CONTENTS

ILLUSTRATIONS

TABLES

4.2 BIOTIC ENVIRONMENT

Presented below are the terrestrial ecosystems, sensitive-strategic ecosystems and/or protected zones, flora, fauna, hydro biological groups and ecologic connectivity.

4.2.1 ECOSYSTEMS

Biomes are the set of terrestrial ecosystems related by their functional and structural features. They differ by their structural vegetal characteristics and climate factors (rainfall and temperature) relevant in the development of vegetal structures.

According to the marine terrestrial ecosystem map for Colombia (IDEAM, IIAP, SINCHI, IAvH, and IGAC, 2008) scale 1:500.000 Colombia has (3) large biomes: big tropical desert biome, big dry tropical forest biome and big biome of tropical damp forest. Each represented by their own zonobiomes, helobiomes, halo biomes and orobiomes.

The studied area is located inside the Big Tropical Damp Forest biome. This biome covers an extension of 105.632.472 ha covering the warm thermic damp flat lands, with an annual rainfall average of over 2000 mm in elevations ranging from 0 to 500m.a.s.l. Located in low areas North East of Antioquia's region, Magdalena River middle valley and, low Valle and Nechi River zone.

This big biome vegetation equates to the tropical rainfall jungle, the damp tropical forests, very rainy damp low grounds, low montane and premontane from Holdridge (1967), sub-tropical from Chapman (1917) and to the tropical forest rain-loving montane and foothill from Unesco classification (1973) (Hernandez and Sanchez, 1992).

This biome is dominated by the following ground covering: natural forests (39, 0%), grass lands (33%) secondary vegetation (22%) and annual or transitory crops (6%) (Toro, 2009) (See Illustration 4.2-1).

In regards of natural forests, though their proportion is few and their reduction accelerated, there exist important jungle masses because of their extension, heterogeneity, wood and biodiversity in general; equally, these are areas with higher pressure due to the deforestation caused by the widening of agriculture and livestock, exploitation of woods, and activities developed by farmer groups settled in the region besides the migratory flow from other states of the country.

On the other hand, the oriobiome where the study area is located is the Andean low oriobiome, with an extension of 14'035.898ha characterized by tempered-dry, tempered damp, and tempered high damp climates and, in some areas warm damp, warmer high damp climates in altitudes ranging from 500 to 1800 m.a.s.l, with temperatures above 18 degrees Celsius.

4.2.1.1 LIVE ZONES

Live zones can be considered as a type of dominant vegetation or a set of associations closely related biotic and abiotic with a significant role on their comportment (Holdridge 1982) (see illustration 4.2-1)

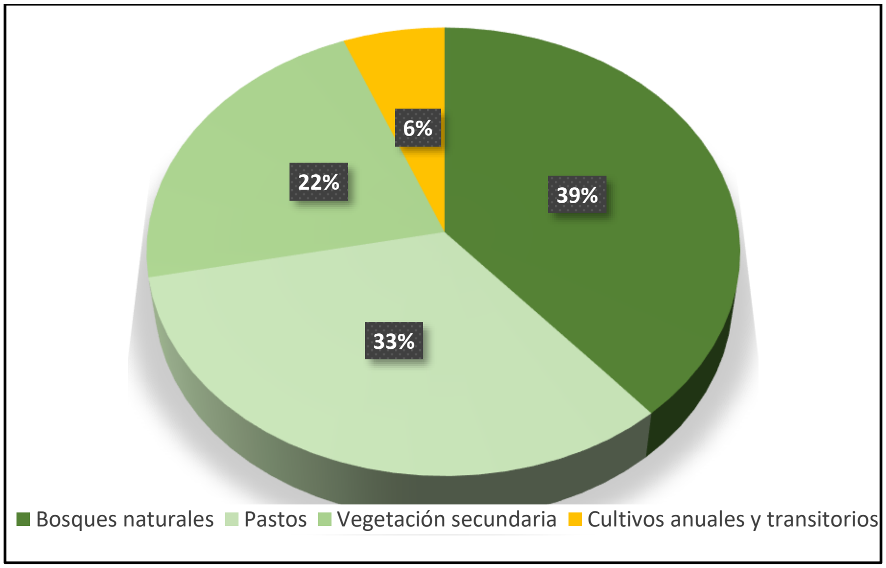


Illustration 4.2-1 Percentage of the dominant coverings in the big biome of tropical damp forest.
Source: Toro, 2009.

In the illustration 4.2-2, Illustration 4.2-3, table 4.2-1 and table 4.2-2 can be identified in detail the actual ecosystems in the studied area such natural forests and secondary vegetation.

Table 4.2-1 Actual biomes area in the big tropical damp forest biome.

BIG BIOME	TYPE OF BIOME	BIOME	AREA (ha)	%
Tropical damp forest	Orobiomes	Low Andean Oriobiome	14.035.898	13,29

Source: Marine Terrestrial Ecosystem for Colombia (Ideam, IIAP, SINCHI, IAvH e IGAC, 2008).

Table 4.2-2. Live zones in El Pescado project.

RANGE	DESCRIPTION	ALTITUDE (mm)	PRECIPITATION	TEMPERATURE (°C)
bh-T	Tropical damp forest	0-1000	2000-4000	24-35

Source: Live zones system Holdridge, 1982.

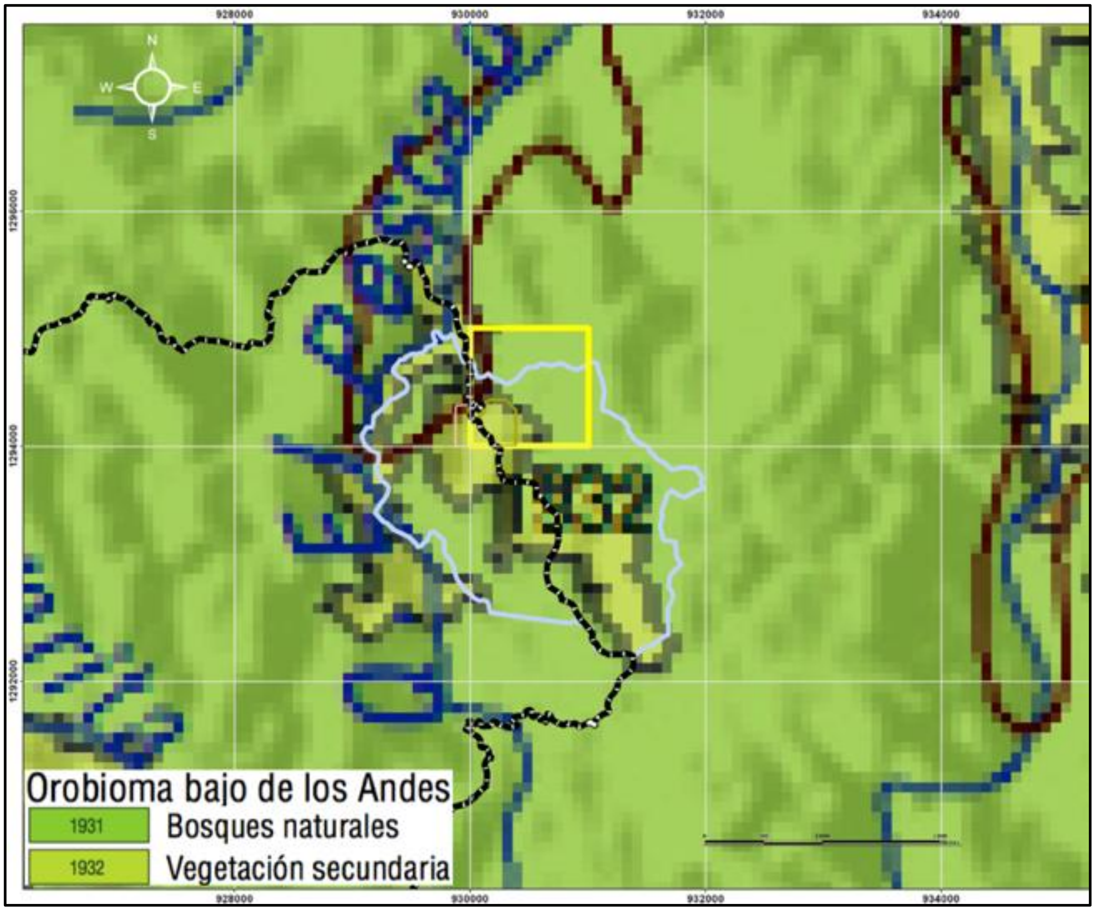


Illustration 4.2-2. Low Andean Orobiome in the area of study.
Source: marine terrestrial ecosystem map for Colombia (IDEAM, IIAP, SINCHI, IAvH, e IGAC, 2008)

There are 11 live zones located In Antioquia's department (Espinal, 1985). The area subject to study is located in the tropical damp forest (bh-T) (see illustration 4.2-4), according to Holdbridge's spatial geo-processing for the climatological component variables and geomorphological. According to Holdbridge's diagram the tropical damp forest has an annual precipitation average ranging 2000 to 4000 mm, an average temperature above 24 degrees Celsius and heights below 1000m.a.s.l (see table 4.2-2).

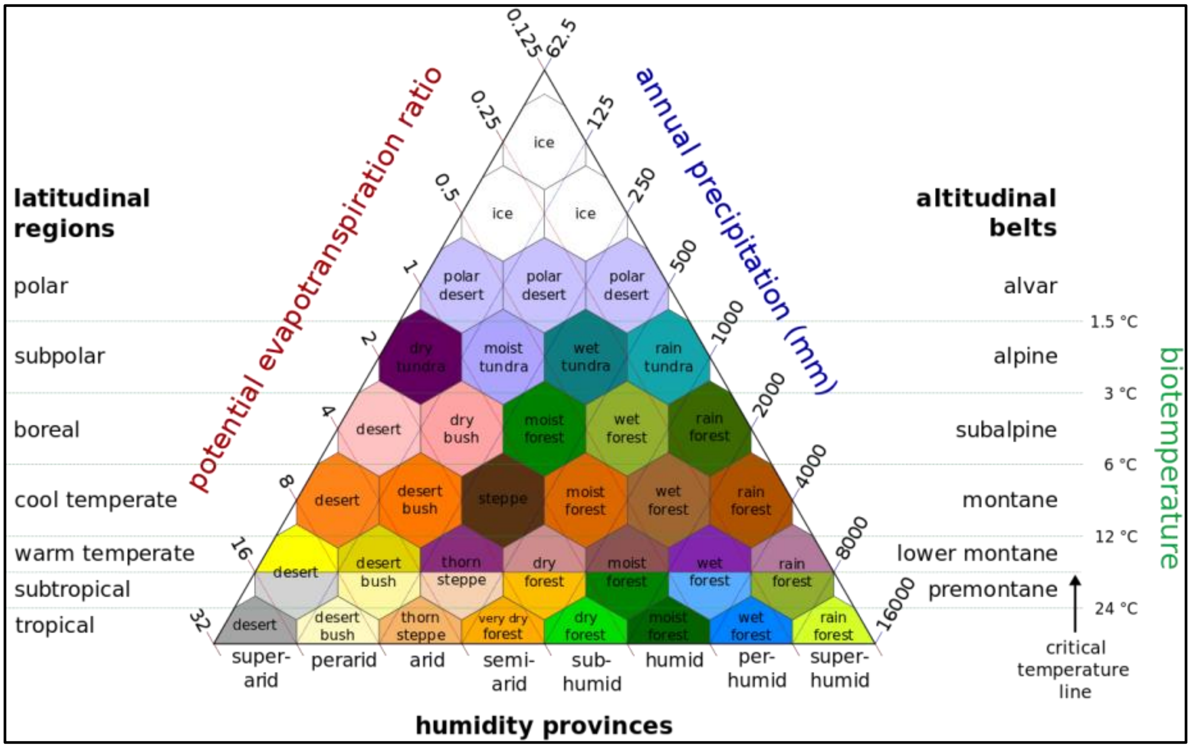


Illustration 4.2-3. Holdbridge's diagram for live zones classification.
Source Holdbridge's live zones system, 1982

According to the bioclimatology component, the Holdbridge's diagram variables that represent the studied area like bh-T are presented below.

Precipitation

The closest pluvio-metric stations are El Bosque, Palma de Coco, El Oriente, Las Brisas and El Londre. Getting an annual precipitation average ranging 2884 – 3946mm/year, with a rainy seasonal period between May and October (529-556 mm) and a dry season between January and July (191-452mm).

Temperature

The annual average temperature corresponds to values between 24,6 C and 26,6 C, where lower temperatures correspond to higher altitude zones and the maximum temperatures are related to the valleys from the rivers.

Humidity

The relative humidity presents a bio mode cycle with peaks in the months of May-June and November and minimal in February and July with values that vary approximately in 83-87%.

Slopes

There are slopes ranging from 0-100% across flat areas near to the drains (0-15%) and the zone where the campsite will locate to the steepest areas where slopes between 50-100% dominate.

Illustration 4.2-4. Bio-zonification climate map of the area of study.
Source: INGEX, 2016.

4.2.2 SENSITIVE STRATEGIC ECOSYSTEMS, AND/OR PROTECTED AREAS

The protected areas include ecosystems that guarantee the existence of necessary ambient for the humanity and the strategic zones for the region that are used in a sustainable way through the time.

4.2.2.1 SENSITIVE STRATEGIC ECOSYSTEMS

Strategic ecosystems guarantee the supply of essential environment goods and services, among others, for the sustainable development of the country. Those ecosystems are characterized by keeping the basic ecological equilibrium and processes such as climate regulation, waters, green-house effect gas storage, water, and air and depuration functions, alimentary resources generation like fishing and biodiversity conservation (MADS). The most sensitive ecosystems are those susceptible and with higher risk of being intervened by anthropic activities such as stockbreeding, agriculture, human settlements and artisanal mining, among others.

Historically, ecosystems alterations have been produced by changing the use of the land, modifying its vegetal covering, filling damp zones that dim floods, changing rivers regular flow and deforesting hillsides; which increases rivers erosion and sedimentation, producing among others, avalanches, landslides, floods and mass removal; joining to the human settlement building and the development of productive activities in areas that may represent a thread, increasing the ecosystems and population vulnerability, by creating risky conditions (lAvH, 2016).

Strategic ecosystems have been supported nationwide, such as paramos, forests, savannahs or basins; which play an important role in the sustainability of natural fundamental processes, socio-economical, ecological or from other sorts; such as, water or food sources. Strategic ecosystems must be understood as distinguishable parts from the territory where natural functions are concentrated in which depend significantly on goods and natural services relevant for the maintenance of the society and nature.

To be able to identify those ecosystems and their importance inside the area of study, they were not treated separately but to the contrary, sensitive strategic ecosystems were blended, obtaining combinations: strategic and sensitive; strategic non-sensitive or strategic and no strategic and/or sensitive.

The ecological identifier or locator criteria of those ecosystems in the area of study are the "existent natural fragments of forests" due to those ecosystems in the area of study being permanently under risk, threat, susceptibility or sensibility of being intervened by the expansion of the extensive stockbreeding border presented in the area. Those ecosystems represent valuable strategic services such as climate stabilization or hydric balance, carbon storage, protection to the hydric function due to the big amount of hydric springs inside those coverings, biodiversity conservation (Franquis & Infante, 2003), food chains of larger complexity, ecologic connectivity, among others.

Those forest coverings are an important ecosystem for the preservation of the biodiversity in the area because they represent the biggest index of biodiversity and species wealth, as it will be later shown in the flora, fauna and hydro biologic group components.

As previously mentioned, forest coverings are relevant for establishing, handling, and following conservation strategies during and after the project realization.

4.2.2.2 PROTECTED AREAS

The area of study and the mining project are located inside the Magdalena River National Forest Reserve (hereinafter MRNFR) (see illustration 4.2-5), declared by law 2 year 1959 and broaden by order 0111 year 1959. Such national reserve has 2'155.590 ha, which means approximately 37% over the initial area declared by effect of subtractions made (MADS, 2011).

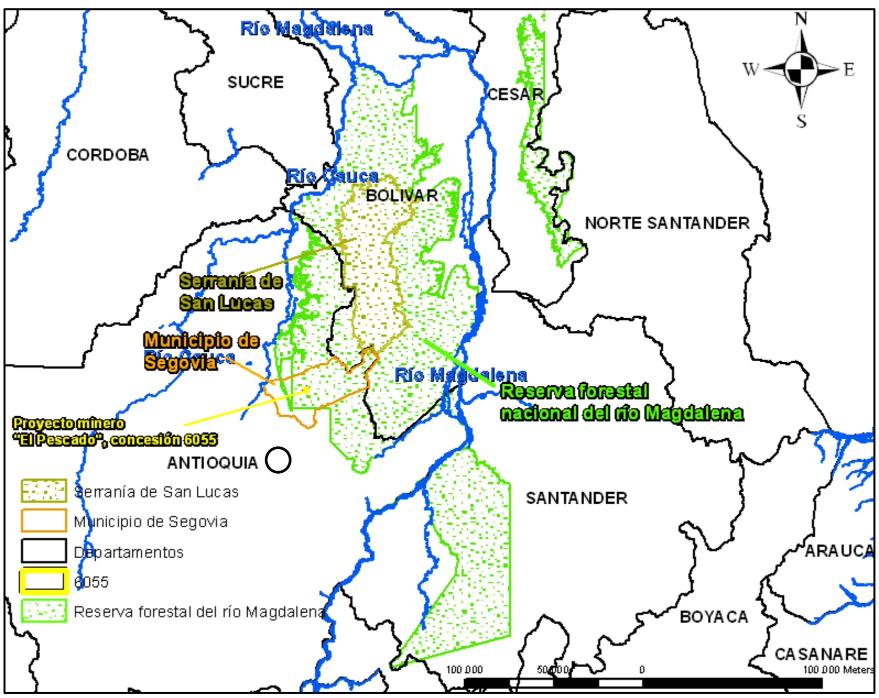


Illustration 4.2-5. Magdalena River National Forest Reserve. St. Lucas mountain range.
Source: MADS.

Inside the MRNFR it exists a sub-area also protected and endorsed as environmental importance (not geographically superimposed with the mining project, approximated distance 40 lineal Km), that is The National Natural Park (hereinafter NNP) St. Lucas Mountain Range (hereinafter SLMR) (see illustration 4.2-5). The first one only subscribed to the National System of Protected Areas (hereinafter NSPA) and the second one to the NSPA and to the Colombian National Natural Parks system (hereinafter CNNPS), according to the sections Number 1 to chapter Number 1 – title Number 2 from unique compiled regulated order from order 2372 year 2010.

The SLMR is approximately located 90% inside Bolivar department jurisdiction and corresponds 9% to the MRNFR. The largest part of the coverings from MRNFR coincides with this NNP, conformed by a big biological and endemism wealth, located in an altitude rank above 2.200 mamsl. A mayor part of the reserved zone corresponds to a kind of forestall covering, mainly Andean forests and damp forests fragments. The high toll of anthropic colonization in the zone and the economic activities related, are a potential threat for the perturbation of the forest coverings inside the reserve.

The SLMR is a fluvial star where several rivers of influence are born in the departments of Bolivar, Magdalena and Antioquia, constituting a strategic area for the region that demands special conservation measures and therefore the sustainable exploitation of its natural resources.

The study area is mainly dominated by structurally connected dense forest fragments, as well as a mosaic of pastures and fragments of secondary or transition vegetation; the latter, product of wood extraction, artisanal mining and opening of land for livestock and agriculture.

In accordance with article 2 of resolution number 1924 of 2013, the MRNFR was zoned for ordering purposes in the following 3 zones (see illustration 4.2-6):

Type A zone: guarantees the maintenance of the basic ecological processes necessary to ensure the supply of ecosystem services, mainly related to water and climate regulation; assimilation of air and water pollutants; the formation and protection of the soil; the protection of unique cultural heritage landscapes, and the support of biological diversity.

Type B zone: they are characterized by having favorable covers for a sustainable management of the forest resource through an integral forest management approach and the integral management of ecosystem diversity and services.

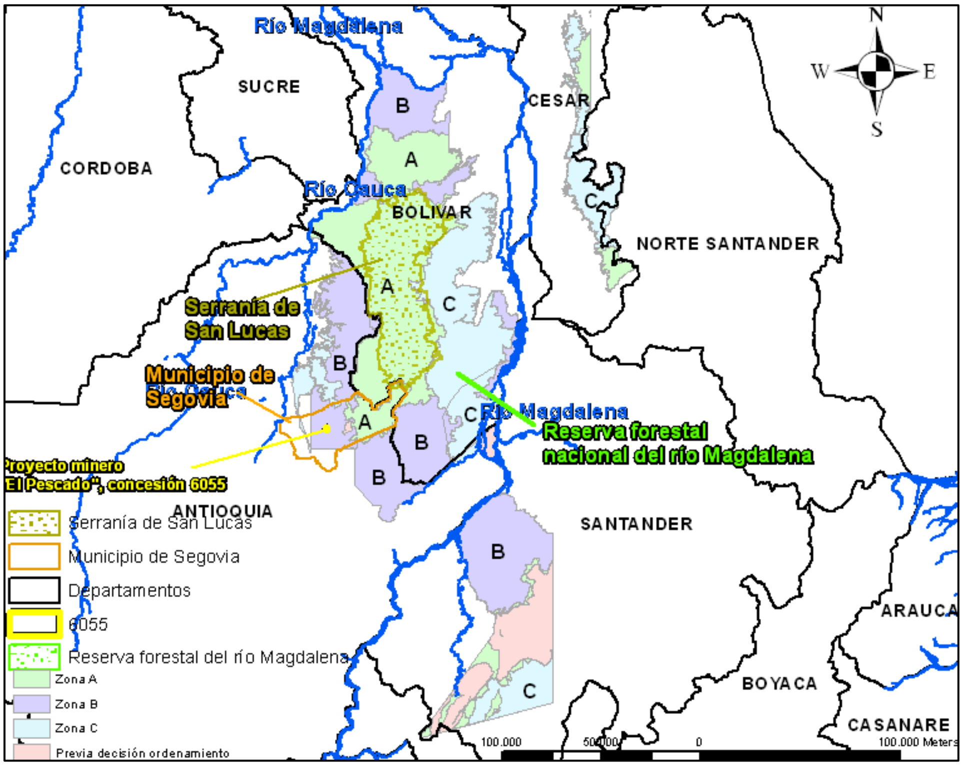


Illustration 4.2-6. Zonification of MRNFR, ST Lucas Mountain range and mining project
Source: MADS.

Type C zone: its biophysical characteristics offer conditions for the development of agroforestry, silvopastoral and other activities compatible with the objectives of the forest reserve, which must be incorporated into the forest component, and which do not imply the reduction of the natural forestall areas present in its forests in their different states of succession.

This mining project is located in zone B (see illustration 4.2-6) where sustainable management of the forest resource, biodiversity and ecosystem services can be given.

According to the articles number 5 and 6 of the resolution 1924 of 2013, and the general ordering of these zones in the reserve and specific of the zone B, is presented below to later establish handling, monitoring and conservation strategies during and after of the execution of the project.

General ordering of the zones

- In the zones that present ecosystems that have modified the characteristics of function, structure and composition due to natural or anthropic disturbances, projects or activities that tend to control their degradation factors should be prioritized, promoting processes of ecological restoration, rehabilitation or recovery as established by the National Restoration Plan.

- The scheme provided in the Compensation Assigning Manual for biodiversity loss may be applied in any of the zones.
- The zoning and ordering of the reserve must be considered in the formulation and adjustment of the Plans of Management and Management of the Hydrographic Basin (hereinafter POMCA).
- When they intend to develop within the collective territories, projects of public utility or social interest that imply change in the use of the soil, the process of subtraction must be advanced, fulfilling for this purpose the procedure of prior consultation that deals with the agreement 169 of the ILO adopted through Law 21 of 1991 and its complementary norms.
- Autonomous regional corporations and those of sustainable development, within the framework of the forest management mentioned in decree 1791 of 1996 or the norm that modifies, adds or replaces it in the forestry reserve areas of Law 2nd of 1959, a process of ordination will be carried out in all the zones enunciated, initiating this process in zones type "B".
- In the areas of the reserve, the connectivity of the protected areas will be promoted through complementary strategies.
- In integrated management districts, soil conservation districts, recreational areas and protective forest reserves included in the NSPA that overlap with forest reserves of the 2nd law where they intend to carry out activities of public or social utility that involve removal of forest or changes in land use, it must previously request the subtraction before the MADS.
- In the areas of forestall reserve zones that present risks of mass removal, ecological preservation and restoration activities may be developed.
- In all types of zones, regional environmental authorities must join efforts to avoid the transformation and loss of ecosystems and natural habitats, over-exploitation, biological invasions, pollution and the adverse effects of climate change.
- In the areas identified as national and regional conservation priorities located inside forestall reserve areas, the authorities will tend to implement measures aimed to promote their conservation.
- According to the provisions of Article 111 Law 99 of 1993 in order 953 of 2013, territorial entities, irrigation districts, and environmental authorities, that do not require an environmental license, shall promote the conservation and recovery of protected strategic areas of importance for the conservation of hydric resources that supply water to the municipal, district and regional aqueducts.
- In the development of activities that do not require subtraction of forest reserve areas, the implementation of environmentally sustainable practices will be promoted.

- In forest reserve areas with biophysical conditions suitable for the development of agricultural activities, the forestry component should be incorporated through agroforestry, silvopastoril and landscape management tools that allow the connectivity of present forest areas and their maintenance as support for the supply of ecosystem services.
- The logging of timber products must be carried out in a sustainable manner under the parameters established for forest management and current regulations, without these implying a change in the forest use of soils.
- Promote the use and marketing of non-timber forest products, as established in order 1791 of 1996 (essential oils, gums and resins, dyes, pigments, dyes, herbs, spices, medicinal plants, exotic flowers, exotic fruits, among others).

Specific ordering of zone B

- Promote the integral forest management of these areas and promote activities related to sustainable forest production, maintenance of air quality, regulation of climate and hydric resources, as well as erosion control.
- Stimulate scientific research applied primarily to ecological restoration and the generation of information on forest management of sources of timber and non-timber products, biological diversity and ecosystem services, according to current regulations.
- Promote the establishment of commercial forest plantations in areas that, due to their conditions, allow the development of these activities, considering the risk evaluation.
- Encourage the reconversion of existing agricultural and livestock production towards sustainable production schemes, which are compatible with the characteristics of the type of area.
- Implement processes of ecological restoration, rehabilitation and recovery according to the provisions of the National Restoration Plan, in order to protect hydric basins for water supply to the population and economic activities.
- Promote the implementation of the forest incentive certificate for commercial plantations and for the conservation in Law 13 of 1994 and the paragraph 250 of Law 223 and 1995.
- Projects related to productive alliances or other strategies, may be developed in private plots, since it does not imply the expansion of the agricultural frontier, avoid the reduction of natural forest areas, have a forest component, do not affect the hydric resources and be executed implementing good practices.
- To advocate for the development of Low Carbon Development activities, including those of the National Strategy for the Reduction of Emissions from Deforestation and Degradation (hereinafter REDD), Clean Development Mechanism (hereinafter CDM) and

other carbon market mechanisms, as well as other recognition schemes for environmental services.

- Promote the lines established in the strategy of entrepreneurship of green businesses, including the national policy of production and sustainable consumption, and the programs that implement it if they are compatible with the aptitudes of the soil and the characteristics of this type of zone.

4.2.3 FLORA

The sampling of woody plants (high forest, stand of trees, saplings and vascular epiphytes) developed by the Merceditas corporation, was carried out by the random plot establishment method and following the methodology proposed by Rangel and Velásquez (1997), which proposes a characterization by plant cover and in plots of 10 x 100 m (separated from each other by at least 200 meters to avoid replicas between them), where the different ages were evaluated as high forests (plots of 10 x 10 m), stand of trees (plots of 5 x 5) and sapling (plots of 2 x 2).
In the study area, 35 sampling plots were carried out (later rectified in the field), in order to know and analyze the structure of the forest, its species and its behavior, in the different types of coverage (See Table 4.2-3 and Illustration 4.2-7), besides of recording each of the morphological characteristics of the species, such as height, growth habit, among others, for later identification.

Tabla 4.2-3. Plots location.

PLOT N°	COORDINATE	
	NORTH (Y)	EAST (X)
1	1293341	931511
2	1293397	931393
3	1293514	931281
4	1293202	931256
5	1292990	931321
6	1293082	931881
7	1292831	930765
8	1293413	930797
9	1292837	930538
10	1292968	930576
11	1293100	930597
12	1293538	930583
13	1293790	930096
14	1293831	930852
15	1294283	931009
16	1292549	930830
17	1292241	931387
18	1292479	931308
19	1292821	931119
20	1293702	931254
21	1293407	930945

PLOT N°	COORDINATE	
	NORTH (Y)	EAST (X)
22	1293661	930496
23	1293524	930313
24	1293744	930202
25	1293673	929941
26	1294285	930190
27	1294676	929945
28	1294691	929749
29	1294545	929612
30	1294448	929502
31	1294136	929269
32	1293850	929540
33	1293494	929637
34	1293419	929474
35	1293183	930009

Source: Merceditas Corporation, 2012.

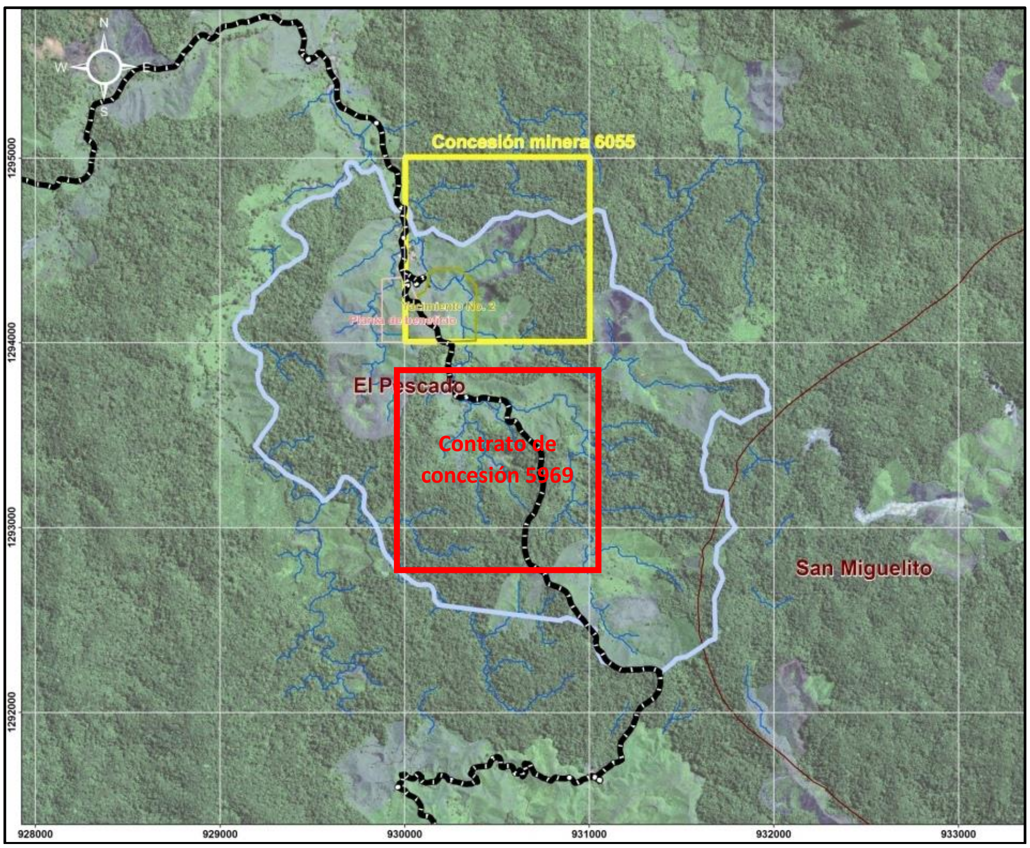


Illustration 4.2-7. Biotic area of study.
Source: INGEX, 2016.

The characterization of non-vascular epiphytes is based on the following methods:

In each of the sites, 35 trees will be selected following the SVERA method (Wolf et al., 2009). This method consists of selecting the closest individual in 5 diametric categories (10 large trees (DBH> 30 cm) and 25 trees in five cohorts (5-10, 10.1-15, 15.1-20, 20.1-25, 25.1-30 cm DAP).

The first tree will be selected at random, starting from the first plot located in the dense forest cover below the solid ground (Bdbtf). Likewise, the diametric category of consecutive trees is selected randomly. It will be ensured that all selected trees be inside the previously established plot that was located in the area of study. In places where no trees are found in the determined categories, they will be omitted in order to not to locate trees at distances greater than 20 m from each other avoiding an effect of landscape change. Each of these trees will be inspected and the epiphyte plants present in them will be registered, in some individuals it will be necessary to make the collections of material and verify from which individual it hosts it.

Each epiphyte plant will be registered, numbered and its position in the tree will be consigned. For each epiphytic plant the location in the tree will be recorded (base of the tree, trunk or shaft, canopy of low branches, canopy, and high branches according to Johansson, 1974) and the height in which it is found. Additionally, the state of the plant will be registered (seedling or adult). In each host tree (phorophyte) the geographical position will be taken, as well as the distance between them and their orientation (cardinal, degrees). For each one will be recorded: (1) their taxonomic identity, (2) structural data such as DBH, total height, crown diameter, and height; besides the number of bifurcations with branches of more than 5 cm in circumference, in order to subsequently determine the size of the trees.

In the case of plantations, where there is no presence of epiphytes in the stems of the trees, we will continue to the census of similar species in the soil, through subplots of 25 m2 (5 m x 5 m).

Next, the vegetal coverings studied, the characterization and floristic composition, the local use of the species, the threatened species, and the species identified in the region according to primary and secondary information are presented.

4.2.3.1 PLANT COVERS

In the area of study, the following six (6) sub-levels of vegetal coverings were identified from an orthophoto of the year 2012, provided by Merceditas Corporation (See Illustration 4.2-4 and Illustration 4.2-8) and the update obtained in field trips in 2016.

- Discontinuous urban TRAFFIC.
- Plantain and cassava crops.
- Cocoa crops.
- Clean grasslands.
- Low secondary vegetation.
- Dense forest under solid ground.

Table 4.2-4. Ground coverings units identified in the area of study.

LEVEL No. 1	LEVEL No. 2	LEVEL No. 3	LEVEL No. 4	LEVEL No. 5	ABREVIATION
1.ARTIFITIALIZED TERRITORIES	1.1. Urban zones	1.1.2. Discontinuous urban traffic			Dut
2.FARMING TERRITORIES	2.2 Permanent crops	2.2.1. Herbaceous permanent crops	2.2.1.3 Plantain and cassava		Hpc
		2.2.2. Bushy permanent crops	Cocoa		Bpc
	2.3 Pastures	2.3.1. Clean grasslands			Cg
3. FORESTS AND SEMI-NATURAL AREAS	3.1. Forest	3.1.1. Dense forest	3.1.1.2. Low dense forest	3.1.1.2.1. Dense lowland forest	Dfusg
	3.2. Areas with herbaceous and/or bushy vegetation.	3.2.3. In transition or secondary vegetation.	3.2.3.2. Low secondary vegetation		Lsv

Source: Corine Land Cover Methodology adapted for Colombia, 2010.

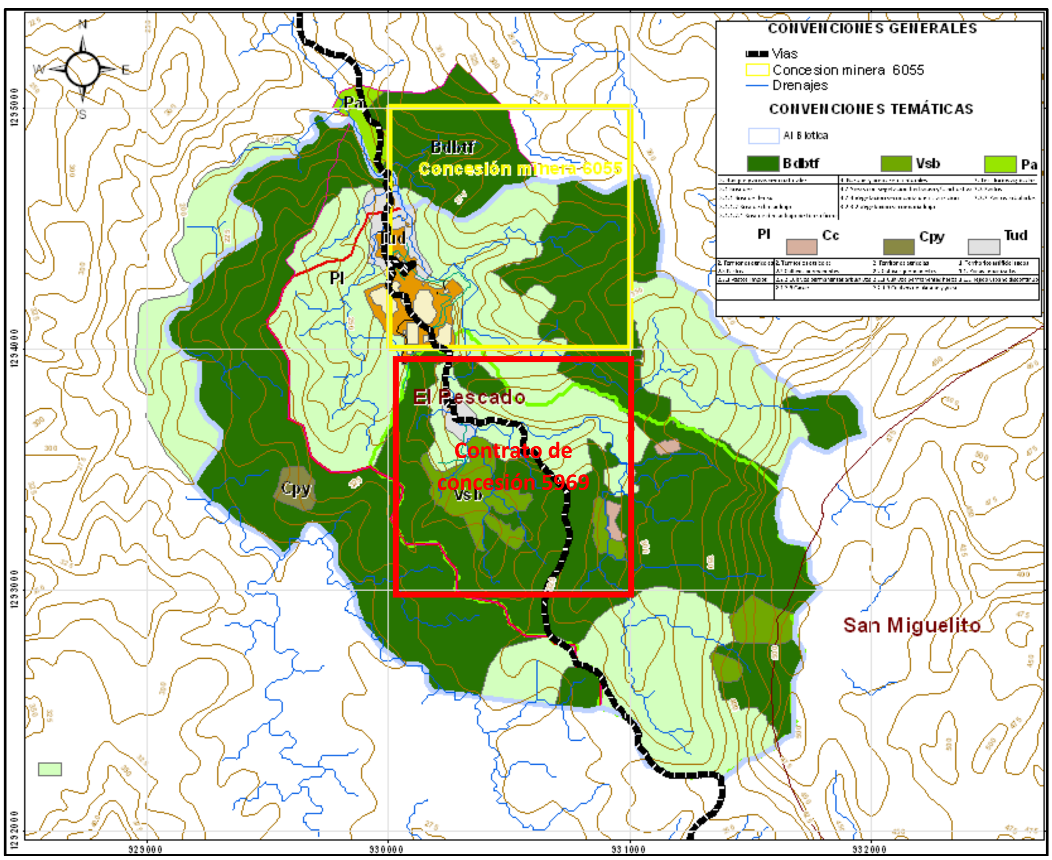


Illustration 4.2-8. Vegetal coverings map for the area of study.
Source: INGEX, 2016.

The percentage distribution in the area of all levels, is presented in the table 4.2-5, Illustration 4.2-9, and described in the following numerals.

Table 4.2-5. Land covers with digits in hectares and percentage by the area of study total.

CODE	CATEGORY	AREA	
		ha	%
1. ARTIFITIALIZED TERRITORIES			
1.1.2	Discontinuous human territory	9,589	2,04
2. FARMING TERRITORIES			
2.2.1.3	Plaintain and cassava	2,360	0,503
2.2.2.3	Cocoa	1,297	0,276
2.3.1	Clean landgrass	187,379	39,937
3. FORESTS AND SEMI-NATURAL AREAS			
3.1.1.2.1	Dense lowland forest	251,966	53,703
3.2.3.2	In transition or secondary vegetation	16,729	3,565
TOTAL		**469.18**	**100**

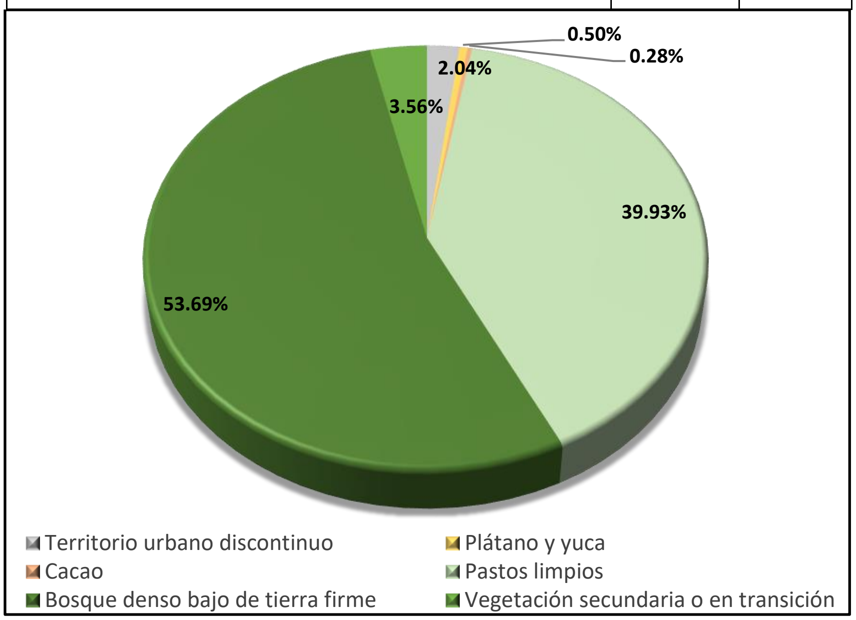


Illustration 4.2-9. Percentage distribution of last level categories.
Source*: INGEX, 2016.*

4.2.3.2 ARTIFITIALIZED TERRITORIES (1)

Includes areas of towns, cities and those that are being incorporated into urban regions and have changed the use of land by commercial, industrial or recreational areas. The only sub-level found is as follows.

Discontinuous urban traffic - Dut (1.1.2)

In this category, existent installations and ways of access are classified as small individual homes inhabited by miners and artisan workers with green spaces; Temporary inhabited and that constitute working zones. It has an extension of 9,589 ha corresponding to the 2,04% of the area of study total (see illustration 4.2-10).

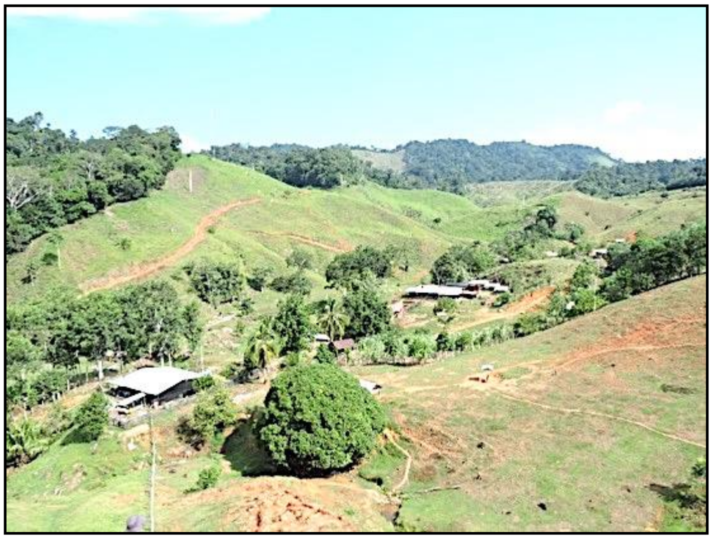


Illustration 4.2-10. Discontinuous urban traffic covering (1.1.2)
Source: INGEX, 2016.

4.2.3.3 AGRICULTURAL TERRITORIES (2)

Are terrains used for food and raw material production; mainly devoted to livestock and crops, whether they are crops with rotating grasses and a rest or fallow. It includes the areas dedicated to permanent crops, transitory crops, grazing areas and heterogeneous agricultural areas in which livestock and agricultural uses can also be used. The units are grouped into the following 3 classes and occupy 40.716% of the study area and are equivalent to 191.036 ha.

Permanent herbaceous crops, plantain and cassava - Copy (2.2.1.3)

In this category raw cane sugar reed, plantain in association with cassava and papaya can be found; such plantations are abandoned and do not evince renovation, maintenance and/or exploitation processes. They are mainly located in the higher part of the basin, close to the hydric resource in an extension of 2,360 ha that represent the 0,503% (see illustration 4.2-11)

Illustration 4.2-11. Plantain and cassava crop at free exposure.
Source: INGEX, 2016.

This type is represented by cocoa crops; a kind of crop that was abandoned without any kind of maintenance. It occupies a surface of 1,297 ha equivalent to the 0,276% of the studied area (see illustration 4.2-12).

Illustration 4.2-12. Cocoa crop.
Source: INGEX, 2016.

Clean grasslands – Cg (2.3.1)

In this category cutting pastures, used for livestock grazing, breed or fatten were classified. The species present in this category are the Brachiaria, Estrella and Panamanian pastures. The unit covers 187,379ha equivalent to 39,937%, they are distributed in almost the whole area, due to the use of the soil change for extensive livestock as one of the main economic activities (see illustration 4.2-13)

Illustration 4.2-13. Clean grasslands (2.3.1).
Source: INGEX, 2016.

4.2.3.4 FORESTS AND NATURAL AREAS (3)

It includes vegetal coverings of woody, shrub and herbaceous type; they occupy 268,695 ha, which is equivalent to 57.269% of the area under study.

Dense forest under solid ground (3.1.1.2.1)

Corresponds to forests that have a physiognomic structure dominated by shrubs, herbaceous and trees. The vegetation of this dense forest corresponds to the zone of life, tropical humid forest (bh-T). It occupies 251,966 ha, equivalent to 53.703%, which makes it the coverage with the highest representation in the area. (See Illustration 4.2-14).

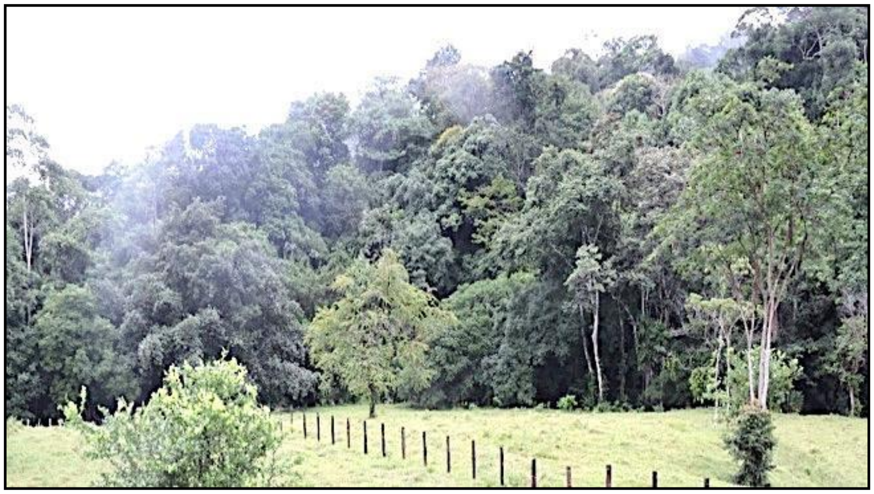


Illustration 4.2-14. Dense lowland forest (3.1.1.2.1).
Source: INGEX, 2016.

Low secondary vegetation -Lsv (3.2.3.2)

Are those areas mainly covered by shrubby and herbaceous vegetation with irregular canopy and occasional presence of trees and vines, which corresponds to the initial states of vegetal succession after presenting a process of forest deforestation or pastures afforestation. It is developed posterior to the original intervention and is generally conformed by shrubs and herbaceous shaped of many species, the secondary vegetation commonly corresponds to a kind of herbaceous shrubby vegetation of short cycle, with heights no greater to five meters and from a dense coverage. Generally, corresponds to a colonization of pre-climate inducers, where species of a more advanced phase settle and start to emerge, it occupies an area of 16,729 ha that correspond to 3,565% of the area of study (see illustration 4.2-15).

Regarding natural and semi natural areas, less than (57,25%) of the place presents natural coverings without any kind of intervention; significant number that contrasts with the accelerated drop of forest covering from year 2015 to the current year, especially in the area of study, as later shows the multitemporary analysis.

Illustration 4.2-15. Low secondary vegetation (3.2.3.2)
Source: INGEX, 2016.

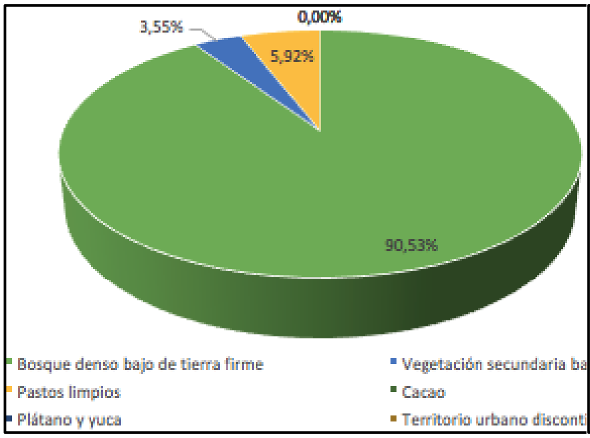
4.2.3.5 MULTIMEMORAL COVERAGE ANALYSIS ANÁLISIS

We proceeded to compare the information in the photographs (year 2005 and 2012 updated with field information in 2016), obtaining the changes presented in Table 4.2-6 and Illustration 4.2-16, in which we can observe the significant decrease in the coverage of dense lowland forest (Dlf) for 10 years (X2 = 33.70, p = <0.001). On the other hand, in the same illustration there was an increase in the coverage of clean pastures (Pl) in the same time interval (X2 = 32.73, p = <0.001).

Table 4.2-6. Data of change detection in each covering of the ground (Corine Land Cover 2010).

VEGETALCOVERING	DETECTION OF CHANGE			
	2005	%	2016	%
Dense lowland cover	424,71	90,52	251,966	53,7
Secondary low vegetation	16,675	3,55	16,729	3,56
Clean grasslands	27,796	5,924	187,379	39,93
Cocoa		0,0	1,297	0,27
Plaintain and cassava		0,0	2,360	0,50
Urban discontinuous traffic		0,0	9,589	2,04

Source: INGEX, 2016.



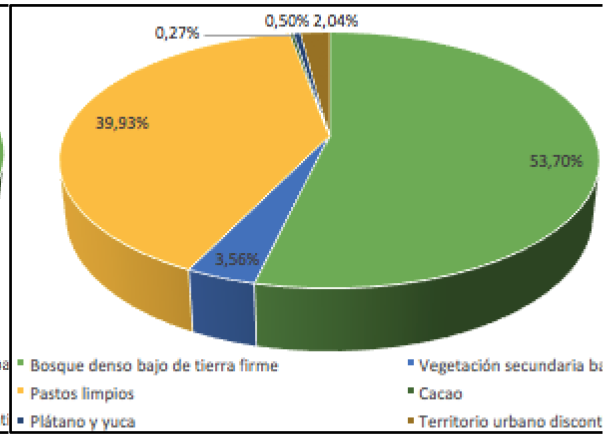


Illustration 4.2-16.Change od covering ration in the area of study between the years 2005 (left) and 2016 (right).
Source: INGEX, 2016.

The 469,18 ha of the area of study, has changed in the last ten years about 39,65% (186,044 ha of the coverings), mainly falling upon the forest by deforestation effects (36%) for livestock, agriculture, human settlements and artisan mining (see illustration 4.2-16).

The degree referred to the increase, stabilization or diminution of processes of anthropic intervention in regard to the change of the coverings or use of land; assessing and estimating each of the changes, are presented in the table 4.2-7 and table 4.2-8

Table 4.2-7. Change of hectares to categorize the natural and semi-natural areas between the years 2005 and 2016.

COVERING		AREA		
CODE	CATEGORY	2005	2016	DIFFERENCE
3.1.1.2.1	Dense lowland forest	424,71	251,966	172,744
3.2.3	Vegetation secondary or in transition	16,675	16,729	0,054
TOTAL		441.385	268,695	172,69

Source: INGEX, 2016.

Table 4.2-8. Anthropization of changes of the use of coverings.

ANTHROPIZATION	AREA
Anthropization increase (loss of forests, and pastures profits, settlements and crops)	172.744 ha
Anthropization stabilization (coverings remaining or with anthropic intervention)	296,382 ha
Anthropization diminution (increase of natural regeneration – Vsb)	0,054 ha

Source: INGEX, 2016.

The results of this analysis allow determining that the change of coverings from 2015 to 2016 was bigger for the anthropization process (see table 4.2-8), because the wooded covering decreased 172,744 ha (40,67%), which indicates that for the forest because the effects of deforestation and increase of clean pastures, and that can be seen in an increase in livestock, agriculture, human settlements and artisan mining. However, the information collected is strictly qualitative and do not reflect the intensity of the anthropization process; because is not the same as 10 hectares of pastures with natural spaces move to permanent crops than 10 hectares of high dense solid ground forest be cut down to give way to a clean pasture covering (CORTOLIMA, 2014).

4.2.3.6 CARACTERIZATION AND FLORISTIC COMPOSITION

For the characterization of the area of study, the curve of accumulation was obtained as can be seen in the Table 4.2-17, such as for the species method and Chao 1, during the days of sampling.

The accumulation curve made of species calculation is syntonic, which means that even if the number of individuals registered or the sampling number or the number of days' increase, the number of species found will not increase.

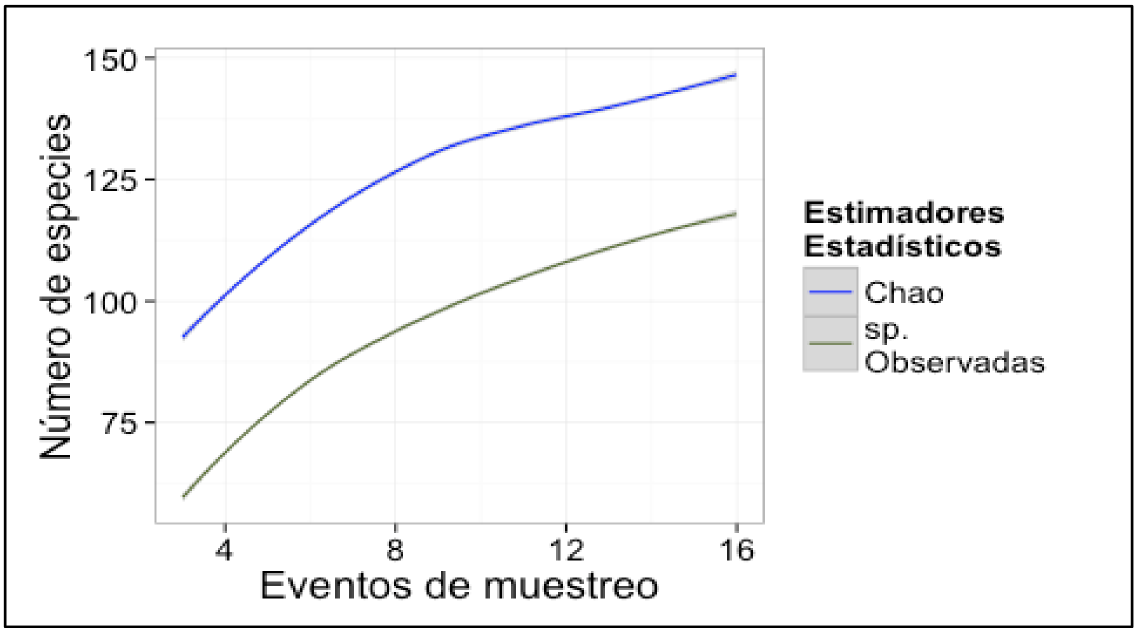


Illustration 4.2-17.Accumulation curves for the species method and Chao 1.
Source: INGEX y Renaturar, 2016.

However, the confidence intervals of the accumulation curve are not overvalued with those of the non-parametric CHAO estimator, indicating that the number of people could have been higher in that sampling time.

For the characterization of the flora, a total of 35 sampling units of 1000 m2 were established, each one (0.1 ha), evenly distributed within the study area (469.18 ha), where 1,072 individuals were found in the high forest state, 1,086 individuals in the stand of trees state and 754 in the sapling state, for a total of 2,912 individuals in the three strata, distributed among 61 families, 143 genera, and 152 species in the aforementioned plant coverings. (See Illustration 4.2-18 and source: Merceditas Corporation, 2012).

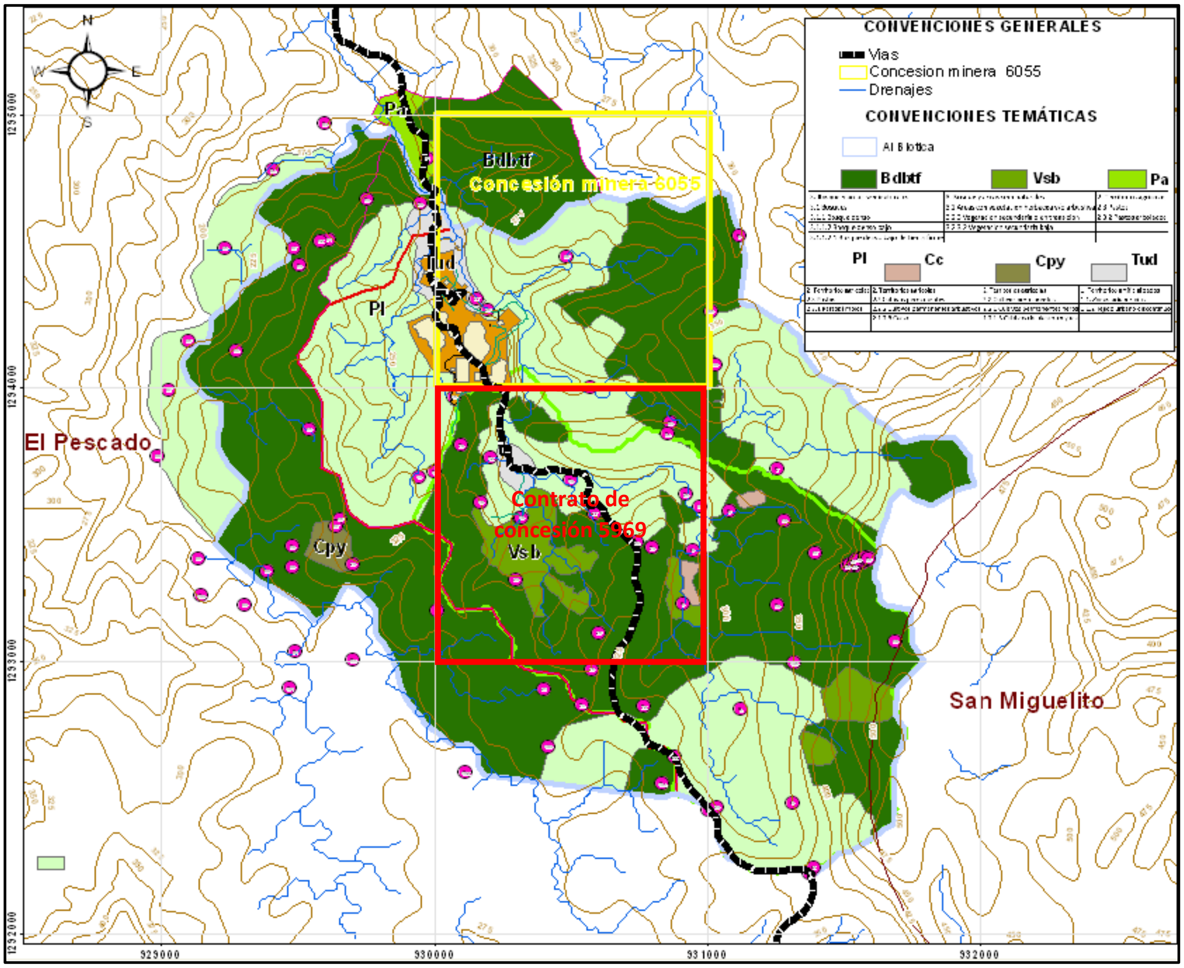


Illustration 4.2-18. Plot settles in the area object of study.
Source: Merceditas Corporation, 2012.

Table 4.2-9. Species registered.

No	FAMILY	SPECIES	COMMON NAME	INDIVIDUALS
1	ACANTHACEAE	*Justicia phytolaccoides* Leonard		3
2	ANACARDIACEAE	*Anacardium excelsum* (Bertero & Balb). Ex Kunth).	Caracolí	3
3	ANACARDIACEAE	*Mangifera indica*	Mango	3
4	ANACARDIACEAE	*Ochoterenaea colombiana* F.A. Barkley	Riñón	19
5	ANACARDIACEAE	*Spondias mombin*	Hobo	29
6	ANACARDIACEAE	*Tapira guianensis* Aubl.	Fresno	19
7	ANNONACEAE	*Guatteria aberrans* Erkens & Maas	Garrapato	3
8	ANNONACEAE	*Guatteria sp*	Guasco	33
9	ANNONACEAE	*Pseudoxandra sclerocarpa*	Garrapato	18
10	ANNONACEAE	*Unonopsis velutina*	Yaya	14
11	ANNONACEAE	*Xylopia aromatica*	Escobo	26
12	ANNONACEAE	*Xylopia frutescens*	Escubillo	8
13	ANNONACEAE	*Xylopia sp.*	Yaya anon	17

No	FAMILY	SPECIES	COMMON NAME	INDIVIDUALS
14	APOCYNACEAE	*Aspidosperma cruentum*	Carreto	69
15	APOCYNACEAE	*Couma macrocarpa*	Perillo	8
16	APOCYNACEAE	*Lacmellea floribunda*	Costillo de res	21
17	APOCYNACEAE	*Stemmadenia sp*	Cojón de fraile	25
18	ARALIACEAE	*Schefflera morototoni*	Pategallina	4
19	ARECACEAE	*Attalea allenii*	Palma Táparo	5
20	ARECACEAE	*Bactris gasipaes*	Palma Chonta	11
21	ARECACEAE	*Cyagrus zancona*	Palma Zancona	67
22	ARECACEAE	*Jessenia polycarca*	Palma Mil Pesos	32
23	ARECACEAE	*Phytelehas pittieri* Of Cook.	Tagua	1
24	ARECACEAE	*Phytlephas macrocarpa*	Tagua	49
25	ARECACEAE	*Sabal mauritiliformis*	Palma Amarga	15
26	ARECACEAE	*Socratea exorrhiza*	Palma zancona	2
27	ARECACEAE	*Welfia regia*	Palma Amargo	21
28	ARECACEAE	*Wettinia kalbreyeri, W. hirsuta*	Macana	151
29	ASTERACEAE	*Piptocoma discolor* (Kunth Pruski)	Gallinazo e monte	11
30	BIGNONIACEAE	*Jacaranda copaia* (Aubl.) D. Don	Chingalé	55
31	BIGNONIACEAE	*Jacaranda mimosifolia*	Gualanday	20
32	BIGNONIACEAE	*Tabebuia chrysanta*	Guayacan	17
33	BIGNONIACEAE	*Tabebuia ochracea*	Cenizo	7
34	BIXACEAE	*Cochlospermum sp*	Flechero	5
35	BOMBACACEAE	*Ceiba pentandra*	Ceiba barrigona	8
36	BOMBACACEAE	*Ochroma lagopus*	Balso	63
37	BOMBACACEAE	*Ochroma pyramidale*	Balso	1
38	BOMBACACEAE	*Phragmotheca rubriflora*		2
39	BRUNELIACEAE	*Brunellia sp.*	Muchocho	2
40	BURSERACEAE	*Crepidospermum rhoifolium* (Benth) Triana & Planch.	Anime/Zapatillo	13
41	BURSERACEAE	*Dacryodes colombiana* Cuatrec	Anime	2
42	BURSERACEAE	*Protium neglectum* Swart	Cariaño	13
43	CAESALPINACEAE	*Caesalpinia eriostachys*	Sagino	35
44	CAESALPINACEAE	*Cassia fistula*	Caña fistula	11
45	CAESALPINACEAE	*Dialium guianense*	Tamarindo	15
46	CAESALPINACEAE	*Hymenaea courbaril* Linneaus	Algarrobo	15
47	CAESALPINACEAE	*Hymenaea oblongifolia*	Algarrobillo	1
48	CAESALPINACEAE	*Peltogyne purpurea*	Nazareno	1
49	CANNABACEAE	*Trema micrantha*	Surrumbo	2
50	CARYOCACEAE	*Caryocar amygdaliferum*	Almendrón	51
51	CARYOCACEAE	*Caryocar glabrum*	Cagüí	31
52	CLUSIACEAE	*Calophyllum mariae* Planch. & Triana	Aceite María	24
53	CLUSIACEAE	*Vismia macrophylla*	Punta de lanza	18
54	BORAGINACEAE	*Varronia spinescens*	Guacimo	27
55	EUPHORBIACEAE	*Alchornea glandulosa* Poepp.	Sangregao	1
56	FABACEAE	*Acacia mangium*	Acacio	57
57	FABACEAE	*Clathrotropis brunnea* Amshoff	Sapán	6
58	FABACEAE	*Dipteryx oleífera*	Almendro	1
59	FABACEAE	*Erythrina glauca*	Chocho	1
60	MIMOSACEAE	*Inga ornata* Kunth	Guamo	7
61	FABACEAE	*Ormosia paraense*	Chocho	4
62	FLACOURTIACEAE	*Casearia corymbosa*	Sangregallo	10
63	FLACOURTIACEAE	*Casearia sp.*	Sagino	6

No	FAMILY	SPECIES	COMMON NAME	INDIVIDUALS
64	HELICONIACEAE	*Heliconia sp*	Heliconia	8
65	HUMIRIACEAE	*Humiriastrum colombianum*	Aceituno	19
66	HUMIRIACEAE	*Humiriastrum procerum* (Little) Cuatr.	Chanúl	5
67	HYPERICACEAE	*Vismia baccifera* (L.) Triana & Planch.	Carate	46
68	LACISTEMATACEAE	*Lacistema aggregatum*	Café de monte	3
69	LAMIACEAE	*Salvia officinalis* L.	Salvia	43
70	LAURACEAE	*Aniba sp*	Canelo	58
71	LAURACEAE	Caryodaphnopsis cogolloi	Yambé	8
72	LAURACEAE	*Nectandra lanceolata*	Laurel Amarillo	22
73	LAURACEAE	*Nectandra sp.*	Laurel mierda	5
74	LECYTHIDACEAE	*Cariniana pyriformis*	Abarco	15
75	LECYTHIDACEAE	*Couratari guianensis*	Coco cabuyo	2
76	LECYTHIDACEAE	*Gustavia gentryi*	Mula muerta	4
77	LECYTHIDACEAE	*Gustavia longifuniculata*	Mula muerta	14
78	LECYTHIDACEAE	*Lecythis mesophylla*	Coco cristal	26
79	LECYTHIDACEAE	*Lecythis ollaria*	Coco oyeto	10
80	LECYTHIDACEAE	*Lecythis sp*	Coco	43
81	LECYTHIDACEAE	*Lecythis tuyrana*	Olla de mono	2
82	LYTHRACEAE	*Lagerstroemia sp*	Carbonero	47
83	MAGNOLIACEAE	*Magnolia espinalii*	Alma negra	6
84	MALPIGHIACEAE	*Bunchosia armeniaca* (Cav.) D.C	Cerezo	38
85	BOMBACACEAE	*Huberodendron patinoi* Cuatrec	Volador	1
86	MALVACEAE	*Luehea seemanii*	Guácimo colorado	6
87	MELASTOMATACEAE	*Bellucia grossullariodes*	Coronillo	8
88	MELASTOMATACEAE	*Bellucia pentamera Naudin*		1
89	MELASTOMATACEAE	*Clidemia capitellata* (Bonpl.) D. Don		1
90	MELASTOMATACEAE	*Miconia prasina* (Sw.) DC	Cenizo	8
91	MELASTOMATACEAE	*Miconia sp*	Tuno o Niguito	32
92	MELASTOMATACEAE	*Miconia spicellata* Bonpl. Ex Naudin	Tuno o Niguito	62
93	MELASTOMATACEAE	*Ossaea macrophylla*	Cenicero	3
94	MELIACEAE	*Cedrela odorata*	Cedro	45
95	MELIACEAE	*Guarea kunthiana*	Cedrillo	1
96	MELIACEAE	*Swietenia macrophylla*	Caoba	2
97	MIMOSACEAE	*Abarema jupumba*	Rayo	18
98	MIMOSACEAE	*Albizia carbonaria* Britton	Cabonero	7
99	MIMOSACEAE	*Inga marginata*	Guamo churimo	1
100	MIMOSACEAE	*Inga punctata* Willd.	Guamo borrachero	19
101	MIMOSACEAE	*Inga sp*	Guamo	199
102	MIMOSACEAE	*Inga spectabilis* (Vahl) Willd.	Guao macheto	3
103	MORACEAE	*Brosimum guianense* (Aubl.) Huber	Sandé	5
104	MORACEAE	*Cousapoa sp.*	Abraza palo	5
105	MORACEAE	*Ficus citrifolia*	Higueron	5
106	MORACEAE	*Ficus sp*		43
107	MORACEAE	*Ficus zarzalensis* Standl.	Lechudo	1
108	MORACEAE	*Helianthostylis sprucei* Baill.	Lechero	32
109	MORACEAE	*Perebea sp.*		5
110	MORACEAE	*Pseudolmedia rigida*	Lecha e perra	51
111	MORACEAE	*Sorocea trophoides* W.C. Burger		2
112	MYRISTICACEAE	*Compsoneura mutisii* A.C. Sm.	Ondequera	28
113	MYRISTICACEAE	*Iryanthera sp*	Soquete	45
114	MYRISTICACEAE	*Myrica pubescens* Willd	Laurel	1

No	FAMILY	SPECIES	COMMON NAME	INDIVIDUALS
115	MYRISTICACEAE	*Virola flexuosa*	Soto	25
116	MYRISTICACEAE	*Virola sebifera* Aubl.	Soto	12
117	MYRTACEAE	*Eugenia egensis* DC.	Arrayan	3
118	MYRTACEAE	*Eugenia sp.*	Guayabo e monte	1
119	MYRTACEAE	*Myrcia ferruginea.*	Arrayan colorado	19
120	MYRTACEAE	*Myrcia sp.*	Arrayan	1
121	MYRTACEAE	*Psidium guajava*	Guayaba	15
122	OCHNACEAE	*Cespedesia macrophylla*	Pacó	46
123	OCHNACEAE	*Cespedesia spathulata*	Alejandro	13
124	OLACACEAE	Mincuartia guianensis	Punte e candado	20
125	PAPILONACEAE	*Andira inermis* (W. Wright) Kunth	Ají	18
126	EUPHORBIACEAE	*Phyllanthus attenuatus* Miq.	Totumo de monte	1
127	PIPERACEAE	*Piper aduncum* L.	Cordoncillo	17
128	PIPERACEAE	*Piper marginatum* Jacq.	Cordoncillo	8
129	POLYGONACEAE	*Coccoloba uvifera*	Buche e pava	2
130	POLYGONACEAE	*Triplaris americana* L.	Vara santa	1
131	POLYGONACEAE	*Triplaris sp*	Vara santa	6
132	RUBIACEAE	*Isertia haenkeana* D.C.	Coralillo	16
133	RUBIACEAE	*Psychotria elata* (Sw.) Hammel	Boca de diablo	1
134	RUBIACEAE	*Randia armata* (Sw.) DC.	Cruceto, Cacho de vaca	3
135	RUBIACEAE	*Rondeletia sp.*	Carbón	7
136	RUTACEAE	*Citrus limon* (L.) Osbeck	Limón	10
137	RUTACEAE	*Zanthoxylum lenticulare* Reynel	Tachuelo	12
138	SAPINDACEAE	*Cupania cinerea*	Mestizo	2
139	SAPINDACEAE	*Cupania sp.*	Mestizo	3
140	SAPOTACEAE	*Chrysophyillum cainito*	Caimo	44
141	SIMAROUBACEAE	*Simaba cedron*	Cedrón	38
142	STERCULIACEAE	*Guazuma ulmifolia*	Guacimo	9
143	STERCULIACEAE	*Herrania sp.*	Cacao e monte	15
144	TILIACEAE	*Apeiba membranacea* Spruce ex Benth	Peine e mono	26
145	CANNABACEAE	*Celtris trinervia* Lam.	Surrumbo	3
146	URTICACEAE	*Cecropia sp*	Yarumo	96
147	URTICACEAE	*Pourouma bicolor* Mart.	Cirpo	8
148	URTICACEAE	*Pourouma hirsutipetiolata*	Cirpo	73
149	URTICACEAE	*Pourouma sp*	Cirpo	22
150	LAMIACEAE	*Aegiphila sp.*	Tabaquillo	3
151	VIOLACEAE	*Leonia sp.*	Bastimento e pobre	2
152	VOCHYSIACEAE	*Vochysia ferruginea* Mart.	Dormilón	24

Source: Merceditas Corporation, 2012.

4.2.3.6.1 Abundance and wealth of high forest families

Considering the categorization of abundance for families and species (see methodology) no abundant families of high forest were found (relative abundance> 10%). However, 16 common families were found (Relative abundance between 2 and 10% and 34 non-common families (Relative abundance between 0.1 and 2%), being Arecaceae and Mimosaceae families that presented higher relative abundances (RA = 9, 05%).

Therefore the families with greater abundance are MIMOSACEAE (8.49%), ARECACEAE (7.84%), MORACEAE (7.46%), URTICACEAE (7.37%), FABACEAE (5.88%) (See Illustration 4.2-20),

APOCYNACEAE (5.78%), LECYTHIDACEAE (5.32%), ANNONACEAE (5.32%), LAURACEAE (4.85%), CARYOCACEAE (4.48%), the other families presented abundances inferior than 4% as the family BOMBACACEAE (3.26%) (See Illustration 4.2-22) and MELIACEAE (2.98%) (See Illustration 4.2-19), in addition to the family HELICONIACEAE (0.09%) who reported the minor values (Illustration 4.2-19, Illustration 4.2-20, Illustration 4.2-21 and Illustration 4.2-21).

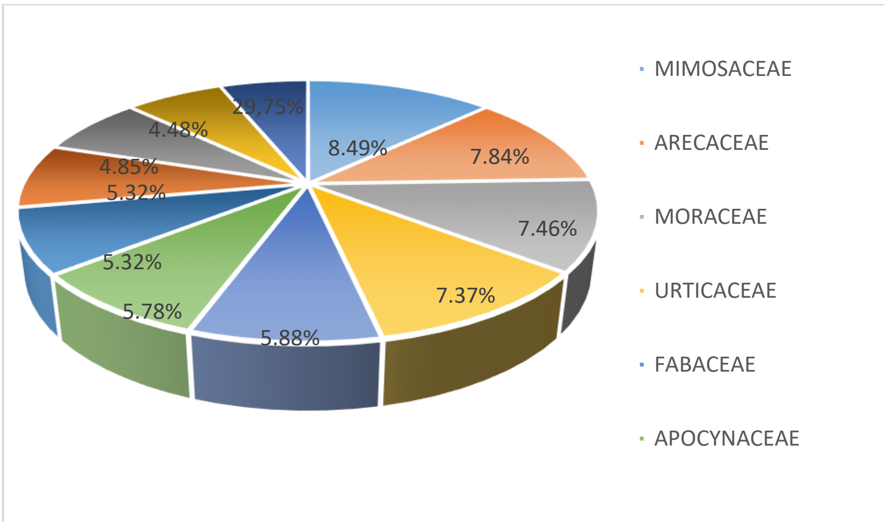


Illustration 4.2-19.Representation of the families with more abundance.
Source: INGEX, 2016.

The species and genders with more individuals were Inga (MIMOSACEAE) with 93 individuals (7.55%), Acacia (FABACEAE) with 57 individuals (5.31%), Aspidosperma (APOCYNACEAE) with 41 individuals (3.82%), Pourouma (URTICACEAE) with 57 individuals (3.63%), Cedrela (MELIACEAE) with 30 individuals (2.80%), Ochroma (BOMBACACEAE) with 31 individuals (2.80%), Pseudolmedia (MORACEAE) with 25 individuals (2, 52%), Caryocar (CARYOCACEAE) with 48 individuals (2.42%), Cecropia sp (URTICACEAE) with 26 individuals (2.42%) and finally Aniba sp (LAURACEAE) with 26 individuals (2.42%) (See Illustration 4.2-23 and Illustration 4.2-24).

