The Climate, Community and Biodiversity Alliance (CCBA)

Project Implementation Report

Restoration of degraded areas and reforestation in Cáceres and Cravo Norte, Colombia

Monitoring period: 2011-2014

Developed by:

Version: 4

Date: December 02, 2016

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i. Project name	Restoration of degraded areas and reforestation in Cáceres and Cravo Norte, Colombia.
ii. Project location	The project is located in two different Departments of Colombia. The first site is located in the municipality of Cáceres in the Department of Antioquia. The second site is located in the municipality of Cravo Norte in the Department of Arauca. In the case of Arauca, the establishment plan has not yet been developed, and no areas will be verified during this verification period.
iii. Project Proponent	Asorpar Ltd Calle 11a # 43D-79 Medellín, Phone (+574) 2661153 Contact person: Juan Guillermo Molina Email: asistente.asorparltda@hotmail.com
iv. Auditor	Instituto Colombiano de Normas Técnicas - ICONTEC -
v. Project lifetime	Project start date: February 1st 2002 Project lifetime: 30 years GHG accounting period: February 1st 2002 - January 31st 2031
vi. Project implementation period covered by the PIR	January 1st 2011 - August 20th 2014
vii. CCB History	Validation: 15 July 2011 First verification: 25 October 2011 Second verification: under verification
viii. Edition of CCB Standard Being Used	Second edition
ix. Summary of Climate, Community and Biodiversity Benefits Generated	**Climate** objectives has been achieved through the establishment and management of 1,116 ha planted, with conservational and productive purposes. Since the start date, the project has generated 361,234 tCO_2e. During the monitoring period, the project has generated 234,334 tCO_2e emission reductions. **Community** objectives are focused in the contribution to community development and poverty alleviation. Asorpar creates employment in an area with few alternative income sources and high levels of instability and economic depression due to guerrilla and paramilitary activities. Not only do the project activities provide employment but they provide an employment in which the workers learn skills that can be applied to achieve better employment opportunities in the future. Among the positive impacts identify for **biodiversity** are those in relation with the recovery of degraded areas and the conservation and connection of the forest relicts to provide for habitat and increased biodiversity. The natural habitats for Colombia's wide variety of flora and fauna found naturally in the forests have been severely compromised by deforestation for ranching and mining. The restoration of native forests has regenerated these conditions and provide sanctuary for the biodiversity that suffered as a result of deforestation. Promote soil conservation and improvement of water resources, protection from soil erosion as a result of grazing and mining. The reforestation activities has started to help with the restoration of the soils that have been highly depleted, over compacted and devastated by mechanized mining activities and grazing activities. These activities will further improve water and soil resources by removing pollution sources like cow dung and mercury. During the verification period, it was not possible to implement the project activities initially planned for the Cravo Norte area. This was the result of public safety issues that arose in this zone. The Department of Arauca, where the project area is located, has historically been an area of armed conflict in Colombia. The specific issue in Cravo Norte is the presence of the ELN guerilla organization (National Liberation Army).

	Despite the lack of implementation of project activities in the Cravo Norte area, the site has not been abandoned. During the entire period, Employees of the company have remained attentive and vigilant in their patrols of the property, protecting against loss of land and ensuring the conservation of the relict natural riparian forests present in the project area.
x. Gold Level Criteria	None
xi. Date of Completion of this Version and Version Number:	02 December 2016 Version 04
xii. Expected verification schedule	December 2016

Introduction

According with the *Rules of Use of the CCB Standard*[1], the Project Implementation Report (PIR) does not need to include information for indicators that has not changes from the validated PDD but shall include relevant information about project implementation and impacts, and any changes to project design. Nevertheless, the document requires the inclusion and development of some specific indicators related in the PDD build under the Third Edition of CCB Standard[2].

Taking into account the validated PDD for this project was built under Second Edition of CCB Standard, the indicators suggested to be mandatorily included in this PIR does not coincide with the exact numeration of them in the PDD. To avoid confusions about this situation, the Table 1 include the indicators according with the numeration of the Third Edition as well as homologous numbering in Second Edition. To facilitate the understanding of the document, its development always will be refer to numbering of Indicators used in the Second Edition.

Table 1. Indicators according with the numeration of the Third Edition as well as homologous numbering in Second Edition.

Project Implementation Report Sections	Third Edition	Second Edition
G1. Project Goals, Design and Long Term Viability	G1.9	G3.4
	G1.10	G3.5
	G1.11	G3.7
G3. Stakeholder Engagement	G3.1	G3.9
	G3.2	New[3]
	G3.3	G3.9
	G3.5	New
	G3.6	New
	G3.7	New
	G3.8	G3.10
	G3.9	G4.3
	G3.10	G4.4
	G3.11	G4.5
	G3.12	G4.6
G4. Management Capacity	G4.2	G4.2
	G4.4	NA[4]
G5. Legal Status and Property Rights	G5.1	G1.6
	G5.2	G5.3
	G5.3	G5.4
	G5.4	G5.5
	G5.5	G.1.6
	G5.6	G5.1

[1] CCBA. 2013. Rules for the Use of the Climate, Community & Biodiversity Standards (December 2013).
[2] CCBA. 2013. Climate, Community & Biodiversity Standards Third Edition.
[3] New indicators refer to those that are included only the Third Edition.
[4] Indicator G4.4 is not included in the Third Edition, either in the Second Edition.

Project Implementation Report Sections	Third Edition	Second Edition
	G5.9	CL1.5
CL3. Offsite Climate Impacts	CL3.2	CL2.2
CL4. Climate Impact Monitoring	CL4.1	CL3.1
	CL4.2	CL3.2
CM2. Net Positive Community Benefits	CM2.1	CM1.1
	CM2.2	G3.6
CM3. Other Stakeholder Impacts	CM3.2	CM2.2
CM4. Community Impact Monitoring	CM4.1	CM3.1
	CM4.2	CM3.2
	CM4.3	CM3.3
B2. Net Positive Biodiversity Benefit	B2.1	B1.1
	B2.3	G3.6
	B2.5	B1.3
	B2.6	B1.4
	B2.7	B1.5
	B2.8	New
	B2.9	New
B3. Other Stakeholder Impacts	B3.2	B2.2
B4. Biodiversity Impact Monitoring	B4.1	B3.1
	B4.2	B3.2
	B4.3	B3.3
CL2. Net Positive Climate Impacts	CL2.1	CL1.1
	CL2.2	CL1.4
CL3. Offsite Climate Impacts	CL3.2	CL2.2
CM2. Net Positive Community Impacts	CM2.2	G3.6
	CM2.3	CM1.1
	CM2.4	CM1.2
CM3. Other Stakeholder Impacts	CM3.3	CM2.3
B2. Net Positive Biodiversity Impacts	B2.2	B1.1
	B2.4	B1.2
	B2.5	B1.3
	B2.8	New
B3. Offsite Biodiversity Impacts	B3.3	B2.3

Project overview

The project anticipates the reforestation of grasslands and degraded ex-mining lands in Colombia. The forestry project activity has resulted in the reforestation of 1,116.42 ha in the Cáceres area of Antioquia and proposes the reforestation of approximately 9,640 ha in Cravo Norte (Arauca). The previous land uses in Cáceres were: (i) extensive livestock farming and (ii) gold mining. The previous land use in Cravo Norte was extensive livestock farming.

The project activity is being implemented by the private company Asorpar Ltd (Asesorías en Ornato Paisajismo y Reforestación, Ltda.). The legal representative is Juan Guillermo Molina, and the technical manager is Luis Gonzalo Moscoso. The total GHG emissions reductions generated during this monitoring period is 234,334.46 tCO2e.

Since 2002, Asorpar Ltd. has been reforesting land with various tree species planted in different stand models that allow for natural regeneration on the reforestation sites. Asorpar Ltd. puts emphasis on promoting mixed stands. This differentiates their approach from other commercial forestry plantation entities active in Colombia. The management of mixed stands is far more challenging than that of monocultures. Exacerbating these difficulties is the fact that little is known about several tree species employed in the project, particularly regarding their growth performance and silvicultural management. Hence, the proposed project activity offers a unique opportunity to obtain valuable knowledge about silvicultural management practices for mixed plantation forestry and the suitability of native tree species for commercial plantation forestry.

The planted area has been split into six strata (1.1; 1.2; 1.3; 1.4 planted in different years on previous livestock area, and 2.1; 2.2 planted in different years on previous gold mining area). Strata 1.1 and 2.1 were planted in 2002, strata 1.2 in 2004, strata 1.3 in 2005, and strata 1.4 and 2.2 in 2007. For climate monitoring, each strata was monitored by farm (e.g. strata 1.1 and 2.1 includes the area called Cáceres I-II) during the monitoring period. Table 2 shows the area planted per strata up to the year 2014, corresponding to a total of 1,116.42 ha. In the case of Arauca, the establishment plan has not yet been developed.

Table 2. Area planted by strata planted by the year 2014.

Name of farm	Strata	Planted area
Cáceres I-II	1.1	543.86
Cáceres III	1.2	88.62
Cáceres IV	1.3	173.91
Cáceres VII	1.4	160.05
Cáceres I-II	2.1	101.42
Cáceres VII	2.2	48.56
Total		**1,116.42**

During the verification period, it was not possible to implement the project activities initially planned for the Cravo Norte area. This was the result of public safety issues that arose in this zone. The Department of Arauca, where the project area is located, has historically been an area of armed conflict in Colombia. The specific issue in Cravo Norte is the presence of the ELN guerilla organization (National Liberation Army).

The presence of the ELN in this region intensified during the peace process negotiations between the

Colombian government and the FARC guerillas (Revolutionary Armed Forces of Colombia), as the group pursued its strategy of establishing its name and presence in this area. This situation has increased the human safety, technical, and economic risks of implementing project activities and has made the viability of planting and maintenance activities in this project area non-viable.

Nevertheless, thanks to the successful peace process with the FARC that ended with the signing of the final agreement and the referendum on this by the Congress, a new path has opened for beginning peace dialogues with the ELN. It is therefore expected that this process, which is just beginning, will transform the current situation in the project area to one that allows for the implementation of project activities, as happened in areas occupied by the FARC during their peace process.

Despite the lack of implementation of project activities in the Cravo Norte area, the site has not been abandoned. During the entire period, Employees of the company have remained attentive and vigilant in their patrols of the property, protecting against loss of land and ensuring the conservation of the relict natural riparian forests present in the project area. The study of the climate, community, and diversity impacts of the project required by the standard has been limited by the aforementioned conflict. The analysis is consequently less detailed than that presented for the Cáceres project area. A species list of fauna and flora as reported by employees, pictures, community and employee surveys, and a land use comparison (2011-2014) are presented in Annex I of the Monitoring Report as proof that there have not been negative impacts on community, biodiversity, or climate during the monitoring period.

Further background information on the project activity can be found in the Project Description (PD) and associated documents, which have been registered and are available on the CCBA webpage: *https://s3.amazonaws.com/CCBA/Projects/Restoration+of+degraded+areas+and+reforestation+in+Cáceres+and+Cravo+Norte,+Colombia/101001_CCBA+PDD_Asorpar_Final.pdf*

Project location

The project is located in two different Departments of Colombia. The first site is located in the municipality of Cáceres in the Department of Antioquia. The second site is located in the municipality of Cravo Norte in the Department of Arauca (Figure 1).

Cáceres is a town and municipality in the Colombian Department of Antioquia, situated in the northwestern, Andean region of Colombia. This Andean region is considered an area of high endemism and species richness and presents considerable environmental variation due to its complex orography and the confluence of several eco-regions). Cáceres is bordered to the north by the department of Córdoba and the municipality of Caucasia, to the east by the municipalities of Caucasia and Zaragoza, to the south by the Anorí and Tarazá, and to the west also by Tarazá and the department of Córdoba.

Arauca is a department of Colombia located in the extreme northern part of Colombia that borders Venezuela (the Orinoco or Llanos Oriental area). It is bordered in the south by the Casanare River and the Meta River, which separate it from the departments of Casanare and Vichada. The Boyacá department is on the western border.

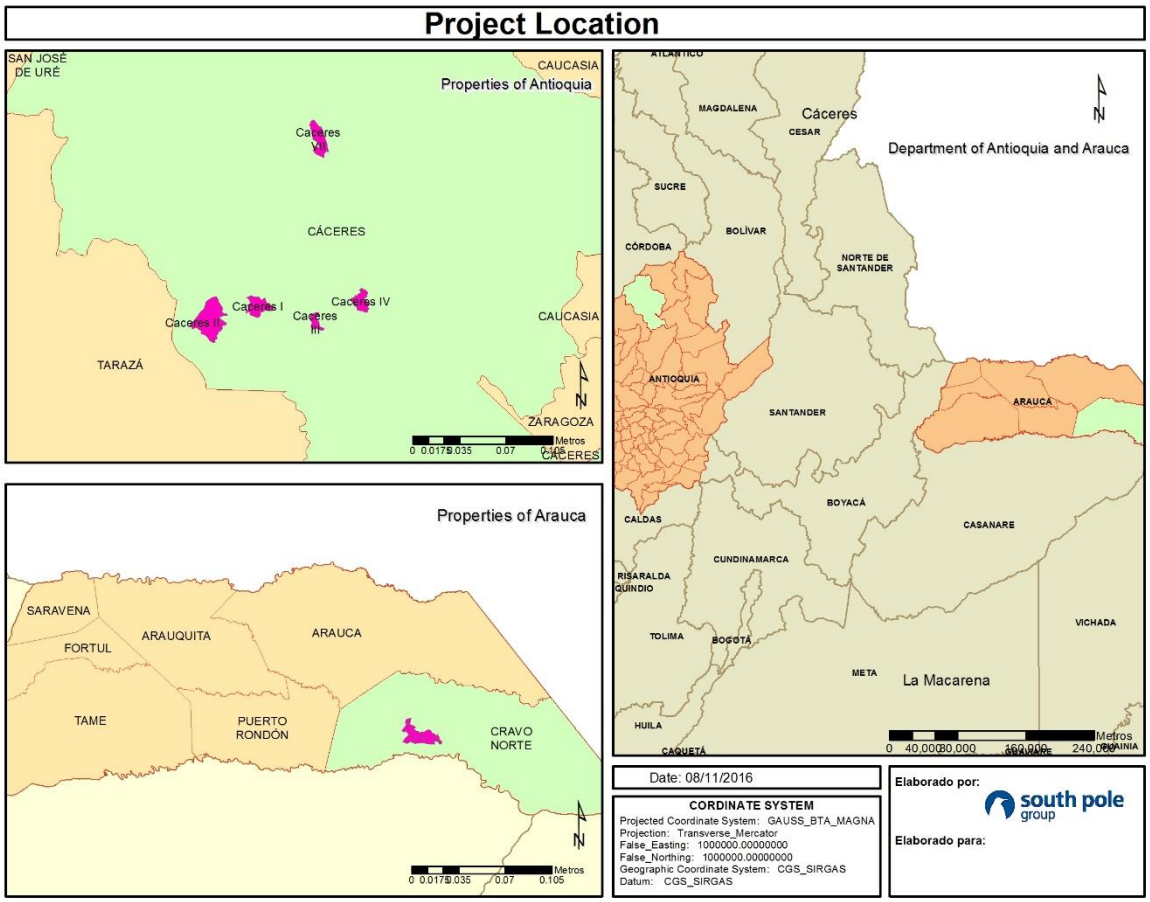

Figure 1. Project location.

Project Indicators

Project Goals, Design and Long Term Viability

G.3.4 Provide a timeframe for the project's duration. Describe the rationale used for determining the Project lifetime. If the accounting period for carbon credits differs from the project lifetime, explain.

This project envisions a permanent sustainable forestry plantation. The crediting period is 30 years as required by the VCS.

G.3.5 Identify likely risks to climate, community and biodiversity benefits during the project lifetime. Outline measures that the project plans to undertake to mitigate the risks.

- **Fire**: as outlined in the management plans, four-meter firebreaks are maintained free of vegetation at strategic areas around all plantations. In general these firebreaks are located every 500m both from north to south and east to west. This varies slightly because the project actively makes use of the natural geography to improve abilities to fight fires. These procedures include using roads and rivers as firebreaks and the high points as lookout stations.

  Workers are trained in firefighting techniques so that the entire community can mobilize in the event of a fire. The instruments used for firefighting include fire extinguishers and small motorized water pumps. Asorpar has carried out extensive capacity building surrounding risks of fire and how to prevent and fight it.

- **Pests and diseases**: Chemical products, including insecticides, pesticides, fungicides and disinfectants, are only used in cases of urgent necessity. In the case of such necessity the project uses the product that is least harmful and with careful attention to dosage and timing. During this monitoring period, the pest and disease control have not been necessary.

- **Political instability due to activity of illegal groups**: safety of all project participants is of paramount importance to Asorpar and was a key concern in designing the project. Asorpar employs local residents to watch over the plantations and notify local authorities immediately if any unauthorized persons are discovered on the plantation. Asorpar has reached out to local military and local government police forces in all zones where project activities are being developed. These security forces have made it a priority to provide security on all plantations and have highlighted the importance of creating a secure environment for projects that create employment and project the country's natural resources. Military units have advised Asorpar to notify them whenever they visit plantations and keep them updated as to what activities are being carried out where so that they may provide security.

G.3.7 Describe the measures that will be taken to maintain and enhance the climate, community and biodiversity benefits beyond the project lifetime.

The Asorpar reforestation project is conceived as a permanent sustainable forestry plantation and a

crediting period is 30 years as required by the VCS. However at the end of that crediting period Asorpar will continue to operate the plantation as a sustainable forestry project. This intention is born out in the contracts signed between Asorpar and the landowners naming sustainable reforestation projects as the soles purpose of the contract. With the continuance of the sustainable forestry plantation, the climate, community and biodiversity benefits will be maintained after the end of the project lifetime. According to the monitoring results, the Project activities have maintained and improved the climate, community and biodiversity benefits (See supporting document "*Monitoring report*").

Stakeholder Engagement

G.3.9 Describe what specific steps have been taken, and communications methods used, to publicize the CCBA public comment period to communities and other stakeholders and to facilitate their submission of comments to CCBA.

All stakeholders will be advised that the PIR is available for public comment. Asorpar will follow up with them in order to include their comments and encourage their further participation.

G.3.10 Formalize a clear process for handling unresolved conflicts and grievances that arise during project planning and implementation. The project design must include a process for hearing, responding to and resolving community and other stakeholder grievances within a reasonable time period.

Project Owner and technical supervisor Luis Gonzalo Moscoso Higuita deals personally with all conflicts and grievances that arise during project planning and implementation. Complaints may be made either orally or in writing and all complaints are treated with the utmost importance. Asorpar also resolve all conflicts through official channels of local government, the Police Inspector or local courts. While Asorpar has not had any complaints from workers, the company has had to rely on law enforcement on several occasions due to attempts of illegal mining on their property.

G.4.3 Include a plan to provide orientation and training for the project's employees and relevant people from the communities with an objective of building locally useful skills and knowledge to increase local participation in project implementation. These capacity-building efforts should target a wide range of people in the communities, including minority and underrepresented groups. Identify how training will be passed on to new workers when there is staff turnover, so that local capacity will not be lost.

One of the primary community objectives of the Asorpar project is to train local workers in skills sustainable forestry techniques and to show a success story so that those skills can help them maintain long-term employment and contribute to sustainable development. All workers receive orientation before beginning their work. This training depends on their tasks, which vary from site preparation, greenhouse work, transplanting, maintenance and harvesting. In any training the workers are instructed on workplace safety, correct use of machinery if necessary and principles of sustainable forestry (on the job training).

G.4.4 Show that people from the communities will be given an equal opportunity to fill all employment positions (including management) if the job requirements are met. Project proponents must explain how employees will be selected for positions and where relevant, must indicate how local community members, including women and other potentially underrepresented groups, will be given a fair chance to fill positions for which they can be trained.

