanent Preserved Areas (APPs) and Legal Reserves (RL) – **Not enough information to evaluate it.**
			Deliverable 1.1 – Positive answers from the questionnaire related to monitoring efforts.
			Land Use Analysis (Topic 6.2) – A high proportion of species, including sensitive and RTE, observed in Natural Forests.
			Landscape Analysis (Topic 6.3) – Case studies on FSC-Certified forest landscapes.
Commitment to biodiversity conservation	FSC Principles 1, 6, 9 and 10	Brazilian Federal Law 12.651/2012 and 9.985/2000	**Deliverable 1.1 –** Positive answers from the questionnaire related to monitoring efforts.
			Quantitative Analysis (Topic 6.1) – As certified forests expand, they provide more comprehensive data on species presence and distribution.
			Quantitative Analysis (Topic 6.1) – Monitoring activities in threatened biomes and evaluation of RTE species.
			Quantitative Analysis (Topic 6.1.1) – Specific actions undertaken to promote biodiversity – **Not enough information to evaluate it.**
			Land Use Analysis (Topic 6.2) – A high proportion of species, including sensitive and RTE, observed in Natural Forests and Planted Forests.
			Landscape Analysis (Topic 6.3) – Case studies on FSC-Certified forest landscapes.
Evaluation of the impacts from management activities and mitigation actions	FSC Principles 8 and 10	Brazilian Federal Law 6.938/1981	**Deliverable 1.1 –** Positive answers from the questionnaire related to monitoring efforts.
			Quantitative Analysis (Topic 6.1.1) – Using the collected data for practical purposes – **Not enough information to evaluate it.**
Effective inspection and enforcement mechanisms	FSC Principle 8	-	**Deliverable 1.1** – Positive answers from the questionnaire related to reporting mechanisms.
Actions to guarantee landscape connectivity	FSC Principles 6 and 9	-	Protection Required by Law on Permanent Preserved Areas (APPs) and Legal Reserves (RL)/Set Asides – **Not enough information to evaluate it.**
			Land Use Analysis (Topic 6.2) – A high proportion of species, including sensitive and RTE, observed in both Planted Forests and Natural Forests.
			Landscape Analysis (Topic 6.3) – Case studies on FSC-Certified forest landscapes.
Maintenance and Protection of High Conservation Value Forests	FSC Principles 9 and 10	-	**Deliverable 1.1 –** Answers from the questionnaire related to monitoring efforts where all CHs developed projects for identifying HCVAs.
			Quantitative Analysis (Topic 6.1) – Monitoring activities in threatened biomes and evaluation of RTE species.
			Land Use Analysis (Topic 6.1.1.1) – Importance of HCVAs for FSC requirements and CHs' engagement.

Law 6.938/1981 – National Environmental Policy – purposes, formulation and application mechanisms, and other measures.

Law 9.985/2000 – National System of Nature Conservation Units – definition of categories and criteria for Protected Area in Brazil.
Law 12.651/2012 – New Forest Code - general rules on vegetation protection, conservation and use.

8. Final Considerations

One of the primary challenges of this project is isolating the factor of "certification" to directly understand the impact of FSC Certification on conserving biodiversity and ensuring landscape connectivity and habitat protection. This challenge persists due to the lack of publicly available and consolidated sources of biodiversity data, coupled with the inability to access geographical information regarding uncertified forests for conducting real comparisons.

Furthermore, another significant factor lies within Brazilian legislation, which legally protects a substantial portion of riparian buffers and set-aside areas. This legal framework complicates the understanding of which conservation areas can be attributed exclusively to FSC requirements.

However, what we can infer is that the combined effect of legal and certification requirements working together is the true added value that enhances biodiversity conservation on a landscape scale in Brazil, considering specially the compliance with the laws (Principle 1), commitment to biodiversity conservation and the evaluation and mitigation of impacts on biodiversity, aligned with effective inspection, enforcement mechanisms and management activities (Principles 6, 8, 9 and 10).

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ANNEX 1: QUESTIONNAIRE OF COMPANY-SPECIFIC INFORMATION ABOUT MONITORING BIODIVERSITY