On the other hand, species of abundant high forest were not found (Relative abundance> 10%) however, 15 common species were registered, 73 unusual species and 29 rare species (relative abundance between 0 and 0.1%).

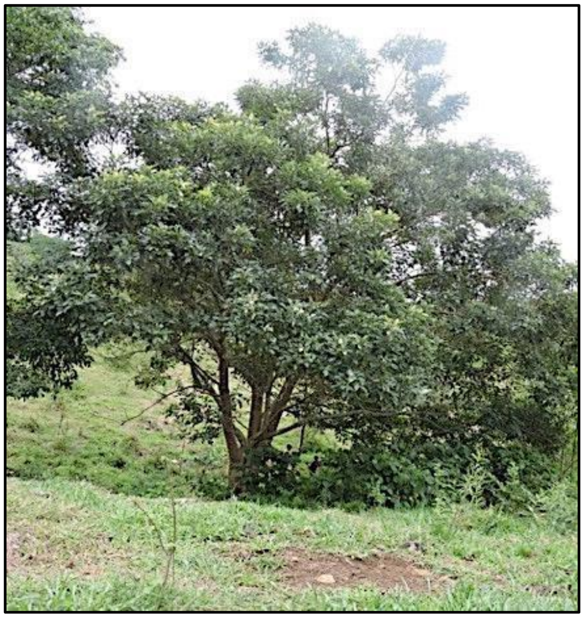


Illustration 4.2-20. FABACEAE *Erythrina glauca.*
Source: Merceditas Corporation, 2012.

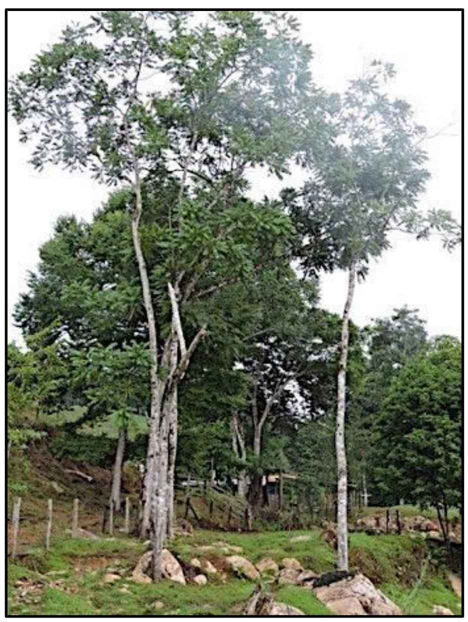


Illustration 4.2-21. MELIACEAE Cedrela odorata.
Source: Merceditas Corporation, 2012.

Illustration 4.2-22. BOMBACACEAE *Ceiba pentandra.*
Source: Merceditas Corporation, 2012.

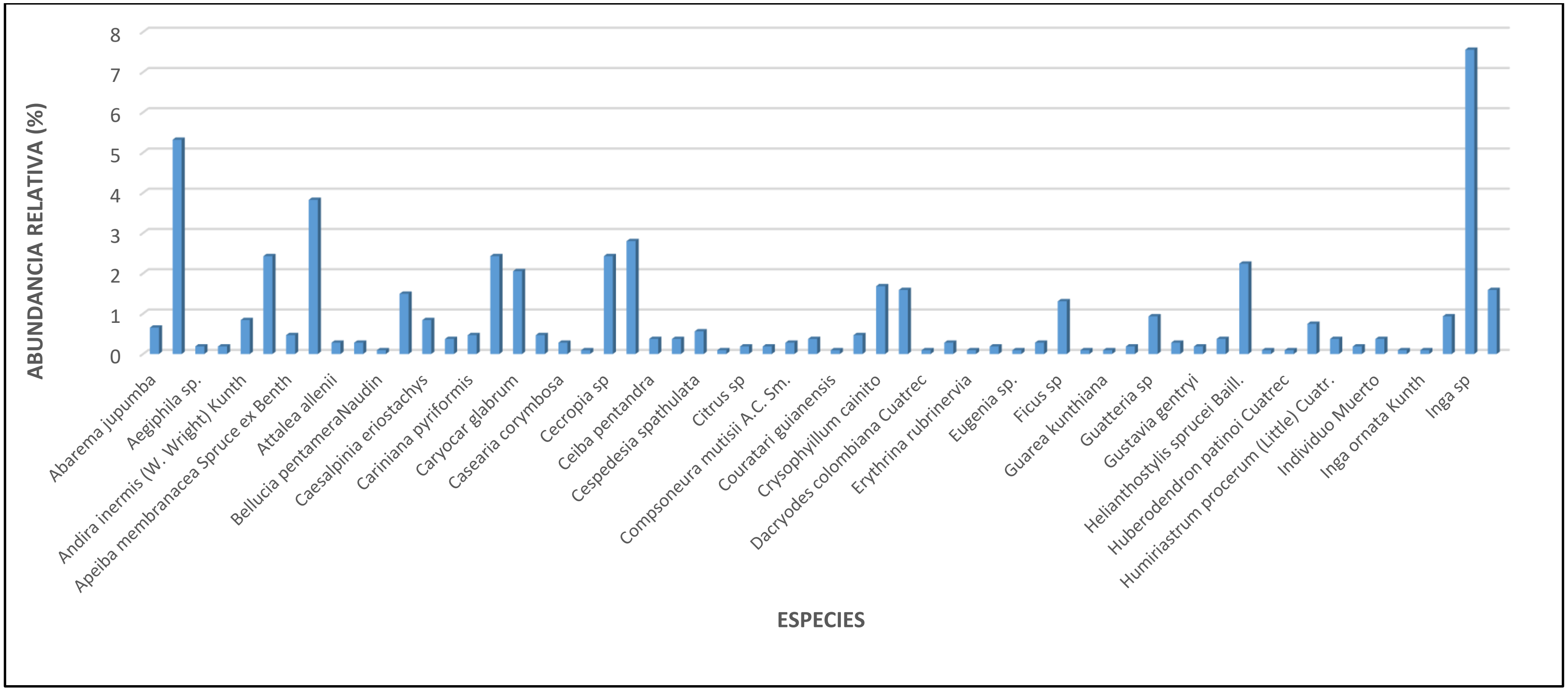


Illustration 4.2-23. Graphic of percentage of species found.
Source: INGEX, 2016.

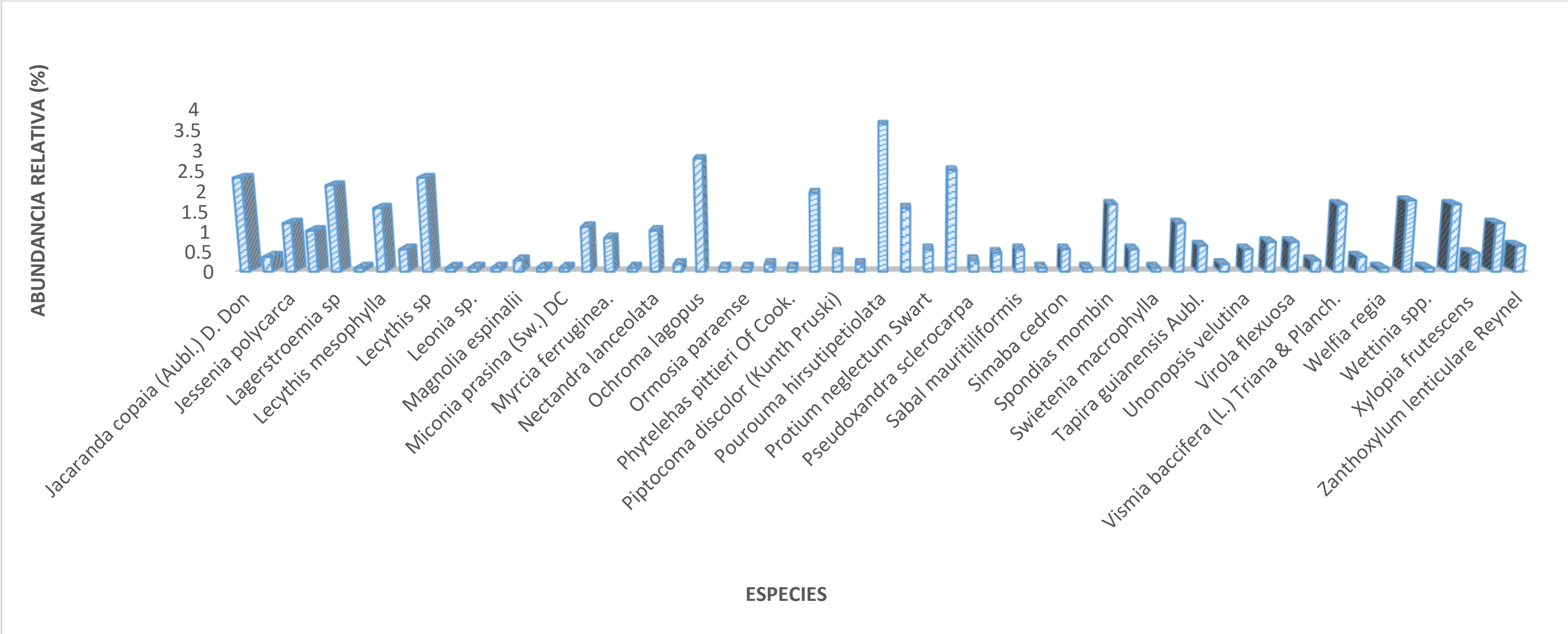


Illustration 4.2-24. Graphic of percentage of species found.

Source: INGEX, 2016.

4.2.3.6.2 Abundance and wealth of families and genres of early natural regeneration (stand of trees and saplings)

Taking into account the categorization of abundance for families and species (see methodology), the Arecaceae family was the most abundant of saplings and stand of trees (Relative abundance> 10%). On the other hand, 16 common families were found (Relative abundance between 2 and 10%), 40 uncommon families (Relative abundance between 0.1 and 2%) and 4 rare families. In the case of early regeneration species, there were no abundant saplings or stand of trees (Relative abundance> 10%) but 7 common, 116 uncommon and 19 rare species were recorded (Relative abundance between 0 and 0.1 %).

For the case of early natural regeneration, it was identified that the families with the largest number of individuals were ARECACEAE (274 individuals), MIMOSACEAE (155 individuals), MELASTOMATACEAE (110), MYRISTICACEAE (82), MORACEAE (74) AND URTICACEAE (69). On the other hand, the genres with more species were *Inga* (136), *Wettinia* (131), *Cecropia* (70), *Cyagrus* (51), *Jacaranda* (46) and *Salvia* (43) (See Illustration 4.2-25 and Illustration 4.2-29).

Illustration 4.2-25. MORACEAE *Ficus sp.*
Source: Merceditas Corporation, 2012.

Illustration 4.2-26. MORACEAE *Perebea sp.*
Source: Merceditas Corporation, 2012.

Illustration 4.2-27. Evidence of early natural regeneration.
Source: Merceditas Corporation, 2012.

Illustration 4.2-28. PIPERACEAE *Pipper sp.*
Source: Merceditas Corporation, 2012.

Illustration 4.2-29. CARYOCACEAE *Caryocar amygdaliferum*.
Source: Merceditas Corporation, 2012.

4.2.3.6.3 Abundance and wealth vascular and non-vascular epiphytes

82 individuals were registered between vascular and non-vascular epiphytes, distributed in 15 genera and 10 families. Angiosperms were represented by 27 individuals and 3 families, ferns by 36 individuals and 5 families, while lichens were represented by 19 individuals and two families (See Table 4.2-10).

Table 4.2-10. Epiphytes registered in the study.

TAXÓN	FAMILY	GENRE	SPECIES	No.
Angiosperma	ARACEAE	*Anthurium*	*Anthurium formosun* Schott	4
Angiosperma	ARACEAE	*Heteropsis*	*Heteropsis oblongofolia* Kunth.	3
Angiosperma	ARACEAE	*Philodendron*	*Philodendron sp.*	2
Angiosperma	ARACEAE	*Spathiphyllum*	*Spathiphyllum floribundum* (Linden & André) N.E Br.	3
Angiosperma	BROMELIACEAE	*Tillandsia*	*Tillandsia sp*	6
Angiosperma	HELICONIACEAE	*Heliconia*	*Heliconia rostrata*	5
Angiosperma	HELICONIACEAE	*Heliconia*	*Heliconia wagnearia*	4
Helecho	CYATHEACEAE	*Cyathea*	*Cyathea sp.*	5
Helecho	GENTIANACEAE	*Sticherus*	*Sticherus rubiginosus* (Matt.) Naka	6
Helecho	GRAMMITIDACEAE	*Cochlidium*	*Cochlidium serrulatum*	5
Helecho	POLIPODYACEAE	*Microgramma*	*Microgramma lycopodioides* (L.) Copel.	4
Helecho	POLYPODIACEAE	*Alansmia*	*Alansmia cultrata*	5
Helecho	PTERIDACEAE	*Acrostichum*	*Acrostichum aureum* L.	7
Helecho	PTERIDACEAE	*Adiantopsis*	*Adiantopsis radiata* (L.) Fée.	4
Líquen	ARTHONIACEAE	*Arthonia*	*Arthonia cinnabarina* (DC.) Wallr.	3
Líquen	ARTHONIACEAE	*Arthonia*	*Arthonia trilocularis* (Mull.Arg.) R. Sant.	10
Líquen	GRAPHIDACEAE	*Phaeographis*	*Phaeographis sp.*	6

Source: Merceditas Corporation, 2012.

Arthonia tricularis (Mull. Arg.) R. Sant., Was the taxon lichen species most abundant with 12.2%. *Acrostichum aureum L*. was more abundant in ferns with 8.54% and in the angiosperm taxon, *Tillandsia sp* with 7.32% (See Illustration 4.2-30).

Taking into account the categorization of abundance for families and species (see methodology) the families Araceae, Polipodyaceae and Pteridaceae were the most abundant of epiphytes (Relative abundance> 10%). In addition, 7 common families were found (Relative abundance between 2 and 10%).

On the other hand, only the species *Sticherus rubiginosus* was abundant (Relative abundance> 10%), while 16 species were common.

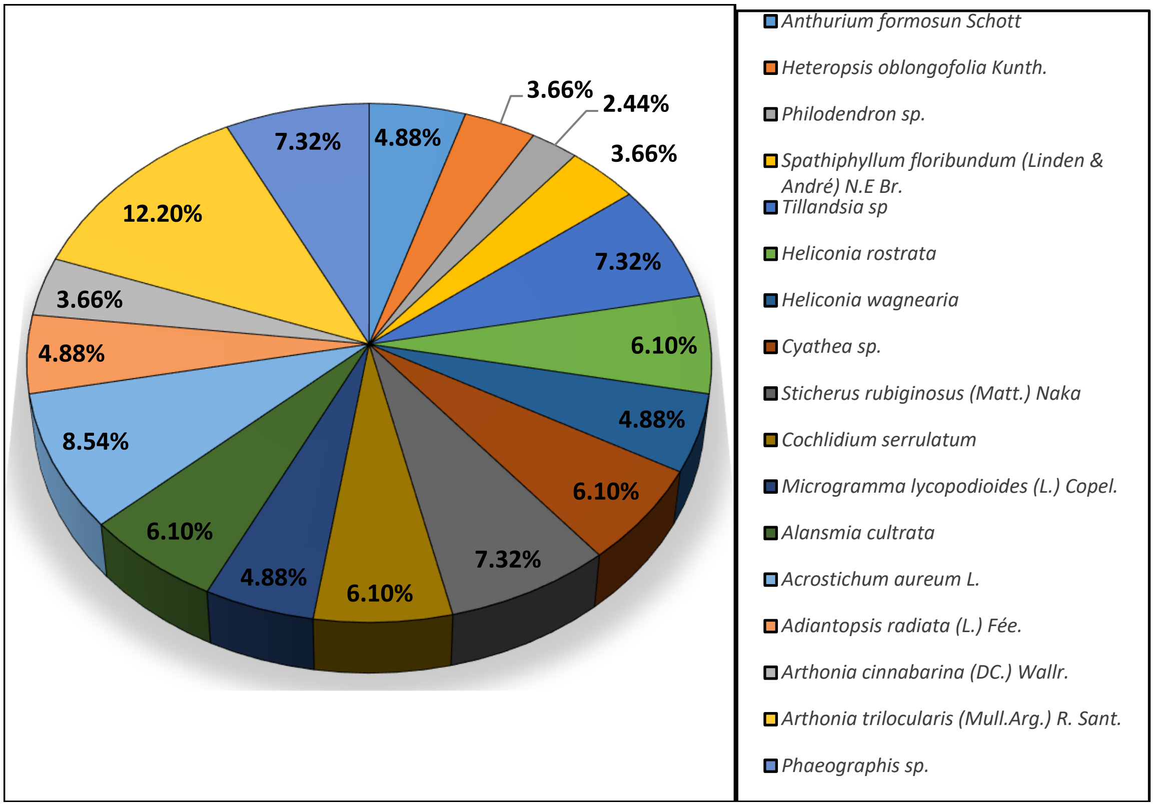


Illustration 4.2-30. Epiphytes with higher abundance.
Source: INGEX, 2016.

4.2.3.6.4 Abundance and wealth by vegetable coverings

In the case of vegetal coverings, families, genres and species differ in their structure and composition (See Illustration 4.2-31). The dense forest covering of the mainland was significantly abundant (Tukey test: p = <0.001) and rich in species (X2 = 173.5844, p = <0.001), compared to other coverings, in this case 49 families, 88 genres, 108 species and 906 individuals (85%, see Illustration 4.2-32 and Illustration 4.2-33), where the most representative and abundant families are ARECACEAE (82 ind = 9.05%), MIMOSACEAE (82 ind = 9.05%), URTICACEAE (71 ind = 7.8%), MORACEAE (68 ind = 7.50%), APOCYNACEAE (61 ind = 6.73%), ANNONACEAE (57 ind = 6.29%), LECYTHIDACEAE (59 ind = 6.07%), LAURACEAE (53 ind = 5.73%), CARYOCACEAE (45 ind = 4.96) and MYRISTICACEAE (32 ind =, 53) (See Illustration 4.2-34 and Illustration 4.2-35) . The coverings of clean grasslands (Cg), discontinuous urban traffic (Dut) and low secondary vegetation (Lsv) did not show significant differences among them in the abundance of species (Tukey test: p=>0,05). However, the Cg covering was significantly richer in species than Dut and Lsv (X^2=15.8261; p=<0,001), while Dut and Lsv did not show significant differences (X^2 = 0.2222, p = 0,63)

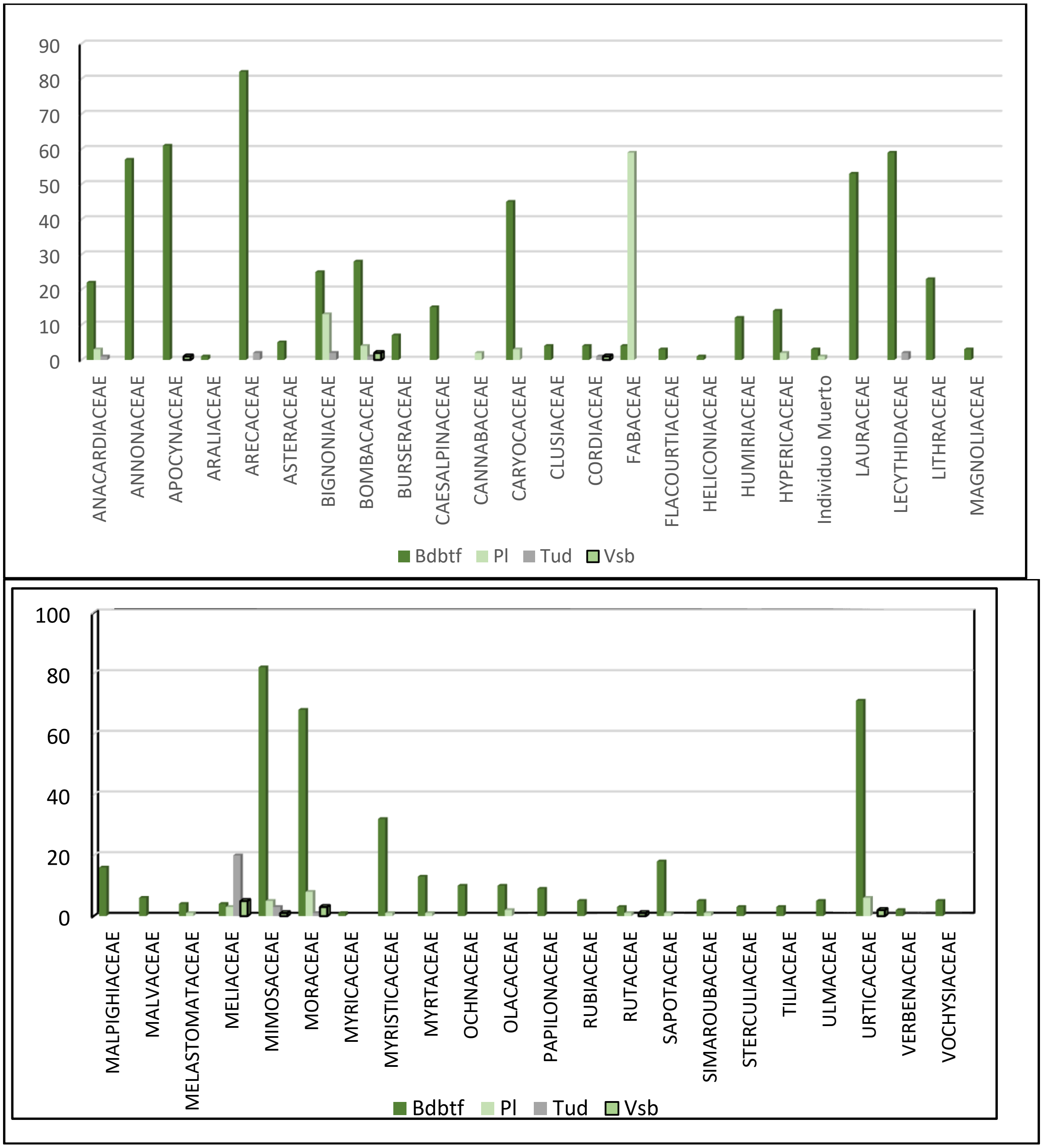


Illustration 4.2-31. Abundance of families by vegetal coverings
Source: Ingex, 2016.

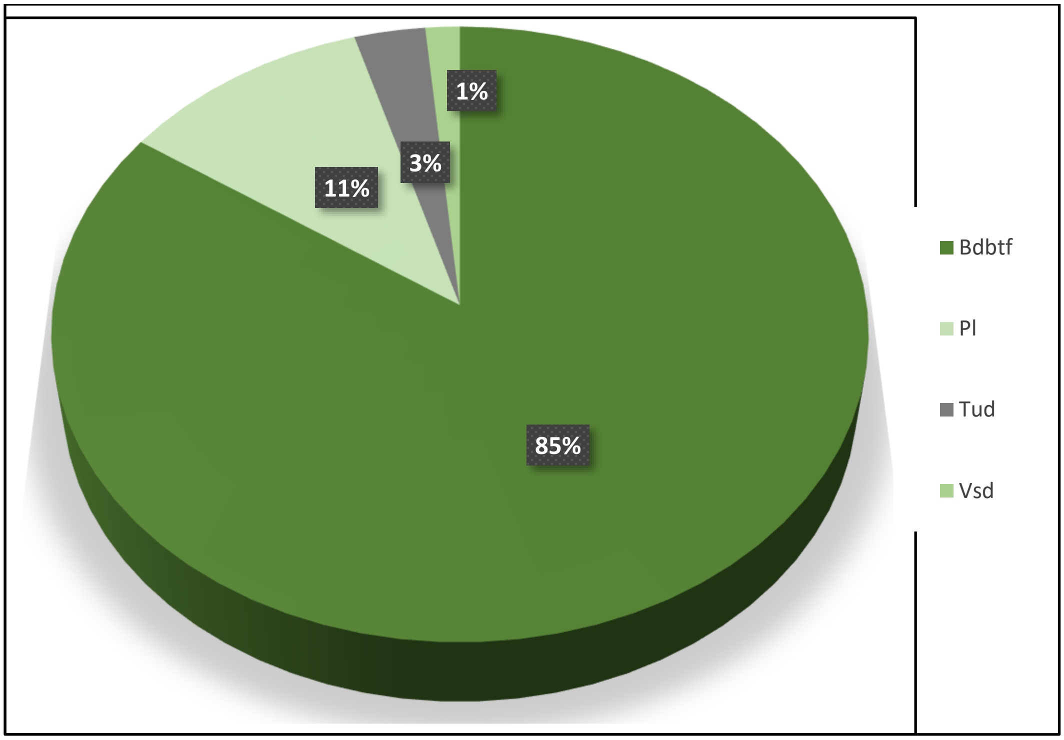


Illustration 4.2-32. Percentage of individuals/ha per vegetal covering.
Source*: INGEX, 2016.*

One of the most notorious aspects in the area of study was the high density of the palms, due to from (10) ten families with more abundance, one of them corresponded to the ARECACEAE. Other authors report similar results for other places and regions of Colombia (Franco-Rosselli et al., 1997) as the low forests of the Biogeographic Chocó (Galeano et al., 1998), although in this case only individuals with a DAP≥10 cm were recorded.

Gentry (1986) claimed that high palm density is a physiognomic feature of tropical damp forests. In some sectors of the forest studied, the palms cover certain areas, restricting the entry of light and the growth of other species. Likewise, a large number of helophyte elements were found, typical of open areas and forest borders, among which we can mainly highlight genres such as Cecropia, Pouruoma and Piptocoma.

The most particular characteristic for the forest under study is to be an area of tropical damp forest (Bh-T) crossed by a watercourse, where each of the plant formations present high diversity, which allows them to have considerable taxonomic variation, Therefore, when comparing the values of other samplings, the area of study possesses one of the highest wealth of families and species documented in samples of 0.1 ha, only comparable with samplings such as Gómez (2005) in the municipality of Anorí, or those of Gentry (2001) in Antadó, the Napo in Ecuador or Candamo River in Peru, where the wealth was over 150 species.

When establishing comparisons with other inventories carried out in tropical forests in Colombia, and considering different numbers of species and sizes of inventoried areas, such as: Chocó (Forero & Gentry, 1989), Providencia - Anorí (Soejarto, 1975), Río Claro (Cogollo, 1996), Tapón del Darién (Brand, 1986), it can be seen that the results obtained in the area coincide with the abundance and diversity of families such as ARECACEAE, MIMOSACEAE, MORACEAE, ANNONACEAE and APOCYNACEAE.

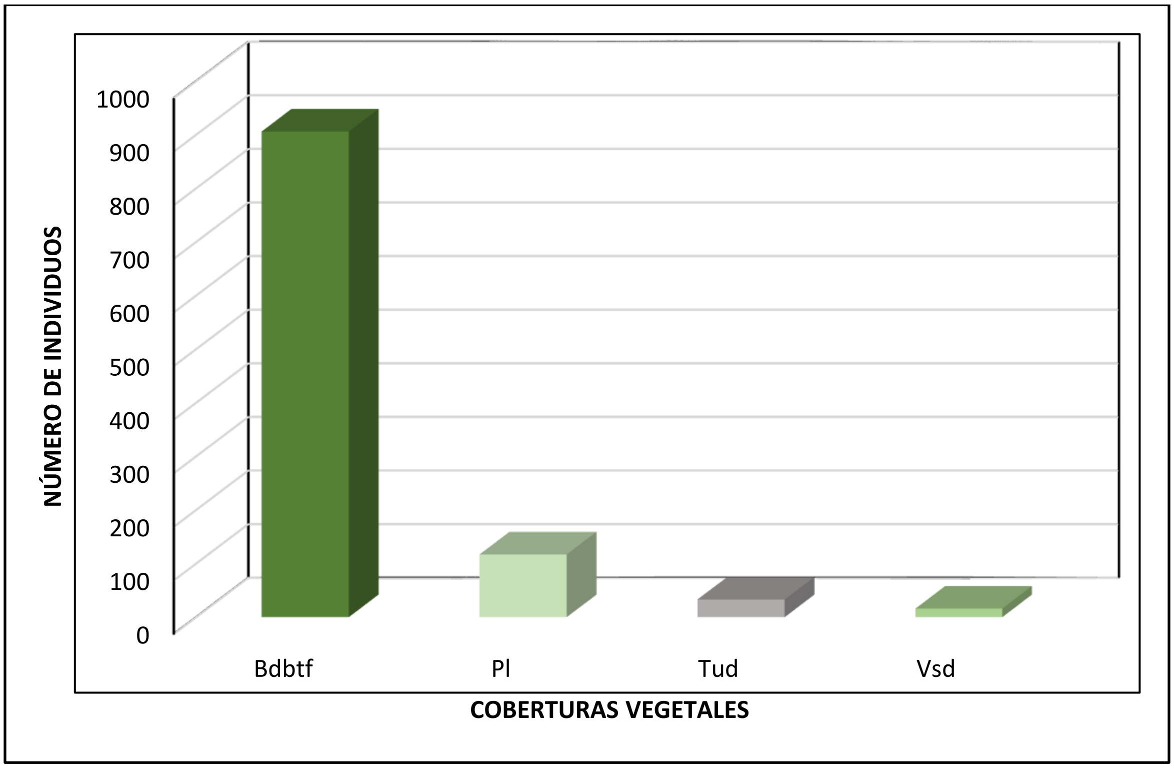


Illustration 4.2-33.Number of individuals/ha per vegetal covering.
Source: INGEX, 2016.

Among the bio indicator species, we can find the ones belonging to the family ARECACEAE, MYRISTICACEAE AND RUBIACEAE, indicators of closed canopy with high levels of humidity. Another indicator species is *Cecropia sp* (Yarumo), colonizing species, indicator of early processes of plant succession, as well as forests in recovery processes. The species belonging to the PIPERACEAE family (*Piper aduncum* L., *Piper marginatum* Jacq.), Are indicators of secondary forest with a certain degree of intervention.

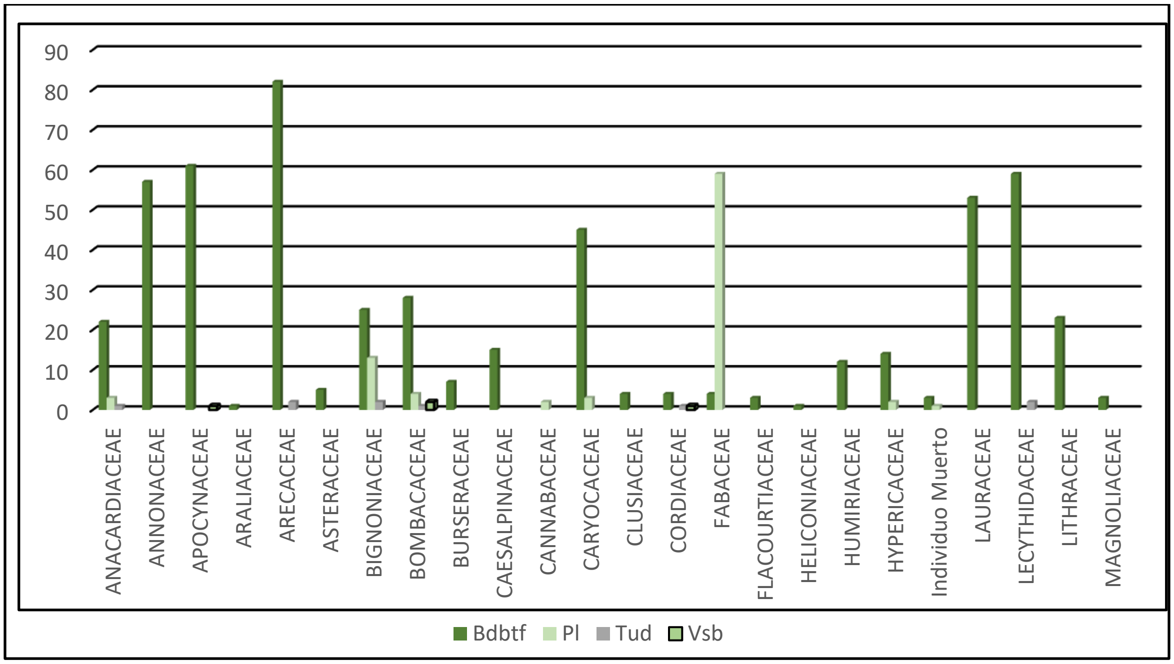


Illustration 4.2-34. Abundance of families by vegetal covering.
Source: INGEX, 2016.

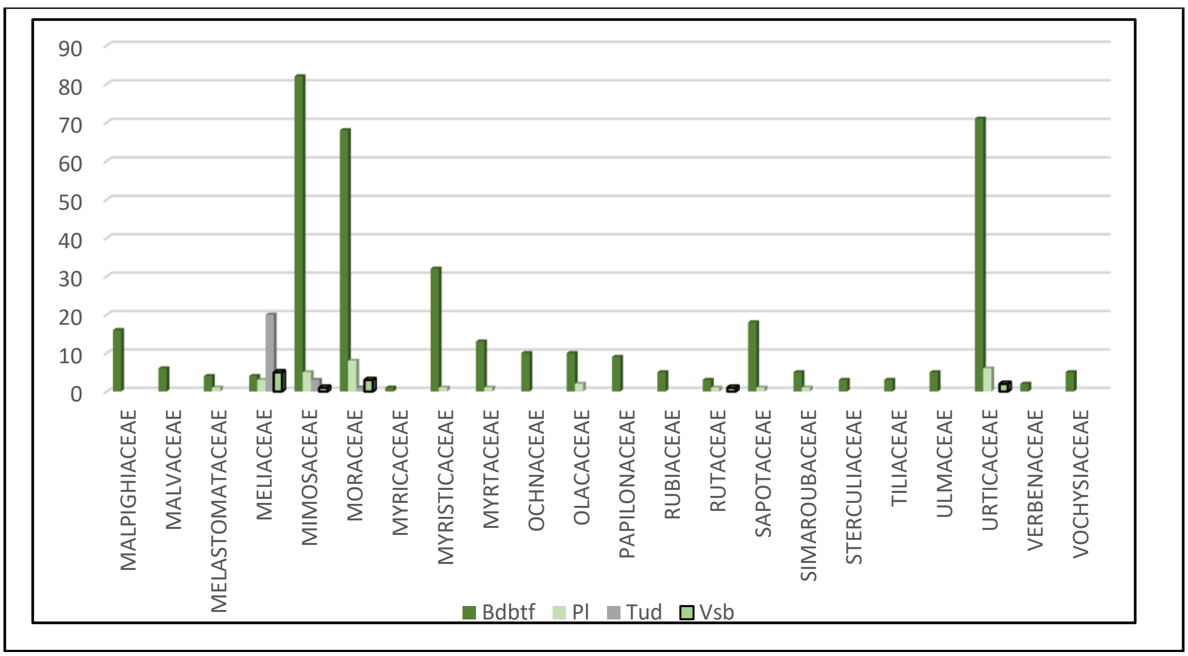


Illustration 4.2-35. Abundance of families by vegetal covering.
Source: INGEX, 2016.

4.2.3.6.5 Abundance and wealth vascular and non-vascular epiphytes by coverings Abundance

For vascular and non-vascular epiphytes there were also differences in abundance and richness due to vegetal coverings. The dense forest coverage of the mainland was significantly more abundant (Tukey test: p=<0.001) and rich in species (X^2=26.2174, p=<0.001) compared to the other coverings; the most abundant species were *Phaeographis sp*, *Heliconia rostrata, Arthonia cinnabarina* (DC.) Wallr., each with a relative abundance a little bigger than 8.95% (6 individuals). On the contrary, in the coverage of clean grasslands (Cg), discontinuous urban traffic (Dut) and low secondary vegetation (Lsv) did not show significant differences between them nor in abundance (Tukey test: p=>0,05) neither in species wealth (X^2=2,6667, p=0,10). Searching species by coverings, in clean grasslands a single species was discovered representing 100% (8 individuals) of relative abundance in such covering *Sticherus rubiginosus* (Matt.) Naka. For the coverings of secondary vegetation or in transition and discontinuous urban traffic, it was observed that the representativeness was lower in comparison with the other coverings, with the registration of two individuals for the species *Sticherus rubiginosus* (Matt.) Naka (2.44% - 2 individuals) in discontinuous urban traffic and in Vsb, a single individual *Acrostichum aureum L., Alansmia cultrata, Anthurium formosun Schott, Phaeographis sp*, *Philodendron sp* and a relative abundance a little greater than 1.22%, as evidenced in Illustration 4.2-36.

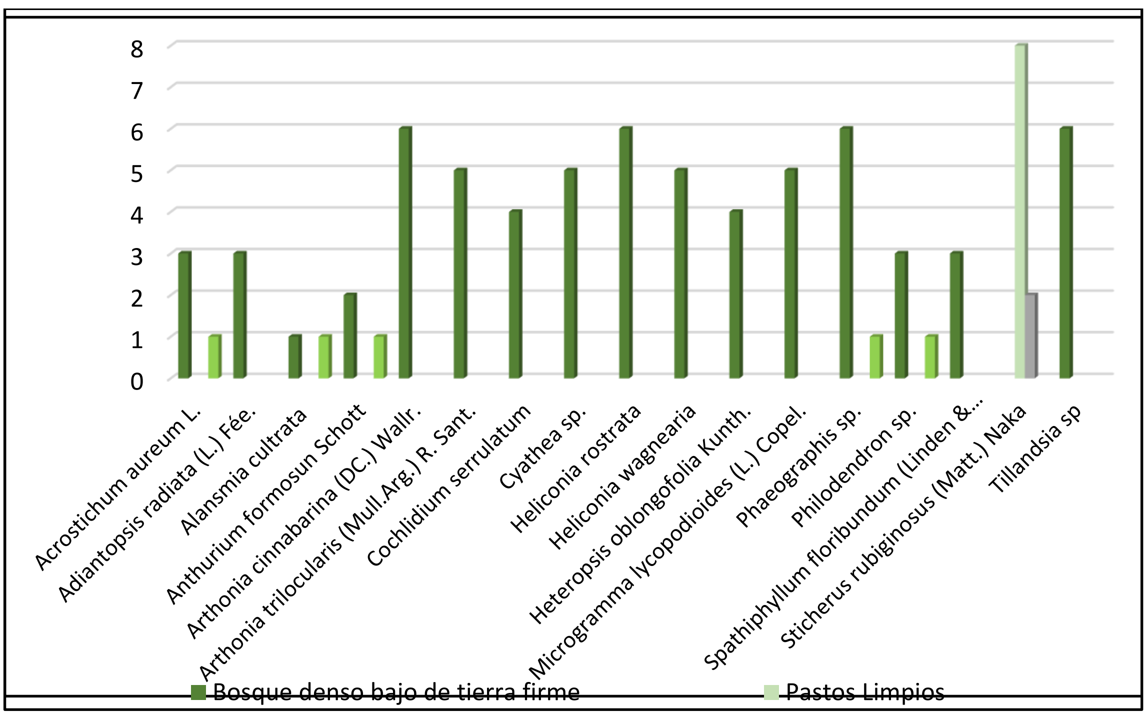


Illustration 4.2-36. Relative abundance of the epiphytes registered. Source: *INGEX, 2016.*

Some authors have reported a higher colonization of epiphytes in localities characterized by being humid and riparian (Annaselvam & Parthasarathy 2001, Leimbeck & Balslev 2001). Within the forest covering (Dlf), there are several births of water or continuous moisture, which could be facilitating a greater colonization of epiphytes in most strata and during all seasons of the year (winter and summer). On the other hand, taller and larger trees provide wider micro environmental gradients and therefore harbor greater diversity of epiphytes (Bennet 1986). These forests are native, well developed and conserved, which allows finding more diversity.

4.2.3.6.6 Structure by vegetable and covering system

Vertical structure

In the analysis of vertical structure by coverings, it was found that there are significant differences in the height between plant covers (ANOVA: p = <0.001). According to a Tukey test, significant differences were found between the heights of the Dlf - Cg covers (Tukey test: p = <0.001) and Lsv - Pl (Tukey test: p=0,01). The altimetry classes I, II and III (5 - 15m) are the most common in low dense forests of the mainland, for this reason we find a greater number of individuals of these altimetry classes than of the number VI (SINCHI, 2009) (Illustration 4.2-37 and Illustration 4.2-38. Diagram of boxes and whiskers the heights of flora in the four coverings.

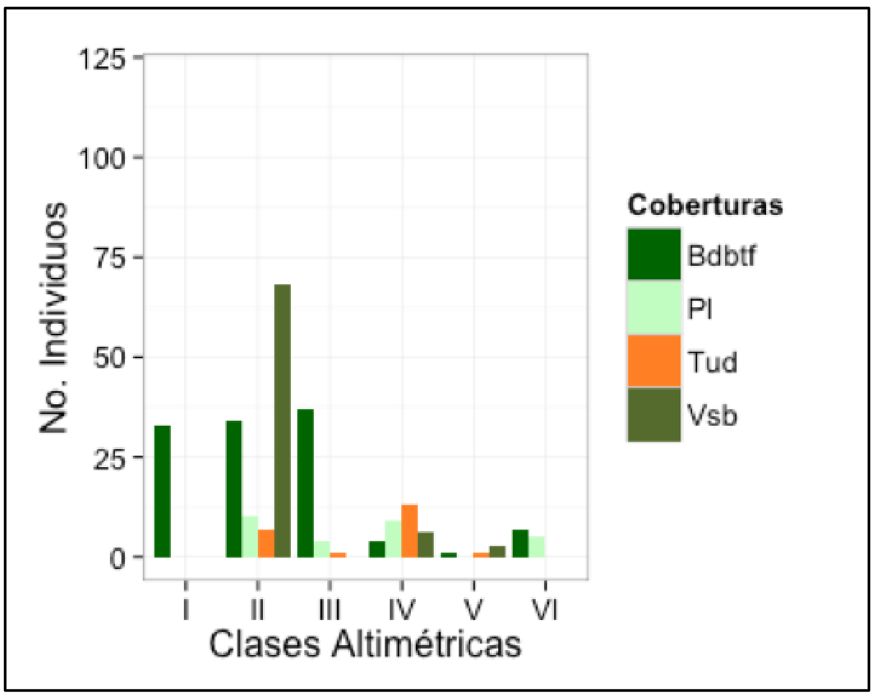


Illustration 4.2-37. Vertical distribution of species and individuals with DAP ≥10 cm and by plant cover.
Source: INGEX y Renaturar, 2016.

Ogawa's scattering diagram (See Illustration 4.2-39), points to three (3) strata (See illustration 4.2-11), which correspond to those suggested by Rangel and Velásquez (1994). According to Melo and Vargas (2001), it can be determined that the dispersion of the points does not present stratification; The trend and the graph are in the shape of a comet tail, which mainly represents heterogeneous and mature forests.

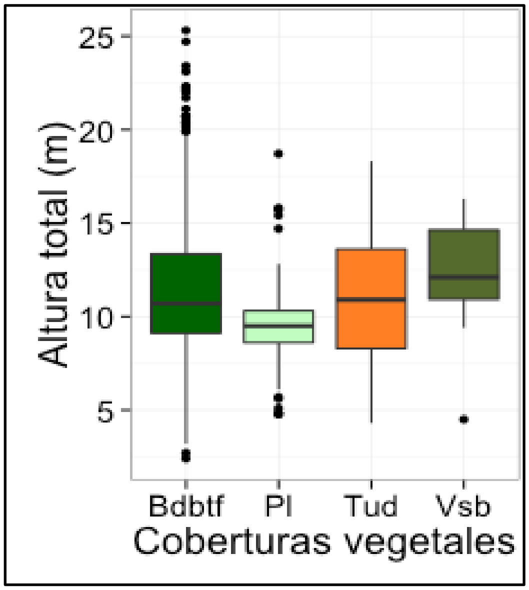


Illustration 4.2-38. Diagram of boxes and whispers of forests in the four coverings.
Source*: Renaturar, 2016.*

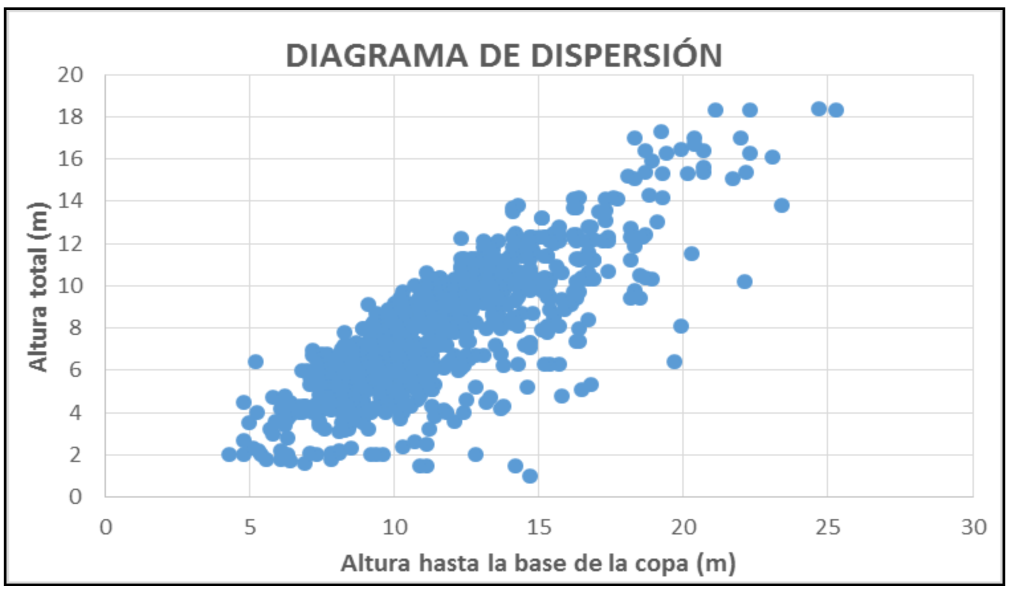


Illustration 4.2-39. Ogawa's crowns scattering diagram.
Source: INGEX, 2016.

Once defined the strata with their respective intervals for the total height, the species with their abundances are located within each of them, to determine their sociological position. Table 4.2-11 shows the sociological position of tropical damp forest species in the area of study.

Table 4.2-11. Distribution of the number of species and their abundance (number of trees) in each stratum (sociological position), for the tropical damp forest, located in Antioquia's department.

STRATA	TREE N°	N° Sp	SPECIES
2,4 – 6,22 (I)	47 (4,38%)	22	*Aniba sp, Attalea allenii, Cariniana pyriformis, Caryocar glabrum, Cedrela odorata, Ceiba pentandra, Citrus sp, Cyagrus zancona, Heliconia sp, Inga punctata* Willd, *Inga sp, Lecythis sp, Myrcia ferruginea, Ochroma lagopus, Phytelehas pittieri* Of Cook, *Phytlephas macrocarpa, Pseudolmedia rigida, Sabal mauritiliformis, Spondias mombin, Tabebuia chrysanta, Vismia baccifera* (L.) Triana & Planch, *Wettinia kalbreyeri, W. hirsuta.*
6,23 – 10,05 (II)	407 (37,96%)	89	*Abarema jupumba, Acacia mangium, Aegiphila sp, Albizia carbonaria* Britton, *Andira inermis, Aniba sp, Apeiba membranaceae, Aspidosperma cruentum, Attalea allenii, Bellucia grossullariodes, Bellucia pentámera, Bunchosia armeniaca, Caesalpinia eriostachys, Callophylum mariae* Tr. Et. Pl, *Cariniana pyriformis, Caryocar amygdaliferum, Caryocar glabrum, Casearia corymbosa, Cassia fistula, Cecropia sp, Cedrela odorata, Ceiba pentandra, Cespedecia macrophylla, Cespedesia spathulata, Cousapoa sp, Crysophyillum cainito, Cyagrus zancona, Dialium guianense, Erythrina rubrinervia, Ficus sp, Ficus zarzalensis, Guatteria sp, Guazuma ulmifolia, Gustavia longifuniculata, Helianthostylis sprucei, Humiriastrum colombianum, Humiriastrum procerum, Hymenaea courbaril, Inga marginata, Inga ornata, Inga punctata, Ing sp, Iryanthera sp, Jacaranda copaia, Jacaranda mimosifolia, Jessenia polycarpa, Lacmellea floribunda, Lagerstroemia sp, Lecythis mesophylla, Lecytis sp, Luehea seemanii, Magnolia espinalii, Mangifera indica, Miconia prasina, Mincuartia guianensis, Myrcia ferruginea, Nectandra lanceolata, Ochroma lagopus, Perebea sp, Phytlephas macrocarpa, Piptocoma discolor, Pourouma bicolor, Pourouma hirsutipetiolata, Pourouma sp, Protium neglectum, Pseudolmedia rigida, Pseudoxandrasclerocarpa, Rondeletia sp, Sabal mauritiliformis, Simaba cedron, Socratea exorrhiza, Spondias mombin, Stemmadenia so, tabebuia chrysanta, Tapira guinensis, Trema micrantha, Unonopsis velutina, Verronia spinescens, Virola flexuosa, Virola sebifera, Vismia baccifera, Vochysia ferruginea, Welfia regia, Wettinia albreyeri, Wettinia spp, Xylopia frutescens, Xylopia sp, Zanthoxylum lenticulare.*
10,06 – 13,88 (III)	420 (39,17)	87	*Abarema jupumba, Acacia mangium, Albizia carbonaria* Britton, *Andira inermis, Aniba sp, Apeiba membranaceae, Aspidosperma cruentum, Bellucia grossullariodes, Bunchosia armeniaca, Caesalpinia eriostachys, Callophylum mariae* Tr. Et. Pl, *Cariniana pyriformis, Caryocar amygdaliferum, Caryocar glabrum, Caryodaphnopsis cogolloi, Casearia corymbosa, Cassia fistula, Cecropia sp, Cedrela odorata, Ceiba pentandra, Cespedecia macrophylla, Cespedesia spathulata, Cousapoa sp, Crysophyillum cainito, Cyagrus zancona, Dacryodes colombiana, Dialium guianense, Eugenia egensis, Eugenia sp, Ficus citrifolia, Ficus sp, Guarea kunthiana, Guatteria aberrans, Guatteria sp, Guazuma ulmifolia, Gustavia gentry, Gustavia longifuniculata, Helianthostylis sprucei, Humiriastrum colombianum, Humiriastrum procerum, Inga punctata, Ing sp, Iryanthera sp, Jacaranda copaia, Jacaranda mimosifolia, Jessenia polycarpa, Lacmellea floribunda, Lagerstroemia sp, Lecythis mesophylla, Lecythis ollaria, Lecytis sp, Magnolia espinalii, Mincuartia guianensis, Myrcia ferruginea, Nectandra lanceolata, Nectandra sp Ochroma lagopus, Ochroma pyramidale, Ormosia paraense, Piptocoma discolor, Pourouma hirsutipetiolata, Pourouma sp, Protium neglectum, Pseudolmedia rigida, Pseudoxandra sclerocarpa, Rondeletia sp, Simaba cedron, Spondias mombin, Stemmadenia sp, Swietenia macrophylla, tabebuia chrysanta, Tapira guinensis, Trema micrantha, Unonopsis velutina, Verronia spinescens, Virola flexuosa, Virola sebifera, Vismia baccifera, Vochysia ferruginea, Wettinia albreyeri, Wettinia spp, Xylopia frutescens, Xylopia sp, Zanthoxylum lenticulare.*
13,89 – 17,71 (IV)	152 (14,17)	59	*Caryocar glabrum, Caryodaphnopsis cogolloi, Mincuartia guianensis, Callophylum mariae Tr. Et. Pl, Inga punctata Willd., Hymenaea courbaril Linneaus, Guatteria sp, Cyagrus zancona, Xylopia aromatica, Phytlephas macrocarpa, Aspidosperma cruentum, Pseudolmedia rigida, Inga sp, Varronia spinescens, Pourouma hirsutipetiolata, Gustavia longifuniculata, Aniba sp, Caryocar amygdaliferum, Lecythis mesophylla, Crysophyillum*

STRATA	TREE N°	N° Sp	SPECIES
			cainito, Jessenia polycarca, Helianthostylis sprucei Baill., Protium neglectum Swart, Xylopia sp., Compsoneura mutisii A.C. Sm., Stemmadenia sp, Ficus sp, Leonia sp., Abarema jupumba, Cedrela odorata, Spondias mombin, Huberodendron patinoi Cuatrec, Apeiba membranacea Spruce ex Benth, Cespedesia spathulata, Ficus citrifolia, Lagerstroemia sp, Spondias mombin, Ochroma lagopus, Bunchosia armeniaca (Cav.) D.C, Piptocoma discolor (Kunth Pruski), Pourouma hirsutipetiolata, Cousapoa sp., Eugenia egensis DC., Humiriastrum colombianum, Cecropia sp, Jacaranda copaia (Aubl.) D. Don, Vismia baccifera (L.) Triana & Planch., Iryanthera sp, Virola flexuosa, Lecythis sp, Wettinia kalbreyeri, W. hirsute, Dialium guianense, Nectandra sp., Vochysia ferruginea Mart., Tapira guianensis Aubl., Virola sebifera Aubl., Clathrotropis brunnea Amshoff, Jacaranda mimosifolia, Tabebuia chrysanta, Lacmellea floribunda, Pourouma sp.
17,72 – 21,54 (V)	36 (3,35%)	23	*Aspidosperma cruentum, Tapira guianensis Aubl., Myrica pubescens Willd, Jacaranda copaia (Aubl.) D. Don, Inga sp, Cousapoa sp., Varronia spinescens, Lecythis mesophylla, Lecythis ollaria, Helianthostylis sprucei Baill., Pourouma hirsutipetiolata, Lecythis sp, Couma macrocarpa, Pseudolmedia rigida, Spondias mombin, Lacmellea floribunda, Stemmadenia sp, Ficus sp, Cedrela odorata, Couratari guianensis, Ficus citrifolia, Caryodaphnopsis cogolloi, Nectandra lanceolata.*
21,55 – 25,37 (VI)	10 (0,93%)	8	*Tapira guianensis Aubl., Protium neglectum Swart, Ochroma lagopus, Ceiba pentandra, Caryocar amygdaliferum, Lecythis mesophylla, Vismia baccifera (L.) Triana & Planch., Lecythis tuyrana.*
TOTAL	**1072**	**288**	

Source: INGEX, 2016.

Horizontal structure

The horizontal structure, allows evaluating the behavior of individual trees and species on the forest surface, in addition to generating all the information on the relationship of a particular individual and its co-specific, which can be used for management purposes and silvicultural planning (Krebs, 1989; Lamprecht, 1990).

The species that showed the highest abundance for the 1072 individuals in the dense forest cover of the mainland (Dlf - 906 individuals) in the respective order they are, Guamo (Inga sp) with 75 individuals (8.28%), Carreto (Aspidosperma cruentum) with 41 individuals (4.53%), Cirpo (Pourouma hirsutipetiolata) with 38 individuals (4.19%), Balso (Ochroma lagopus) with 26 individuals (2.87%), Laurel (Aniba sp) with 26 Individuals (2.97%), Leche e perra (Pseudolmedia rigida) with 25 individuals (2.76), Coco (Lecythis sp) with 25 individuals (2.76%), Milkman (Helianthostylis sprucei Baill.) with 24 individuals (2.64%), Almendro (Caryocar amygdaliferum) with 23 individuals (2.54%), Chingalé (Jacaranda copaia (Aubl.) D. Don) with 23 individuals (2.54%) and Carbonero (Lagerstroemia sp) with 23 individuals (2.54%), all of them registered more than 23 individuals in all the identified plant covers, while the less abundant ones were Mahogany (Swietenia macrophylla) with a single individual (0.11%) and the bitter palm (Welfia regia) with one individual (0.11%), were also identified as the most frequent species, including Macana (Wettiniakalbreyeri, W. hirsuta) with 2.46%, Escobo (Xylopia aromatica) with 2.27% and the cagüí (Caryocar glabrum) with 2.27%, they were presented in more than 12 of the 24 plots established in the forest for structural and ecological evaluation.

Finally, the species that reported the highest dominance were *Aspidosperma cruentum* (Carreto), *Caryodaphnopsis cogolloi* (Yambé), *Pourouma hirsutipetiolata* (Cirpo), *Inga sp* (Guamo), *Ficus citrifolia* (Higueron), whose percentages exceed 4.9%. This indicates that they are the species whose diameters present the highest values. In Illustration 4.2-40, Illustration 4.2-41 and Illustration 4.2-42, are listed the species whose values of abundance, frequency and relative dominance were the highest and representative in the dense forest cover of the mainland.

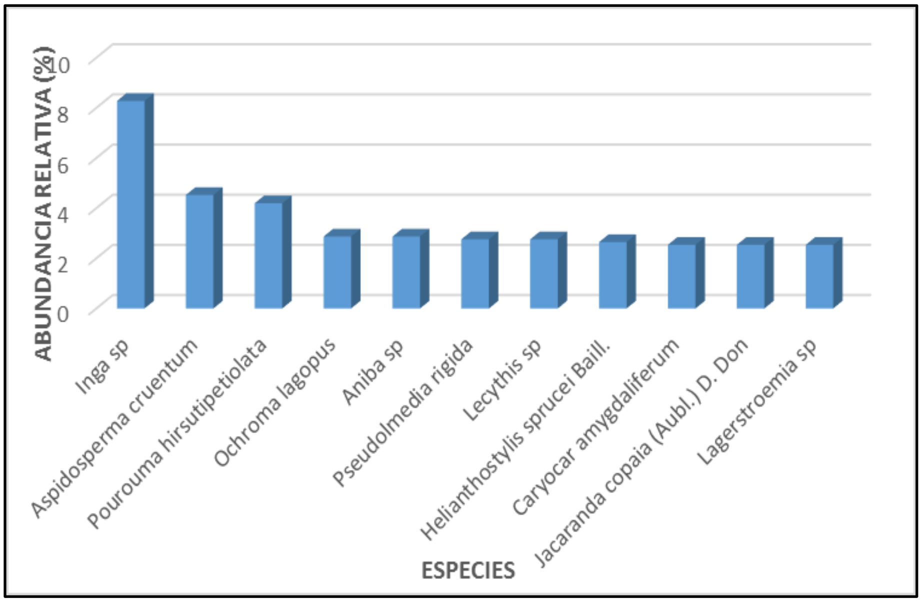


Illustration 4.2-40. Relative abundance of the most representative species, found in Bdbtf.
Source*: INGEX, 2016.*

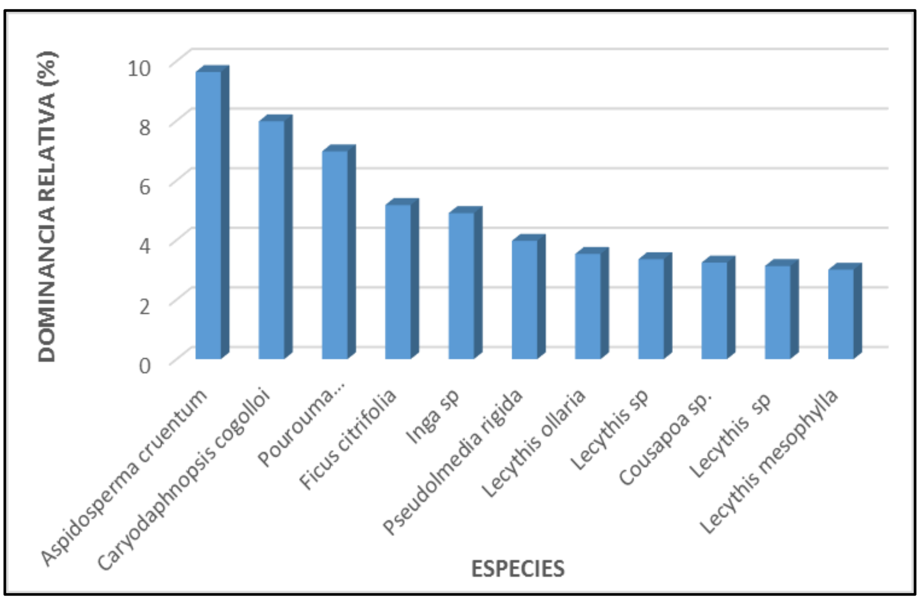


Illustration 4.2-41.Relative dominance of the species found.
Source: INGEX, 2016.

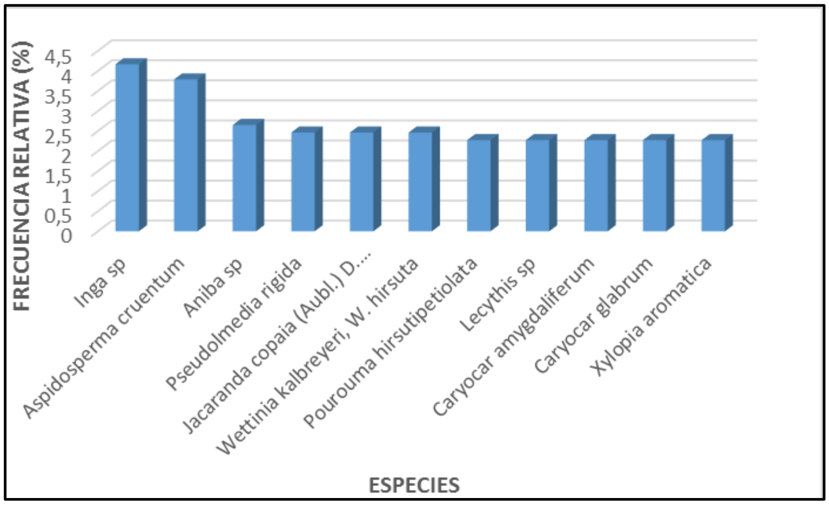


Illustration 4.2-42 Relative frequency of the species found.
Source: INGEX, 2016.

In the low secondary vegetation (Lsv), two sampling units of 100 * 10 m were established, where it was found that the species with the highest abundance are Cedro (Cedrela odorata) with five individuals (31.25%), higueron (Ficus sp) with three individuals (18.75%) and yarumo (Cecropia sp) with 2 individuals (12.5%), all of them have more than two individuals, and the least abundant species is Lemon (Citrus sp) with only one individual (6.25%). Likewise, the most frequent species were identified, in which the cedar (Cedrela odorata) is also identified with 22.2%, in two of these established plots and the less frequent found were abarema jupumba and acacia mangium (See Illustration 4.2-43).

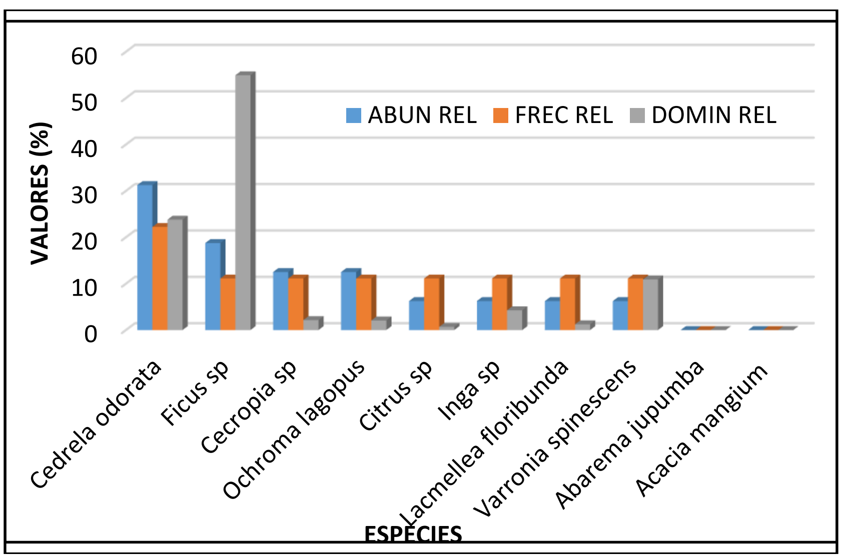


Illustration 4.24.2-43. Abundance, Frequency and Dominance of the species registered in Lsv.
Source: INGEX, 2016.

Finally, these species had the highest values in dominance or were the individuals with the most considerable diameters. In the same way, nine sample units were established in the coverings of clean grasslands (Cg), identifying the following species as the most abundant: Acacio (Acacia mangium) with presence of 57 individuals (48.1%), Guayacan (Tabebuia chrysanta) with 9 individuals (7.69%), Higueron (Ficus sp) with 6 individuals (5.12%) and Yarumo (Cecropia sp) with 5 registered individuals (4.27%). Regarding the values of frequency and dominance, the highest values were obtained for the aforementioned species, being found in more than 3 sampling units of the nine established and bigger than 24.17% (See Illustration 4.2-44).

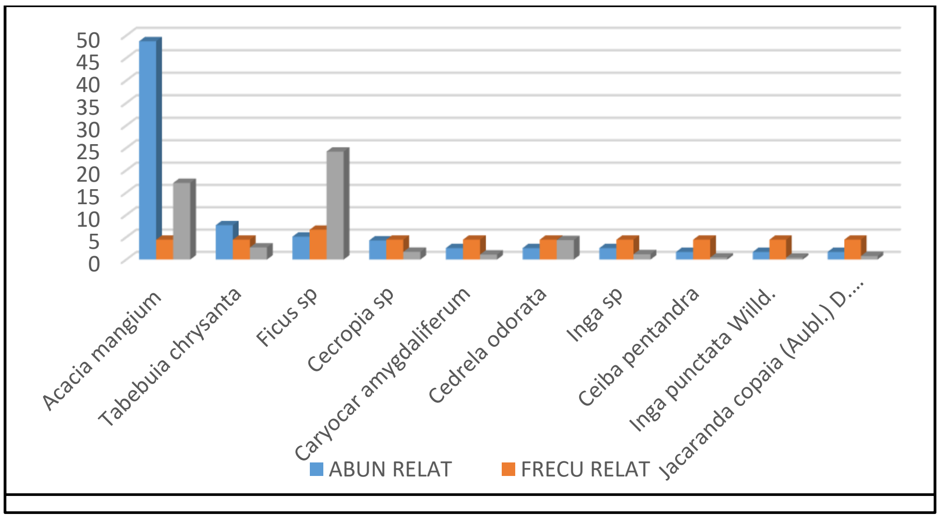


Illustration 4.24.2-44. Abundance, Frequency and relative Dominance of the most representative species registered in Cg.

Source: INGEX, 2016.

For the coverage of Discontinuous Urban Territory (Dut), two sampling units of 10 * 100 mts were established, where it was observed that the species with more dominance are the Cedar (*Cedrela odorata*) with a registry of 20 individuals (60.6%), followed by Guayacan (*Tabebuia chrysanta*) with two (2) individuals (6.06%) and finally the Guamo de monte (Inga sp) with two individuals (6.06%), the least abundant species being the Guamo churimo (*Inga marginata*) with the presence of an individual (3.03%). In the same way, the most frequent species were established, in which the Cedar was found and is present in the two established plots, in the same way as the Guayacan with 16.66%; the least frequent or the ones found in a single sample unit are the Guamo Churimo and Guácimo (Spondias mombin) with 8.33% (See Illustration 4.2-45).

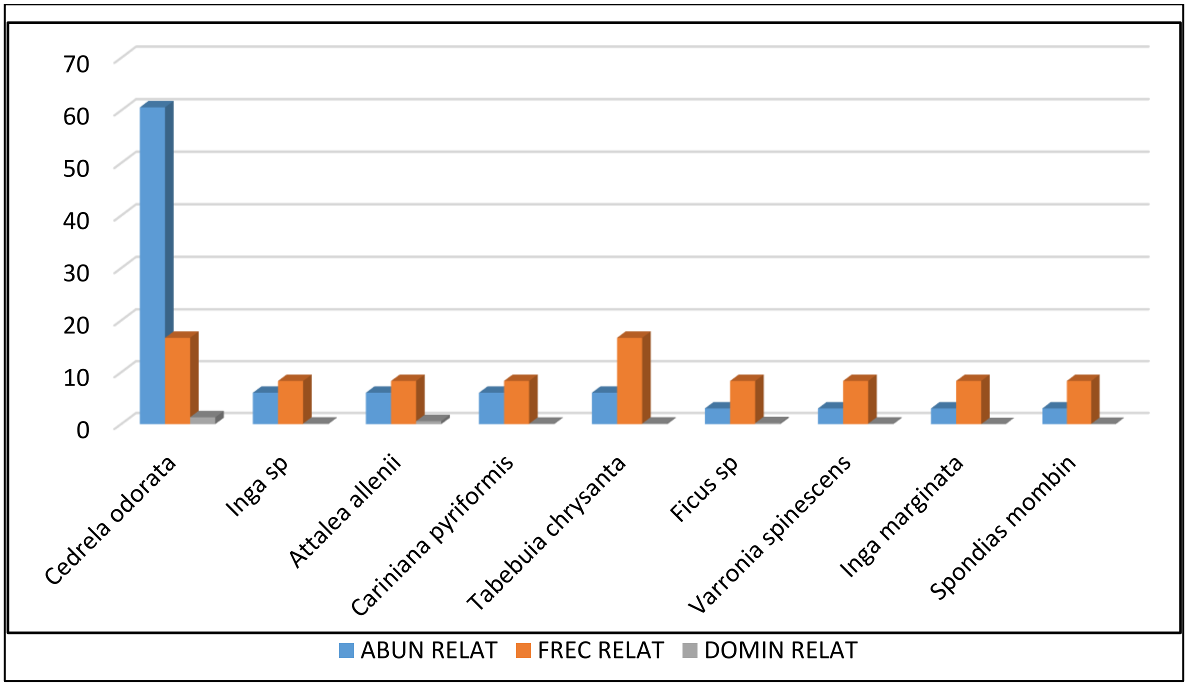


Illustration 4.24.2-45. Abundance, Frequency and Dominance of the species registered in Dut.
Source: INGEX, 2016.

Mixing Ratio (MR)

The mixing ratio gives a value of 1: 9.09 or expressed in decimal (0.11), which indicates that for every 9 individuals sampled, it is possible to find a different species. It is observed, therefore, a little diverse forest with a tendency towards heterogeneity due to the high number of individuals per species registered, when compared with the forests of Jenaro Herrera, Loreto, where the approximate mixing coefficient is 1: 4 for individuals with diameters greater than 10 cm. (Sabogal, 1980).

The high floristic heterogeneity found in the area under study shows that small patches of forest can support a high diversity.

Natural Regeneration

For the evaluation of the early natural regeneration, sampling units of 2 * 2 m for saplings and 5 * 5 m for latitudes were carried out, where 1840 individuals, 62 families, 110 genres and 142 species were recorded. From which the most representative families or with greater abundance are ARECACEAE with 274 individuals (14.89%), MIMOSACEAE with the representation of 155 species (8.42%), MELASTOMATACEAE with 110 individuals (5.97%), MYRISTICACEAE with 82 individuals (4.45%), MORACEAE with 74 individuals (4.02%), URTICACEAE with 69 individuals (3.75%), CAESALPINACEAE with 63 individuals (3.42%), ANNONACEAE with 62 individuals (3.37%), APOCYNACAE with 61 individuals (3.31%) and LAURACEAE with 50 individuals (2.71%) (See illustration 4.2-46).

Similarly, the most abundant genres are *Wettinia* with the presence of 131 individuals (7.12%), *Inga* with 118 individuals (6.41%), *Cecropia* with 70 individuals (3.80%), *Miconia* with 62 individuals (3.36%), *Cyagrus* with 51 individuals (2.77%), *Salvia* with 43 individuals (2.33%), *Cespedecia* with 42 individuals (2.28%), *Pourouma* with 34 individuals (1.84%), *Ochroma* with 33 individuals (1.79%) and *Aniba* with 32 individuals (1.73%) in the different coverings identified (See Illustration 4.2-47).

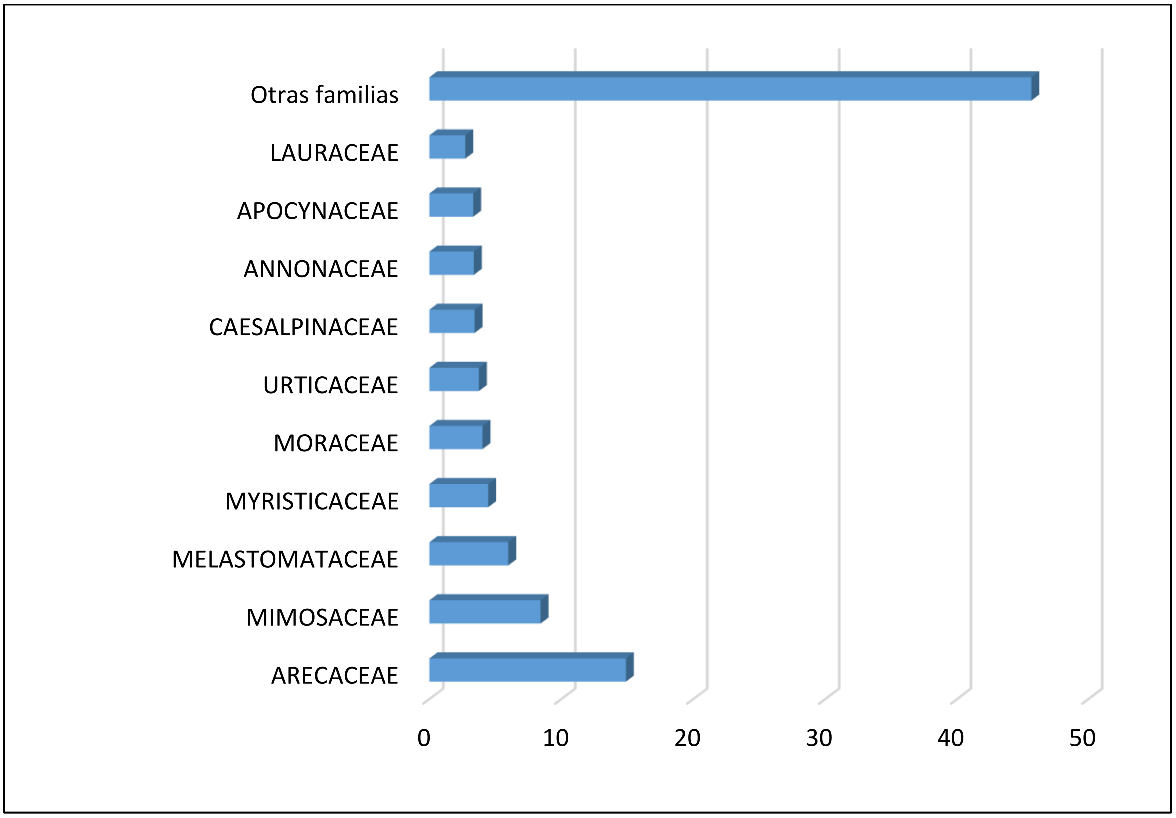


Illustration 4.24.2-46.Abundance for early natural regeneration.
Source: INGEX, 2016.