All employees have been local stakeholders with the exception of the technical team. Asorpar is an equal opportunity employer and trains male and female employees in the same way.

G.4.5 Submit a list of all relevant laws and regulations covering worker"s rights in the host country. Describe how the project will inform workers about their rights. Provide assurance that the project meets or exceeds all applicable laws and/or regulations covering worker rights and, where relevant, demonstrate how compliance is achieved.

Permanent employees of Asorpar are contracted directly and all taxes and social security payments are made directly by Asorpar and employees are advised of their rights directly. For temporary employees in the field Asorpar hires contractors who are paid based on performance and are responsible for covering the taxes and social security obligations of their employees and to advise them of their rights. Asorpar's contracts with all contractors specifically provide that the contract shall be deemed invalid if contractors do not comply with their legal responsibilities.

The project complies with international rules and standards on worker's rights. Situations and occupations that pose a substantial risk to worker safety have been assessed and have been communicated to the staff involved as well as the safety measures that should be taken. For each activity carried out on the plantations, Asorpar provides training and all necessary safety equipment.

Asorpar makes it a priority to make sure that work conditions are clean and safe with particular attention to the following areas:

- Sanitary considerations
- Protective gears as specified for the different activities
- Training of workers and staff on safety precautions.

The company is committed to meet local and regional legal requirements. Fair wages are paid in accordance with Colombian law and on time.

G.4.6. Comprehensively assess situations and occupations that pose a substantial risk to worker safety. A plan must be in place to inform workers of risks and to explain how to minimize such risks.

Aspects of work on the plantation that entail risks include site preparation, planting, thinning, disease control, harvesting as well as road construction work and natural hazards such as snakes and other venomous/dangerous animals, on site accidents and chemical poisoning. Use of chemicals is generally not anticipated. In case the need for the use of chemicals arises, these are properly transported, stored and used following chemical use guidelines. Workers are provided with personal protective equipment including gloves, masks, helmets and boots while performing field operations to minimize such risks when necessary. Asorpar does not require the use of this equipment when the work is not mechanized and the workers are using tools with which they are extremely familiar

like *machetes*.

Workers are properly trained before undertaking any field operations with which they are not familiar. The level of mechanization of site preparation and plantation maintenance is minimal which significantly lowers the risk of on the job accidents.

Management Capacity

G.4.2 Document key technical skills that will be required to implement the project successfully, including community engagement, biodiversity assessment and carbon measurement and monitoring skills. Document the management team's expertise and prior experience implementing land management projects at the scale of this project.

Reforestation is the core business of ASORPAR. The technical manager, partner and director, Luis Gonzalo Moscoso Higuita, has worked in the forestry, environmental and landscaping areas for many years. He has the reputation of having designed and implemented outstanding projects, due to the knowledge he has gained in environmental and forestry management.

Technical skills are necessary for implementation and management of the project activities including maintenance, pruning, thinning and monitoring. The capable team of forestry engineers and technicians assists in implementation and supervision of all activities to ensure uniform and high quality of these activities.

Legal Status and Property Rights

G.1.6 A description of land tenure at the project site.

Partnership contracts between Asorpar and investors were signed. The investor's stake in the initial investment totals up to 70%. Land is purchased and forest plantations are established from the investor's financial participation. While the group of investors represents the major share-holder, Asorpar is assuming 30% of the costs and is in charge of reforesting the purchased land. Once the project has received and will receive the financial support from the CIF or carbon credits revenues, Asorpar will reimburse some of the initial costs to the group of investors. The ownership structure of the land and reforested trees will change with the reimbursement and both parts will hold an equitable share of 50%.

While most land tenure in the project zone is private property, Colombia law does accord land tenure rights to squatters who occupy unproductive land for a period of 10 years. The situation where rural lands are abandoned and unproductive was very common when paramilitary groups controlled most of the rural areas. As these areas return to government control and the public safety situation improves, some areas have contested land title due to the two different sources of rights to land tenure in Colombia[5]. Please refer to section G.5.4 for details on how Asorpar did handle squatter issues in the project area.

[5] Interview with Juan Guillermo Molina, 13 April 2010.

G.5.3. Demonstrate with documented consultations and agreements that the project will not encroach uninvited on private property, community property or government property and has obtained the free, prior, and informed consent of those whose rights will be affected by the project.

The reforestation project is being carried out exclusively on private land. It has not and will not encroach on either government or community property. Contracts have been signed with all landowners that cede 50% of the ownership of the land to Asorpar in exchange for implementation of the project. In the few cases where there were squatters who had been on unused land for more than 10 years and thus had a limited legal right to the land, those individuals were paid fair price for the land.

G.5.4 Demonstrate that the project does not require the involuntary relocation of people or of the activities important for the livelihoods and culture of the communities.

In the project sites in the area of Cáceres (Antioquia) there were many families of squatters. Asorpar Ltd. and its investors not only bought the land from the legal title holder, but also paid fair prices to the squatters for the land that they inhabited even though they did not own it. All squatters who sold the land they inhabited did so willingly and those who chose not to sell the land they inhabited were allowed to stay on their land and that part of the farm was excluded from the project boundary, to allow for subsistence production of food crops. In addition to cash payments for the land the squatters inhabited, Asorpar has employed many of the squatters giving them a stable form of income.

G.5.5 Identify any illegal activities that could affect the project's climate, community or biodiversity impacts (e.g., logging) taking place in the project zone and describe how the project will help to reduce these activities so that project benefits are not derived from illegal activities.

In Cáceres, 100% of the area was planted in 2007. During the current monitoring period, the project area was monitored and was affected by mining activities in Cáceres II and agricultural activities in Cáceres VII, leaving a total of 1,116.42 ha verifiable (See supporting document "*Monitoring report VCS*"). This area was not considered for accounting of GHG emission reductions and was recovered and replanted by project owner after 2014. To ensure that no one encroaches on the reforested land, Asorpar employs local workers to patrol the areas and report any incidents.

G.5.1. Submit a list of all relevant national and local laws and regulations in the host country and all applicable international treaties and agreements. Provide assurance that the project will comply with these and, where relevant, demonstrate how compliance is achieved.

Currently, the laws consigned in the PDD are in force. There are not new laws related to the project activities.

Climate Impact Monitoring and Offsite Climate Impacts

The methodology and results with respect to the monitoring of climate indicators need not be submitted as part of this monitoring report, given that the climatic benefits for the 2011 – 2014 period were verified in 2014 under the VCS standard. The VCS monitoring report is included as a supporting document to the present report.

Community Impact Monitoring, Net Positive Community Benefits and Other Stakeholder Impacts

CM.1.1a Describe the appropriate methodologies used (e.g. the livelihoods framework) to estimate the net benefits to communities resulting from planned project activities.

The analysis of the net benefits to the communities resulting from the project activity was organized around the Sustainable Livelihoods Approach (SLA). The SLA includes a framework for understanding the complexities of poverty and guiding principles for action. This framework is designed to center around people and the influences that affect how they can support themselves and their families. The basic units of analysis are *livelihood assets*, which are divided into five categories: human capital, social capital, physical capital, natural capital and financial capital. One of the key factors that affect access to livelihood assets is the *vulnerability context*. This idea incorporates into the analysis economic, political, technological trends as well as shocks and seasonality.

The guiding principles of the SLA are:

- ***Be people-centred.*** SLA begins by analyzing people's livelihoods and how they change over time. The people themselves actively participate throughout the project cycle.
- ***Be holistic.*** SLA acknowledges that people adopt many strategies to secure their livelihoods, and that many actors are involved; for example the private sector, ministries, community-based organizations and international organizations.
- ***Be dynamic.*** SLA seeks to understand the dynamic nature of livelihoods and what influences them.
- ***Build on strengths.*** SLA builds on people's perceived strengths and opportunities rather than focusing on their problems and needs. It supports existing livelihood strategies.
- ***Promote micro-macro links.*** SLA examines the influence of policies and institutions on livelihood options and highlights the need for policies to be informed by insights from the local level and by the priorities of the poor.
- ***Encourage broad partnerships.*** SLA counts on broad partnerships drawing on both the public and private sectors.
- ***Aim for sustainability.*** Sustainability is important if poverty reduction is to be lasting[6].

[6] International Fund for Agricultural Development. "The sustainable livelihoods approach". http://www.ifad.org/sla/index.htm. Site accessed 3 May, 2010.

CM.1.1b Include a credible estimate of net benefits changes in community wellbeing given project activities. This estimate must be based on clearly defined and defendable assumptions about how project activities will alter social and economic wellbeing over the duration of the project.

The evaluation of the net benefits to the community of the project have been based on a comparison with the baseline scenario and structured based on the Sustainable Livelihoods Approach. The information upon which this analysis is based has been gathered by the project owner at the site and through local stakeholder consultations. Table 3 summarizes the improvements in each category of livelihood asset that the project has provided to the local communities.

Table 3. Net Community Benefits.

Livelihood Asset		With Project Scenario	Net Effect	Relevant Project	Comment
Human Capital	Health	Asorpar has organized many talks for employees and their family members including education relating to sanitation, antiseptics and clean cooking stoves to prevent indoor pollution.	NA	Cáceres (Antioquia)	During the current monitoring period, Asorpar has not organized talks about this topic.
	Nutrition	These talks have also included training about how to include local flora and fauna in cooking to encourage healthier, variable, cheaper and more sustainable cooking habits.	NA	Cáceres (Antioquia)	During the current monitoring period, Asorpar has not organized talks about this topic.
	Education	Asorpar works actively with educational institutions throughout Colombia to further promote understanding of reforestation. These efforts have included bringing various groups of students and professors from the University of Cáceres (Antioquia) and National University and foreign country representatives to the project site to learn about reforestation with native species.	Positive	Cáceres (Antioquia)	
	Knowledge and skills	Asorpar has trained all of its workers in the techniques of reforestation and maintenance of forest plantations. This training includes all steps from site preparation to building temporary greenhouses to transplanting to pruning, thinning and harvest. This training benefits local workers since Asorpar hires almost exclusively from within the local communities.	Positive	Cáceres (Antioquia)	

Livelihood Asset		With Project Scenario	Net Effect	Relevant Project	Comment
Social Capital	Networks and Connections	Restoration activities and project process have been presented in different academic, technical and political scenarios, such as the parallel meetings to Lima Climate Change Conference (COP 20).	Positive	Cáceres (Antioquia)	
	Relations of trust and mutual support	Asorpar has forged strong links with key members of the community and local governments. Through these connections they have lobbied extensively for programs to improved living conditions and improve access to forest incentives. Of particular importance have been the strongly positive relationships between Asorpar and the Bishop of Caucasia. Furthermore, on a case-by-case basis Asorpar has provided support to families displaced by the activities of illegal groups by providing them with homes and work on the plantations.	Positive	Cáceres (Antioquia)	
	Leadership	In training its employees, Asorpar has allowed many of them to rise to leadership positions that otherwise would not have been available to them. These types of positions include supervisor of site preparation, maintenance, monitoring, operations etc.	Positive	Cáceres (Antioquia)	
Physical Capital	Infrastructure	Asorpar has carried out the improving of roadways where the project is located, as well as the maintenance of the boundary lines of the project area.	Positive	Cáceres (Antioquia)	

Livelihood Asset		With Project Scenario	Net Effect	Relevant Project	Comment
	Tools and Technology	Asorpar has provided the region and its communities with the tools to take advantage of their natural resources in a sustainable manner. This training has included everything form promoting local wood markets, to illustrating the importance of native flora and fauna to training in ecotourism. One of the most important skills Asorpar has been able to return to the area is that of collecting, drying, storing and selling seeds from rare native trees. These are traditional techniques that have been largely lost but create the possibility for an important income from exporting seeds.	NA	Cáceres (Antioquia)	During the current monitoring period, Asorpar has not carried out activities related with this livelihood asset.
Financial Capital	Investment	Asorpar through its reforestation project has brought significant investment into the region. In addition to funds from investors, Asorpar has gained incentive payments from the Ministry of Agriculture through the Forest Incentive Certificates (CIF) and will bring carbon revenues. Additionally, Asorpar, by conducting a project that is a one of the first of its kind is proving the viability of such plantations, which may attract further investment to the region.	Positive	Cáceres (Antioquia)	
	Employment	Asorpar's reforestation project has contributed to increase employment in these rural areas. In the baseline the land was used for extensive cattle ranching and was owned by a few large landowners. Cattle ranching provides less demand for labor and the majority of the community did not benefit from ranching activities[7].	Positive	Cáceres (Antioquia)	

[7] Taylor, Davis F. "Employment-based analysis: an alternative methodology for project evaluation in developing regions, with an application to agriculture in Yucatán." Ecological Economics, 36:2 (2001) Pg. 249-

Livelihood Asset		With Project Scenario	Net Effect	Relevant Project	Comment
Natural Capital	Water resources	Asorpar's reforestation project improves water resources in the project area. In particular, in the area of Cáceres where the water supply has been contaminated by mining activities.	Positive	Cáceres (Antioquia)	According to the perception of the communities, the quality of water improved due to project activities (See *monitoring report*). Nevertheless, there is not a direct monitoring of the water resource.
	Trees and forest products	Asorpar by reforesting a region devastated by cattle ranching is replenishing the area with trees and forest products. In particular Asorpar has used endangered trees species including Abarco and Ceiba Tolua in its reforestation activities. In addition to this, new species have been registered in the planting areas.	Positive	Cáceres (Antioquia)	See monitoring report.
	Wildlife	Reforestation contributes to protect and expand the habitats of native wildlife.	Positive	Cáceres (Antioquia)	See monitoring report.
	Biodiversity	Forests are among the habitats most rich in biodiversity. The project areas in Cáceres (Antioquia) have all suffered extraordinary loss of forest habitats due to deforestation for the purpose of extensive cattle ranching and mining. The reforestation with native species carried out in this project has contributed significantly to protect biodiversity and increased the forest habitat in the project area.	Positive	Cáceres (Antioquia)	See monitoring report.

CM.1.1c Compare the "with-project" scenario with the baseline scenario of social and economic wellbeing in the absence of the project. The difference (i.e., the net community benefit) must be positive.

A summary of the net benefits from the project are presented in the Table 3 above.

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G.3.6 Demonstrate that the project design includes specific measures to ensure the maintenance or enhancement of the high conservation value attributes identified in G1 consistent with the precautionary principle.

The only HCV identified in G1 is HCV1: significant concentrations of biodiversity values. This is due to the fact that the project zone contains a wide variety of vulnerable, endangered and critically threatened species. One of the primary objectives of the project was to create sustainable forestland that can support the natural biodiversity of the region. In the baseline, the project areas are grasslands and mining lands that support a much smaller variety of both flora and fauna. By using a mix of native species in the forest plantation, the project seeks to create conditions similar to primary forests that support these species. The project is in line with the precautionary principle because the project activity does not imply a risk of reduction of biodiversity values. On the contrary, the conversion of pasture and mining lands to forestland have increased the support for threatened species (See supporting document "*monitoring report*").

CM.1.2 Demonstrate that no High Conservation Values identified in G1 will be negatively affected by the project.

The only HCV identified in G1 is HCV1: significant concentration of biodiversity values. This conclusion is based on the wide variety of threatened species of both flora and fauna found in the project zone. Far from negatively affecting these endangered species, the project activity will actively contribute to improving and expanding natural ecosystems and habitats for this panoply of species. In the project area, the reforestation project is restoring pastureland and land devastated by alluvial gold mining. Forests by nature support a much greater diversity of flora and fauna than grasslands, pasturelands or degraded mining land. By utilizing a generous mix of native tree species in the reforestation project, the project owner is enhancing the ecosystem that supports these endangered species. For more detailed information please see Section G.3.6 and monitoring report.

CM.2.2 Describe how the project plans to mitigate these negative offsite social and economic impacts.

During the monitoring period, there were not identified negative offsite social and economic impacts.

CM.2.3 Evaluate likely unmitigated negative offsite social and economic impacts against the social and economic benefits of the project within the project boundaries. Justify and demonstrate that the net social and economic effect of the project is positive.

During the monitoring period, there were not identified negative offsite social and economic impacts.

CM.3.1 Define the initial plan for how they will select community variables to be monitored, and the frequency of monitoring. Potential variables include income, health, roads, schools, food security, education and inequality. Include in the monitoring plan, community variables at risk of being negatively impacted by Project activities.

The community monitoring plan seeks to measure the direct impacts of the project through surveys of employees and community members. The variables to be monitored have been selected based on an evaluation of potential positive and negative direct impacts of the project activity and based on the categories of the Sustainable Livelihoods Approach including social capital, financial capital, natural capital and human capital. These variables include income, employment, local participation, professional know-how, job security and environmental factors. The surveys have been offered in both written and oral form in order to gain the feedback and insights from the many people who do not read and write (See supporting document "*Monitoring report*").

CM.3.2 Develop an initial plan for how they will assess the effectiveness of measures used to maintain or enhance High Conservation Values related to community well-being (G1.8.4-6) present in the project zone.

The only HCV identified in the project zone is HCV1: significant concentration of biodiversity values. Included in the community and biodiversity monitoring plan are inventories of flora and fauna found in the project areas. Part of the project's aim is to educate local communities about how to sustainably use forest resources and provide those resources. For that reason, some of the tree species chosen for use in the reforestation project have particular traditional uses. Abarco for instance is a traditional wood for construction. For this reason, as well as the fact that it is a threatened species, Abarco is being utilized in the project activity. Other tree species provide shelter and co-benefits of other species of plants and their seeds attract animals.

CM.3.3 Commit to developing a full monitoring plan within six months of the project start date or within twelve months of validation against the Standards and to disseminate this plan and the results of monitoring, ensuring that they are made publicly available on the internet and are communicated to the communities and other stakeholders

A full community monitoring plan has been developed. The results of the monitoring have been disseminated to communities and other stakeholders (See supporting folder "PIR dissemination").

Biodiversity Impact Monitoring, Net Positive B Benefits and Other Stakeholder Impacts

B.1.1 Describe the appropriate methodologies used to estimate changes in biodiversity as a result of the project. Base this estimate on clearly defined and defendable assumptions. Compare the "with project" scenario with the baseline "without project" biodiversity scenario completed in G2. The difference (i.e., the net biodiversity benefit) must be positive.

The pasturelands for cattle simply cannot support the diversity of a forest; cows pollute water sources and compact soil which decreases fertility. In areas affected by mining, the damage is even more drastic. In addition to violent disruptions to the natural landscape, clear cutting of vegetation, and destruction of animal habitats, alluvial gold mining has severely affected water sources by releasing mercury into rivers and streams.

The "with-project" scenario is constituted by diverse secondary forests. By replacing pasture lands and former mining lands with native-species forests, the project activities restore habitat and foster the growth of a great diversity of flora and fauna (See supporting document "*Monitoring report*").

B.1.2 Demonstrate that no High Conservation Values identified in G1.8.1-3 will be negatively affected by the project.

Please see sections G3.6 and CM3.2.

B.1.3 Identify all species to be used by the project and show that no known invasive species will be introduced into any area affected by the project and that the population of any invasive species will not increase as a result of the project.

There are no invasive species being used in the project activity. Table 4 below contains all species that will be used in the project activity.

Table 4. Species used in project activity.

Species used in reforestation activities	
Acacia mangium	*Gmelina arborea*
Cariniana pyriformis	*Hevea sp*
Cedrela odorata	*Hymenaea courbaril*
Cespedesia macrophylla	*Ochroma pyramidale*
Cordia gerascanthus	*Pochota quinata*
Croton smithianus	*Schyzolobium parahyba*
Didimopanax morototoni	*Swietenia macrophylla*
Dipteryx oleifera	*Tabebuia rosea*
Enterolobium cyclocarpum	*Tapirira guianensis*

B.1.4 Describe possible adverse effects of non-native species used by the project on the region"s environment, including impacts on native species and disease introduction or facilitation. Project proponents must justify any use of non-native species over native species.