Title	Description
Certificate	Insert the certificate code you are responding to - if there is more than one, insert on another line.
Certificate Holder	Insert the name of the certified company or forestry group
Name	Name of the person(s) responding to this questionnaire
Forest Management Unit (FMU)	If applicable
State	Insert the states where the FMU is located
Year of Certification	Year of the company's first certification
Type of Certification	Individual or Group ownership? If it is a group, please specify the number of owners.
Total Area (ha)	Total area of the certified base
Would you like to keep the company name anonymous?	yes/no
Do you have certification for Ecosystem Services?	yes/no
Planted area (ha)	Total area of the Forest Management Unit (must be less than or equal to the total area)
How do you perceive the demands from environmental agencies?	Insert a value from 1 to 5, where 1 (low) - 5 (high)
Perception of environmental agencies and autarchies	Describe your perception regarding environmental agencies related to biodiversity issues
Planted species	If native management, include the exploited species
Monitoring Description	Motivation: Why does your company carry out this monitoring? Legal requirements, certification, voluntarily.
What types of data are used?	Primary or Secondary
Evaluated Biological Groups	Plants, medium and large-sized mammals, birds, amphibians, reptiles, fish, bees, butterflies - if there are only a few locations, please fill in only the common groups in this field.
How many areas are monitored?	If monitoring is limited to some fragments or FMUs, count those locations. Or if farms, include the quantity of evaluated farms.
Monitored area (ha)	Sum the total area considered in the previous column
Type of area	Private property or public areas
Has the company developed any projects for identifying HCVAs?	yes/no
How many HCVAs are there? And what are the HCV attributes?	Specify the total number of HCVAs and with which attribute - if the same HCVAs has more than 1 attribute, please specify - see example: "x areas with HCV y"
Has any scientific article been published based on the collected data?	yes/no - If yes, fill in the "Articles" folder
Does your company have a dedicated team to deal with social aspects?	yes/no
Does your company have projects with local communities?	yes/no

Has your company published a Sustainability Report in the last 5 years?	yes/no
Does your company have a complaint or reporting mechanism?	yes/no
Are areas with illegal or unauthorized activities (hunting, wood extraction, etc.) mapped?	yes/no
What illegal activities have been detected?	List activities with evidence found in the field
Do you have exotic fauna or flora species? Which ones?	yes/no - If yes, list for which ones
Is there any program for combating exotic or invasive species?	yes/no
Are monitoring activities conducted by your own team or third parties?	yes/no. If by third parties, specify if it is with a university, environmental consultancy, or other.
Do you believe that certified forests generate positive impacts on biodiversity?	Insert a value from 1 to 5, where 1 (low) - 5 (high)
Does the company have another certification? For example, PEFC, ISCC? Which ones?	yes/no - If yes, list which ones.
Are the collected data used for other initiatives (GRI, TFND, IFC, etc.)? Which ones?	yes/no - If yes, list which ones.
Do you believe that your company's forestry business is economically viable in the long term?	yes/no

ANNEX 2: QUESTIONNAIRE ABOUT THE DATA RELATED TO BIODIVERSITY MONITORING INITIATIVES UNDERTAKEN BY FSC FM CH

Raw Data Questionnaire		
Title	**Priority**	**Description**
Certificate Holder	***Non-priority***	Insert the name of the certified company or forestry group
Forest Management Unit (FMU)	***Non-priority***	If applicable
Project Type	***Non-priority***	If the project is biodiversity monitoring, HCV monitoring, restoration monitoring, diagnosis, etc.
Year	***Non-priority***	Year in which the monitoring was carried out
Date	***Mandatory***	Date on which the record occurred
Municipality	***Non-priority***	Municipality where the monitored area is located
State	***Non-priority***	Federative Unit (UF) where the monitored area is located
Farm Name	***Desirable***	Name of the monitored farm
Farm Code	***Non-priority***	Unique code referring to the farm
Sample Unit	***Desirable***	Number or name given to the sample unit (point, plot, transect)
Biome	***Desirable***	Brazillian Biomes (Amazon, Caatinga, Cerrado, Atlantic Forest, Pantanal, Pampa)
Phytogeography	***Desirable***	In cases where the land use is Natural Forest, fill in with the phytogeography. Example: Dense Ombrophilous Forest, Cerrado stricto sensu, Gallery Forest...
Land use	***Desirable***	Example: Eucalyptus, Pine, Native Vegetation, Pasture, Anthropogenic use...
Method	***Mandatory***	What method was used in monitoring. Example: Listening points, permanent plot, track transect...
Biological Group	***Desirable***	Example: Amphibians, Birds, Mammals, Reptiles, Vegetation
Species	***Mandatory***	Scientific name of the recorded species
UTM Zone	***Mandatory***	In the case of UTM coordinates, use this column to enter the **Zone**
Latitude	***Mandatory***	Coordinate referring to the **Y** axis
Longitude	***Mandatory***	Coordinate referring to the **X** axis

Monitoring Methods	
Title	**Description**
Monitoring	Specify the monitoring scope according to the "Monitoring" Spreadsheet
Group	Biological Group
Method	Provide details on the collection methodology
Effort	Elaborate on the sampling effort employed in monitoring
Sampling Frequency	Include the interval between each collection

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