In terms of frequency, the species with the highest or most frequent values, which means that are above 1.8% are *Inga sp*, *Cespedecia macrophylla, Cecropia sp, Miconia spicellata Bonpl. Ex Naudin, Cyagrus zancona, Wettinia kalbreyeri, Aniba sp, Jacaranda copaia, Aspidosperma cruentum* and *Pseudolmedia rigida*, as shown in Illustration 4.2-48.

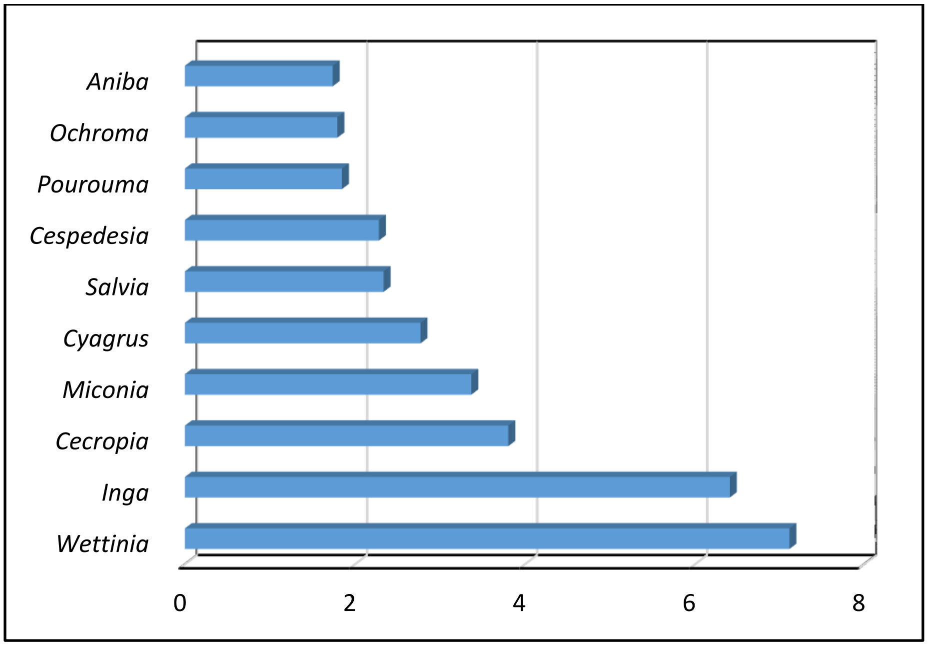


Illustration 4.24.2-47. More Abundant genus.
Source: INGEX, 2016.

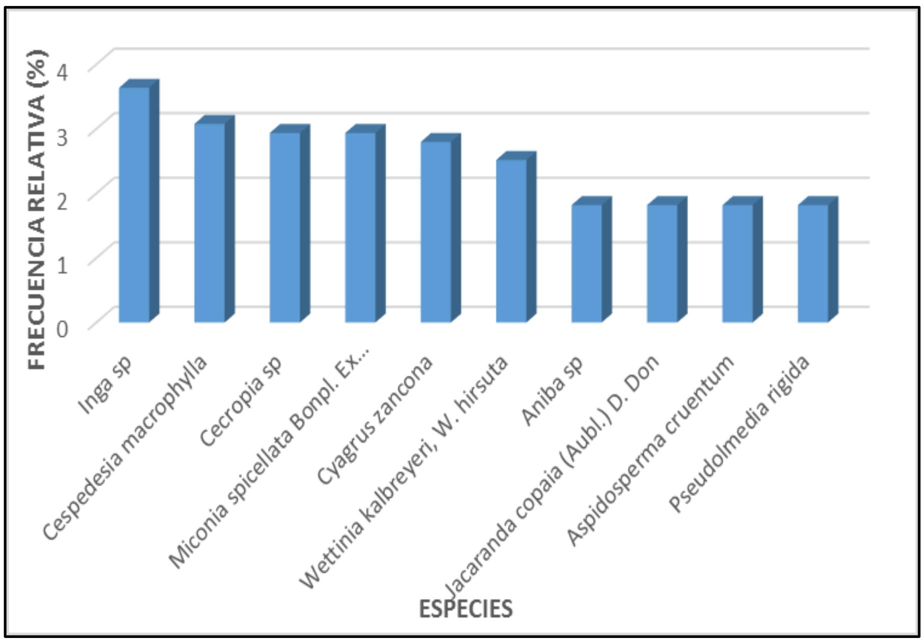


Illustration 4.24.2-48. Frequency for early natural regeneration.
Source: INGEX, 2016.

Value Index of Extended and not extended Importance

Table 4.2-11 relates the IVI (%), the sociological position (Sp%), the percentage of natural regeneration (Rn%) and the IVIA (%) for each of the species recorded in the forest cover.

Table 4.24.2-12 Value of Importance Index and Value Index of Accumulated Importance (%).

SPECIES	I.V.I (100%)	IPF	Rn%	IVIA(%)
Abarema jupumba	0,99442553	3,34518061	0,73224479	5,07185093
Acacia mangium	2,59224157	9,15659893	0	11,7488405
Aegiphila sp.	0,12630015	0,22994339	0,07306075	0,4293043
Albizia carbonaria Britton	0,20458823	0,35024163	0,19544072	0,75027058
Andira inermis (W. Wright) Kunth	0,65940994	1,37657812	0,4562723	2,49226036
Aniba sp	1,94198613	4,31299268	1,80896206	8,06394087
Apeiba membranacea Spruce ex Benth	0,41688934	1,27586274	0,95932835	2,65208043
Aspidosperma cruentum	4,9259945	17,5454119	1,66866927	24,1400756
Attalea allenii	0,44465807	1,57739228	0,1543491	2,17639945
Bellucia grossullariodes	0,16356692	0,35671654	0,6158522	1,13613566
Bellucia pentameraNaudin	0,0925158	0,12206522	1,16416794	1,37874896
Bunchosia armeniaca (Cav.) D.C	1,53299636	3,45714387	1,47840518	6,46854542
Caesalpinia eriostachys	0,93429882	1,95464032	1,17460417	4,06354331
Callophylum mariae Tr. Et. Pl	0,34960031	0,68171301	0,63288167	1,66419499
Cariniana pyriformis	0,4399511	0,79203123	1,45773027	2,6897126
Caryocar amygdaliferum	2,10418198	5,19304177	0,5835967	7,88082046
Caryocar glabrum	1,6383192	3,57602645	0,16478028	5,37912592
Caryodaphnopsis cogolloi	2,47510097	11,8344331	0,4646276	14,7741617
Casearia corymbosa	0,30310272	0,50485483	0,40741441	1,21537196
Cassia fistula	0,09134539	0,11571478	0,5528006	0,75986076
Cecropia sp	1,97494302	4,49181159	3,51204781	9,97880242
Cedrela odorata	2,56731078	9,23106673	0,93285165	12,7312292
Ceiba pentandra	0,46903043	1,02524151	0,28177254	1,77604449
Cespedecia macrophylla	0,38636143	0,88117304	2,41025256	3,67778704
Cespedesia spathulata	1,09503031	4,27095718	0,4235466	5,78953408
Chrysophyillum cainito	0,11029205	0,21851637	0,18364031	0,51244873
Citrus sp	0,19519778	0,29929055	0,15149859	0,64598692
Clathrotropis brunnea Amshoff	0,20704009	0,36354506	0,24069154	0,81127668
Compsoneura mutisii A.C. Sm.	0,23078226	0,41693593	1,38778008	2,03549828
Couma macrocarpa	0,36887916	0,78631697	0,34646737	1,50166349
Couratari guianensis	0,14031662	0,38142492	0,0757493	0,59749083
Cousapoa sp.	1,76068283	7,6536326	0	9,41431543
Crysophyillum cainito	1,54645972	3,68381356	1,20955709	6,43983037
Cyagrus zancona	1,23340947	2,06068273	2,74712868	6,04122088
Dacryodes colombiana Cuatrec	0,09078075	0,11265111	0,09113554	0,29456739
Dialium guianense	0,32353125	0,6156968	0,62867255	1,5679006
Erythrina rubrinervia	0,09651307	0,14375377	0	0,24026684
Eugenia egensis DC.	0,19444535	0,295208	0,09113554	0,58078889
Eugenia sp.	0,26074432	1,03484664		1,29559097
Ficus citrifolia	1,61921914	7,64589473	0,10487855	9,36999242
Ficus sp	3,09865552	13,320946	1,54588759	17,9654891
Ficus zarzalensis Standl.	0,09602572	0,14110951	0	0,23713523
Guarea kunthiana	0,12036467	0,2731688	0	0,39353347

SPECIES	I.V.I (100%)	IPF	Rn%	IVIA(%)
Guatteria aberrans Erkens & Maas	0,20174849	0,33483369	0,0757493	0,61233148
Guatteria sp	0,8032735	1,47276771	1,13444078	3,41048199
Guazuma ulmifolia	0,29498175	0,46079173	0,37080352	1,126577
Gustavia gentryi	0,21759576	0,42081847	0,13565103	0,77406526
Gustavia longifuniculata	0,41815734	0,74921213	0,72042075	1,88779022
Helianthostylis sprucei Baill.	1,75047932	4,33820925	0,44776009	6,53644866
Heliconia sp	0,08721125	0,09328358	0,29730681	0,47780164
Huberodendron patinoi Cuatrec	0,11893007	0,2653849	0	0,38431497
Humiriastrum colombianum	0,54263679	1,1228963	0,58353378	2,24906687
Humiriastrum procerum (Little) Cuatr.	0,33513584	0,60323106	0,09113554	1,02950244
Hymenaea courbaril Linneaus	0,46055914	1,73909938	0,8436587	3,04331722
Individuo Muerto	0,36875777	0,48117789	0	0,84993566
Inga marginata	0,09231061	0,12095191	0	0,21326253
Inga ornata Kunth	0,09210947	0,11986057	0,30733959	0,51930963
Inga punctata Willd.	1,06952489	2,30844477	0,51952516	3,89749483
Inga sp	5,43771386	15,4778209	5,40384921	26,319384
Iryanthera sp	1,22960978	2,95350768	1,5650961	5,74821356
Jacaranda copaia (Aubl.) D. Don	1,98929558	4,34063623	1,61523986	7,94517168
Jacaranda mimosifolia	0,41212076	0,71645862	0,78082869	1,90940806
Jessenia polycarca	0,86785566	1,59688907	0,98321618	3,4479609
Lacmellea floribunda	1,21535507	2,71978537	0,66365415	4,59879458
Lagerstroemia sp	1,5468817	3,30895111	1,27096546	6,12679827
Lecythis sp	0,90731084	4,5430145	0	5,45032534
Lecythis mesophylla	1,76558003	5,86159763	0,63721344	8,2643911
Lecythis ollaria	1,3378444	5,58842809	0,28031489	7,20658738
Lecythis sp	2,33103051	7,10827744	1,09067453	10,5299825
Lecythis tuyrana	0,12917105	0,32095081	0,07306075	0,52318261
Leonia sp.	0,18162079	0,60553484	0,09113554	0,87829117
Luehea seemanii	0,09469149	0,13387018	0,28789557	0,51645724
Magnolia espinalii	0,25319255	0,53853061	0,21140033	1,00312348
Mangifera indica	0,26074432	1,03484664	0,10772905	1,40332002
Miconia prasina (Sw.) DC	0,09952237	0,16008178	0,36170227	0,62130642
Mincuartia guianensis	1,12106509	1,82827195	0,54053886	3,4898759
Myrcia ferruginea.	0,79054961	1,1746798	0,50409962	2,46932903
Myrica pubescens Willd	0,13620352	0,35910791	0	0,49531143
Nectandra lanceolata	0,90728702	1,9616982	0,82768848	3,69667369
Nectandra sp.	0,20556823	0,66003946	0,19601409	1,06162178
Ochroma lagopus	2,44699737	7,05586274	1,60436779	11,1072279
Ochroma pyramidale	0,11223302	0,22904773	0	0,34128075
Ormosia paraense	0,09570811	0,1393862	0,18016652	0,41526082
Perebea sp.	0,18684726	0,25398196	0,13702026	0,57784948
Phytelehas pittieri Of Cook.	0,08721125	0,09328358	0	0,18049483
Phytlephas macrocarpa	1,10999738	2,30726851	1,53812133	4,95538723
Piptocoma discolor (Kunth Pruski)	0,44737047	0,83228758	0,39441735	1,6740754
Pourouma bicolor	0,18504778	0,24421827	0,50019318	0,92945923
Pourouma hirsutipetiolata	3,80492367	13,7448828	1,68208412	19,2318906
Pourouma sp	1,18103213	2,99441349	0,32197988	4,4974255
Protium neglectum Swart	0,86592533	2,72338923	0,4060951	3,99540966
Pseudolmedia rigida	2,68232245	8,25451025	1,48629916	12,4231319
Pseudoxandra sclerocarpa	0,28135777	0,38687015	0,81421616	1,48244408
Rondeletia sp.	0,43482071	1,06867502	0,18227107	1,68576681

SPECIES	I.V.I (100%)	IPF	Rn%	IVIA(%)
Sabal mauritiliformis	0,35491733	0,55970149	0,41581459	1,33043341
Schefflera morototoni	0,09690118	0,1458596	0,18016652	0,4229273
Simaba cedron	0,46847591	0,87137195	1,61294972	2,95279759
Socratea exorrhiza	0,09293831	0,1243577	0,09113554	0,30843155
Spondias mombin	1,77393223	4,30908256	0,75541297	6,83842776
Stemmadenia sp	0,69809577	1,5082921	0,63434994	2,84073781
Swietenia macrophylla	0,11500605	0,2440938	0,09113554	0,45023539
Tabebuia chrysanta	0,90972802	2,12856236	0,20169147	3,23998185
Tapira guianensis Aubl.	0,61308596	1,27609236	0,67876639	2,56794471
Trema micrantha	0,19065213	0,2746266	0	0,46527873
Unonopsis velutina	0,57167408	0,82234796	0,44729876	1,84132081
Varronia spinescens	1,01024499	3,05110366	1,01461194	5,07596059
Virola flexuosa	0,62897363	1,28686589	0,86503232	2,78087184
Virola sebifera Aubl.	0,28299825	0,70025163	0,50636614	1,48961602
Vismia baccifera (L.) Triana & Planch.	1,9555614	7,12145659	1,496579	10,573597
Vochysia ferruginea Mart.	0,3835534	1,17041758	1,14951702	2,703488
Welfia regia	0,092599	0,12251669	0,92914584	1,14426153
Wettinia kalbreyeri, W. hirsuta	1,51075941	2,80571796	5,53162247	9,84809984
Wettinia spp.	0,08721125	0,09328358	0	0,18049483
Xylopia aromatica	1,48463395	3,04387621	0,49660735	5,02511751
Xylopia frutescens	0,39149139	0,83357699	0,18016652	1,4052349
Xylopia sp.	1,04817888	2,27081392	0,29984732	3,61884013
Zanthoxylum lenticulare Reynel	0,62547773	1,03884765	0,31644083	1,98076621

Source: INGEX, 2016.

The value index of importance allows comparing the ecological weight of the species within the plant community. The species with the greatest ecological weight in the study were Guamo (*Inga sp*), Carreto (*Aspidosperma cruentum*), Cirpo (*Pourouma hirsutipetiolata*), Acacia (*Acacia mangium*), Cedar (*Cedrala odorata*), Yambé (*Caryodaphnopsis cogolloi*), Balso (*Ochroma lagopus*), Coco (*Lecythis sp*) and Almendrón (*Caryocar amygdaliferum*), whose values are above 2.12% (See Table 4.2-49).

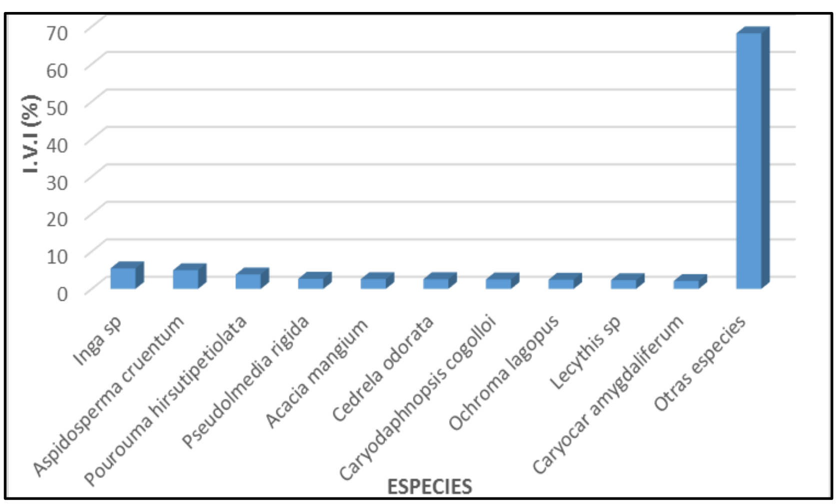


Illustration 4.24.2-49. Value Index of Significant Importance (IVI), in DIf.
Source: INGEX, 2016.

In the case of the Value Index of Significant Importance (hereinafter VISI), the results show that the species that presented the highest values in the sociological position were Carreto (*Aspidosperma cruentum*), Guamo (*Inga sp*), Cirpo (*Pourouma hirsutipetiolata*), *Ficus sp* and Yambé (*Caryodaphnopsis cogolloi*) with percentages higher than 11%. The natural regeneration was recorded for 103 of the 118 species, where the Macana palm (*Wettinia kalbreyeri, W. hirsuta*), Guamo (*Inga sp*) and Yarumo (*Cecropia sp*) with percentages of 5.53%, 5.40% and 3.51% respectively and finally the notable species for their value index of extended importance were the same species mentioned for the IVIA, In spite the above and in the same way as in the IVI, the sum of the value for the category of other species, records the highest value. The results obtained for the IVIA can be seen in Table 4.2-50.

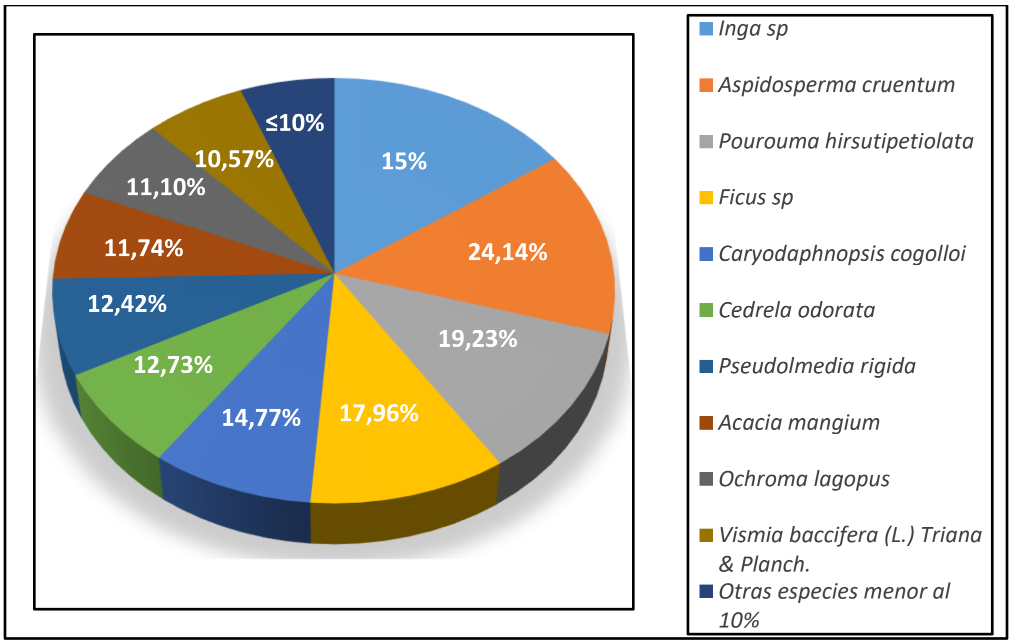


Illustration 4.24.2-50. Value Index of Significant Importance for species.
Source*: INGEX, 2016.*

The ecological importance of the species represented by the values of IVI, suggest a heterogeneous behavior within the ecosystem. The IVI is strongly influenced by the presence of large individuals, such as the case of the species *Inga sp*, which presented one of the highest values of IVI with 199 individuals, which had diameters greater than 45 cm. This coincides with data reported in tropical forests, where a few trees with heights and high diameters present the highest IVI in the forest (Dueñas et al 2007).

The structural behavior of genres such as *Wettinia*, *Vochysia* and *Compsoneura* was similar to that observed by Gómez (2005) in other forests, where they are reported as having high ecological importance within the ecosystem.

Diametric distributions by types

The diametric distribution shows an irregular inverted Jay behavior (See Table 4.2-13 e Table 4.2-51), typical behavior of natural forests. VI diameter classes were differentiated, where 85.88% of the individuals correspond to class I (10 - 38cm), followed by class II (38.1 - 66.1 cm) with 7.05% and III (66, 2-94.2cm) with 1.32% of the individuals. The upper classes (V and VI) have a low number of individuals (9 and 3 respectively), which represent 0.33%.

Table 4.24.2-13. Distribution of diametric classes in the forest.

DIAMETRIC CLASS	LIMITS (cm)	ABUNDANCE	
		ABSOLUTE	RELATIVE
I	10 - 38	779	85,88754135
II	38,1 - 66,1	64	7,056229327
III	66,2 - 94,2	12	1,323042999
IV	94,3 - 122,3	4	0,441014333
V	122,4 - 150,4	9	0,992282249
VI	150,5 - 178,5	3	0,33076075
Palmas		36	3,969128997
TOTAL		907	100

Source: INGEX, 2016.

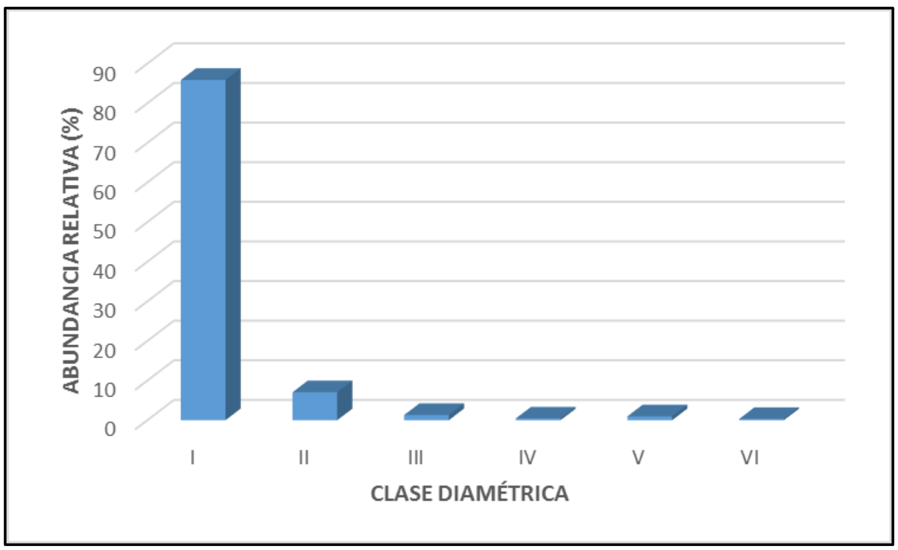


Illustration 4.24.2-51. Diametric distribution histogram in Forest.
Source: INGEX, 2016.

According to Palacios and Ramos (1999), an aspect that influences the presence of small or medium diameters, can be mainly due to the presence of many clearings in the forest caused by the fall of one or several trees either because they fulfill their biological cycle or by anthropic effect. The distribution of the individuals by diametric class, as previously mentioned, showed a behavior similar to an inverted "J", this product of a slow recovery after having supported selective extraction of characteristic wood that makes the diametric distribution have this form. Lamprecht

(1990) states that the diametric distribution of individuals in young native forests or in recovery processes present a tendency in this way. On the contrary, Pardo and Cediel (1994), explain that the diametric distribution in the form of inverted "J" of individuals in the forests of Cabo Corrientes (Chocó) can be the result of the interaction of factors such as: permanently washed soils and with low content of nutrients that do not allow the support of large trees, the steep topography of the terrain that influences the dynamics of the forest and favors the presence of individuals with smaller diameters.

Height distribution

The behavior of the altimetry distribution is not very similar to the diameter distribution, as shown in Table 4.2-14 e Table 4.2-52. The individuals are distributed indistinctly and are concentrated in the intermediate height classes, as shown by the peaks of the histogram, in VI class of intervals; this is how 50.44% are distributed in classes I, II, IV, V and VI, with category III having the largest number of individuals (363) and class VI having the smallest number of individuals (10 ind).

Table 4.24.2-14. Distribution of altimetry classes in wood.

ALTIMETRIC	LIMITS (m)	ABSOLUTE ABUNDANCE	RELATIVE ABUNDANCE
I	2,4 - 6,22	33	3,078358209
II	6,23 - 10,05	327	30,50373134
III	10,06 - 13,88	363	33,8619403
IV	13,89 - 17,71	137	12,77985075
V	17,72 - 21,54	34	3,171641791
VI	21,55 - 25,37	10	0,932835821
TOTAL		1072	100

Source: INGEX, 2016.

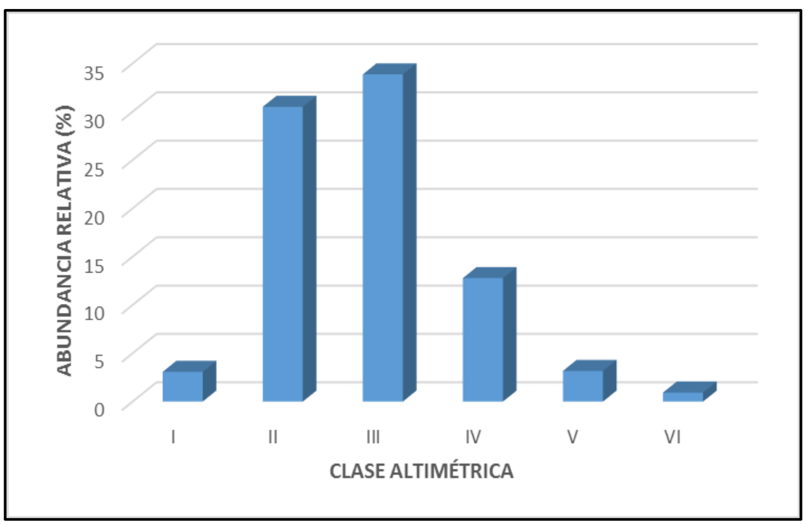


Illustration 4.24.2-52. Altimetry distribution histogram in wood.
Source: INGEX, 2016.

According to Table 4.2-52, it is observed that most individuals are growing or waiting for better lighting conditions in order to ascend to the canopy, but there are also individuals of certain smaller species that remain in the lower classes throughout their whole lives. The palm *Phytelephas macrocarpa* (Tagua or vegetable ivory), was frequently found in the plots; however, due to morphological aspects (acauline or very small trunk) it was not evaluated.

Individuals of some species were present in all forest strata, such as *Aspidosperma cruentum* (Carreto), *Tapira guianensis Aubl*. (Fresno), *Ochroma lagopus* (Balso), *Aniba sp* (Laurel), *Caryocar glabrum* (Cagui), *Cecropia sp* (Yarumo), Guamo de monte (*Inga sp*), *Calophyllum mariae* Planch. & Triana (Olive oil), *Iryanthera sp* (Soquete) and *Pourouma hirsutipetiolata* (Cirpo), which occasionally reach the canopy. There are also individuals restricted to the forest such as *Miconia sp* (Tuno or Niguito), *Miconia spicellata* Bonpl. Ex Naudin (Tuno or Niguito), *Psychotria elata* (Sw.) Hammel (Mouth of devil), *Vismia baccifera* (L.) Triana & Planch. (Carate) and Inga ornata Kunth (Guamo).

Total and commercial volume per plot

The total and commercial volume of wood was determined for each of the plots and per hectare. The average volume of total wood is 23,598 m3 / plot. For the commercial, 70% of the total volume of wood was considered. The total and commercial volumes per plot and hectare are presented in Table 4.2-15.

Table 4.24.2-15. Total and commercial volume per plot.

PLOTS	Vt (m³)/plot	Vc (m³)/ploy	Vt (m³)/ha	Vc (m³)/ha
1	17,48947793	14,07742288	174,8947793	140,7742288
2	40,3614298	30,84392809	403,614298	308,4392809
3	35,01605382	28,33542034	350,1605382	283,3542034
4	37,08936445	27,87521603	370,8936445	278,7521603
5	23,25977337	17,79282197	232,5977337	177,9282197
6	45,29975095	35,48826074	452,9975095	354,8826074
7	23,96280152	16,50986719	239,6280152	165,0986719
8	12,68612831	8,8816451	126,8612831	88,816451
9	41,78853378	28,0462055	417,8853378	280,462055
10	14,7008517	9,976349443	147,008517	99,76349443
11	25,32685387	17,05784653	253,2685387	170,5784653
12	8,316968542	5,237630827	83,16968542	52,37630827
13	13,35678662	9,090465657	133,5678662	90,90465657
14	14,69216851	10,01881521	146,9216851	100,1881521
15	17,13074495	11,59028982	171,3074495	115,9028982
16	25,70876999	17,53077538	257,0876999	175,3077538
17	7,435981012	2,512869274	74,35981012	25,12869274
18	4,975553468	1,201366285	49,75553468	12,01366285
19	11,58141539	3,196253106	115,8141539	31,96253106
20	31,96886534	20,60825565	319,6886534	206,0825565
21	18,29262203	10,18620912	182,9262203	101,8620912
22	4,227588453	2,070302258	42,27588453	20,70302258
23	28,15700409	10,35210368	281,5700409	103,5210368

PLOTS	Vt (m³)/plot	Vc (m³)/ploy	Vt (m³)/ha	Vc (m³)/ha
24	17,03840208	6,441899064	170,3840208	64,41899064
25	8,816176047	5,771879514	88,16176047	57,71879514
26	8,137598128	5,029278109	81,37598128	50,29278109
27	13,53909607	7,230177365	135,3909607	72,30177365
28	9,239513962	5,945541657	92,39513962	59,45541657
29	37,25578682	28,75192756	372,5578682	287,5192756
30	14,46725951	10,27219461	144,6725951	102,7219461
31	95,62359646	75,93557863	956,2359646	759,3557863
32	30,32357588	20,79968129	303,2357588	207,9968129
33	35,81108183	28,92487142	358,1108183	289,2487142
34	21,25765594	12,03228786	212,5765594	120,3228786
35	31,62225667	17,24782249	316,2225667	172,4782249
TOTAL	**825,9574873**	**562,8634596**	**8259,574873**	**5628,634596**
AVERAGE	**23,59878535**	**16,08181313**	**235,9878535**	**160,8181313**

Source: INGEX, 2016.

The results of the traditional statistical parameters for the analysis of the existence of wood in the forests, are within the accepted values to consider the sampling as sufficient and representative (See Table 4.2-16)

Table 4.24.2-16. Calculation of traditional statistical parameters.

PARAMETERS	CALCULATED VALUES
Average	160,82
Standard deviation	17,04
T Student	1,697
Sampling error (%)	9
Coefficient of variation	10,60

Source: INGEX, 2016.

Biomass, carbon, moisture and other physicochemical properties

Biomass

Estimating forest biomass reserves is a useful tool to assess the amount of carbon stored in living structures at a given moment, important for assessing their contribution to the carbon cycle. Hence the interest in making estimations of biomass in tropical forests (Brown, 1997).

In Colombia, biomass estimations have been made in forests of different natural regions of the country. The Andean and Amazonian regions have the highest number of estimations, while towards Magdalena Medio and the Caribbean, there are very few studies of this type (Anzola & Rodríguez, 2001).

The biomass was estimated based on aspects of the vegetation structure (WTP, height, specific weight of the individuals' wood). For this calculation, the equation proposed by Chave et al. (2005), specific equation for wet tanks (See Table 4.2-17).

Table 4.24.2-17. Algometric model used to estimate the aerial biomass of trees with DAP>10 cm of the tropical damp forest, area of study.

AUTHOR	ALOMETRIC EQUATION	ORIGIN	AMPLITUDE DAP
Chave et al. (2005)	B= ρi * exp (-1.499 + 2.148*ln(DAP) + 0.207 $(\ln(DAP))^2$ - 0.0281$(\ln(DAP))^3$	Global tropical damp forests	>10 cm

Source: Chave et al, 2005.

The biomass estimated for each one of the plant covers present in the site varied from 36.33 ± 16.21ton/0.1ha. For lifting carried out in the forest, it varies from 35.69 ± 16.43ton/0.1ha, for clean grasslands it varies from 36.02 ± 18.09ton/0.1ha, for the low secondary vegetation varies from 33 , 34 ± 16.86 ton/0.1ha and finally for discontinuous urban traffic varied from 31.87 ± 16.72ton/0.1ha, although the values are very similar, the differences presented indicate that the characteristics of each of the coverings (structure, floristic composition, degree of disturbance) are related to the amount of biomass stored in the vegetation. Table 4.2-18 clearly shows the values for each coverage.

Table 4.24.2-18. Average values of the variables of the structure of the biomass in the different coverings.

TYPE OF COVERING	BIOMASS (t/ha)	TYPE OF RCB
Low dense forest of the mainland	36,69 ± 16,43	HIgh
Low secondary vegetation	33,34 ± 16,86	Middle
Clean lgrasslands	36,02 ± 18,09	High
Discontinuous urban traffic	31,87 ± 16,72	Middle

Source: INGEX, 2016.

When comparing the data found with the forests of the south and north-west of Córdoba (Velásquez & Arellano, 2009), the values are similar, since their highest rank is 46.05 ± 34.72tons/0.05ha and the lowest varies from 10.51 ± 5.88 tons/0.05ha approximately. In a study conducted in tropical humid and super-humid forest, in relation to other studies, such as those carried out in Costa Rica, the maximum values are 207 Mg ha-1 in damp and very damp forest (Ulate, 2011). The variation of the results is possibly due to the different evaluation methods that are applied to raise the information and the intrinsic biophysical characteristics in the areas of study, which are determinant in the stocks of aerial biomass and stored carbon.

In the distribution of biomass by diametric class (DAP), the dominance of some individuals is observed due to a high amount of biomass (See Table 4.2-19).

Table 4.2-19. Biomass values by diametric class.

DIAMETRIC CLASS	LIMITS	BIOMASS (t/ha)
I	10 - 38	20,6183065
II	38,1 - 66,1	27,46663016
III	66,2 - 94,2	31,42014752
IV	94,3 - 122,3	33,17730776
V	122,4 - 150,4	34,73242152
VI	150,5 - 178,5	35,80407479

Source: INGEX, 2016.

Carbon, moisture and other physical properties of the soil

The carbon present in the soil is closely related to the decomposition process of the biomass. According to the guide for the determination of carbon in small rural properties (2009), there are five types of carbon deposits that can be measured (See Table 4.2-20).

Table 4.2-20. Description of the different types of carbon deposit.

TIPE OF DEPOSIT		DESCRIPTION
Live Biomass	Biomass upon the ground	The whole live biomass found upon the ground, including trunks, live stumps, branches, rinds, seeds and leaves. To facilitate the measures the aerial arboreal biomass and the non-arboreal aerial biomass is evaluated separately.
	Subterranean Biomass	All the biomass of live roots. Fine roots less than 2 mm in diameter are excluded, because they are difficult to distinguish from the organic matter in the soil.
Dead Organic Matter	Dead wood	All non-living forest biomass: fallen logs, standing dead trees, and stumps larger than 10 cm in diameter.
	Dead leaves	The whole biomass does not live on the soil (leaves, branches and fruit shells) in different stages of decomposition. It includes the layers of detritus and humus. A minimum diameter can be previously established to differentiate from "dead wood" (for example, 10 cm).
Soils	Ground organic matter	It comprises organic carbon in mineral and organic soils at a specific depth selected by the project proponent.
		Thin live roots with diameter less than 2 mm.

Source: INGEX, 2016.

Carbon is found organically and inorganically in the soil. The organic carbon present in the soil represents a dynamic balance between the absorption of dead plant material and the loss by decomposition (mineralization).

In order to determine the carbon stored in the biomass, it is usual to multiply the same and the carbon fraction contained in it, for this case it was calculated using the ratio of the biomass with the carbon of 0.5 as defined in the model of the Canadian Forest Sector Carbon Budget (hereinafter CBM-CFS3). In addition to creating carbon curves, applying its relationship with biomass.

That is to say that the carbon content for the compartments "On the ground", "Underground" and "Dead wood" constitutes 50% of the biomass. The carbon content on the soil comes from the soil component presented for the vegetation and horizons (depth in meters).

The results of the carbon content by covering and diameter class are presented in Table 4.2-21 and Table 4.2-22.

Table 4.2-21. Results of the different plant cover for the average carbon content.

TYPE OF COVER	CARBON (Tn/0.1Ha)
Dense forest under mainland	18,35 ± 8,22
Low secondary vegetation	16,67 ± 8,43
Clean grasslands	18,01 ± 8,1
Discontinuous urban traffic	15,93 ± 8,36

Source: INGEX, 2016.

Table 4.24.2-22. Carbon values by diametric class.

DIAMETRIC CLASS	LIMITS	CARBON (t/0,1ha)
I	10 - 38	10,31
II	38,1 - 66,1	13,73
III	66,2 - 94,2	15,71
IV	94,3 - 122,3	16,58
V	122,4 - 150,4	17,36
VI	150,5 - 178,5	17,90

Source: INGEX, 2016.

The carbon captured by each forest region depends on the surface of the region and the increase of dry matter per hectare for each type of vegetation cover and diametric class. For the purposes of this project and the biotic studied area, the dense lowland forest presented the highest values, since it has the highest values both in basal area and in height, this is the case of *Aspidosperma cruentum, Inga sp, Ceiba pentandra, Caryodaphnopsis cogolloi, Ficus sp* and *Caryocar glabrum*. The covering with lower values such as discontinuous urban traffic, has low values of basal area and height as the associations of *Ochroma lagopus, Cecropia sp, Trema micrantha, Bellucia pentámera Naudin* and *Isertia haenkeana* D.C.

The absence of trees in crop coverage (plantain - cassava and cocoa), did not allow to quantify these variables (biomass and carbon).

The structure of vegetation among forest types varied in terms of distribution of diameter classes, biomass reserves and carbon. The difference between presence and absence of large individuals (diameter classes and upper strata) between the different forest types is related to the variation in observed biomass and carbon reserves (Vásquez & Arellano, 2012).

No significant difference was observed in the values of carbon and biomass reserves in plants cover, behavior that is quite related to the state of plant succession, natural factors and anthropic intervention.

The high structural variability found closely resembles to the one made by *Sierra et al* (2007) in the Porce region, where a heterogeneous vegetation was quantified in both primary and secondary forest and high basal area values were related to the variability of biomass, in addition to its relation to the use of soil and its physical and chemical characteristics.

In the same way, species contribute unevenly to the storage of biomass and carbon. It is evident that the largest amount of carbon is deposited in the biomass of a small number of species; on average of the 117 species only five of them possess between 1.205 - 1.309%. These species include *Caryodaphnopsis cogolloi* (1.309%), *Eugenia sp* (1.289%), *Mangifera indica* (1.289%), *Ficus citrifolia* (1.266%) and *Cousapoa sp* (1.205%).

Besides the forests that function as large carbon sinks, the role of secondary vegetation is also fundamental, although they have not presented high amounts of biomass, since they can be constituted as carbon sinks due to the phase in which they are located. They capture carbon dioxide and store it in their structures.

It is also evident that the largest amount of biomass is concentrated in a small number of species, on average five species that contain between 50 and 80% of the biomass and carbon reserves in each type of covering. This condition indicates that if anthropic pressure (felling) is exerted on the populations of these species, a significant amount of carbon will be released in turn.

Moisture content, organic carbon and other physicochemical properties of the soil, for the development of vegetation.

The moisture content in plants is one of the critical values of their physiological development and is a key parameter to determine water stress conditions. The humidity available in the plant directly influences cell growth, transpiration and photosynthesis. Variations in the moisture content of plants and ultimately water stress, cause physiological and anatomical changes of different nature depending on the species.

The lack of water leads to a reduction in the transpiration of the plant, which implies an increase in the temperature of the leaves, since evapotranspiration releases heat into the atmosphere. In addition, by reducing the available water, the plant tries to reduce transpiration by closing the stomata, which causes a lower absorption of CO_2, a deterioration of tissue structure, a reduction in photosynthesis and, ultimately, lower productivity. (Hale and Orcutt 1987). In the forest, soil moisture can be conserved by the type and percentage of vegetation cover (Cortés, Rodriguez & Alcalá, 2000), which is why it is important to know the variation in soil moisture, for the six-different plant covers present in the area under study.

The results showed that in the forest zone, the moisture content was higher than in the other covers. In the site with the highest tree cover, the effect of reducing soil water loss was evidenced. Without tree cover, more than 200 m3 / ha of soil are lost (Cortés et al., 2000). The secondary low vegetation can be important in sites that have lost the arboreal stratum; therefore, they show an important initial effect in the conservation of soil water. According to Toro (2009), towards the lower parts of the Magdalena Medio forests (Segovia, Remedios, Anorí, Amalfi), the forest cover, have seen highly modified, due to the opening of agricultural areas, extensive cattle ranching, timber extraction, illicit crop plantations and artisanal mining. Therefore, the properties of the soil are modified to a greater or lesser degree, depending on the level of the disturbance, the extension and the time in which it is exposed to degradation factors.

One of the physical properties of the soil, which is highly affected by these factors, is the moisture content, due to the various ecological functions it fulfills, such as being a source of water for the vegetation in each of its strata. It is also part of the biological activity of organisms such as bacteria, fungi, among others. In addition to promoting the processes of germination, growth and development of new seedlings. For the study of the behavior of the vegetation according to the value of the moisture content of the soil, the results are shown in Table 4.2-23 to Table 4.2-28 and illustration 4.2-53.

Table 4.24.2-23 Humidity content (%) in the soil for Forest (Dlf).

COVERING	HORIZON	CH%
SLE-Bdbtf	HB2	25,54%
DLE2-Bdbtf (28)	HA	33,82%
SLE-Bdbtf	HB1	35,33%
DL-Bdbtf	HB	36,82%
DLE2-Bdbtf (28)	HB	41,15%
DL-Bdbtf	HA	45,75%
SLE-Bdbtf	HBAP	53,69%
TOTAL		272,1%

Source: INGEX, 2016.

Table 4.24.2-24. Humidity content (%) in the soil for Low secondary vegetation (Lsv).

COVERING	HORIZON	CH%
FHyP-DL-Vsb	HB2	26,08%
FHyP-DL-Vsb	HA	27,40%
FHyP-DL-Vsb	HB1	28,05%
TOTAL		81,53%

Source: INGEX, 2016.

Table 4.24.2-25. Humidity content (%) in the soil for clean grasslands (Cg).

COVERING	HORIZON	CH%
FHyP-DL-Pl	HA	18,37%
YANO Pl	HA	22,05%
YANO Pl	HB	24,60%
FHyP-DL-Pl	HB	26,11%
YANO-FT-Pl	HB	32,13%
YANO-FT-Pl	HA	36,90%
DLM2-Pl (11)	HB	40,17%
DEL-Pl	HB2	40,59%
DEL-Pl	HB1	43,49%
DLM2-Pl (11)	HA	55,88%
DEL-Pl	HA	83,09%
TOTAL		423,38%

Source: INGEX, 2016.

Table 4.24.2-26. Humidity content (%) In the soil for cocoa (Cc).

COVERING	HORIZON	CH%
Cc	HA	48,36%
Cc	HB1	32,19%
Cc	HB2	39,69%
Cc	HB3	32,00%
TOTAL		152,24%

Source: INGEX, 2016.

Table 4.2-27. Humidity content (%) In the soil for plantain and cassava (Cpc).

COVERING	HORIZON	CH%
Cpy	HA	33,25%
Cpy	HB1	39,04%
Cpy	HB2	36,88%
TOTAL		109,17

Source: INGEX, 2016.

Table 4.24.2-28. Humidity content (%) In the soil for discontinuous urban traffic (Dut).

COVERING	HORIZON	CH%
Dut (24)	HB	32,81%
TOTAL		32,81%

Source: INGEX, 2016.

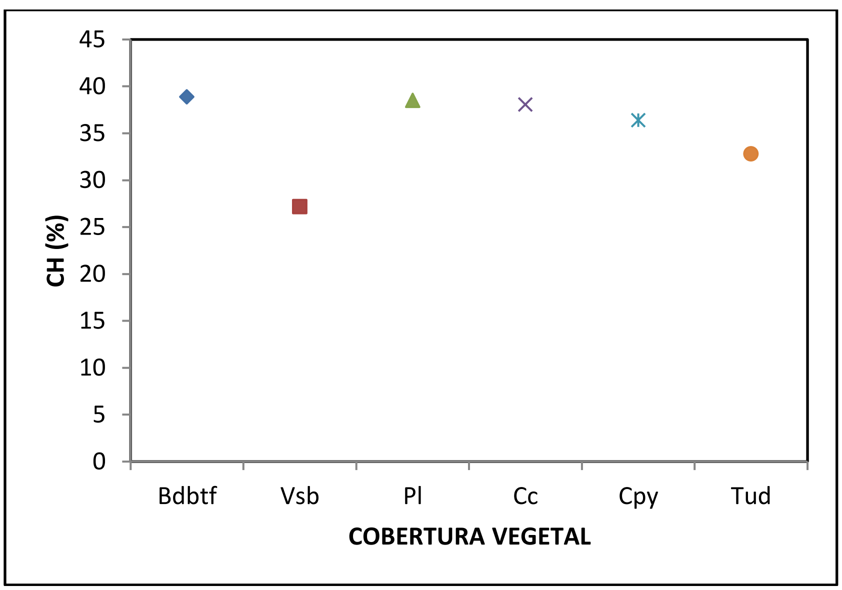


Illustration 4.24.2-53. Average humidity content of the soil.
Source: INGEX, 2016.

The results of each of the plant coves were observed, where the lowest values were found in the low secondary vegetation (hereinafter Lsv) and discontinuous urban tissue (Dut). Thus the difference of total moisture (%) between the forest and the Vsb was 190.57%, it was also found that when comparing the total moisture content of the forest with the zone of discontinuous urban traffic, the difference is 239.29%. This clearly shows the important effect of forest cover and forest mulch in the conservation of humidity in the studied area, reducing evapotranspiration. The differences in moisture contents when comparing the Vsb zone and theCg area was 341.85%. This suggests that it is possible that the Vsb combined with the clean grass cover begin to have a protective effect on the soil, which could be accentuated as the foliage of the growing trees expands.

When comparing the forest with the pasture area, the negative value of -151.28% was obtained, which corroborates the assumption that the forest area loses moisture more rapidly and that the pasture cover plays a fundamental role in the soil protection, in the area under study. The high values, in some areas where the sampling was carried out, corroborated that during the rainy period the soil moistening in the coverage of clean grasses (Cg) is faster than in the forest (Dlf).

The water content present in the soil can decrease below the field capacity as a consequence of the evaporation and transpiration of the plants. When the water film that surrounds the soil particles becomes thinner, it becomes impossible for it to be absorbed by the roots and is in the state called wilting point. This process is characterized by the fact that the plants cannot take water from the soil, consequently experiencing permanent wilting.

Among the most relevant species in each of the plant covers or with the highest importance value index, are the Guamo (*Inga sp*), Carreto (*Aspidosperma cruentum*), Cirpo (*Pourouma hirsutipetiolata*), Acacio (*Acacia mangium*), Cedar (*Cedrala odorata*), Yambé (*Caryodaphnopsis cogolloi*), Balso (*Ochroma lagopus*), Coco (*Lecythis sp*) and Almendrón (*Caryocar amygdaliferum*), with specimens that can reach up to 25 meters in height, which require defined soil conditions, in addition to reduce the rate of evaporation. This amount of water can make the difference between wilting and the survival of a plantation in dry periods.

Next, some of these species are mentioned, such as the *Acacia mangium*, which fulfills a very important function of soil protection, with its structure (stem and leaves) decreases the direct effect of sun, rain and wind; with its deep and extended roots reduce the surface runoff of rainwater, allow a better absorption of water and nutrients due to the big area explored, also counteract the compaction processes due to continuous tillage or grazing (Benavides J, 1998). The litter they produce is a source of organic matter. In it the macro and microorganisms of the soil find favorable conditions to multiply and decompose the complex forms present in the tissues, in simple substances such as nitrogen, phosphorus, potassium, magnesium and calcium to be absorbed again by trees and neighbor crops. Trees can use their stems as firewood, wood or material for new crops and their foliage to feed animals.

Depending on the final use, the time between the cuts is fixed; at higher intervals the production of woody material increases and at lower intervals the production of forage (Benavides J, 1998).

Cedrela odorata grows very well on lithe soils and rend zines, as well as calcareous, clayey soils, deep sandy, black-sandy, black-stony, red-clayey, brownish-limy. Besides being a demanding species in soils, it requires deep, aerated, well-drained, fertile soils, pH between 5.0 and 7.0 with good availability of larger elements, ranging from clay loam to sandy loam.

In the case of *Caryodaphnopsis cogolloi*, the required soils should be developed, moderately deep to superficial, with medium textures, excessively drained, low to very low fertility, high aluminum content toxicity, poor in bases and high organic carbon content (Polanco, Caicedo & Beltrán, 2013).

In the same way the *Ochroma lagopus* needs clayey, silty and well drained soils, as well as being a species that requires a rich nutrient demand, it is helophytic, so it does not tolerate shade.

Once each of the soil requirements by species has been described, it is said that plant covers not only protect the soil from erosive processes, reduce the impacts of rain drops, reduce temperature increase, acidity, among others, but also prevents the loss of water from the soil by evaporation; besides protecting the soil from the sun's impact.

Other properties of the soil (physical), which determine the development of the roots and each of the species that lodge there, such as porosity, organic carbon, relative density and bulk density, as shown in Table 4.2-29 and Table 4.2-30

Table 4.24.2-29. Classification of the soil according to moisture content.

COLORS	CH%	HUMIDITY DEGREE	TACT
	<25%	Low	It crumbles and does not clump
	25-50%	Middle	It crumbles but it coalesces
	50-75%	Acceptable	A ball is formed and agglutinates with pressure
	75-100%	Excellent	A ball is formed agglutinates and is friendly

Source: INGEX, 2016.

Table 4.24.2-30. Physical properties of the soil.

Sample N°	COVERING	HORIZON	CH%	CO	POROSITY	D. R.	D. A.
8	FHyP-DL-Pl	HA	18,37%	1,32%	48,96%	1,92 g/cm³	0,93 g/cm³
6	YANO Pl	HA	22,05%	1,58%	52%	2,5 g/cm³	1,00 g/cm³
7	YANO Pl	HB	24,60%	0,57%	50%	2,08 g/cm³	0,84 g/cm³
14	SLE-Bdbtf	HB2	25,54%	0,11%	48,08%	2,08 g/cm³	0,65 g/cm³
20	FHyP-DL-Vsb	HB2	26,08%	0,17%	49,04%	2,08 g/cm³	1,13 g/cm³
9	FHyP-DL-Pl	HB	26,11%	0,40%	52,08%	1,92 g/cm³	1,05 g/cm³
21	FHyP-DL-Vsb	HA	27,40%	6,36%	47,40%	1,92 g/cm³	0,79 g/cm³
22	FHyP-DL-Vsb	HB1	28,05%	0,58%	49,48%	1,92 g/cm³	0,83 g/cm³
29	Cc	HB3	32,00%	0,25%	54,18%	2,27 g/cm³	N.A
3	YANO-FT-Pl	HB	32,13%	0,67%	56,18%	1,78 g/cm³	0,85 g/cm³
26	Cc	HB1	32,19%	0,34%	50,48%	2,08 g/cm³	N.A
1	Tud (24)	HB	32,81%	0,68%	62,02%	2,08 g/cm³	0,88 g/cm³
23	Cpy	HA	33,25%	1,55%	56,73%	2,08 g/cm³	N.A
18	DLE2-Bdbtf (28)	HA	33,82%	2,94%	53,61%	1,66 g/cm³	0,83 g/cm³
13	SLE-Bdbtf	HB1	35,33%	0,43%	51,56%	1,92 g/cm³	0,67 g/cm³
17	DL-Bdbtf	HB	36,82%	0,56%	52,81%	1,78 g/cm³	0,78 g/cm³
25	Cpy	HB2	36,88%	0,09%	62,50%	2,08 g/cm³	N.A
2	YANO-FT-Pl	HA	36,90%	2,54%	35,39%	1,78 g/cm³	0,92 g/cm³

Sample N°	COVERING	HORIZON	CH%	CO	POROSITY	D. R.	D. A.
24	Cpy	HB1	39,04%	0,28%	55,73%	1,92 g/cm³	N.A
28	Cc	HB2	39,69%	0,12%	51,54%	2,27 g/cm³	N.A
5	DLM2-Pl (11)	HB	40,17%	0,65%	53,37%	1,78 g/cm³	0,83 g/cm³
12	DLE-Pl	HB2	40,59%	0,38%	55,73%	1,92 g/cm³	1,02 g/cm³
19	DLE2-Bdbtf (28)	HB	41,15%	0,58%	57,29%	1,92 g/cm³	0,67 g/cm³
11	DLE-Pl	HB1	43,49%	1,72%	48,44%	1,92 g/cm³	0,93 g/cm³
16	DL-Bdbtf	HA	45,75%	3,98%	60,67%	1,78 g/cm³	0,65 g/cm³
27	Cc	HA	48,36%	2,60%	60,42%	1,92 g/cm³	N.A
15	SLE-Bdbtf	HBAP	53,69%	5,61%	55,13%	1,56 g/cm³	0,76 g/cm³
4	DLM2-Pl (11)	HA	55,88%	5,04%	56,02%	1,66 g/cm³	0,66 g/cm³
10	DLE-Pl	HA	83,09%	<0,08%	57,69%	1,56 g/cm³	0,53 g/cm³

Source: INGEX, 2016.

Most of the data obtained during the sampling are at medium humidity, indicating that the soil crumbles, but they clump together, that is, they lose moisture easily.

The porosity values were in the high range for "normal" soils: around 53.34% on average. The highest measured values corresponded to the covers of discontinuous urban traffic (62.02%), followed by the covers of plantain and cassava (58.32%), the dense lowland forest and cocoa growing with 54.16% each. The minimum value was obtained for the covers of clean grasslands and low secondary vegetation with 51.44% and 48.64%. However, these differences between each of the covers can be considered quite similar or belonging to the same population, although probably also due to low values of organic carbon.

Constant cultural activities, such as tillage, produces the soil aggregates to break and the porosity to decrease, giving place to raisings in the apparent density value; for this reason, the highest value found was obtained in the low secondary vegetation correlated with its low percentage of organic carbon (2.37%).

In terms of apparent density, it is considered that fine-textured, well-textured soils with high organic matter contents have lower apparent density values than coarse-textured, poorly structured soils with low organic matter content. Within the reference values, are the following (Schargel & Delgado, 2010) (See Table 4.2-31).

Table 4.24.2-31 Reference values according to the texture.

TEXTURE	APPARENT DENSITY
Fine (clayey)	1,00 – 1,30 Mg m^{-3}
Middle(Francs)	1,30 – 1,50 Mg m^{-3}
Thick (sandy)	1,50 – 1,70 Mg m^{-3}

Source: INGEX, 2016.

The apparent density affects the growth of the plants due to the effect of the resistance and porosity of the soil on the roots. With an increase in apparent density, the mechanical resistance tends to increase, and the soil porosity tends to decrease, with these changes the growth of the roots is limited to critical values. For the study area, the apparent density on average relates low values such as 0.86 g / cm^3 for the coverage of clean grasses, low dense forest on the mainland (0.71 g / cm^3), low secondary vegetation (0, 92 g / cm^3), Discontinuous urban territory (0.88 g / cm^3), taking into account that for covers of cocoa, banana and cassava crops, this parameter was not performed. The secondary vegetation registered higher values, mainly due to its contribution of nutrients and leaf litter to the soil.

Finally, it was estimated that the plant cover with the lowest organic carbon content was plantain and cassava (0.64%). In contrast, the low secondary vegetation was the cover with the highest total carbon (2.37%), which is due to a series of factors such as the physical and biological conditions of the soil and the history of the inputs of organic material to the Soils, which can determine the rates of change of organic carbon under the soil when vegetation and management practices have changed, such as in the elimination of forest to establish pastures (Post and Kwon 2000). This means that this situation is mainly due to the gain or loss of soil carbon, depending on the specific characteristics such as the use of fertilizers or the elimination of plant cover.

Therefore, the results show that in each of the plant covers, clean grasslands are not contributing significantly to carbon sequestration and could even be emitting carbon into the atmosphere, while in secondary vegetation the land uses do not offer a greater potential for carbon sequestration.

Diversity indices

Alpha diversity

The diversity indices found for each of the plant coverings found are listed below (See Table 4.2-32 and Illustration 4.2-54)

Table 4.2-32. Diversity indices for each of the plant covers.

Indices	Dlf	Cg	Dut	Lsv
Dominance_D	0,02401	0,2534	0,3866	0,1797
Simpson_1-D	0,976	0,7466	0,6134	0,8203
Shannon_H	4,119	2,26	1,513	1,89
Margalef	15,71	5,67	2,574	2,525

Source: INGEX, 2016.

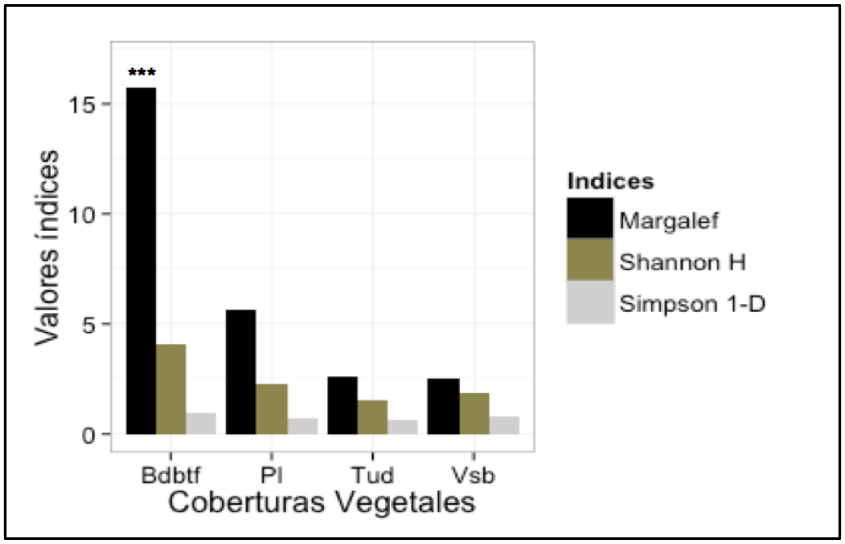


Illustration 4.2-54. Heterogeneity and dominance indices (Shannon, Simpson y Margalef).

Source: INGEX and Renaturar, 2016.

The indices of both richness and diversity corroborate the diversity characteristics of the ecosystems formed by tropical damp forests, where a considerable variety of species is reflected in high diversity indexes. These results characterize a very diverse biotic community with a tendency to heterogeneity, typical of the areas of tropical rainforests.

Although there were no significant differences in the Shannon index between plant cover (X2 = 1,641, p = 0.65), for the Dlf covering the value of this index (4,119) shows a high diversity in forest species, compared with other forests quite diverse as the Serranía del Baudó whose values of diversity are around 4.43; that is, all species are well represented and not only one species stands out as the most abundant. For the remaining coverings, low values are found, indicating that the vegetation in the area under study can be found in different stages of ecological succession and only a few species are dominant, as is the case of Cedro (*Cedrela odorata*) and Higueron (*Ficus sp*).

On the other hand, it can be inferred that the abundances present in the Dlf and Cg hedges are more similar, without being a marked dominance of some species, bearing in mind that they present the highest values of the Shannon index. This is related to a better distribution of resources, because the characteristics of the habitat (number of tree species, density of trees and shrubs and canopy cover) allow a better vertical distribution of the species of different strata that are used by the different trophic groups (Verea et al., 2000). At the same time, the lowest value of Dut cover (1,513) is the product of the high dominance of the species *Cedrela odorata* and *Ficus sp*, which are favored by the increase in open areas.

The Margalef index has quite high values (15.71), which reiterates the high forest diversity (X2 = 17.6245, p <0.001), since it is a high proportion of different species for the number of individuals found.

Therefore, these values are probably due to the proximity of the studied area to the Serranía de San Lucas found at approximately 40 lineal km, where the rates of very high endemism are found and can be considered as a strategic site for studies of biological diversity.

For the Simpson Index no significant differences were found between plant covers (X2 = 0.0869, p = 0.99) and according to the data obtained, it can be established that in general all the evaluated points have a low dominance (0.976). Denoted by this index that shows values with low trends.

According to what was previously mentioned, it can be highlighted that in terms of diversity, the points evaluated, and taking into account their abundance, there is a high variability in the horizontal structure showing high heterogeneity and low dominance of one or few species.

If we take into account the wealth and the aforementioned indices, it can be assumed that the evaluated forests have successional and conservation states that can be framed as conserved systems and in advanced successional states such as those shown.

Beta diversity

Bray-Curtis index

The Bray-Curtis technique generated two abundance dendrograms, where one of them shows the similarity or comparison between species and the other between the covers present in the studied area.

Illustration 4.2-52 shows that there is a higher similarity between the species that are in the same stratum (Forest) such as Bastimento de pobre (*Leonia sp*), Ape comb (*Apeiba membranaceae*), Heliconia (*Heliconia sp*), Coco crystal (*Lecythis mesophylla*), Carreto (*Aspidosperma cruentum*), Cirpo (*Pourouma bicolor*), Dead Mula (*Gustavia longifuniculata*), Balso (*Ochroma lagopus*), Carbonero (*Albizia carbonaria*), Yaya blood (*Guatteria sp*), among others; and lower among the other species found in the different covers present within the project area. However, the values of similarity are relatively low, which suggests that these species do not share physical characteristics, which is why we speak of a forest that tends towards ecological heterogeneity, with a great diversity of species. However, there are some similarities that relate them to each other along with the environment they share.

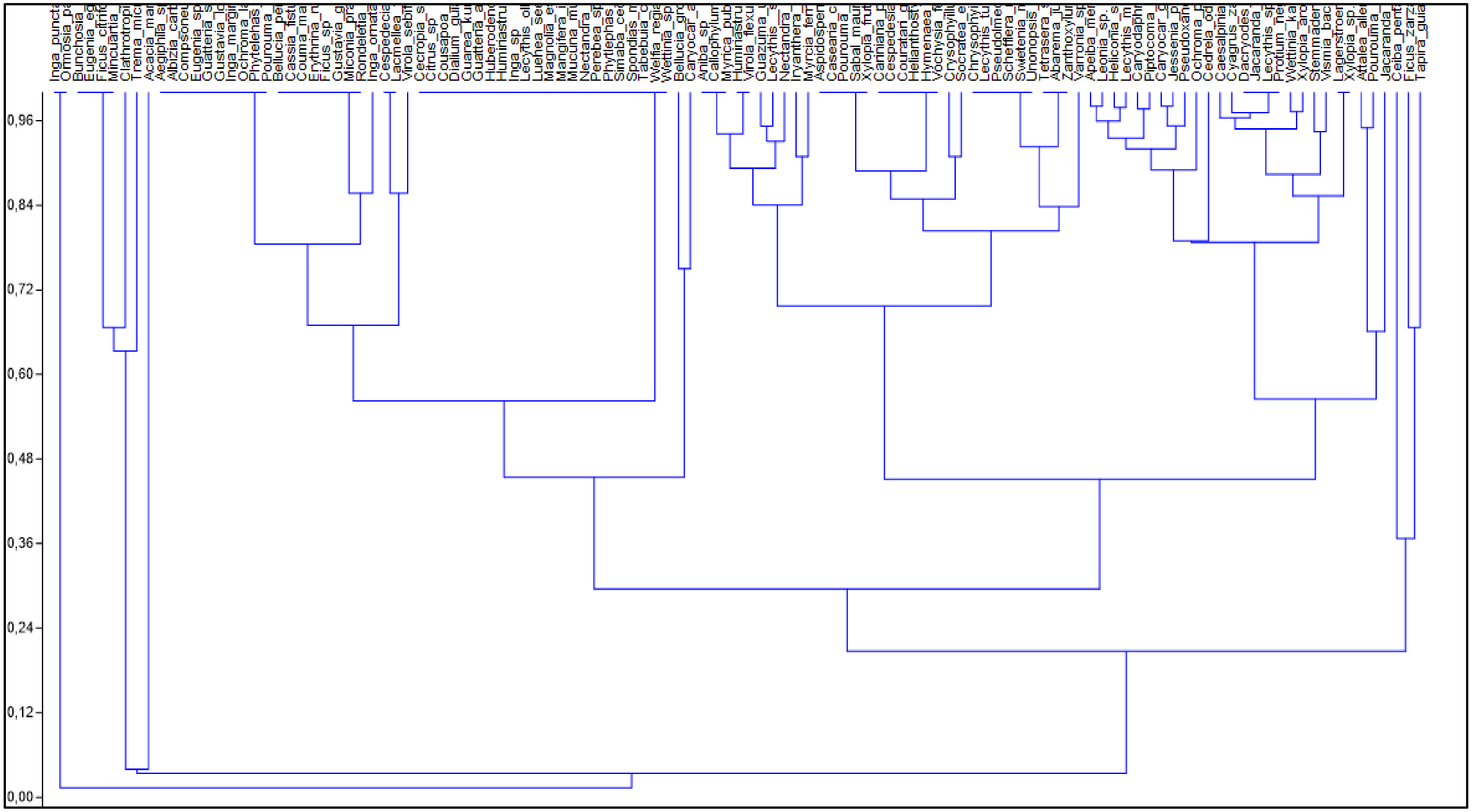


Illustration 4.24.2-55. Dendrograme by species of Bray-Curtis.

Source: INGEX, 2016.

Illustration 4.2-56 clearly shows that there is a great similarity between the cover of discontinuous urban traffic (Dut) and the lower secondary vegetation (Lsv) and less between these and the coverage of clean pastures (Cg) and dense lowland forest (Dlf). However, similarity values are relatively low (ranging between 0.96 - 0), suggesting that plant covers do not share physical characteristics, so there is no ecological homogeneity.

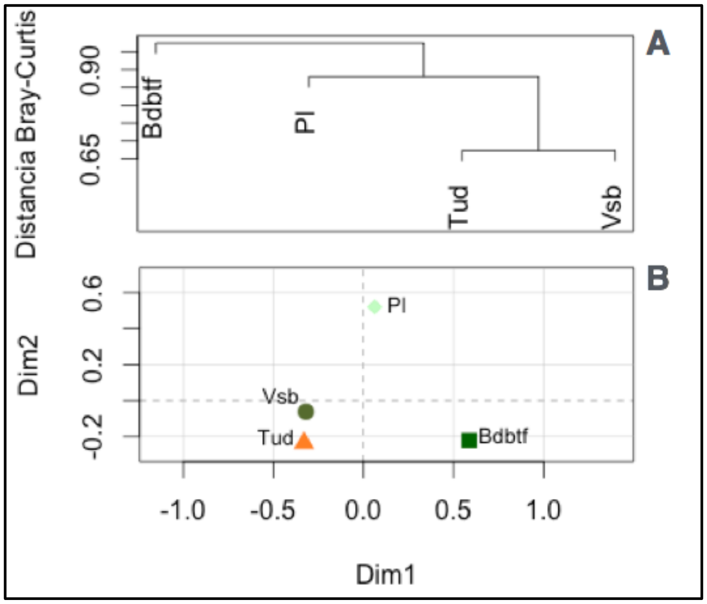


Illustration 4.24.2-56. Dendrogram by plant cover using the Bray-Curtis index.
Source: INGEX y Renaturar, 2016.

The characteristics of the four sites are substantially different therefore also the floristic composition of each of them. However, there are some similarities that relate them, such as humidity and temperature factors, as well as climate seasonality.

4.2.3.6.7 Local use of species

According to the interviews conducted during the characterization by each of the field assistants and inhabitants of the region, the uses that some of the species registered in the studied area were registered and were recorded in Illustration 4.2-33.

Table 4.2-33. Use of the species and importance at cultural level.

N	FAMILY	SPECIES	COMMON NAME	USE
1	ANACARDIACEAE	*Mangifera indica*	Mango	Edible fruit
2	ANACARDIACEAE	*Tapira guianensis* Aubl.	Fresno	Structural wood, Construction
3	ANNONACEAE	*Xylopia frutescens*	Escubillo	Wood for firewood
4	APOCYNACEAE	*Lacmellea floribunda*	Costillo de res	Wood for firewood
5	ARECACEAE	*Jessenia polycarca*	Palma Mil Pesos	For roofs
6	BIGNONIACEAE	*Jacaranda copaia* (Aubl.) D. Don	Chingalé	Strcutural wood, Construction.
7	BIGNONIACEAE	*Jacaranda mimosifolia*	Gualanday	Strcutural wood,

N	FAMILY	SPECIES	COMMON NAME	USE
				Construction.
8	BOMBACACEAE	*Ochroma lagopus*	Balso	Wood for rafts
9	BURSERACEAE	*Dacryodes colombiana* Cuatrec	Anime	Structural wood, Construction.
10	CAESALPINACEAE	*Hymenaea courbaril* Linneaus	Algarrobo	Structural wood, Construction.
11	CARYOCACEAE	*Caryocar glabrum*	Cagüí	Structural wood, Construction.
12	CLUSIACEAE	*Calophyllum mariae* Planch. & Triana	Aceite María	Structural wood, Construction.
13	FABACEAE	*Clathrotropis brunnea* Amshoff	Sapán	Structural wood, Construction.
14	FABACEAE	*Ormosia paraense*	Chocho	Artisanal
15	HUMIRIACEAE	*Humiriastrum procerum* (Little) Cuatr.	Chanúl	Structural wood, Construction.
16	HYPERICACEAE	*Vismia baccifera* (L.) Triana & Planch.	Carate	Wood for firewood
17	LAURACEAE	*Aniba sp*	Canelo	Structural wood, Construction.
18	LAURACEAE	Caryodaphnopsis cogolloi	Yambé	Structural wood, Construction.
19	LAURACEAE	*Nectandra lanceolata*	Laurel Amarillo	Structural wood, Construction.
20	LECYTHIDACEAE	*Cariniana pyriformis*	Abarco	Structural wood, Construction.
21	LECYTHIDACEAE	*Lecythis mesophylla*	Coco cristal	Structural wood, Construction.
22	LITHRACEAE	*Lagerstroemia sp*	Carbonero	Structural wood, Construction..
23	MALVACEAE	*Huberodendron patinoi* Cuatrec	Volador	Structural wood, Construction.
24	MELASTOMATACEAE	*Miconia prasina* (Sw.) DC	Cenizo	Wood for firewood
25	MELASTOMATACEAE	*Miconia sp*	Tuno o Niguito	Wood for firewood
26	MELIACEAE	*Cedrela odorata*	Cedro	Structural wood, Construction.
27	MIMOSACEAE	*Inga sp*	Guamo	Wood for firewood
28	MORACEAE	*Pseudolmedia rigida*	Lecha e perra	Wood for firewood
29	MYRISTICACEAE	*Iryanthera sp*	Soquete	Wood for firewood
30	MYRISTICACEAE	*Virola flexuosa*	Soto	Structural wood, Construction.
31	MYRTACEAE	*Psidium guajava*	Guayaba	Fruto comestible
32	OLACACEAE	Mincuartia guianensis	Punte e candado	Structural wood, Construction.
33	POLYGONACEAE	*Coccoloba uvifera*	Buche e pava	Structural wood, Construction.
34	SAPOTACEAE	*Chrysophyillum cainito*	Caimo	Structural wood, Construction.
35	SIMAROUBACEAE	*Simaba cedron*	Cedrón	Medicine
36	URTICACEAE	*Cecropia sp*	Yarumo	Wood for firewood
37		*Pourouma hirsutipetiolata*	Cirpo	Wood for firewood
38		*Pourouma sp*	Cirpo	Wood for firewood
39	VIOLACEAE	*Leonia sp.*	Bastimento e pobre	Edible fruit

Source: INGEX, 2016.

It is noteworthy that the forests of the area under study are exposed to great anthropic pressure, for the indiscriminate extraction of wood for marketing, expansion of pastures for pastures for livestock and some agricultural crops (banana, cassava, cocoa, papaya), in addition to domestic uses such as fences, houses, firewood, chocks of mines, among others.

4.2.3.7 ENDEMIC SPECIES

Within the studied area about nine endemic species were found, both at the national and regional level, among which are *Justicia phytolaccoides* Leonard, *Pseudoxandra sclerocarpa, Phragmotheca rubriflora, Colombian Dacryodes Cuatrec, Humiriastrum colombianum* and *Caryodaphnopsis cogolloi.* These species have been little studied and information on its natural history is very scarce, reducing it to data taken from flora inventories, catalogs of species and specific studies of the area made by CORANTIOQUIA.

Justicia phytolaccoides **Leonard.**

Habitat and geographic distribution: Endemic taxon of Colombia, distributed in the primary forests along the streams, tropical damp forests and in mountainous elevations, between 200 and 1300 meters above sea level. Only reported for the departments of Antioquia, Santander and Tolima.

Description: Shrub 1 to 3 meters high, its leaves are simple, opposite decussate, crenate margin and venation prominent on the underside, its inflorescences are terminal as spikes. Flowers with foliate bracts, green with red to purple spots, light green calyx with red spots, white bilabiate corolla, lower lip with three lobes and purple stripes inside, stamens with green filaments and light brown anthers, white pistil. The fruit is a brown claviform capsule, containing spherical, flattened, brown seeds (EPM, 2014).

Uses: For the change of its flowers and its foliage, its main use is ornamental.

Pseudoxandra sclerocarpa**.**

Distribution and ecology: Endemic species of Antioquia, reported for tropical damp forest and well-preserved forests.

Description: Tree 10 to 20 meters high, its bark is smooth gray, which comes off in the form of guasca. Leaves: Simple, alternate, distichous, entire margin and very thin secondary veins, their flowers are Axillary, solitary or in small groups. Fruits: Monocarp green, with hard pericarp and a brown seed (ISAGEN, 2011).

Use: The wood is used in the elaboration of tool ends and in rural constructions.

Phragmotheca rubriflora.

Distribution: Endemic Species from Colombia, belonging to the Malvaceae family. The information that is available about this species is very limited, since it is under study.

Humiriastrum colombianum

Habitat and local distribution: This species is usually found in tropical damp forest (Td-F) below 800masl, typical of primary or well-preserved forest. In Colombia, it is found in the middle Magdalena region, Bajo Cauca and the Pacific region and, in the department of Antioquia, it has been reported in the municipalities of Cáceres, Caucasia, Anorí, Segovia, among others.

Botanic description: Aceituno is a large tree that, in natural ecosystems, can reach up to 30 m in height and 50 to 60 cm in diameter. The stem is straight and cylindrical, without roots; It presents a brown-reddish crust, with large scales that break off. The wood is reddish brown when it is green and brownish in dry condition, very hard, heavy and easy to work, with a specific weight of 0.87 g / cm3 (CORANTIOQUIA, 2007).