The project activity involved the planting of around 25 native tree species as well as small percentages of *Gmelina arborea* and *Acacia mangium*. *Gmelina arborea* and *Acacia mangium* are non-native species but they are not invasive species. The project is one of the only of its kind in Colombia that combines a vast array of native species in plantations. The majority of the plantations in Colombia use eucalyptus, pine, or teak, and even those that use native species tend to be monocultures.[8]

[8] Resumen de Plantaciones 2009 Cáceres (Antioquia). Cadena Forestal Cravo Norte (Arauca).

Acacia mangium, an exotic tree species in Colombia, is used exclusively in areas in Cáceres that were affected by alluvial gold mining. Acacia is a remarkably hardy species that can adapt to some of the worst soil conditions and acts to replenish the soil nutrients as well as improve the soil structure. This species was used in the sub-stratum affected by mining because very few tree species are capable of thriving under such conditions.

Gmelina arborea has been used primarily for living fences due to its fast growth pace in the first five to six years after planting.[9] It has also been used selectively to create shade to protect other young trees.

The use of acacia and gmelina will not have any significant negative effects on biodiversity. Acacia is distinguished as one of the species that best regenerates soils in grave states of depletion or erosion. Acacia fixes nitrogen and phosphorus in the soils allowing it to revert to its natural qualities, which can sustain a wider variety of species in the future.[10] Melina is considered an optimal species for agroforestry, living fences, windbreaks and protecting young trees as well as for recuperating ecosystems.[11]

Project activities laid out in the Management Plans contribute to the protection of these threatened species by regenerating their natural habitats that have been destroyed through deforestation. Project activities have been designed to be minimally invasive during site preparation by carrying out most site preparation manually and without machines.

B.1.5 Guarantee that no genetically modified organisms will be used to generate carbon credits.

No genetically modified organisms have been used in this project activity.

B.2.2 Describe how the project plans to mitigate these negative offsite biodiversity impacts.

The project does not presented any unmitigated offsite biodiversity impacts (See supporting document "*Monitoring report*").

B.2.3 Evaluate likely unmitigated negative offsite biodiversity impacts against the biodiversity benefits of the project within the project boundaries. Justify and demonstrate that the net effect of the project on biodiversity is positive.

The project does not presented any unmitigated offsite biodiversity impacts (See supporting document "*Monitoring report*").

[9] Obregon Sanchez, Maria. "Gmelina arborea: Versatilidad, Renovación y Productividad Sostenible para el Futuro." M&M Revista. www.revista-mm.com.
[10] Obregon Sanchez, Carolina . "La Acacia Mangium: Una Especie Promisoria." M&M Revista. www.revista-mm.com.
[11] Obregon Sanchez, Carolina. "Gmelina arborea: Versatilidad, Renovación y Productividad Sostenible para el Futuro." M&M Revista. www.revista-mm.com.

B.3.1 Describe the initial plan for how they will select biodiversity variables to be monitored. Potential variables include species abundance and diversity, landscape connectivity, forest fragmentation, habitat area and diversity, etc. Clarify the frequency of monitoring. Include in the monitoring plan, biodiversity variables at risk of being negatively impacted by project activities.

See supporting document "*Monitoring report"* (Methodology section).

B.3.2 Develop an initial plan for assessing the effectiveness of measures used to maintain or enhance High Conservation Values related to globally, regionally or nationally significant biodiversity (G1.8.1-3) present in the project zone.

Please see section CM.3.2.

B.3.3 Commit to developing a full monitoring plan within six months of the project start date or within twelve months of validation against the Standards and to disseminate this plan and the results of monitoring, ensuring that they are made publicly available on the internet and are communicated to the communities and other stakeholders.

A full biodiversity monitoring plan has been developed. The results of the monitoring have been disseminated to the communities and other stakeholders (See supporting folder "PIR dissemination").

The Climate, Community and Biodiversity Alliance (CCBA) Monitoring Report

Restoration of degraded areas and reforestation in Cáceres and Cravo Norte, Colombia

Monitoring period: 2011-2014

Developed by:

Version: 4

Date: December 02, 2016

i. Project name	Restoration of degraded areas and reforestation in Cáceres and Cravo Norte, Colombia.
ii. Project location	The project is located in two different Departments of Colombia. The first site is located in the municipality of Cáceres in the Department of Antioquia. The second site is located in the municipality of Cravo Norte in the Department of Arauca. In the case of Arauca, the establishment plan has not yet been developed, and no areas will be verified during this verification period.
iii. Project Proponent	Asorpar Ltd Calle 11a # 43D-79 Medellín, Phone (+574) 2661153 Contact person: Juan Guillermo Molina Email: asistente.asorparltda@hotmail.com
iv. Auditor	Instituto Colombiano de Normas Técnicas - ICONTEC -
v. Project lifetime	Project start date: February 1st 2002 Project lifetime: 30 years GHG accounting period: February 1st 2002 - January 31st 2031
vi. Project implementation period covered by the PIR	January 1st 2011 - August 20th 2014
vii. CCB History	Validation: 15 July 2011 First verification: 25 October 2011 Second verification: under verification
viii. Edition of CCB Standard Being Used	Second edition
ix. Summary of Climate, Community and Biodiversity Benefits Generated	**Climate** objectives has been achieved through the establishment and management of 1,116 ha planted, with conservational and productive purposes. Since the start date, the project has generated 361,234 tCO_2e. During the monitoring period, the project has generated 234,334 tCO_2e emission reductions. **Community** objectives are focused in the contribution to community development and poverty alleviation. Asorpar creates employment in an area with few alternative income sources and high levels of instability and economic depression due to guerrilla and paramilitary activities. Not only do the project activities provide employment but they provide an employment in which the workers learn skills that can be applied to achieve better employment opportunities in the future. Among the positive impacts identify for **biodiversity** are those in relation with the recovery of degraded areas and the conservation and connection of the forest relicts to provide for habitat and increased biodiversity. The natural habitats for Colombia's wide variety of flora and fauna found naturally in the forests have been severely compromised by deforestation for ranching and mining. The restoration of native forests has regenerated these conditions and provide sanctuary for the biodiversity that suffered as a result of deforestation.

	Promote soil conservation and improvement of water resources, protection from soil erosion as a result of grazing and mining. The reforestation activities has started to help with the restoration of the soils that have been highly depleted, over compacted and devastated by mechanized mining activities and grazing activities. These activities will further improve water and soil resources by removing pollution sources like cow dung and mercury. During the verification period, it was not possible to implement the project activities initially planned for the Cravo Norte area. This was the result of public safety issues that arose in this zone. The Department of Arauca, where the project area is located, has historically been an area of armed conflict in Colombia. The specific issue in Cravo Norte is the presence of the ELN guerilla organization (National Liberation Army). Despite the lack of implementation of project activities in the Cravo Norte area, the site has not been abandoned. During the entire period, Employees of the company have remained attentive and vigilant in their patrols of the property, protecting against loss of land and ensuring the conservation of the relict natural riparian forests present in the project area.
x. Gold Level Criteria	None
xi. Date of Completion of this Version and Version Number:	02 December 2016 Version 04
xii. Expected verification schedule	December 2016

CONTENTS

FIGURES

TABLES

1. Summary description of the project

The project anticipates the reforestation of grasslands and degraded ex-mining lands in Colombia. The forestry project activity has resulted in the reforestation of 1,116.42 ha in the Cáceres area of Antioquia and proposes the reforestation of approximately 9,640 ha in Cravo Norte (Arauca). The previous land uses in Cáceres were: (i) extensive livestock farming and (ii) gold mining. The previous land use in Cravo Norte was extensive livestock farming.

The project activity is being implemented by the private company Asorpar Ltd (Asesorías en Ornato Paisajismo y Reforestación, Ltda.). The legal representative is Juan Guillermo Molina, and the technical manager is Luis Gonzalo Moscoso. The total GHG emissions reductions generated during this monitoring period is 234,334.46 tCO_2e.

Since 2002, Asorpar Ltd. has been reforesting land with various tree species planted in different stand models that allow for natural regeneration on the reforestation sites. Asorpar Ltd. puts emphasis on promoting mixed stands. This differentiates their approach from other commercial forestry plantation entities active in Colombia. The management of mixed stands is far more challenging than that of monocultures. Exacerbating these difficulties is the fact that little is known about several tree species employed in the project, particularly regarding their growth performance and silvicultural management. Hence, the proposed project activity offers a unique opportunity to obtain valuable knowledge about silvicultural management practices for mixed plantation forestry and the suitability of native tree species for commercial plantation forestry.

The planted area has been split into six strata (1.1; 1.2; 1.3; 1.4 planted in different years on previous livestock area, and 2.1; 2.2 planted in different years on previous gold mining area). Strata 1.1 and 2.1 were planted in 2002, strata 1.2 in 2004, strata 1.3 in 2005, and strata 1.4 and 2.2 in 2007. For climate monitoring, each strata was monitored by farm (e.g. strata 1.1 and 2.1 includes the area called Caceres I-II) during the monitoring period. Table 1 shows the area planted per strata up to the year 2014, corresponding to a total of 1,116.42 ha. In the case of Arauca, the establishment plan has not yet been developed.

Table 1. Area planted by strata planted by the year 2014.

Name of farm	Strata	Planted area
Caceres I-II	1.1	543.86
Caceres III	1.2	88.62
Caceres IV	1.3	173.91
Caceres VII	1.4	160.05
Caceres I-II	2.1	101.42
Caceres VII	2.2	48.56
Total		**1,116.42**

During the verification period, it was not possible to implement the project activities initially planned for the Cravo Norte area. This was the result of public safety issues that arose in this zone. The Department of Arauca, where the project area is located, has historically been an area of armed conflict in Colombia. The specific issue in Cravo Norte is the presence of the ELN guerilla organization (National Liberation Army).

The presence of the ELN in this region intensified during the peace process negotiations between the Colombian government and the FARC guerillas (Revolutionary Armed Forces of Colombia), as the group pursued its strategy of establishing its name and presence in this area. This situation has

increased the human safety, technical, and economic risks of implementing project activities and has made the viability of planting and maintenance activities in this project area non-viable.

Nevertheless, thanks to the successful peace process with the FARC that ended with the signing of the final agreement and the referendum on this by the Congress, a new path has opened for beginning peace dialogues with the ELN. It is therefore expected that this process, which is just beginning, will transform the current situation in the project area to one that allows for the implementation of project activities, as happened in areas occupied by the FARC during their peace process.

Despite the lack of implementation of project activities in the Cravo Norte area, the site has not been abandoned. During the entire period, Employees of the company have remained attentive and vigilant in their patrols of the property, protecting against loss of land and ensuring the conservation of the relict natural riparian forests present in the project area. The study of the climate, community, and diversity impacts of the project required by the standard has been limited by the aforementioned conflict. The analysis is consequently less detailed than that presented for the Cáceres project area. A species list of fauna and flora as reported by employees, pictures, community and employee surveys, and a land use comparison (2011-2014) are presented in Annex I of the Monitoring Report as proof that there have not been negative impacts on community, biodiversity, or climate during the monitoring period.

Further background information on the project activities can be found in the Project Description (PD) and associated documents, which have been registered and are available on the CCBA webpage: *https://s3.amazonaws.com/CCBA/Projects/Restoration+of+degraded+areas+and+reforestation+in+Caceres+and+Cravo+Norte,+Colombia/101001_CCBA+PDD_Asorpar_Final.pdf*

2. Project location

The project is located in two different Departments of Colombia. The first site is located in the municipality of Cáceres in the Department of Antioquia. The second site is located in the municipality of Cravo Norte in the Department of Arauca. Given that the project activities in Cravo Norte are in their beginning stages, the verification for this period is only being carried out in the Cáceres portion of the project. Therefore, the description of project location is focused on the project area in the jurisdiction of Cáceres (Antioquia).

Cáceres is a town and municipality in the Colombian Department of Antioquia, situated in the northwestern, Andean region of Colombia. This Andean region is considered an area of high endemism and species richness and presents considerable environmental variation due to its complex orography and the confluence of several eco-regions (Figure 1). Cáceres is bordered to the north by the department of Córdoba and the municipality of Caucasia, to the east by the municipalities of Caucasia and Zaragoza, to the south by the Anorí and Tarazá, and to the west also by Tarazá and the department of Córdoba.

Besides subsistence agriculture, the main legal economic activity in this district is mining. Two indigenous groups are settled in Cáceres: Nutabes and Tahamíes[1].

The previous land use in Cáceres was extensive livestock farming. That activity was favored due to the presence of open grassland vegetation. Gold mining is also considered to be a feasible alternative for economic activity in the region. Other lands in the vicinity of Cáceres have similar land cover and are not expected to be used for private reforestation projects.

[1] http://www.caceres-antioquia.gov.co/

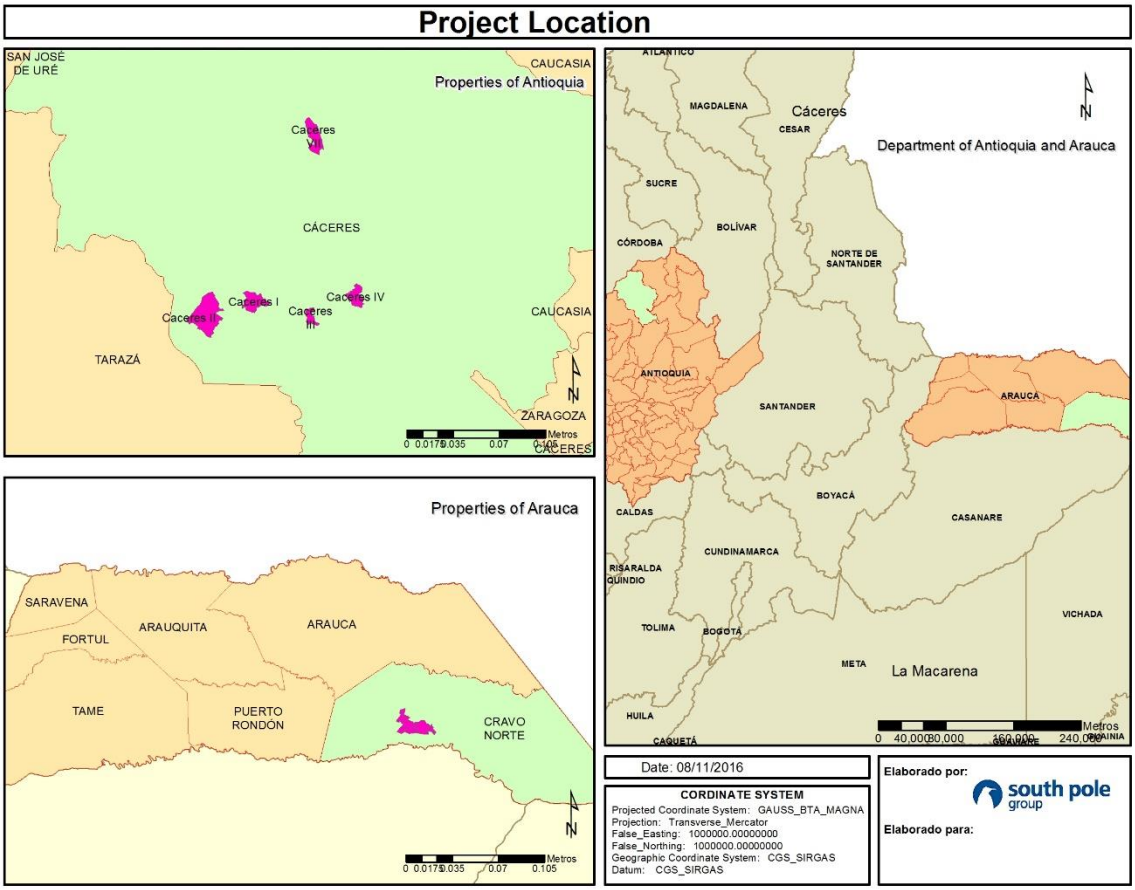


Figure 1. Project location.

3. Monitoring methodology

3.1. Biodiversity

Biodiversity monitoring includes both the flora and fauna components of biological diversity. The monitoring area is composed of two forest zones that differ in their previous land use between gold mining restoration (Figure 2) and livestock restoration (Figure 3). This monitoring places a special emphasis on assessing the presence and diversity of fauna, as these act both as direct indicators of the restoration of ecosystem functioning and the connectivity and recuperation of habitat. Therefore, the goal of monitoring is to demonstrate that project activities (i.e. recuperation of areas degraded by mining and livestock farming via establishment of native and introduced species) are supporting the recovery of site conditions, soil quality, microclimates, and other factors that favor the return of species originally displaced by land use change.

Figure 2. Gold mining reforestation areas.

Figure 3. Livestock restoration area.

The methodologies used in the monitoring of flora and fauna are described below.

3.2. Flora

Of the 166 plots established in the project area, one plot was chosen per stratum, as indicated in the monitoring plan. Care was taken to select plots that were inventoried for forest mensuration and flora in both 2012 and 2014 to allow for a comparative analysis of floristic and structural composition of plots between monitoring events. Permanent plots established in the project area account for a total of 250 m^2. Four of these plots were established in zones of former livestock use, and two fall in zones previously impacted by mining activity (Table 2).

Table 2. Permanent plots used for flora monitoring.

Plot	Farm	Stratum	Year of Planting	Former Land Use
Plot 34	Cáceres I-II	Stratum 1.1.	2002	Livestock
Plot 12	Cáceres III	Stratum 1.2.	2004	Livestock
Plot 106	Cáceres IV	Stratum 1.3.	2005	Livestock
Plot 80	Cáceres VII	Stratum 1.4.	2007	Livestock
Plot 43	Cáceres II	Stratum 2.1.	2002	Mining
Plot 71	Cáceres VII	Stratum 2.2.	2007	Mining

In each plot, all individuals measured were identified to the species level and measured for diameter at breast height (DBH) and total height (H). The analysis of flora was principally based on diversity,

measured using the Inverse Simpson index, and the structure of plots, based on diameter distributions.

Species diversity

A Simpson Index was calculated to evaluate species diversity. This index measures the probability that two individuals chosen at random belong to the same species. It does so by accounting for both the number of species (species richness) and the distribution of individuals, based on the species encountered. For a finite sample size, the following equation is employed, where n_i is the number of individuals of species i and N is the total sample size[2]:

$$I_S = \sum_{i=1}^{N} \frac{n_i(n_i - 1)}{N(N-1)},$$

As the equation is formulated, greater values of I_S indicate lower species diversity. For this reason, the Inverse Simpson Index is more commonly used as a measure of diversity and is calculated as 1-I_S, with values that range zero and one. A value of zero (0.00) indicates that there is no probability that two randomly selected individuals belong to different species. Therefore, higher values of the Inverse Simpson Index indicate higher species diversity.

Structure

A comparison of diameter distribution between the 2012 and 2014 monitoring periods was conducted with the aim of identifying structural changes occurring within the plots. This was completed by constructing histograms using R i386 3.2.3 software to display the number of individuals per diameter class.

3.3. Fauna

Amphibian and reptile survey

To document the presence of herpetofauna, each baseline land use was sampled using a visual-encounter survey method (VES). With VES, the observer samples relative abundance by walking a predefined area (e.g. along a stream or pond) and searching for individuals in all microhabitats available in the study area (stream-side vegetation, stream banks, and the surface and substrate of the stream). Areas with high accumulation of leaf litter or nearby water bodies are particularly thoroughly examined (Figure 4). This is the most efficient way to detect the greatest number of individuals and species in the shortest time (Angulo et al., 2006). All animals collected were identified and released within the forest immediately, unless further documentation (e.g. photographs) was required. Surveys were carried out in the morning 7:00 – 10:00 and evening/night 18:00 – 22:00.

[2] Peet, Robert K. "The measurement of species diversity." *Annual review of ecology and systematics* (1974): 285-307.

Figure 4. Amphibian and reptile survey.

Mammal survey

Mammals occupy a diversity of habitats and display different behaviors, so it is necessary to implement a variety of census techniques in order to record the majority of species that occur in the study area[3]. Four census techniques were implemented: mist nets, camera traps, tracking and direct observation, and knowledge of local inhabitants.