***Caryodaphnopsis cogolloi*.**

Habitat and distribution: Endemic species from Colombia; It is distributed mainly between 300 and 500 masl.

Use: Wood of very good quality, resistant to decomposition, and used in buildings

4.2.3.8 THREAT SPECIES

In accordance with resolution 0192 of 2014 "By which the list of threatened wild species of biological diversity found in the national territory is established, and other provisions are issued" and resolution 10194 of 2008 "which regulates the use and exploitation of threatened flora in the jurisdiction of CORANTIOQUIA", identified the following fifteen woody species and three epiphytes, categorized as Vulnerable (VU), Endangered (EN) and Critically Endangered (CE) and eight species with restriction and / or prohibition in the studied area (See Table 4.2-34 and Table 4.2-35), in addition to the consultation conducted by IUCN and CITES.

For these species it is common to find that the main threats are deforestation, the fragmentation of habitats and the conversion of land for agricultural activities. There are also particular threats that directly affect some species, such as overexploitation of the wood resource, especially pressing those species that are considered to be fine woods.

Specialized works on threatened species (Calderón et al 2002, 2005, Cárdenas and Salinas 2007), propose the elaboration of management plans for the conservation of these species (Illustration 4.2-57 to Illustration 4.2-65), including the identification of natural populations, studies of structure and population dynamics, as well as in situ and ex situ conservation programs.

Table 4.24.2-34. Categorized species with certain degree of threat in the area under study, res 0192 de 2014.

N	FAMILY	SPECIES	COMMON NAME	THREAT
1	BIGNONIACEAE	*Jacaranda mimosifolia*	Gualanday	VU
2	BIXACEAE	*Cochlospermum sp*		EN
3	BOMBACACEAE	*Phragmotheca rubriflora*		VU
4	BURSERACEAE	*Dacryodes colombiana* Cuatrec	Anime	EN
5	CARYOCACEAE	*Caryocar glabrum*	Caguí	VU
6	CARYOCACEAE	*Caryocar amygdaliferum*	Almendrón	VU
7	LAURACEAE	Caryodaphnopsis cogolloi	Yambé	CR
8	LECYTHIDACEAE	*Cariniana pyriformis*	Abarco	CR-Veda
9	LECYTHIDACEAE	*Couratari guianensis*	Coco cabuyo	VU
10	LECYTHIDACEAE	*Gustavia gentryi*	Mula muerta	VU
11	LECYTHIDACEAE	*Gustavia longifuniculata*	Mula muerta	EN
12	LECYTHIDACEAE	*Lecythis mesophylla*	Coco cristal	VU
13	LECYTHIDACEAE	*Lecythis tuyrana*	Olla de mono	VU
14	MAGNOLIACEAE	*Magnolia espinalii*	Alma negra	CR
15	MALVACEAE	*Huberodendron patinoi* Cuatrec	Volador	VU
16	URTICACEAE	*Pourouma hirsutipetiolata*	Cirpo	Nativa – VU
17	PTERIDACEAE	*Acrostichum aureum* L	Helecho	LC
18	ARACEAE	*Philodendron sp*	Angiosperma	LC
19	BROMELIACEAE	*Tillandsia sp*	Angiosperma	VU

Source: INGEX, 2016.

Table 4.2-35. Species with restriction and prohibition in the area under study, resolution 10194 of 2008.

COMMON NAME	SCIENTIFIC NAME	FAMILIY	CONDITION
Canelo	*Aniba sp*	LAURACEAE	Prohibition
Alma negra	*Magnolia espinalii*	MAGNOLIACEAE	Prohibition - Veto
Macana	*Wettinia kalbreyeri, W. hirsuta*	ARECACEAE	Restriction
Guayacan	*Tabebuia chrysanta*	BIGNONIACEAE	Restriction
Algarrobo	*Hymenaeae coubaril*	CAESALPINACEAE	Restriction
Caguí	*Caryocar amygdaliferum*	CARYOCACEAE	Restriction
Sapan	*Clathrotropis brunnea* Amshoff	FABACEAE	Restriction
Aceituno	*Humiriastrum colombianum*	HUMIRIACEAE	Restriction

Source: INGEX, 2016.

Illustration 4.24.2-57. Illustration of *Caryocar amygdaliferum*.
Source*: www.plantsilustration.org*

Illustration 4.24.2-58. *Caryocar amygdaliferum.*
Source: Merceditas Corporation, 2012.

Illustration 4.2-59. *Jacaranda mimosifolia*.
Source: Merceditas Corporation, 2012.

Illustration 4.24.2-60. *Caryodaphnopsis cogolloi.*
Source: Merceditas Corporation, 2012.

Illustration 4.24.2-61. *Cariniana pyriformis.*
Source: Merceditas Corporation, 2012.

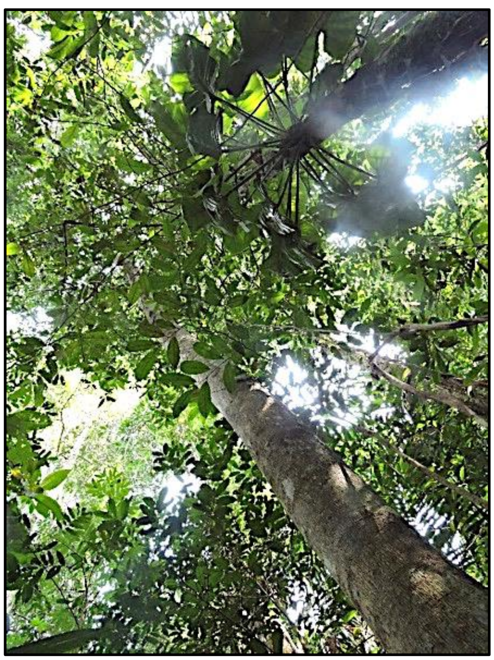


Illustration 4.24.2-62. *Lecythis mesophylla*.
Source: Merceditas Corporation, 2012.

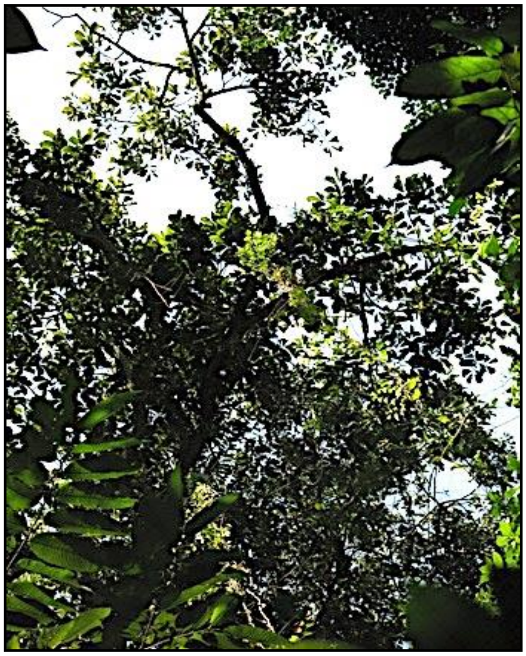


Illustration 4.24.2-63. *Couratari guianensis*.
Source: Merceditas Corporation, 2012.

Illustration 4.24.2-64*. Lecythis tuyrana*.
Source: Merceditas Corporation, 2012.

Illustration 4.24.2-65. *Lecythis tuyrana*.
Source: Merceditas Corporation, 2012.

4.2.3.9 SPECIES IDENTIFIED IN THE REGION ACCORDING TO SECONDARY INFORMATION

In 1970, INDERENA carried out a forest inventory of 561,000 ha of tropical damp forest in San Lucas Mountain Range, which served as the basis for the INDERENA / UNDP / FE-FAO / COL 14 project for the promotion of an industrial complex in this area. Region (Toro, 2009). A total of 258 tree species were recorded; conformed by 35 commercial, 36 potentially commercial and 187 non-commercial.

Among the potentially commercial species reported by INDERENA (1970), the following 22 species stand out (Table 4.2-36)

Table 4.2-36. Species found by INDERENA, 1970.

COMMON NAME	GENRE	SPECIES	FAMILY
Abarco	*Cariniana*	*Cariniana pyriformis*	LECYTHIDACEAE
Aceituno	*Humiriastrun*	*Humiriastrun colombianum*	HUMIRIACEAE
Algarrobillo	*Hymenaea*	*Hymenaea oblongifolia*	CAESALPINACEAE
Almendrón	*Caryocar*	*Caryocar amygdaliferum*	CARYOCACEAE
Algarrobo	*Hymenaea*	*Hymenaea courbaril*	CAESALPINACEAE
Caguí	*Caryocar*	*Caryocar glabrum*	CARYOCACEAE
Canime	*Copiafera*	*Copiafera canime*	CAESALPINACEAE
Caracolí	*Anacardium*	*Anacardium excelsum*	ANACARDIACEAE
Cedro	*Cedrela*	*Cedrela odorata*	MELIACEAE
Cativo	*Prioira*	*Prioira copaifera*	FABACEAE

COMMON NAME	GENRE	SPECIES	FAMILY
Ceiba tolua	*Pachira*	*Pachira quinata*	BOMBACACEAE
Comino	*Aniba*	*Aniba perutilis*	LAURACEAE
Chaquiro	*Podocarpus*	*Podocarpus guatemalensis*	PODOCARPACEAE
Fresno	*Tapirira*	*Tapirira guianensis*	ANACARDIACEAE
Masábalo	*Carapa*	*Carapa guianensis*	MELIACEAE
Nazareno	*Peltogyne*	*Peltogyne paniculata*	FABACEAE
Perillo	*Couma*	*Couma macrocarpa*	APOCYNACEAE
Sajino	*Goupia*	*Goupia glabra*	GOUPIACEAE
Sapán	*Clathrotropis*	*Clathrotropis brunnea*	FABACEAE
Solera	*Cordia*	*Cordia alliodora*	BORAGINACEAE
Soto	*Virola*	*Virola sebifera*	MYRISTICACEAE
Tamarindo	*Dialium*	*Dialium guianensis*	CAESALPINACEAE

Source: Toro, 2009.

These humid tropical forests are mainly located in the regions of Cauca, Northeast and North, mostly in the municipalities of Ituango, El Bagre, Segovia, Remedios, Tarazá, Anorí, Amalfi, Cáceres, Yondó, Puerto Berrío and Zaragoza.

The municipalities of Segovia (77.2%), El Bagre (69.0%), Tarazá (68.2%), Anorí (62.7%), Ituango (60.2%), Remedios (58, 8%) and Amalfi (55.3%), are highlighted for having more than half of its surface covered by dense or poorly managed natural forests (Toro, 2009).

Likewise, several species with a high value index of importance have been found, because they are endemic, in the damp tropical forests of the Northeast, Magdalena Medio and Bajo Cauca Antioqueño, including the foothills of the central mountain range and San Lucas Mountain Range, in heights below 1,000 masl, as described in Illustration 4.2-37.

Table 4.24.2-37. Endemic species of the tropical damp forest of the Magdalena, below Cauca and North East of Antioquia.

CAT. AME	GENRE	SPECIES	FAMILY	ALTITUDE RANGE	DISTRIBUTION	COLECTION OF REFERENCE
VU/EN	*Aphelandra*	*Aphelandra antioquensis (*Wassh, 1989)	ACANTHACEAE	300-820	Remedios, Tarazá	R. Callejas, S. Churchill, P. Acevedo & F. Saldarriaga 2433, HUA
	Cremastosperma	*Cremastosperma antioquense* (Pirie, 2005)	ANNONACEAE	500-700	Anorí	D. D. Soejarto 3586, HUA
	Duguetia caniflora	*Duguetia caniflora* (Maas, 1988)	ANNONACEAE	400-900	Anorí	D. D. Soejarto, J.L. Zarucchi, T. Swain, & J. Bagley 4044, HUA
	Anthurium	*Anthurium anorianum* (Croat, 1991)	ARACEAE	300-750	Anorí, Caucasia, Segovia, Valdivia	D. D. Soejarto 2995, HUA
	Spathiphyllum	*Spathiphyllum*	ARACEAE	180-500	Tarazá	R. Callejas

CAT. AME	GENRE	SPECIES	FAMILY	ALTITUDE RANGE	DISTRIBUTION	COLECTION OF REFERENCE
		oblongifolium (Cardona, Inédito)				2422, HUA
	Gonolobus	*Gonolobus antioquensis* (Morillo, 1989)	ASCLEPIADACEAE	350-900	Anorí	J. Denslow 2271, HUA
	Phragmotheca	*Phragmotheca rubriflora* (Alonso, 1996)	BOMBACACEAE	250-750	Remedios, Segovia	R. Callejas, et al. 5165, HUA
CR/EN	*Billbergia*	*Billbergia ambigua* (Betancur & N. R. Salinas, 2006)	BROMELIACEAE	400-700	Anorí	D. D. Soejarto 3228, HUA
	Croton	*Croton colombianus* (Murillo, 1999)	EUPHORBIACEAE	400-900	Anorí	D. D. Soejarto et al. 4074, HUA
	Rhodothyrsus	*Rhodothyrsus hirsutus* (Esser, 1999)	EUPHORBIACEAE	200	Zaragoza	R. Fonnegra & F.J. Roldan 2569, HUA
VU/EN	*Gustavia*	*Gustavia gentryi* (Mori, 1979)	LECYTHIDACEAE	0-900	Zaragoza	R. Fonnegra & F.J. Roldan 2557, HUA
	Magnolia	*Magnolia silvioi* (Govaerts, 1996)	MAGNOLIACEAE	400-1500	Amalfi, Anorí, Yalí, Yarumal, Yolombó, Caracolí	Gustavo Lozano C., Julio Díaz 3253, MEDEL
	Calathea	*Calathea sp* (Inédita)	MARANTACEAE	400-700	Anorí	Suárez & Robles, 2007 (S. Suárez, 2616, JAUM)
	Topobea	*Topobea rhodantha* (Uribe, 1975)	MELASTOMATACEAE	400-900	Anorí	D. D. Soejarto 2969, HUA
EN	*Tessmannianthus*	*Tessmannianthus quadridomius* (Wurdack)	MELASTOMATACEAE	700-1850	Anorí, San Carlos, San Luis, Guatapé	L. Albert, 8133; HUA
	Calliandra	*Calliandra antioquiae* (Barneby, 1998)	MIMOSACEAE	110-1500	Medellín, Anorí	Callejas et al. 4512, HUA
	Inga	*Inga colombiana* (Romero, 2005)	MIMOSACEAE	400-700	Remedios	R. Callejas et al. 8076, HUA
	Zygia	*Zygia codonocalyx* (Barneby & J. W. Grimes, 1997)	MIMOSACEAE	120	Tarazá	R. Callejas et al 5452 , HUA
	Zygia	*Zygia multipunctata* (Barneby & J. W. Grimes, 1996)	MIMOSACEAE		Anorí	W.S. Alverson et al. 386, HUA
CR/EN	*Compsoneura*	*Compsoneura anoriensis* (Janovec & A. K. Nelly, 2002)	MYRISTICACEAE	400-900	Anorí	D. D. Soejarto et al 4300, HUA
	Coryanthes	*Coryanthes misasii*	ORCHIDACEAE	500-1000		
	Epidendrum	*Epidendrum cancanae*	ORCHIDACEAE	500-1000		
	Peperomia	*Peperomia antioquiensis* (DC, 1898)	PIPERACEAE	410-500	Valdivia	R. Callejas, et al. 3457, HUA
	Ayenia	*Ayenia cuatrecasae*	STERCULIACEAE	200	Zaragoza	Haught, O.

CAT. AME	GENRE	SPECIES	FAMILY	ALTITUDE RANGE	DISTRIBUTION	COLECTION OF REFERENCE
		(Cristóbal, 1962)				2160, US
	Ayenia	*Ayenia saligna* (Dorr, 1996)	STERCULIACEAE	150	Zaragoza	R. Fonnegra & F.J Roldan, 2685, HUA

Source: Toro, 2009.

Some of these species are reported for localities that are currently heavily intervened; therefore, they represent great importance for conservation, due to their restricted distributions, which could indicate their presence in serious categories of threat.

It is important to emphasize that the reported extinctions have been increasing drastically in recent years, due to the accelerated increase in population and industrialization.

According to Toro (2009), the Magdalena Medio, Bajo Cauca and Northeast regions have been strongly modified by the opening of land for extensive livestock ranching, illegal timber extraction and illicit crops (Amalfi, Anorí, Briceño, Cáceres, Caucasia, El Bagre, Ituango, Nechí, Remedios, Segovia, Tarazá, Valdivia, Vegachí, Yondó and Zaragoza), mainly in the flat lands, where the tropical damp forests have been destroyed. The most conserved forests are towards the foothills of San Lucas Mountain Range.

In this territory (Magdalena Medio and Bajo Cauca), the largest extension of natural forests in the jurisdiction of CORANTIOQUIA is preserved, especially in the mountainous areas and foothills of the Central Mountain Range towards the valleys of the Nechí and Cauca rivers, in the mountainous areas and from the municipality of Amalfi and in the foothills of San Lucas Mountain Range, in the municipalities of Remedios, Segovia, El Bagre and Nechí.

The natural forests of this territory are subject to strong pressure for the expansion of the agricultural frontier, mainly for the establishment of paddocks and crops for illicit use, for the extraction of wood and illegal mining. In the humid lowland forests of the territory mentioned, 49 endemic species have been recorded for the department of Antioquia, of which 24 are unique to these forests (See Table 4.2-37), including a new species of the genus Calathea, recently discovered in the study conducted by Suárez & Robles (2007).

Is to highlight that the regional reserve under Cauca Nechí, in the jurisdiction of the municipalities of Anorí, Cáceres and Zaragoza, where 32 of the endemic species of Antioquia are present in the tropical damp forests, 12 of which are exclusive to the mentioned reserve, is noteworthy. Likewise, it has other lower plant species such as mosses and ferns, as well as palms as described in Illustration 4.2-38 and Illustration 4.2-40.

Table 4.2-38. Species of native moss of the jurisdiction of CORANTIOQUIA.

FAMILY	SPECIES (TAXÓN)	DISTRIBUTION	ALTITUDE	COLECTION OF REFERENCE
BARTRAMIACEAE	*Philonotis glaucescens* (Homsch.) Broth	Anorí, Barbosa, Medellín, Salgar	310-1530	S.P. Churchill et al. 14430 HUA

FAMILY	SPECIES (TAXÓN)	DISTRIBUTION	ALTITUDE	COLECTION OF REFERENCE
BARTRAMIACEAE	*Philonotis uncinata* (Schwagr). Bird.	Anorí, Caracolí, Medellín, Tarazá, Valdivia	500-2700	M. Escobar 674 HUA
BRACHYTHECIACEAE	*Zelometeorium patulum* (Hedw.). Manuel	Barbosa, Tarazá, Caldas, Gómez Plata, Sabanalarga, Salgar.	80-2420	S.P. Churchill et al. 14306 HUA
BRYACEAE	*Bryum coronatum* Schwagr.	Caldas, Caucasia	45-2900	L. Albert 6944 NY
CALYMPERACEAE	*Calymperes afzelii* Sw.	Maceo, Remedios, Tarazá	130-1500	I. Sastre & S.P. Churchill 963 HUA
CALYMPERACEAE	*Calymperes erosum* Mull. Hal.	Anorí	400-900	R. Fonnegra et al. 464 NY
CALYMPERACEAE	*Calymperes guildinigii* Hook. & Grev.	Medellín, Tarazá	280-1500	S.P. Churchill et al. 14890 HUA
CALYMPERACEAE	*Calymperes lonchophyllum* Schwag	Caucasia, Caldas, Tarazá	110-2440	I. Sastre et al. 986 HUA
CALYMPERACEAE	*Octoblepharum pulvinatum* (Dozy & Molk) Mitt.	Anorí, Caucasia, Maceo, Remedios, Tarazá	110-1350	S.P. Churchill et al. 14941 HUA
CALYMPERACEAE	*Syrrhopodon circinatus* (Bird) Mitt.	Caucasia	110-150	R. Callejas et al. 5325 NY
CALYMPERACEAE	*Syrrhopodon cryptocarpus* Dozy & Molk	Medellín, Tarazá	280-1030	S.P. Churchill et al. 14960 HUA
DICRANACEAE	*Campylopus heterostachys* (Hampe)A.Jaeger	Anorí, Medellín	320-2450	R. Callejas & M. Escobar 7377 HUA
DICRANACEAE	*Dicranella hilariana* (Mont.) Mitt.	Anorí, Caucasia, Tarazá, Valdivia	110-2430	I. Sastre et al. 977 HUA
DICRANACEAE	*Holomitrium arboreum* Mitt.	Remedios, Santa rosa de osos, Yolombó	500-2935	S.P. Churchill et al. 14124 HUA
FISSIDENTACEAE	*Fissidens guianensis guianensis* Mont.	Caracolí, Tarazá	60-300	I. Sastre et al. 988 HUA
FISSIDENTACEAE	*Fissidens neglectus* H. A. Crum	Tarazá	200	I. Sastre et al. 1041 HUA
FISSIDENTACEAE	*Fissidens prionodes* Mont.	Tarazá	200-280	S.P. Churchill et al. 14897 HUA
LEPTODONTACEAE	*Pseudocryphaea domingensis* (Spreng.) W. R. Buck	Remedios	250-2165	S.P. Churchill et al. 14658 HUA
LEUCOMIACEAE	*Leucomium strumosum* (Horhsch.) Mitt.	Anorí, Caldas, Mdellín, Tarazá	80-2440	S.P. Churchill et al. 14774 HUA
METEORIACEAE	*Papillaria nigrescens* (Hedw.) A.Jaeger	Amplia distribución	80-2600	S.P. Churchill et al. 13218 HUA
NECKERACEAE	*Neckeropsis undulata* (Hedw.) Reichardt.	Anorí, Remedios, Segovia, Tarazá	100-1830	S.P. Churchill et al. 15029 HUA
SEMATOPHYLLACEAE	*Sematophyllum chlorocormum* (Mull.Hal.) W. R. Buck, S. P. & I. Sastre	Tarazá	280-300	S.P. Churchill et al. 14923 HUA
STEREOPHYLLACEAE	*Pilosium chlorophyllum* (Hornsch.) Mull. Hal. In Broth.	Anorí, Caucasia, Maceo, Remedios, Tarzá	70-1165	I. Sastre et al. 999 HUA
THUIDIACEAE	*Cyrto-hypnum involvens* (Hedw.)	Anorí	20-310	R. Callejas et al. 4596 NY

FAMILY	SPECIES (TAXÓN)	DISTRIBUTION	ALTITUDE	COLECTION OF REFERENCE
	W.R. Buck & H.A.			
THUIDIACEAE	*Thuidium urceolatum* Lorentz	Remedios, Caldas	250-3440	R. Callejas et al. 5210 NY

Source: Toro, 2009.

Table 4.24.2-39. Ferns and other vascular plants without native sedes.

FAMILY	SPECIES (TAXÓN)	DISTRIBUTION	ALTITUDE	COLECTION OF REFERENCE
ASPLENIACEAE	*Asplenium delitescens* (Maxon) L.D. Gómez	Anorí, Nechí	0-1500	W. Rodríguez 4110 HUA
ASPLENIACEAE	*Asplenium formosum* Willd.	Remdios, Valdivia	250-500	R. Callejas 5196 HUA
ASPLENIACEAE	*Asplenium serratum* L.	Anorí, San Luis	0-1000	W. Rodríguez 4208 HUA
BLECHNACEAE	*Blechnum polypodioides* Raddi	Anorí, Frontino, Liborina, Medelín, San Luis, Zaragoza, Tarazá	300-2200	W. Rodríguez 4351 HUA
CYATHEACEAE	*Cyathea lockwoodiana* (P.G. Windisch) Lellinger	Anorí, San Carlos, San Luis	0-1000	F. Giraldo 2534 HUA
CYATHEACEAE	*Cyathea microdonta* Desv.) Domin	Anorí, Segovia, Murindó	0-2000	F. Giraldo 2027 HUA
CYATHEACEAE	*Cyathea trichiata* (Maxon) Domin	Anorí, Remedios, Cáceres	0-2500	F. Giraldo 2538 HUA
DENNSTAEDTIACEAE	*Dennstaedtia cicutaria* (Sw.) T. Moore	Anorí, Caldas, San Luis, Turbo	0-2500	J. Denslow 1226 HUA
DENNSTAEDTIACEAE	*Saccoloma inaequale* (Kunze) Mett.	Amalfi, Anorí, Cáceres, Fredonia, Remedios, San Luis, Urrao, Yolombó	0-2500	W. Rodríguez 4229 HUA
DRYOPTERIDACEAE	Cyclodium trianae (Mett.) A.R. Sm.	Anorí, San Luis, Tarazá	0-1200	W. Rodríguez 4210 HUA
DRYOPTERIDACEAE	*Cyclopeltis semicordata* (Sw.) J. Sm.	Anorí, Remedios, San Luis, Turbo, San Carlos	0-500	A. Brant 1713 HUA
DRYOPTERIDACEAE	*Diplazium carnosum* H. Christ	Anorí	0-1000	J. Shepherd 752 HUA
DRYOPTERIDACEAE	Elaphoglossum crinitum (L.) H. Christ	Anorí	0-1000	W. Rodríguez 4250 HUA
DRYOPTERIDACEAE	*Elaphoglossum doanense* L.D. Gómez	Anorí, San Luis	0-800	W. Rodríguez 4530 HUA
DRYOPTERIDACEAE	*Lomariopsis japurensis* (Mart.) J. Sm.	Anorí, Remedios, Tarazá	0-1000	R. Callejas 4704 HUA
DRYOPTERIDACEAE	*Lomariopsis nigropaleata* Holttum	Anorí	0-1000	J. Shepherd 441 HUA
DRYOPTERIDACEAE	*Lomariopsis prieuriana* Fée	Anorí	0-1000	W. Rodríguez 4503 HUA
DRYOPTERIDACEAE	*Lomariopsis vestita* E. Fourn.	Anorí, Turbo	0-1000	W. Rodríguez 4305 HUA
DRYOPTERIDACEAE	*Tectaria incisa* Cav.	Jericó, Liborina, Olaya,	0-2500	W. Rodríguez 4777 HUA

FAMILY	SPECIES (TAXÓN)	DISTRIBUTION	ALTITUDE	COLECTION OF REFERENCE
		San Luis, Segovía, Tarazá		
DRYOPTERIDACEAE	*Tectaria plantaginea* (Jacq.) Maxon	Anorí, Remedios, San Luis	0-1500	W. Rodríguez 4082 HUA
DRYOPTERIDACEAE	*Triplophyllum funestum* (Kunze) Holttum	Caucasia, Remedios, Tarazá	0-500	R. Callejas 8054 HUA
HYMENOPHYLLACEAE	*Trichomanes diversifrons* (Bory) Mett. Ex Sadeb.	Anorí, Remedios, San Luis	0-1000	W. Rodríguez 4248 HUA
HYMENOPHYLLACEAE	*Trichomanes osmundoides* DC. Ex Poir.	Tarazá	0-500	R. Callejas 2576 HUA
LYCOPODIACEAE	*Huperzia linifolia* (L.) Trevis.	Anorí, Barbosa, San Carlos, San Rafael, Tarazá, Urrao, Zaragoza	0-2500	W. Rodríguez 5050 HUA
LYCOPODIACEAE	*Lycopodiella cernua* (L.) Pic. Serm.	Amalfi, Anorí, Cáceres, Frontino, Medellín, Tarazá, Urrao, Valdivia, Yarumal, Yolombó, Zaragoza	0-3000	W. Rodríguez 4510 HUA
MARATTIACEAE	*Danaea moritziana* C. Presl	Anorí, Caicedo, Fredonia, Jericó, Macedonia, Medellín, Remedios, San Carlos, Santa rosa de osos, Tarazá, Urrao, Yarumal	0-3000	W. Rodríguez 4795 HUA
MARATTIACEAE	*Danaea nodosa* (L.) Sm.	Anorí, Remedios	0-1000	R. Callejas 4705 HUA
POLYPODIACEAE	*Campyloneurum angustifolium* (Sw.) Fée	Angelópolis, Anorí, Cáceres, Puerto Valdivia, San Luis, San Rafael, Tarazá, Zaragoza	0-2500	W. Rodríguez 4239 HUA
POLYPODIACEAE	*Campyloneurum aphanophlebium* (Kunze) T. Moore	Anorí, Remedios, Zaragoza	0-1000	W. Rodríguez 4518 HUA
POLYPODIACEAE	*Dicranoglossum desvauxii* (Klotzsch) Proctor	Anorí	0-1000	S. White 230 HUA
POLYPODIACEAE	*Dicranoglossum polypodioides* (Hook.) Lellinger	Remedios, San Luis, Yolombó, Zaragoza	0-1000	D. Giraldo 402 HUA
POLYPODIACEAE	*Pecluma ptilota* (Kunze) M.G. Price	Angelópolis, Betania, Medellín, Remedios, Sopetrán	0-3000	J. Betancur 1115 HUA
POLYPODIACEAE	*Phlebodium decumanum* (Willd.) J. Sm.	Remedios, Puerto Berrio	0-1000	R. Callejas 8067 HUA
POLYPODIACEAE	*Pleopeltis bombycina* (Maxon) A.R. Sm.	Anorí, San Luis, San Rafael, Tarazá, Yolombó	0-1500	A. Brant 1509 HUA
POLYPODIACEAE	*Serpocaulon loriciforme* (Rosenst.) A.R. Sm.	Anorí, Cáceres, San Carlos, Zaragoza	0-1500	W. Rodríguez 4221 HUA
PTERIDACEAE	*Adiantum humile* Kunze	Zaragoza	0-500	D. Soejarto 2652 HUA
PTERIDACEAE	*Adiantum*	Amalfi, Fredonia, Jericó,	0-2000	W. Rodríguez 4771 HUA

FAMILY	SPECIES (TAXÓN)	DISTRIBUTION	ALTITUDE	COLECTION OF REFERENCE
	macrophyllum Sw.	Liborina, Segovia		
PTERIDACEAE	*Adiantum petiolatum* Desv.	Anorí, Nechí, Remedios, San Luis	0-1500	R. Callejas 5203 HUA
PTERIDACEAE	*Adiantum pulverulentum* L.	Anorí, Remedios, Turbo, Zaragoza	0-1000	R. Callejas 5202 HUA
PTERIDACEAE	*Adiantum tetraphyllum* Humb. & Bonpl. Ex Willd.	Ebéjico, Puerto Nare, Puerto Triunfo, Remedios, San Carlos, San Luis, Segovia, Tarazá	0-1000	F. Roldán 2049 HUA
PTERIDACEAE	*Pteris grandifolia* L.	Liborina, Puerto Nare, Salgar, Segovia, Turbo	0-1000	R. Callejas 9782 HUA
SCHIZAEACEAE	*Lygodium venustum* Sw.	Anorí, Cáceres, Caucasia, San Luis, Tarazá, Valdivia, Zaragoza	0-2000	W. Rodríguez 4522 HUA
SCHIZAEACEAE	*Lygodium volubile* Sw.	Anorí, Zaragoza	0-1000	J. Shepherd 918 HUA
SELAGINELLACEAE	*Selaginella anceps* (C. Presl) C. Presl	Amalfi Anorí, San Luis, Segovia, Tarazá, Yolombó, Zaragoza	0-1500	W. Rodríguez 4462 HUA
SELAGINELLACEAE	*Selaginella applanata* A. Braun	Anorí, Tarazá, Zaragoza	0-1000	W. Rodríguez 4473 HUA
SELAGINELLACEAE	*Selaginella conduplicata* Spring	Anorí, Cáceres, Caucasia, Remedios, San Luis, Segovia, Tarazá, Valdivia, Zaragoza	0-1000	W. Rodríguez 4207 HUA
SELAGINELLACEAE	*Selaginella 106entate106106e* Spring	Amalfi, Anorí, Segovia, Tarazá, Turbo, Valdivia	0-1500	R. Callejas 9152 HUA
SELAGINELLACEAE	*Selaginella fragilis* A. Braun	Caucasia, Remedios, Tarazá	500-1000	R. Callejas 8047 HUA
SELAGINELLACEAE	*Selaginella haematodes* (Kunze) Spring in Mart	Anorí, Barbosa, Puerto Berrio, San Carlos, San Luis, Segovia, Zaragoza	0-1500	W. Rodríguez 4252 HUA
SELAGINELLACEAE	*Selaginella humboldtiana* A. Braun	Anorí, Cáceres, Remedios, Segovia, Tarazá, Valdivia, Zaragoza	0-1000	R. Callejas 522 HUA
SELAGINELLACEAE	*Selaginella 106entate106* A. Braun	Anorí, Puerto Berrio, San Carlos, San Luis, Tarazá, Zaragoza	0-1000	W. Rodríguez 4349 HUA
THELYPTERIDACEAE	*Macrothelypteris torresiana* (Gaudich.) Ching	Angelópolis, Anorí, Medellín, Remedios, San Luis	0-2000	W. Rodríguez 4313 HUA
THELYPTERIDACEAE	*Thelypteris 106entate* (Forssk.) E.P. St.John	Anorí, Zaragoza	0-1500	W. Rodríguez 4145 HUA
THELYPTERIDACEAE	*Thelypteris lingulata* (C. Chr.) C.V. Morton	Anorí, Cáceres, Puerto Berrio, Remedios, San Luis	0-1500	W. Rodríguez 4146 HUA
VITTARIACEAE	*Vittaria costata* Kunze	Remedios, Turbo	0-500	R. Callejas 5221 HUA

Source: Toro, 2009.

Table 4.2-40. Species of the faimily ARECACEAE native (Palms).

SPECIES	DISTRIBUTION	ALTITUDE	COMMON NAME	COLECTION OF REFERENCE
Asterogyne martiana (H. Wendl.) H. Wendl. Ex Hemsl.	Amalfi, Anorí, Segovia, Zaragoza	0-1100		Henderson et al., 1995; Ariza, 2006
Astrocaryum malybo H. Karst.	Cáceres, Caucasia, Nechí Segovia	0-750	Anchamba, lanceta, palma estera	Galeano & Bernal, 2005; Cogollo et al., 2006
Astrocaryum standleyanum L. H. Bailey	Anorí, Cáceres, Zaragoza	0-500	Palma guerre, Güerregue	Henderson et al., 1995
Attalea allenii H. E. Moore	Anorí, Cáceres, Zaragoza	0-500	Taparín, Táparo	Henderson et al., 1995
Bactris barronis L. H. Bailey	Anorí, Cáceres	0-700	Lata	Henderson et al., 1995
Bactris brongniartii Mart	Cáceres, Caucasia	0-700		Henderson et al., 1995
Bactris guineensis (L.) H. E. Moore	Caucasia, Nechí, Cáceres	0-850	Corozo, Lata	Henderson et al., 1995
Bactris pilosa H. Karst.	Anorí, Caucasia, Cáceres, Zaragoza	0-600	Lata macho	Henderson et al., 1995
Chamaedorea linearis (Ruiz & Pavon) Mart.	Amplia distribución	40-2700	Palmicho	Henderson et al.; Toro, 2000
Desmoncus orthacanthos Mart.	Amplia distribución	0-100	Matamba	Henderson et al., 1995
Elaeis oleifera	Caucasia, Nechí, Puerto barrio, Puerto Nare, Segovia, Yondó	0-800	Nolí	Cogollo et al., 2006
Euterpe oleracea Mart.	Caucasia, Nechí	0-500	Marrapo, Naidí	Henderson et al., 1995
Genoma congesta H. Wendl.ex Spruce	Bajo Cauca	0-900	Palmicho	Henderson et al., 1995
Genoma leptospadix Trail	Magdalena Medio	0-750	Palmicho	Henderson et al., 1995
Genoma máxima (Poit.) Kunth	Noreste, Magdalena Medio	0-500	Palmicho	Henderson et al., 1995
Genoma stricta (Poit.) Kunth	Magdalena Medio	0-1100	Palmicha	Henderson et al., 1995
Phytelephas seemannii o. f. Cook	Bajo Cauca	0-200	Palma Tagua	Henderson et al., 1995
Sabal mauritiformis (H. Karst.) Grises, ex H. Wendl.	Caucasia, El Bagre, Nechí	0-1000	Palma amarga	Henderson et el., 1995
Socratea exorhiza (Mart.) H Wenl.	Amalfi, Anorí, Cáceres, Maceo	0-1000	Zancona, Bombón	Henderson et el., 1995; Ariza, 2006
Syagrus sancona H. Karst	Amagá, Fredonia, Titiribí, Anorí, Amalfi	0-1200	Palma zancona	Henderson et al., 1995
Welfia regia H. Wendl ex André	Amalfi, Anorí	0-1500	Palma san juan	Henderson et al., 1995
Wettinia quinaria K(O. F. Cook & Doyle) Burret	Cordillera Occidental	0-1000	Memé, Gualte	Henderson et al.,1995.
Wettinia hirsute Burret	Amalfi, Anorí, Yalí, Yolombó	400-1300	Palma mazorca, Macana	Cogollo et al, 2001

Source: Toro, 2009

In the Management Plan presented for a natural forest of 700 hectares in the municipality of El Bagre, by CORANTIOQUIA in 2003, several valuable species were recorded, and the largest representation is found in the diameter classes less than 40 cm in normal diameter. The forest inventory showed the following data (Illustration 4.2-41).

Table 4.24.2-41. Species reported in the 700ha Forest Management Plan in El Bagre, CORANTIOQUIA.

COMMON NAME	SCIENTIFIC NAME	FAMILY
Aceite maría	*Calophyllum mariae* Tr. Et Pl	CLUSIACEAE
Aceituno	*Humiriastrum colombianum* Cuatr.	HUMIRIACEAE
Alejandro	*Cespedecia macrophylla*	OCHNACEAE
Algarrobo	*Hymenaea courbaril* L.	CAESALPINACEAE
Almendrillo	*Caryocar sp.*	CARYOCACEAE
Amargo	*Ormosia*	PAPILONACEAE
Anime	*Protium neglectum* Swart.	BURSERACEAE
Arizá	*Brownea ariza*	CAESALPINACEAE
Arrayan	*Eugenia biflora*	MYRTACEAE
Azuceno	*Himatanthus articulatus*	APOCYNACEAE
Machare	*Symphonia globulifera*	CLUSIACEAE
Guácimo blanco	*Goethalsia meiantha*	TILIACEAE
Balso	*Ochroma lagopus*	BOMBACACEAE
Barbasco	*Lacmellea panamenis*	APOCYNACEAE
Cabalonga	*Thevetia peruviana*	APOCYNACEAE
Cacaona	*Pachira aquatica*	BOMBACACEAE
Caimo	*Chrysophyllum cainito*	SAPOTACEAE
Caguí	*Caryocar glabrum*	CARYOCACEAE
Canelo	*Aniba sp*	LAURACEAE
Canime macho	*Copaifera canime*	CAESALPINACEAE
Capacho	*Buchenavia capitata*	COMBRETACEAE
Caracolí	*Anacardium excelsum*	ANACARDIACEAE
Anime	*Dacryodes colombiana*	BURSERACEAE
Carreto	*Aspidosperma cruentum*	APOCYNACEAE
Cedrillo	*Guarea guidonia*	MELIACEAE
Cedrón	*Simaba cedron*	SIMAROUBACEAE
Ceiba	*Ceiba pentandra*	BOMBACACEAE
Chingale	*Jacaranda copaia* (Aubl.) D. Don	BIGNONIACEAE
Coco	*Lecythis sp*	LECYTHIDACEAE
Corcho	*Apeiba sp*	TILIACEAE
Coronillo	*Bellucia sp*	MELASTOMATACEAE
Dormilón	*Vochysia ferruginea*	VOCHYSIACEAE
Fresno	*Tapirira guianensis*	ANACARDIACEAE
Gualanday	*Jacaranda sp*	BIGNONIACEAE
Guamo	*Inga sp*	MIMOSACEAE
Guarumillo	*Pourouma sp*	URTICACEAE
Guayabopelao	*Terminalia sp*	COMBRETACEAE
Higueron	*Ficus sp*	MORACEAE
Jobo	*Spondias mombin*	ANACARDIACEAE
Leche e perra	*Pseudolmedia sp*	MORACEAE
Mestizo	*Helyanthostilis sp*	PAPILIONACEAE
Negrito	*Machaerium capote*	FABACEAE
Pedro Tomin	*Cespedecia macrophylla*	OCHNACEAE
Pega Pega	*Desmodium sp*	FABACEAE
Perillo	*Couma macrocarpa*	APOCYNACEAE
Polvillo	*Tabebuia sp*	BIGNONIACEAE
Punte candado	*Minquartia guianensis*	OLACACEAE
Rayo	*Parkia pendula*	MIMOSACEAE
Saino	*Goupia glabra*	GOUPIACEAE
Sangre de gallo	*Virola flexuosa*	MYRISTICACEAE

COMMON NAME	SCIENTIFIC NAME	FAMILY
Sapán	*Clathrotropis brachypetala*	CAESALPINACEAE
Cirpo	*Pourouma apiculata*	URTICACEAE
Tabaquillo	*Miconia sp*	MELASTOMATACEAE
Tamarindo	*Dialium guianensis* (Aubl.)	CAESALPINACEAE
Vara blanca	*Triplaris sp*	POLIGONACEAE
Yarumo	*Cecropia sp.*	CECROPIACEAE
Yaya sangre	*Annona sp*	ANNONACEAE
Zapatillo	*Macrolobium gracile*	CAESALPINACEAE

Source: Plan of management El Bagre, 2003.

This information was filtered with the taxonomy update and excludes some species that according to the information issued by the scientific collections of the National University, are not distributed in the area under study, nor close to it.

Additionally, there are other studies that allow recognizing the flora of Magdalena Medio, as the illustrated guide of flora for the canyon of the Porce River - Antioquia in agreement with the University of Antioquia, University of Antioquia Herbario and EPM, as a product of the study for hydroelectric plants of Porce II and Porce III. In it, 700 species of flora have been reported, corresponding to 1.70% of the total species reported for Colombia.
The plant covers present in the area correspond, in most cases, to successional, advanced stages as well as intervened primary forests, low stubble, high stubble, secondary forests and forest plantations for protection purposes, as well as pasture areas used for extensive livestock and crops (Flora Porce River guide, 2014).

Similarly, the study for the identification of the most commercial timber species in the territorial directions Panzenú and Zenufaná (Arteaga, 2002), which highlights the most important species such as Aceite maría (*Calophyllum brasiliense*), Aceituno (*Humiriastrum colombianum*), Algarrobillo (*Hymenaea oblongifolia*), Almendrón (*Caryocar amygdaliferum*), Caguí (*Caryocar glabrum*), Canelo (*Aniba sp*), Caracolí (*Anacardium excelsum*), Cativo (*Prioira copaifera*), Cedro (*Cedrela odorata*), Ceiba tolua (*Pachira quinata*), chaquiro dulce (*Podocarpus guatemalensis*), Chaquiro real (*Podocarpus oleifolius*), Comino (*Aniba perutilis*), Dormilón (*Vochysia ferruginea*), Fresno (*Tapirira guianensis*), Guayacán rosado (*Tabebuia rosea*), Laurel piedro (*Persa rigens*), Masábalo (*Carapa guianensis*), Nazareno (*Peltogyne paniculata*), Perillo (*Couma macrocarpa*), Piñon de oreja (*Enterolobium cyclocarpum*), Roble de tierra fría (*Quercus humboldtii*), Saino (*Goupia glabra*), Soto (*Virola sebifera*), Tamarindo (*Dialium guianensis*) & Volador (*Huberodendron patina*).

A high number of these timber species are threatened with extinction in the jurisdiction, mainly due to over exploitation and destruction of forests, for this reason CORANTIOQUIA through Resolution No. 03183 of 2000 banned the use of 7 species and restricted 12 more species. Such resolution was replaced by No. 10194 of April 10, 2008, through which the harvesting of 19 timber species is restricted and 11 other species are restricted (Toro, 2009).

4.2.4 FAUNA

The herpetofauna, mastofauna and avifauna studied are presented next

4.2.4.1 HERPETOFAUNA

Amphibians and reptiles (herpetofauna) have a key functional role in ecosystems, because they are groups that indicate and sustain the health of the same, through the following roles:

- They keep the waters clean.
- They are effective controllers of crop pests and human disease vectors.
- They contribute to the pollination of flowers and dispersion of seeds.
- Maintain the flow of matter and energy between aquatic and terrestrial environments, as well as between the canopy of forests and the soil.
- Influence primary production and ecological recycling (Urbina et al., 2015).
- They provide biomass to the trophic chains because they maintain a natural equilibrium by consolidating as primary and secondary predators (Vitt et al., 2014).

This reflects the importance of these groups of fauna, despite the fact that their knowledge in ecological level and conservation status is low. However, it is known that anthropic activities such as livestock, agriculture and logging are closely linked to changes in the diversity of amphibians and reptiles, as they produce fragmentation, loss of habitat and degradation of quality in native cover, leading to many populations towards ecological isolation and causing great impacts on the structure and composition of the herpetofauna (Gardner et al., 2007; Urbina et al., 2015).

Amphibians and reptiles are groups that are very sensitive to changes in habitat and can respond negatively or positively to anthropogenic activities in ecosystems, which is why they have been proposed as a focal group when monitoring and evaluating restoration processes due to the species have particular biological and ecological characteristics that make them sensitive to microclimatic changes and the plant structure in their habitat. Because of this, they are vulnerable to the transformation or degradation of the ecosystems in which they are found (Urbina et al., 2015).

The taxonomic composition of the herpetofauna and species identified in the region according to primary and secondary information is presented next.

4.2.4.1.1 Taxonomic composition

According to the sampling of herpetofauna, the general taxonomic composition of the studied area is made up of four (4) orders, the Anura order of the Amphibia class and the Squamation, Testudines and Crocodylia orders, of the Reptile or Sauropsida class.

During the surveys conducted by the Merceditas Corporation in 2012, a total of forty-eight (48) species of the mentioned orders were registered. Recognizing for the Anura order six (6) families and sixteen (16) species, for Testudines two (2) families and two (2) species, for Crocodilian one (1) family and one (1) species, and for Squamata thirteen (13) families and twenty-nine (29) species. (See Illustration 4.2-66).

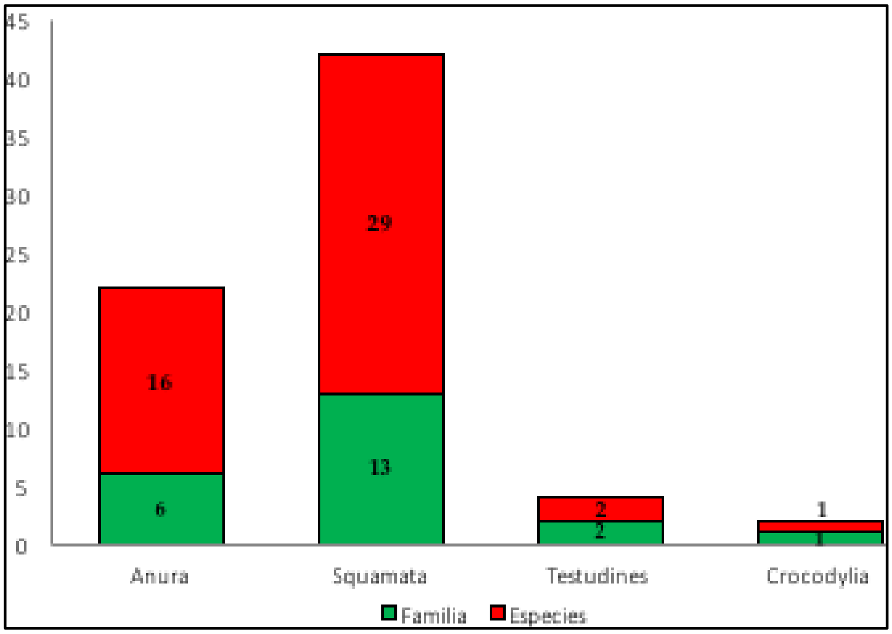


Illustration 4.24.2-66. Taxonomic composition of the herpetofauna registered.
Source: INGEX, 2016.

With the coverings defined in the studied area and the collection of primary information, the taxonomic compositions of herpetofauna were determined by plant cover.

The taxonomic composition of herpetofauna, more diverse by plant cover, is the one corresponding to Bdbdtf (3.1.1.2.1) presenting four (4) orders, eighteen (18) families and thirty-four (34) species, followed by Pl (2.3 .1) with the four (4) orders, thirteen (13) families and twenty-three (23) species. The Lsv cover (3.2.3.2) registered two (2) orders, ten (10) families and seventeen (17) species; the coverage of 1.1.2 Dut recorded two (2) orders, six (6) families and twelve (12) species. The Cphc (Cocoa Crops) coverage (2.2.2.3) presented three (3) orders, four (4) families and four (4) species and the Cphyp (2.2.1.3) coverage (plantain and cassava crops) registered two (2) orders with two (2) families and two (2) species (See Illustration 4.2-67).

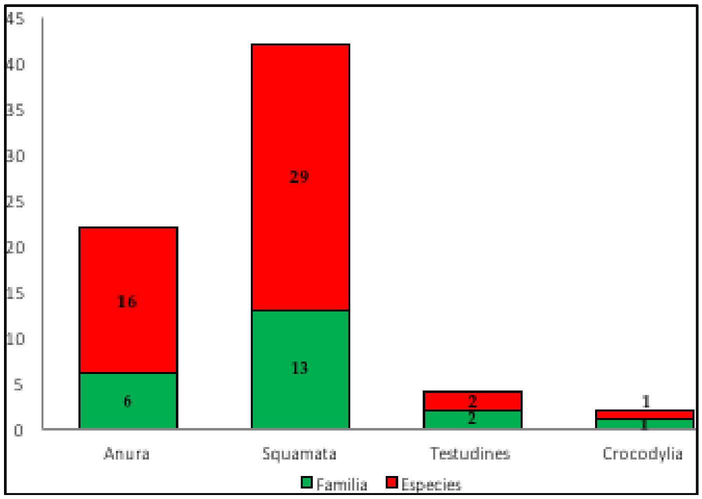


Illustration 4.24.2-67. Taxonomic composition of the herpetofauna registered.
Source: INGEX, 2016.

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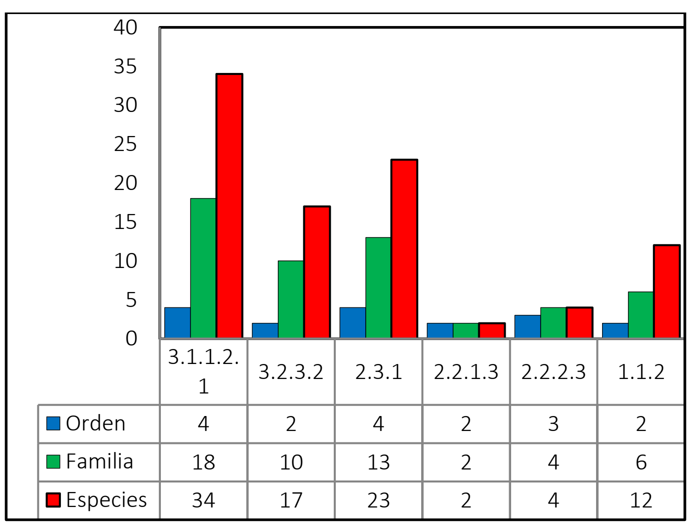


Illustration 4.2-68. Taxonomic composition by plat cover.
Source: INGEX, 2016.

The accumulation curve and the taxonomic classification for amphibians and reptiles registered in the studied area are presented next.

4.2.4.1.2 Curve of species accumulation

The species accumulation curves are used to estimate the number of species expected in a sample (Villareal et al., 2004) and are directly related to the sampling effort because, the greater this effort, the bigger the number of species. Species collected and incorporated into the inventory (Jiménez et al., 2003).

A total of 45 transects or sampling events were carried out in 22 days of field work, carried out by a field manager and a field assistant, reaching an effort of 5 hours / transect / vegetation cover.

For the calculation of the curves, the Biodiversity Pro software was used, where the estimator of accumulation of species for amphibians and reptiles has a relatively constant growth, with a tendency to gradually stabilize (See Illustration 4.2-68). When discriminating between amphibians and reptiles, the accumulation curve for amphibians has a tendency to stabilize towards final sampling and that of reptiles shows a relatively constant growth (See Illustration 4.2-69) with a tendency to begin to stabilize. This is not necessarily a demonstration that the sampling was not adequate, since in the case of reptiles it may be influenced, possibly, by the variation in the number of individuals reported for most of the species, which can be interpreted as a good size population, since the species are not distributed uniformly in all areas, additionally there are species of low detectability that during the sampling are only registered once increasing the estimator of accumulation as it is the case of the snakes or the lizards of wooded areas.

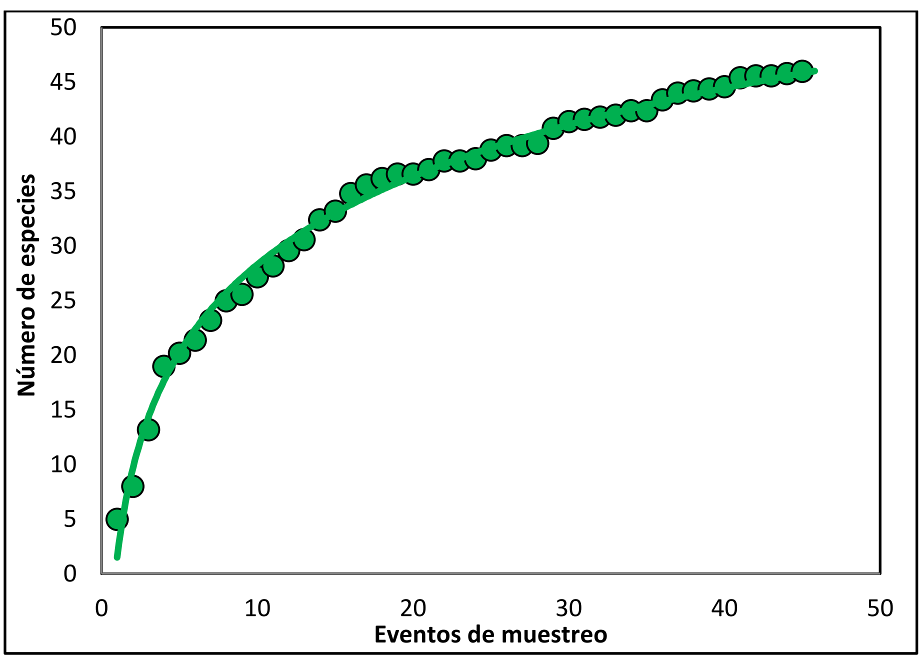


Illustration 4.24.2-69. Curve of species accumulation of herpetofauna registered.
Source: INGEX, 2016.

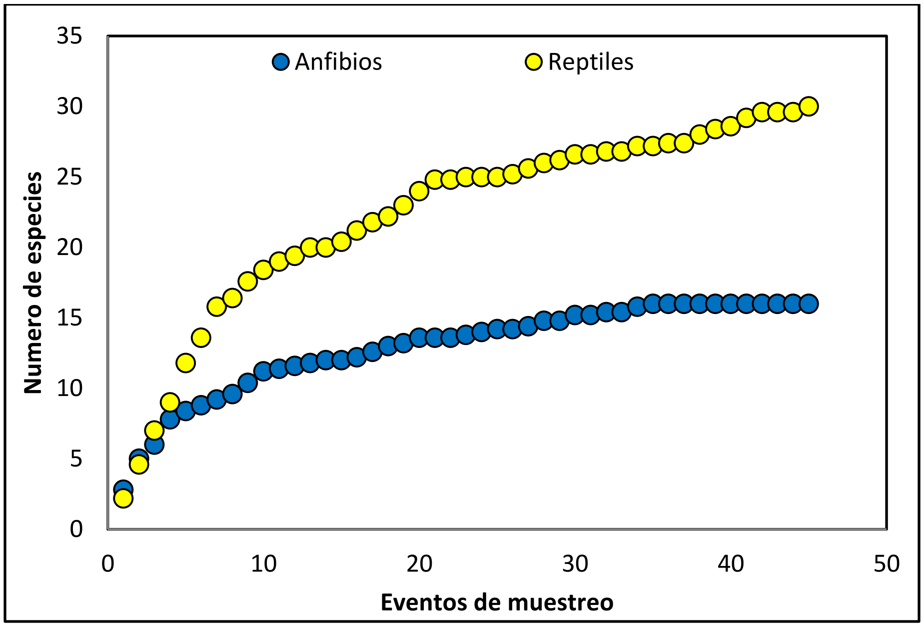


Illustration 4.2-70. Curve of accumulation of species registered.
Source: INGEX, 2016.

4.2.4.1.3 Amphibian taxonomic composition

In the quantitative sampling, sixteen (16) species grouped in the Anura order were registered, comprised in six (6) families and ten (10) genres. The best represented family is Hylidae with six (6) species (37.5%), followed by the family Leptodactylidae with four (4) species (25%), Bufonidae with two (2) species (12.5%), Dendrobatidae with two (2) species (12.5%), Craugastoridae with one (1) species (6.25%) and Ranidae with one (1) species (6.25%). See Illustration 4.2-70.

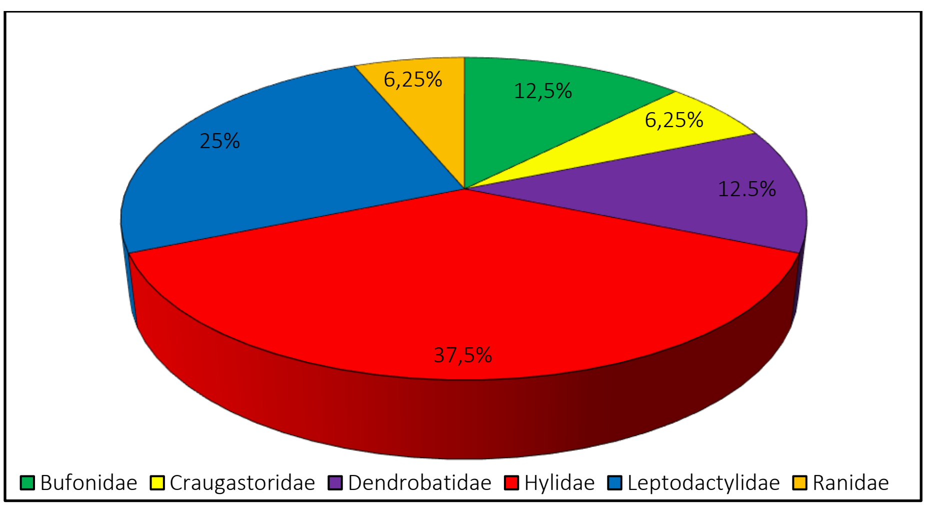


Illustration 4.2-71. Percentage of species registered by family.
Source: INGEX, 2016.

During the sampling, a total of 311 individuals were recorded, with the Leptodactylidae family being the most abundant with one hundred forty-three individuals (46%), followed by the Bufonidae family with one hundred and four individuals (34%), the Dendrobatidae family with twenty-nine individuals (9%), the family Hylidae with twenty-three individuals (7%), the family Craugastoridae with 10 individuals (3%) and the family Ranidae with two individuals (1%) (See Illustration 4.2-71 .)

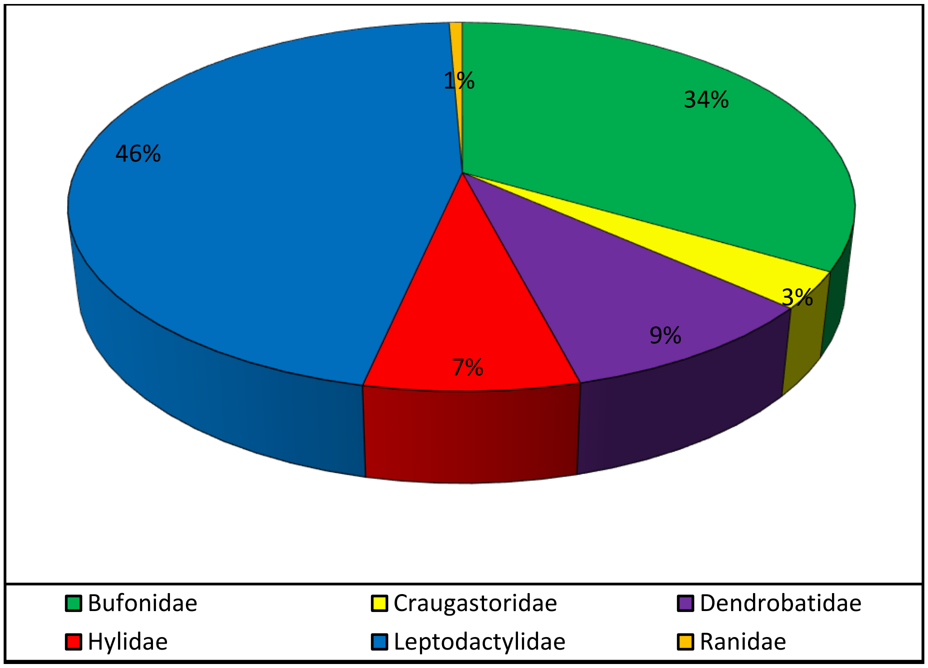


Illustration 4.24.2-72. Percentage of individuals registered by family.
Source: INGEX, 2016.

The registered species present the following microhabitats, habits, period of activity and some national endemism (Table 4.2-42).

Table 4.24.2-42. List of species of amphibians registered and ecologic attributes.

FAMILY	SPECIES	MICROHABITAT	HABITAT	PERIOD OF ACTIVITY	NATIONAL ENDENISM
Bufonidae	Rhinella marina Linnaeus (1758)	Ponds in pastures; trails; Stuble; pastures	Terrestrial	Nocturnal	No
Bufonidae	Rhinella granulosa Spix (1824)	Ponds in pastures; trails; Stuble; pastures	Terrestrial	Nocturnal	No
Craugastoridae	Craugastor raniformis Boulenger (1896)	Stuble; Pastures	Terrestrial	Nocturnal	No
Dendrobatidae	Colostethus cf inguinalis Cope (1868	Forest bodies of water	Terrestrial	Diurnal	Si
Dendrobatidae	Dendrobates truncatus Cope (1861)	Bodies of water; Stuble, leaf litter	Terrestrial	Diurnal	Si
Hylidae	Hypsiboas boans Linnaeus (1758)	Bodies of water, stuble, Pastures	Arboreal/ Terrestrial	Nocturnal	No

FAMILY	SPECIES	MICROHABITAT	HABITAT	PERIOD OF ACTIVITY	NATIONAL ENDENISM
Hylidae	Hypsiboas crepitan Wied-Neuwied (1824)	Bodies of water, stuble, Pastures	Arboreal/ Terrestrial	Nocturnal	No
Hylidae	Hypsiboas pugnax Schmidt (1857)	Bodies of water, stuble, Pastures	Arboreal/ Terrestrial	Nocturnal	No
Hylidae	Scinax ruber Laurenti (1768)	Bodies of water, stuble, Pastures	Terrestrial /Semiaquatic	Nocturnal	No
Hylidae	Scinax rostratus Peters (1863)	Bodies of water, stuble, pastures	Terrestrial / Semi-aquatic	Nocturnal	No
Hylidae	Smilisca phaeota Cope (1862)	Bodies of water, stuble, pastures	Terrestrial / Semi-aquatic	Nocturnal	No
Leptodactylidae	Engystomops pustulosus Cope (1864)	Bodies of water, stuble, pastures	Terrestrial	Nocturnal	No
Leptodactylidae	Leptodactylus fragilis Brocchi (1877)	Pastures; Paths; Leaf litter	Terrestrial	Nocturnal	No
Leptodactylidae	Leptodactylus fuscus Schneider (1799)	Pastures; Paths; Leaf litter	Terrestrial	Nocturnal	No
Leptodactylidae	Leptodactylus pentadactylus Laurenti (1768)	Pastures; Paths; Leaf litter	Terrestrial	Nocturnal	No
Ranidae	Lithobates vaillanti Brocchi (1877)	Bodies of water, Stuble, pastures	Terrestrial	Nocturnal	No

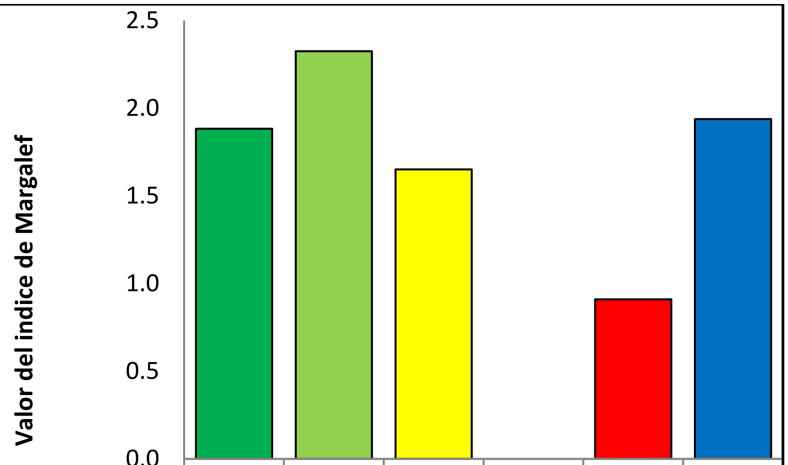
Source: Merceditas Corporation, 2012.

Next, we present the richness by plant cover, curve of accumulation of species (for the specific case of amphibians), indexes of diversity, trophic guilds, conservation status, endemic species and species identified in the region according to primary information.

4.2.4.1.4 Wealth of species by vegetal covering

The species wealth was calculated by means of the Margalef index; this index refers to the number of species in a defined sampling unit (Magurran, 1988). The index presented the maximum values in coverage 3.2.3.2 (M=2.3) with a total of ten (10) species. This is because most of the species recorded here are quite common because they are tolerant species to disturbed sites such as the common toad *Rhinella marina* or *Engystomops pustulosus* just to name a few. The vegetable coverings Bdbtf (3.1.1.2.1) and Dut (1.1.2) presented a value of the margalef index of M=1.9, with a total of nine (9) species each. The coverage of clean grasses (2.3.1) obtained a value of M=1.7, registering a total of nine (9) species. The coverage of cocoa crops (2.2.2.3) obtained an index of M=0.9 registering two species (2). On the other hand, the coverage of arable crops of cassava and plantain (2.2.1.3) obtained the lowest value of richness (M=0) counting only one (1) species (See Illustration 4.2-72).

No significant differences were found in the number of species among plant coverings (X^2=0.2973, p=0.96). Coverages of Cocoa and Yucca Crops were not considered in the statistical analysis considering that they presented very few species.



	3.1.1.2.1	3.2.3.2	2.3.1	2.2.1.3	2.2.2.3	1.1.2
Margalef M	1.9	2.3	1.7	0.0	0.9	1.9

Illustration 4.24.2-73. Values of wealth of Margalef by vegetal covering.
Source: INGEX, 2016.

The coverage of clean pastures (2.3.1) was significantly more abundant (X^2=61.8491, p=<0.001), with a total of one hundred twenty-seven (127) individuals, followed by forest cover (3.1.1.2.1) with a total of seventy (70) individuals, Dut (1.1.2) with a total of sixty-two (62) individuals, Lsv (3.2.3.2) with a total of forty-eight (48) individuals, and the Cphc (2.2.2.3) and the Cphy (2.2.1.3) with three (3) and one (1) individuals respectively (See Illustration 4.2-73).

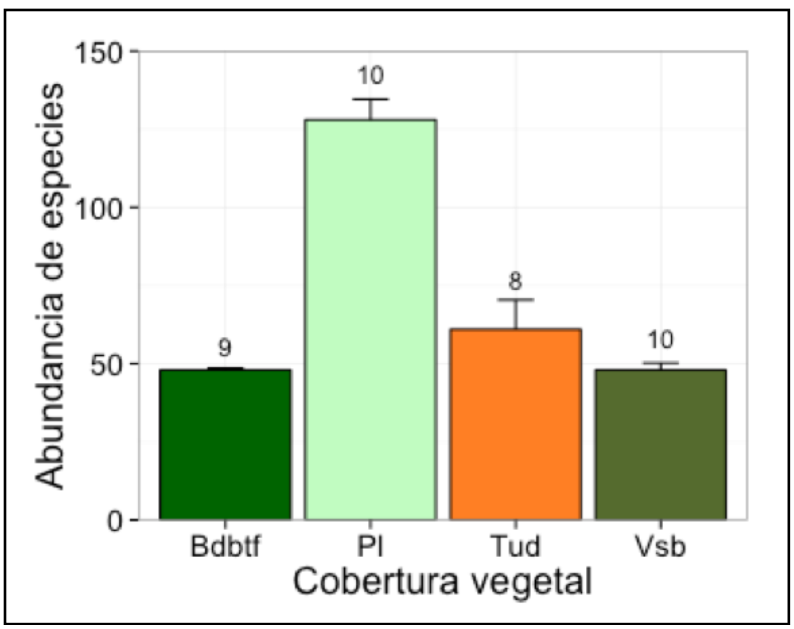


Illustration 4.2-4.274. Graph of abundance of amphibian individuals by plant cover. The whiskers on each bar indicate the standard deviation. The numbers above the whiskers indicate the richness of species for each plant cover.
Source: INGEX, 2016.

Regarding relative abundance, 2 abundant species were recorded (relative abundance> 10%). On the other hand, 7 common species were found (Relative abundance between 2 and 10%) and the remaining 7 uncommon species (Relative abundance between 0.1 and 2%).

The species with the highest abundance for sampling in general was *Engystomops pustulosus* (See Illustration 4.2-74) with a total of 121 individuals registered in four (4) of the six (6) plant coverings (Bdbtf, Lsv, Cg and Dut), being the coverage Pl (2.3.1) in which more individuals were found (sixty-one individuals). This species is quite common, found in lowlands of humid and dry tropical forest in natural, open and disturbed environments, in anthropogenic habitats and around natural or artificial temporary ponds, in puddles, potholes, hull footprints, ditches, pastures, secondary vegetation and along the edges of the forest. It reproduces in temporary and permanent lagoons. The males make calls at night while floating in the water (See Illustration 4.2-75), while the females of this species prefer to nest communally (Santos et al., 2010, Angarita et al., 2013). During the sampling, this species was recorded in temporary ponds in forest, pasture and grasslands, and several males and females were found singing in the same pond, in mating making foam nests and tadpoles were also seen. Additionally, individuals were found alone in stubble, pasture and litter.

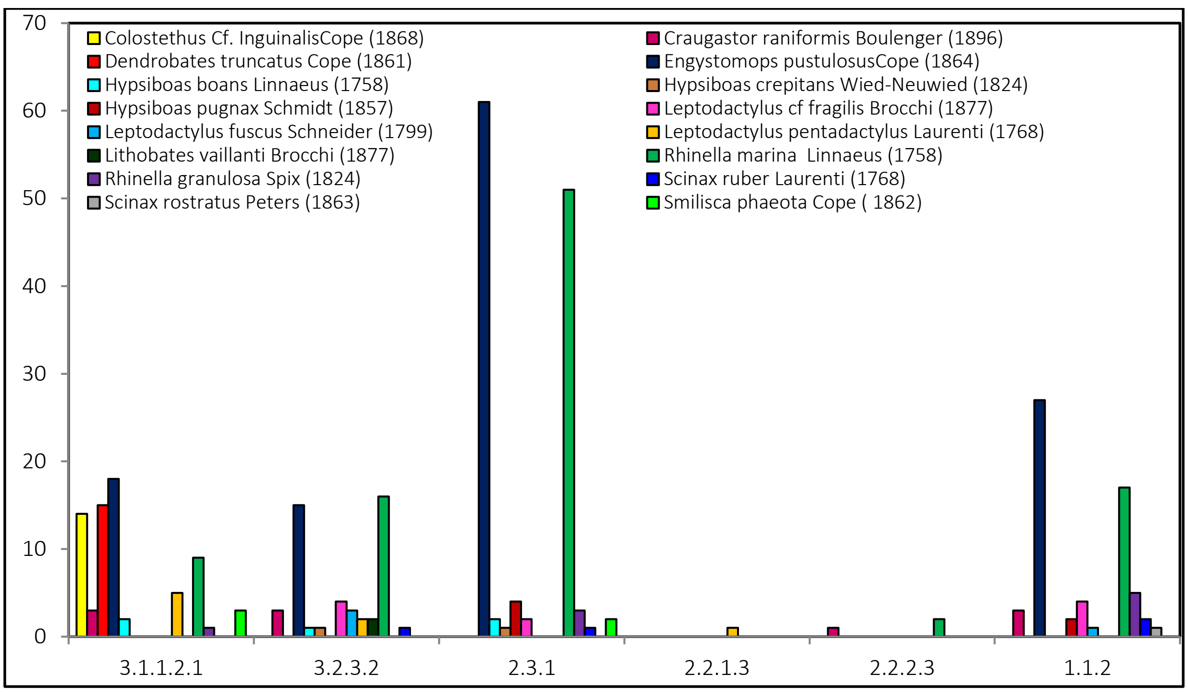


Illustration 4.2-75. Number of individuals per amphibian species registered in each of the covers.
Source: INGEX, 2016.

Illustration 4.2-76. Macho *Engystomops pustulosus*, Vocalizing in a paddock pond.
Source: Merceditas Corporation, 2012

The *marine Rhinella* species is the second most abundant of the sampling with a total of 95 individuals registered in five of the six plant covers (Bdbtf 3.1.1.2.1, Vsb 3.2.3.2, Cphc 2.2.2.3, Cg2.3.1 and Dut 1.1 .2), being the coverage of clean grasses (2.3.1) in which more individuals were found (fifty-one individuals). It is a cosmopolitan species and is the amphibian that inhabits the greatest number of natural regions, which suggests a broad environmental tolerance. It inhabits open areas, natural or artificial, including agricultural areas, pastures, gardens, trails and roads (Rengifo et al., 1999, Savage 2002, Powell et al 2009, Solís et al., 2010, Coloma et al., 2013). During the sampling, this species was recorded at the edge of the forest, stubble, pasture, paddock, edge of streams, trails and roads, and in the vicinity of the project camps, in the rooms and bathrooms of the residences. Individuals were found vocalizing near bodies of water, in addition to many tadpoles at different stages. The individuals who were seen near the houses were recorded feeding on different insects, taking advantage of the light of the lamps to which they are attracted.

Illustration 4.2-77. *Rhinella marina*, San Luis - Tolima.
Source: INGEX, 2015.

The species *Dendrobates truncatus* and *Colostethus Cf. inguinalis* were those that showed the highest records after *R. marina* with fifteen (15) and fourteen (14) individuals respectively, but these species were only recorded in dense forest cover (3.1.1.2. 1). The *D. truncatus* frog is found in humid and dry forests and tolerates habitats with certain degrees of intervention such as small banana plantations (Castro et al., 2004). During the sampling, this species was recorded inside and at the edge of the forest, in the litter, rocks, roots and on the shores of water births, both solitary individuals and in groups. The little frog *C. cf. Inguinalis* is a species of humid lowland and montane forest, which live along streams. It is often found along rocky stretches of streams and forest springs. It is assumed that the species has some immunity to anthropogenic habitat change (Grant et al., 2004), although in the sampling it was found only in very little disturbed sites, such as water births, in rocks, litter and decomposing trunks. This species was always found alone, and no vocalization was heard during the sampling time.

The species *Leptodactylus cf. fragilis* and *Craugastor raniformis* presented 10 individuals each, finding *C. raniformis* in the coverage of Bdbtf (3.1.1.2.1), Lsv (3.2.3.2), Cphc (2.2.2.3) and Dut (1.1.2) and *L cf. fragilis* in the Bdbtf coverage (3.2.3.2), Cg (2.3.1) and Dut (1.1.2). The species *L. cf. fragilis* is found in damp and dry tropical forests, in grasslands and open habitats, it is also seen near anybody of lentic or temporary water, and is common in disturbed sites in meadows, crops and ditches (Heyer et al., 2010). It was seen on edges of forest, stubble, pasture and paddocks and in the vicinity of the camps, in the meadows near the houses. The species *C. raniformis* is found in humid forests in low vegetation and is adaptable to environments with some disturbance (Solís et al., 2004). This species was recorded in the sampling near bodies of water, in litter and pastures.

The toad *Rhinella granulosa* registered nine (9) individuals, being found in the coverage of Bdbtf (3.1.1.2.1), Pl (2.3.1) and Dut (1.1.2). This toad commonly inhabits open areas, forests, banks of streams, and reproduces explosively in permanent and temporary bodies of water. Its presence in the forests is apparently due to the colonization of habitats intervened along roads and paths (Silvano et al., 2010). In the sampling, it was recorded on trails and forest edges, on the shores of bodies of water and pastures.

The South American bullfrog *Leptodactylus pentadactylus* recorded eight (8) individuals, being found in the plant covers of Bdbtf (3.1.1.2.1), Lsv (3.2.3.2) and Cphy (2.2.1.3). This species is nocturnal and terrestrial and is found in litter, tropical primary, secondary and seasonal flood forests. It has also been found in more open areas (Heyer et al., 2008). This specimen was recorded during the Forest sampling, in deep burrows where it was necessary to dig to be able to remove it, on the shores of water springs, on the edge of the forest and in leaf litter of plantain crops.

Of the species *Hypsiboas pugnax*, six (6) individuals were registered in the coverage of Cg (2.3.1) and Dut (1.1.2). This tree frog is found in humid lowlands, degraded forests, grasslands, agricultural and urban areas. It is often found in the shrubs, on the edges of ponds or in the water and in shallow waters of these ponds (La Marca et al., 2010). This species was seen during sampling in pasture ponds and in shrubs near the houses.

The species *Hypsiboas boans and Smilisca phaeota* presented five (5) individuals each found in the coverage of Bdbtf (3.1.1.2.1), Lsv (3.2.3.2), Pl (2.3.1), and Bdbtf (3.1.1.2. 1) and Cg (2.3.1) respectively. *H. Boans* is a nocturnal species found in trees up to a height of 5 meters. It is also found in bushes, trees, gallery forests, and rocks. Sometimes it is found in the sandy or muddy edges of lentic water currents. It is not known if the species can adapt to the habitat modification (La Marca et al., 2010), although in the sampling it was found in pasture shrubs, on banks of forest stream and secondary vegetation, vocalizing. The *S. phaeota* frog is found in damp lowland forests, on the edge of the forest and in open fields, even when there are few trees, on the banks of temporary surface lagoons and occasionally on the edges of streams or large ponds. Tolerates certain disturbance, it reproduces in temporary pools, even in livestock tracks (Solís et al., 2008). During the sampling, this species was always found vocalizing on banks of streams, forests and pastures.

Scinax ruber and *Leptodactylus fuscus* frogs were recorded with four (4) individuals each in the coverage of Lsv (3.2.3.2), Cg (2.3.1), Dut (1.1.2) and Lsv (3.2.3.2), Dut (1.1.2) respectively. *S. ruber* is a tree frog very abundant in disturbed areas; They are found in low shrubs near pools and can sometimes be seen near buildings (Ron et al., 2014). This species was recorded in the stubble, paddocks and in the bathrooms of the houses. *L. fuscus* is a terrestrial and nocturnal frog found in open fields, savannahs, grasslands, marshes, degraded forests and urban habitats. It is an adaptable species that can survive in modified habitats (Reynolds et al., 2004). This species was found in stubble and meadows near the houses.

For the species *Hypsiboas crepitans* and *Lithobates vaillanti* two (2) individuals were recorded for each one and were found in the Lsv covers (3.2.3.2) Cg (2.3.1), and Lsv (3.2.3.2) respectively. *H. crepitans* is found in a wide variety of habitats such as forests, open areas near water sources and has high tolerance for severely degraded habitats, including urban areas and human dwellings (La Marca et al., 2010; Medina et al., 2011; Angarita et al., 2013). This species was found on the banks of streams of stubble and paddocks. The bullfrog *L. vaillanti* is found in moist and dry forests, open areas or disturbed environments and is closely associated with bodies of water (Santos et al., 2008). This specimen was recorded on the muddy shores of births with high stubble.

Of the frog *Scinax rostratus*, only one individual was recorded in the Dut cover (1.1.2), on the shore of a birth in a paddock (Illustration 4.2-77). This species is nocturnal, and is found in sub humid and humid forests, in weeds and stubble, in the low vegetation at the edges of temporary or permanent ponds. This species can reproduce in modified habitats (Solís et al., 2010).

Illustration 4.2-78. *Scinax rostratus* on the shore of a water birth of the project.
Source: Merceditas Corporation, 2012.

4.2.4.1.5 Curve of accumulation of amphibian species

As already mentioned, for the characterization of amphibians a total of 39 sampling days were established, where 289 individuals were found, distributed in 6 families, 10 genera and 16 species in the different vegetation cover sampled. The accumulation curve for amphibian species has a tendency to stabilize, that is, it behaves asymptotically more accurately from event 36 (Illustration 4.2-78). Even if the number of sampled individuals or the number of days is increased, the number of species found will not increase significantly. In addition, the confidence intervals of the accumulation curve overlap with those of the non-parametric CHAO estimator, indicating that the number of species found could not have been greater in that sampling time.

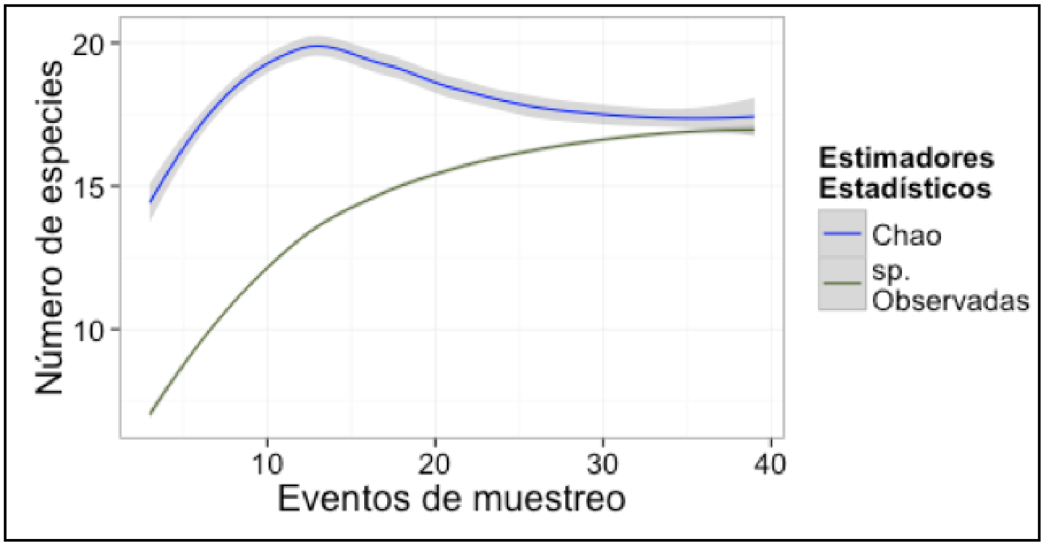


Illustration 4.2-79. Curve of accumulation of amphibian species registered with the nonparametric estimator **CHAO.** (The shaded regions represent confidence intervals).
Source: INGEX, 2016.

In the previous curve CHAO shows a curve of expected species much higher than that of observed species. This result can show that this estimator is sensitive to the presence of species seen once or twice, which often generates estimates of the values obtained. (see Illustration 4.2-78).

4.2.4.1.6 Diversity indexes

Alpha diversity α: Alpha diversity measures the point diversity of a sampling unit. For the alpha measure the following indexes were used:

Shannon index (H'): They indicate how uniform the species are represented, taking into account all the species sampled (Villareal et al, 2004). It reflects the heterogeneity of an ecosystem, based on species richness and equity (Franco et al., 1989). The values of these indexes frequently range between 1.5 and 3.5, and rarely exceed 4.5; values below 2 are considered low while those greater than 3 are considered high (Pla, 2006)

The Shannon diversity index (H ') has quite variable and relatively low diversity values for each cover. No significant differences were observed in the Shannon index between plant covers (X^2=2.1439, p=0.82). The values of this index in each coverage were between 0.6 and 1.79, being the highest that reached in the covering of Bdbtf (3.1.1.2.1) (H'= 1.9) since it presented both species specific to that vegetation as common and generalist species. This result demonstrates once again that amphibians have great affinity for wooded vegetation, since they have a preference for humid places (Angulo et al., 2006). The rest of the covers presented the following values: Coverage Lsv (3.2.3.2) (H'= 1.8), cover Dut (1.1.2) (H' = 1.6), cover Cg (2.3.1) (H'= 1,2). Coverages with the lowest index were the Cphc (2.2.2.3) (H' = 1,2) and the Cphy (2.2.1.3) (H'= 0), result that is due to the low representation of species in these (See Illustration 4.2-79).

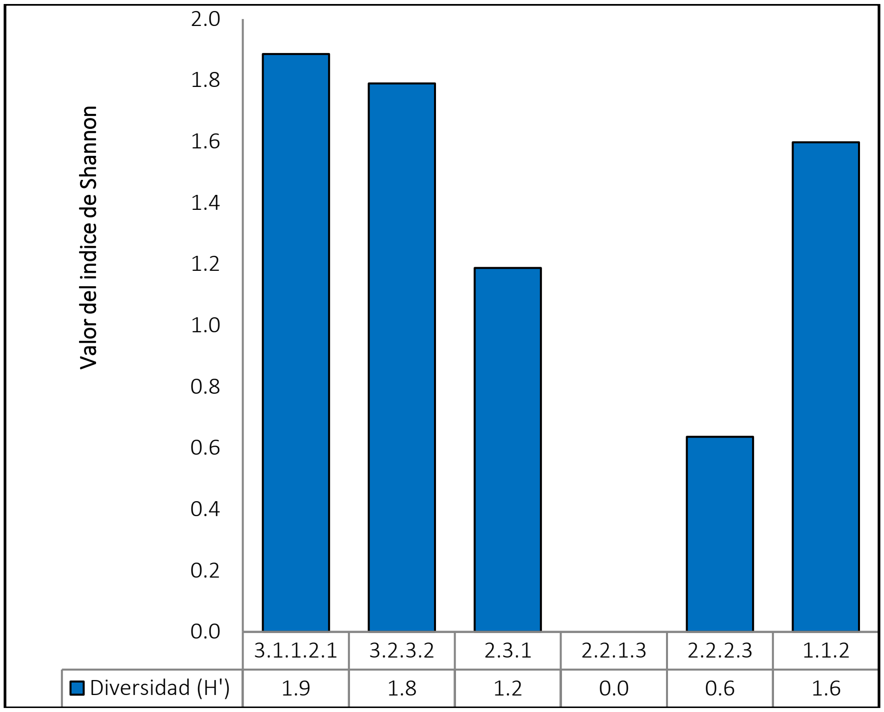


Illustration 4.2-80. Graph of the Shannon index of value by plant cover.
Source: INGEX, 2016.

Simpson’s dominance index (D): It shows the probability that two individuals taken at random from a sample correspond to the same species (Villareal et al., 2004). It reflects the weighting of species abundance.

For the Simpson dominance index (Ds) no significant differences were found between plant covers (X^2=3.4226, p=0.63), showing relatively high dominance for cover (Illustration 4.2-80) that is, they are very homogeneous covers.

The equity index of Pielou (J´): It relates the observed diversity (H') and the maximum diversity (H'max). It varies between 0 and 1, where 1 is the situation in which all species are equally abundant and 0 implies absolute dominance of one or few taxa.

The equity of Pielou (J') shows how the hedges Bdbtf (3.1.1.2.1) and Cphc (2.2.2.3) present the greatest equity in terms of the number of individuals per species per cover (J') =0.9 (See Illustration 4.2-81).

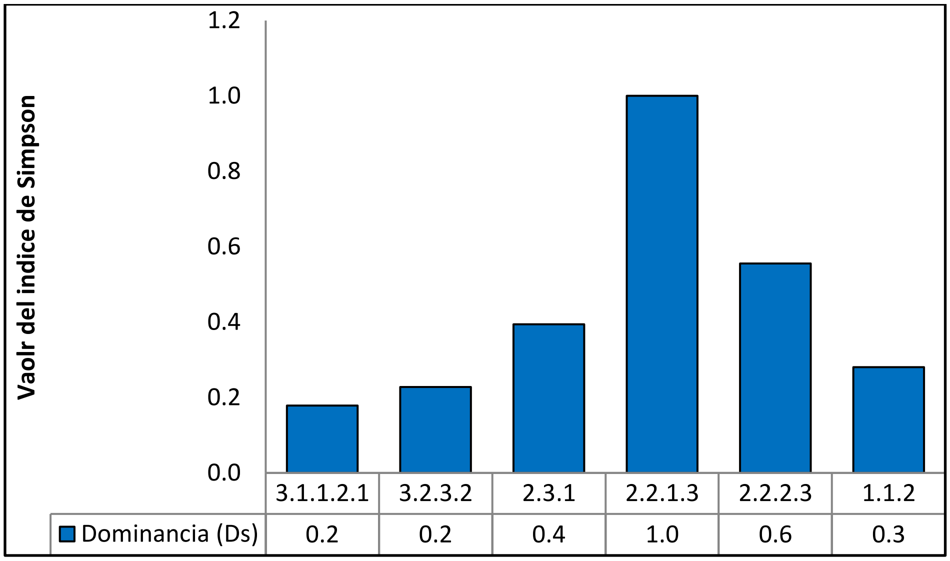


Illustration 4.2-81. Simpson's index graph for amphibians by plant cover.
Source: INGEX, 2016.

Finally, it is appropriate to consider that these results on alpha richness and diversity for amphibians in the aforementioned plant coverings are due to the fact that most of the species recorded here are quite common because they are tolerant species to disturbed sites as mentioned above. These species are generally overrepresented and can generate a bias in the estimation of these indices.

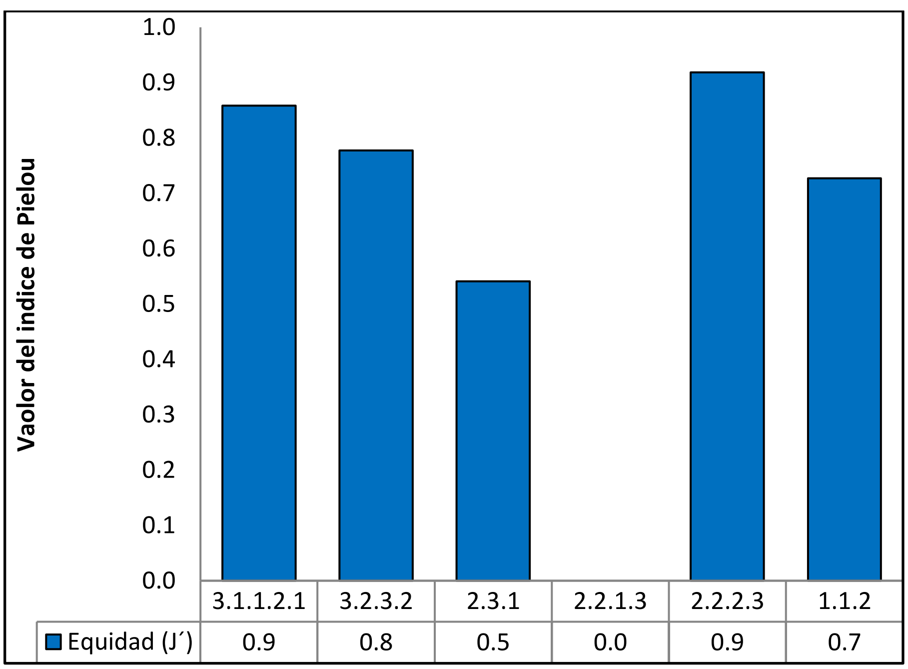


Illustration 4.24.2-82. Index of equity of Pielou for amphibians by plant cover.
Source: INGEX, 2016.

Beta diversity β

Bray Curtis Analysis

This index uses the data of relative abundance between the environments and is useful to evaluate the differences in the structure of the community between samplings.

In this analysis it was evidenced that there is a great similarity between the covers Lsv (3.2.3.2) and Dut (1.1.2), since they have several species in common and numbers of similar individuals. The Bdbtf coverage (3.1.1.2.1) is also similar to the coverage of Lsv (3.2.3.2) and Dut (1.1.2) since they present species in common. The coverage Cg (2.3.1) is similar in its composition and structure of amphibians with the coverage Bdbtf (3.1.1.2.1), Lsv (3.2.3.2) and Dut (1.1.2) perhaps due to the number of species and of individuals in common. The Cphy (2.2.1.3) and Cphc (2.2.2.3) covers are the least similar because they presented a very low number of species and individuals (See Illustration 4.2-82). In the same way, a Principal Coordinate Analysis also shows the similarity between the Lsv and Dut cover in a two-dimensional space (illustration 4.2-82). The characteristics of the three similar coverings in comparison with the crops are evidently different, which suggests dissimilarity in the composition of amphibians of each of them.

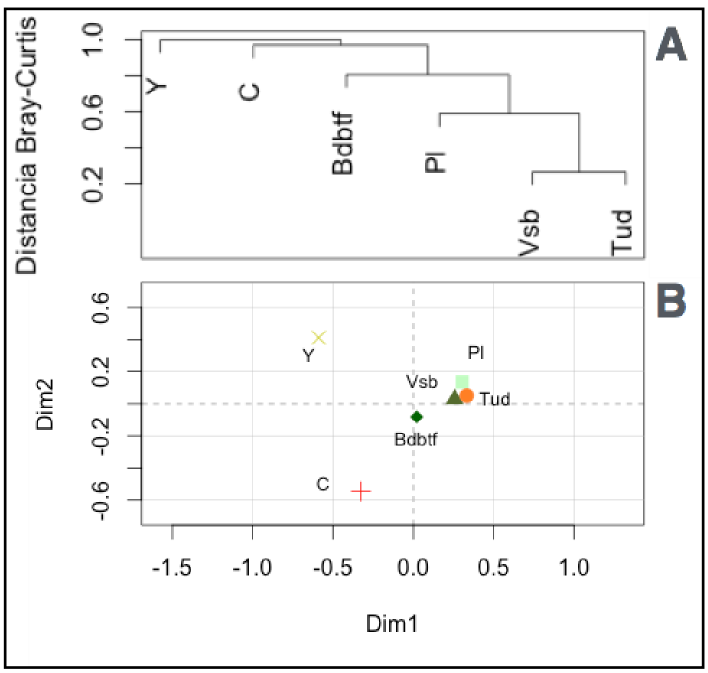


Illustration 4.24.2-83 Beta diversity graph of analysis, based on a Bray Curtis dendrogram (A) and a principal coordinate analysis (B) for amphibians.

Source: INGEX, 2016

4.2.4.1.7 Trophic guilds

Amphibians have a very varied diet, usually feed on annelids, insects and arthropods but can vary to a single type of prey. Even among the species that live in the same area, the diets may differ

(Savage, 2002, Vitt et al., 2014). To know the items included in the anuran diets, it is necessary to analyze the stomach contents, but only secondary information about the diet of the individuals was used in this sampling (Savage, 2002, De la Ossa et al., 2011; Coloma et al., 2013, Torres et al., 2014, Vitt et al., 2014) (Table 4.2-43).

Table 4.2-43. Food guilds registered amphibian species.

SPECIES	TROPHIC GUILD	ITEMS
Rhinella marina Linnaeus (1758)	Omnivore	Artrhopods, Insects, Anelids, Amphibians
Rhinella granulosa Spix (1824)	Insectivorous	Arthropods, Insects
Colostethus Cf. Inguinalis Cope (1868)		
Craugastor raniformis Boulenger (1896)		
Dendrobates truncatus Cope (1861)		
Engystomops pustulosus Cope (1864)		
Hypsiboas boans Linnaeus (1758)		
Hypsiboas crepitansWied-Neuwied (1824		
Hypsiboas pugnax Schmidt (1857)		
Leptodactylus cf fragilis Brocchi (1877)		
Leptodactylus fuscus Schneider (1799)		
Leptodactylus pentadactylus Laurenti (1768)		
Lithobates vaillanti Brocchi (1877)		
Scinax ruber Laurenti (1768)		
Scinax rostratus Peters (1863)		
Smilisca phaeota Cope (1862)		

Source: INGEX, 2016. Modified of Merceditas Corporation, 2012

According to Table 4.1-41 93,5% of the species registered are insectivorous and 6,5% omnivores.

4.2.4.1.8 Conservation status of amphibians

The species *R. marina* presents Cosmopolitan distribution being native to the Neo trophic but introduced in the Caribbean islands and Southeast Asia and Australia. The species *C. raniformis, H. pugnax, H. boans, H. crepitans, E. pustulosus, L.cf. fragilis, L. fuscus, L. pentadactylus, L. vaillanti, R. granulosa, S. ruber, S. rostratus, S. phaeota* present Neotropical distribution and species *C. cf. Inguinalis* and *D. truncatus* are endemic to Colombia. In terms of threat categories, all the Anuran species recorded in this sample are in the minor concern category (LC) of the IUCN Red List (Table 4.2-44). The species *D. truncatus* is the only one that is included in Appendix II of the Cites since it is a species that is marketed as a pet. None of the registered species are found in the red book of amphibians of Colombia (Rueda et al., 2004), nor in resolution 0192 of 2014 (MADS, 2014), neither considered important for Corantioquia (Restrepo et al. 2010).

Table 4.2-44. Threat categories of the UICN and the CITES for the amphibian species registered.

SPECIES	UICN	CITES
Colostethus Cf. Inguinalis Cope (1868)	LC	No
Craugastor raniformis Boulenger (1896)	LC	No
Dendrobates truncatus Cope (1861)	LC	Apéndice II
Engystomops pustulosus Cope (1864)	LC	No
Hypsiboas boans Linnaeus (1758)	LC	No

SPECIES	UICN	CITES
Hypsiboas crepitansWied-Neuwied (1824	LC	No
Hypsiboas pugnax Schmidt (1857)	LC	No
Leptodactylus cf fragilis Brocchi (1877)	LC	No
Leptodactylus fuscus Schneider (1799)	LC	No
Leptodactylus pentadactylus Laurenti (1768)	LC	No
Lithobates vaillanti Brocchi (1877)	LC	No
Rhinella marina Linnaeus (1758)	LC	No
Rhinella granulosa Spix (1824)	LC	No
Scinax ruber Laurenti (1768)	LC	No
Scinax rostratus Peters (1863)	LC	No
Smilisca phaeota Cope (1862)	LC	No

Source: INGEX, 2016

4.2.4.1.9 National endemic Species

Within the study area, two endemic frogs' species were found for the Colombian territory, such as the yellow-band dart frog *Dendrobates truncatus* and the dart frog *Colostethus inguinalis,* these species are territorial and defend a particular site that is favorable for access to the resources they need for their survival or reproduction (Duellman et al., 1986; Vaz-Silva et al., 2007).

4.2.4.1.10 Dendrobates truncatus Cope (1861)

Distribution in Colombia: This species is distributed in Colombia on the western flank of the Eastern Mountain range, and the eastern flank of the Central mountain range, between 0 and 1,200 masl. It is found in the sub-Andean forests, humid, dry and very dry tropical forests, in the Caribbean and Andean region, in the Magdalena river valley, in the departments of Antioquia, Bolívar, Boyacá, Caldas, Cesar, Chocó, Córdoba, Cundinamarca, Huila, Magdalena, Santander, Sucre and Tolima.

Natural history: This species is active during the day in the litter of the forest of the mainland, and exceptionally in the flooded forest. The males are usually hidden among dry leaves or fallen trunks. During the night they are found immobile on leaves. The parents carry the tadpoles on their back, to deposit them in bromeliads, so that they complete their development. They are markedly territorial and exhibit aggressive behavior in courtship and mating (De la Ossa et al., 2012). This species is tolerant to disturbed habitats such as banana plantations (Castro et al 2004, Acosta 2015). It is insectivorous, especially myrmecophagy; Their diet include ants, termites, small flies, spiders, centipedes, mosquitoes and other small invertebrates, it is estimated that toxins may be related to their diet (Cadwell, 1996, De la Ossa et al.).

For the species there are several works on their ecology of populations in both wild life and that of Molina et al.; 2014, De la Ossa et al. 2011 and in captivity as that of De la Ossa et al.; 2012

The study by Molina et al.; 2014 evaluates the population dynamics in a given time of three populations of frogs, among which is *D. truncatus* (Illustration 4.2-83), carried out in the buffer zone of two Isagen hydroelectric plants in Antioquia. The study evaluated parameters such as the probability of survival, where this species presents high probabilities (60% to 80% according to probabilities exposed by other authors) of recapture where the species obtained high probability because it is an easily detectable species, and the rate of population growth, which was constant for the species.

According to De la Ossa et al. 2011, in its study of Censuses in the Serranía de Coraza Protective Forest Reserve, Montes de María, Sucre, Colombia, this species presented a density of 3,250 ind / km2 in the studied area, much lower than that found by Galván et al. 2009 (73.68 ind / km2) for that same area.

Conservation: It is classified as a minor concern (LC) by the IUCN red list due to its wide distribution and tolerance to a certain degree of habitat modification (Castro et al 2004, Acosta 2015).

Illustration 4.2-84. Photograph of the dart frog *Dendrobates truncatus* in the forest.
Source: Merceditas Corporation, 2012.

4.2.4.1.11 Colostethus Cf. Inguinalis Cope (1868)

Distribution in Colombia: This species is endemic from Colombia, it is extended from the north of the Department of Chocó in the lowlands of the Pacific, humid tropical forests of the northern Pacific region, Middle Magdalena Valley and north foothills of the western slope of the Western Mountain range in the Departments of Antioquia, Boyacá, Caldas, Córdoba and Santander, between 300-800 meters above sea level (Grant et al., 2004a, Grant et al., 2004b, Acosta 2015).

Natural history: It is a diurnal species of lowland and humid and montane forests. It is often found in the Forests, along rocky stretches of streams. The eggs are deposited in the litter, and the adults carry the tadpoles to the streams. It is assumed that the species (Illustration 4.2-84) has some immunity in exchange for anthropogenic habitat (Grant et al., 2004a, Grant et al., 2004b).

Most of the studies carried out for this species have to do with taxonomy and systematics (Grant et al., 2004b, Lynch et al., 2004; Acosta et al., 2006; Romero et al., 2012; Acosta et al., 2016). Ecological or population studies are not known for this species.

Conservation: It is categorized as a minor concern (LC) by the IUCN red list (Grant *et al.* 2004a).

Illustration 4.24.2-85. Photography of the rocket frog *Colostethus Cf. Inguinalis*, taken from the database from objects and learning bank from Antioquia's university.
Source http://aprendeenlinea.udea.edu.co/ova/?q=node/295, 23-2015.

4.2.4.1.12 Forbidden species

Forbidden amphibian species were not found for the area of study.

4.2.4.1.13 Species used by the community

In the area of study there is no use of amphibians by the community.

4.2.4.1.14 Migratory species

In the area of study, no amphibian species with migratory patterns were registered.

4.2.4.1.15 Taxonomic composition of reptiles

The Reptile or Sauropsida class registered three orders: Crocodylia, Testudines and Squamata, being the latter the most representative during sampling (See Illustration 4.2-85).

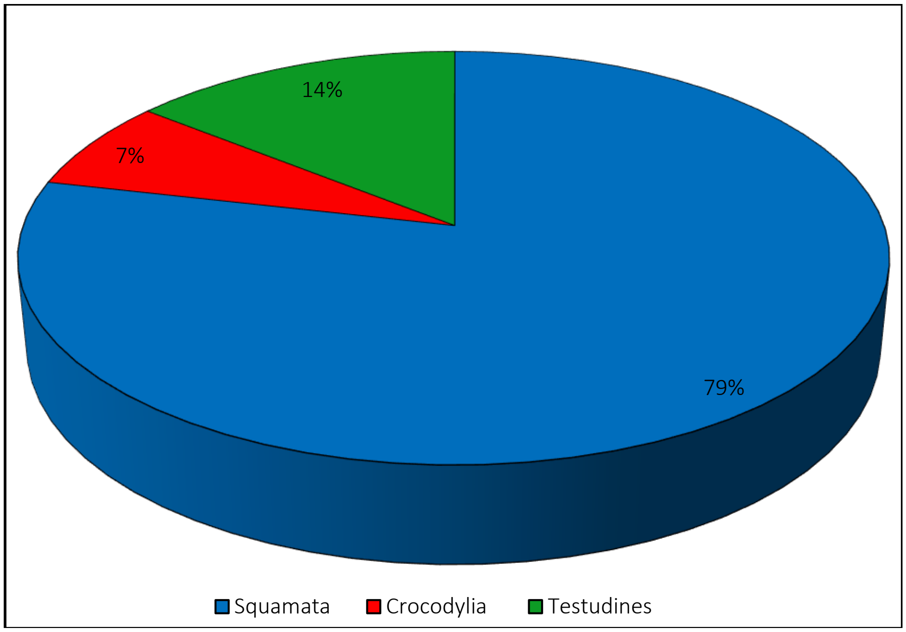


Illustration 4.2-86. Percentage of order in terms of families.
Source: INGEX, 2016.

The Squamata order registered eleven families, twenty-seven species, with the Colubridae family being the best represented with six species (20%), followed by the Dipsadidae and Dactyloidae families with four species each (14% each), Corytophanidae with three species (10 %), Boidae, Teiidae and Viperidae with two species each (7% each), and the families Gymnophthalmidae, Iguanidae, Phyllodactylidae and Scincidae with one species each (3%). From the order Testudines a record of two (2) families was obtained: Geoemydidae and Kinosternidae one species each (3% each). The order Crocodylia obtained a family in the sampling: Alligatoridae with one species (3%) (See Illustration 4.2-86).

During the sampling a total of 235 individuals were registered, of which two hundred and seventeen belong to the order Squamata, fourteen to the order Crocodylia and four to the order Testudines. For the Squamata order, the Corytophanidae family was the most abundant with seventy-nine individuals (33.6%), followed by the Teiidae family with fifty-five individuals (23.4%), the Dipsadidae family with twenty-five individuals (10.6%). %), Iguanidae with sixteen individuals (6.8%), Boidae with twelve individuals (5.1%), Colubridae and Scincidae with seven individuals each (3% for each), Dactyloidae with six individuals (2.6%)), Phyllodactylidae and Viperidae with four individuals each (1.7% in both cases) and Gymnophthalmidae with two individuals (0.9%). From the order Crocodylia, the Alligatoridae family obtained a total of fourteen individuals (6%), and for the order Testudines, the Kinosternidae family registered three individuals (1.3%) and the family Geoemydidae a single individual (0.4%) (See Illustration 4.2-87).

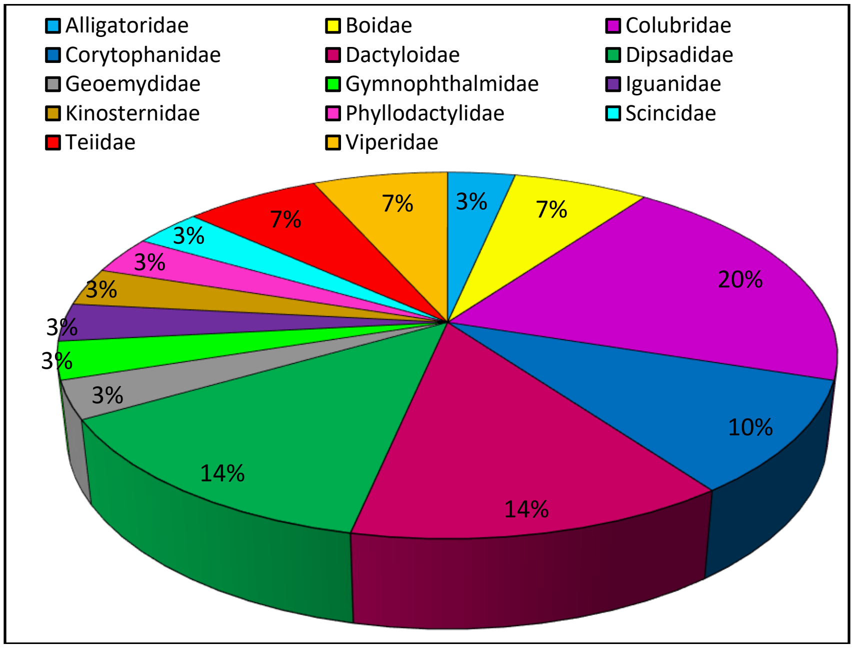


Illustration 4.24.2-87. Percentage of species registered by reptile family.
Source: INGEX, 2016.

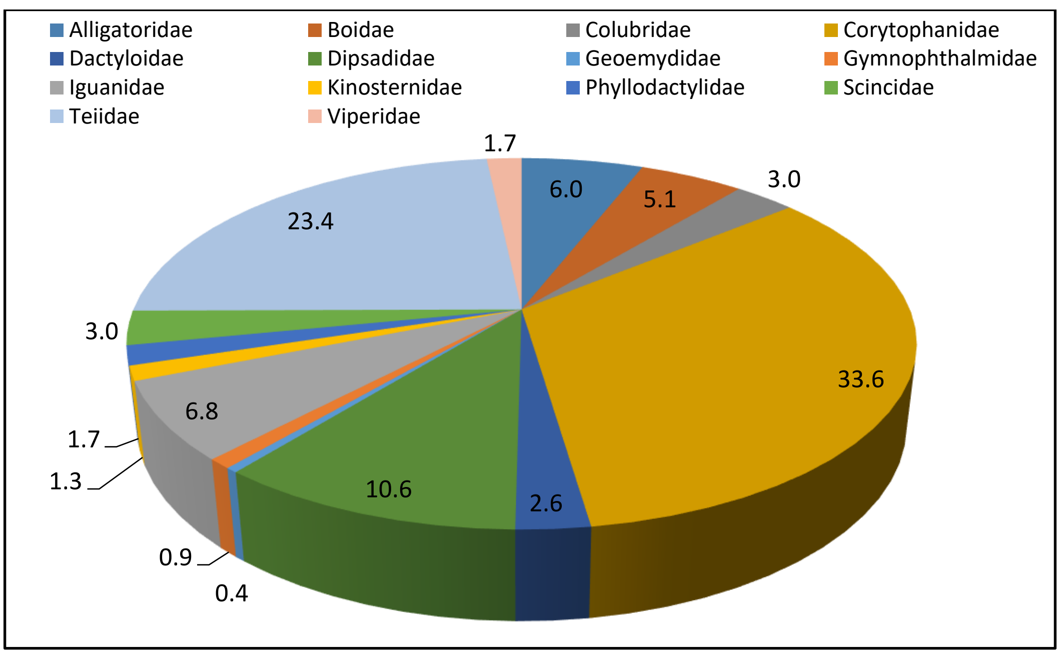


Illustration 4.2-88 Percentage of individuals per families registered.
Source: INGEX, 2016.

The species of reptiles registered in the zone present the following microhabitats, habitats, period of activity and some national endemism (Table 4.2-45).

Table 4.2-45. List of registered reptile species and ecological attributes.

FAMILY	SPECIES	MICROHABITAT	HABITAT	ACTIVITY PERIOD	NATIONAL ENDENISM
Dactyloidae	*Anolis sp 1*	Shrubs in paddocks	Arboreal	Diurnal	Non-defined
Dactyloidae	*Anolis aff. biporcatus* Wiegmann (1834)	Trees and shrubs in forest	Arboreal	Diurnal	No
Dactyloidae	*Anolis sp 3*	Shrubs and trunks on the shore of ravine	Arboreal	Diurnal	Non-defined
Dactyloidae	*Anolis vittigerus* Cope (1862)	Shrubs and trunks on the shore of ravine	Arboreal	Diurnal	No
Corytophanidae	*Basiliscus basiliscus* Linnaeus (1758)	Water body edge rocks	Arboreal /Terrestrial/Semi acuatic	Diurnal	No
Corytophanidae	*Basiliscus galeritus* Duméril (1851)	Water body edge rocks	Arboreal /Terrestrial/Semi acuatic	Diurnal	No
Teiidae	*Cnemidophorus lemniscatus* Linnaeus (1758)	Trails of forest, Stubble, Litter, Ravines, Roads, Gardens near homes.	Terrestrial	Diurnal	No
Corytophanidae	*Corytophanes cristatus* Merrem (1820)	Trees and shrubs of forest.	Arboreal	Diurnal	No
Teiidae	*Holcosus festivus* Lichtenstein (1856)	Stubble, trails	Terrestrial	Diurnal	No
Iguanidae	*Iguana iguana* Linnaeus (1758)	Water body edge rocks	Arboreal /terrestrial	Diurnal	No
Scincidae	*Mabuya sp.*	Trails, leaf litter, stubble, pastures, shores of ravines	Terrestrial	Diurnal	No
Phyllodactylidae	*Thecadactylus rapicauda* Houttuyn (1782)	Rocks, trunks	Arboreal	Nocturnal	No
Gymnophthalmidae	*Tretioscincus bifasciatus* Dumeril (1851)	Trunks, leaf litter of forest borders	Terrestrial	Diurnal	No
Viperidae	*Bothrops asper* Garman (1883)	Forest, border of forest, trails, stubble, pastures, paddocks, bodies of water	Terrestrial	Nocturnal	No
Colubridae	*Chironius carinatus* Linnaeus (1758)	Border of forest, trails, Stubbles, Paddocks	Terrestrial	Diurnal	No
Boidae	*Corallus annulatus* Cope (1876)	Trees and shrubs of forest at ravine shore	Arboreal	Nocturnal	No
Boidae	*Corallus ruschenbergerii* Cope (1875)	Trees and shrubs of forest at ravine shore	Arboreal	Nocturnal	No
Colubridae	*Dendrophidion sp.*	Trail of forest	Terrestrial	Diurnal	No information
Dipsadidae	*Helicops danieli*	Bodies of water with	Semiacuatic	Nocturnal	Yes

FAMILY	SPECIES	MICROHABITAT	HABITAT	ACTIVITY PERIOD	NATIONAL ENDENISM
	Amaral (1938)	low flow			
Dipsadidae	*Imantodes cenchoa* Linnaeus (1758)	Trees and shrubs of forest at ravine shore	Arboreal	Nocturnal	No
Dipsadidae	*Leptodeira septentrionalis* Kennicott (1859)	Trails of forest, stubble, paths, paddocks, shores of bodies of water	Terrestrial	Nocturnal	No
Colubridae	*Mastigodryas pleei* Dumeril, Bibron & Dumeril (1854)	Border of forest, stuble, trails, paddock	Terrestrial	Diurnal	No
Viperidae	*Porthidium lansbergii* Schlegel (1841)	Forest, border of Forest, trails, stubble	Terrestrial	Nocturnal	No
Dipsadidae	*Pseudoboa neuwiedii* Dumeril, Bibron & Dumeril (1854)	Border of Forest, trails, stable, paddock, bodies of water	Terrestrial	Nocturnal	No
Colubridae	*Rhinobothryum bovallii* Andersson (1916)	Border of forest, trails, stables, Paddock, bodies of water	Semiarboreal	Nocturnal	No
Colubridae	*Spilotes pullatus* Linnaeus (1758)	Forest, Border of forest, trails, stubble, pastures	Semiarboreal	Diurnal	No
Colubridae	*Stenorrhina cf degenhardtii* Berthold (1846)	Border de forest, trails, stuble, pastures	Terrestrial	Diurnal	No
Alligatoridae	*Caiman crocodilus* Linnaeus (1758)	Bodies of water with low or moderate flow	Semiacuatic	Nocturnal	No
Kinosternidae	*Kinosternon leucostomum* Duméril, Bibron Y Duméril (1851)	Bodies of water	Acuatic	Diurnal /Nocturnal	No
Geoemydidae	*Rhinoclemmys annulata* Gray (1860)	Forest, leaf litter, shore of bodies of water	Terrestrial / Semiacuatic	Diurnal	No

Source: Merceditas Corporation, 2012.

4.2.4.1.16 Wealth of species by plant cover

The species richness was calculated by means of the Margalef index (Table 4.2-88); this index refers to the number of species in a defined sampling unit (Magurran, 1988). The index presented the maximum values in the cover of the fragmented forest (3.1.1.2.1) (M=5.0) with a total of ten (10) species, more than half of those registered in the sampling; finding species that were only found in this vegetation and common species, tolerant to disturbed sites such as the lizards *Basiliscus* and *Cnemidophorus lemniscatus*. In terms of significant differences, the Bdbtf cover (3.1.1.2.1) was significantly richer in species compared to the Dut (1.1.2) and Lsv (3.2.3.2) cover (X^2=11.2414; p=0.003) but not in comparison with grassland cover (2.3.1) (X^2=0.8065, p=0.36).

Coverages of Cocoa and cassava crops were not considered in the statistical analysis considering that they presented 2 and 1 species, respectively.

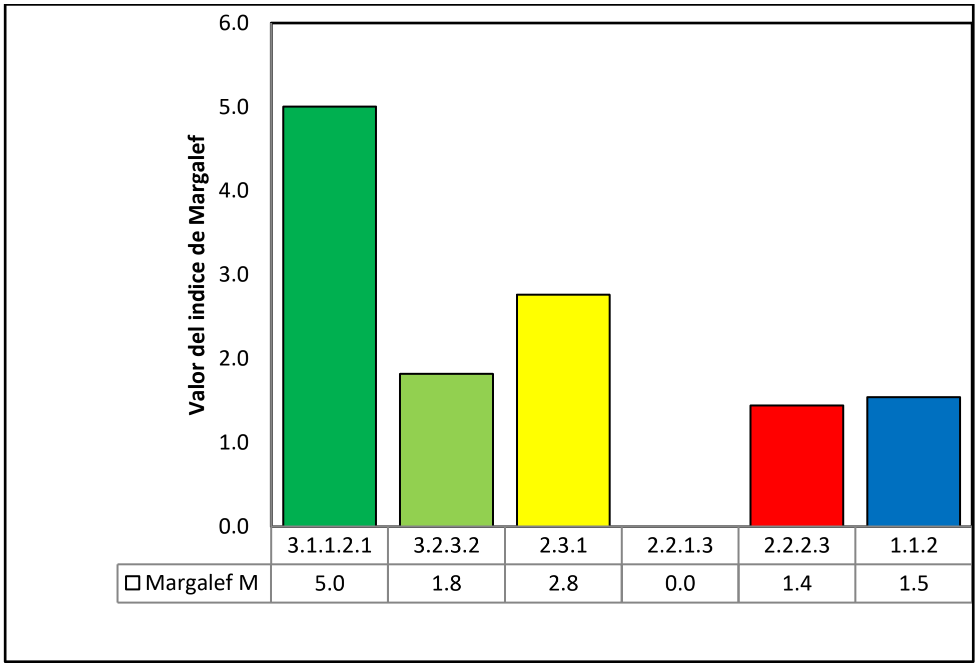


Illustration 4.2-89. Values of wealth of Margalef by plant cover.
Source: INGEX, 2016.

4.2.4.1.17 Relative abundance of species by plant cover

The dense forest cover of the mainland (3.1.1.2.1) was significantly more abundant than the other coverings with a total of one hundred and twenty one (121) individuals, followed by the coverage of clean pastures (2.3.1) with a total of seventy-seven (77) individuals, with which there were no significant differences (X2 = 2.0867, p = 0.14), followed by Lsv (3.2.3.2) with a total of twenty-seven (27) individuals, the Dut (1.1.2) with a total of seven (7) individuals, and the Cphc (2.2.2.3) and the Cphy (2.2.1.3) with two (2) and one (1) individuals respectively with whom it presents significant differences (X2 = 107.1905; p = <0.001) (See Illustration 4.2-89 and Illustration 4.2-90).

Considering the categorization of abundance for species, 2 abundant species were recorded (relative abundance> 10%). 8 common species (Relative abundance between 2 and 10%) and the remaining 16 uncommon species (Relative abundance between 0.1 and 2%).

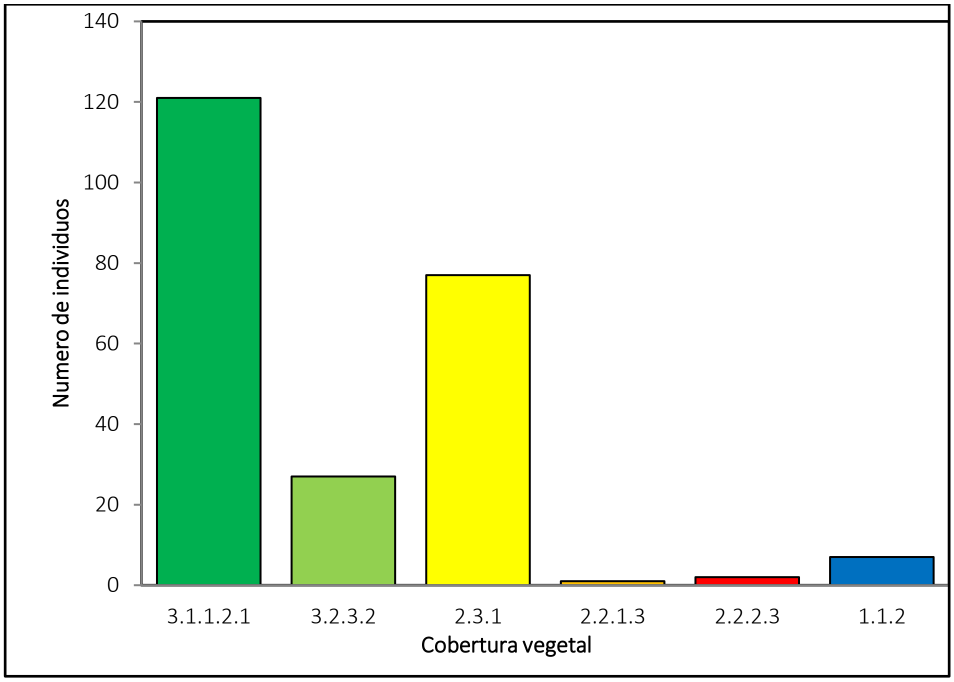


Illustration4.2-90. Number of reptile individuals by plant cover.
Source: INGEX, 2016.

The species with the greatest abundance for sampling in general was *Basiliscus* (Illustration 4.2-91) with a total of seventy-four (74) individuals registered in three of the six plant covers (Bdbtf 3.1.1.2.1, Lsv 3.2.3.2 and Cg 2.3.1), being the Bdbtf cover (3.1.1.2.1) in which more individuals were found (forty-nine individuals). This quite common lizard inhabits dry forests, very wet and humid, near the banks of rivers and lagoons and its peculiarity is that it moves quickly on its hind legs on water and land. The speed that can reach in a race on the water is of 9 kilometers per hour (Ayala, 1986). During the sampling this species was recorded on the banks of the streams within the Forest, secondary vegetation and pasture shrubs. At night, some individuals were observed sharing a perch with the *Iguana iguana* species, sleeping in the same bush, but not in the same branch.

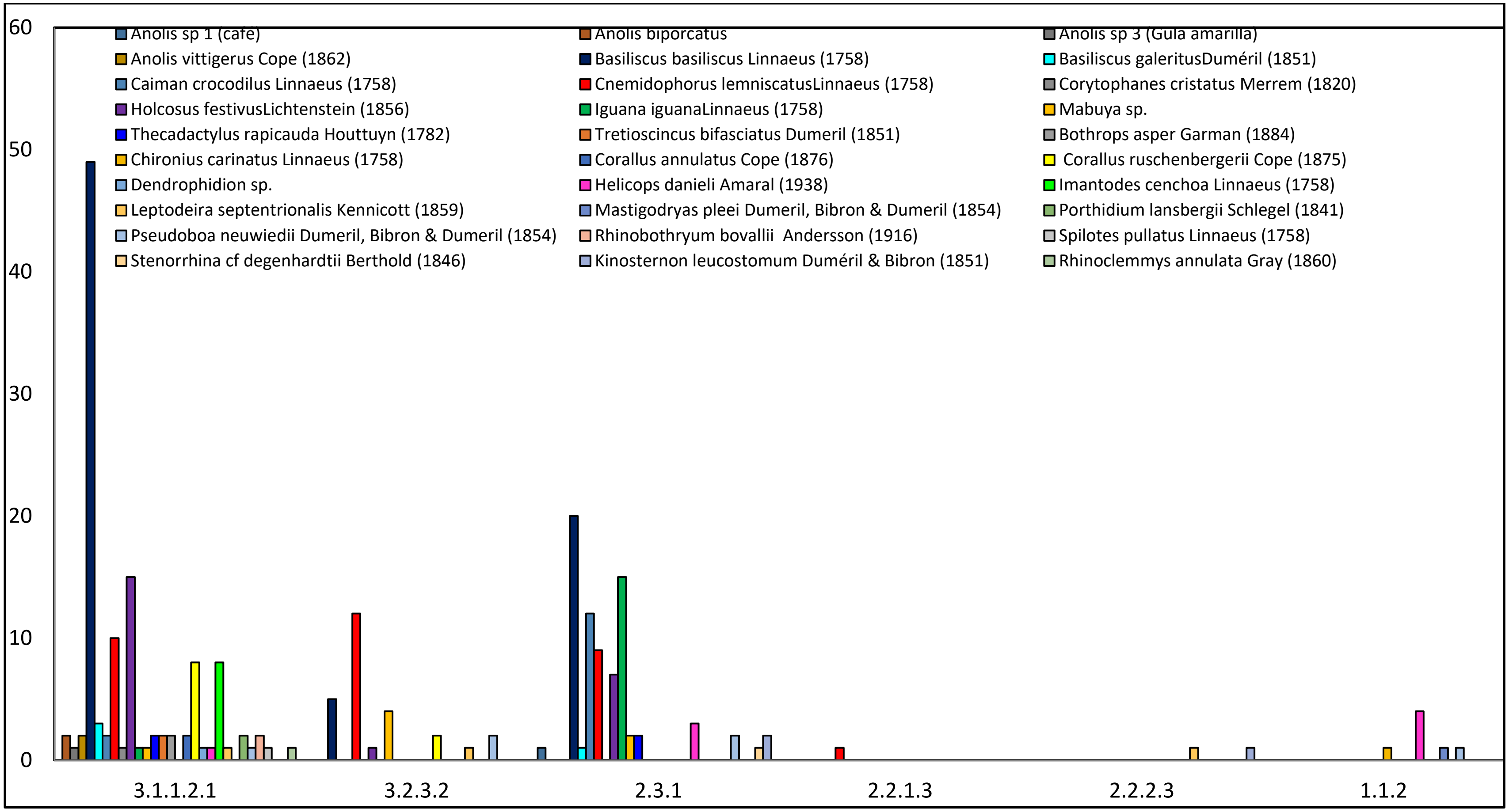


Illustration 4.2-91. Number of individuals by registered Reptile species in each of the plant covers.

Source: INGEX, 2016.

Illustration 4.24.2-92. Photograph of *juvenile Basiliscus basiliscus* thermo regulating on the bank of a stream.
Source*: Merceditas Corporation, 2012.*

The second most abundant species was *Cnemidophorus lemniscatus* (Illustration 4.2-92) with a total of thirty-two (32) individuals recorded in four of the six plant covers (Bdbtf 3.1.1.2.1, Lsv 3.2.3.2, Cg 2.3.1 and Cphy 2.2.1.3), being the coverage Lsv (3.2.3.2) in which more individuals were found (twelve individuals). This lizard commonly observed in areas with low vegetation, forest clearings, near bodies of water and also associated with open spaces and habitats with anthropic intervention (Cole et al., 1993, Grisales et al., 2014). During the sampling, individuals were found on the edge of the forest, stubble, paddocks, roads and near some houses.

The *Holcosus festivus* species had a representativeness of twenty-three individuals in three coverings (Bdbtf 3.1.1.2.1, Lsv 3.2.3.2, Cg 2.3.1), with forest cover (3.1.1.2.1) in which most the individuals were recorded (fifteen individuals). This lizard is very common and is in constant movement, its activity is concentrated in the midday hours when it is sunny (Savage 2002). It is found in humid, dry forest and in open areas, such as trails or areas with certain degrees of anthropic modification (Renjifo et al 1999, Savage 2002). During the sampling, it was recorded in banks of streams within the forest, in stubble, leaf litter, trails and in bodies of water within pastures and paddocks.

Illustration 4.2-93. *Cnemidophorus lemniscatus* found in stubbles and pastures.
Source: Merceditas Corporation, 2012.

The *Iguana* species presented sixteen individuals in the cover of Bdbtf 3.1.1.2.1 and Cg 2.3.1, being the latter the one where most individuals were registered (15 individuals). These lizards are mainly found in tropical damp forests, although they can be found in dry forest, gallery forest and savannas with little arboreal vegetation. It is an herbivorous species, mainly arboreal, though it can descend to the ground to nest. Normally it sleeps on the vegetation, but some individuals can be observed sleeping in tunnels that build the ravines or the ground (Bock 2013). This species was seen on the edge of the forest and pasture paddocks that were on the banks of the stream.

The species *Corallus ruschenbergerii* presented ten individuals in the cover Bdbtf (3.1.1.2.1) and Lsv (3.2.3.2). This species of boa is found in riverbank forest, palmar, dry forest, wooded grassland and paddock (Medina et al., 2011), is nocturnal and arboreal, very common to see on the trees that are on the banks of the streams (Renjifo et al 1999). This snake feeds mainly on birds, rodents and lizards (Medina et al., 2011, Henderson et al., 2013). During the sampling, this species was recorded on the banks of forest ravines, forest edge and stubble, and was recorded an individual who had consumed a prey, which could not be determined since the individual was not collected.

For The species *Helicops danieli* and *Imantodes cenchoa* eight individuals were recorded finding *H. danieli* in the coverage of Bdbtf (3.1.1.2.1), Pl (2.3.1) and Bdbtf (3.1.1.2.1) and *I. cenchoa* only in Bdbtf cover (3.1.1.2.1). The species *H. danieli* is a nocturnal and aquatic snake, and feeds on fish, tadpoles, frogs, bird chicks and cockroaches. It is predated by waders and large fishes (Renjifo et al 1999, Medina et al., 2011) and was observed in the streams of the forest edge, pasture and paddock project. The species *I. cenchoa* is a nocturnal and arboreal species, it is an active forager and they usually feed on frogs and lizards. It is oviparous and apparently reproduces throughout the year. It is not aggressive, and as a defense mechanism it remains quiet when an eventual predator approaches, when it is manipulated, it gives off an unpleasant smell through the sewer and twists the body (Pazmiño et al., 2013). This species was only observed in the forest mainly on the banks of the streams.

The species *Mabuya sp*. was registered in the cover of Bdbtf (3.1.1.2.1), Lsv (3.2.3.2) and Cg (2.3.1) with a total of seven individuals. This lizard can be found in damp, very damp, and dry forest, it tolerates disturbed and man-modified sites, found on forest edge over fallen leaves, fallen trunks or pastures near dwellings (Renjifo et al 1999; Savage 2002;) is diurnal and semi-wild and sunbaths near its lair, it feeds on arthropods and saurian (Medina et al., 2011). In the sampling, it was recorded at the edge of the forest, in stubble and banks of pasture streams.

For the species *Pseudoboa neuwiedii*, a total of six individuals were found in the cover Bdbtf (3.1.1.2.1), Lsv (3.2.3.2), Cg (2.3.1) and Dut (1.1.2). This species is found in tropical damp forest and dry forest, it is nocturnal, terrestrial or semi-fossil and feeds on other snakes, saurian and rodents (Renjifo et al 1999, Medina et al., 2011). This snake was found in the leaf litter at the edge of the forest, in stubble and paddocks near streams and near dwellings.

The species *Basiliscus galeritus* and *Thecadactylus rapicauda* presented four individuals each, both being in the cover Bdbtf (3.1.1.2.1) and Cg (2.3.1). The species *B. galeritus* is found in Damp tropical forests, and it is a diurnal habit reptile. It remains on the rocks and trunks on the sides of the streams where it hunts insects, at night it sleeps on branches of trees, in nearby areas or on ravines. It remains in the canyon or steep areas of the rivers (Suarez et al., 2014). This species was observed in forests and edge of forests near paddocks, on the banks of the streams. *The T. rapicauda salamanqueja* is a nocturnal species that is mainly found in gallery forests, in trunks, roots, and palm leaves (Renjifo et al 1999, Angarita-Sierra et al., 2013). It is a lizard that lacks eyelids and uses its tongue to clean the squama that covers the eye. Its name is due to the ease with which it detaches its tail when it feels threatened (Suarez et al., 2014). This species was found in dry trunks of forest and edge of forest near paddocks.

Of the species *Leptodeira septentrionalis* only three individuals were recorded in the plant covers of Bdbtf (3.1.1.2.1), Lsv (3.2.3.2) and Cphc (2.2.2.3). *L. septentrionalis* is commonly known as ranera because the main item of its diet is frogs. It inhabits humid and dry tropical forests and even secondary vegetation near human dwellings (Duellman 1958; Kohler 2008). This species within the study area was recorded in forest, stubble and leaf litter of cocoa crops near the banks of the stream.

Two individuals of each species were recorded in the Bdbtf cover (3.1.1.2.1) for: *Anolis biporcatus, Anolis vittigerus, Tretioscincus bifasciatus, Bothrops asper, Corallus annulatus, Porthidium lansbergii* and *Rhinobothryum bovallii*. The species *A. biporcatus* is diurnal and arboreal. It is found in the vertical stratum up to five meters or more, it is rarely found on the ground (Ayala et al., 2011). This species was observed during sampling only in forests in trees, near water sources. The species *A. vittigerus* is diurnal and lives in forests that have not been intervened; at night, they sleep on the leaves of bushes (Renjifo et al 1999). This lizard was recorded sleeping on bushes on the banks of the streams during sampling.

The *T. bifasciatus* lizard is diurnal, feeds on arthropods and is common in environments of medium and high degree of transformation, despite its low frequency of observation (Medina et al., 2011). This species was observed on the leaf litter of the edge of the forest. The *viper B. asper* lives in damp tropical forests, rainy deciduous, thorny, savannah borders, near rivers or other sources of water. It is a species that tolerates disturbances and habitat modification and is highly poisonous (Campbell et al., 2004, Rodríguez, 2011). This viper was only seen inside the forest on the edges of a stream. The species *C. annulatus* is a species of arboreal boa that is difficult to observe, found in humid and very humid forests, mainly in primary and secondary forests (Henderson et al., 2001). It is nocturnal, and sometimes tries to bite when manipulated, excrete excreta and vibrates its tail, to name a few (Lewis et al., 2011). This snake feeds mainly on birds, rodents, chiropteran and saurian. (Henderson et al., 2001; Lewis et al., 2011; Henderson et al., 2013). This species was only recorded inside the forest at the edge of a stream. The *viper P. lansbergii* is found in humid and dry tropical forests, it is terrestrial, nocturnal and with preference for disturbed habitats. When they are juveniles they feed on invertebrates, in intermediate stages they consume frogs and lizards and when they are adults they feed only on mammals and birds. It is highly poisonous (Suarez et al., 2014).

The false coral snake *R. bovallii* is a species of nocturnal and arboreal habits. It is difficult to observe, since it mainly lives in treetops in mature forests where it feeds on lizards (Stafford et al., 2010; Suarez et al., 2014).

During the sampling, only one individual of the species was recorded: *Corytophanes cristatus, Spilotes pullatus, Anolis sp* 3 and *Dendrophidion sp*. in the forest cover (3.1.1.2.1). The *C. cristatus* lizard is a diurnal species, mainly arboreal, it does not actively search for its prey, it remains still on its perch to hunt preys within reach (Páez et al., 2002). The species *S. pullatus* is diurnal, with mainly arboreal habits. It feeds mainly on mammals, lizards, frogs, eggs of birds and nesting birds (Marques et al 2014, Savage 2002). As a defense mechanism, it inflates its neck, raises the head and neck, places itself in "S" position and waves the tail against leaf litter (Renjifo et al. 1999). In some situations, it can persecute the observer a few meters, and suddenly turn around and flee quickly (Pazmiño 2014). The species *Anolis sp*.3, like most *Anolis*, is a diurnal species with arboreal habits (Ayala et al. 1986) and was found in the forest, in a shrub near a bank of thermo-regulating creek. The *species Dendrophidion sp*. is a diurnal and terrestrial species (Cadel et al., 2014) and was seen in the litter at the edge of a path, thermo-regulating.

Additionally, *Chronis carina Tus* and *Matagorda's plea* were recorded in the Dut cover (1.1.2), and *Stentorian cu degenhardtii* and *Anolis sp 1* in the pasture cover (2.3.1). The species *C. carinatus* is a diurnal snake with terrestrial and arboreal habits and is frequently found near swamps (Renjifo et al., 1999). As a defense mechanism, this snake raises its head from the ground and simulates an attack while keeping its mouth open (Savage, 2002, Rodríguez et al 2013). The species *S. cf degenhardti* is a rare snake that inhabits humid and very humid forests and premontane forest. It is apparently semi-fossorial and diurnal (Savage, 2002). The species *Anolis sp.1,* like most Anolis, is a diurnal species with arboreal habits (Ayala et al., 1986). For the Crocodylia Order, the species *Caiman crocodilus* was registered with fourteen individuals in the coverage of Bdbtf (3.1.1.2.1) and g (2.3.1). This species is nocturnal, although it is observed sunning itself during the day in beaches of the rivers. Their foraging is active and passive, they are generalist carnivores, and present maternal parental care; that is, the female takes care of its offspring until several months after hatching. The females build litter nests or any available plant material on the banks of rivers and lagoons, when it is time for the eggs to hatch, the offspring give off sounds that stimulate the mother to open the nest, and in some cases, break the Eggs, once the hatchlings have completely hatched, she moves the offspring inside her mouth to the water (Ortiz et al., 2013). This species was observed only at night hours within the streams or other tributaries of the project (Illustration 4.2-93).

Finally, for the Order Testudines, the species *Kinosternon leucostomum* (Illustration 4.2-94) registered three individuals in the covers of Cg (2.3.1) and Cphc (2.2.2.3). This species lives in the muddy edges of water bodies, in large rivers and can live in permanent or temporary aquatic habitats (Páez et al., 2012). This species was found in pasture streams and ponds of cocoa crops. The species *Rhinoclemmys annulata* (Illustration 4.2-95) was only recorded with an individual in the Bdbtf cover (3.1.1.2.1). This species inhabits tropical jungles, riverine forests and dry forests up to 1,000 masl; it is exclusively terrestrial; however, certain individuals alight on superficial waters. They can move in irregular and steep terrain (Páez et al., 2012). In the sampling, this species was recorded near a water spring in the Forest.

Illustration 4.24.2-94. *Caiman crocodilus,* found in stream.
Source: Merceditas Corporation, 2012.

Illustration 4.24.2-95. *Kinosternon leucustomun* found in water births within the AID.
Source: Merceditas Corporation, 2012.
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Illustration 4.2-96. *Rhinoclemmys annulata* found in forest.
Source: Merceditas Corporation, 2012.

4.2.4.1.18 Curve of reptile species accumulation

The accumulation curve in reptile sampling is not stabilized, this may be due to the fact that in the last sampling events (event 43) the number of individuals per species was very high (20 registered individuals), but without new species, while for event 45, new species were recorded for sampling with a low number of individuals; Most of the new species in event 45 were snakes, species with low detectability that could have been found in previous events, but were only visible until the last sampling event (See Illustration 4.2-96). The confidence intervals of the accumulation curve do not overlap with those of the non-parametric CHAO estimator, indicating that the number of species found may have been higher in that sampling time.

The CHAO estimator shows a curve of expected species much higher than that of observed species; keep in mind that this estimator is sensitive to the presence of species seen once or twice, which often generates estimations of the values obtained.

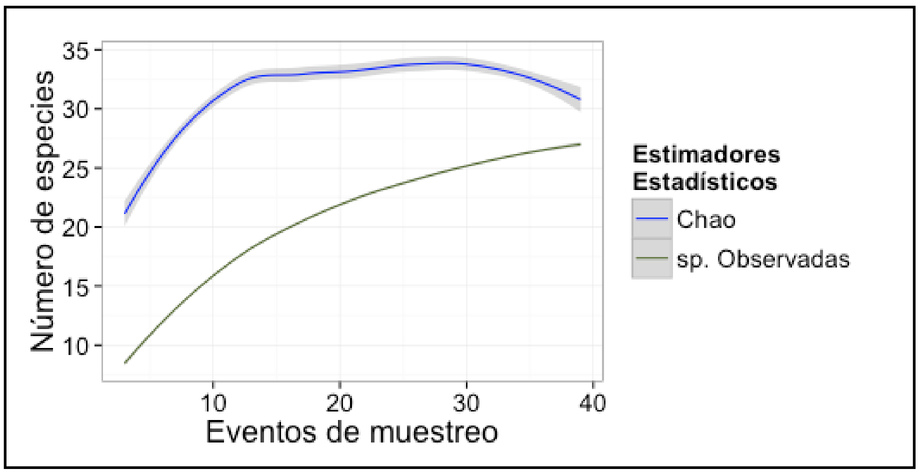

Illustration 4.24.2-97. Graph of the curve of species accumulation registered with the non-parametric estimator CHAO. (The shaded regions represent confidence intervals of 95%).
Source: INGEX, 2016.

4.2.4.1.19 Diversity indices

Alpha diversity α

Alpha diversity measures the point diversity of a sampling unit. For alpha diversity, the following indices were used:

Shannon index (H'): They indicate how uniform the species are represented, taking into account all the species sampled (Villareal et al, 2004). It reflects the heterogeneity of an ecosystem, based on species richness and equity (Franco et al., 1989). The values of the indexes mentioned frequently oscillate between 1.5 and 3.5, and rarely exceed 4.5; values below 2 are considered low while those greater than 3 are considered high (Pla, 2006).

The Shannon diversity index (H ') has quite variable and relatively low diversity values for each cover (Illustration 4.2-97), nor were significant differences in the Shannon index between plant covers observed (X2 = 2.5545; p = 0.76). The values of this index in each cover were between 0.6 and 2.1, which indicates that all the species are not well represented, and some species stand out as the most abundant, as is the case of *Basiliscus basiliscus* or *Cnemidophorus lemniscatus*.

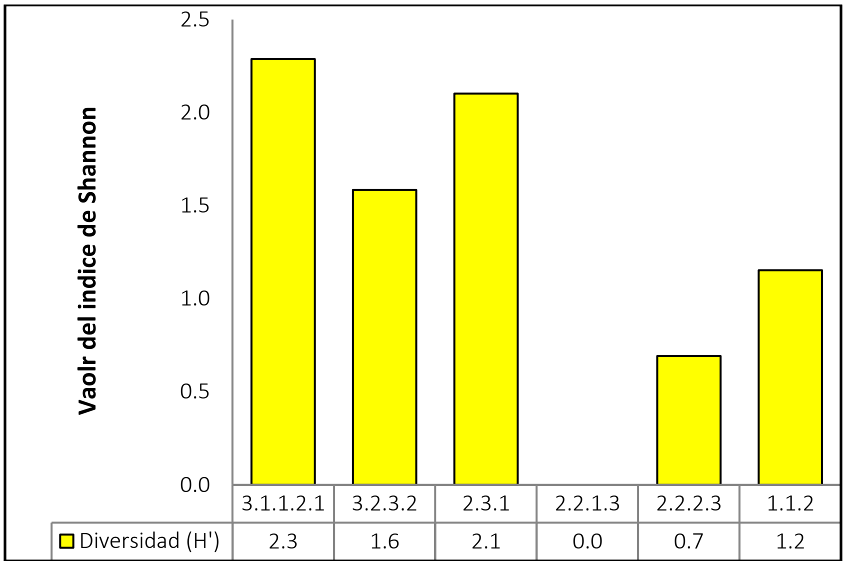

Illustration 4.24.2-98. Graph of the value of Shannon index by plant cover.
Source: INGEX, 2016.

Simpson’s index of dominance (D): It shows the probability that two individuals taken at random from a sample correspond to the same species (Villareal et al., 2004). It reflects the weighting of species abundance (Illustration 4.2-98).

For the Simpson index, significant differences were found between the coverage of clean pastures (2.3.1) and cassava cultivation (2.2.1.3) (X2 = 3.9313, p = 0.04), although very marginal. On the other hand, no significant differences were found in this index among the remaining plant covers (X2 = 5.4665, p = 0.36), showing relatively high dominance by coverage (Bdbtf = 3.52, Lsv = 3.09, Dut = 2.57, Pl = 6.39, Cphy = 2 and Cphc = 1) that is, they are very homogeneous covers.

The equity index of Pielou (J´): It relates the observed diversity (H ') and the maximum diversity (H'max). It varies between 0 and 1, where 1 is the situation in which all species are equally abundant and 0 implies absolute dominance of one or few taxa.

The equity of Pielou (J') shows how the Cphc cover presents the greatest equity in terms of the number of individuals per species per cover (J') = 1.0 (Illustration 4.2-99).

In general terms, these results on alpha richness and diversity for reptiles in the aforementioned plant covers are due to the fact that most of the species recorded here are quite common because they are tolerant species to disturbed sites such as the lizards *Basiliscus basiliscus* or

Cnemidophorus lemniscatus to name but a few. These species are generally overrepresented and can generate a bias in the estimation of these indices.

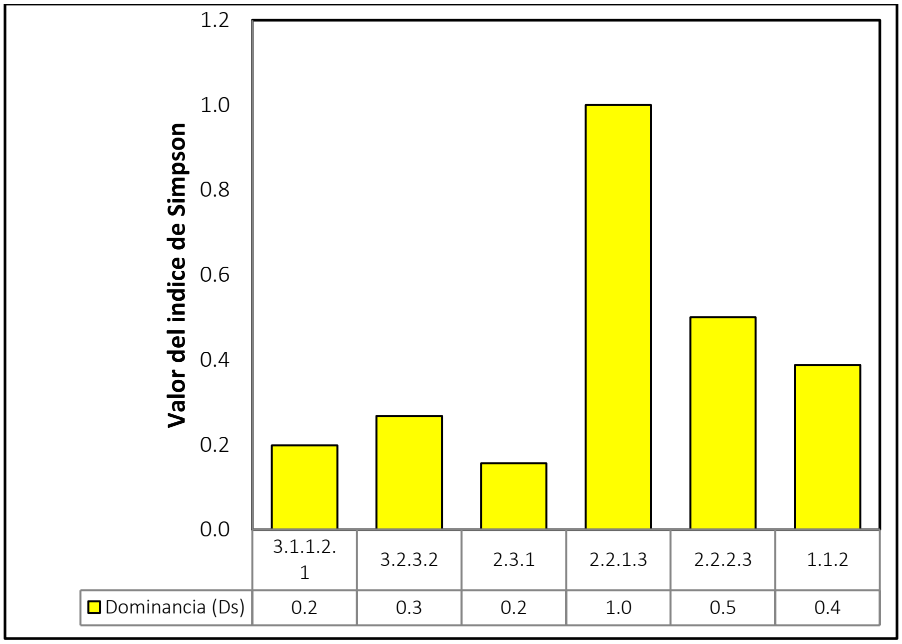

Illustration 4.24.2-99. Graph of the value of the Simpson index by plant cover.
Source: INGEX, 2016.

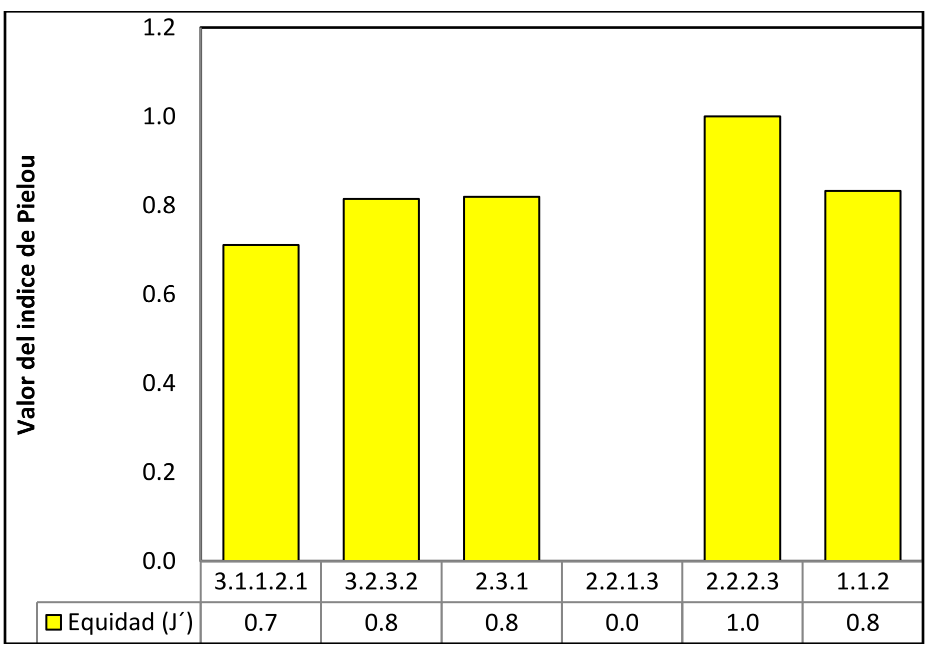

Illustration 4.24.2-100. Graph of the value of the Pielou index by plant cover.
Source: INGEX, 2016.

Beta diversity β

Bray Curtis analysis

This index uses the data of relative abundance between the environments and is useful to evaluate the differences in the structure of the community between samplings.

In this analysis it was evidenced that between the coverage of Bdbtf (3.1.1.2.1) and Cg (2.3.1) there is a great similarity since they have several species in common. The coverage is additionally similar to the coverage Lsv (3.2.3.2) and Dut (1.2.2); Covers with which it also shares species. The coverage of Cphy (2.2.1.3), Cphc (2.2.2.3) and Dut (1.1.2) are the least similar because they presented a very low number of species and individuals or did not share species with the other covers. In the same way, a Principal Coordinate Analysis also shows the similarity between the Bdbtf and Cg coverage in a two-dimensional space (Illustration 4.2-100). The characteristics of the two most similar coverings in comparison with the crops and the discontinuous urban traffic are evidently different, which suggests dissimilarity in the composition of reptiles of each one of them.