Three six-meter mist nets were placed in each sampling point, across streams and forest paths, and were deployed for four consecutive hours beginning at sunset (Figure 5). We checked the nets every twenty minutes. Each bat captured was kept in captivity for up to one hour to be identified to the species-level, sexed, weighed, classified as adult or non-adult and for reproductive status, measured and photographed, and then released at the site of capture.

[3] Voss, R. S., & Emmons, L. H. (1996). Mammalian diversity in Neotropical lowland rainforests: a preliminary assessment. American Museum of Natural History.

Figure 5. Mist nets for bat sampling.

To record medium-sized and large mammals, six Bushnell® HD trophy camera camo traps were employed (two per size), mounted on trees at least 2.5 – 3.5 meters from the path or trail with the infrared beam set approximately 30 cm from the ground (Figure 6). Each camera was deployed for 24 hours during eight effective days and set in video mode.

Figure 6. Camera traps used to record medium-sized and large mammals.

Mist nets and camera trap surveys were complemented by direct observation, tracking footprints, and by employing local knowledge. Direct observation and tracking footprints were completed by walking through forests and recording individuals detected directly, with binoculars, by tracks left in soft ground, marks in trees, or at feeding or resting sites. Animal tracks were identified with specialized field guides[4][5]. Local knowledge of species sightings in the study zone was gathered through interviews in which local residents identified animals from photographs and species characteristics[6].

[4] Aranda, J.M.S. 2012. Manual para el rastreo de mamíferos silvestres de México. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (Conabio). México, D.F., México.255 pp.
[5] Rodríguez-Herrera, B.; Medellín, R.A. & Timm R.M. 2007. Murciélagos neotropicales que acampan en hojas; 1 edición. Instituto Nacional de Biodiversidad, INBio, Santo Domingo de Heredia, Costa Rica: 184 p.
[6] Emmons, L.H & Feer, F.1997. Neotropical Rainforest Mammals. Second Edition. University of Chicago Press. Chicago.

Data analysis

Functional traits

The functional traits of mammals were used to assign each species to a guild, based on experienced knowledge of mammal ecology and previous studies[7], including Robinson y Redford (1986)[8] for terrestrial mammals and Linares (1987)[9] and Laval & Rodríguez (1999)[10] for bats. Guild allocation was primarily based on foraging and trophic niche (Table 3) and locomotion (arboreal, aerial canopy, aerial understory, scansorial, semi-aquatic, semi-excavator, terrestrial) characteristics. These were used to create groups of species that reflect similar patterns of resource use (food) and/or movement (locomotion)[11].

Table 3. Trophic classification of mammals.

Category	Frequency
Nectarivore-omnivore (N-O):	>50% nectar and pollen
Frugivore-granivore (F-G)	Mostly fruits and seeds
Frugivore-omnivore (F-O)	>50% fruits, remainder mostly invertebrates and vertebrates
Frugivore-nomad (F-N)	>50% fruits of large trees (seasonal production)
Frugivore - sedentary (F-S)	>50% fruits of small trees or shrubs (continuous production)
Insectivore-omnivore (I-O)	>50% invertebrates
Myrmecophage (M),	>75% ants and termites
Herbivore (H)	>50% leaves and twigs
Piscivorous (PI),	>75% fish, crustaceans and mollusks
Carnivore (C)	>50% vertebrates

Endangered species

Species with high priority conservation status or special attention requirements were defined as "species of special interest," based on endemism, conservation category, and level of commercialization in illegal wildlife traffic[12].

Connectivity analysis for Jaguar (*Panthera onca*)

There are numerous methods and software for delineating corridors and estimating functional connectivity[13]. Here, a least-cost functional connectivity model[14] (

[7] Morrison, M.L, Marcot, B.G & Mannan, R.W. 1992. Wildlife–habitat relationships. Concepts and applications. University of Wisconsin Press, Madison.
[8] Robinson, J.G. & Redford, KH. 1986. Body size, diet, and population density of neotropical forest mammals. American Naturalist 128(5):665-680.
[9] Linares, O., 1987. Murciélagos de Venezuela. Edit. Lagoven, Caracas, Venezuela.
[10] Laval, R. & Rodríguez-H, B. 2002. Murciélagos de Costa Rica. 1ª ed.-Santo Domingo de Heredia, Costa Rica: Instituto Nacional de Biodiversidad, INBIO. 320p.
[11] Gitay, H. y Noble, I.R. 1997. What are functional types and how should we seek them? Pp. 3-19 en: Plant functional types. Their relevance to ecosystem properties and global change. Smith TM, Shugart HH y Woodward FI (eds). Cambridge University Press, Cambridge.
[12] According to the IUCN red list (http://www.iucnredlist.org/), Colombian red books[12], national of threatened lists (Resolución 0192 de 2014 del Ministerio de Ambiente y Desarrollo Sostenible de Colombia), and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, https://www.cites.org/).
[13] Calabrese, J. M. and Fagan, W. F. 2004. A comparison-shopper ' s guide to connectivity metrics. - Front. Ecol. Environ. 2: 529–536.
[14] McRae, B. H. and Kavanagh, D. M. 2011. Linkage mapper connectivity analysis software. - Comput. Softw. Progr. Prod. by Nat. Conserv. Seattle, WA, USA. Available online http//www. circuitscape. org/linkagemapper (accessed 16 April 2016) in press.

Figure 7) was chosen to *(i)* analyze potential corridors for the movement of jaguar (*Panthera onca*) at regional (northern Antioquia) and local scales (municipality scale) and *(ii)* demonstrate the contribution of forests and project restoration areas to the conservation of this keystone species. Functional connectivity can be seen as the degree to which landscape structure facilitates or impedes the movement of species among habitat patches and is generally a species-specific estimate.

Calculation of functional connectivity included several steps:

i. ***Classification of landscape forests remnants***: first, a forest/non-forest satellite image of northwestern Antioquia was obtained using CLASlite software[15]. Then, this image was classified with a Morphological Spatial Pattern Analysis (MSPA) (Figure 8), a segmentation technique recently developed by Vogt et al. (2009)[16]. MSPA is based on morphological image processing techniques already used in the detection of landscape spatial elements like structural and functional corridors in forests. The seven MSPA classes have the following properties: *Core* – inner foreground pixels beyond a defined distance *d* from the foreground-background boundary; *edge* – transition pixels between the core and the external non-core; *perforation* – transition from the core to the internal background; *bridge* – foreground pixels connecting at least two disjointed core areas; *islet* – foreground patch too small to contain core; *loop* – foreground pixels connecting a core area with itself; *branch* – foreground pixels linked to a core but that do not connect to another core. This classification was carried out with GuidosToolbox[17].
ii. ***Creation of cost surface or permeability matrix:*** The approach chosen was that proposed by Rabinowitz and Zeller (2010)[18], to assign cost values to the attributes of the individual landscape layers (altitude; probability of human access; percentage of fractional cover of vegetation canopies, dead vegetation, and bare surfaces) based on how costly a particular attribute would be to jaguar movement. Cost values ranged from 0 (no cost to jaguar movement) to 10 (high cost for jaguar movement). Probability of human access was calculated using the priority areas for conservation identification toolbox developed by Ríos-Franco et al. (2013)[19] and the fractional cover of vegetation was extracted from satellite image of northwestern Antioquia using CLASlite software[20]. The resulting cost surface was a raster map of 30-meter pixel resolution. Each pixel in a cost surface is given a value reflecting the energetic cost, difficulty, or mortality risk of moving across that pixel.

[15] Asner, G. P. et al. 2009. Automated mapping of tropical deforestation and forest degradation: CLASlite. - J. Appl. Remote Sens. 3: 33543.
[16] Vogt, P. et al. 2009. Mapping functional connectivity. - Ecol. Indic. 9: 64–71.
[17] (Graphical User Interface for the Description of image Objects and their Shapes; http://forest.jrc.ec.europa.eu/download/software/guidos/).
[18] Rabinowitz, A. and Zeller, K. A. 2010. A range-wide model of landscape connectivity and conservation for the jaguar, Panthera onca. - Biol. Conserv. 143: 939–945.
[19] Ríos-Franco, C. A. et al. 2013. Toolbox para la identificación de áreas prioritarias para la conservación, Modelo SIG dinámico V1.0. - Wildlife Conservation Society Colombia - MacArthur Foundation.
Vogt, P. et al. 2009. Mapping functional connectivity. - Ecol. Indic. 9: 64–71.
[20] Asner, G. P. et al. 2009. Automated mapping of tropical deforestation and forest degradation: CLASlite. - J. Appl. Remote Sens. 3: 33543.

iii. ***Calculation of movement routes and corridor delineation***: To determine optimal routes of travel across the permeability matrix, we used the Linkage Mapper toolkit for ArcGIS[21]. Linkage Mapper uses the maps of core forests (calculated in step ***i***), areas, and resistances to identify and map linkages between cores. The tool identifies adjacent (neighboring) core forest areas and creates maps of least-cost corridors between them. It then joins the individual corridors to create a single composite corridor map. The result shows the relative value of each pixel in providing connectivity between core forests areas, allowing for the identification of routes that facilitate or impede movement between core areas.

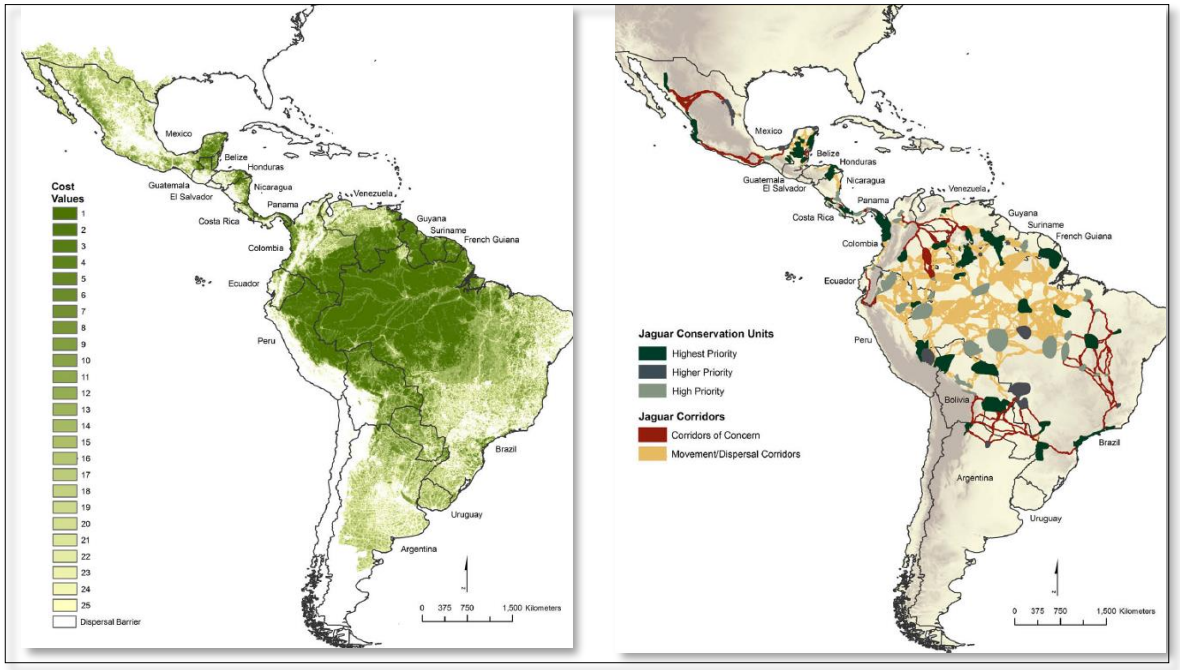


Figure 7. Connectivity analysis at continental scale from Rabinowitz and Zeller (2010).[22] Left: resistance matrix; Right: Jaguar corridors.

[21] McRae, B. H. and Kavanagh, D. M. 2011. Linkage mapper connectivity analysis software. - Comput. Softw. Progr. Prod. by Nat. Conserv. Seattle, WA, USA. Available online http//www. circuitscape. org/linkagemapper (accessed 16 April 2016) in press.

[22] Rabinowitz, A., & Zeller, K. A. (2010). A range-wide model of landscape connectivity and conservation for the jaguar, Panthera onca. Biological conservation, 143(4), 939-945.

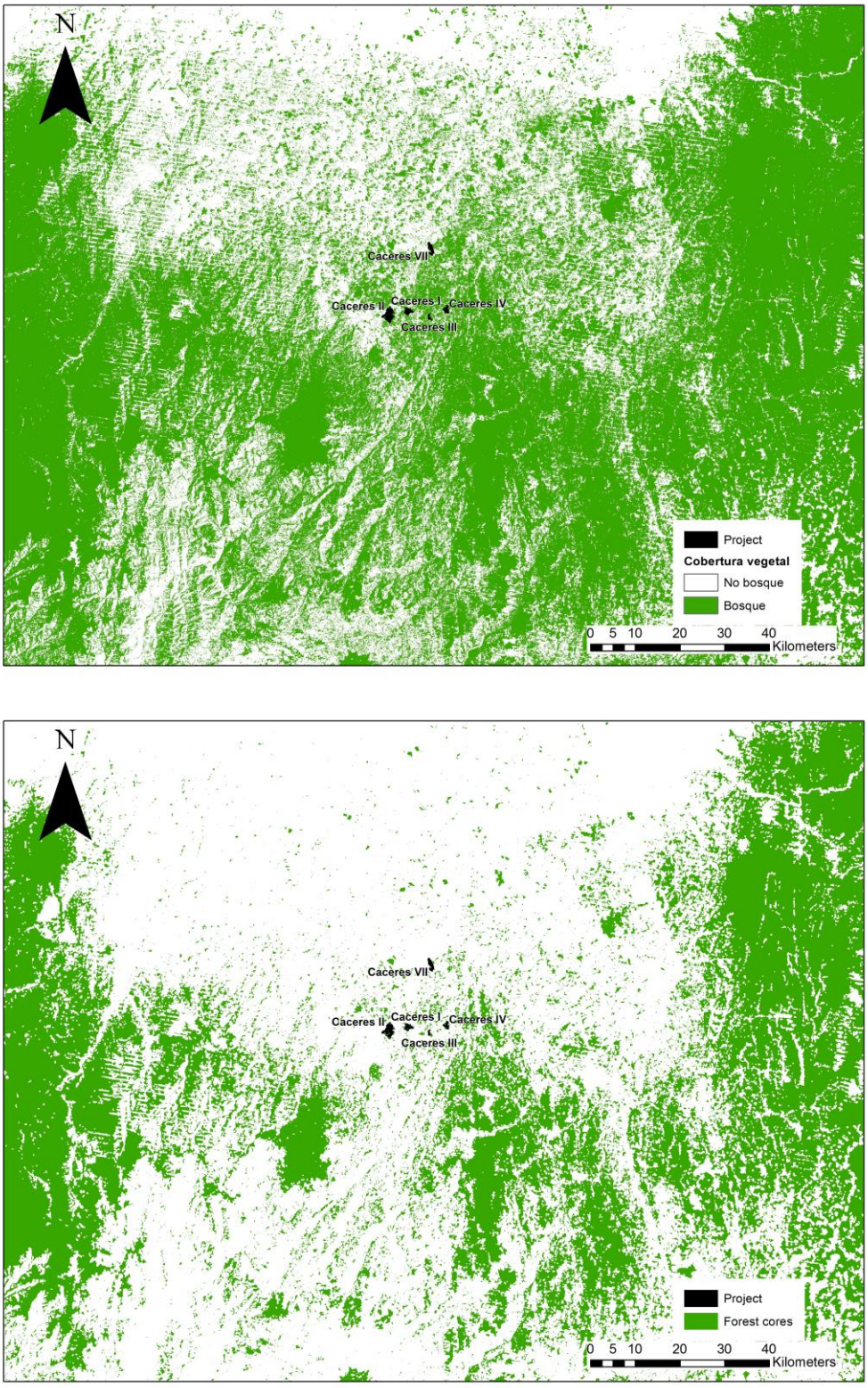


Figure 8. Forest cover maps used in connectivity analysis. Above: Forest/Non-Forest map; Below: Forest used as habitat cores.

3.4. Direct social impacts

The community monitoring plan seeks to measure the direct impacts of the project through surveys with workers and employees. The variables monitored were selected based on an evaluation of potential positive and negative direct impacts of the project activities and based on the categories of the Sustainable Livelihoods Approach, including social capital, financial capital, natural capital and human capital. These variables included income, employment, local participation, professional know-how, job security and environmental factors. The surveys presented to the workers and communities are found in Annexes I and II of this document.

To evaluate the variables, the following scale was used:

1: Poor
2: Average
3: Good
4: Very good
5: Excellent

3.5. Climate

The methodology and results with respect to the monitoring of climate indicators need not be submitted as part of this monitoring report, given that the climatic benefits for the 2011 – 2014 period were verified in 2014 under the VCS standard. The VCS monitoring report is included as a supporting document to the present report.

4. Monitoring Results

4.1. Biodiversity

4.1.1. Flora

Species diversity

The species found in the six plots are presented in Table 4. Table 5 displays the number of species and individuals recorded in the 2012 and 2014 monitoring events.

Table 4. Flora species reported during monitoring.

Scientific Name	
Acacia mangium	*Luehea seemannii*
Apeiba aspera	*Macrolobium gracile*
Bellucia pentamera	*Marila sp*
Cecropia sp	*Trichospermum sp*
Cespedesia macrophylla	*Simaba cedron*
Clathrotropis brachypetala	*Spondias mombin*
Croton smithianus	*Swietenia macrophylla*
Didymopanax morototoni	*Tabebuia rosea*
Dipteryx oleifera	*Tapirira guianensis*
Ficus sp	*Trema spp.*
Inga grandis	*Vismia baccifera*

Table 5. Change in the number of species and individuals present between 2012 and 2014.

Plot	Number of Species		Number of Individuals	
	2012	2014	2012	2014
34	7	6	32	29
43	1	3	20	18
12	8	12	27	29
106	9	9	34	35
71	1	4	16	17
80	2	2	24	24

As demonstrated by Table 5, the number of species either remained the same or slightly increased in the majority of the measured plots between 2012 and 2014. The only plot in which the number of species decreased during that period was 34. The measured number of individuals displayed a similar pattern of change, however, two plots (34 and 43) were found to have a decrease in the number of individuals during that period. The lowest number of species and individuals was found in the plots previously used for mining (43 and 71).

The number of species and individuals describes in a general manner species turnover in the zones evaluated. However, it is important to note that these values do not fully capture the dynamics of species mortality and recruitment. For example, while an increase in the total number of individuals could occur alongside net species recruitment (without mortality), this could also occur under a scenario of low mortality and high recruitment. It is also possible that an individual of a common species dies and is replaced by one of a rare species. In these cases, only examining the number of species and individuals can misrepresent the diversity of the zone. The indices described in the following sections allow for more accurate representations of diversity to account for the examples presented in this paragraph.

Mortality was observed in all plots, represented mainly by *Acacia mangium* individuals (the principal species planted at the start of the project) and, to a lesser extent, by individuals identified as *Croton smithianos*, C*espedesia macrophylla*, *Trema sp*, *Trichospermum* spp. and *Marila* spp.

In all of the plots other than Plot 34, recruitment of new individuals was observed. These individuals were mainly of the species *Vismia baccifera* and *Didymopanax morototoni*, along with some individuals of the species *Swietenia macrophylla, Bellucia pentamera, Dipteryx oleífera, Cespedesia macrophylla* and *Ficus* spp*.* Species like *S. macrophylla* and *D. oleifera* are of great importance, due to the fact that they are reported as threatened in the red book of wood-bearing tree species of Colombia[23]. *S. macrophylla* is classified as "Critically Endangered", meaning that it faces an extremely high risk of extinction in the wild in the immediate future. *D. oleifera*, on the other hand, is classified as "vulnerable," meaning that it faces a moderate risk of extinction or reduced population in the medium-term. Both species were observed in Plot III, land which was previously used for livestock farming.

The results of the Inverse Simpson Index are presented in Table 6. These calculations indicate that in the majority of the plots, the diversity index increased or at least remained the same as in the previous monitoring period.

Table 6. Inverse Simpson Diversity Index.

Plot	Stratum	Inverse Simpson Index Value	
		2012	2014
34	Stratum 1.1	0.78	0.78
43	Stratum 2.1	0.00	0.39
12	Stratum 1.2	0.84	0.87
106	Stratum 1.3	0.85	0.85
71	Stratum 2.2	0.00	0.42
80	Stratum 1.4	0.08	0.08

The most significant change in diversity was observed in plots 43 and 71. In 2012, the porbability of finding two different species when selecting two individuals at random was zero for each of these plots. A value of zero indicates that in 2012, essentially all of the individuals in these plots belonged to the same species (i.e. *Acacia mangium*). In 2014, the values jumped to 0.39 and 0.42, respectively, representing a significant increase in species diversity.

Recruitment of new species depends on factors such as the quality of the seed bank, the availability of nutrients and water, and the dispersal patterns and strategies of each species. In this case, it is

[23] Cárdenas, L. D., & Salinas, N. R. (eds.). 2007. Libro rojo de plantas de Colombia. Volumen 4. Especies maderables amenazadas: primera parte. Serie libros rojos de especies amenazadas de Colombia. Bogotá, Colombia. Instituto Amazónico de Investigaciones Científicas SINCHI - Ministerio de Ambiente, Vivienda y Desarrollo Territorial. 232 pp.

likely that these new species were able to successfully establish themselves due to the improvement of soil conditions and the increase in available microclimates that resulted from reforestation with *A. mangium*. This species has provided good results with respect to the recruitment of new species by successfully restoring degraded soils and improving other aspects of site conditions[24] [25] [26].

Structure

Figure 9 displays the diameter distributions for each plot during each monitoring year (2012 and 2014). In any given plot, individuals were observed during 2014 with diameters that exceeded the maximum diameters recorded for that plot during 2012. Despite the fact that this behavior is a clear indicator of overall tree growth during this period, it is not clear from the histograms that individuals passed from one diameter class to another across the diametric range. This non-systematic behavior could be associated with the recruitment of new species with growth curves that differ from those of the species initially planted in these plots.

At the same time, the absence of some diameter classes observed in 2012 from the 2014 histogram is associated with mortality events. When conducting a plot-level analysis, many diameter classes are represented by a sole individual, and therefore the absence of a diameter class can result from the death of one individual.

Species recruitment depends significantly on the degree of soil recuperation achieved, the seed bank, appropriate dispersal vectors, and inter- and intraspecific competition, among other factors. The record of recruitment is thus an indicator of the recovery of forest dynamics. For this reason, the project follows a natural approach to forest regeneration rather than artificially assisting enrichment.

[24] Sánchez, P. A., Woomer, P. L., & Palm, C. A. (1994). Agroforestry approaches or rehabilitating degraded lands after tropical deforestation. In JIRCAS International Symposium Series (Japan).
[25] Norisada, M., Hitsuma, G., Kuroda, K., Yamanoshita, T., Masumori, M., Tange, T., ... & Kojima, K. (2005). Acacia mangium, a nurse tree candidate for reforestation on degraded sandy soils in the Malay Peninsula. Forest Science, 51(5), 498-510.
[26] Sang, P. M., Lamb, D., Bonner, M., & Schmidt, S. (2013). Carbon sequestration and soil fertility of tropical tree plantations and secondary forest established on degraded land. Plant and soil, 362(1-2), 187-200.

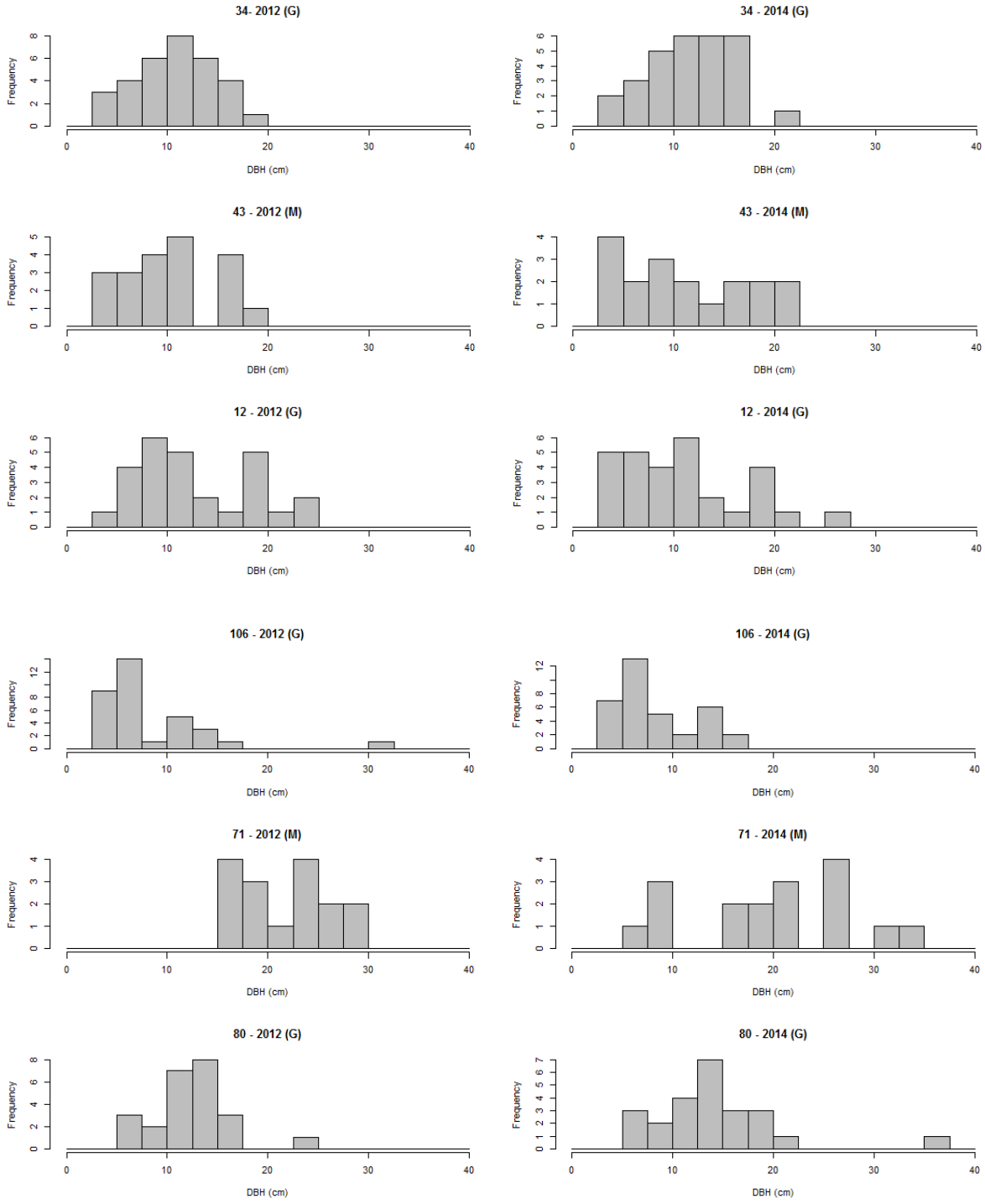


Figure 9. Diameter distributions for 2012 and 2014.

4.1.2. Fauna

Amphibian and reptile diversity

In the study area, ten amphibian species belonging to nine genus (Figure 11) and eleven reptile species belonging to nine genus (Figure 12) were observed (Table 7 and Figure 10). Forest and gold mining areas presented the highest amphibian diversity, with five and six species respectively, possibly due to the high humidity in these areas and adjacency to water bodies. Most of species detected are habitat generalist and form species assemblages that replace original communities after degradation or ecosystem interventions. Life history characteristics of amphibians restrict their distribution and activity, due to the fact that they are highly dependent on specific water and temperature requirements; most species have high skin permeability and reproductive strategies that require very humid areas to complete their life cycle. In addition, amphibians are ectothermic animals so environmental temperature affects behavior, reproduction, and geographic distribution[27] [28]). Such dependencies and physiological constraints cause low amphibian species richness in localities or landscapes that have been highly transformed or degraded. Despite low diversity, the presence of species in the genera *Dendrobatidae* and *Centrolenidae* in study area may indicate recuperation of ecological functioning in restored areas surrounding forest patches.

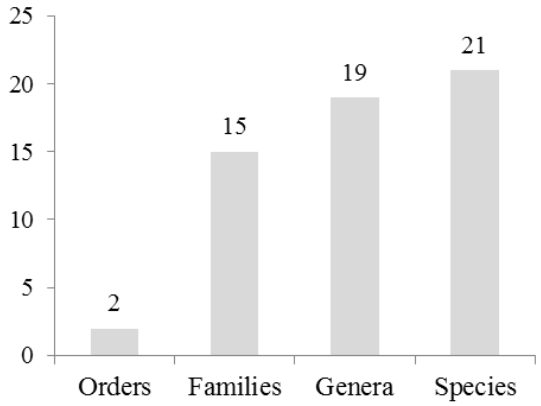


Figure 10. Amphibian and reptile diversity recorded in the project study area.

Table 7. Diversity of amphibian and reptile species observed in the study area.

Area	Class	Family	Species
Forest	Amphibia	Aromobatidae	*Colosthetus sp.*
	Amphibia	Craugastoridae	*Craugastor raniformis*
	Amphibia	Craugastoridae	*Pristimantis sp*
	Amphibia	Dendrobatidae	*Dendrobates truncatus*
	Amphibia	Hylidae	*Hylidae sp1*
	Reptilia	Corytophanidae	*Basiliscus galeritus*
	Reptilia	Dactyloidae	*Anolis sp2*
	Reptilia	Gymnophthalmidae	*Pholidobolus vertebralis*
Gold mining restoration	Amphibia	Bufonidae	*Rhinella marina*

[27] Zug, G. R., Vitt, L., & Caldwell, J. P. (2001). Herpetology: an introductory biology of amphibians and reptiles. Academic Press.

[28] Navas, C. A. (2006). Patterns of distribution of anurans in high Andean tropical elevations: insights from integrating biogeography and evolutionary physiology. Integrative and Comparative Biology, 46(1), 82-91.

Area	Class	Family	Species
	Amphibia	Centrolenidae	*Centrolenidae sp*
	Amphibia	Craugastoridae	*Craugastor raniformis*
	Amphibia	Hylidae	*Dendropsophus bogerti*
	Amphibia	Leptodactylidae	*Engystomops pustulosus*
	Amphibia	Leptodactylidae	*Leptodactylus fuscus.*
	Reptilia	Boidae	*Boa constrictor*
	Reptilia	Colubridae	*Leptodeira septentrionalis*
	Reptilia	Corytophanidae	*Basiliscus galeritus*|
	Reptilia	Dactyloidae	*Anolis sp1*
	Reptilia	Sphaerodactylidae	*Gonatodes albogularis*
	Reptilia	Viperidae	*Bothriechis schlegelii*
Livestock restoration	Amphibia	Craugastoridae	*Pristimantis sp*
	Reptilia	Colubridae	*Atractus sp*
	Reptilia	Gymnophthalmidae	*Pholidobolus vertebralis*
	Reptilia	Teiidae	*Ameiva ameiva*

Figure 11. Amphibian species recorded in the study area.

Figure 12. Reptile species recorded in study area.

Mammals diversity

A total of 31 species belonging to seven orders, 19 families, and 30 genera were recorded during the diurnal and nocturnal surveys. 13 of these were recorded in forest, 24 in the gold mining restoration zone and 13 in the livestock restoration zone (Table 8 and Figure 13).

Figure 13. Mammal diversity recorded in the study area of project.

Chiroptera and Carnivora were the most diverse orders, comprising 33% and 30% of the total species recorded, respectively (Table 8 and Figure 14). Interestingly, eight families were only observed in gold mining restoration area, including Mephitidae (skunks), Aotidae (night monkeys), and Callitrichidae (tamarins) (Table 8). The family with the highest diversity in the study area was Phylostomidae (order Chiroptera; Figure 15), with eight species that represent 27% of total observed mammal diversity. Phyllostomidae also was the most abundant family, with 56 individual captured and processed.

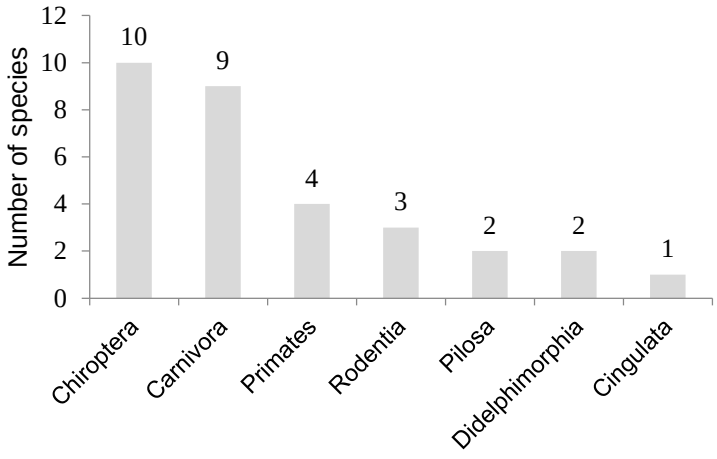


Figure 14. Mammal order diversity.

Table 8. List of mammal species recorded in the study area of the project "Restoration of Degraded Areas and Reforestation in Cáceres and Cravo Norte, Colombia".

Order	Family	Species	Common Name (English / Spanish)	Ecological Importance	Locomotion	Activity Periods	Dietary categories	Observation method	Areas of Study		
									Forest	Mining	Rangelands
Didelphimorphia	Didelphidae	*Didelphis marsupialis*	Common Opossum / Chucha común	E3	S	D-N	F-O	T	X	X	X
		Metachirus nudicaudatus	Brown Four-eyed Opossum / Chucha cuatro ojos	E2	S	N	I-O	CT			X
Cingulata	Dasypodidae	*Dasypus novemcinctus*	Nine-banded Armadillo / Armadillo común	E2	SE	N	I-O	T, CT	X	X	X
Pilosa	Megalonychidae	*Choloepus hoffmanni*	Hoffmann's Two-toed Sloth / Perico de pelo	E5	A	N	H	LK	X	X	
	Myrmecophagidae	*Tamandua mexicana*	Northern Tamandua / Hormiguero	E2	T	N	M	CT		X	
Chiroptera	Vespertilionidae	*Myotis sp.*	Bat / Murciélago insectívoro	E2	A-C	N	I-O	O		X	
	Molossidae	*Molossus sp.*	Mastiff Bat / Murciélago mastín	E2	A-C	N	I-O	O		X	
	Phyllostomidae	*Carollia perspicillata*	Seba's Short-tailed Bat / Murciélago frutero común	E1	A-U	N	F-S	MN	X	X	X
		Carollia castanea	Chestnut Short-tailed Bat / Murciélago castaño	E1	A-U	N	F-S	MN	X	X	
		Artibeus lituratus	Great Fruit-eating Bat / Murciélago frutero	E1	A-U	N	F-O	MN			X
		Chiroderma trinitatum	Little Big-eyed Bat / Murciélago frutero	E1	A-U	N	F-N	MN			X
		Dermanura phaeotis	Pygmy Fruit-eating Bat / Murciélago pardo	E1	A-U	N	F-N	MN	X	X	X
		Sturnira sp.	Yellow-shouldered Bat / Murciélago frutero	E1	A-U	N	F-S	MN		X	X
		Uroderma bilobatum	Tent-making Bat / Murciélago frutero	E1	A-U	N	F-N	MN			X
		Vampyressa thyone	Northern Little Yellow-eared Bat / Murciélago frutero	E1	A-U	N	F-N	MN		X	X
Carnivora	Felidae	*Leopardus pardalis*	Ocelot / Ocelote	E3	S	N	C	LK	X	X	
		Panthera onca	Jaguar / Jaguar	E4	T	D-N	C	CT		X	
		Puma yagouaroundi	Jaguarundi / Gato pardo	E3	S	D-N	C	LK		X	
	Canidae	*Cerdocyon thous*	Crab-eating Fox / Zorro común	E3	T	N	C	LK	X	X	X
	Mustelidae	*Lontra longicaudis*	Neotropical Otter / Nutria	E3	SA	D-N	PI	LK		X	
		Eira barbara	Tayra / Comboro, tayra	E3	S	D-N	C	LK	X		
	Procyonidae	*Nasua nasua*	South American Coati / Cusumbo	E1	A	N	F-O	T		X	
		Procyon cancrivorus	Crab-eating Raccoon / Zorra patona	E3	S	N	PI	T		X	
	Mephitidae	*Conepatus semistriatus*	Striped Hog-nosed Skunk / Mofeta	E2, E3	T	N	I-O	T		X	
Primates	Aotidae	*Aotus griseimembra*	Grey-handed Night Monkey / Marteja	E1	A	N	F-O	O		X	
	Callitrichidae	*Saguinus leucopus*	Silvery-brown Tamarin / Mono tití	E1	A	D	F-O	O		X	
	Atelidae	*Alouatta seniculus*	Guianan Red Howler Monkey / Aullador colorado	E5	A	D	H	V	X		
	Cebidae	*Cebus albifrons versicolor*	White-fronted Capuchin / Machín	E1, E3	A	D	F-O	LK	X		
Rodentia	Sciuridae	*Sciurus granatensis*	Red-tailed Squirrel / Ardilla Colorada	E1	A	D	F-G	O, CT	X	X	X
	Cuniculidae	*Cuniculus paca*	Spotted Paca / Guagua, Tinajo, Boruga	E1	SE	N	F-G	TC, T	X	X	X
	Dasyproctidae	*Dasyprocta punctata*	Central American Agouti / Guatín, Ñeque	E1	T	D	F-G	T		X	
Number of species									**13**	**24**	**13**

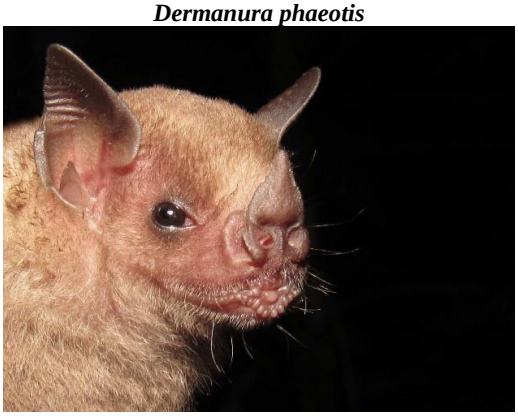
Ecological Importance: E1: Seed dispersal, E2: insect population control, E3: vertebrates population control, E4: pollinator. E5: recycling of organic matter of plant origin. **Locomotion:** A: arboreal, A-C: aerial canopy, A-U: aerial understory, S: scansorial, SA: semiaquatic, SE: semiexcavator, T: terrestrial. **Activity Periods:** D: diurnal, N: nocturnal. **Diet:** C: Carnivore, F-G: Frugivore-granivore, F-N: Frugivore-nomad, F-O: Frugivore-omnivore, F-S: Frugivore - sedentary, H: Herbivore, I-O: Insectivore-omnivore, M: Myrmecophage, PI: Piscivorous. **Register types:** T: trail, O: observation, LK: local knowledge, MN: mist nets, V: vocalization, TC: camera traps

Carollia perspicillata

Carollia castanea

Dermanura phaeotis

Uroderma bilobatum



***Sturnira* sp.**

Vampyressa thyone

Chiroderma trinitatum

Artibeus lituratus

Figure 15. Bat species recorded in the study area.

In addition to the individuals recorded with mist nets, five individuals of *Myotis* spp. and another four individuals of *Molossus* spp were detected during the direct observation transects. These groups were using roofs of houses built with the palm *Carludovica palmata* (Cyclanthaceae) as refuge (Figure 16).