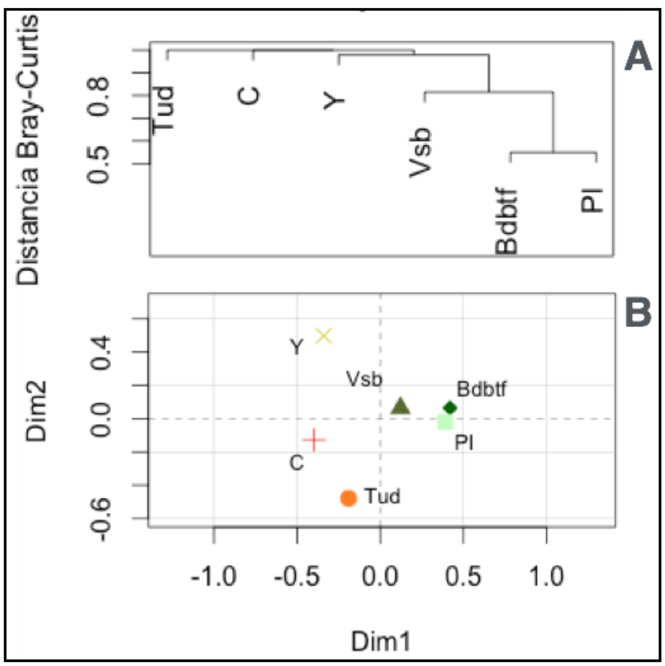

Illustration 4.24.2-101. Graph of the beta diversity analysis of reptiles among plant coverings, based on a Bray-Curtis dendrogram (A) and a principal coordinate analysis (B).
Source*: INGEX, 2016.*

4.2.4.1.20 Trophic guilds

The reptiles have a very varied diet, they are very general since they feed on mollusks, insects and arthropods and Vertebrates, plants, fruits and even flowers (Vitt et al., 2014). The reptile diets are complex and can be influenced by abiotic and biotic variables. To know the items included in the reptile diets, the stomach contents are analyzed, but in this sampling only secondary information was used about the diet of the individuals (Ayala et al., 1968, Renjifo et al., 1999, Savage 2002; Torres et al., 2014, Vitt et al., 2014). During the sampling an individual of the species *C. ruschenbergerii* that had consumed a prey was sighted, which could not be determined because the individual was not collected. In addition, an individual of the species *H. danieli* was recorded and a species of freshwater eel shaped fish, possibly *Synbranchus marmoratus*, was extracted from the stomach.

In general, the largest number of registered species were located within the trophic guild of insectivores and carnivores, being significantly higher, compared to the few species located within the omnivorous and herbivorous guild (X2 = 12.7692, p = 0.005)

Table 4.2-46. Food guilds of registered reptile species.

SPECIES	TROPHIC GUILD	ITEMS
Rhinoclemmys annulata Gray (1860)	Omnivore	Arthropods, Annelids, Amphibians, Fishes
Kinosternon leucostomum Duméril, Bibron Y Duméril (1851)		
Caiman crocodilus Linnaeus (1758)		
Iguana iguana Linnaeus (1758)	Herbivorous	Plantas
Anolis sp 1	Insectivorous	Arthropods, Insects, Annelids
Anolis sp 3		
Anolis aff. biporcatus Wiegmann (1834)		
Anolis vittigerus Cope (1862)		
Basiliscus basiliscus Linnaeus (1758)		
Basiliscus galeritus Duméril (1851)		
Corytophanes cristatus Merrem (1820)		
Cnemidophorus lemniscatus Linnaeus (1758)		
Holcosus festivus Lichtenstein (1856)		
Mabuya sp.		
Tretioscincus bifasciatus Dumeril 1851		
Thecadactylus rapicauda Houttuyn (1782)		
Bothrops asper Garman (1883)	Carnivore	Amphibians, Saurian, Ophidians, Mammals, Birds
Chironius arinatus Linnaeus (1758)		
Corallus annulatus Cope (1876)		
Corallus ruschenbergerii Cope (1875)		
Dendrophidion sp.		
Helicops danieli Amaral (1938)		
Imantodes cenchoa Linnaeus (1758)		
Leptodeira septentrionalis Kennicott (1859)		
Mastigodryas pleei Dumeril, Bibron & Dumeril (1854)	Carnivore	Amphibians, Saurians, Ophidians, Mammals, Birds

SPECIES	TROPHIC GUILD	ITEMS
Porthidium lansbergii Schlegel (1841)		
Pseudoboa neuwiedii Dumeril, Bibron & Dumeril (1854)		
Rhinobothryum bovallii Andersson (1916)		
Spilotes pullatus Linnaeus (1758)		
Stenorrhina cf degenhardtii Berthold (1846)		

Source: INGEX, 2016. Modification of Merceditas Corporation, 2012

4.2.4.1.21 Reptile conservation status

Most of the reptile species recorded in this study have a neo tropical distribution, with different ranges of distribution. Only the species *Rhinobothryum bovallii* is categorized in the IUCN Red List as LC (Table 4.2-47 and Illustration 4.2-101). No species is included in the Appendix of the Cites, nor the red book of the reptiles of Colombia (Castaño et al., 2002), nor in resolution 0192 of 2014 (MADS, 2014), nor are they considered important for Corantioquia (Restrepo et al., 2010).

Table 4.2-47. Threat categories of IUCN and CITES for registered Reptile species.

SPECIES	UICN	CITES
Rhinobothryum bovallii Andersson (1916)	LC	No

Source: INGEX, 2016.

Illustration 4.2-102. Photograph of Rhinobothryum bovallii taken from the database "The Reptile Data Base".
Source: http://reptile-database.reptarium.cz/species?genus=Rhinobothryum&species=bovallii.

However, the great majority of snake species in the region are under constant threat, because they are often sacrificed due to fear and ignorance of the communities, since any species is considered potentially dangerous. During the sampling, 14 species of snakes were identified, of which only two species represent a real danger since they are highly poisonous and potentially lethal, as is the case of *B.asper* (Illustration 4.2-102) and *P. lansbergii* (Otero et al. 2002). Additionally, a moderately toxic and in some cases potentially lethal species was recorded: *H. danieli* (Illustration 4.2-103). It should be noted that the majority of the ophitic accidents in the region are caused by the *viper B. asper* and this is related to the fact that this snake is very tolerant to a great variety of habitats, since it can be found in the forest, in a paddock, on roads and even near homes (Sasa et al 2009). Some species, such as *R. bovallii* and *P. neuwiedii*, are considered dangerous because their coloration is confused with that of corals and because of this they are quite susceptible to being sacrificed. Although these species have opistogilfa dentition (fangs in the back of the maxilla) that inoculate venom, they present low toxicity and are not lethal for humans, but for their prey (Walteros et al., 2014).

Other species that are confused with poisonous animals are the boas of the Corallus genera, and the species *L. septentrionalis*, since by the shape of their head, their teeth and their eyes in the shape of a cat, they are associated with species such as B. asper or a species of which there is no record in the region called *Bothrops punctatus*.

According to some people in the region, species such as the *snakes Lachesis acrochorda* and *Bothriechis schlegelii* have been progressively rare in the last 10 years. The possible reasons for this phenomenon is that these species are from very conserved forests, so they are not easy to see or because they are selectively hunted because of their high toxicity and the danger they represent.

Illustration 4.2-103. *Bothrops asper* photographed in a forest birth located in the studied area.
Source: Merceditas Corporation, 2012.

4.2.4.1.22 Endemic species

Within the study area, an endemic species was found for the Colombian territory, more precisely for the valley of the Magdalena river called *Helicops danieli* (Illustration 4.2-103). This species has been little studied and information on its natural history is very scarce, reducing it to data taken from wildlife inventories and species catalogs.

4.2.4.1.23 Helicops danieli Amaral (1938)

Distribution in Colombia: This species is distributed to the Northwest of Colombia in Antioquia, Atlántico, Bolívar, Chocó, Córdoba, Santander and Sucre; in the Magdalena, Cauca, Atrato and Sinú rivers from 0 to 500 masl. (Rossman 2002, Medina et al., 2011 Wallach et al., 2014).

Natural history: It is a nocturnal aquatic snake, it feeds on fish, tadpoles, frogs, chicks of birds and cockroaches. It is predated by waders and large fish (Renjifo et al 1999, Medina et al., 2011). It is a snake with opistoglyph dentition and has a moderately toxic poison (Estrella et al., 2011).

Conservation: Although this species is not found in any category of threat, it is very susceptible to being slaughtered because most fishermen are afraid of it and consider it very dangerous due to its aggressive behavior and its resemblance to *B. asper* species, which is why it is commonly called Mapaná de agua.

Illustration 4.24.2-104. Photograph by *H. Danieli found on the streams of the studied area*.
Source: Merceditas Corporation, 2012.

4.2.4.1.24 Prohibited species

For the area under study no prohibited reptile species were found.

4.2.4.1.25 Species used by the community

No use of reptiles by the community is evidenced in the area under study.

4.2.4.1.26 Migratory species

No reptile species with migratory patterns were evidenced in the area under study.

4.2.4.1.27 Species identified in the region according to secondary information

The trans-Andean region of Colombia includes three (3) Andean mountain ranges, the inter-Andean valleys and the Caribbean and Pacific coastlines. It presents biogeographic units (Hernandez et al., 1992), which define, based on physiognomic criteria of vegetation, landscape criteria, climatic conditions and other biotic components.

Therefore, the herpetological information of the Choco Magdalena bio geographical province is used, where the Antioquia northeast region is located. This has its own characteristics for certain floristic and fauna species that are only there. Furthermore, it is very likely to find species related to this biota, in the characterization of the previously presented studied area and peripheral areas.

The secondary information of herpetofauna of the municipality of Segovia, is very scarce. No studies published as such of this municipality have been found, but there are records about this in the biological collections, such as the Museo de la Salle (See Table 4.2-48).

Table 4.24.2-48. Collection of snakes, museum of La Salle University.

MUSEUM ID	CLASS	ORDER	FAMIY	SPECIES
MLS-of 1108	Reptilia	Squamata	Dipsadidae	*Leptodeira Septentrionalis*
MLS-of 1237	Reptilia	Squamata	Colubridae	*Tantilla alticola*
MLS-of 1371	Reptilia	Squamata	Dipsadidae	*Oxyrhopus petolarius*
MLS-of 1450	Reptilia	Squamata	Elapidae	*Micrurus mipartitus*
MLS-of 1704	Reptilia	Squamata	Viperidae	*Porthidium nasutum*
MLS-of 401	Reptilia	Squamata	Colubridae	*Pliocercus euryzonus*
MLS-of 406	Reptilia	Squamata	Dipsadidae	*Coniophanes fissidens*
MLS-of-448	Reptilia	Squamata	Dipsadidae	*Erythrolamprus epinephelus*
MLS-of 672	Reptilia	Squamata	Dipsadidae	*Erythrolamprus mimus*
MLS-of 564	Reptilia	Squamata	Dipsadidae	*Xenodon rabdocephalus*
MLS-of 593	Reptilia	Squamata	Dipsadidae	*Xenodon severus*
MLS-of 94	Reptilia	Squamata	Boidae	*Epicrates maurus*
MLS-of 959	Reptilia	Squamata	Dipsadidae	*Imantodes cenchoa*

source: http://evirtual.lasalle.edu.co:8080/ipt/. Museo de la Salle. Universidad de la Salle (2011). Collection of Reptiles Museum of La Salle Bogotá, 4487 Records, contributed by Espitia-Barrera JE.

The collection of the museum of herpetology of the University of Antioquia does not register specimens for the municipality of Segovia in particular, but there is information of neighboring municipalities like Remedios, Zaragoza and El Bagre. This information is very important since the fauna registered in these municipalities could be found in some areas of the municipality where the project is located (See Table 4.2-49).

Table 4.2-49. Collection of amphibians and reptiles, museum of herpetology of the University of Antioquia.

MUSEUM ID	CLASS	ORDER	FAMILY	SPECIES	LOCALITY
MHUA-A 672917	Amphibia	Anura	Bufonidae	*Rhinella sp*	Remedios
MHUA-R 1682851	Reptilia	Squamata	Dactyloidae	*Anolis lyra*	Remedios
MHUA-R 1681818	Reptilia	Squamata	Gymnophthalmidae	*Bachia bicolor*	Remedios
MHUA-R 1683892	Reptilia	Squamata	Colubridae	*Stenorrhina degenhardtii*	Remedios
MHUA-R 1681976	Reptilia	Squamata	Gymnophthalmidae	*Tretioscincus bifasciatus*	Remedios
MHUA-R 1683302	Reptilia	Squamata	Leptotyphlopidae	*Trilepida macrolepis*	Remedios
MHUA-A 673557-673558	Amphibia	Anura	Leptodactylidae	*Engystomops pustulosus*	Zaragoza
MHUA-R 1683179	Reptilia	Squamata	Dactyloidae	*Anolis sulcifrons*	Zaragoza
MHUA-R 1683927	Reptilia	Squamata	Dipsadidae	*Leptodeira septentrionalis*	Zaragoza
MHUA-R 1683926	Reptilia	Squamata	Colubridae	*Mastigodryas pleei*	Zaragoza
MHUA-R 1684176	Reptilia	Squamata	Viperidae	*Porthidium nasutum*	Zaragoza
MHUA-A 671967	Amphibia	Anura	Bufonidae	*Rhinella sp*	El Bagre
MHUA-A 671982	Amphibia	Anura	Bufonidae	*Rhinella granulosa*	El Bagre
MHUA-A 671984	Amphibia	Anura	Dendrobatidae	*Colostethus sp.*	El Bagre
MHUA-A 671970	Amphibia	Anura	Dendrobatidae	*Dendrobates truncatus*	El Bagre
MHUA-A 671971	Amphibia	Anura	Craugastoridae	*Craugastor raniformis*	El Bagre
MHUA-A 671976	Amphibia	Anura	Hylidae	*Dendropsophus ebraccatus*	El Bagre

MUSEUM ID	CLASS	ORDER	FAMILY	SPECIES	LOCALITY
MHUA-A 671977	Amphibia	Anura	Hylidae	*Dendropsophus microcephalus*	El Bagre
MHUA-A 672149	Amphibia	Anura	Hylidae	*Hypsiboas pugnax*	El Bagre
MHUA-A 671973	Amphibia	Anura	Hylidae	*Scinax sp.*	El Bagre
MHUA-A 671975	Amphibia	Anura	Hylidae	*Scinax rostratus*	El Bagre
MHUA-A 671966	Amphibia	Anura	Hylidae	*Scinax ruber*	El Bagre
MHUA-A 671980	Amphibia	Anura	Hylidae	*Smilisca phaeota*	El Bagre
MHUA-A 671987	Amphibia	Anura	Hylidae	*Trachycephalus typhonius*	El Bagre
MHUA-A 671981	Amphibia	Anura	Leptodactylidae	*Engystomops pustulosus*	El Bagre
MHUA-A 671979	Amphibia	Anura	Microhylidae	*Elachistocleis pearsei*	El Bagre
MHUA-A 671985	Amphibia	Anura	Ranidae	*Lithobates vaillanti*	El Bagre
MHUA-R 1682199	Reptilia	Squamata	Dactyloidae	*Anolis auratus*	El Bagre
MHUA-R 1682198	Reptilia	Squamata	Dactyloidae	*Anolis vittigerus*	El Bagre
MHUA-R 1682195	Reptilia	Squamata	Corytophanidae	*Basiliscus galeritus*	El Bagre
MHUA-R1683824	Reptilia	Squamata	*Boidaex*	*Corallus ruschenbergerii*	El Bagre
MHUA-R 1683822	Reptilia	Squamata	Colubridae	*Dendrophidion percarinatum*	El Bagre
MHUA-R 1682196	Reptilia	Squamata	Sphaerodactylidae	*Gonatodes albogularis*	El Bagre
MHUA-R 1683823	Reptilia	Squamata	Dipsadidae	*Helicops danieli*	El Bagre

Source: http://data.sibcolombia.net/datasets/resource/92, Museum of Herpetology of the University of Antioquia (2013). Collection of reptiles- Herpetology Museum of the University of Antioquia. 5148 Records, contributed by Daza-Rojas JM (Publisher).

Finally, there was a document prepared in 2005 by CORANTOQUIA, called the River Basin Management and Management Plan, municipalities of Remedios, Segovia and Zaragoza (Table 4.2-50). In this document, information on the potential fauna of the basin among this the Herpetofauna was found. Reviewing the information contained in the document it was found that the taxonomic identity of the species is out of date with respect to the current one and therefore the names of the species had to be updated using the Frost proposal. 2015 and Acosta et al. 2016 and Uetz, P. 2015 for Amphibians. Additionally, during the review, it was found that several species of the list did not correspond to the altitudinal gradient of the area where the project is located, therefore, the species with altitudinal distributions of 2000 meters above sea level were not included. We also found certain species whose distribution does not agree with specimens of the middle Magdalena and some do not even present distribution for Colombia, therefore, they were not included in this list.

Table 4.24.2-50. List of modified species of the document called: Management plan and river basin management El Bagre, municipalities of Remedios, Segovia and Zaragoza, Antioquia.

CLASS	ORDER	SUBORDER	FAMILY	SPECIES
Amphibia	Anura	No applicable	Bufonidae	*Rhinella truebae*
Amphibia	Anura		Bufonidae	*Rhinella nicefori*
Amphibia	Anura	No applicable	Bufonidae	*Rhaebo haematiticus*
Amphibia	Anura	Not applicable	Craugastoridae	*Pristimantis gaigei*
Amphibia	Anura	Not applicable	Centrolenidae	*Centrolene antioquiense*
Amphibia	Anura	No applicable	Centrolenidae	*Espadarana prosoblepon*
Amphibia	Anura	No applicable	Centrolenidae	*Rulyrana susatamai*
Amphibia	Anura	No applicable	Dendrobatidae	*Colostethus thorntoni*
Amphibia	Anura	No applicable	Hylidae	*Dendropsophus microcephalus*

CLASS	ORDER	SUBORDER	FAMILY	SPECIES
Amphibia	Anura	No applicable	Hylidae	*Trachycephalus typhonius*
Amphibia	Anura	No applicable	Hemiphractidae	*Gastrotheca dunni*
Amphibia	Anura	No applicable	Leptodactylidae	*Pseudopaludicola pusilla*
Amphibia	Anura	No applicable	Microhylidae	*Ctenophryne aterrima*
Amphibia	Gymnophiona	No applicable	Rhinatrematidae	*Epicrionops parkeri*
Amphibia	Gymnophiona	No applicable	Typhlonectidae	*Typhlonectes natans*
Reptilia	Squamata	Sauria	Dactyloidae	*Anolis auratus*
Reptilia	Squamata	Sauria	Dactyloidae	*Anolis antioquiae*
Reptilia	Squamata	Sauria	Gymnophathalmidae	*Echinosauria horrida*
Reptilia	Squamata	Sauria	Polychrotidae	*Polychrus gutturosus*
Reptilia	Squamata	Sauria	Teiidae	*Ameiva ameiva*
Reptilia	Squamata	Serpentes	Anomalepididae	*Helminthophis praeocularis*
Reptilia	Squamata	Serpentes	Boidae	*Boa constrictor*
Reptilia	Squamata	Serpentes	Colubridae	*Pliocercus euryzonus*
Reptilia	Squamata	Serpentes	Colubridae	*Mastigodryas danieli*
Reptilia	Squamata	Serpentes	Colubridae	*Mastigodryas boddaerti*
Reptilia	Squamata	Serpentes	Colubridae	*Urotheca lateristriga*
Reptilia	Squamata	Serpentes	Colubridae	*Lampropeltis triangulum*
Reptilia	Squamata	Serpentes	Colubridae	*Dendrophidion percarinatum*
Reptilia	Squamata	Serpentes	Dipsadidae	*Erythrolamprus melanotus*
Reptilia	Squamata	Serpentes	Dipsadidae	*Lygophis lineatus*
Reptilia	Squamata	Serpentes	Dipsadidae	*Clelia clelia*
Reptilia	Squamata	Serpentes	Dipsadidae	*Sibon nebulata*
Reptilia	Squamata	Serpentes	Elapidae	*Micrurus dumerillii*
Reptilia	Testudines	Cryptodira	Kinosternidae	*Kinosternon scorpioides*
Reptilia	Testudines	Cryptodira	Testudinidae	*Chelonoidis carbonaria*

Source: CORANTIOQUIA https:// www.corantioquia.gov.co

4.2.4.2 MASTOFAUNA

Next, is presented the curve of species accumulation, species richness and taxonomic composition, abundance, diversity indices, trophic guilds, conservation status and species identified in the region according to primary information.

4.2.4.2.1 Species accumulation curve

For the elaboration of this curve, the general registration method was used within the studied area. Illustration 4.2-104 presents the behavior of the characterization, in relation to the accumulation of mammalian species during the sampling period.

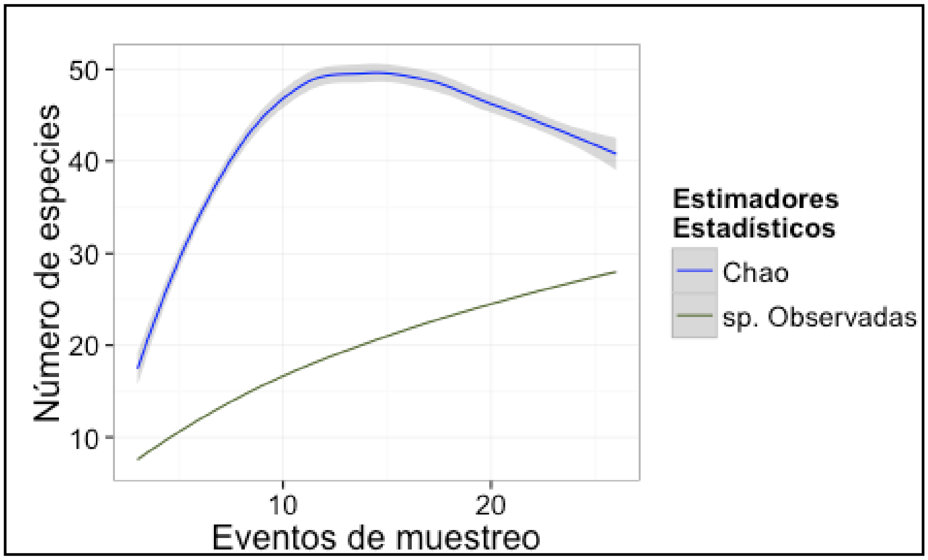

Illustration 4.2-105. Species accumulation curve for mastofauna sampling.
Source: INGEX, 2016.

The non-parametric statistical estimator CHAO was used to calculate the number of species expected to be recorded under optimal conditions within the sampling, considering the relationship between the number of unique species or those that only appear in a single sampling event and the number of species duplicated or that appear in more than one sampling event.

During the field phase for the characterization of mammals, a total of thirty (30) species of mammals were recorded in a period of twenty-six (26) days of sampling (See illustration 4.2-104). The accumulation curve of mammalian species is not stabilized, that is, it is necessary to increase the sampling or the number of days so that the number of species found increases significantly. In addition, the confidence intervals of the accumulation curve do not overlap with those of the non-parametric CHAO estimator, indicating that the number of species found may have been higher in that sampling time (illustration 4.2-104).

The species expected for sampling are around 50; In this order of ideas, the sampling of mammals carried out reached approximately 75% representativeness. Although the representativeness of mammalian sampling is high, it should be taken into account that in general terms a real inventory never comes to completion, given that the number of species depends on the temporal and spatial resolution used in a sample (Jiménez -Valverde & Hortal, 2003).

4.2.4.2.2 Species wealth and taxonomic composition

Species richness is one of the simplest ways to measure biodiversity since it is based solely on the number of present species in a given area (Magurran, 1988 & 2004, Moreno, 2001, Sarkar, 2002, Carrascal et al 2008). Biodiversity measures, wealth mainly, play a key role in assessing the impact of human activities on ecological systems and can be used as a measure of the general state of ecosystems (Leitner & Turner, 2001; González-Oreja et al 2010).

The richness of mammals in Colombia, place the country as the fifth country in the world with the greatest diversity of this group of vertebrates, after Indonesia, Brazil, Peru and Mexico (Rodríguez-Mahecha et al 2006). Of this wealth, about half of the species are located in the Andes and around 40% are unique to this region (López-Arévalo & Montenegro-Díaz, 1993, Alberico et al 2000). The Andean region of Colombia exhibits a great environmental variety, where the altitudinal gradient is combined with the variety of climatic factors, resulting in high levels of endemism, as well as enormous biological diversity. (Castaño & Corrales, 2010).

Wealth

During the sampling phase, a total of 31 species were recorded, belonging to 18 families and 9 orders of mammals (See illustration 4.2-105 and Table 4.2-51), which corresponds to approximately 6.37% of the national wealth (Alberico et al. 2000).

The order with the greatest wealth within the sampling period was the order Chiroptera with a total of 13 registered species, followed by the order Primates with 5 species and the orders Rodents and Carnivores with 4 species respectively (See Illustration 4.2-106 and Illustration 4.2-51).

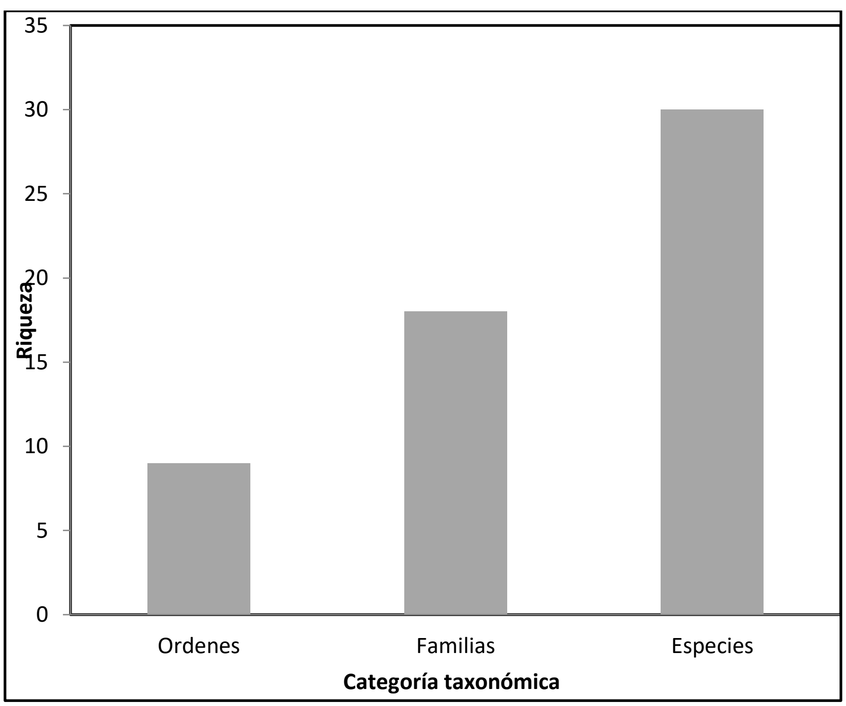

Illustration 4.2-106. Total taxonomic composition of mastofauna.

Source: INGEX, 2016.

Table 4.2-51. Species of mammals registered.

Order	Family	Species	Vernacular Name	Covering	Method of registration
Carnivore	Canidae	*Cerdocyon thous*	Fox	(2.3.1), (3.1.1.2.1), (1.1.2)	Track
	Felidae	*Leopardus pardalis*	Wild cat	(3.1.1.2.1)	Track
		Panthera onca	Jaguar	(3.1.1.2.1), (2.2.2.3)	Audil, footprint
	Procyonidae	*Potos flavus*	Hill dog	(2.3.1), (3.2.3.2)	Direct
Certatiodactyla	Cervidae	*Odocoileus virginianus*	Deer	(3.2.3.2)	Track
Chiroptera	Emballonuridae	*Saccopteryx bilineata*	Bat	(2.3.1)	Direct
	Phyllostomidae	*Artibeus lituratus*		(3.1.1.2.1), (1.1.2)	Capture
		Carollia brevicauda		(2.3.1), (3.1.1.2.1)	Capture
		Carollia castanea		(3.1.1.2.1), (3.2.3.2), (1.1.2)	Capture
		Carollia perspicillata		(2.3.1), (3.1.1.2.1), (3.2.3.2), (1.1.2)	Capture
		Dermanura gnoma		(3.1.1.2.1)	Capture
		Lonchorhina aurita		(3.2.3.2)	Capture
		Mimon crenulatum		(3.1.1.2.1), (3.2.3.2)	Capture
		Phyllostomus hastatus		(3.1.1.2.1)	Capture
		Saccopteryx bilineata		(3.1.1.2.1)	Capture
		Sturnira lilium		(2.3.1)	Capture
		Uroderma magnirostrum		(2.3.1)	Capture
		Vampyressa thyone		(2.3.1), (3.1.1.2.1), (1.1.2)	Capture

Order	Family	Species	Vernacular Name	Covering	Method of registration
Cingulata	Dasypodidae	*Dasypus novemcinctus*	Armadillo	(3.1.1.2.1)	Direct
Didelphimorphia	Didelphidae	*Philander opossum*	Chucha	(3.2.3.2)	Direct
Lagomorpha	Leporidae	*Sylvilagus floridanus*	Rabbit	(3.1.1.2.1)	Heces
Pilosa	Bradypodidae	*Bradypus variegatus*	Sloth	(3.1.1.2.1)	Direct
Primates	Aotidae	*Aotus griseimembra*	Marteja	(2.3.1)	Direct
	Atelidae	*Alouatta seniculus*	Howler monkey	(3.1.1.2.1)	Direct, Aural
		Ateles hybridus brunneus	Marimonda	(3.1.1.2.1)	Direct
	Callithrichidae	*Saguinus leucopus*	Titis	(3.1.1.2.1)	Direct
	Cebidae	*Cebus albifrons*	Corn monkey	(3.1.1.2.1)	Direct
Rodentia	Cricetidae	*Melanomys sp*	Mouse	(3.1.1.2.1)	Sherman Trap
	Cuniculidae	*Cuniculus paca*	Guagua	(3.1.1.2.1)	Camera trap
	Heteromyidae	*Heteromys sp*	Mouse	(3.1.1.2.1)	Sherman Trap
	Sciuridae	*Sciurus granatensis*	Squirrel, ardita	(3.1.1.2.1)	Direct

Source: Merceditas Corporation, 2012.

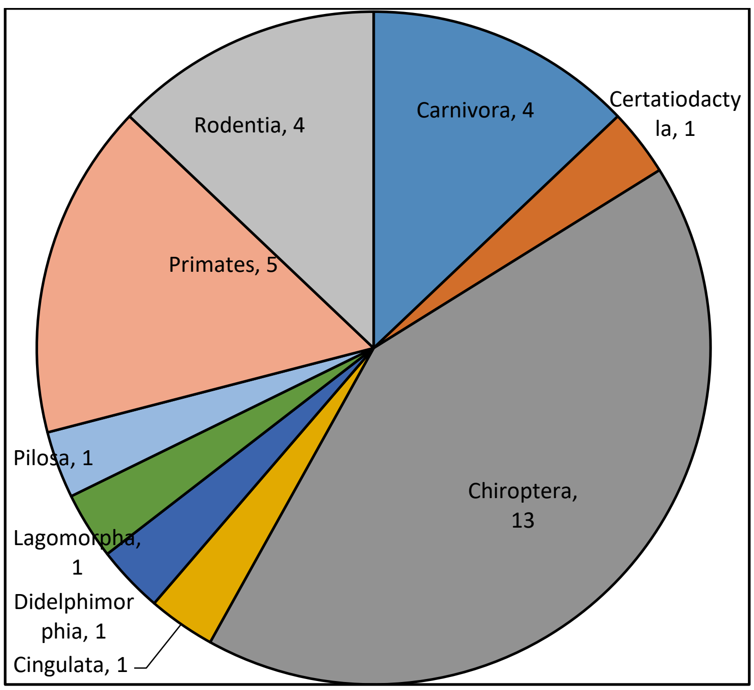

Illustration 4.2-107. Wealth of species for each order of registered mammals.
Source: INGEX, 2016.

As is evident, the mastofaunal wealth in the area is concentrated punctually in a few orders. In the case of chiroptera, it is important to mention that this order of mammals is one of the most diverse in the neo tropics (Gardner, 2007) and in Colombia, being this the second most diverse country in the world in this group of mammals (Alberico et al. to 2000).

The representative wealth of primate species in the study area is noteworthy, because the studied area is located relatively close to the Serranía de San Lucas, which has a great diversity of this group of mammals and high amounts of endemic species. (Defler, 2003). Case of the marine monkey *Ateles hybridus brunneus* Geoffroy, 1829, considered an endemic sub-species of the lower parts of the Cauca and Magdalena rivers (Defler, 2003). Due to its frugivorous diet it is of great importance for the structure and ecosystemic functionality within the habitats that it occupies. *Saguinus leucopus* (Günther, 1877) (Illustration 4.2-107), is other of the endemic primate species recorded.

Illustration 4.2-108. *Saguinus leucopus* (Günther, 1877) (Primates: Callithrichidae).
Source: Merceditas Corporation, 2012.

Although the species wealth of the Rodentia order (Illustration 4.2-108) was not as high compared to other studies in the neo tropics (Barragan et al 2010, Aragón, 2011), its diversity can be linked to the attributes of the habitat level of the landscape and its heterogeneity, since the spatial distribution of different niches and the type of such components is the main modulator of the diversity of this type of mammals.

On the other hand, the diversity of the Carnivore order is an important factor when evaluating the optimal ecological conditions for the studied area; These species, being great predators, are an indispensable factor within trophic networks and in the maintenance of population stability within the different mastofaunal communities in the area. As mammal species in general of large size and hierarchy are large contributors of biomass within the different plant units, mainly for forest cover.

At a lower taxonomic level, the richest family was Phyllostomidae with 12 recorded species (See Illustration 4.2-109 and Illustration 4.2-51); which has the highest abundance of species and number of individuals per species in Colombia (Muñoz-Arango, 2003). Diversity that is best represented in tropical forests in a wide altitudinal range and in generally forested covers. The phyllostomids are mainly characterized by the presence of lanceolate nasal dermal projections that allow them to address the sonar used in echolocation (Timm et al 1999).

Illustration 4.2-109. *Melanomys sp*. Cricetidae: Rodentia capturado.

Source: Merceditas Corporation, 2012.

Particularly the other families of mammals were represented by less than 2 species (See illustration 4.2-109); proof of a certain balance within the community despite the existing difference with the number of species for the Phyllostomidae family. Although, in spite of the fact that there was no considerable diversity and richness of species in the area compared to other areas in the neo tropics (Pozo de la Tijera & Escobedo-Cabecera, 1999, Riechers-Pérez, 2004, Espinoza-Medinilla et al 2004), within the studied area still maintains good quality of the ecological conditions.

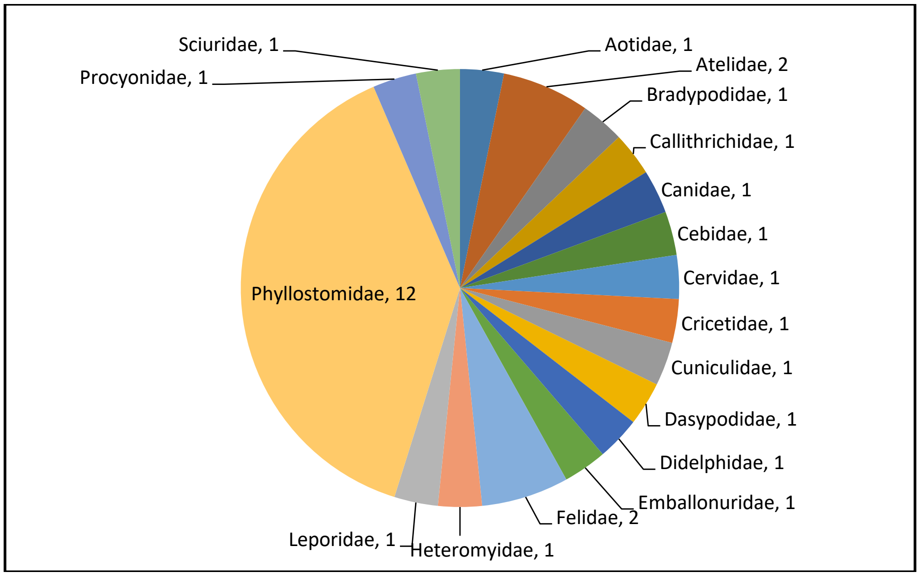

Illustration 4.2-110. Wealth of species for each family of registered mammals.
Source: INGEX; 2016.

4.2.4.2.3 Plant cover wealth

The richness in all the taxonomic levels behaved in a similar way, being the dense forest coverings low (3.1.1.2.1) those that presented greater richness in species (X2 = 12.5897, p = 0.005) and in families (X^2=9.2857, p=0.02) in comparison with the other plant covers (Vsb, Dut and Cg), within which no significant differences were found (X^2=1.3, p=0.52). (See Illustration 4.2-110). Although mammals are not distributed homogeneously in the country, they do have a certain preference to inhabit within forest cover where basic requirements such as food, habitat, displacement, among others, are met (Alberico et al 2000). Additionally, the sampling effort focused on forest cover, which also represents the difference in richness between the different plant structures (See Illustration 4.2-110).

On the other hand, the covering with the greatest anthropic impact, as in the case of clean grasslands (2.3.1), discontinuous urban traffic (1.1.2) and to a lesser extent secondary or transitional vegetation (3.2.3.2), present wealth of low species and the presence of certain records in these covers is due to species with high anthropic tolerance, mainly chiroptera.

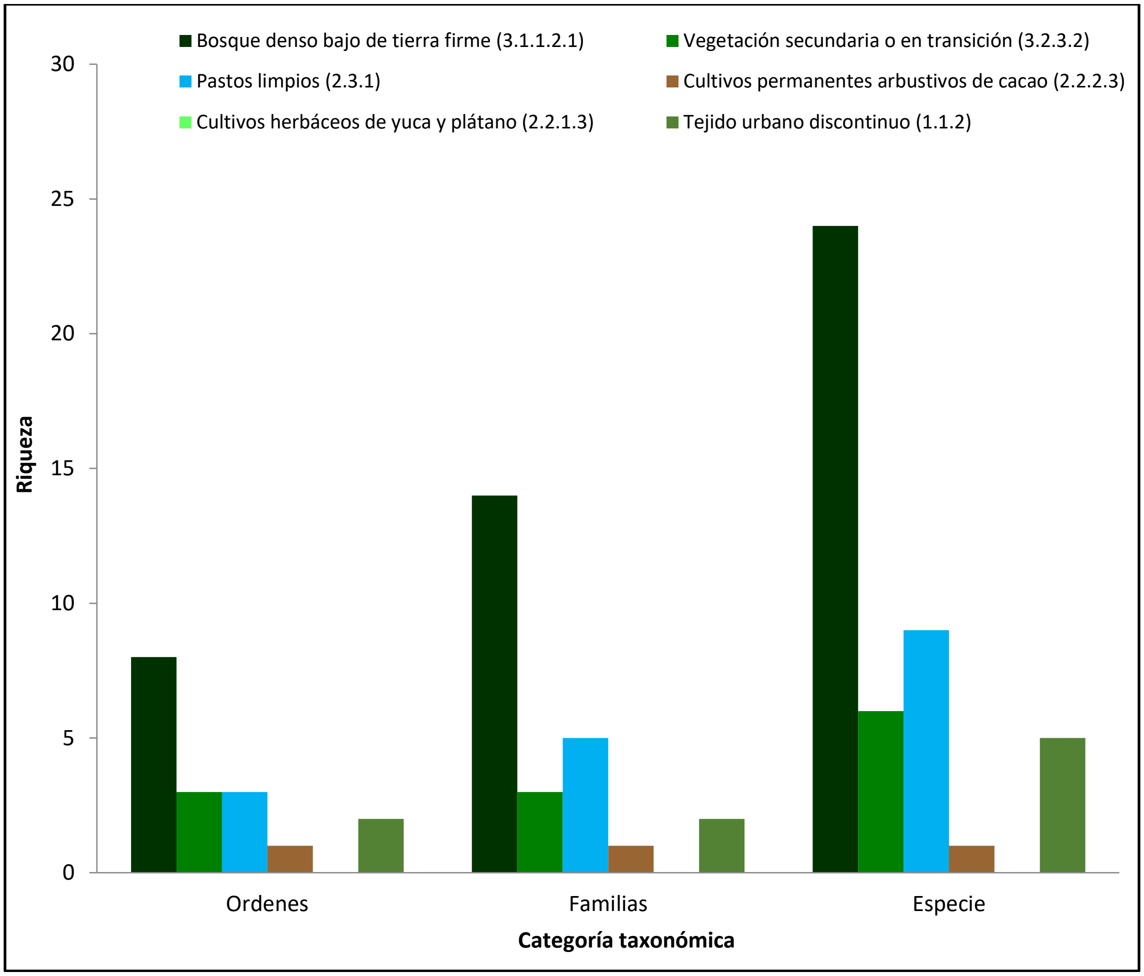

Illustration 4.2-111. Taxonomic composition for each vegetation cover sampled.
Source: INGEX, 2016.

4.2.4.2.4 Abundance

The most representative mammalian families for sampling are illustrated below. It is worth mentioning that the illustrated percentage is proportional, since families that were represented by less than 3% of records were excluded from the illustration (Illustration 4.2-111).

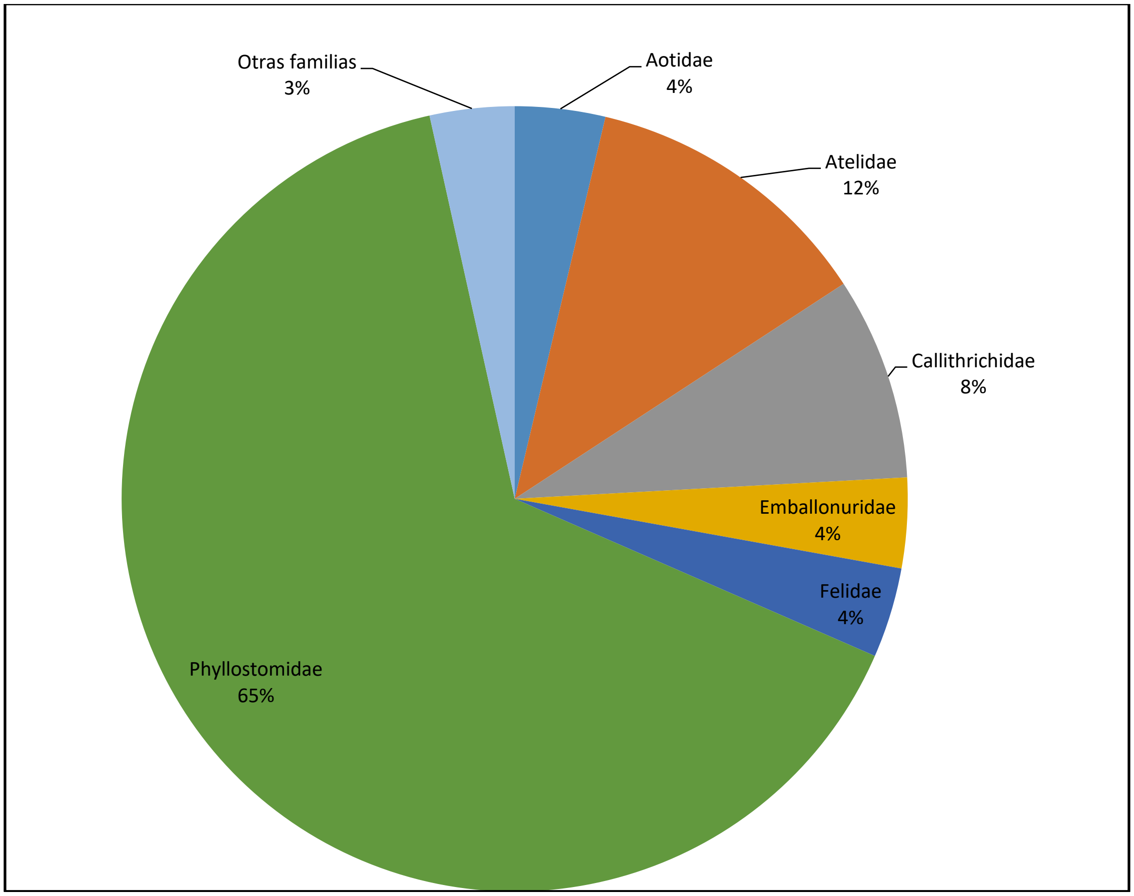

Illustration 4.24.2-112. Most representative families of mammals.
Source: INGEX, 2016.

The most abundant and representative family during the execution of the field phase was the Phyllostomidae chiropter family (See illustration 4.2-112), which obtained records in most of the plant covers sampled in the area, mainly in the covering with some degree of anthropic modification.

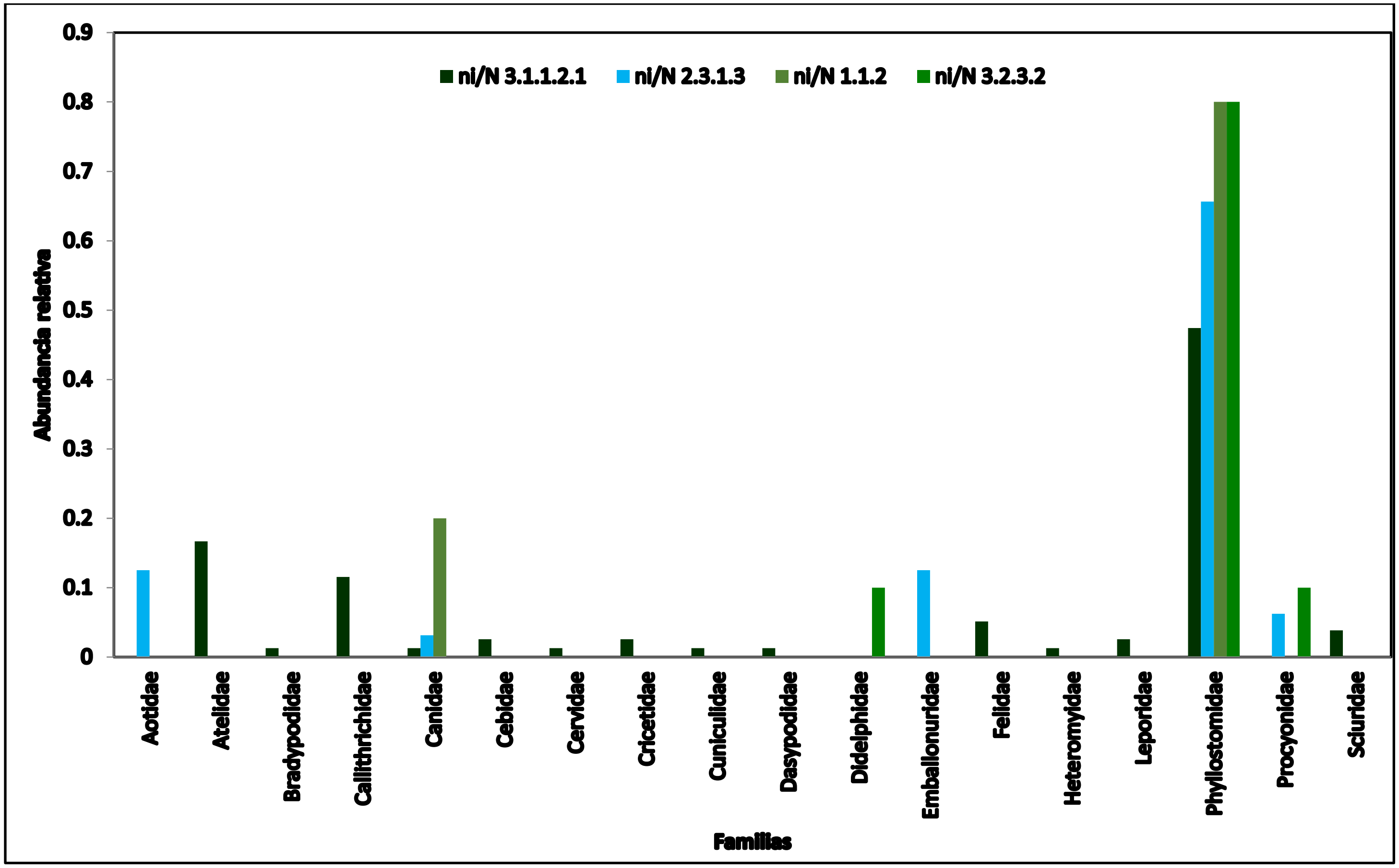

Illustration 4.24.2-113. Relative abundance of the most representative families of mammals for each cover.
Source: INGEX, 2016

Some studies have revealed that in tropical forest fragments, the diversity and abundance of bats (Chiroptera) is influenced by the distance between the forest patches, foraging strategies and the size of the living space (Estrada et al 1993; Cosson et al. 1999, Mena, 2010). Therefore, these results can be attributed to a good condition in general terms of the study area; although it is important to deepen for the area in aspects such as the use at different levels of stratification of the forest by the different populations of bats, phyllostomids in this case.

The chiropter samplings are usually carried out in medium-low forest strata; that is why the knowledge of the richness, diversity and abundance of these, within rapid environmental assessments, tends to be representative, but not complete, due to the dramatic ecological and evolutionary radiation of these mammals, which virtually occupy all trophic levels in all the strata of the forests; in this sense the distribution and abundances of species can differ significantly from the canopy to the understory. In contrast, sampling within vegetation coverage in transition due to its early succession status tends to be covered in its entirety by methodological treatment.

As mentioned above, the highest relative abundance of phyllostomid bats in the study area was found in coverings with some degree of anthropogenic disturbance, mainly in secondary vegetation coverage or in transition (See illustration 4.2-111). It is important to mention that some species usually use agricultural fields and secondary vegetation as temporary sites for foraging and / or fodder (Mena, 2010), a phenomenon to which the abundances observed are attributable.

Other of the most representative families of mammals in the sample were: the family of primates Atelidae (See Illustration 4.2-111), which for Colombia includes the *genera Alouatta*, *Ateles, Brachyteles, Lagothrix* and *Oreonax*, which are large primates, with prehensile tails and post-cranial adaptations similar to that of great apes (Defler, 2010). Two species of this family were recorded within the studied area (See Table 4.2-51): *Ateles hybridus brunneus* Geoffory, 1829 and *Alouatta seniculus* (Linnaeus, 1766) (See illustration 4.2-113), which were only recorded within the plant cover corresponding to low dense forest on the mainland (3.1.1.2.1).

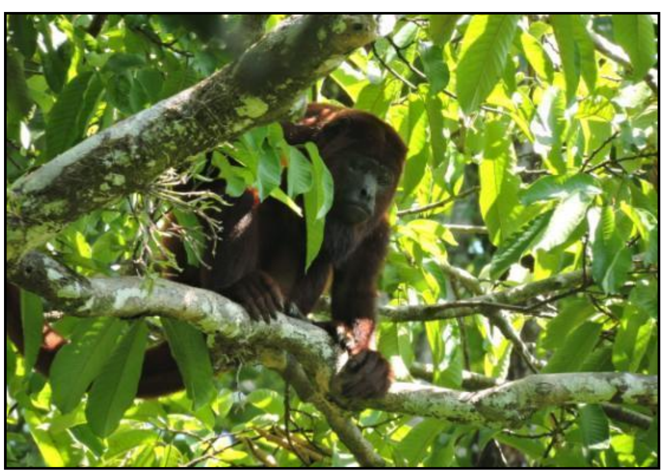

Illustration 4.2-114. *Alouatta seniculus* (Linnaeus, 1766), registered.
Source: Merceditas Corporation, 2012.

It is presumable that inside the studied area, the populations of the Atelid primates, being distributed exclusively in forest cover, have suffered the consequences of anthropogenic colonization; The reduction of forest cover in the area due to the expansion of the cattle frontier is the main threat to the maintenance of these populations. It has been shown that as habitat fragmentation increases, rates of primate population growth decrease markedly (See illustration 4.2-114) (Garber et al 2009).

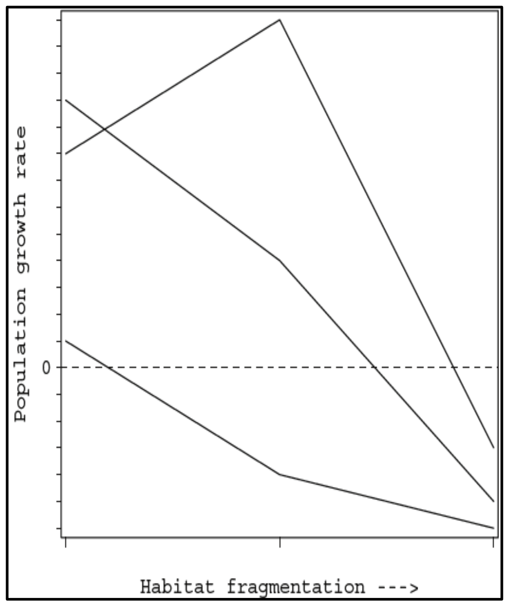

Illustration 4.2-115. Normal growth reaction of three imaginary primate populations at different degrees of habitat fragmentation.

Source: Garber et al 2009.

The Callithrichidae family was another of the most representative within the area (See illustration 4.2-111), also recorded only in forest cover as the majority of primate records in the area (See illustration 4.2-112), which shows the strong relationship that exists between the diversity of primates and the type of plant cover. The good quality of the forests within the area and their structural connectivity to each other depend on the abundance and diversity of the species of this family, since in general they need large areas of forest, as many of the species belonging to this family, perform daily group tours of approximately 2 km (Defler, 2010).

In general terms, families of mammals registered in the area, had specificity for some type of plant cover since most of the families were not registered in more than two covers, except the Phyllostomidae family, which was registered in four of the covers sampled, as already mentioned. If we take into account that these species are strictly frugivorous, being present in most of the plant units within the studied area, their abundance is of great importance in the structure and dynamics of the ecosystem, contributing greatly in seed dispersal processes (Shanahan et al 2010).

Considering the categorization of abundance for species (see methodology), the most abundant species was *Carollia perspicillata* (relative abundance> 10%). On the other hand, 19 common species were found (relative abundance between 2 and 10%) and the remaining 7 rare species (relative abundance between 0.1 and 2%). (See Illustration 4.2-115).

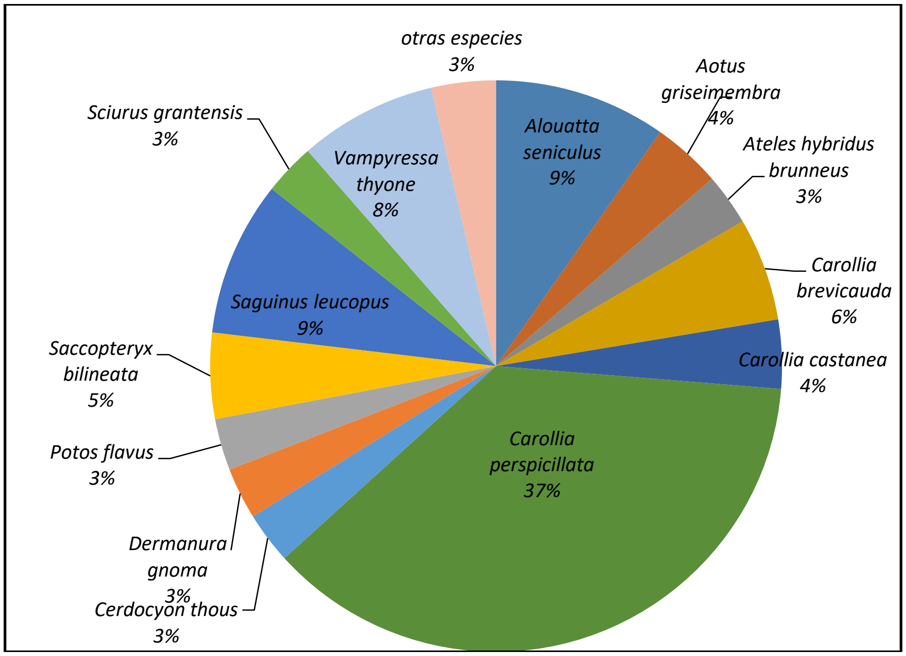

Illustration 4.24.2-116. Most representative mammals' species.
Source*: INGEX, 2016.*

The abundance of the species *Carollia perspicillata* Linnaeus, 1758 (Illustration 4.2-116) in all plant covers where samplings were taken (See Illustration 4.2-117), is attributable to the generalist condition of this species (Isaac-Junior & Sabato 1994; & Tadei 1997, Medellín et al 2000). It should also be mentioned that this species forms family groups ranging from a few individuals to thousands of individuals (Rodríguez-Mahecha et al 2008), which exploit their food resources in different forest strata, where with the fog nets method it is quite probable to capture them (Bejarano-Bonilla, 2007). In spite of finding individuals of *Carollia perspicillata* Linnaeus, 1758, in open and anthropically disturbed areas, they are also usually abundant within dense vegetation cover, such as primary and secondary forests; where it has been reported that they travel considerable distances, because they are considered good dispersers of seeds and of great importance in the maintenance of specific habitats (Rodríguez-Mahecha et al 2008).

The presence of *Carollia perspicillata* in most covers despite its general condition, is proof of a good connection and dynamic between the covers already mentioned; This phenomenon can contribute substantially in processes of ecological succession and gene exchange between populations of this species and populations of some plant species associated with these bats.

Illustration 4.2-117. *Carollia perspicillata* Linnaeus, 1758 within the sampling zone
Source: Merceditas Corporation, 2012.

Although the greater diversity and abundance of mammals occurs within forest cover or with some degree of arborization (Diamond, 1998), it is important to highlight the considerable representativeness of bats species in open areas, mainly in the cover corresponding to clean grasslands (2.3.1) (See Illustration 4.2-117). Many species of birds, arthropods and mammals of tropical forests, use and exploit food resources mainly in agricultural fields and deforested areas (Medellín et al 2000, Castro-Luna et al 2007). It should be noted that many of the records of bats in pasture covers were made in places near the edges of forests, therefore it was more likely to capture them.

The most representative mammal species within the study area are chiropter species, mainly of the Phyllostomidae family, thus becoming the most abundant, as well as the most diverse for the area.

In general terms, abundance patterns of mammalian communities at the level of families and species, behave in the typical way (inverted J), where few species have high densities, while most

The species of mammals by plant cover are illustrated below (See Illustration 4.2-117).

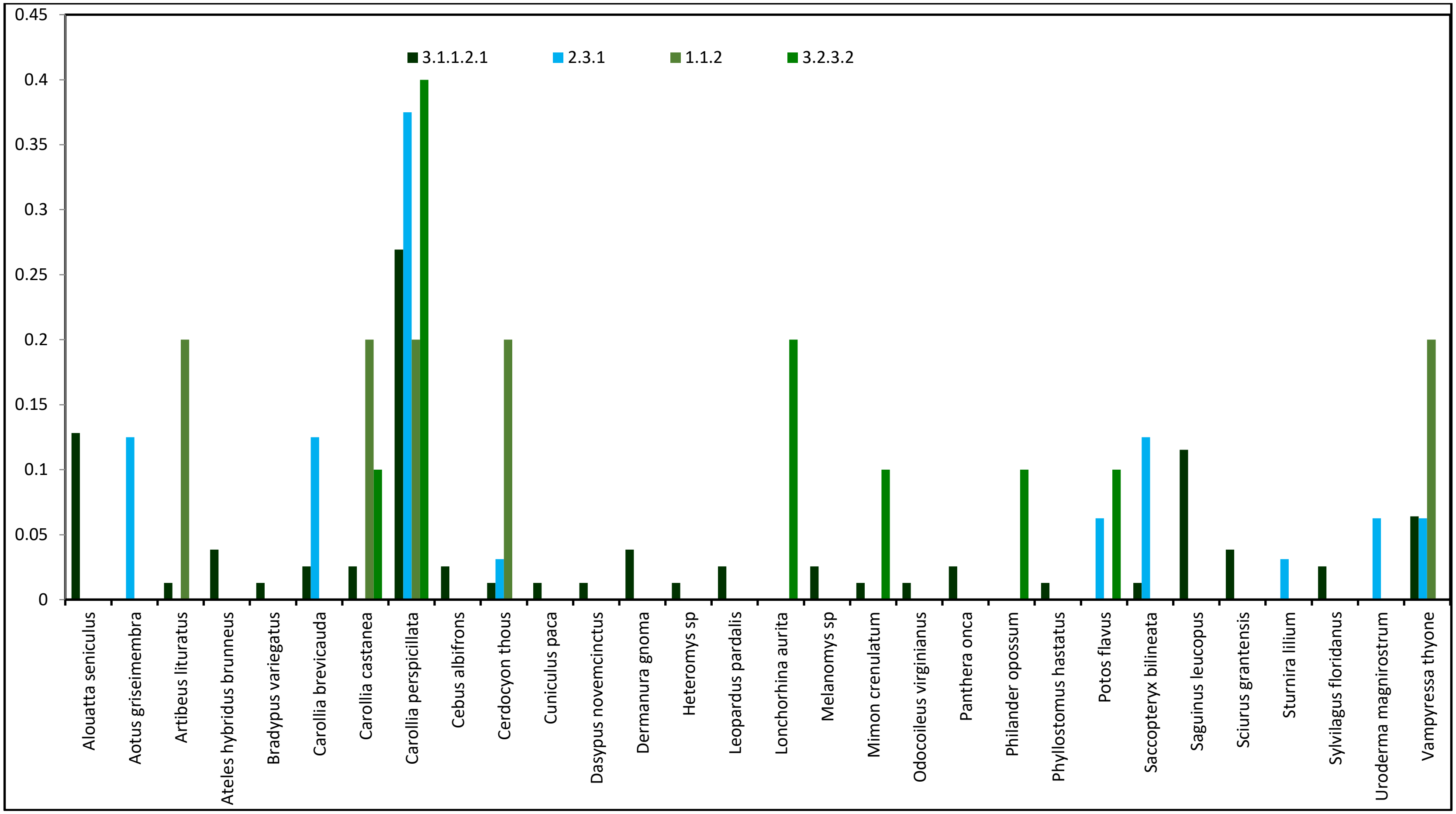

Illustration 4.24.2-118. Relative abundance of the most representative mammal species within the different plant cover sampled.
Source*: INGEX 2016.*

4.2.4.2.5 Diversity indexes

Below the alpha and beta indexes are presented.

Alpha diversity (α)

Alpha diversity is the intrinsic diversity of a community (Moreno, 2001), in this case in a community of mammals. As mentioned, alpha diversity implies indices of wealth, dominance and abundance. The indices obtained by the sampled vegetation cover are presented below (See Table 4.2-52 and Illustration 4.2-118).

Table 4.24.2-52. Alpha diversity indices (α) for sampled plant cover.

Index	Dense forest below mainland (3.1.1.2.1)	Secondary Vegetation or in transition (3.2.3.2)	Clean grasslands (2.3.1)	Discontinuous urban traffic (1.1.2)	Permanent bushy cocoa crops (2.2.2.3)	Permanent herbaceous cassava and plantain crops (2.2.1.3)
Shannon H’ Log Base 10,	2, 635	1,609	1,884	1,609	0	0
Simpson (D)	0,118	0,24	0,2012	0,21	1	-
Margalef M	5,279	2,171	2,308	2,485	0	-

Source: INGEX, 2016.

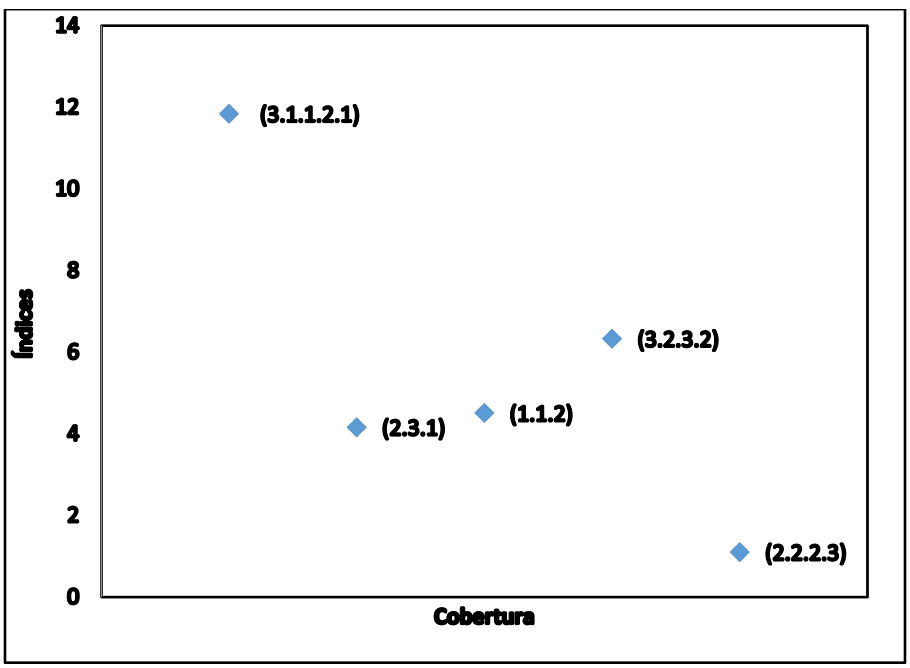

Illustration 4.2-119. Alpha diversity for the different vegetal covers sampled.
Source: INGEX, 2016.

In general terms, no significant differences were found in the alpha diversity indices evaluated (Simpson, Shannon and Margalef) among the vegetation cover studied.

The vegetable coverings Bdbtf, Lsv, Cg and Dut presented a value of the Margalef index of 5,279; 2,171; 2,308 and 2,485 respectively, without presenting significant differences between them (X^2=1.3166, p=0.72). This similarity may be due to the bias introduced by the large number of species of the order Chiroptera found in covers with some degree of intervention. In addition, mammals may also prefer open areas for feeding (Alberico et al., 2000) (Table 4.2-51)

For the Simpson diversity index, no significant differences were found between the coves studied (X^2=5.9635, p=0.11), although the Bdbtf cover was the one with the highest value.

With respect to the Shannon index, no significant differences were observed between plant covers (X^2=0.4077, p=0.93). The values of this index in each covering were between 1.6 and 2.6 which indicates that all the species are not well represented, and some species stand out as the most abundant, as is the case of the species *Carollia perspicillata*.

Dense forest below mainland (3.1.1.2.1)

According to the alpha diversity indices obtained for the area, in general terms, the greatest diversity of mammals was recorded in the dense low forest cover of the mainland (3.1.1.2.1) in comparison to the other vegetation cover sampled (See illustration 4.2-118). This difference may be subject to the greater effort of sampling within these covers and the abundances and wealth of species recorded in this type of coverage.

The Shannon-Wiener index, for forest cover in the area, was H '= 2,635; value close to those that have already been recorded in other similar tropical environments (González-Christen, 2008, Vargas-Miranda et al 2008, Rodríguez-Macedo et al 2014). The tropical forests, primary and secondary, from the soil to the canopy provide several surfaces that potentially contain a wide variety of invertebrates and plants, which feed a great diversity of mammals.

In terms of dominance, low dense forest cover was the one with the lowest index (D = 0, 117. Bear in mind that forest cover, being the most diverse and rich, is inversely the one with the lowest dominance of species in particular, with respect to other vegetation cover.

The Margaleff index for forest cover was the highest compared to the other coverings (M = 5,279) his value is important, mainly due to the characteristics of the sampled region, because despite suffering an enormous anthropic pressure, due to the exploitation of specific natural resources, even the forests in the area maintain diversities of substantial mammals.

Secondary vegetation or in transition (3.2.3.2)

In relation to the Shannon-Wiener index obtained by this covering (H'= 1,609), it can be said that it has a medium-high diversity, in comparison to similar plant covers in the neotropics (Pla, 2006). Presumably the vegetal structure is similar to the forests within the zone that favors the structural connectivity between different patches and remnants since the passage of mammals between these coverages is presumably constant.

It should be noted that although the dominance in the area for the different coverings does not present abysmal differences between them, it is worth noting the abundance in the cover of transitional vegetation of bats, mainly of the Phyllostomidae family.

It should be mentioned that areas with secondary vegetation could function as buffer zones for species at the landscape level (García-Morales et al 2011). Several factors influence the presence of mammal species and other vertebrates within these coverages, for example, for plant communities, the richness and diversity of species is greater in areas of secondary vegetation than in jungle areas, possibly due to spatial heterogeneity of the different regenerative stages after the abandonment of human activities (Castillo-Campos et al 2008). In addition to a high diversity, a high rate of exchange in the floristic composition between hedges has also been documented (Trejo & Dirzo, 2002). This could suggest that the presence of mammal species that feed on plant tissue in these coverings does not depend so much on the number of species, but on the floristic composition (García-Morales et al 2011).

Clean grasslands (2.3.1)

This vegetation cover, despite being associated in the area with deforestation processes for cattle and wood activities mainly, has alpha diversity indexes very similar to covers with a higher degree of vegetation such as dense forests and vegetation in transition (Table 4.2-51); this result is attributable to the considerable richness and diversity of bat species of generalist habits in the sites sampled within the coverage.

The diversity indices obtained for this cover are not negligible if one takes into account that the creation of homogeneous environments, as is the case of grasslands and pastures in the Andean region is the main cause of the loss of biodiversity (Rangel-Ch , 2010), due among other things to the fact that these interrupt the genetic flow of populations of mammalian species that do not move between remnants of distant forests.

Finally, it should be mentioned that the coverage of clean grasslands in the area compared to forested coverings, where theoretically the greatest diversity of mammals occurs, are less representative in terms of their area, therefore the interruption of the genetic flow and the mobility of species of mammals among forest cover is not yet very marked.

Discontinuous urban traffic (1.1.2)

The settlement of human communities within the study area negatively influences the diversity of fauna in the area, in this specific case of mammals. The deforestation of forests, the construction of access roads, extensive cattle ranching, among other anthropic activities, modulate the distribution and dynamics of species populations. This coverage has physiognomic characteristics very similar to the cover of clean grasses (2.3.1) and the presence of generalist species mainly conform the mastofaunistic diversity of these coverings.

Cocoa permanent crops (2.2.2.3) and permanent herbaceous of cassava and plantain (2.2.1.3)

These covers were the poorest and little diverse within the studied area, obtaining values equal to zero in terms of diversity and wealth, and abundance values equal to one (See Illustration 4.2-53). It should be noted that values of the Shannon and Margaleff index, mean remarkably poor and little diverse environments, while abundance values close to or equal to one are a symptom of sites dominated by a few species (Moreno, 2001).

The results obtained for these plant covers are due to the fact that these coverings have minimum areas in comparison to the other vegetation coverings within the area, therefore the sampling within these coverings was differential with respect to other sampling sites.

Equity J'

Table 4.2-53. Equity J' for plant covers sampled.

	FOREST BELOW MAINLAND (3.1.1.2.1)	SECONDARY VEGETATION OR IN TRANSITION (3.2.3.2)	CLEAN GRASSLANDS (2.3.1)	DISCONTINUOUS URBAN TRAFFIC (1.1.2)	CASSAVA AND PLAINTAIN CROPS (2.2.1.3)	PERMANENT BUSHY COCOA CROPS (2.2.2.3)
Equity J'	0,8288	0,8982	0,8575	1	-	-

Source: INGEX, 2016.

According to the equity index for the sampled coverages, all obtained values close to or equal to one (See Table 4.2-52), suggesting that all species were more or less represented for the same number of individuals except for a few dominant species.

Beta diversity (β)

The beta (β) biodiversity analyzes for the mammalian community are presented next. Understanding beta diversity (β), as the rate of change in species between two adjacent communities, therefore, reflects the difference in the composition of two communities and, ultimately, the heterogeneity of the landscape.

Cluster analysis of Bray-Curtis

The cluster dendrogram based on the Bray-Curtis index is presented below, which establishes the percentage of similarity among the sampled plant coverings in terms of its mastofaunal composition.

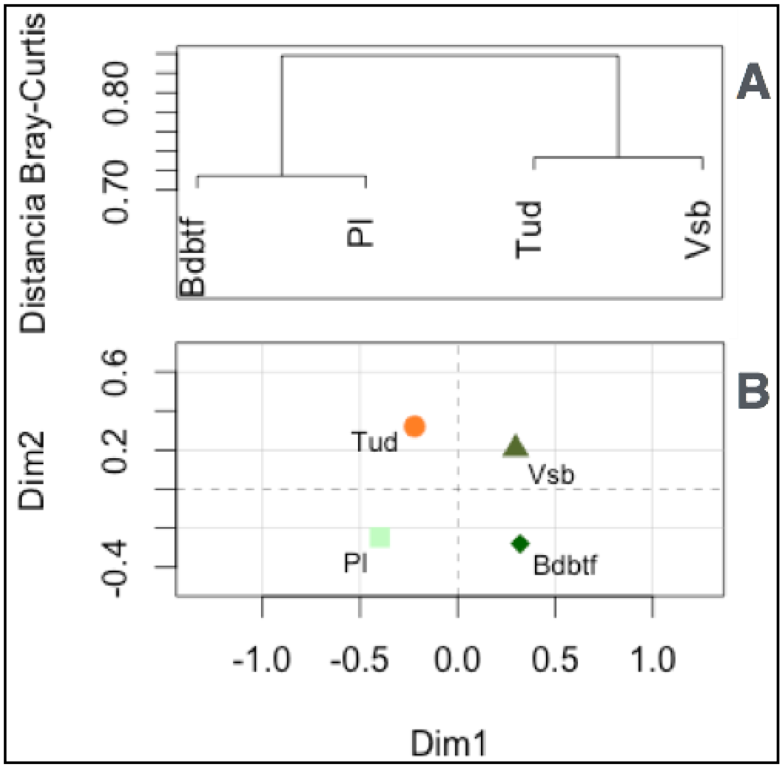

Illustration 4.2-120. Cluster analysis (% similarity) for the six plant covers sampled
Source: INGEX, 2016.

The vegetal coverings sampled within the area most similar in terms of their mastofaunistic composition were those corresponding to clean grasslands (2.3.1) and Urban and Discontinuous traffic (1.1.2) (See Illustration 4.2-121), which, despite not being the richest they did proportionally share the greatest number of species, it should be noted that all of them have general characteristics and are highly tolerant of anthropogenic disturbances.

In particular, forest covers (3.1.1.2.1), despite being totally dissimilar to grass coverings and urban traffic in terms of its vegetal composition, was in terms of mammalian communities, more similar to these than to coverings with characteristics more floristic alike, as is the case of the cover corresponding to secondary vegetation or in transition (3.2.3.2), presumably also result from the presence of species of generalist mammals that transit with some regularity between these covers. In the same way, in a Principal Coordinate Analysis, the similarity between these covers in a two-dimensional space is also evident.

4.2.4.2.6 Trophic guilds

Determining the trophic structure of an ecosystem is important when it comes to knowing the dynamics of a particular community (Pérez-Irineo & Santos-Moreno, 2013). Through the classification of trophic guilds within a community we can determine patterns of composition.

The ecology of food in mammals has been widely studied, which makes it easy to group them in different trophic guilds. For this study, the main trophic guilds proposed by Ceballos & Navarro, 1991 were included.

The trophic structure for this case (based on the presence of food) will be expressed through values of importance, that is, the proportion or percentage in which each category is found within the total of species.

Main trophic guilds

The local mastofauna during the course of the biotic characterization, was grouped into 5 trophic guilds, these are: carnivores, frugivores, herbivores, insectivores and omnivores. The most representative trophic guild within the area is the equivalent to the frugivores (See Illustration 4.2-120), presenting significant differences compared to the others (X2 = 60.5714; p <0.001).

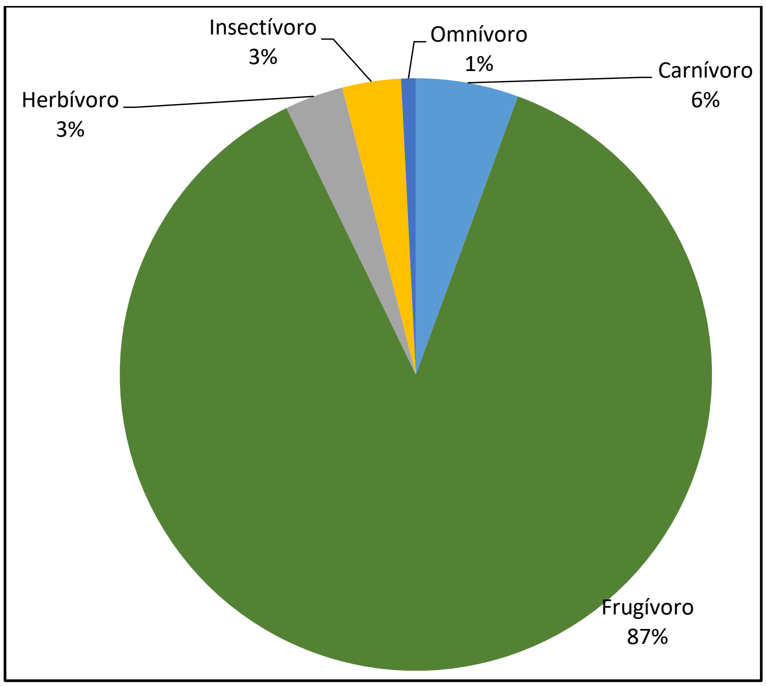

Illustration 4.2-121. Representativeness for each trophic guild within mammalian sampling.
Source: INGEX, 2016.

The high representativeness of frugivores in the area is attributable, among other things, to the remarkable representativeness of chiroptera of the Phyllostomidae family; which groups bat species with highly versatile eating habits (Passos & Graciolli, 2004), where frugivory is one of their most important behaviors. Additionally, there are other extrinsic factors that influence the high representativeness of frugivores for the case of phyllostomid bats; the diversity, seasonality and abundance of the food resource can be mainly mentioned (Flores-Martínez et al 2000, Molinari & Soriano, 2014), so the representativeness of this trophic guild in the area must be understood in terms of the functionality within the coverages sampled.

The most conspicuous importance of frugivorous species within a natural system, mainly of bats, is that of consuming a great variety of plant species (Medellín & Gaona, 1999); so, their role as seed dispersers is highlighted for the establishment of plants within tropical plant communities (Flores-Martínez et al 2000). In this order of ideas, the presence of frugivorous species in the area and its high representativeness, can be considered as an indicator of successional status within the plant communities. The other trophic guilds were represented by less than 13% (See illustration 4.2-120), and its representativeness within the zone in comparison to the frugivorous guild is minimal. Within this 13%, carnivores constitute around 6% (See Illustration 4.2-120), which play a key role in the natural maintenance of biodiversity (Berger, 1999), since they act as controllers of prey populations and other carnivorous mammals, thus achieving the maintenance and stabilization of the trophic structure of ecosystems (Gittleman et al 2001).

Trophic distribution

In the Illustration 4.2-121 shows the representativeness of the different trophic guilds within the different vegetation coverings. The frugivorous trophic guild obtained the highest representation within all plant covers in which records of mammals were produced; being the dense low forest cover of the mainland (3.1.1.2.1), where the highest representativeness of this group of mammals was obtained (See Illustration 4.2-121).

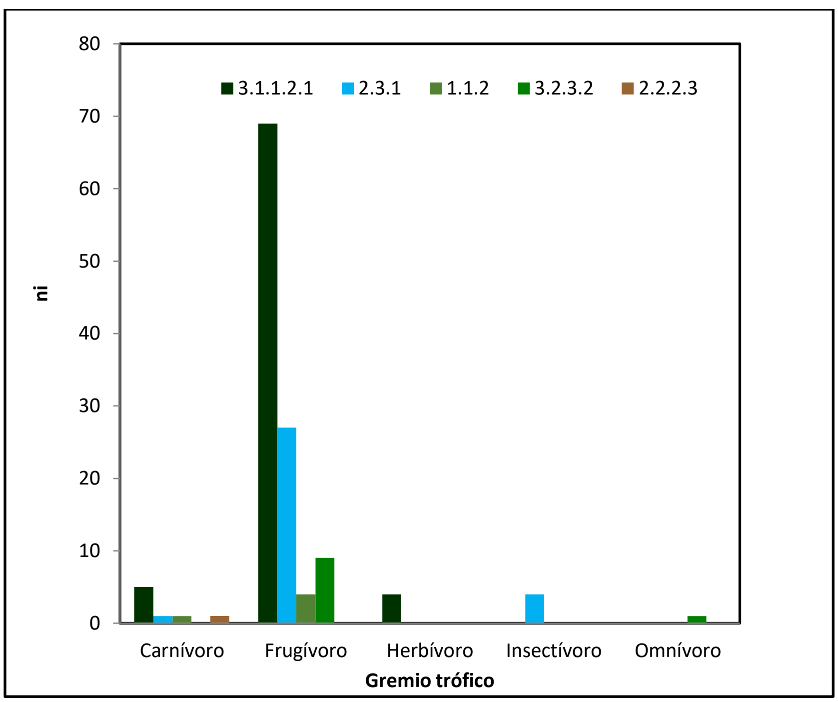

Illustration 4.24.2-122. Distribution of trophic guilds within the different plant covers.
Source: INGEX, 2016.

The presence of frugivorous mammal species within the forest cover is an important indicator of the heterogeneity of the floristic composition within these plant units, because when carrying out seed dispersal processes, they alter the reproductive processes of the plant communities (Novoa et al. to 2011). Frugivorous mammals, moving to different environments, help seeds escape from predators, increasing germination rates and the probability of seedling establishment, decreasing inbreeding and favoring genetic interchange among populations of plant species (Fleming & Sosa, 1994; Romo, 2004).

On the other hand, the coverage corresponding to clean grasslands (2.3.1), was the vegetable unit in obtaining the second representative of frugivorous mammals (see illustration 4.2-121), above covers with greater plant development and presumably food supply, as is the case of secondary or transitional vegetation cover (3.2.3.2). This result is noteworthy, if we remark that the representativeness of frugivores is attributable to the presence of bat species of the Phyllostomidae family, as already mentioned above. In this order of ideas, the seeds transferred by chiroptera are usually the most important source in the early colonization of disturbed habitats (Lobova et al 2003), as is the case of the cover highlighted. In this sense frugivorous mammals contribute to the introduction of pioneer plants in open sites, participating in plant regeneration or secondary succession (Young et al 1996, Galindo-González et al 2000).

In general terms, the less represented trophic guilds were present in a single coverage, which is presumably the result of occasional records of this type of mammals, rather than to some degree of specificity for any food resource within the sampled plant cover, although it should be noted the presence of insectivorous mammals in the cover of clean grasslands(2.3.1), which can be linked to the abundance of certain groups of insects in open and disturbed areas, where this food resource is more accessible and exploitable by this type of mammals. On the other hand, the presence of carnivorous mammal species within several plant coverings; despite its low representativeness, its contribution in ecological terms is fundamental, since these are in general large contributors of biomass, mainly in tropical forests (Prins & Reitsma, 1989) and for their role as modulators of the population dynamics of other species of mammals (Gittleman et al 2001).

4.2.4.2.7 Status of mammal conservation

During the course of the biotic characterization, a total of 4 species of mammals included in some category of threat at national and international level were recorded (Illustration 4.2-54). It should be mentioned that only those species that were in a higher risk category, that is, those classified as of minor concern (LC) by the IUCN, were not included in the following list.

Table 4.24.2-54. Species of mammals with some degree of threat registered.

Order	Family	Species	Resolution 0192 of 2014	IUCN
Primates	Atelidae	*Ateles hybridus brunneus*	CR	CR
	Aotidae	*Aotus griseimembra*	VU	VU
	Callithrichidae	*Saguinus leucopus*	EN	VU
Carnivorous	Felidae	*Panthera onca*	VU	VU

Source: INGEX, 2016.

Of the 4-species included in this list 3 are primates, a result that is remarkable if we take into account the high rate of endemism of this group of mammals in the Serranía de San Lucas (Defler, 2003) which is located 40 km from the studied area. Currently the Serranía de San Lucas is one of the areas of Colombia that faces the greatest anthropic pressure, due to logging, mining and livestock, for which the forest habitats where these species predominate are seriously threatened.

Additionally, of these 3 species of registered primates, one species, (*Saguinus leucopus* (Günther, 1877) and one sub-species (*Ateles hybridus brunneus* (Geoffroy, 1829) are endemic to Colombia and particularly to the Serranía de San Lucas.

Ateles hybridus is one of the primate species considered to be at high risk of extinction (CR) in the country, being the loss of habitat the greatest threat. In addition, the densities of their populations are unknown and is the subject of intense hunting in some areas of the country. On the other hand, *Ateles hybridus brunneus* (Geoffroy, 1829), is probably the most threatened subspecies due to its small areal of distribution and to the increase of anthropogenic activities in it (Defler, 2010).

In the sampling area, this species was recorded in the low dense forest vegetation cover of the mainland, with a relative representativeness within the sampling of 3% of the records. Within the studied area, livestock activity and logging have been fragmenting and destroying their habitat progressively, which demonstrates the urgency of implementing measures for the conservation, management and protection of populations.

At the national level, this species does not present conservation measures, so it is necessary to propose protected areas within the National System of Protected Areas (SINAP), where this species is distributed, and an education plan is required to protect this species in the Serranía de San Lucas and its surroundings (Defler et al 2006).

Saguinus leucopus (Günther, 1877) (Illustration 4.2-107), is a species that is distributed in tropical dry forests, damp forests and very humid tropical forests, both primary and secondary in the departments of Antioquia , Caldas and Tolima (Defler et al 2010); This species is perhaps one of the primate species threatened in the area with the largest distribution area in the country, but still faces serious conservation problems, which has been cataloged nationally and internationally as vulnerable (VU) (Rodríguez-Mahecha et al 2006) and in danger (EN) (Morales-Jiménez et al 2008) respectively. It is usually sighted in groups of 3 to 9 individuals, consuming fruits or in free movement within forest cover mainly.

Within the study area this species, obtained a relative representativeness of 9% of the records, becoming together with *Alouatta seniculus* (Linnaeus, 1766), the most representative species of primates in the area (Illustration 4.2-117). The greatest threat that this species faces locally is the destruction and fragmentation of its habitat, as a consequence of anthropic activities in the area. It is pertinent to establish and clearly delimit its area of distribution within the studied area and surrounding areas, in order to establish whether there is still a genetic flow of this species within the different forest remnants.

At the national level, this species is not protected in any area of the SINAP, even though its distribution area coincides with sites of high anthropic colonization, it is only protected in some small private reserves and is included in Appendix I of CITES, so that their possession and trade is prohibited (Rodríguez-Mahecha et al 2006). It is worth mentioning that this species, because it is a small primate, could be easily protected, once conservation strategies are implemented locally and nationally.

On the other hand, the Aoutus maguey Grisimembra Elliot, 1912 (Illustration 4.2-122), it is a species of strictly nocturnal primate and it is one of the most threatened species of the *Aotus* genus. (Morales-Jiménez et al 2008), due to the extensive destruction of their habitat since they are captured to be used in biomedical research. This species is highly susceptible to Plasmodium, a parasite that causes malaria, being the ideal model to carry out research related to this disease (Defler, 2010).

Within the area, this species obtained a representativeness of 4% of the records (Illustration 4.2-117), being sighted in vegetal covers with good vegetation development, as in those with certain degree of disturbance, usually in small groups. Within the study area this species is not persecuted by hunters, so its greatest extinction pressure in the area is the destruction and fragmentation of its habitat. It is important to establish mechanisms that generate awareness and attitude of protection at the local level by the inhabitants.

For this species there are no proposed conservation measures, however, it is presumably distributed in some national natural parks of SINAP. Despite this, it is essential to establish clear rules for the use of this species in biomedical research (Defler & Rodríguez-Mahecha, 2006).

Illustration 4.24.2-123. *Aotus griseimembra* Elliot, 1912.
Source: ©Ken Lucas/www.ardea.com. Photo from www.arkive.org.

Finally, other of the species with some degree of threat, registered within the area, was *Panthera onca* (Linnaeus, 1758) (See Illustration 4.2-123 and Illustration 4.2-124), this species of mammal is the feline of greater scope and hierarchy for the new world (Nowell & Jackson, 1996), which is of solitary and territorial habits, mainly carnivorous, eat any animal that can stalk, trap and kill (Payan-Garrido & Soto-Vargas, 2012).

Illustration 4.24.2-124. *Panthera onca* (Linnaeus, 1758). Felidae: Carnivora.
Source: © Nick Gordon. Disponible en www.arkive.com.

Illustration 4.2-125. Footprint of *Panthera onca* (Linnaeus, 1758), registered.
Source: Corporación Merceditas, 2012.

This species was registered in a large part of the forest cover of the studied area, basically due to the structural connectivity that exists between them. This species has been strongly persecuted in the area because some individuals can attack the cattle present in the area, so they are hunted by farmers and hunters. Additionally, its natural habitat, primary and secondary forests, mainly, have been destroyed and notoriously fragmented, which is why the minimum area for viable maintenance of the populations of this species is lower.

At the national level, this species is in a state of vulnerability (VU) (Res 0192 of 2014) and its distribution area is the same in most national parks, even though many of the populations that are outside these areas are in imminent danger, due mainly to the expansion of the cattle and agricultural frontier and to intensive hunting.

It is worth mentioning the enormous efforts at the international level of the Panthera foundation for the conservation of this species in the American countries where this species currently lives and where it has lived historically, with the aim of establishing biological corridors where the populations of this species can be communicated.

The Serranía de San Lucas is one of the regions where there are still potentially good populations of this species, so it is urgent to evaluate the potential of remnants of existing forests in the area, to turn them into eventual biological corridors to connect the local population with other populations, mainly in the biogeographic Chocó (obs pers.).

4.2.4.2.8 Prohibited species

In accordance with resolution 848 of August 6, 1973, the species *Panthera onca, Leopardus pardalis, Potos flavus* and *Cerdocyon thous* present an indefinite ban at a national level.

4.2.4.2.9 Species used by the community

None of the mammal species registered in the study area are used by the community.

4.2.4.2.10 Species identified in the region according to secondary information

For the species of mammals registered in the region, a secondary information search was carried out; mainly checklist, available for the areas surrounding the area of biotic influence (Cuartas-Calle, 2001, Muñoz, 2001, Cuartas-Calle & Muñoz, 2003a, Cuartas-Calle & Muñoz, 2003b, Restrepo-Llano, 2010). It should be mentioned that the distributions of many of the species included in the list are likely to be distributed in the area, due to the proximity of the places where records have been made regarding the area of biotic influence and in addition to the similarity of ecological and climatic factors between different sites.

A total of 129 species of mammals, 11 orders and 36 families were included, among which the Phyllostomidae family is the richest with 42 species. Additionally, this list includes 8 species with some degree of threat of extinction according to the IUCN; distributed as follows: 5 in vulnerable state (VU), 1 in danger (EN) and 2 in critical state of threat (CR) (See Table 4.2-63).

Only two (2) endemic species have been registered for the area, specifically for the Serranía de San Lucas; this is the case of *Ateless hybridus brunneus* Geoffroy, 1829 and the monkey S*aguinus leucopus* (Günther, 1877). Finally, it should be noted that the Serranía de San Lucas corresponds to one of the main refuges of the Pleistocene, so it has a high diversity and a high degree of endemism of mammals, mainly primates (Defler, 2003).

Table 4.24.2-55. Species of mammals registered in adjacent geographic zones.

ORDER	FAMILY	*SPECIES*	VERNACULAR NAME	HABITAT	SITE OF REGISTRATION	REGISTERED IN THE AID
Artiodactyla	Cervidae	*Mazama americana*	Deer	Primary forest	Territorial Zenufaná	
	Tayasssuidae	*Pecari tajacu*	Pecarí de collar	Primary forest	Territorial Zenufaná	
Carnivorous	Canidae	*Cerdocyon thous*	Zorro perruno o plateado	Secondary forest, vegetation in transition	Territorial Zenufaná	X
		Nasua nasua	Cusumbo	Primary forest, Secondary forest	Territorial Zenufaná	
		Urocyon cinereoargenteus	Silver or cat-like Fox	Secondary forest, vegetation in transition	Territorial Zenufaná	
	Felidae	*Herpailurus yaguarondi*	Cat like, yaguarundi	Primary forest, Secondary forest	Territorial Zenufaná	
		Leopardus pardalis	Wild cat	Primary forest, Secondary forest	Territorial Zenufaná	X
		Panthera onca	Jaguar	Primary forest, Secondary forest	Territorial Zenufaná	X
		Puma concolor	Cougar, red color lion	Primary forest, Secondary forest	Territorial Zenufaná	
	Mustelidae	*Conepatus semistriatus*	Mofeta, skunk	Primary forest	Low Cauca	
		Eira barbara	Ulamá, Tayra	Primary forest, Secondary forest	Territorial Zenufaná	
		Galictis vittata	Hurón, Mapuro	Primary forest, Secondary forest	Magdalena river valley	
		Lontra longicaudis	Otter	Cuerpos de agua	Magdalena river valley	
		Mustela frenata	Weasel	Secondary forest, vegetation in transition	Magdalena river valley	
	Procyonidae	*Potos flavus*	Hill dog	Primary forest, Secondary forest	Territorial Zenufaná	X
		Procyon cancrivorus	Raccoon	Primary forest, Secondary forest	Territorial Zenufaná	
Chiroptera	Emballonuridae	*Centronycteris centralis*	Bat	Forest, opened and semi-opened areas	Territorial Zenufaná	
		Centronycteris maximiliani	Bat	Forest, opened and semi-opened areas	Territorial Zenufaná	
		Saccopteryx bilineata	Bat	Forest, opened and semi-opened areas	Territorial Zenufaná	X
		Saccopteryx canescens	Bat	Forest, opened and semi-opened areas	Territorial Zenufaná	
		Saccopteryx leptura	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
	Molossidae	*Eumops bonariensis*	Bat	Primary forest, Secondary	Low Cauca	

ORDER	FAMILY	*SPECIES*	VERNACULAR NAME	HABITAT	SITE OF REGISTRATION	REGISTERED IN THE AID
				forest		
		Eumops glaucinus	Bat	Primary forest, Secondary forest	Low Cauca	
		Molossops abrasus	Bat	Primary forest, Secondary forest	Low Cauca	
		Molossus molossus	Bat	Primary forest, Secondary forest	Low Cauca	
		Molossus sinaloe	Bat	Primary forest, Secondary forest	Low Cauca	
		Nyctinomops aurispinosus	Bat	Primary forest	Low Cauca	
		Nyctinomops laticaudatus	Bat	Primary forest, Secondary forest	Low Cauca	
		Nyctinomops macrotis	Bat	Primary forest, Secondary forest	Low Cauca	
		Promops centralis	Bat	Primary forest, Secondary forest	Low Cauca	
	Mormoopidae	*Mormoops megalophylla*	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Pternotus parnelli	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Pteronotus davyi	Bat	Primary forest, Secondary forest	Low Cauca	
		Pteronotus parnellii	Bat	Primary forest, Secondary forest	Low Cauca	
		Pteronotus personatus	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
	Natalidae	*Natalus stramineus*	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
	Noctiionictidae	*Noctilio albiventris*	Bat	Forest, opened and semi-opened areas	Territorial Zenufaná	
		Noctilio leporinus	Bat	Forest, opened and semi-opened areas	Territorial Zenufaná	
	Phyllostomidae	*Artibeus cinereus*	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Artibeus glaucus	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Artibeus intermedius	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Artibeus jamaicensis	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Artibeus lituratus	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Artibeus obscurus		Primary forest, Secondary forest	Territorial Zenufaná	
		Carollia brevicauda		Forest, opened and semi-opened areas	Territorial Zenufaná	X
		Carollia castanea	Bat	Forest, opened and semi-opened areas	Territorial Zenufaná	X
		Carollia colombiana	Bat	Primary forest, Secondary forest	Territorial Zenufaná	

ORDER	FAMILY	*SPECIES*	VERNACULAR NAME	HABITAT	SITE OF REGISTRATION	REGISTERED IN THE AID
		Carollia perspicillata	Bat	Bosques, áreas semiabiertas y abiertas	Territorial Zenufaná	X
		Centurio senex	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Chiroderma villosum	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Chrotopterus auritus	Bat	Primary forest	Territorial Zenufaná	
		Desmodus rotundus	Bat	Forest, opened and semi-opened areas	Territorial Zenufaná	
		Glossophaga commissarisi	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Glossophaga soricina	Bat	Secondary forest	Territorial Zenufaná	
		Glyphonycteris sylvestris	Bat	Primary forest, Secondary forest	Low Cauca	
		Lampronyderis brachyotis	Bat	Primary forest, Secondary forest	Low Cauca	
		Leptonycteris curasoae	Bat	Secondary forest	Territorial Zenufaná	
		Lonchophylla thomasi	Bat	Primary forest	Territorial Zenufaná	
		Lonchorhina aurita	Bat	Primary forest, Secondary forest	Territorial Zenufaná	X
		Lophostoma brasilense	Bat	Primary forest, Secondary forest	Low Cauca	
		Macrophyllum macrophyllum	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Mesophylla macconnelli	Bat	Primary forest, Secondary forest	Low Cauca	
		Micronycteris hirsuta	Bat	Forests, opened and semi opened-areas	Territorial Zenufaná	
		Mimon bennettil	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Mimon crenulatum	Bat	Primary forest, Secondary forest	Territorial Zenufaná	X
		Phylloderma stenops	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Phyllostomus discolor	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Phyllostomus elongatus	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Phyllostomus hastatus	Bat	Primary forest, Secondary forest	Territorial Zenufaná	X
		Platyrrhinus aurarius	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Platyrrhinus brachycephalus	Bat	Primary forest, Secondary forest	Territorial Zenufaná	X
		Platyrrhinus helleri	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Sturnira lilium	Bat	Primary forest, semi-	Territorial	X

ORDER	FAMILY	*SPECIES*	VERNACULAR NAME	HABITAT	SITE OF REGISTRATION	REGISTERED IN THE AID
				opened areas	Zenufaná	
		Sturnira luisi	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Trachops cirrhosus	Bat	Primary forest, Secondary forest	Territorial Zenufaná	X
		Uroderma bilobatum	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Uroderma magnirostrum	Bat	Primary forest, Secondary forest	Territorial Zenufaná	X
		Vampyressa brocki	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Vampyressa nymphaea	Bat	Secondary forest, vegetation in transition	Territorial Zenufaná	
		Vampyrum spectrum	Bat	Primary forest, Secondary forest	Low Cauca	
	Thyropteridae	*Thyroptera discifera*	Bat	Primary forest, Secondary forest	Low Cauca	
	Vespertilionidae	*Eptesicus brasilensis*	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Lasiurus cinereus	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
		Myotis albescens	Bat	Primary forest, Secondary forest	Low Cauca	
		Myotis ripalus	Bat	Primary forest, Secondary forest	Territorial Zenufaná	
Cingulata	Dasypodidae	*Cabassous centralis*	Armadillo tail cloth	Primary forest, Secondary forest	Territorial Zenufaná	
		Dasypus novemcinctus	common Armadillo	Primary forest, Secondary forest	Territorial Zenufaná	X
Didelphimorphia	CaluromyIdae	*Caluromys derbianus*	Wool opossum	Primary forest, Secondary forest	Low Cauca	
		Caluromys lanatus	Chucha roja real	Secondary forest	Territorial Zenufaná	
	Didelphidae	*Chironectes minimus*	Chucha de agua	Streams	Territorial Zenufaná	
		Didelphis marsupialis	Weasel	Primary forest, Secondary forest	Low Cauca	
		Metachirus nudicaudatus	Chucha mantequera	Primary forest, Secondary forest	Territorial Zenufaná	
		Philander opossum	Chucha cuatro ojos	Secondary forest	Territorial Zenufaná	X
	Mormosidae	*Marmosa murina*	Marmosa común	Primary forest, Secondary forest	Territorial Zenufaná	
		Marmosa robinsoni	Marmosa	Primary forest, Secondary forest	Territorial Zenufaná	
		Micoureus regina	Chucha mantequera	Primary forest, Secondary forest	Low Cauca	
Folivora	Bradypodidae	*Bradypus variegatus*	Sloth	Primary forest, Secondary forest	Territorial Zenufaná	X
	Megalonychidae	*Choloepus hoffmanni*	Two finger sloth	Primary forest, Secondary forest	Territorial Zenufaná	

ORDER	FAMILY	*SPECIES*	VERNACULAR NAME	HABITAT	SITE OF REGISTRATION	REGISTERED IN THE AID
Lagomorpha	Leporidae	*Sylvilagus brasiliensis*	Hill rabbit	Primary forest, semi-opened areas	Territorial Zenufaná	
		Sylvilagus floridanus	Savannah rabbit	Primary forest, semi-opened areas	Territorial Zenufaná	X
Perissodactyla	Tapiridae	*Tapirus terrestris*	Tapir, danta	Primary forest	Territorial Zenufaná	
Primates	Aotidae	*Aotus lemurinus*	Marteja	Primary forest, Secondary forest	Territorial Zenufaná	
		Aoutus griseimembra	Marteja	Primary forest, Secondary forest	Territorial Zenufaná	X
	Atelidae	*Alouatta seniculus*	Howler monkey	Primary forest	Territorial Zenufaná	X
		Ateles geoffroyi	Spider monkey	Primary forest, Secondary forest	Territorial Zenufaná	
		Ateles hybridus	Spider monkey	Primary forest	Territorial Zenufaná	X
	Callitrichidae	*Saguinus leucopus*	Tití gris	Primary forest	Territorial Zenufaná	X
	Cebidae	*Cebus albifrons*	Tití maicero	Primary forest, Secondary forest	Territorial Zenufaná	X
		Cebus capucinus	Tití capuchino	Primary forest, Secondary forest	Territorial Zenufaná	
Rodentia	Cuniculidae	*Agouti paca*	Guagua , boruga	Primary forest, Secondary forest	Territorial Zenufaná	
		Cuniculus paca	Guagua	Primary forest, Secondary forest	Low Cauca	X
	Dasyproctidae	*Dasyprocta punctata*	Ñeque, guatin	Primary forest, Secondary forest	Territorial Zenufaná	
	Dinomyidae	*Dinomys branickii*	Guagua loba	Primary forest, Secondary forest	Territorial Zenufaná	
	Echimyidae	*Proechimys magdalenae*	Carisagua del magdalena	Primary forest, Secondary forest	Territorial Zenufaná	
		Echimys semivillosus	Thorn rat	Primary forest, Secondary forest	Low Cauca	
	Erethizontidae	*Coendou prehensilis*	Common hedgehog	Primary forest	Territorial Zenufaná	
	Heteromyidae	*Heteromys anomalus*	Chacaro mouse	Primary forest, Secondary forest	Territorial Zenufaná	
		Heteromys australis	Chacaro mouse	Primary forest, Secondary forest	Territorial Zenufaná	
	Muridae	*Mus musculus*	Home mouse	Urban areas	Territorial Zenufaná	
		Rattus norvegicus	Rat	Urban areas	Territorial Zenufaná	
		Rattus rattus	Common rat	Urban areas	Territorial Zenufaná	
	Sciuridae	*Sciurus granatensis*	Ardilla alazanja	Primary forest, Secondary forest	Territorial Zenufaná	X
	Sigmodontidae	*Oryzomys alfaroi*	Mouse	Primary forest, Secondary forest	Low Cauca	
		Oryzomys	Mouse	Primary forest, Secondary	Low Cauca	

ORDER	FAMILY	*SPECIES*	VERNACULAR NAME	HABITAT	SITE OF REGISTRATION	REGISTERED IN THE AID
		talamancae		forest		
		Sigmodon hispidus	Savannah mouse	Áreas abiertas y semiabiertas	Territorial Zenufaná	
		Zygodontomys brevicauda	Shorttail mouse	Primary forest, Secondary forest	Territorial Zenufaná	
Vermilingua	Myrmecophagidae	*Cyclopes didactylus*	Osito trueno, angelito	Primary forest, Secondary forest	Territorial Zenufaná	
		Tamandua mexicana	Tamndua, anteaters	Primary forest, Secondary forest	Territorial Zenufaná	

Source: Cuartas-Calle, 2001; MUÑOZ, 2001; Cuartas-Calle & Muñoz, 2003a; Cuartas-Calle & Muñoz, 2003b; Restrepo-Llano, 2010

Table 4.2-56. Species of mammal with certain threat, registered in adjacent áreas.

ORDER	FAMILY	SPECIES	VERNACULAR NAME	THREAT STATUS
Carnivora	Felidae	*Panthera onca*	Jaguar	VU
	Mustelidae	*Lontra longicaudis*	Nutria	VU
Perissodactyla	Tapiridae	*Tapirus terrestris*	Tapir, danta	CR
Primates	Aotidae	*Aotus lemurinus*	Marteja	VU
		Aoutus griseimembra	Marteja	VU
	Atelidae	*Ateles geoffroyi*	Mono araña	EN
		Ateles hybridus	Mono araña	CR
Rodentia	Dinomyidae	*Dinomys branickii*	Guagua loba	VU

Source: Cuartas-Calle, 2001; MUÑOZ, 2001; Cuartas-Calle & Muñoz, 2003a; Cuartas-Calle & Muñoz, 2003b; Restrepo-Llano, 2010

4.2.4.3 AVIFAUNA

The curve of species accumulation, richness and taxonomic composition, abundance, diversity indexes, trophic guilds, conservation status and endemic species, migratory species, and species identified in the region according to primary and secondary information are presented Next.

4.2.4.3.1 Curve of species accumulation

To generate the species accumulation curve and validate the sampling, the non-parametric CHAO estimator was plotted; which determines the number of expected species based on the presence and abundance of the species recorded in a sample, correlated with the number of singletons (single species in a sample) and doubletons (duplicate species) (Moreno, 2001) (See Illustration 4.2-125).

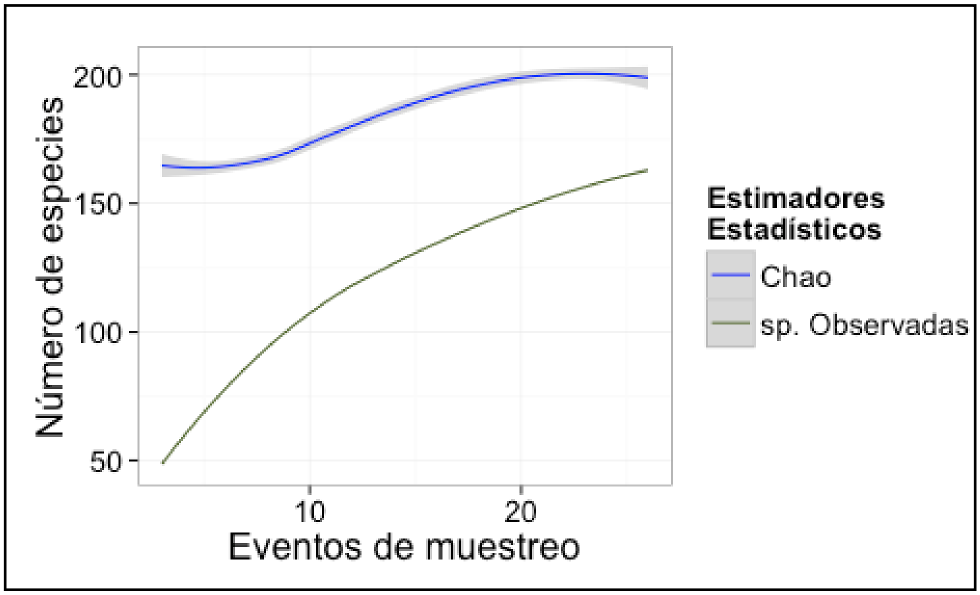

Illustration 4.24.2-126. Graph of the curve of accumulation of birds of species with the non-parametric estimator CHAO (The shaded regions represent trust intervals of 95%)
Source: INGEX, 2016.

According to the CHAO index, the number of species expected for sampling is approximately 240, while the number of species observed was 186 species (77.5% of the expected species).

The accumulation curve of bird species is not stabilized, that is, it is necessary to increase the sampling or the number of days so that the number of species found increases significantly. In addition, the confidence intervals of the accumulation curve do not overlap with those of the non-parametric CHAO estimator, indicating that the number of species found may have been higher in that sampling time.

4.2.4.3.2 Bird wealth and taxonomic composition

Biodiversity is the variety within the living world and can be expressed according to genes, species, populations, communities and ecosystems (Rangel, 2010), together with the services that can be provided.

The quantification of biodiversity implies wealth indices and others based on the combination of wealth and abundance. The richness of species is the simplest measure of biodiversity, which simply involves the number of species in a specific area, although it depends notably on the sampling effort used (Carrascal et al 2008). In general terms in nature it is observed that the great majority of communities are characterized by the dominance of a few species, accompanied by others that are relatively rare or uncommon (Krebs, 1989).

Birds are good candidates to evaluate different ecosystems, because they are very abundant and diverse vertebrates, with different trophic functions and diversity of body sizes (Díaz et al., 2005;

Bojorges, 2006); therefore, the structure of their community and the composition of species are good indicators of nutrient and energy routes.

A total of 186 species were recorded (See Illustration 4.2-157) in 31 net days of sampling.

Table 4.24.2-57. Species of birds registered.

ORDER	FAMILY	*SPECIES*	COVER	VERNACULAR NAME
Accipitriformes	Accipitridae	*Accipiter striatus*	(2.3.1)	American sparrow hawk
		Buteo brachyurus	(2.3.1)	Short tail Sparrow hawk
		Buteo nitidus	(3.2.3) (3.1.1.2.1)	Gray Eagle
		Buteo platypterus	(3.1.1.2.1)	Eagle
		Buteogallus meridionalis	(2.3.1) (3.1.1.2.1)	Savannah Sparrow hawk
		Elanoides forficatus	(3.1.1.2.1) (3.2.3) (1.1.2)	Scissor Sparrow hawk
		Gampsonyx swainsonii	(2.3.1) (3.1.1.2.1)	Elanio, gavilancito
		Harpagus bidentatus	(2.3.1)	Milano
		Rupornis magnirostris	(3.1.1.2.1) (3.2.3) (1.1.2) (2.2.2.3)	Chicken hawk
	Cathartidae	*Cathartes aura*	(2.3.1) (3.1.1.2.1) (1.1.2) (2.2.2.3)	Gualo, Turkey buzzard
		Cathartes burrovianus	(3.2.3) (3.1.1.2.1)	Gualo, Turkey buzzard
		Coragyps atratus	(2.3.1) (1.1.2) (3.2.3)	Gualo, Turkey buzzard
		Sarcoramphus papa	(3.1.1.2.1) (3.2.3)	King Turkey buzzard
	Pandionidae	*Pandion haliaetus*	(3.1.1.2.1) (3.2.3)	Fishing Eagle
Apodiformes	Apodidae	*Streptoprocne rutila*	(3.1.1.2.1)	Vencejo cuellirojo
		Streptoprocne zonaris	(3.2.3) (3.1.1.2.1)	Swift
	Trochilidae	*Amazilia amabilis*	(3.2.3)	Hummingbird, Suck flower
		Amazilia tzacatl	(2.3.1) (1.1.2) (3.2.3)	Humming bird, Suck flower
		Chlorostilbon mellisugus	(2.3.1)	Humming bird, Suck flower
		Florisuga mellivora	(2.3.1) (3.2.3)	Suck flower collarejo
		Glaucis hirsutus	(2.3.1) (3.2.3) (3.1.1.2.1)	Humming bird, Suck flower
		Heliothryx barroti	(3.2.3)	Humming bird, Suck flower
		Juliamyia julie	(2.3.1)	Humming bird, Suck flower
		Phaethornis anthophilus	(2.3.1) (3.2.3) (3.1.1.2.1)	Humming bird, Suck flower
		Phaethornis guy	(2.3.1) (3.1.1.2.1)	Suck flower
		Phaethornis striigularis	(3.1.1.2.1)	Humming bird, Suck flower
		Phaethornis syrmatophorus	(3.1.1.2.1) (3.2.3)	Humming bird, Suck flower
		Threnetes ruckeri	(3.2.3) (3.1.1.2.1)	Humming bird, Suck flower
Caprimulgiformes	Caprimulgidae	*Chordeiles acutipennis*	(3.1.1.2.1) (3.2.3)	Swift
		Nyctidromus albicollis	(2.3.1)	Blind hen
Charadriiformes	Charadriidae	*Vanellus chilensis*	(2.3.1)	Bittern
Columbiformes	Columbidae	*Columbina minuta*	(3.2.3) (2.2.2.3)	Turtledove
		Columbina passerina	(1.1.2)	

ORDER	FAMILY	SPECIES	COVER	VERNACULAR NAME
		Columbina talpacoti	(1.1.2) (2.3.1) (3.2.3)	Turtledove
		Geotrygon montana	BSB (3.2.3)	Partridge pigeon
		Leptotila verreauxi	(1.1.2) (2.3.1) (3.1.1.2.1) (3.2.3) (2.2.2.3)	Hill pigeon
		Patagioenas cayennensis	(3.1.1.2.1)	Coloured pigeon
Coraciiformes	Alcedinidae	*Chloroceryle americana*	(2.3.1) (1.1.2)	Martin fisher
		Megaceryle torquata	(1.1.2) (3.1.1.2.1)	Martin Fisher
	Momotidae	*Baryphthengus martii*	(3.1.1.2.1) (2.2.2.3)	Yeruvá
Cuculiformes	Cuculidae	*Coccyzus americanus*	(3.1.1.2.1)	Cuclillo piquilargo
		Crotophaga ani	(3.2.3) (2.3.1)	Garrapatero
Falconiformes	Falconidae	*Caracara cheriway*	(3.2.3)	Caracara
		Daptrius ater	(1.1.2) (3.1.1.2.1)	Caracara negro
		Falco peregrinus	(3.2.3)	Migrant hawk
		Falco rufigularis	(3.2.3)	Bat hawk
		Falco sparverius	(2.3.1) (3.1.1.2.1)	Rapine
		Herpetotheres cachinnans	(3.1.1.2.1)	Laughter sparrow hawk
		Ibycter americanus	(3.2.3) (2.3.1) (3.1.1.2.1)	Cocoa
		Milvago chimachima	(2.3.1) (1.1.2)	Caracara chimachima
Galliformes	Cracidae	*Crax alberti*	(3.1.1.2.1)	Paujíl
		Ortalis columbiana	(3.1.1.2.1)	Guacharaca
		Penelope cf purpurascens	(3.1.1.2.1) (3.2.3)	Turkey
	Odontophoridae	*Colinus cristatus*	(3.1.1.2.1)	Partridge
		Odontophorus erythrops	(3.1.1.2.1)	Corcovado frentirojo
Passeriformes	Cardinalidae	*Piranga rubra*	(1.1.2)	Piranga roja
	Corvidae	*Cyanocorax affinis*	(3.2.3) (2.3.1)	Carriquí pechiblanco
	Cotingidae	*Lipaugus unirufus*	(3.1.1.2.1)	Forest ranger
		Querula purpurata	(3.1.1.2.1) (3.2.3)	Cotinga
	Dendrocolaptidae	*Dendrocincla fuliginosa*	(3.2.3) (3.1.1.2.1)	Trunk climber
		Dendrocincla tyrannina	(3.1.1.2.1)	Trunk climber
		Dendrocolaptes picumnus	(3.1.1.2.1)	Trunk climber
		Glyphorynchus spirurus	(3.1.1.2.1) (1.1.2) (3.2.3)	Trunk climber
		Sittasomus griseicapillus	(3.1.1.2.1)	Trunk climber
		Xiphorhynchus picus	(3.1.1.2.1)	Trunk climber
		Xiphorhynchus susurrans	(3.1.1.2.1)	Trunk climber
	Fringillidae	*Euphonia laniirostris*	(3.2.3)	Eufonia
	Furnariidae	*Clibanornis rubiginosus*	(3.1.1.2.1)	Ticotico
	Hirundinidae	*Hirundo rustica*	(2.3.1)	Common swallow
		Petrochelidon pyrrhonota	(3.1.1.2.1)	Cliff swallow
		Progne tapera	(2.3.1) (3.2.3)	swallow
		Pygochelidon cyanoleuca	(2.3.1)	Cliff swallow
		Riparia riparia	(3.2.3)	Cliff swallow
		Stelgidoptryx ruficollis	(3.2.3) (2.3.1) (1.1.2) (3.1.1.2.1)	Cliff swallow
	Icteridae	*Icterus auricapillus*	(1.1.2)	Turpial coroniamarillo
		Icterus chrysater	(1.1.2)	Turpial
		Icterus galbula	(2.2.2.3)	
		Icterus mesomelas	(3.2.3) (2.2.1)	Turpial coliamarillo
		Leistes militaris	(2.3.1) (1.1.2)	Soldadito
		Molothrus bonariensis	(3.1.1.2.1)	Tordito
		Psarocolius decumanus	(3.1.1.2.1) (3.2.3)	Oropéndola
		Quiscalus mexicanus	(1.1.2)	María Mulata
	Mimidae	*Mimus gilvus*	(1.1.2) (2.3.1) (3.1.1.2.1)	Sinsonte

ORDER	FAMILY	*SPECIES*	COVER	VERNACULAR NAME
	Onychorhynchidae	*Myiobius atricaudus*	(3.1.1.2.1) (3.2.3)	Moscareta colinegra
	Pipridae	*Ceratopipra erythrocephala*	(3.1.1.2.1) (3.2.3)	Manaquín cabecidorado
		Lepidothrix coronata	(3.1.1.2.1)	Saltarin coroniazul
		Manacus manacus	(3.1.1.2.1) (1.1.2) (3.2.3)	Saltarin barbiblanco
	Pipromorphidae	*Leptopogon superciliaris*	(3.1.1.2.1)	Orejero
		Lophotriccus pileatus	(3.1.1.2.1) (3.2.3)	Cimerillo
		Mionectes oleagineus	(3.1.1.2.1) (1.1.2) (3.2.3) (2.2.1)	Mosquerito ocráceo
		Oncostoma olivaceum	(2.3.1) (3.1.1.2.1) (1.1.2) (3.2.3)	Mosquerito piquicurvo
		Todirostrum cinereum	(1.1.2)	Titirijí
	Polioptilidae	*Microbates cinereiventris*	(3.1.1.2.1)	Solterillo
		Polioptila schistaceigula	(3.1.1.2.1)	Perlita pizarrosa
	Thamnophilidae	*Cercomacra nigricans*	(3.2.3)	Hormiguerito
		Epinecrophylla fulviventris	(3.1.1.2.1)	Small anteater
		Formicivora grisea	(3.2.3) (3.1.1.2.1)	Cucaracherito pechiblanco
		Gymnopithys bicolor	(3.1.1.2.1) (3.2.3)	Cucaracherito
		Hylophylax naevioides	(3.1.1.2.1)	Anteater moteado
		Microrhopias quixensis	(3.1.1.2.1)	Small anteater
		Poliocrania exsul	(3.2.3)	Small anteater
		Sipia palliata	(3.1.1.2.1)	Magdalena's anteater
		Thamnophilus punctatus	(3.1.1.2.1)	Batará
	Thraupidae	*Chlorophanes spiza*	(3.2.3)	Mielerito
		Coereba flaveola	(3.2.3)	Platanero
		Dacnis cayana	(3.2.3)	Dacnis azul
		Eucometis penicillata	(3.1.1.2.1)	Tangara cabecigris
		Hemithraupis flavicollis	(3.1.1.2.1)	Tángara gorjigualda
		Heterospingus xanthopygius	(3.1.1.2.1)	Tángara cejiroja
		Melanospiza bicolor	(2.3.1) (3.1.1.2.1) (3.2.3)	Semillero bicolor
		Ramphocelus carbo	(2.3.1) (3.2.3)	Tángara pico e' plata
		Ramphocelus dimidiatus	(2.3.1) (1.1.2) (3.2.3) (2.2.2.3)	Toche piquiplateado
		Ramphocelus flammigerus icteronotus	(3.1.1.2.1) (3.2.3)	Sangre de toro lomo de fuego
		Saltator striatipectus	(3.2.3)	Pepitero
		Sicalis flaveola	(2.2.2.3) (1.1.2)	Svannah canary
		Sporophila crassirostris	(2.3.1) (3.2.3)	Semillero
		Sporophila minuta	(2.3.1)	Semillero pechirufo
		Sporophila schistacea	(3.1.1.2.1)	Semillero
		Tachyphonus luctuosus	(3.1.1.2.1) (2.2.2.3)	Tangara luctuosa
		Tachyphonus rufus	(2.3.1)	Tángara negra
		Tangara vitriolina	(3.2.3)	Tangara rastrojera
		Tangara xanthocephala	(3.2.3)	Tángara
		Tersina viridis	(3.2.3) (3.1.1.2.1)	Tangara
		Thraupis episcopus	(2.3.1) (1.1.2) VS	Azulejito
		Thraupis palmarum	(3.2.3) (1.1.2) (2.3.1)	Tángara palmera
		Tiaris obscurus	(2.3.1)	Semillero oscuro
		Tiaris olivaceus	(3.1.1.2.1)	Semillerito
		Volatinia jacarina	(3.2.3) (2.3.1) (1.1.2)	Semillero volatinero

ORDER	FAMILY	*SPECIES*	COVER	VERNACULAR NAME
	Tityridae	*Pachyramphus cinnamomeus*	(1.1.2) (3.2.3)	Cabezón canelo
		Schiffornis turdina	(3.1.1.2.1)	Llorón
		Tityra semifasciata	(1.1.2)	Titira enmascarado
	Troglodytidae	*Campylorhynchus griseus*	(1.1.2) (2.3.1) (3.2.3)	Chupahuevos
		Troglodytes aedon	(1.1.2)	Cucaracherito
	Turdidae	*Catharus ustulatus*	(3.1.1.2.1)	Zorzalito
		Turdis ignobilis	(1.1.2)	Mirla, Zorzal
	Tyrannidae	*Aphanotriccus audax*	(3.2.3)	Mosquero piquinegro
		Contopus cinereus	(3.1.1.2.1)	Pibi
		Contopus sordidulus	(3.1.1.2.1)	Pibi occidental
		Elaenia flavogaster	(2.3.1) (3.1.1.2.1) (1.1.2) (3.2.3)	Copetona
		Machetornis rixosa	(1.1.2)	Picabuey
		Myiarchus tuberculifer	(3.1.1.2.1) (3.2.3)	Copeton
		Myiodynastes maculatus	(1.1.2)	
		Myiozetetes cayanensis	(2.3.1) (1.1.2) (3.2.3)	Bichofué
		Myiozetetes similis	(1.1.2) (3.2.3) (2.2.2.3)	Bichofué
		Pitangus lictor	(2.3.1)	Bichofué pequeño
		Pitangus sulphuratus	(2.3.1) (1.1.2) (3.2.3)	Bichofué
		Terenotriccus erythrurus	(3.1.1.2.1)	Mosquerito colirojo
		Tyrannus melancholicus	(3.2.3) (1.1.2) (2.3.1) (2.2.2.3)	Sirirí
		Tyrannus savana	(1.1.2) (3.2.3) (3.1.1.2.1)	Tijereto
		Tyrannus tyrannus	(3.2.3)	Tirano occidental
	Vireonidae	*Vireo olivaceus*	(3.2.3)	Vireo ojirojo
Pelecaniformes	Ardeidae	*Agamia agami*	(1.1.2) (3.1.1.2.1)	Heron
		Ardea alba	(1.1.2)	Real heron
		Bubulcus ibis	(1.1.2)	Garzita del ganado
		Butorides striata	(3.1.1.2.1)	Martin pescador
		Pilherodius pileatus	(3.1.1.2.1)	Garza crestada
		Tigrisoma fasciatum	(2.3.1)	Avetigre
		Tigrisoma lineatum	(1.1.2)	Avetigre
Piciformes	Bucconidae	*Malacoptila mystacalis*	(3.1.1.2.1)	Bobo bigotudo
		Monasa morphoeus	(3.1.1.2.1) (3.2.3) (2.2.1)	Monjita
	Bucconidae	*Nystalus radiatus*	(3.1.1.2.1)	Bobo barrado
	Picidae	*Campephilus melanoleucos*	(2.3.1) (3.1.1.2.1) (3.2.3)	Real woodpecker
		Capito maculicoronatus	(3.1.1.2.1)	Cabezon
		Celeus loricatus	(3.1.1.2.1) (3.2.3)	Carpintero canelo
		Colaptes punctigula	(2.3.1) (3.2.3) (2.2.2.3)	Woodpecker
		Colaptes rubiginosus	(3.2.3) (1.1.2) (2.3.1)	Woodpecker
		Dryocopus lineatus	(1.1.2)	Woodpecker
		Melanerpes formicivorus	(3.1.1.2.1)	Woodpecker
		Melanerpes rubricapillus	(2.3.1) (3.2.3)	Red Crown Woodpecker
	Ramphastidae	*Pteroglossus torquatus*	(2.3.1) (3.1.1.2.1) (3.2.3) (1.1.2)	Toucan
		Ramphastos citrolaemus	(2.3.1) (3.1.1.2.1) (3.2.3)	Diostedé
		Ramphastos swainsonii	(3.1.1.2.1) (3.2.3)	Diostedé
Psittaciformes	Psittacidae	*Amazona amazonica*	(3.2.3)	Parrot
		Amazona autumnalis	(2.3.1)	Parrot
		Amazona ochrocephala	(3.2.3) (3.1.1.2.1)	Real parrot

ORDER	FAMILY	*SPECIES*	COVER	VERNACULAR NAME
		Ara ararauna	(3.1.1.2.1)	Macaw
		Ara chloropterus	(3.1.1.2.1)	Greenwing parrow
		Brotogeris jugularis	(3.2.3) (3.1.1.2.1)	Small parakeet
		Forpus conspicillatus	(2.3.1) (2.2.1)	Small parakeet
		Pionus menstruus	(2.3.1) (3.1.1.2.1) (3.2.3)	Cheja
		Pyrilia pyrilia	(3.1.1.2.1)	Lorito cabecidorado
Strigiformes	Strigidae	*Bubo virginianus*	(3.1.1.2.1)	Owl
		Pulsatrix perspicillata	(3.2.3)	Owl with glasses
Tinamiformes	Tinamidae	*Tinamus major*	(3.1.1.2.1)	Gallineta
Trogoniformes	Trogonidae	*Trogon chionurus*	(3.1.1.2.1) (3.2.3)	Trogon coliblanco
		Trogon melanurus	(3.1.1.2.1)	Trogon colinegro

Source: Merceditas Corporation, 2012.

The 186-registered species correspond to 42 families and 16 bird orders (See Illustration 4.2-126) This is equivalent to 9.8% of the Colombian avifauna (Clements et al 2015) and 47% of the avifauna recorded in the entire altitudinal range of the San Lucas range (Salaman et al 2001, Salaman et al 2002). This richness of bird species is high, taking into account that the sampled area corresponds to 0.0003% of the Colombian mainland.

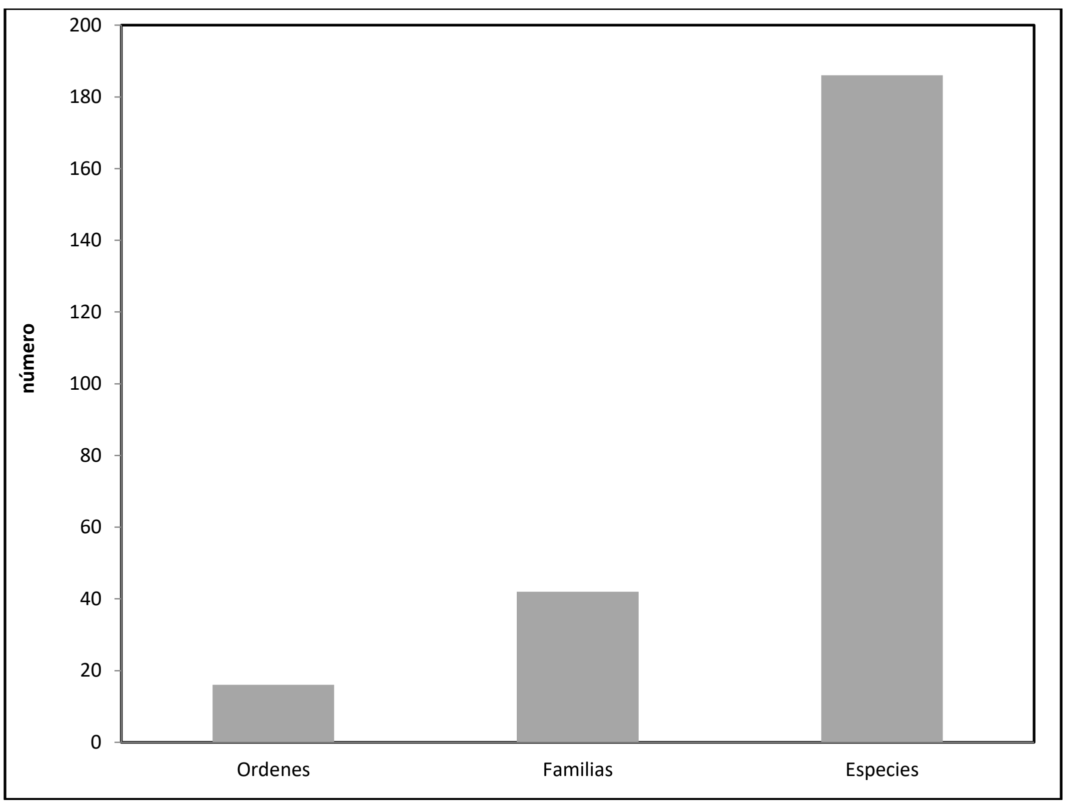

Illustration 4.24.2-127. Taxonomic composition of avifauna within the studied area.
Source: INGEX, 2016.

At a taxonomic level, the richness of bird species behaves heterogeneously and is concentrated in a few orders and families. This variable is presented in orders, families and plant covers.

4.2.4.3.3 Wealth of orders by families and species

The order with the greatest number of families (20 families = 48%) and species (88 species = 51%) registered, corresponds to the most diverse of the planet (60% of the birds, 56 families with more than 5000 species) (Machado & Peña, 2000) (See Illustration 4.2-127 and Illustration 4.2-128) this plays a fundamental ecological role, because they fulfill important functions within natural systems, considered fundamental components in the dynamics and conservation of them (Kattan et al 1996).

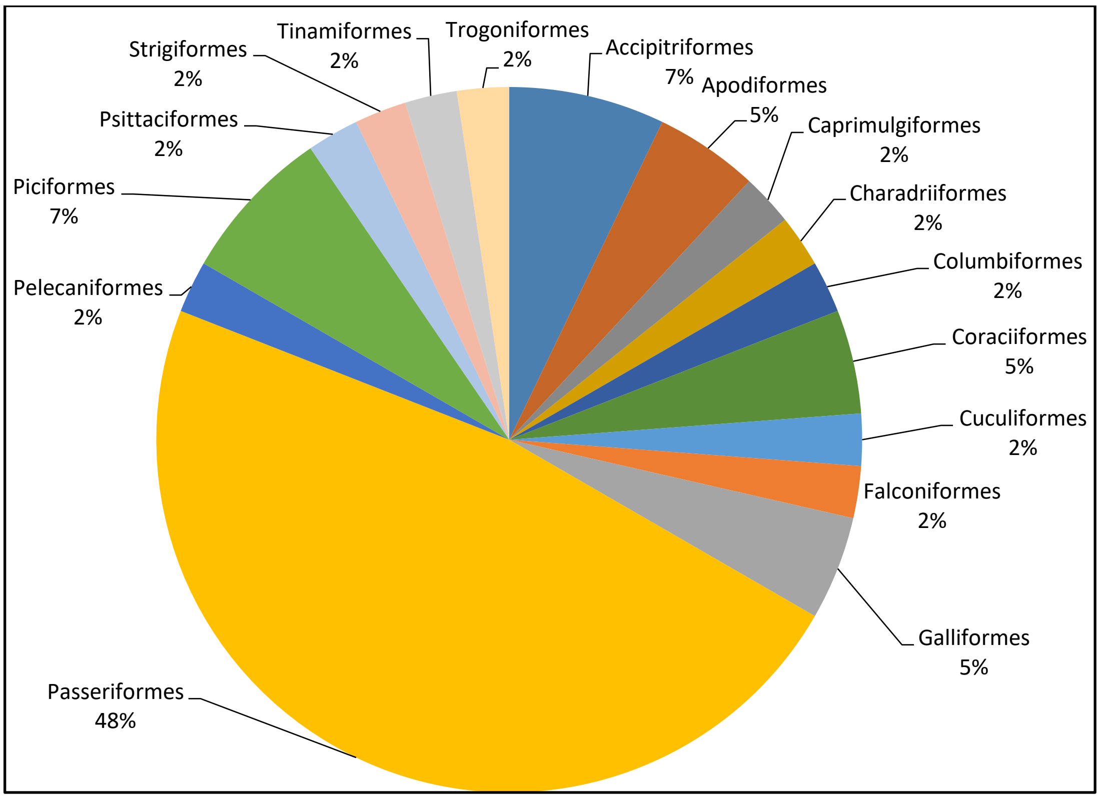

Illustration 4.24.2-128. Orders of birds with greater wealth of families.

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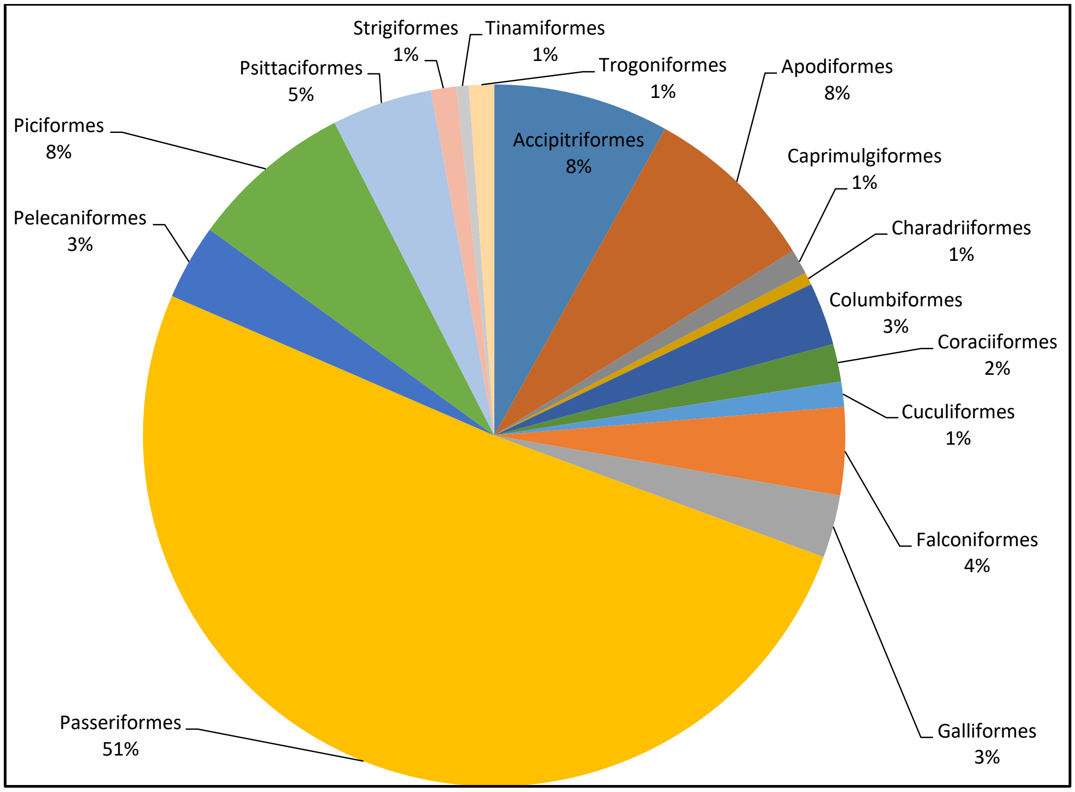

Illustration 4.24.2-129. Orders of birds with the greatest wealth of species.
Source: INGEX, 2016.

4.2.4.3.4 Wealth of families by species

The richest families in the study are Thraupidae with 25 species and Tyrannidae with 13 species. It should be mentioned that these families concentrate the greatest diversity of birds in the Neotropics (See Illustration 4.2-129).

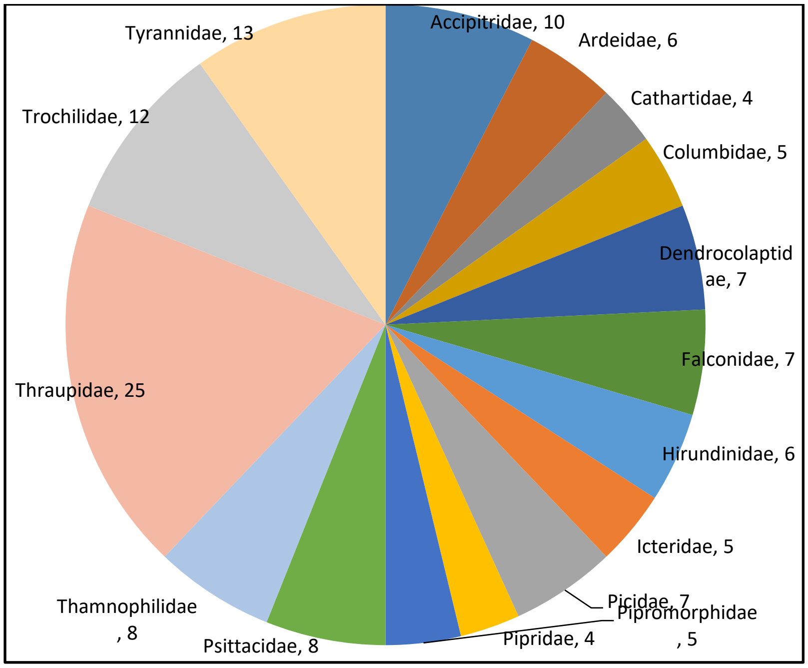

Illustration 4.24.2-130. Number of species for the more representative families of birds.
Source: INGEX, 2016.

The Thraupidae family groups the Neotropical tanagers, the group of birds with the highest radiation in the continent, becoming an important component of the Neotropical fauna (Burns et al 2014) with 386 species (Clements et al 2015), being exceeded in diversity only by the Tyrannidae family with 418 species (Clements et al 2015).

While the Tyrannidae family groups around 420 species, distributed in 104 genera, so that their ecological spectrum has equivalents in almost all neo tropical terrestrial ecosystems (Hilty & Brown, 1986). In general, they are diurnal insectivores and are sighted in pairs or as solitary territorial individuals. In general terms, these species are easily registered in open spaces, such as pastures and crops where they carry out active foraging activities (Sarria, 2011).

Therefore, it is atypical that the Thraupidae family has been more diverse than the Tyrannidae family. Unlike the tyranids, the variety of niches exploited by species within the Thraupidae family is noteworthy, given that they have representatives with a variety of diets, behaviors and ecological requirements (Burns et al 2014); therefore, within the area it may be attributable to a condition of heterogeneity and diversity of available offers.

Within this characterization also Accipitrridae families with 10 species, Falconidae with 7 species were highlighted (See Illustration 4.2-130), Trochilidae with 12 species, Picidae with 7 species and Psittaciformes with 8 species, that although they were not the most diverse, fulfill extremely important roles in diverse ecosystems.

Illustration 4.2-131. *Falco sparverius* Linnaeus, 1758 (Falconidae).
Source: Merceditas Corporation, 2012.

The number of species recorded for the Accipitridae and Falconidae raptors is consistent, given that Colombia is one of the most diverse raptor countries in the world with 76 species, as well as being one of the migratory raptors' concentration points (Márquez et al. 2005). It is important to mention that some species are very sensitive to the destruction and fragmentation of their habitat, mainly the jungle species. Their ecological requirements make this group of birds considered an excellent biological indicator, since their absence can mean big changes in the places where they usually live, that is why they are used to evaluate and monitor conservation efforts in different environments or ecosystems (Burnham et al 1989). The diversity of the family Trochilidae (Hummingbirds) in the area although it was not high in comparison to other families, can be associated as has been recently documented to succession processes (Navarro Alberto et al 2015), a late product of deforestation.

The richness and abundance of birds of the order Piciformes is positively correlated with the density, height and extent of the wooded areas; variables that are integrating forests (Tobalske &, 1999, Mikusinski et al 2001, Drever & Martin, 2010). Therefore, its presence and diversity in the area can be attributed to good extensions of forest cover.

Finally, it is important to highlight the biodiversity in the studied area of Psittaciformes birds (Parrots, macaws and parakeets), so that it will focus later on and in the course of the mining project in question, various monitoring and monitoring efforts; since, unfortunately, parrots have become one of the orders of birds with the highest number of endangered species during the last decades, since 29% of the species of parrots that are distributed in the world are seriously threatened of global extinction, while another 11% is considered highly vulnerable (Forshaw, 2010). The presence of these species in different ecosystems is also substantial, especially where coverings with some degree of vegetation abound, since their frugivorous diet allows them to become excellent dispersers (Aguilar, 2001, Abraham de Noir et al 2002, Flórez, 2006).

4.2.4.3.5 Wealth by plant cover

In general terms, the diversity at different taxonomic levels behaved in a similar way in all the vegetal coverings sampled. The covers with the greatest wealth of orders, families and species were those with some degree of vegetation development, such as the low dense forest of the mainland (3.1.1.2.1) and secondary or transition vegetation (3.2.3.2) (See Illustration 4.2-131). Between these two covers, there were no significant differences in abundance, number of families and orders (X2 = 2.1824, p = 0.13). However, significant differences were found in abundance and wealth of families and orders, between these two covers and the Cg, Dut and C covers (X2 = 240.7709, p = <0.001).

While the coverings with greater anthropic influence, clean grasslands (2.3.1) and discontinuous urban traffic (1.1.2), presented low diversities in all taxonomic categories respectively in comparison to the aforementioned covers. There is a clear and direct relationship between avifauna diversity and other biological groups and the conservation of Neotropical forest fragments (Turner, 1996, Brooks et al 1999, Tews et al 2004).

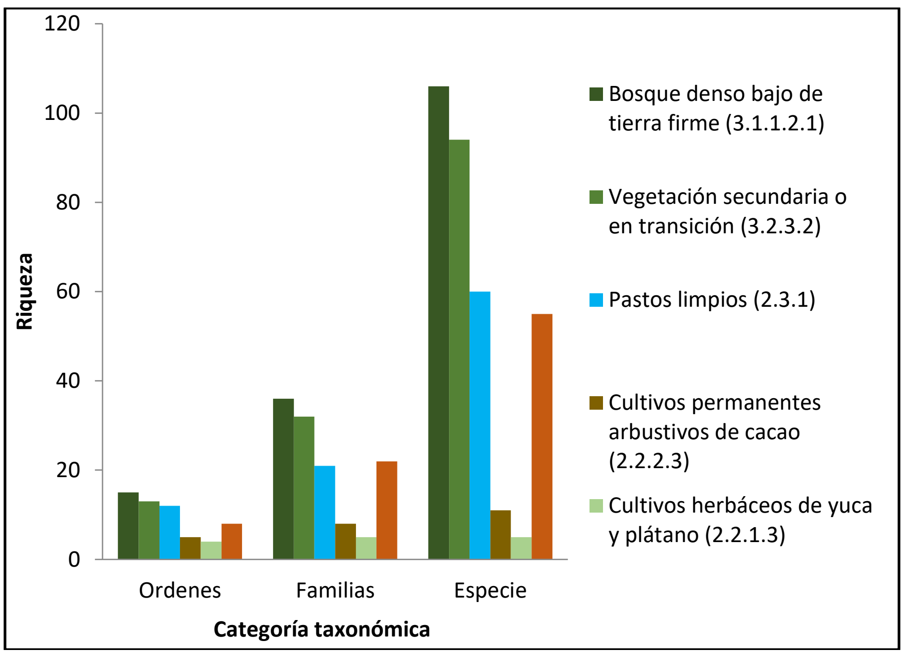

Illustration 4.2-132. Taxonomic composition by plant cover.
Source: INGEX, 2016.

However, these coverings, in spite of suffering the permanent anthropic pressure, registered quantities of significant species (See Illustration 4.2-132). Phenomenon attributable to different and complex ecological processes and adaptation, and methodological factors, given that the detectability of birds increases in open areas. It should also be mentioned that flight capacity and adaptability have allowed some bird species not to restrict their habitat to native ecosystems such as primary forests or clean bodies of water (Londoño-Betancourth, 2013).

The diversity of species in the cover of cocoa (2.2.2.3), cassava and plantain (2.2.1.3) crops on time is much lower compared to the other sampled covers (See Illustration 4.2-131), this can be adjudicated to structural factors of such coverages than to some specific ecological parameter; since the total area of these coverages are insignificant in comparison with the others.

4.2.4.3.6 Abundance

In the Illustration 4.2-132 it is summarized the abundances of the most representative families, corresponding to the most diverse.

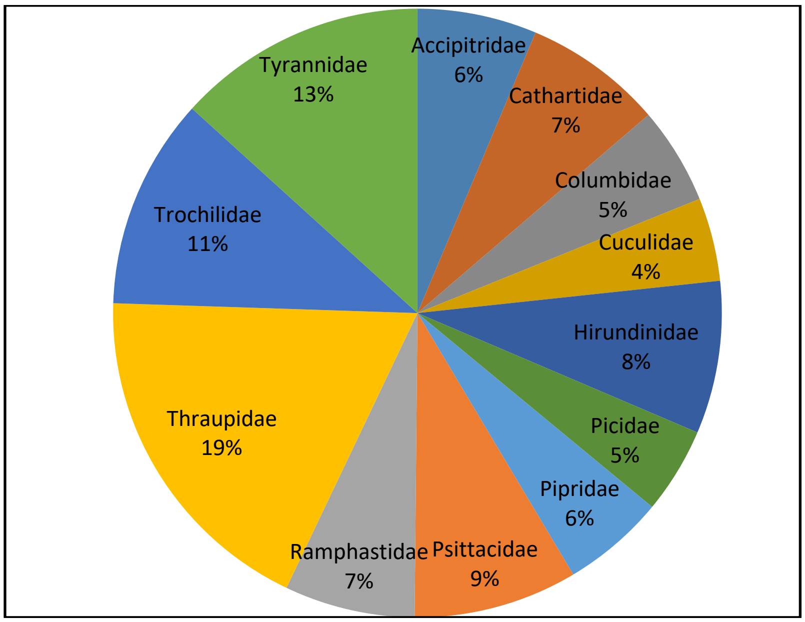

Illustration 4.2-133. Abundance of the most representative families.
Source: INGEX, 2016.

The Thraupidae family presented the highest representation of abundance (19%) (See Illustration 4.2-132 and Illustration 4.2-133). Species with specific as well as generalist habits were registered; the last recorded in more than two (2) plant covers, presumably thanks to their wide range of tolerance to anthropically disturbed environments.

Illustration 4.2-134. *Sicalis flaveola* (Linnaeus, 1766) (Passeriformes: Thraupidae).
Source: Merceditas Corporation, 2012.

The Thraupidae family has a set of attributes that can favor the diversity and abundance of the group in different ecosystems and habitats (Carrascal et al 2008); particularly in the neotropical region this family can be considered as endemic, where this group of birds experienced a huge evolutionary radiation occupying numerous niches (Burns et al 2014). The traps are ecologically diverse and found from northern Mexico to southern South America, in altitudes that vary from sea level to high mountain Andean ecosystems. The Thraupidae family has representatives in 20 of the 22 zoological regions and in 27 of the 29 terrestrial habitats of the neotropics (Parker et al 1996), therefore their abundance in the sampling area (See Illustration 4.2-132), combined with its diversity (Table 4.2-56), it is feasibly the result of an equivalent diversity and abundance of habitats.

The Tyrannidae family was the second most abundant (13%) (See Illustration 4.2-132). The tyranids have undergone an enormous morphological and ecological diversification in South America (Ohlson et al 2008) and their ecological requirements are well known for most of their species, especially those belonging to the most conspicuous and tolerant genera, such as *Tyrannus, Myiarchus, Pitangus, Myiozetetes* (See Illustration 4.2-134). In general terms, tyranids exploit environments with high diversity and abundance of arthropods, which are presumably abundant in different natural systems (Naranjo & Chacón de Ulloa, 1997).

Illustration 4.2-135. *Myiozetetes similis* (Von Spix, 1825) (Passeriformes:Tyrannidae).
Source: Merceditas Corporation, 2012.

Next, is presented the abundance of families and species by plant cover.

4.2.4.3.7 Abundances of families by plant cover

The coverings that obtained the greatest abundances of families were those in which the least diversities were presented, such as the cultivation of cocoa (2.2.2.3) cultivation of cassava and plantain (2.2.1.3) respectively (See Illustration 4.2-135). In these covers very few species were recorded as mentioned, because they are minimum extensions of land compared to other vegetation cover.

The families Thraupidae and Tyrannidae, which were the most diverse and abundant in the sampling, presented representative abundances together and could be considered as dominant in the cover of greater vegetal development such as forests (3.1.1.2.1) and coverings with secondary vegetation (3.2 .3.2). Taking into account again the enormous ecological, morphological and behavioral diversity of the species belonging to the families Thraupidae and Tyrannidae (Ohlson et al 2008, Burns et al 2014), it is presumable that diversity and abundance is related to an equivalent wealth and abundance of ecological niches in the forests, which despite suffering like most rural landscapes, an enormous anthropic pressure historically by processes mainly of colonization, still maintains a biodiversity of substantial natural forest, even when the soil has suffered a variety of uses (Petit et al 1995).