Individuals of *Myotis sp.* using roofs of houses built with palm leaves *Carludovica palmata*

Individuals of *Molossus* sp using roofs of houses built with palm leaves*Carludovica palmata*

Figure 16. Groups of bats using human constructions as refuge.

In addition to those individuals captured with the mist nets, other species captured were found to have made refuges in areas of all three land cover classes, which indicates that all three types of cover provide not only food but also sufficient protection for these bats. Three types of tent-roosting bats were observed. The first tent style observed is a mixture of two types (boat/apical)[29] (Figure 17). The bat species found to occupy these types of tents, identified through capture in mist nets, include *Uroderma bilobatum*, *Vampyressa thyone*, *Dermanura* spp., and *Artibeus* spp[30] (Figure 15).

[29] Rodríguez-Herrera, B.; Medellín, R.A. & Timm R.M. 2007. Murciélagos neotropicales que acampan en hojas; 1st edition. Instituto Nacional de Biodiversidad, INBio, Santo Domingo de Heredia, Costa Rica: 184 p.
[30] Rodríguez-Herrera, B.; Medellín, R.A. & Timm R.M. 2007. Murciélagos neotropicales que acampan en hojas; 1st edition. Instituto Nacional de Biodiversidad, INBio, Santo Domingo de Heredia, Costa Rica: 184 p.

Boat/apical tents on *Anthurium sp.* (Araceae).

Tents cut circularly on leaves of *Carludovica palmata* (Cyclanthaceae)

cut heart-shaped tents on leaves of *Carludovica palmata* (Cyclanthacea)

Figure 17. Types of tents built by bats in study area.

Overall, 20 species were recorded, representing six orders and 16 families of medium and large-sized mammals (Table 8). Seven species were detected in the footprint surveys, including *Didelphis marsupialis*, *Nasua nasua*, *Conepatus semistriatus* and *Dasyprocta punctate* (Figure 18). Most observations were associated with the gold mining restoration area, which contains swampy areas near water bodies and substrates that record print traces. In contrast, forest and rangeland restoration areas have rocky substrates and areas with high accumulation of leaf litter, and therefore, it is difficult to detect traces in these sites.

Among the three study areas, the similarity of mammal species was estimated to be 23%. Although seven species are shared between study areas, each area presents a unique pattern of diversity. In

summary, it appears that restoration efforts focused on creating conservation corridors to connect former mining and livestock areas and the establishment of protected strips of water bodies has been an appropriate strategy for the conservation of mammals.

Footprint (hand) ***Dasyprocta punctata*** **Footprint (foot)** ***Dasypus novemcinctus***

Footprint (foot) ***Cuniculus paca*** **Footprint (hand)** ***Procyon cancrivorus***

Footprint (hand) ***Didelphis marsupialis*** **Footprint (foot)** ***Conepatus semistriatus***

Figure 18. Mammal footprints observed in study area.

Six species were detected using camera traps (Figure 19). Camera trap sampling was completed for an equivalent of 48 camera-days (number of cameras multiplied by total days). Some of the species recorded with this method include *Panthera onca*, *Metachirus nudicaudatus*, *Dasypus novemcinctus*, and *Tamandua mexicana*. Through visual encounters (Figure 20), we recorded *Aotus griseimembra, Saguinus leucopus* and *Sciurus granatensis*, all three of which were observed in gold mining restoration areas. Guianan red howler monkey (*Alouatta seniculus*) was recorded in livestock restoration areas (Table 8).

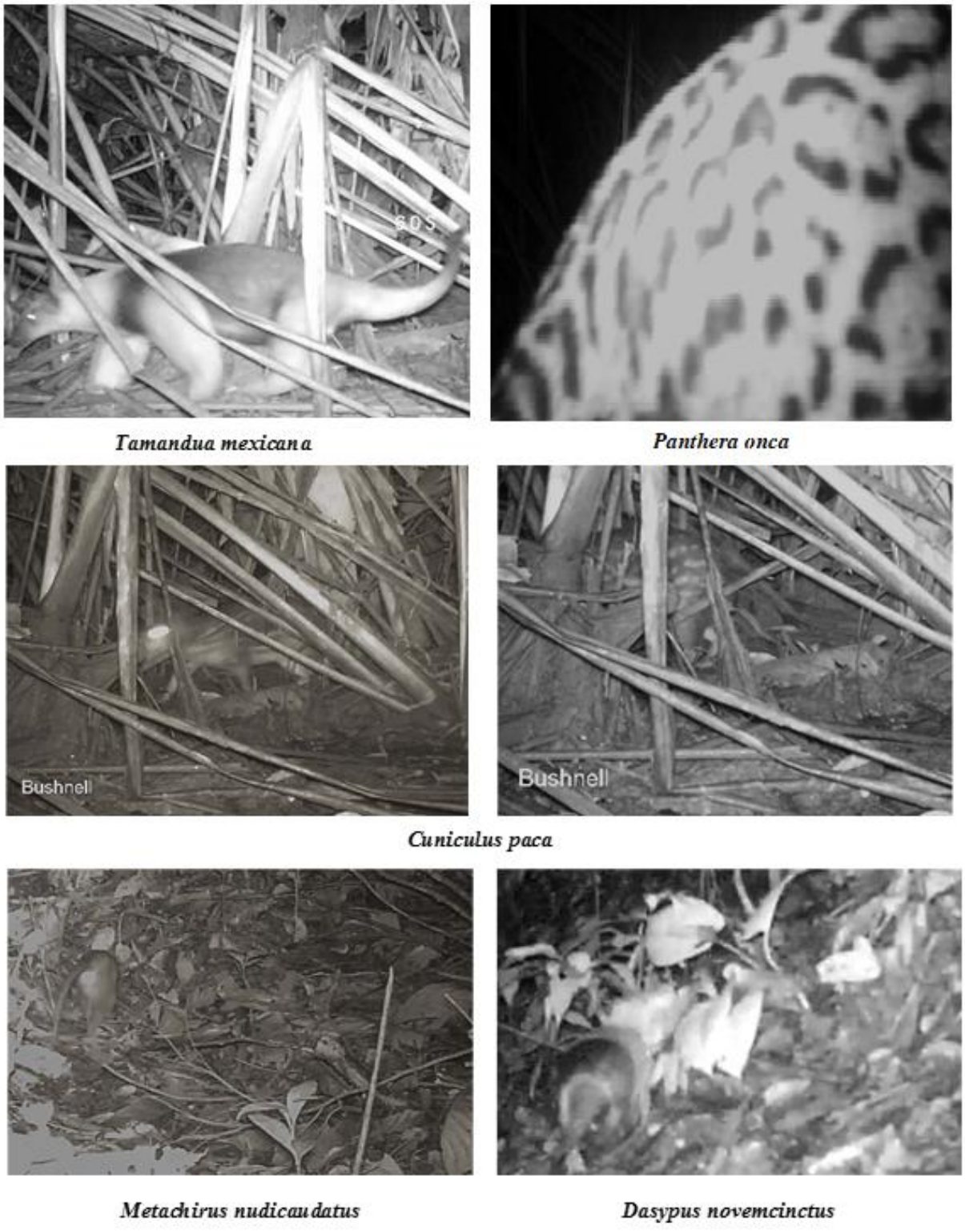
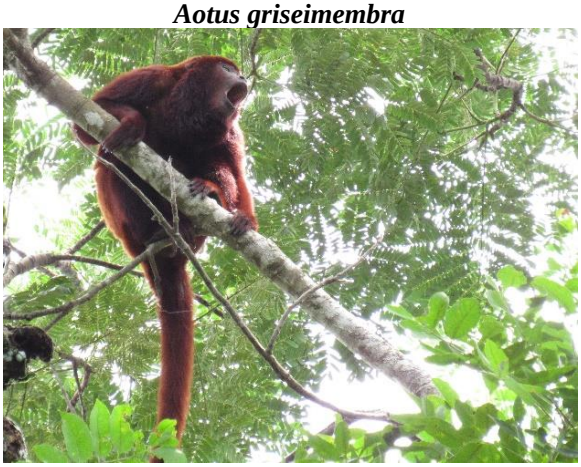


Figure 19. Camera trap recordings of mammals.

Aotus griseimembra

Saguinus leucopus



Alouatta seniculus

Sciurus granatensis

Figure 20. Direct observations of mammals in study area.

Data analysis

Functional traits

We identified seven types of mammalian locomotion types in the study area (Figure 21). Most species of observed in the study area are either of aerial understory (bats), arboreal (sloths, primates, squirrels) or scansorial movement habits, representing between 20% and 27% of species. Each other types of locomotion only represented 17% or less of species.

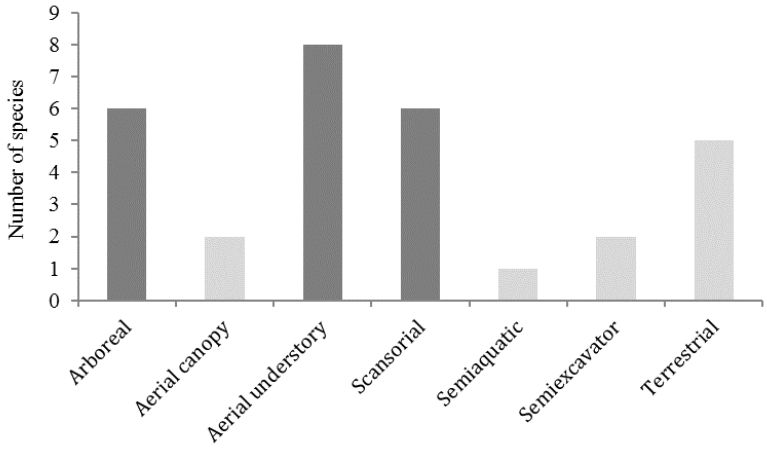


Figure 21. Locomotion types of mammals observed in the study area.

When assessed based on trophic classification, nine trophic guilds were identified from the mammal assemblage in the study area. Fruit consumption was the most common trophic guild in terms of the number of species represented and accounted for 50% of total mammal richness. This includes frugivore-omnivores (17%, e.g. *N. nasua*, *A. griseimembra*), frugivore-nomad (17%, e.g. *C. trinitatum*, *V. thyone*), frugivore-granivore (10%, e.g. *S. granatensis*, *D. punctata*) and frugivore-sedentary (6.7%, e.g. *Carollia* sp.). Carnivores (e.g. *Leopardus pardalis*, *Panthera onca*) represent 17% of total mammal richness (Figure 22).

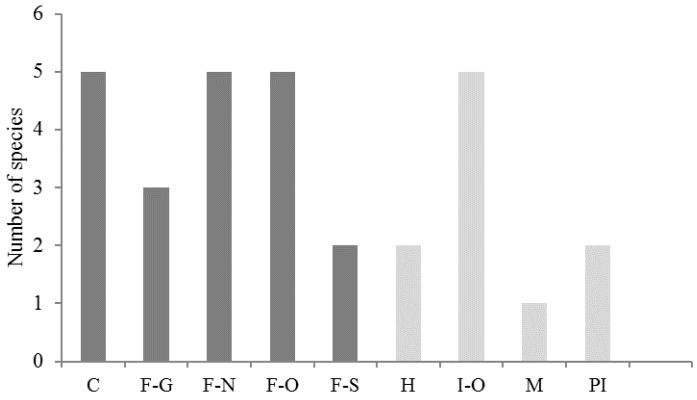


Figure 22. Trophic guild of mammals observed in study area. Carnivore (C), Frugivore-granivore (F-G), Frugivore-nomad (F-N), Frugivore-omnivore (F-O), Frugivore - sedentary (F-S), Herbivore (H), Insectivore-omnivore (I-O), Myrmecophage (M), Piscivorous (PI).

Eighteen functional guilds were defined from the species assemblage of mammals in the study area, taking into account feeding preferences and type of locomotion (Table 8). The gold mining restoration area had the highest number of functional guilds as well as the largest number of species. The influence of functional guild diversity on the structure and composition of communities is related to the niche complementarity hypothesis[31]. According to this hypothesis, a greater variety of niches (high niche divergence), caused by various mechanisms such as strong competition or high resource availability, leads to greater variation in the functional guilds present in a particular area.

[31] Trenbath, B.R. 1974. Biomass productivity of mixtures. Advances in Agronomy 26:177-210.

Endangered species

Based on the classifications provided in the Global Red List of Endangered Species (UICN 2014), most of the species identified in the study area were found to be of "Least Concern." This is due to the fact that they are relatively common throughout their range, occupy most habitats, and populations are generally considered stable, despite the fact that no estimates of population sizes are available. Likewise, they are excluded from the national red lists[32] and from Resolution No. 0192 of February 10, 2014, passed by the Ministerio de Ambiente y Desarrollo Sostenible de Colombia[33] (Table 9). However, the grey-handed night monkey (*Aotus griseimembra*) is listed as Vulnerable (VU) in national and international red lists[34].

Cebus albifrons versicolor, Panthera onca and *Lontra longicaudis* are listed as Near Threatened (NT) in large portions of their respective ranges, as a result of a large variety of anthropogenic threats, habitat loss, deforestation, and forest habitat fragmentation. Specifically, the neotropical otter has been identified as "Threatened" on regional and local Red Lists, indicating its declining populations. In light of this fact, authorities are considering whether to list the neotropical otter as Near Threatened, given that it nearly qualifies for the Threatened category under criterion A3cd[35].

The silvery-brown tamarin or tití gris (*Saguinus leucopus*) is endemic to Colombia, with distribution limited by the Magdalena and Cauca Rivers. With a range of up to 1,500 m.a.s.l, its geographic range is the smallest in its genus. It is listed in Appendix I of CITES, and under IUCN criteria it is considered to be "Endangered." Its conservation was declared an international priority at the 1990 International Primatological Society Congress in Japan, due primarily to ongoing threats including deforestation and live capture for the pet trade[36].

Table 9. Species of special conservation interest.

Species	Threat Category				Study Areas		
	IUCN	Res 0192	Red Book	CITES	Forest	Mining	Rangelands
Cerdocyon thous	LC	-	-	II	X	X	X
Panthera onca	NT	VU	VU	I		X	
Leopardus pardalis	LC	-	NT	I	X	X	
Choloepus hoffmanni	LC	-	-	III	X	X	
Cuniculus paca	LC	-	-	III	X	X	X
Dasyprocta punctata	LC	-	-	III		X	
Lontra longicaudis	NT	VU	VU	I		X	
Puma yagouaroundi	LC	-	-	II		X	
Aotus griseimembra	VU	VU	VU	II		X	
Cebus albifrons versicolor	NT	-	NT	II			

[32] Rodríguez-Mahecha, J.V., Alberico, M., Trujillo, F. & Jorgenson, J. 2006. Libro rojo de los mamíferos de Colombia. Serie libros rojos de especies amenazadas de Colombia. Conservación Internacional Colombia, Ministerio de Ambiente, Vivienda y Desarrollo Territorial. Bogotá, Colombia. 433p.
[33] Ministerio de Ambiente y Desarrollo Sostenible de Colombia. 2014. Resolución 0192 de 2014. Por la cual se establece el listado de las especies silvestres amenazadas de la diversidad biológica colombiana que se encuentran en el territorio nacional, y se dictan otras disposiciones. 36pp.
[34] Defler, T.R. 2003. Primates de Colombia. Serie de Guías Tropicales de Colombia 4. Conservación Internacional, Bogotá.
[35] Rodríguez-Mahecha, J.V., Alberico, M., Trujillo, F. & Jorgenson, J. 2006. Libro rojo de los mamíferos de Colombia. Serie libros rojos de especies amenazadas de Colombia. Conservación Internacional Colombia, Ministerio de Ambiente, Vivienda y Desarrollo Territorial. Bogotá, Colombia. 433p.
[36] Defler, T.R. 2003. Primates de Colombia. Serie de Guías Tropicales de Colombia 4. Conservación Internacional, Bogotá.

Species	Threat Category				Study Areas		
	IUCN	Res 0192	Red Book	CITES	Forest	Mining	Rangelands
*Saguinus leucopus**	EN	VU	VU	I		X	
Boa constrictor				I		X	
VU: vulnerable, NT: near threatened, EN: endangered, LC: Least concern. *Endemic specie							

Connectivity corridors for jaguar (*Panthera onca*)

The permeability matrix from this analysis (Figure 23) represents areas that could potentially be used for jaguar dispersal at regional (Figure 24) and local scales (Figure 25). At both scales analyzed, corridors for jaguar movement were identified that overlap with forest areas of the restoration project. The presence of jaguar was detected with camera traps, and the connectivity analysis displayed here shows that both native/preserved and managed/restored forests in the study area offer habitat and resources appropriate for this species. Maps and analysis presented here represent an extension of the results obtained by McRae and Kavanagh (2011)[37] at a finer geographic scale and specific to northern andean region of Colombia.

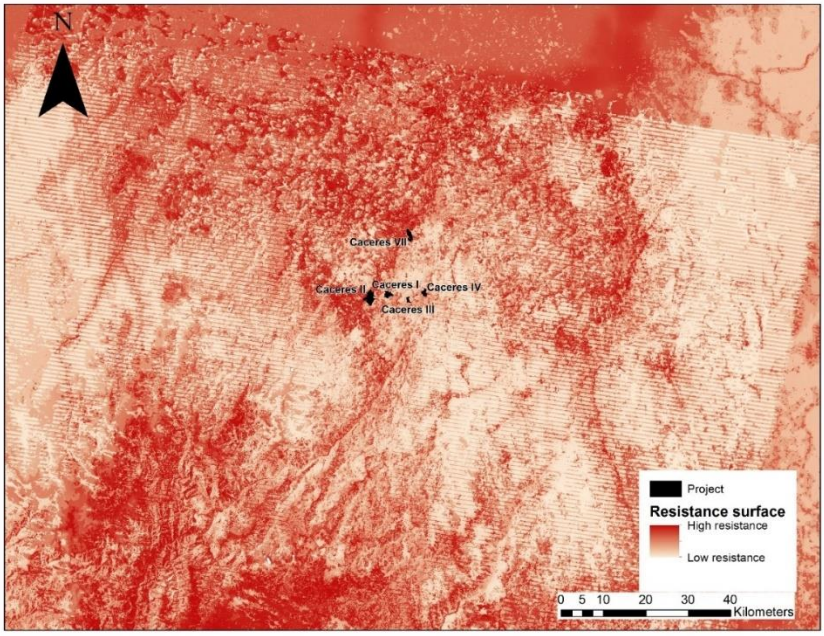


Figure 23. Permeability matrix for jaguar movement.

[37] McRae, B. H., & Kavanagh, D. M. (2011). Linkage Mapper Connectivity Analysis Software. The Nature Conservancy, Seattle WA.

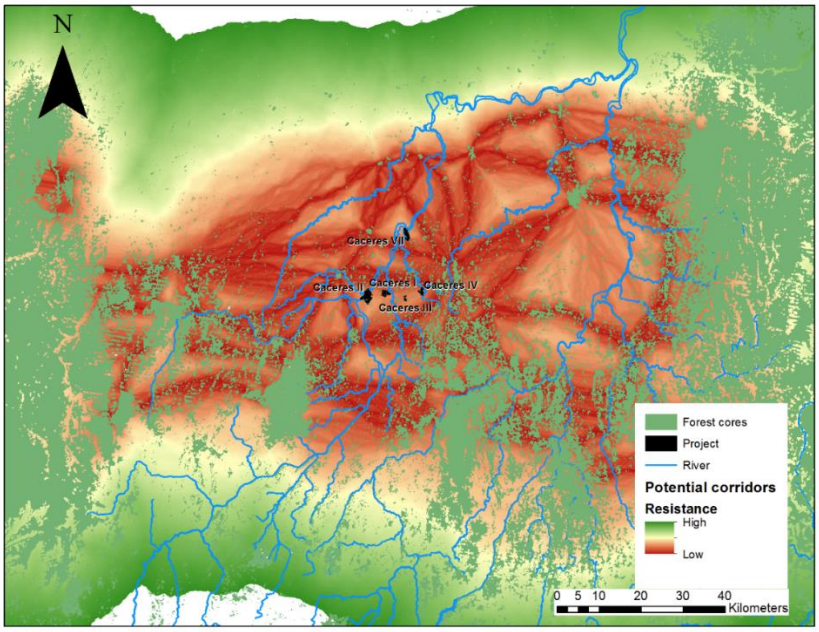


Figure 24. Regional-scale connectivity analysis for jaguar.

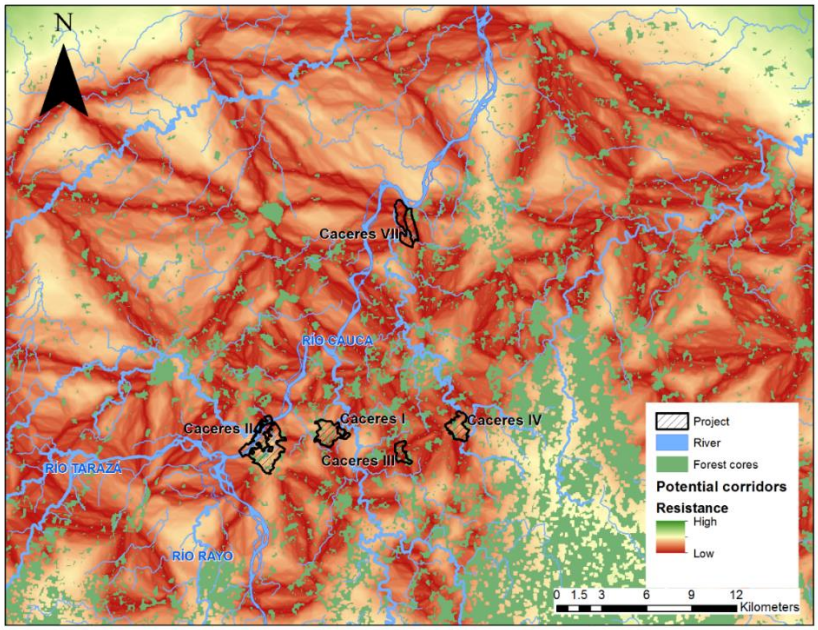


Figure 25. Local connectivity analysis for jaguar.

4.2. Direct social impact

Twenty-five surveys of workers directly involved in reforestation processes and twenty surveys of communities indirectly impacted by the project were conducted. The surveys of each group can be found in the supporting documentation ("Community Surveys" and "Employee Surveys").

4.2.1. Human Capital

Worker perceptions:

According to the surveys carried out, 96% of the workers have acquired knowledge and skills related to reforestation and sustainable management as a result of this project. Figure 26 presents the grade that workers assigned to the quality of the knowledge acquired. Of that group, 75% had a positive perception of this knowledge, and only 13% considered the knowledge to be average in quality. None of the workers thought that the knowledge was of bad quality. 12% of the workers did not grade the quality of the knowledge that they gained.

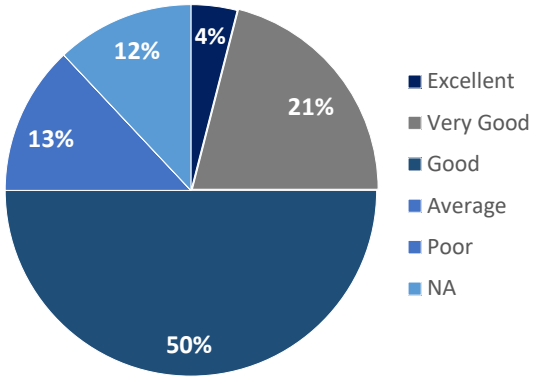


Figure 26. Workers' perceptions of the quality of reforestation and sustainable management knowledge acquired.

With respect to the use of tools and new equipment, 36% of respondents claimed to have used technology that they had not previously used. The majority of this group reported to have received training in the proper use of these instruments. Of these tools and equipment, workers highlighted the telescopic pruner (pole saw), the shovel used to bag in the nursery, the GPS, diametric tape, and the clinometer as being previously unknown or unused.

With respect to the generation of employment in the region, 84% of respondents believe that there is sufficient employment for those in the project area.

Community perceptions:

All community members surveyed confirmed that the quality of life of their immediate family (generally four or five persons) improved as a result of the recuperation of forested areas. The grading of these improvements based on the surveys is displayed in Figure 27.

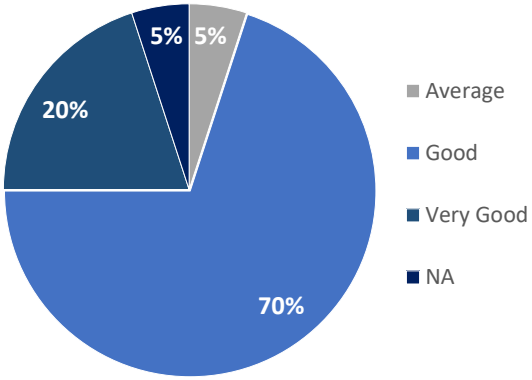


Figure 27. Assessment of the improvements in quality of life as a result of the project.

4.2.2. Financial Capital

Worker perceptions:

Though only 24% of those surveyed have worked full-time with ASORPAR, 68% confirmed that they earn more money working with the project (Figure 28) than in their previous work activities, which ranged in nature from various farming tasks to small-scale mining.

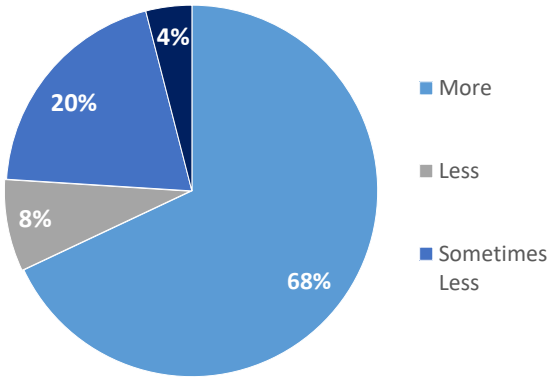


Figure 28. Earnings working with ASORPAR as compared with former employer(s).

The majority of workers that do not work full time (89%) work in other places to supplement their income. Of those workers, 37% work in small-scale mining. Despite the fact that these workers continue to dedicate a portion of their time to mining, it is important to highlight that new opportunities generated by other environmentally friendly and socially appropriate projects – similar to the project of ASORPAR – considerably reduce the amount of time available to be invested in high-impact activities like mining.

Community perceptions:

The main activities of those surveyed are related to agriculture, livestock, fishing, and mining. Some 90% of community members surveyed feel that the implementation of the project has improved the economy[38], and those that claim the opposite generally do not depend on the forest for their livelihood.

4.2.3. Social Capital

Worker perceptions:

76% of those surveyed are originally from the project area, and another significant portion, although not originally from this area, have been living there for around ten years. With respect to staff training, 92% of respondents confirm that they received training while working on the project, mainly related with management tools, personal safety, and filling of field forms. All found the training useful.

Community perceptions:

90% of those surveyed claim that their livelihoods or a portion of their assets are derived from surrounding forests. All confirm that they have greater or easier access to forest products now than at the start of the project. As shown in Figure 29, 80% of people consider this access to forest products as "good." With respect to this indicator, no "poor" or "average" ratings were received.

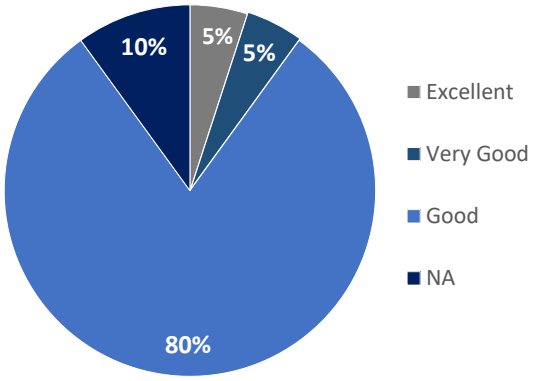


Figure 29. Survey results grading access to forest products after project implementation.

4.2.4. Natural Capital

With respect to the perception of the natural environment after project implementation, all those surveyed perceive that there is a greater number of plants and animals, improved water quality, and favorable climatic changes. The perception of climate change is displayed in Figure 30. The majority of people (92%) observe an improvement in soil conditions.

[38] 44% of people graded the improvement as "average" and 39% graded it as "good." However, this is considered a positive grade due to the fact that, as mentioned earlier, survey participants are not directly related with the planting work that generated income directly. This perceived improvement is mainly credited to the availability of forest-based resources, which are more difficult to perceive.

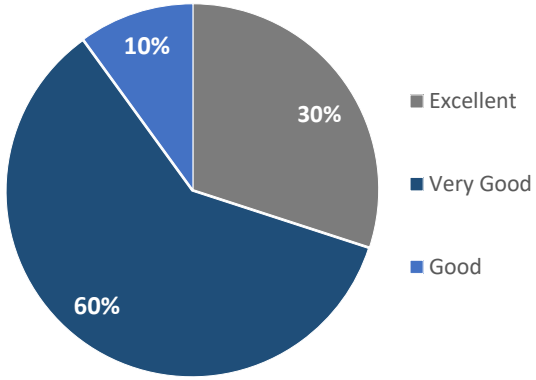


Figure 30. Community perceptions of improvements in climate after project Implementation.

5. Conclusions

Impact of Project Activities on the recovery and conservation of biodiversity

Flora

With respect to flora, recruitment of new species and overall greater diversity was observed to have occurred in the plots during the period evaluated. As such, the horizontal structure of the forest, assessed through the distribution of tree diameter ranges, suggests the passing of individuals from lower to higher diameter classes and the appearance of new individuals in lower diameter classes, which is directly associated with natural recruitment. These improvements are related with recovered soil quality and the creation of microclimates, both of which are a result of the implementation of project activities that have allowed for the gradual recuperation of ecosystem functioning in this area.

Fauna

Abundance and species richness of amphibian, reptile and mammals can be a good indicator of successful restoration[39]. We observed 10 amphibian, 11 reptile and 31 mammal species in the Restoration of Degraded Areas and Reforestation in Cáceres and Cravo Norte (Colombia) project direct-influence zone. Forest and gold mining areas were the most diverse. Native forest areas contained five amphibian, three reptile and 13 mammal species. The gold mining restoration area contain six amphibian, six reptile and 24 mammal species.

Restoration and conservation of forest canopy, understory and water bodies in the gold mining area appear to meet the minimum requirements for these species, allowing for the establishment of a greater variety of functional guilds and the presence of the highest vertebrate species richness in the study area. We can define 18 functional guilds among the assembly of mammals in the study area, taking into account feeding preferences and type of locomotion. As higher guild variation is related with a great variety of niches, the variety of functional guilds present in study area may indicate a high availability of resources for mammal species. In addition, high functional diversity is related to high ecosystem services supply; therefore, it can be concluded that forests within project study area may provide diverse ecosystem services and ecological functions. The observed number of species of both flying and non-flying fruit-eating mammals shows that seed dispersion is one of the most important ecosystem services provided by mammals in study area.

Seed dispersal by mammal species in study area may play an important role for the maintenance of plant diversity and ecosystem dynamics, because seeds are regurgitated or defecated after consumption in places far from their parents, where the environmental conditions can be better for germination the likelihood of recruitment is higher[40]. Bats have been identified as one of the best seed dispersers in terms of the amount of seeds and transport distance when compared to terrestrial mammals in terms of mobility, type of food, and retention time of the seeds they eat[41]. Even frugivorous-granivorous mammals like the red squirrel (*S. granatensis*) and some rodents (*P. semispinosus and D. punctata*) have an antagonistic relationship with the plant species because they

[39] Aguilar-Garavito M. & W. Ramírez (eds.) 2015. Monitoreo a procesos de restauración ecológica, aplicado a ecosistemas terrestres. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH). Bogotá D.C., Colombia. 250 pp.
[40] Dirzo, R., & Domínguez, C. 1986. Seed shadows, seed predation, and the advantages of dispersal, en A. Estrada y T.H. Fleming (eds.), Frugivores and seed dispersal. Junk Publishers, Dordrecht, pp. 237-250.
[41] Galindo, G., Guevara S. & Sosa V. 2000. Bat and Bird-Generated seed rain in at isotated trees pastures in a tropical rain forest. Conservation Biology. 14(6): 1603 – 1703.

predate the seeds and prevent potential germination[42] [43]. In this sense, the frugivorous bats and some medium-sized mammals detected in this study can facilitate and accelerate the process of natural regeneration through seed dispersal.

Most species detected are habitat generalists and form assemblages that replace original communities after an ecosystem interventions or degradation. Life history characteristics of amphibians restrict their distribution and activity due to high dependence on water and specific temperature conditions. Despite low diversity, the presence of *Dendrobatidae* and *Centrolenidae* species in study area could indicate recuperation of ecological functioning in restored areas that surround forests patches.

Mammals can be excellent indicators of successful restoration processes and/or natural regeneration. The presence of jaguar (*Panthera onca*) is a good indicator of ecosystem health and forest restoration. This species is typical of environments in good condition with little to no anthropogenic pressure[44] [45]. They have very low population densities and reproductive rates, which make them the first species to disappear as a result of disturbance processes and human exploitation. Also, they require large forest patches to persist and depend on an abundance of prey animals for their survival[46] [47].

On the other hand, endemic species (white-footed tamarin) or those under some degree of threat (*Lontra longicaudis*, gray-handed night monkey, *Cebus albifrons versicolor*) have more specialized ecological niches and thus are more susceptible to habitat disturbance. Their presence as well is key to assessing the success of restoration[48]. These species require that specific conservation actions be taken, due to their risk of extinction and often limited distributions.

Some species including *Carollia perspicillata* and *Carollia castanea* bats, are typical of degraded environments[49]. In this study, these species were the most abundant bats, accounting for 48% of all catches. This may indicate that restored areas are still in early stages of succession, as species with more specialized niches will likely begin to colonize restoration areas as they approach more natural forest conditions.

Impact of project activities on the community

ASORPAR's employees and temporary workers have positive perceptions with regards to the social benefits generated by the project. Highlighted among these impacts was the acquisition of new skills from the training received during project participation (75% report to have acquired new knowledge). In addition, these workers perceive that project participation offered higher economic returns than the income traditionally available from typical economic activities of this region in which they took part

[42] Dirzo, R., & Domínguez, C. 1986. Seed shadows, seed predation, and the advantages of dispersal, en A. Estrada y T.H. Fleming (eds.), Frugivores and seed dispersal. Junk Publishers, Dordrecht, pp. 237-250.
[43] Martínez-Ramos, M. 2008. Grupos funcionales, en Capital natural de México, vol. I: Conocimiento actual de la biodiversidad. Conabio, México, pp. 365-412.
[44] Dunn, R. R. (2004). Recovery of faunal communities during tropical forest regeneration. Conservation Biology, 18(2), 302-309.
[45] Medellín, R.A, Equihua, M. & Amin, M.A. 2000. Bat diversity and abundance as indicators of disturbance in neotropical rainforests. Conservation Biology 14(6):1666-1675.
[46] Tirira, D. 2007. Guía de campo de los mamíferos del Ecuador. Ediciones Murciélago Blanco. Publicación especial sobre los mamíferos del Ecuador 6. Quito. 576pp.
[47] Payán Garrido, E., & Soto Vargas, C. (2012). Los felinos de Colombia (No. Doc. 26068) CO-BAC, Bogotá).
[48] Young, B.E. (2007) Distribución de las especies endémicas en la vertiente oriental de los Andes en Perú y Bolivia. NatureServe, Arlington, Virginia, EE UU.
[49] Aguilar-Garavito M. & W. Ramírez (eds.) 2015. Monitoreo a procesos de restauración ecológica, aplicado a ecosistemas terrestres. Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH). Bogotá D.C., Colombia. 250 pp.

(mainly mining and caring for properties). Finally, these people have a positive view of the work offered to those living near the project area, highlighting the fact that there are sufficient opportunities to access project activities.

Communities settled in the zones that surround the project area see the restoration activities of the project as highly positive. Survey participants especially note an improvement in quality of life of themselves and their families due to the recovery of forest area, which has resulted in a greater availability of natural capital, improved water quality, and resulted in favorable changes in microclimates. The new conditions generated by the implementation of project activities allow for greater and easier access to the products and benefits offered by forest ecosystems, which serves a great benefit to the community given that 90% of those surveyed reported that a grand part of their livelihoods and assets are derived from these forests.

6. Annexes

ANNEX I
CRAVO NORTE INFORMATION

Biodiversity

Photographic records taken by employees can be found as a supporting document in the Project folder "*Biodiversity pictures_Cravo Norte*". Table 10 and Table 11 present the species list of fauna and flora observed by the employees who spend the majority of their time in the Project area. The complete monitoring assessment (register and identification) will be carried out in the next monitoring report.

Table 10. List of flora species recorded by employees staying in the Project Area.

Scientific name	Common name
Cariniana pyriformis	Abarco
Acacia mangium	Acacia
Copaifera pubiflora	Aceite
Bowdichia virgilioides	Alcornoque
Hymenaea courbaril	Algarrobo
Not identified	Apamate
Not identified	Cachicamo
Not identified	Camoruco
Not identified	Canillo de Venado
Cassia moschata	Cañafistulo
Not identified	Caracaro
Cedrela odorata	Cedro
Not identified	Cedro Amargo
Not identified	Chaparro Bobo
Curatella americana	Chaparro de Agua
Dipteryx oleifera	Choibá
Not identified	Clavellino
Swartzia sericea, (Cochlospermum orinocense, Acosmium nitens)	Congrio
Copaifera officinalis	Copaiba o Aceite
Tapirira guianensis	Fresno (Patillo)
Not identified	Guarataro
Tabebuia serratifolia	Guayacan polvillo (Yellow flower)
Not identified	Jobo
Not identified	Laurel
Not identified	Leche Miel
Arbutus unedo	Madroño
Not identified	Maiz Tostado
Melicoccus bijugatus	Mamoncillo
Manguifera indica	Mango
Not identified	Manirote
Glaricidia sepium	Matarratón

Scientific name	Common name
Gmelina arborea	Melina
Licania pyrifolia	Merecure
Not identified	Merey
Cordia alliodora	Nogal (Pardillo negro)
Not identified	Olla de Mono
Not identified	pardillo
Not identified	Platanote
Tabebuia rosea	Roble (Apamáte)
Caraipa llanorum	Saladillo Rojo
Vochysia lehmanii	Salado Blanco (Boqui)
Not identified	Tamarindo
Schizolobium parahybum	Tambor
Bombacopsis quinata	Tolúa (cedro)
Guarea trichiliodes	Trompillo
Piptadenia peregrina	Yopo
Not identified	Zarrapio

Table 11. Lists of fauna species recorded by employees staying in the Project Area.

Mammals	
Scientific name	**Common name**
Dasypus novemcinctus	Cachicamo O Armadillo
Not identified	Cajuche Marrano
Not identified	Chacharo
Not identified	Chigüiro
Not identified	Danta
Not identified	Jaguar
Not identified	Lapa
Not identified	Marrano Montañero
Not identified	Mono Aullador
Not identified	Murciélagos
Not identified	Oso Palmero / Oso Hormiguero
Not identified	Puma
Not identified	Tigrillo /Cunaguaro
Not identified	Vaca Criolla
Odocoileus virginianus	Venado
Not identified	Zorro
Not identified	Zorro Guate

Reptiles and Amphibians	
Scientific name	**Common name**
Not identified	Cachirri O Babilla
Not identified	Caimán Amarillo
Not identified	Caimán Negro
Not identified	Higuana
Not identified	Lagartija
Not identified	Mato

Reptiles and Amphibians	
Scientific name	**Common name**
Not identified	Rana Blanca
Not identified	Rana Vaquera
Not identified	Sapo
Not identified	Serpiente Anaconda
Not identified	Serpiente Boa
Not identified	Serpiente Cascabel
Not identified	Serpiente Cazadora
Not identified	Serpiente Cuatro Narices
Not identified	Serpiente Lora
Not identified	Serpiente Tigra
Not identified	Serpiente Verdigalla
Not identified	Terecay
Not identified	Tortuga

Fishes	
Scientific name	**Common name**
Not identified	Bagre
Not identified	Barbiancho
Not identified	Blanco
Not identified	Cachama
Not identified	Caribe
Not identified	Coporo
Not identified	Payara
Not identified	Pez Amarillo
Not identified	Rambusapo
Not identified	Raya
Not identified	Roncho
Not identified	Sapuara
Not identified	Sierra Cuca
Not identified	Temblador
Not identified	Tonina
Not identified	Valenton
Not identified	Yaque

Birds	
Scientific name	**Common name**
Not identified	Aguila
Not identified	Alcaravan
Not identified	Araguato
Not identified	Arauco
Not identified	Arrendajo
Not identified	Chenchena
Not identified	Chiricoca
Not identified	Chiriguare
Not identified	Codua
Not identified	Conoto

Birds	
Scientific name	**Common name**
Not identified	Corocora
Not identified	Gaban
Not identified	Garza
Not identified	Garza Morena
Not identified	Garza Paleta
Not identified	Guacamaya
Not identified	Guacharaca
Not identified	Loro
Not identified	Maracana
Not identified	Mirla
Not identified	Ñenguere
Not identified	Oripopo
Not identified	Palometas
Not identified	Pato Carretero
Not identified	Pato Ganso
Not identified	Pato Gorreto
Not identified	Pato Guire
Not identified	Pato Real
Not identified	Pato Yaguazo
Not identified	Pavo De Monte
Not identified	Perdiz
Not identified	Rapiño
Not identified	Rey Samuro
Not identified	Tarotaro
Not identified	Tautaco
Not identified	Zamurita
Not identified	Zamuro

Social Impacts

Eleven surveys of workers directly involved in reforestation processes and seven surveys of communities indirectly impacted by the project were conducted. The surveys of each group can be found in the supporting documentation ("Community Surveys" and "Employee Surveys").

Human Capital

Worker perceptions:

According to the surveys carried out, all workers have acquired knowledge and skills related to reforestation and sustainable management as a result of this project.

With respect to the use of tools and new equipment, 64% of respondents claimed to have used technology that they had not previously used. The majority of this group reported to have received training in the proper use of these instruments. Of these tools and equipment, workers highlighted pluviometer, the shovel used to bag in the nursery and the diametric tape as being previously unknown or unused.

With respect to the generation of employment in the region, 82% of respondents believe that there is sufficient employment for those in the project area.

Community perceptions:

Some 57% of the community members surveyed confirmed that the quality of life of their immediate family (generally three or five persons) improved as a result of the project activities.

Financial Capital

Worker perceptions:

Though only 18% of those surveyed have worked full-time with ASORPAR, 55% confirmed that they earn more money working with the project (Figure 28) than in their previous work activities, which ranged in nature from various farming tasks to construction and fishing.

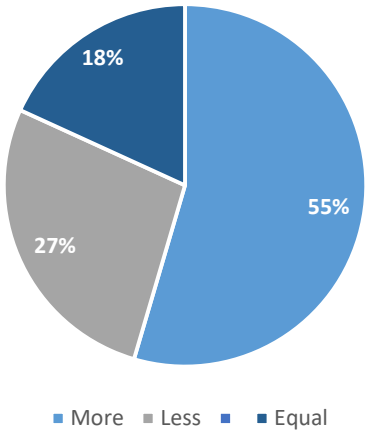


Figure 31. Earnings working with ASORPAR in Cravo Norte as compared with former employer(s).

The majority of workers that do not work full time (89%) work in other places to supplement their income. Complementary activities vary widely in the region, where most of the surveyed workers affirmed to work also in livestock, pig-farming, agriculture, welding and even politics.

Community perceptions:

The main activities of those surveyed are related to agriculture, livestock, transport, and commerce. All community members surveyed feel that the implementation of the project has improved the economy.

Social Capital

Worker perceptions:

Some 82% of those surveyed are originally from the project area. With respect to staff training, all respondents confirm that they received training while working on the project, mainly related with nurseries, management tools, personal safety, and the environment. All found the training useful.

Community perceptions:

All surveyed claim that their livelihoods or a portion of their assets are derived from surrounding forests. Some 87% confirmed that they have greater or easier access to forest products now than at the start of the project.

Natural Capital

With respect to the perception of the natural environment after project implementation, all those surveyed perceive that there is a greater number of plants and animals, and favorable microclimatic changes. The majority of people (67%) observe an improvement in soil conditions.

Climate

Landsat images from the project area are presented in **¡Error! No se encuentra el origen de la eferencia.**, **¡Error! No se encuentra el origen de la referencia.** and **¡Error! No se encuentra el origen de la referencia.**. The changes between the years corresponds with changes in flooded areas. The project area is susceptible of temporal inundations due to its location. On the other hand, the figures show that there was not negative impact in the existent forest and that there were not new areas planted between 2010 and 2014.

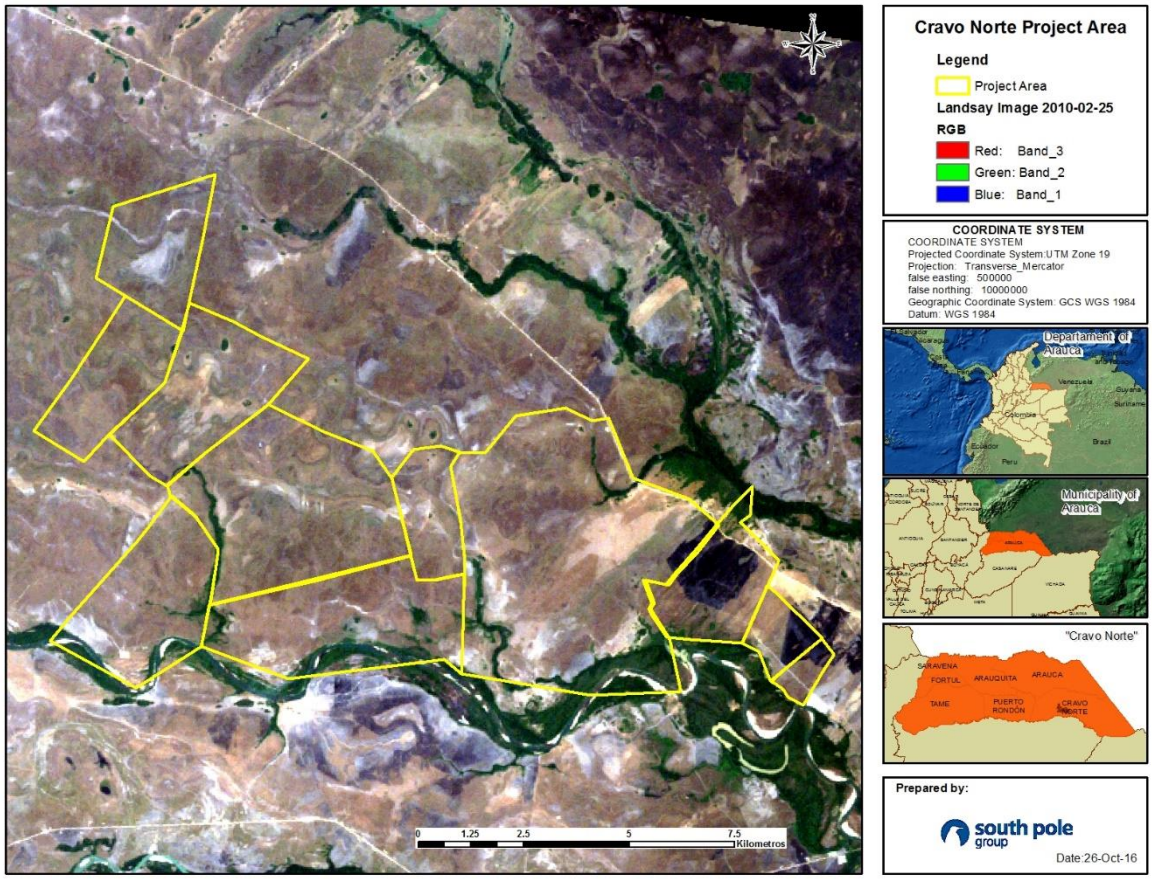


Figure 32. Map of the project area in 2010.

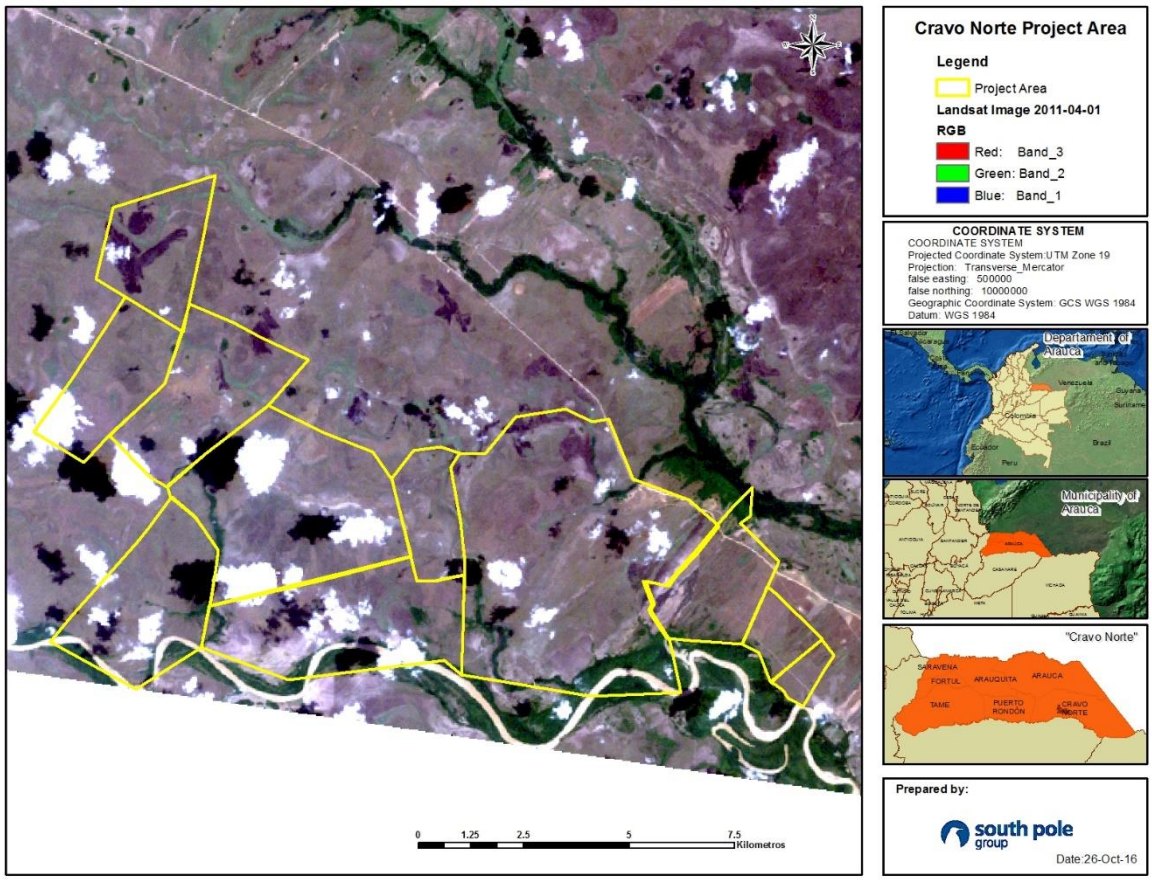


Figure 33. Map of the project area in 2011.

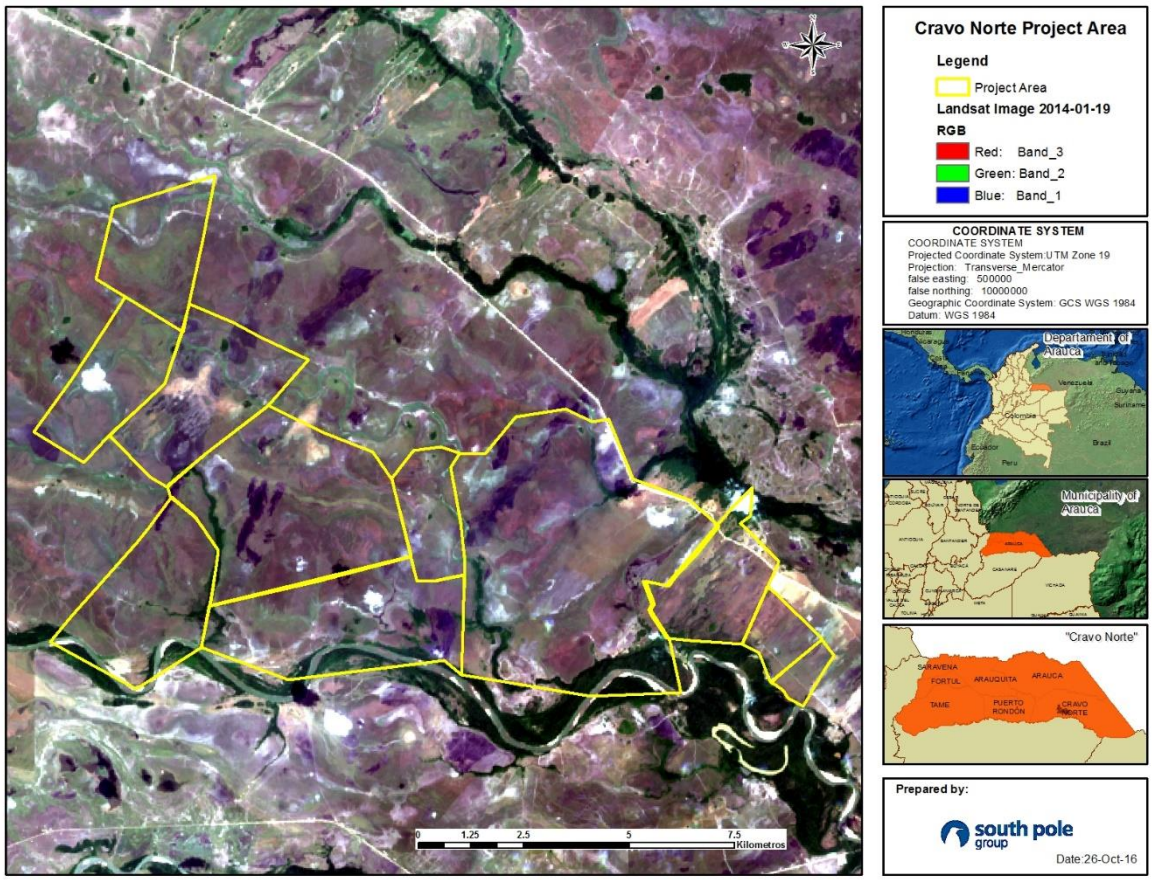


Figure 34. Map of the project area in 2014.

ANNEX II

Survey conducted on workers (translation)

NOTE: Please respond with one of the following: 1 (Poor), 2 (Average), 3 (Good), 4 (Very Good), 5 (Excellent).

ITEM TO EVALUATE	DESCRIPTION	**Company:**
		Name:
		Position:
		ID Number:
Human Capital	**Monitoring of direct impacts (workers)**	
	Have you acquired new knowledge concerning reforestation and sustainable land management?	
	Have you used tools or equipment new to you while working with Asorpar? Which?	
	If you have used machinery, did you receive training concerning correct use?	
	In the project area, is there typically enough work for the people of the region?	
Financial Capital	What have you done for work?	
	What was your work before being contracted by Asorpar?	
	Do you work full-time with Asorpar? (Yes/No)	
	Do you have other work on the side?	
	Do you earn more or less than in your previous work?	
Social Capital	Have you received training during your time with Asorpar?	
	What type of training?	
	Did it seem useful?	
	Are you local to the project area?	
	Are your coworkers local to the project area?	
Natural Capital	Have you seen more plant and animal species?	
	Have you seen an improvement in water quality in the project area?	
	Have soil conditions improved?	
	Have you noticed favorable changes in weather/climate?	

Survey conducted on workers (Spanish version)

ITEM A EVALUAR	DESCRIPCIÓN	Empresa:
		Nombre:
		Cargo:
		N° Cedula:
Capital humano	**Monitoreo de impactos directos (empleados)**	
	¿Ha adquirido conocimientos sobre reforestación y manejo sustentable?	
	¿En su trabajo con Asorpar ha usado equipos y herramientas que no conocía? ¿Cuáles?	
	¿Si ha usado maquinas, ha recibido capacitación sobre su uso correcto?	
	En el área del proyecto, ¿normalmente hay suficiente trabajo para la gente de la región?	
Capital financiero	¿En qué áreas ha trabajado?	
	¿En qué trabajaba antes de ser contratado por Asorpar?	
	¿Trabaja tiempo completo para Asorpar? Si/No	
	¿Trabaja en otra cosa aparte?	
	¿Ganaba más o menos en su empleo anterior?	
Capital social	¿Ha recibido alguna capacitación en su trabajo con Asorpar?	
	¿De qué se trataba?	
	¿Le pareció útil?	
	¿Usted es local del área del proyecto?	
	¿Sus compañeros de trabajo también pertenecen al área del proyecto?	
Capital natural	¿Ha visto más especies de animales y plantas?	
	¿Ha observado una mejora en la calidad del agua en el sitio del proyecto?	
	¿Han mejorado las condiciones del suelo?	
	¿Ha notado cambios favorables en el clima?	

ANNEX III

Survey provided to the community (translation)

NOTE: Please respond with one of the following: 1 (Poor), 2 (Average), 3 (Good), 4 (Very Good), 5 (Excellent).

ITEM TO EVALUATE	DESCRIPTION	Name: ID Number:
Human Capital	**Monitoring of direct and indirect impacts (communities)**	
	How many people make up your immediate family?	
	Do you feel as though the quality of life of you and your family has improved due to the recovery of forested areas?	
Financial Capital	What is your main economic activity?	
	Has the project implementation improved your economic situation? For example, in terms of greater availability or offering of forest products.	
Social Capital	Do you derive all or part of your livelihood or assets from nearby forests? (For example, firewood, food, medicine, etc.)	
	Since the beginning of project implementation, have you had greater or easier access to forest products?	
Natural Capital	Since the beginning of project implementation, have you seen more plant or animal species in the area?	
	Have you observed an improvement in water quality in the project area?	
	Have soil conditions improved?	
	Have you noticed favorable changes in weather/climate?	

Encuesta realizada a la comunidad

ITEM A EVALUAR	DESCRIPCIÓN	Nombre: N° Cedula:
Capital humano	**Monitoreo de impactos directos e indirectos (comunidades)**	
	¿Cuántas personas componen su núcleo familiar?	
	¿Considera que su calidad de vida y la de su familia han mejorado gracias a la recuperación de las áreas boscosas?	
Capital financiero	¿Cuál es su actividad económica principal?	
	¿Considera que la implementación del proyecto ha mejorado su economía), por ejemplo, en términos de una mayor oferta de productos del bosque?	
Capital social	¿Deriva su sustento o parte de el de los bienes que proporcionan los bosques aledaños? (por ejemplo: leña, alimentos, medicinas)	
	Desde que el proyecto comenzó su implementación, ¿Ha tenido un mayor y fácil acceso a los productos del bosque?	
Capital natural	Desde que el proyecto comenzó su implementación, ¿Ha visto más especies de animales y plantas en la zona?	
	¿Ha observado una mejora en la calidad del agua en el sitio del proyecto?	
	¿Han mejorado las condiciones del suelo?	
	¿Ha notado cambios favorables en el clima?	

NOTA: La calificación puede ser 1 malo, 2 regular, 3 bueno, 4 muy bueno y 5 excelente