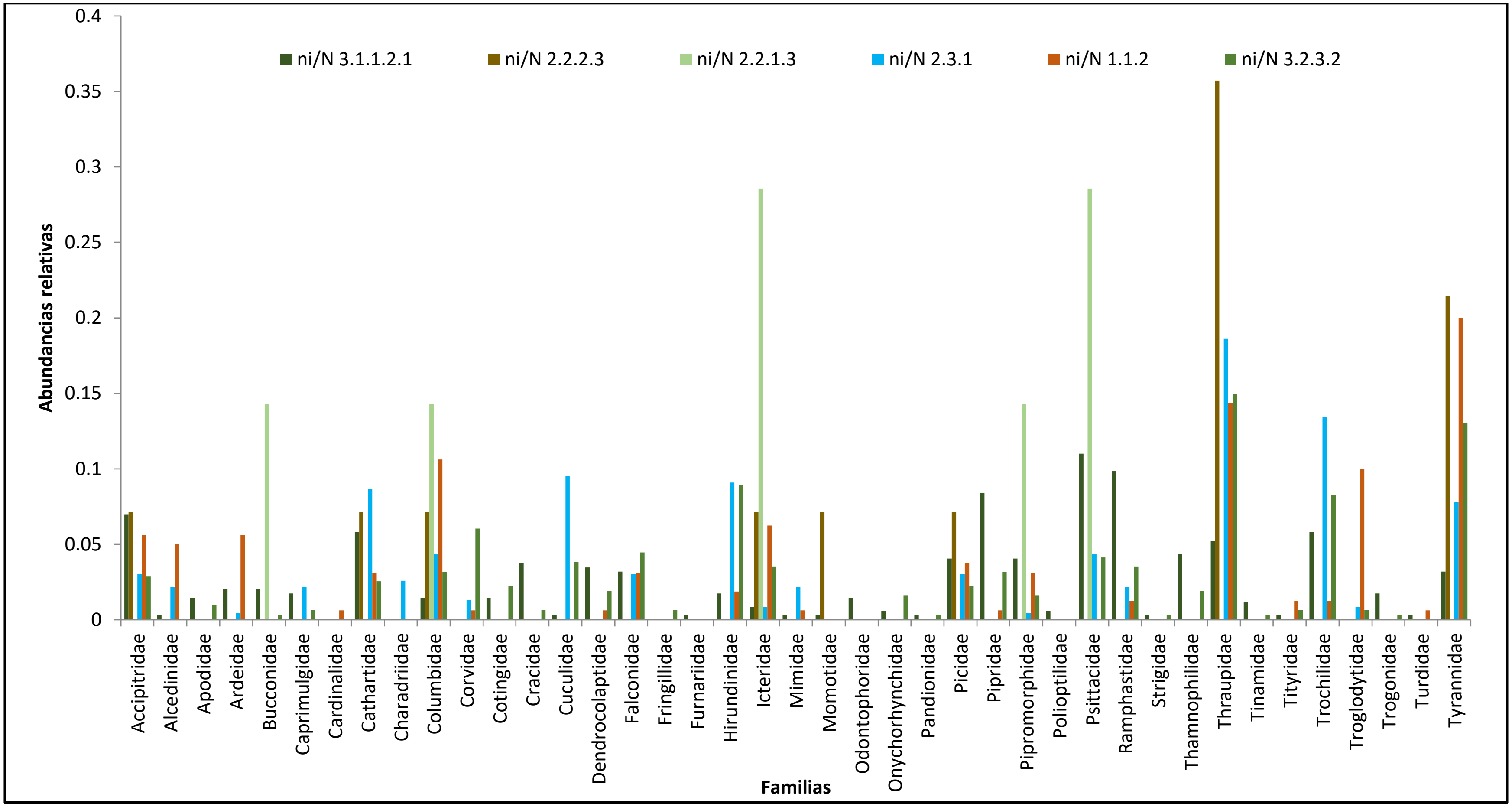

Illustration 4.2-136. Abundance of bird families for each plant.
Source: INGEX, 2016

4.2.4.3.8 Abundance of species by plant cover

At a specific level, the abundance was a little more homogeneous than in other taxonomic levels; since there were no species that were clearly dominant or abundant; 12 common species were found (Relative abundance between 2 and 10%, and the remaining 150 rare species (Relative abundance between 0.1 and 2%) (see Illustration 4.2-133)

In general, the most representative species in the zone were of generalist habits, without specific requirements of area, dispersion, intraspecific and habitat relationships. It should be mentioned that in the studied area, the processes of fragmentation of natural environments have been profound, because the extensions of open and degraded areas available for generalist bird species are considerable.

In general terms, the most abundant bird species were recorded in two or more vegetation coverings within the studied area (See Illustration 4.2-136), being differentially more abundant in habitats with particular conditions, which can be proof of the avifaunistic dominance and biotic homogeneity in these covers (Illustration 4.2-136).

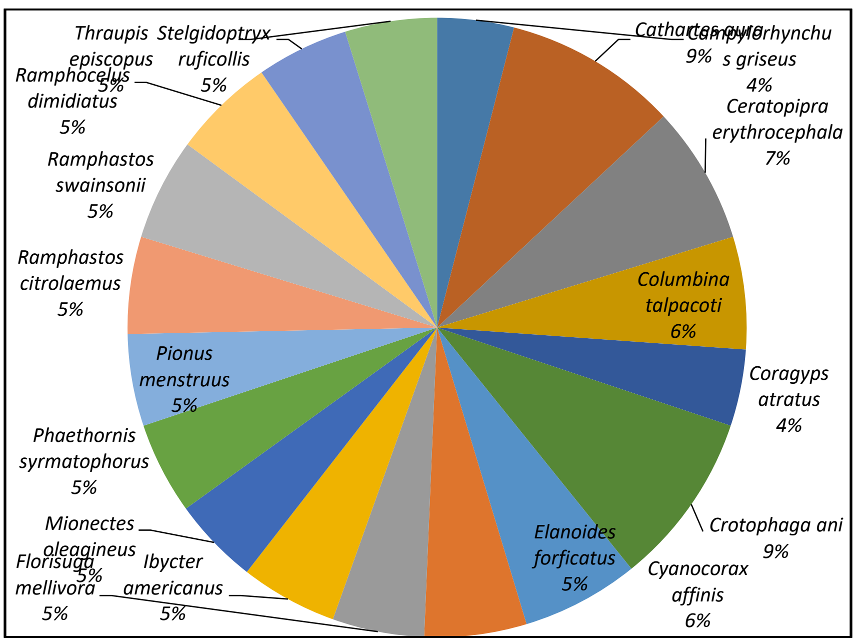

Illustration 4.2-137.Species of birds more representative.
Source: INGEX, 2016.

The covers with greater dominance of species in particular were those corresponding to cocoa crops (2.2.2.3) cassava and plantain crops (2.2.1.3) (See Illustration 4.2-138); being the latter, the one with the highest relative abundance, specifically of the species Mionectes oleagineus (Lichstenstein, 1823) (See Illustration 4.2-137); who is commonly registered in different covers with some degree of tree development, due to its high frugivorous and seasonal insectivore rate (Snow &, 1979, Greeney et al 2006).

Illustration 4.2-138. *Mionectes oleagineus* (Lichstenstein, 1823) (Passeriformes: Pipromorphidae).
Source: Merceditas Corporation, 2012.

In cocoa crops, the highest relative abundances were presented by species with a high degree of tolerance to disturbed environments, as well as being easily detected in the field, such as Cathartes aura Linnaeus, 1758, Ramphocelus dimidiatus Lafresnaye, 1837 and Tyrannus melancholicus (Vieillot, 1819) (See illustration 4.2-138).

On the other hand, in the forested coverings, it was where the greatest wealth of bird species was presented (See Illustration 4.2- 131). The most representative species for this cover was the pipid *Ceratopipra erythrocephala* (Linnaeus, 1758) (See Illustration 4.2-132) Generally a solitary species, but that in breeding season groups of males are registered displaying their courtship behavior (Peña & Quirama, 2004). It was registered in coverings with some degree of vegetation development, such as the case of dense lowland forest (3.1.1.2.1) and secondary or transition vegetation (3.2.3.2); although this species has been registered previously in this type of cover (Hilty & Brown, 1986).

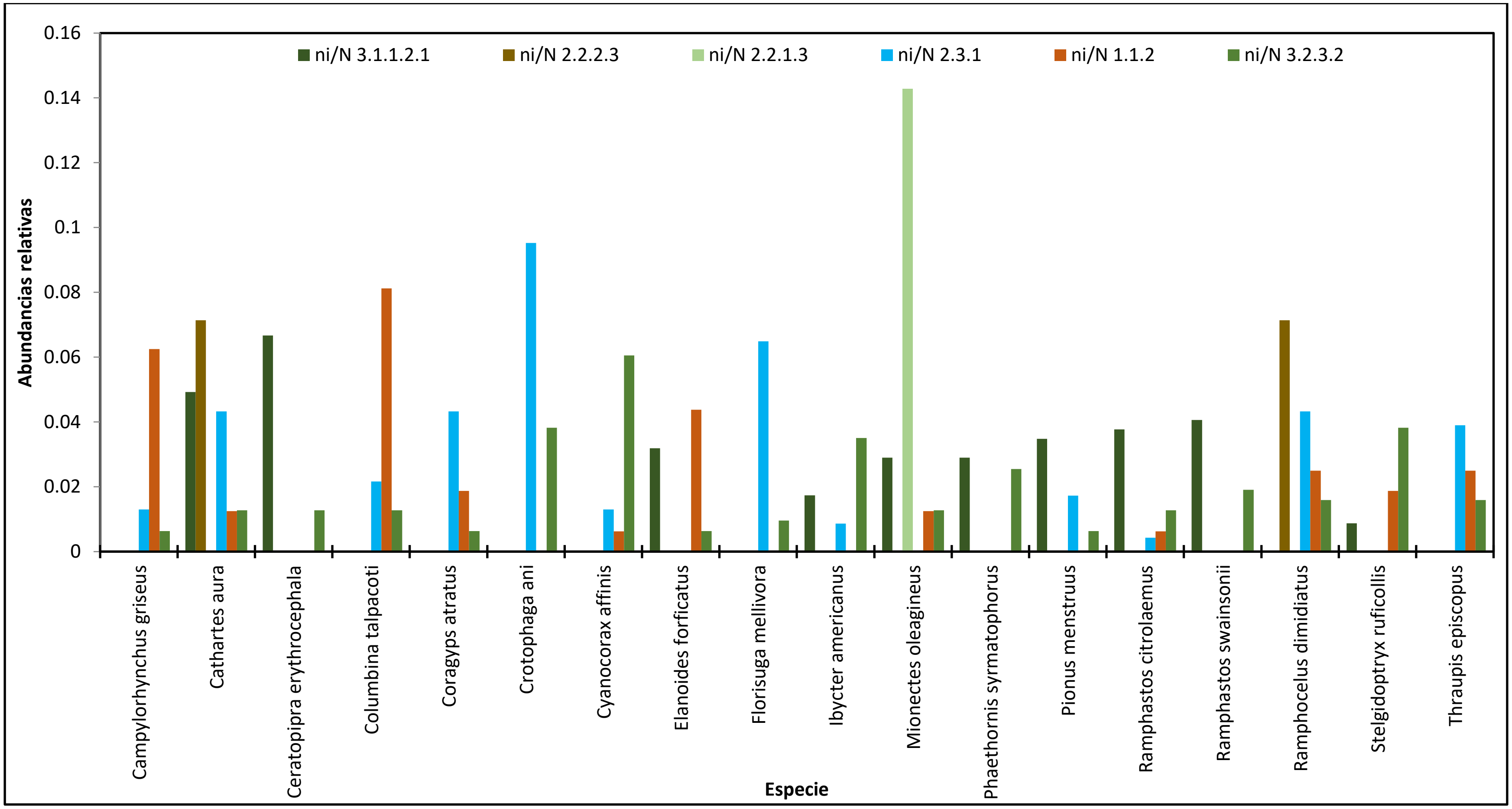

Illustration 4.24.2-139. Species of birds more abundant for each plant cover.

Source: INGEX, 2016.

Illustration 4.2-140. *Ceratopipra erytrocephala* (Linnaeus, 1758) (Passeriformes: Pipridae).
Source: Merceditas Corporation, 2012.

It is worth mentioning the representativeness of toucan species in the forest cover, mainly of the species *Ramphastos swainsonii* Gould, 1833 (See Illustration 4.2.140) and *Ramphastos citrolaemus* (Gould, 1844); that have been reported as highly abundant in forested coverings (Hilty & Brown, 1986) and in different strata within such covers, mainly due to their wide ranges of movement (Pereira & Barrantes, 2009); phenomenon that during the sampling period was evident, mainly with foraging records of *Ramphastos swainsonii* Gould, 1833 (See Illustration 140) in medium and high forest strata.

The most representative species mentioned above were recorded in different strata of forest, being *C. erythrocephala* (Linnaeus, 1758) (See Illustration 139) registered mainly in the undergrowth, while species like *R. swainsonii* Gould, 1833 (See Illustration 4.2-140) in higher strata. These results are indirect proof of the greater offer of niches for bird species within the cover with greater plant development at different levels of stratification.

For the vegetal cover that presented the second diversity in the zone: secondary vegetation or in transition (3.2.3.2) the most dominant and representative species was the migratory Tyrannus tyrannus (Linnaeus, 1758) (See Illustration 4.2-141) and precisely its abundance in such cover is due to its migratory status, since this species is registered in large migrant groups in open forests and open areas with trees (Hilty & Brown, 1986; Naranjo et al. 2012).

Illustration 4.24.2-141. *Ramphastos swainsonii* Gould, 1833 (Piciformes: Ramphastidae).
Source: Merceditas Corporation, 2012.

Illustration 4.2-142. *Tyrannus tyrannus* (Linnaeus, 1758) (Passeriformes: Tyrannidae).
Source: Merceditas Corporation, 2012.

In the cover of clean grasslands (2.3.1), the most representative species were gregarious species, as is the case of *Crotophaga ani* (Linnaeus, 1758) and species easily detectable and common in open and even urbanized areas such as *Cathartes aura* Linnaeus, 1758 and *Coragyps atratus* (Bechstein, 1793) (Hilty & Brown, 1986). It is worth mentioning the representativeness of the *Florisuga mellivora* hummingbird (Linnaeus, 1758), presumably due to the presence of shrubs with flowers in said covers.

It is important to highlight the diversity and abundance of several avifauna species within the transitional and open vegetation coverings (3.2.3.2 and 2.3.1) sampled in the area, it is important to bear in mind that within these covers several authors have pointed out that the diversity of birds is greater in comparison to other more "closed" vegetative coverings (Hutto, 1989, Morales-Pérez, 2002), mainly due to the physiognomy of the same, so that the detectability of specimens is greater, due to patterns of displacement of species in particular (Ramos-Ordoñez, 2004) and the food supply, mainly of insects, which is higher (Rios-Muñoz, 2012).

Finally, and in general terms, the abundance model behaves in the typical way, where a few species are dominant with high abundances, while the rest of the species are represented by few individuals (Pla, 2006; Koleff & Soberon, 2008).

4.2.4.3.9 Indices of diversity

Next the diversity indices alpha and beta are presented

Alpha diversity α

In the illustration -142 it is presented the general alpha diversity values for each plant cover sampled in the area.

The alpha diversity (α), is the intrinsic diversity of a community, this implies indices of wealth, abundance and dominance (Moreno, 2001) (See Table 4.2-57) in this case of a bird community.

Table 4.24.2-58. Alpha diversity indices (α) for the plant covers.

INDEX	DENSE FOREST UNDER MAINLAND3.1.1.2.1)	SECONDARY VEGETATION OR IN TRANSITION (3.2.3.2)	CLEAN GRASSLANDS (2.3.1)	COCOA CROPS (2.2.2.3)	CASSAVA AND PLANTAIN CROPS (2.2.1.3)	DISCONTINUOUS URBAN TRAFFIC (1.1.2)
Shannon H' Log base 10	1,838	1,789	1,634	1,017	0,673	1,603
Simpson D	0,018	0,021	0,028	0,033	0,095	0,027
Margaleff M	73,255	74,491	78,693	162,286	220,093	84,387

Source: INGEX, 2016.

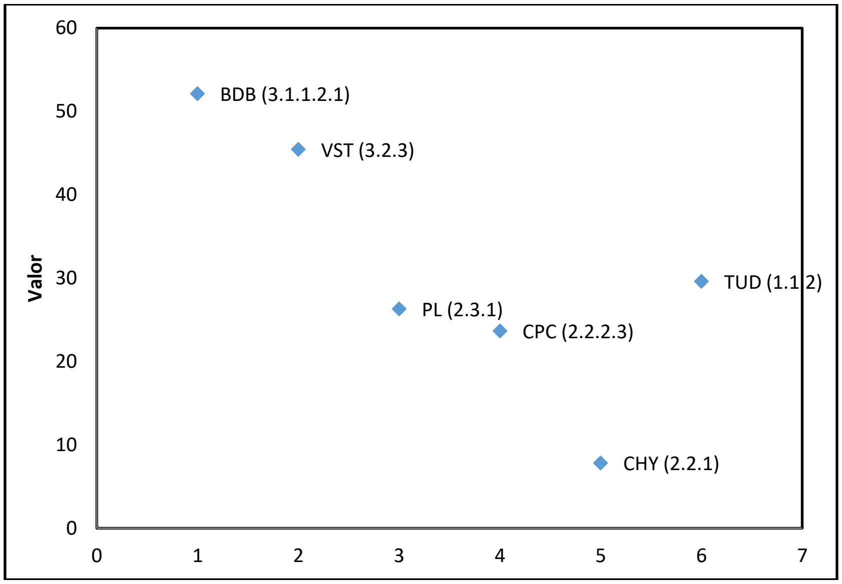

Illustration 4.24.2-143.Individuals registered per plant covers.
Source: INGEX, 2016.

Then, the indices of wealth, abundance and dominance of plant coverings are sustained.

Low dense forest of the mainland (3.1.1.2.1)

Based on the Shannon index (H 'Log base 10) H' = 1,837 for this cover, this is the highest value of the index (See Table- 57) compared to other covers indicating a slight development and stability of the avifaunistic community. This value is within the range of variation of this index (1.5 and 3.5) (Magurran, 1988), although for neotropical forests this index can reach values close to 5 (Pla, 2006; Encina-Dominguez et al 2007; Moralez-Salazar et al 2012); In this sense, the index obtained for this cover is a reflection of an intermediate diversity, in comparison to the diversity of birds present in other forest coverings in the neotropics (Pla, 2006). It should be noted that these forests have historically suffered anthropogenic pressures related to the colonization processes in the area, such as artisanal mining, extensive cattle ranching, logging, selective hunting, among others; factors that negatively influence the fauna diversity of forest remnants.

There are also the following factors and ecological parameters that allow the dense forest cover of the mainland (3.1.1.2.1) to be the most diverse:

- There are no marked dominances of species in particular, a factor that contributes to the higher diversity indices, unlike the other covers.

- They harbor an enormous diversity of biotic and abiotic factors that interact with each other and that allow the favorable establishment of diverse faunal populations (Guariguata & Kattan, 2002). The rapid transformation of the landscape by human activities has created patches of vegetation with different degrees of modification (Arellano & Halffter, 2003) and forest remnants consist mainly of isolated and scattered fragments (Estrada et al 2000). Forest fragmentation can indirectly affect the intensity and quality of biological interactions, processes such as pollination and seed dispersal can be affected (Bustamente & Grez, 1995). All these assumptions cause that the biotic diversity behaves in a special way in said remnants.

Within forest cover species were presumably registered with a high degree of specificity, given that they were only registered within these coverings. Some of these species were: *Crax Alberti* Fraser, 1852, endemic species and in critical danger of extinction (See Illustration 4.2-143), *Lipaugus unirufus* Sclater, 1859, *Trogon chionurus* Sclater & Salvin, 1871, *Trogon melanurus* Swainson, 1838, among others (See Table 4.2-56).

Illustration 4.2-144. *Crax alberti* Fraser, 1852 (Galliformes: Cracidae).
Source: Merceditas Corporation, 2012.

In relation to dominance, this cover obtained an index close to zero (See Table 4.2-57) result of a high diversity and therefore of the absence of dominant species, indicating diversity of niches within the coverage.

The Margaleff index shows the relationship between species diversity and the number of individuals, or in other terms may reflect the avifaunal richness of the area. It can also be understood as a reflection of bird communities with good ecological conditions that allow the establishment of complex ecological interactions within a particular habitat. In the case of this coverage, a low index was presented indicating high diversity.

Vegetation secondary or in transition (3.2.3)

The diversity indices obtained in this cover were very similar to the forest cover (See Table 4.2-57), becoming the second most diverse covering in the area; interesting result within an area that has suffered some type of alteration or disturbance, but as has been reported in some cases, habitat modifications, fragmentation and the creation of secondary environments, cause a high diversity of birds, due to the use of the resources found in the places that have been modified, finding that these habitats are dominated by generalist species that are tolerant to this type of environment (Waburton, 1997, Rioz-Muñoz, 2012).

Clean grasslands

The diversity of birds obtained in this cover can be considered as intermediate in comparison with the other covers (See Table 4.2-57). The pastures of livestock use with some degree of succession are characterized by being poor in the ecological requirements for certain species, the diversity of birds in these areas generally corresponds to generalist species.

The considerable diversity of birds in the vegetation cover of clean grasslands (2.3.1) is noteworthy, bearing in mind that the great extensions of pastures in the Andean region are the main cause of diversity loss at present (Rangel, 2010), due to, among other things, that they interrupt the genetic flow of populations of birds that do not make large displacements or local migrations, in contrast to species that perform longer periods of flight.

Discontinuous urban traffic (1.1.2)

Low and high diversity indexes of dominance are presented, in comparison to the coverings with some vegetation development (See Table 4.2-57); reflect of a lower species richness and diversity.

In this cover, natural spaces are mixed, mainly with clean grasslands, where the vegetal physiognomy of both is basically the same. In terms of diversity, there are no marked differences, given that the avifauna community behaves similarly to the coverage of clean grasslands.

Cocoa (2.2.2.3) cassava and plantain crops (2.2.1.3)

In contrast, the least diverse covers or with the lowest values of the Shannon index were those corresponding to the crops of cocoa (2.2.2.3), cassava and plantain (2.2.1.3) (See Table -57); result attributable to the effort of differential sampling in these covers, because its size, is significantly lower compared to the other covers.

In terms of dominance, based on Simpson's diversity index, there are two clear contrasts for the vegetation cover sampled; On the one hand, plantain and cassava crops (2.2.1.3) obtained a dominance index close to one (See Table -57), indicating the presence of a few dominant species within the coverage, which is also indicative of a significant low diversity. While the cocoa coverage (2.2.2.3) shows low dominance.

Beta diversity

Beta diversity (β) or diversity among habitats is the degree of species replacement or biotic change through environmental gradients (Whittaker, 1972). Unlike the alpha and gamma diversities that can be easily measured according to the number of species, the measurement of beta diversity is a different dimension because it is based on proportions or differences (Magurran, 1988).

Equity J'

All sampled plant covers were proportionally equitable, that is, the majority of registered bird species were represented by the same number of individuals (See Table -58), although there were clear exceptions for the case of the most dominant species observed.

Table 4.2-59. Equity J' for the plant covers sampled.

	DOWN FOREST OF THE MAINLAND (3.1.1.2.1)	VEGETATION SECONDARY OR IN TRANSITION (3.2.3.2)	CLEAN GRASSLANDS (2.3.1)	COCOA CROPS (2.2.2.3)	CASSAVA AND PLANTAIN CROPS (2.2.1.3)	DISCONTINUOUS URBAN TRAFFIC (1.1.2)
Equity J'	0,907	0,906	0,919	0,977	0,963	0,921

Source: INGEX, 2016.

Cluster analysis (Bray-Curtis)

The most similar vegetation coverings were those corresponding to secondary and transition vegetation (3.2.3.2) and clean pastures (2.3.1); covers that in turn and together, maintain a high degree of similarity with the forest cover (3.1.1.2.1), although in the last the number of species shared with the other covers is not so high (see Illustration 4.2-144). The aforementioned covers form a well-defined group in terms of avifauna composition and richness; for which it is presumable that they maintain the avifaunistic diversity of the area, in front of a presumable modification of the landscape. On the other hand, the most dissimilar coverings were those equivalent to crops (2.2.2.3., 2.2.1.3) (See Illustration 4.2-144), due to the fact that during the sampling, within these covers a remarkably low richness was registered in comparison to the other covers sampled, so that the number of bird species shared with other coverings was minimal. It is difficult to attribute this phenomenon to ecological characteristics within the crops, taking into account that these coverings have a smaller area.

Finally, despite the fact that there is a group of covers in the area that are the most similar among themselves, as mentioned before, this similarity is not greater than 50% (see table 4.2-59 and Illustration 4.2-144), this is evidence of a remarkable specificity of certain bird species for particular plant coverings.

Additionally, in a Principal Coordinates Analysis, is also evident the similarity between them in a two-dimensional space (See Illustration 4.2-144).

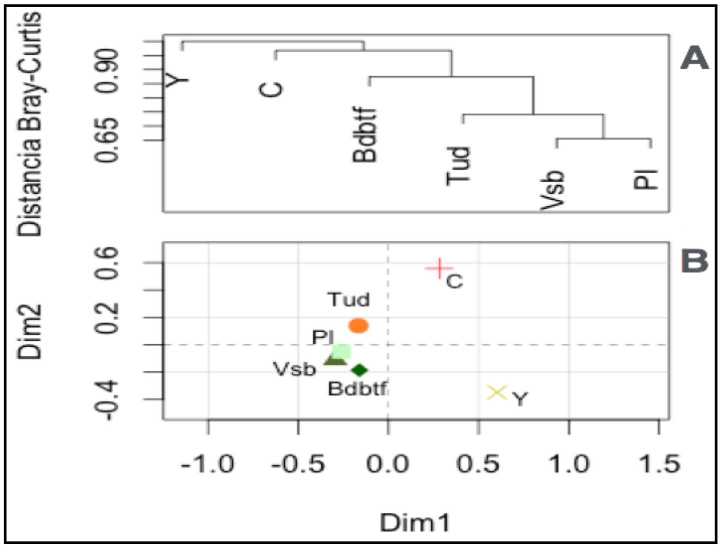

Illustration 4.2 4.2-145. Analysis of the beta diversity of birds among plant covers, based on a Bray-Curtis cluster analysis dendrogram (A) and a principal coordinate analysis (B).

Source: INGEX, 2016.

Table 4.2-60. Percentage of similarity (Jaccard) by plant covers.

COVER	BDB (3.1.1.2.1)	VST (3.2.3.2)	PL (2.3.1)	CC (2.2.2.3)	CHY (2.2.1.3)	TUD (1.1.2)
BDB (3.1.1.2.1)	*	33,1691	13,4831	2,3324	1,7804	12,2271
VST (3.2.3.2)	*	*	34,3685	5,4795	3,4965	25,5528
PL (2.3.1)	*	*	*	3,6866	2,8436	28,3133
CPC (2.2.2.3)	*	*	*	*	0	11,3475
CHY (2.2.1.3)	*	*	*	*	*	2,963
TUD (1.1.2)	*	*	*	*	*	*

Source: INGEX, 2016.

4.2.4.3.10 Trophic guilds

Trophic guilds are groups of species that use the same resource in a similar way (Root, 1967). Such guilds are one of the most significant ecological aspects to be taken into account in the study of any biological system. For example, we could determine how the composition of species or the distribution of different populations according to the availability of food varies.

Particularly, the birds have been a widely studied group, which makes possible to group them in different trophic guilds according to their type of foraging and their anatomical characteristics (peaks, legs, wings, size, etc.) in a feasible manner. These guilds are mainly: carnivorous, frugivorous, insectivorous, nectarivorous, scavenger, omnivorous and granivorous.

The trophic guilds in which birds are usually grouped, usually vary in the range of specificity of a behavior; that is, within insectivores can be found active foraging insectivores, as is the case of the swallows of the Hirundinidae family, and insectivores of passive foraging. In turn, active foraging species can be found in soil forages, such as some species of the genus *Turdus* (Turdidae) and aerial fodder, as is the case with most species of the Tyrannidae family (Reales et al 2009).

Due to the trophic plasticity of many bird species and that many of them exploit more than one food resource, for this study the birds were functionally classified within the trophic guild in which the major part of their diet was based, that is, if a species feeds on 80% of seeds and 20% of insects, this will be considered as granivorous for practical terms. For cases in which the diet of one species comprised several food items approximately in the same proportions, it was considered omnivore.

Below the main trophic guilds are presented.

Main trophic guilds

The bird species registered were grouped by percentage in 7 general trophic guilds, these are: omnivores, carnivores, scavengers, frugivorous, granivorous, insectivorous and nectarivorous (See Illustration -145).

The most representative trophic guild was the insectivore with 42% representativeness, being significantly higher than the species located within the other trophic guilds (X^2=119,8415; p < 0,001), followed by the frugivorous with 18%, omnivore with 10% and in smaller proportions the nectarivorous, granivorous and carnivorous with 8% respectively, and scavengers with 6% (See Illustration -145).

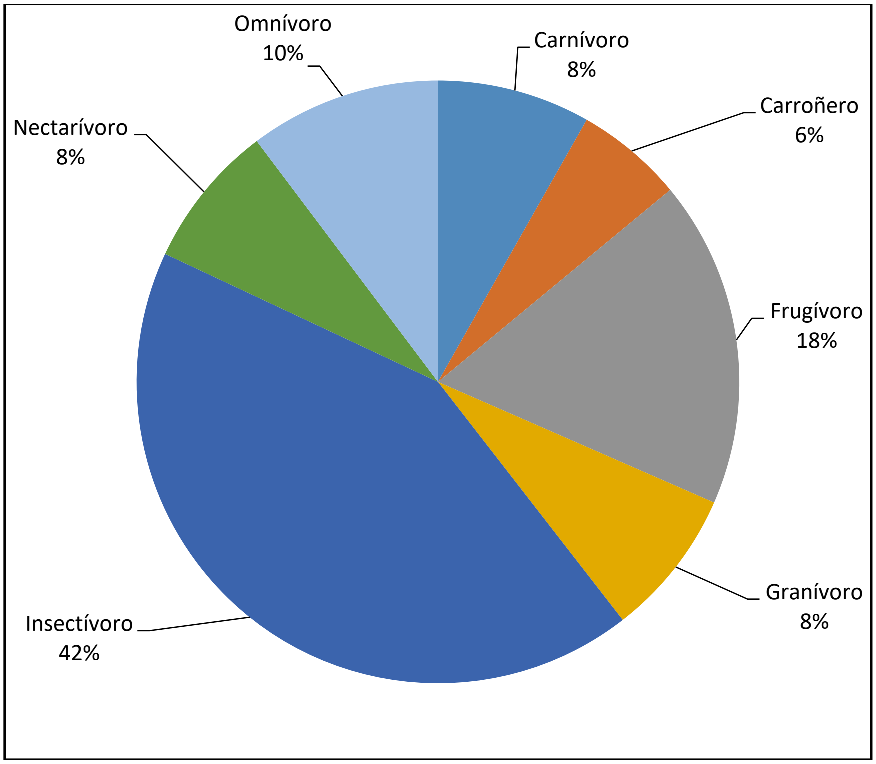

Illustration 4.24.2-146. Percentage of representativeness for each trophic.
Source: INGEX, 2016.

The high representativeness of insectivorous birds is attributable to the high availability of food, because insects are the most diverse and diverse group on the planet and are found in virtually all ecosystems (Grimaldi & Engels, 2005), being one of the main food items of many organisms. Additionally, one of the most representative families of birds was Tyrannidae; which constitute approximately one third of the bird communities in many habitats and together with the furnarids are the major predators of small and medium-sized arthropods (Fitzpatrick et al 2004).

The high representation of frugivorous birds in the area is also noteworthy, given that they play a preponderant role within the natural systems they inhabit, where they act as one of the main seed dispersers. It has been estimated that a large percentage of tree and shrub species in tropical forests are dispersed by birds; being frugivory a fundamental mechanism for ecological sustainability of these types of ecosystems (Guariguata & Kattan, 2002).

The omnivore may reflect the high generalist characteristics of these species, because they exploit a large amount of food resources.

Nectarivorous and granivorous birds are strongly regulated by the availability of food (Grant et al 2001) and can become opportunistic depending on the availability of the same (Pérez & Bulla, 2000).

Carnivorous birds and scavengers, were the least representative (See Illustration 4.2-145), these are fundamental in maintaining the balance or equilibrium of the ecosystem being at the end of multiple food networks, since they regulate the populations of their prey avoiding overpopulation, dissemination and famine (Méndez et al 2006) and are considered as indicators of the state of conservation of the ecosystems to which they belong.

Trophic distribution per plant cover

In the illustration -146 the representativeness of the different trophic guilds is shown inside each sawn vegetation cover.

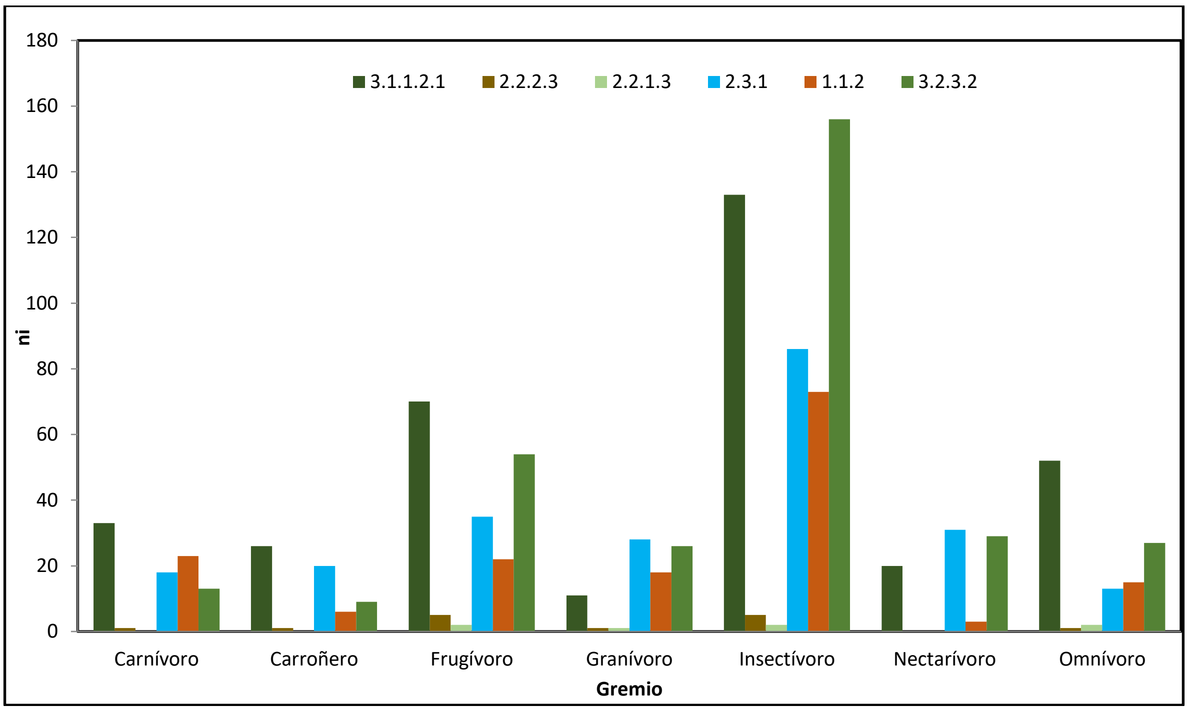

Illustration 4.24.2-147. Trophic distribution per plant cover sampled.
Source: INGEX, 2016.

The insectivores were the most abundant trophic guild in all the sampled plant covers compared to other trophic groups (See Illustration 4.2-146). It is worth mentioning that the greatest abundance of insectivorous birds occurred in the cover with some degree of plant development (3.1.1.2.1 and 3.2.3.2), reflecting a differential availability of the food resource; this is consistent taking into account that the greater diversity and richness of arthropods, mainly of insects for the neotropics, is mainly found in forested areas compared to other more disturbed areas (Grimaldi & Engels, 2005). Particularly the majority of the insectivorous birds of the tropical forests, are firmly rooted to the altitudinal zones in which they are found, rarely seen more than three hundred meters above or below them; an evidence of the specificity of these species for some type of habitat.

Within forest cover, the second most representative trophic guild was formed by frugivorous birds, which fulfill the role of dispersers. Succession, regeneration and establishment of new species depend on their effectiveness (Guariguata & Kattan, 2002).

In general terms in forest covers (3.1.1.2.1), the most representative of all the trophic guilds was presented, except for the nectarivores that were more representative in the coverage of clean grasslands (2.3.1), presumably due to the presence of generalist species.

In this order of ideas, the maintenance of forest covers in good condition, can eventually guarantee the functionality and maintenance of the different trophic interactions within them.

Dentro de las coberturas boscosas el segundo gremio trófico más representativo fue el formado por las aves frugívoras, que cumplen con el papel como dispersoras, de su efectividad dependen procesos de sucesión, regeneración y establecimiento de nuevas especies (Guariguata & Kattan, 2002).

En términos generales en las coberturas boscosas (3.1.1.2.1), se presentó la mayor representatividad de todos los gremios tróficos, exceptuando a los nectarívoros que fueron más representativos en la cobertura de pastos limpios (2.3.1), presumiblemente debido a la presencia de especies generalistas.

4.2.4.3.11 Conservation status and endemic species.

A total of 5 cataloged species were registered with some degree of threat (See Table 60); one (1) of them is in critical threat of extinction according to the IUCN and the resolution 092 of 2014 of the MADS, additionally three (3) species in almost threatened state (NT) according to the IUCN and one (1) in state of vulnerability (VU).

Table 4.24.2-61. Species of birds registered with some degree of threat.

ORDER	FAMILY	SPECIES	NATIONAL CATEGORY	IUCN	CITES
Galliformes	Cracidae	*Crax alberti*	CR	CR	Apéndice III
Passeriformes	Thamnophilidae	*Sipia palliata*		NT	
Pelecaniformes	Ardeidae	*Agamia agami*		VU	
Psittaciformes	Psittacidae	*Pyrilia pyrilia*		NT	
Tinamiformes	Tinamidae	*Tinamus major*		NT	

Source: INGEX, 2016.

Crax alberti Fraser Crax alberti Fraser, 1852 (See Illustration 4.2-143), is the species with the highest risk of extinction registered in the area, cataloged in the CR state by the IUCN (del Hoyo et al. 2014) and by Resolution 092 of 2014 of the Ministry of Environment and is found in Appendix III of CITES. Additionally, this species is endemic to northern Colombia, it is known from the lowlands and the foothills of the middle valley of the Magdalena river from Honda to the San Lucas mountain range (Renjifo et al 2002). This species is rare and local throughout its range of distribution, although it can be recorded with some regularity during the reproductive season in slightly altered continuous forests (Renjifo et al 2002). Its population has been rapidly declining in recent years, for the nineties its population was estimated between 1000 and 2500 individuals (Renjifo et al 2002), currently there is data of some populations within some small protected areas of about 250 to 1000 individuals (BirdLife International, 2013). This species is not tolerant to small disturbances of its habitat; The accelerated loss of forest cover has led to the accelerated reduction of their populations. It has been estimated that the loss of *Crax alberti* curassow habitat, due to deforestation, extensive cattle ranching, illicit crop cultivation and illegal mining is around 2.1-7% annually, for a total loss of 88% of its habitat. On the other hand, the intense hunting suffered by this species is another of the greatest extinction threats it suffers; Their hunting occurs mostly during the reproductive season at the end of December, because individuals are easily located due to the male vocalizations.

Currently, although there are no specific conservation measures for this species, it can be found within some reserve areas nationwide. In 2004, it is worth mentioning the protection of around 848 ha of forest in the Magdalena Valley, Serranía de las Quinchas for the protection of some populations of this species (IUCN, 2015). Additionally, *Crax alberti* is present in the lower part of the Paramillo National Natural Park, which only protects its upper altitudinal limit of distribution, where this species is rarely sighted, so the effectiveness of its conservation is still doubtful. Although this species is presumably found in other protected areas, it is essential and urgent to determine the current status of its populations and their distribution, particularly in the San Jacinto, San Lucas and Las Quinchas mountain ranges, in order to increase and declare new protected areas for this species. It is also urgent to implement forceful conservation measures within the existing protected areas and carry out educational campaigns.

In the studied area this species was previously chased for hunting by some inhabitants of the area, although during conversations with some of them, they claimed that the hunt for this species had not taken place again.

Other species that faces the greatest threat of extinction in the area is the Pelecaniforme *Agamia agami* (Gmelin, 1789) (See -147), cataloged internationally according to the IUCN in state vulnerable to extinction (VU) (del Hoyo et al 2014).

Illustration 4.24.2-148. *Agamia agami* (Gmelin, 1789) (Pelecaniformes: Ardeidae).
Source: Merceditas Corporation, 2012.

This species is generally difficult to observe in the places it inhabits. Its distribution area extends from Mexico to northern Argentina (del Hoyo et al 2014). It is suspected that this species has lost around 18 - 26% of its distribution area and that around 30% have been lost for the next three generations (IUCN, 2015). It is found on the margins of streams and muddy lakes of tropical forests and seasonal marshes, where it feeds mainly on cichlid and characid fish (Hilty & Brown, 1986).

The greatest threats to this species globally is the deforestation of its main habitats, mainly in the Amazon basin through the expansion of the livestock border, soy plantations and the increase of the road network.

In an almost threatened state (NT) the species *Sipia palliata* Todd, 1917 (See Illustration 4.2-148), *Pyrillia pyrillia* (Bonaparte, 1853) (See -149) and *Tinamus major* (Gmelin, 1789) (See Illustration 4.2-150) are identified. These species, despite being in a state of minor threat, compared to the previous described species, it is necessary to implement conservation measures, to avoid losses and accelerated populations decline in the future within the area.

Illustration 4.2-149. *Sipia palliata* Todd, 1917 *sensu* Clements *et al* 2015 (Passeriformes: Thamnophilidae)
Source: Neotropical Birds Online, 2010.

Illustration 4.2-150. *Pyrillia pyrillia* (Bonaparte, 1853) (Psittaciformes: Psittacidae).
Source: Neotropical Birds Online, 2010.

Illustration 4.24.2-151. *Tinamus major* (Gmelin, 1789) (Tinamiformes: Tinamidae).
Source: Merceditas Corporation, 2012.

4.2.4.3.12 Species of migratory birds

Migration is one of the most characteristic phenomena of many species of birds, which perform spectacular seasonal trips through large latitudes to carry out their reproduction or simply to avoid winters in their places of origin.

Migration involves the persistent displacement of a population or of a group of individuals of the same species, it has a duration and scope far superior to those that normally have those movements that are made for the dispersion of juvenile individuals for the maintenance of a territory or during routine tours around a domestic environment. Migration is a direct movement, unlike the usual routes of an animal, which constantly change direction and even involve setbacks during the same sequence (Naranjo et al 2012).

There are different types of migration depending on the magnitude, distance and purpose of migration, not all migrations are made through the jurisdiction of several countries, there are many cases of migrations at the local level that cover large altitudinal ranges.

During the sampling period in the months of September, October and February; 25 species were recorded with some type of migration (See Table 4.2-61), where 3 are local migrants, 13 are non-reproductive wintering, 7 are permanent reproductive wintering and 2 are wintering Occasional reproductive (See Table 4.2-61).

Table 4.2-62. Species of birds registered with certain degree of migration.

TYPE OF MIGRATION	SPECIES
Local migratory	*Amazilia tzacatl* (de la Llave, 1833)
	Chorostilbon mellisugus (Linnaeus, 1758)
	Phaethornis guy (Lesson, 1833)
wintering non-breeding	*Accipiter striatus* Vieillot, 1818
	Buteo platypterus (Vieillot, 1823)
	Catharus ustulatus (Nuttal, 1840)
	Coccyzus americanus (Linnaeus, 1758)
	Contopus sordidulus Sclater PL, 1859
	Falco peregrinus Tunstall, 1771
	Hirundo rustica Linnaeus, 1758
	Icterus galbula (Linnaeus, 1758)
	Myiodynastes maculates (Statius Muller, 1776)
	Pandion haliaetus (Linnaeus, 1758)
	Petrochelidon pyrrhonota (Vieillot, 1817)
	Riparia riparia (Linnaeus, 1758)
	Tyrannus tyrannus (Linnaeus, 1758)
Wintering with permanent breeding populations	*Ardea alba* Linnaeus, 1758
	Bubulcus ibis (Linnaeus, 1766)
	Chordeiles acutipennis (Hermann, 1783)
	Piranga rubra (Linnaeus, 1758)
	Tyrannus melancholicus Vieillot, 1819
	Tyrannus savana Daudin, 1802
	Vireo olivaceus (Linnaeus, 1766)
Wintering with occasional breeding populations	*Cathartes aura* (Linnaeus, 1758)
	Elanoides forficatus (Linnaeus, 1758)

Source: INGEX, 2016

Below the local migratory species, wintering non-breeding, wintering with permanent breeding populations and wintering with occasional breeding populations are presented.

Local migratory

Local migratory species are those species of birds whose populations migrate or travel in a considerable altitudinal and latitudinal gradient, without trespassing the border limits of a given country (Naranjo et al 2012). During the field phase, a total of 4 species with this type of migration were recorded (See Table 4.2-61), all of them hummingbird species. It should be mentioned that the movements of these types of birds are generally modulated by the availability and seasonality of the food resource (Naranjo et al 2012).

Hummingbirds: Amazilia tzacatl (from the Key, 1833), Chlorostilbon mellisugus (Linnaeus, 1758), Phaethornis guy (Lesson, 1833)

These species, distributed in the majority of ecosystems present in Colombia (HIty & Brown, 1986), do not have precise records of their migration routes. Although it is documented that the species of Colombian hummingbirds present altitudinal movements; data based on the absence presence of some species and occasional records, in addition to the extrapolation of information from species present in the country for which migration data are available in other countries. (Naranjo et al 2012) In general terms it can be considered that these species have a type of intra-generational migration; that is, migratory displacement occurs within a single generation, with a cyclical and seasonal direction (Naranjo et al 2012).

Invertebrates with non-reproductive populations

These types of migrants are species of birds that migrate to more tropical lands, coming from the north or south of the American continent (Naranjo et al 2012).

It is important to mention that the majority of species with this type of migration were registered in coverings with some degree of vegetation development (See Illustration 4.2-151).

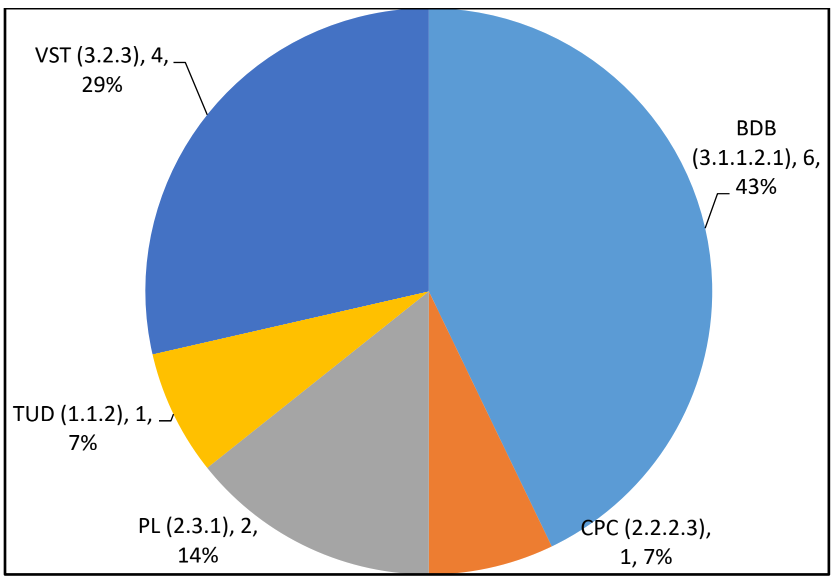

Illustration 4.24.2-152. Number of registers of non-reproductive migrants by plant cover.
Source: INGEX 2016.

This indicates the importance of these covers as transit sites and as eventual corridors within the main migratory routes. It should also be taken into account the registration of certain species of birds of prey with this type of migration during the sampling phase, which although are not very broad it can shed light on the importance of certain sites as migratory routes.

Next, data are collected (based on secondary information) on some relevant aspects of the species of birds with registered non-breeding wintering status (See table 4.2-61).

Accipiter striatus (Vieillot, 1807)

It is a species of accitipid that reproduces to the south of Canada and that inhabits in time of non-reproduction the south of the United States, until low California of the south and north of Mexico

(Rosenfield & Bielefeldt, 1993). For winter migration, this species flies fast and at low altitudes and although there are routes established for North America, its movements to the south are still not very clear. Apparently, this species takes the Central America route to Honduras and occasionally reaches the North of South America, mainly to Colombia (Naranjo et al 2012), making its registration within the interesting zone.

Within the chronology of their migration it is known that the movements of autumn begin at the end of September, extending until the end of November. It has been recorded that females precede males and that juveniles initiate their movements before adults, followed by juveniles of two years and then those older than two years (Duncan, 1981, Müller et al 2001). The movements towards the north for their reproduction start again between March and May, and this time the males precede the females and juveniles (Müller et al 2001).

Buteo platypterus (Vieillot, 1823)

This other non-reproductive migratory accipiter species recorded in the area is distributed in the reproductive season to the south of Canada and in almost all the United States. It is worth mentioning that there are several non-migrant sub-species and resident in some Caribbean islands, especially Cuba, Puerto Rico and Trinidad and Tobago (Raffaele et al 1998) daytime migration taking advantage of thermal springs. Almost all the population goes down through North America to southern Texas, from where it borders the Gulf of Mexico and Central America. After passing through Veracruz, they arrive at the Isthmus of Tehuantepec, where most of them continue on the Caribbean side to the Gulf of Fonseca between Honduras and El Salvador. There they continue on the Pacific side to the lowlands of northeastern Costa Rica, cross again for the Caribbean side and continue along the foothills of this slope to Panama, where they cross to the Pacific at the height of the Barú volcano, before entering the northwest of Colombia by the Darién. After passing through Colombia (the majority goes down the Central and Eastern mountain range before crossing to the southeast), it disperses from southeastern Colombia, northeastern Peru and western Brazil to the east of the Amazon, although they are wintering from Guatemala to Brazil. The return to the north follows more or less the same route although it is more dispersed and the large concentrations seen in the northern autumn are not noticed (Naranjo et al 2012). In Colombia it has been registered in around 24 departments from sea level to 3400 meters above sea level (Naranjo et al 2012), for our country it is a species with very general requirements.

Catharus ustulatus (Nuttal, 1840)

The boreal zorzalito (See Illustration -152) as it is known vernacularly, is distributed during the reproductive period in northwestern, central and southeastern Canada and the western and northwestern United States. During the winter, this species is recorded from southern Mexico to northwestern South America, including Panama, Colombia, Venezuela, Ecuador, eastern Peru, northern and eastern Bolivia and a small portion of Paraguay, Argentina and Brazil (Naranjo et al 2012).

Illustration 4.24.2-153. *Catharus ustulatus* (Nuttal, 1840) (Passeriformes: Turdidae).
Source: Merceditas Corporation, 2012.

The species has two (2) genetically and morphologically different populations with different migration routes (Ruegg & Smith, 2002). Coastal populations migrate along the Pacific coast through Central America and remain there during the winter (from Mexico and Costa Rica) (Ruegg & Smith 2002). The continental populations migrate from the east of North America, cross the Caribbean and use the Antilles as places of passage, until reaching South America; where they spend the winter from Panama to Bolivia (Ruegg & Smith 2002).

Starts its fall migration between August and the end of September. Spring migration can start at the beginning of March and extend until the beginning of April; the last dates of return to North America are presented at the beginning of June (Kaufman, 1996). In Colombia it is common from September and October, until March and April. This species is recorded up to 2,900 meters, generally in dry, tropical humid forests and montane forests, secondary vegetation, scrub and forest edges (Naranjo et al 2012).

Coccyzus americanus (Linnaeus, 1758)

This species is mainly distributed in the reproductive season throughout North America (Hilty & Brown, 1986) (See Illustration -153). It mainly lives in South America from the north to the south of Brazil and Argentina.

This species migrates from North America through Puerto Rico, where a small portion of the population is established and can be resident throughout the year (Kepler &, 1978). It also uses the Central American route, where they migrate through Costa Rica in mid-August, early November and late April-early June. In our country it can be seen from October to mid-April in environments generally with vegetation development such as transition areas, secondary and intervened forests.

Illustration 4.24.2-154. *Coccyzus americanus* (Linnaeus, 1758) (Cuculiformes: Cuculidae).
Source: Merceditas Corporation, 2012.

Contopus sordidulus Sclater, 1859

It is a species of tyranid (See Illustration 4.2-154) that reproduces mainly in Canada to the south Yukon, British Columbia and the south of central Manitoba, in the United States, in the center of Alaska. It generally moves from eastern Nebraska, the Colorado River valley, the Gulf of California, southwest of Louisiana and takes the southern route through western and central Mexico, through Central America. In Colombia it is distributed up to 2600 meters along the western zone. Atlantic Coast, including the northern zone of the Central and Eastern Cordillera (Hilty & Brown, 1986), where they can be registered from October to mid-April.

Illustration 4.24.2-155. *Contopus sordidulus* Sclater, 1859 (Passeriformes: Tyrannidae).
Source: Merceditas Corporation, 2012.

Falco peregrinus Tunstall, 1771

On the other hand, (Falconiformes: Falconidae) is one of the birds with the greatest distribution in the world, being considered as cosmopolitan. This species has several sub-species in each geographical region they occupy; in Colombia there are three sub-species: *F. p. tundrius* and *F. p. anatum* which are wintering non-reproductive and *F. p. Cassini*, which is wintering with permanent breeding populations.

The sub-species *tundrius* is concentrated on the coasts of North America. The populations of Greenland cross Canada and the United States to reach the Florida Keys, from there some follow the Antilles (Pendergrass, 2000) and others take the route to Central America (Chavez-Ramirez et al 1994). There is little information on *F. p cassini,* but it seems to migrate along the western flank of the Andes. *F. p anatum* falls along the west coast and central United States and Mexico (White et al 1994), from where it continues through Central America (Chávez-Ramirez et al 1994) to South America.

Hirundo rustica (Linnaeus, 1758)

Species of cosmopolitan distribution, reproduces in North America, Europe, Asia and North Africa. North American birds winter in South America, Aruba and Trinidad and Tobago (Hilty & Brown, 1986). On their migration routes they pass through the Caribbean and throughout Central

America. In Colombia it is registered throughout the national territory, up to 3,000 meters and mainly between August and May in mixed flocks in open areas and pastures (Naranjo et al 2012).

Icterus gálbula (Linnaeus, 1758)

It reproduces in the northeastern and central states of the United States and southwestern Canada (Naranjo et al 2012). winters in Florida (United States), higher and lower Antilles, all the countries of Central America, Colombia and the North and West of Venezuela.

Apparently, this species migrates through the interior to Florida, where it is wintering or continuing through the Greater Antilles to the northwestern part of the minor ones (National Geographic 2002) and also through the Pacific corridor, where it reaches the north, center and west of Colombia and to the north and west of Venezuela (Hilty 2003). In Colombia it is of Andean distribution, assenting large concentrations in the Cauca and Magdalena inter-Andean valleys (Naranjo et al 2012). It can be registered from the beginning of September to the middle of April.

Myoidynastes maculatus (Vieillot, 1819)

Breeding from eastern Mexico to central Argentina and southeast Brazil, passing through northern South America. The migratory populations of northern Central America winter in Panama and northern South America, while the southern migrant populations of southern Peru, southeast Brazil and central Argentina, winter east of the Andes to northern South America (Hilty & Brown, 1986). The austral migrants arrive in Colombia from May to July and remain until December in the east and center of the Andes (See Illustration -155).

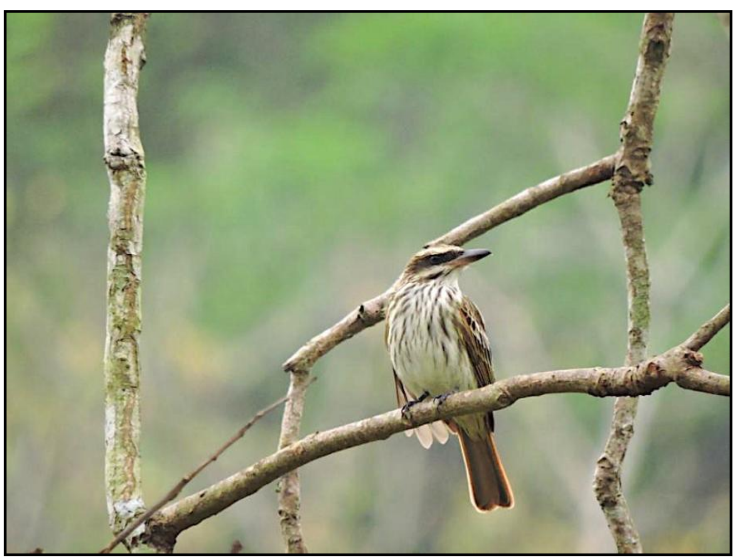

Illustration 4.24.2-156. *Myiodynastes maculatus* (Vieillot, 1819) (Passeriformes: Tyrannidae).
Source: Merceditas Corporation, 2012.

Pandion haliaetus (Linnaeus, 1758)

Breeds in temperate areas of the planet and the subspecies *carolinensis* is mainly in the area of the great lakes between Canada and the United States. In Central America and the Caribbean, it mainly inhabits the coasts of Mexico and Cuba (Howell & Web 1995, Raffaele et al 1998). It is important to note that some of the individuals that migrate for the first time to the neotropics, take a full year before returning to the breeding site (Poole et al 2002).

According to the breeding site, there are two major migratory routes, which are not exclusive. The eagles that inhabit the east coast, usually migrate to the south, following coastlines or staying close to the sea. Some descend through the Florida peninsula and cross to Cuba from where they continue south to the Guajira peninsula and subsequently take different routes into the interior of South America. However, most individuals follow a continental migration route, passing through Mexico and Central America before entering Colombia, where they take different migration routes (Naranjo et al 2002).

Petrochelidon pyrrhonota (Vieillot, 1817)

This species nests from western and central Alaska to Mexico, with the exception of northern Canada and the southeastern United States (Ridgely et al 2003). In northern South America it is widely distributed and during its journey to the south it passes through Colombia, Venezuela, Guyanas, Ecuador, northern Brazil, Peru and northern Chile.

This species migrates southward through Costa Rica at the end of August or between the beginning of September and the end of October. It is registered in Colombia mainly at the beginning of September and mid-October (Hilty & Brown, 1986).

Riparia riparia (Linnaeus, 1758)

In breeding season, it is distributed in the northern hemisphere and locally in tropical portions of the old world and in North America (Hilty & Brown, 1986); they winter in South America, mainly covering the entire continent. It is presumed that the majority of migrants follow the Central American route between North and South America. Migration has been observed mainly in coastal and lowland regions (Garrison, 1999).

Tyrannus tyrannus (linnaeus, 1758)

The migratory sirirí (See Illustration 4.2-141) as it is known, is reproduced throughout the eastern United States and southeastern Canada. The populations migrate completely to South America. The limits of its distribution are not well known, but individuals can be found from western Venezuela and northern Colombia, to northern Argentina and Paraguay.

This species mainly migrates through Mexico and Central America; Migration begins towards the end of July or the beginning of August and the bulk of the population migrates from mid-August to mid-September (Murphy, 1996). The beginning of the return to the breeding areas happens in the middle of March and April (Naranjo et al 2012). It should be mentioned that this species was one of the most representative (See illustration 4.2-138).

Wintering with permanent and occasional breeding populations

The species cataloged within this type of migration are species with some populations that perform intra generational migrations, that is to say in several generations (Naranjo et al 2012) and that therefore have reproductive populations in the places where they make these migrations. Generally, they are species of generalist habits and without defined migratory routes.

4.2.4.3.13 Banned species

For bird species registered in the studied area there are no National or regional closures. However, hunting and commercialization of wildlife is generally prohibited.

4.2.4.3.14 Species used by the community

None of the species of birds registered in the area of study is used by the community.

4.2.4.3.15 Species identified in the region according to secondary information.

For bird species registered in the region, a search was made for secondary information available for areas surrounding the area of biotic influence (ASAM 2011, Chaparro-Herrera et al 2013, Cuervo et al 2007, Cuervo et al 2008a, Cuervo et al. 2008b, Donegan & Salaman 2014, Lara 2012, Restrepo-Llano et al 2010, Salaman et al 2001, Salaman & Donegan 2009). The species listed below were included following direct and indirect distribution criteria; either because they have been registered in the area or in habitats with similar ecological and climatic characteristics, given that the species found here are species that can potentially be found in the area of biotic influence.

A total of 469 species of birds are recorded. The families Tyrannidae and Thraupidae have the largest number of records (44 and 43 species respectively), followed by the family Trochillidae (Hummingbirds) (32 species) (See Table 4.2-62).

Table 4.2-63. Species of birds registered in the region and surrounding geographical areas.

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
Accipitriformes	Accipitridae	*Accipiter bicolor*	Gavilan bicolor	Semi open zones	Magadalena river valley	
		Accipiter superciliosus	Gavilancito americano	Semi open zones	Territorial Zenufaná	
		Buteo albonotatus	Busardo aura	Semi open zones	Magadalena river valley	
		Buteo brachyurus	Busardo colicorto	Semi open zones	Magadalena river valley ena	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		Buteo nitidus	Busardo gris meridional	Semi open zones, secondary forest	El Bagre- EBAS Project	X
		Buteo platypterus	Busardo aliancho	Semi open zones, secondary forest	Territorial Zenufaná	X
		Buteo swainsoni	Busardo chapulinero	Semi open zones	Magdalena river valley	
		Buteogallus anthracinus	Busardo negro	Secondary forest	Territorial Zenufaná	
		Buteogallus meridionalis	Gavilan sabanero	Semi open zones	El Pescado footpath	X
		Buteogallus urubitinga	Cangrejero grande	Semi open zones	Magdalena river valley	
		Elanoides forficatus	Elanio tijereta	Semi open zones	El Bagre- EBAS Project	X
		Elanus leucurus	Elanio maromero	Semi open zones	El Bagre- EBAS Project	
		Gampsonyx swainsonii	Elano enano	Semi open zones	Territorial Zenufaná	X
		Geranospiza caerulescens	Azor zancón	Secondary forest	Territorial Zenufaná	
		Harpagus bidentatus	Milano bidentado	Semi open zones, secondary forest	El Bagre- EBAS Project	X
		Ictinia plumbea	Elanizo	Semi open zones, secondary forest	El Pescado footpath	
		Leptodon cayanensis	Milano cabecigris	Open zones, semi open	Territorial Zenufaná	
		Leucopternis semiplumbeus	Busardo semiplomizo	Primary forest, secondary forest	El Bagre- EBAS Project	
		Parabuteo leucorrhous	Busardo culiblanco	Semi open zones	Magdalena river valley	
		Pseudastur albicollis	Busardo blanco	Primary forest, secondary forest	El Bagre- EBAS Project	
		Rostrhamus sociabilis	Caracolero común	Semi open zones, secondary forest	Territorial Zenufaná	
		Rupornis magnirostris	Gavilan pollero, Cabo	Semi open zones, open zones	El Pescado footpath	X
		Spizaetus tyrannus	Águila negra	Primary forest, secondary forest	El Bagre- EBAS Project	
	Cathartidae	*Cathartes aura*	Gualo, gallinazo	Open zones, semi open zones	Vereda El Pescado	X
		Cathartes burrovianus	Gualo, gallinazo	Open zones	El Bagre- EBAS Project	X
		Coragyps atratus	Gualo, gallinazo	Open and semi open zones	El Pescado footpath o	X

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		Sarcoramphus papa	Rey gallinazo	Semi open zones, secondary forest	El Pescado footpath	X
	Pandionidae	*Pandion haliaetus*	Aguila pescadora	Open zones and semi open zones	El Bagre- EBAS Project	X
Anseriformes	Anatidae	*Anas clypeata*	Pato cucharo	Open and semi open zones	Territorial Zenufaná	
		Anas cyanoptera	Cerceta colorada	Open and semi open zones	Territorial Zenufaná	
		Anas discors	Cerceta aliazul	Open and semi open zones	Territorial Zenufaná	
		Cairina moschata	Pato criollo	Open and semi open zones	Territorial Zenufaná	
		Dendrocygna autumnalis	Pisingo común	Open and semi open zones	Territorial Zenufaná	
		Dendrocygna bicolor	Pisingo maria	Open and semi open zones	Territorial Zenufaná	
		Dendrocygna viduata	Iguasa careta	Open and semi open zones	Magdalena river valley	
		Mareca americana	Pato americano	Open zones	Magdalena river valley	
	Anhimidae	*Chauna chavaria*	Chajá	Open zones	El Bagre- EBAS Project	
Apodiformes	Apodidae	*Chaetura brachyura*	Vencejo rabón	Semi open zones	Territorial Zenufaná	
		Chaetura cinereiventris	Vencejo ceniciento	Semi open zones, secondary forest	El Bagre- EBAS Project	
		Chaetura spinicaudus	Vencejo lomiblanco	Semi open zones	Territorial Zenufaná	
		Chalybura urochrysia	Colibrí colibronceada	Primary forest, secondary forest	El Bagre- EBAS Project	
		Streptoprocne rutila	Vencejo cuellirojo	Secondary forest	Territorial Zenufaná	X
		Streptoprocne zonaris	Vencejo acollarado	Semi open zones, secondary forest	El Bagre- EBAS Project	X
	Trochilidae	*Amazilia amabilis*	Amazilia amable	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Amazilia castaneiventris	Colibrí, chupaflor	Primary forest, secondary forest	Nechi-San Lucas province	
		Amazilia franciae	Colibrí, chupaflor	Semi open zones	Territorial Zenufaná	
		Amazilia saucerrottei	Amazilia coliazul	Primary forest, secondary forest	Nechí river basin	
		Amazilia tzacatl	Colibrí, chupaflor	Semi open zones, secondary forest	El Pescado footpath	X
		Androdon aequatorialis	Colibrí piquidentado	Primary forest, secondary forest	Nechí river basin	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		Anthracothorax nigricollis	Colibrí, chupaflor	Semi open zones, secondary forest	El Pescado footpath	
		Campylopterus falcatus	Colibrí lazulita	Primary forest, secondary forest	Nechí river basin	
		Chalybura buffonii	Colibrí de Bufon	Primary forest, secondary forest	Magdalena river valley	
		Chlorostilbon gibsoni	Esmeralda piquiroja	Primary forest, secondary forest	El Bagre- EBAS Project	
		Chlorostilbon melanorhynchus	Colibrí esmeralda	Secondary forest	Territorial Zenufaná	
		Chlorostilbon mellisugus	Esmeralda de cola azul	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Chrysolampis mosquitus	Colibrí rubí	Primary forest, secondary forest	Magdalena river valley	
		Doryfera ludovicae	Colibrí, chupaflor	Bosque secundario	Territorial Zenufaná	
		Eutoxeres aquila	Picohoz coliverde	Primary forest, secondary forest	Magdalena river valley	
		Florisuga mellivora	Colibrí, chupaflor	Open and semi open zones	El Pescado footpath	X
		Florisuga mellivora	Colibrí nuquiblanco	Opened zones	El Bagre- EBAS Project	X
		Glaucis hirsutus	Ermitaño hirsuto	Open and semi open zones	El Bagre- EBAS Project	X
		Heliomaster longirostris	Colibrí piquilargo	Primary forest, secondary forest	Magdalena river valley	
		Heliothryx barroti	Colibrí hada occidental	Secondary forest	El Bagre- EBAS Project	X
		Juliamyia julie	Colibrí de julia	Primary forest, secondary forest	Nechí river basin	X
		Klais guimeti	Colibrí, chupaflor	Secondary forest	Territorial Zenufaná	
		Lepidopyga coeruleogularis	Colibrí gorjizafiro	Primary forest, secondary forest	Nechí river basin	
		Lepidopyga goudoti	Colibrí de Goudot	Primary forest, secondary forest	Magdalena river valley	
		Phaethornis anthophilus	Colibrí, chupaflor	Secondary forest	El Pescado footpath	X
		Phaethornis guy	Colibrí, chupaflor	Semi open zones, secondary forest	Territorial Zenufaná	X
		Phaethornis longirostris	Ermitaño piquilargo	Primary forest, secondary forest	El Bagre- EBAS Project	
		Phaethornis longuemareus	Ermitaño piquilargo	Primary forest, secondary forest	El Bagre- EBAS Project	
		Phaethornis striigularis	Colibrí, chupaflor	Semi open zones, secondary forest	Territorial Zenufaná	
		Schistes geoffroyi	Colibrí, chupaflor	Semi open zones	Territorial	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
					Zenufaná	
		Thalurania colombica	Ninfa coroniazul	Primary forest, secondary forest	Magdalena river valley	
		Threnetes ruckeri	Colibrí, chupaflor	Secondary forest	El Pescado footpath	X
Caprimulgiformes	Caprimulgidae	*Chordeiles acutipennis*	Chotacabras	Secondary vegatation	Territorial Zenufaná	X
		Chordeiles nacunda	Añapero nacunda	Semi open zones	Magdalena river valley	
		Nyctidromus albicollis	Guardacaminos	Open and semi open zones	El Pescado footpath	X
		Systellura longirostris	Chotacabras	Secondary vegetation	Territorial Zenufaná	
	Nyctibiidae	*Nyctibius griseus*	Bienparado	Open and semi open zones	El Pescado footpath	X
Charadriiformes	Charadriidae	*Charadrius collaris*	Chortilejo	Open and semi open zones	El Bagre- EBAS Project	
		Vanellus chilensis	Alcaraván	Open and semi open zones	El Bagre- EBAS Project	X
	Jacanidae	*Jacana jacana*	Jacana	Open and semi open zones	El Bagre- EBAS Project	
	Scolopacidae	*Tringa solitaria*	Andarrios solitario	Streams, rivers	Territorial Zenufaná	
Columbiformes	Columbidae	*Claravis pretiosa*	Tortolita especiosa	Open zones	Territorial Zenufaná	
		Columba livia	Paloma bravía	Urban zones, open and semi open	El Bagre- EBAS Project	
		Columbina minuta	Columbina minuta	Open and semi open zones	El Bagre- EBAS Project	X
		Columbina passerina	Columbina común	Open and semi open zones	El Bagre- EBAS Project	X
		Columbina squammata	Tortolita escamosa	semi open zones	Territorial Zenufaná	
		Columbina talpacoti	Torcaza, tortolita	Open and semi open zones	El Pescado footpath	X
		Geotrygon montana	Paloma perdíz común	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Geotrygon veraguensis	Paloma perdíz de Veragua	Primary forest, secondary forest	El Bagre- EBAS Project	
		Geotrygon violacea	Paloma perdíz violacea	Primary forest, secondary forest	El Bagre- EBAS Project	
		Leptotila cassinii	Paloma montaraz pechigris	Secondary forest	Magdalena river valley	
		Leptotila verreauxi	Paloma de monte	Open and semi open zones	El Pescado footpath	X
		Patagioenas cayennensis	Paloma colorada	Semi open zones	El Bagre- EBAS Project	X
		Patagioenas	Paloma collareja	Semi open	Territorial	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		fasciata		zones, secondary forest	Zenufaná	
		Patagioenas goodsoni	Paloma oscura	Semi open zones, secondary forest	Nechí river basin	
		Patagioenas speciosa	Paloma escamosa	Secondary forest	El Bagre- EBAS Project	
		Patagioenas subvinacea	Paloma vinosa	Open and semi open zones	Nechi-San Lucas province	
		Zenaida auriculata	Torcaza	Urban zones, open and semi open	El Bagre- EBAS Project	
		Zentrygon goldmani	Paloma perdíz de Goldman	Secondary forest	Nechí river basin	
Coraciiformes	Alcedinidae	*Chloroceryle amazona*	Martín pescador	Open and semi open zones	El Bagre- EBAS Project	
		Chloroceryle americana	Martín pescador	Open and semi open zones	El Pescado footpath	X
		Megaceryle torquata	Martín pescador	Semi open zones	El Pescado footpath	X
	Momotidae	*Baryphthengus martii*	Momoto Yeruvá	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Electron platyrhynchum colombianum	Momoto picoancho, soledad	Secondary forest	Nechi-San Lucas province	X
Cuculiformes	Cuculidae	*Coccycua pumila*	Cuclillo enano	Primary forest, secondary forest	Nechí river basin	
		Coccyzus americanus	Cuclillo migratorio	Secondary forest	Magdalena river valley	X
		Crotophaga ani	Garrapatero	open zones	El Pescado footpath	X
		Crotophaga sulcirostris	Garrapetero azurcado	Open and semi open zones	El Bagre- EBAS project	
		Piaya cayana	Cuco ardilla común	Open zones, secondary forest	El Pescado footpath	
		Tapera naevia	Cuclillo crestado	Open zones, secondary forest	El Pescado footpath	
Eurypygiformes	Eurypygidae	*Eurypyga helias*	Tígana	Secondary forest	El Bagre- EBAS Project	
Falconiformes	Falconidae	*Caracara cheriway*	Carancho norteño	Open and semi open zones	El Bagre- EBAS Project	X
		Falco columbarius	Esmerejón	Semi open zones	Magdalena river valley	
		Falco femoralis	Halcón	Semi open zones	El Pescado footpath	
		Falco peregrinus	Halcón peregrino	Open and semi open zones	Magadalena river valley	X
		Falco rufigularis	Halcón murcielaguero	Semi open zones secondary forest	El Bagre- EBAS Project	X
		Falco sparverius	Cernícalo	Open and semi	El Bagre- EBAS	X

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
			americano	open zones	Project	
		Herpetotheres cachinnans	Halcón reidor	Semi open zones secondary forest	El Bagre- EBAS Project	X
		Ibycter americanus	Cacao	Semi open zones secondary forest	El Bagre- EBAS Project	X
		Micrastur ruficollis	Hlacón montes agavilanado	Secondary forest	El Bagre- EBAS Project	
		Milvago chimachima	Caracara	Open and semi open zones	El Pescado footpath	X
Galbuliformes	Bucconidae	*Hypnelus ruficollis*	Chacurú	Secondary forest	El Pescado footpath	
		Malacoptila mystacalis	Buco bigotudo	Secondary forest	Territorial Zenufaná	X
		Malacoptila panamensis	Buco barbudo	Primary forest, secondary forest	El Bagre- EBAS Project	
		Monasa morphoeus	Monja frentiblanca	Primary forest, secondary forest	Nechi-San Lucas province	X
		Nonnula frontalis	Monjita carigris	Primary forest, secondary forest	Nechí river basin	
		Notharchus hyperrhynchus	Buco piquigordo	Primary forest, secondary forest	El Bagre- EBAS Project	
		Notharchus pectoralis	Buco pechinegro	Primary forest, secondary forest	El Bagre- EBAS Project	
		Notharchus tectus	Buco pio	Secondary forest	El Bagre- EBAS Project	
		Nystalus radiatus	Buco barrado	Primary forest, secondary forest	El Bagre- EBAS Project	X
	Galbulidae	*Galbula ruficauda*	Jacamarán	Secondary forest	El Bagre- EBAS Project	
Galliformes	Cracidae	*Crax alberti*	Paujíl	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Ortalis columbiana	Chalalaca colombian	Semi open zones	El Bagre- EBAS Project	X
		Ortalis garrula	Chalalaca aliroja	Semi open zones	El Bagre- EBAS Project	
		Penelope purpurascens	Pavas	Semi-open zones, secondary forest	El Bagre- EBAS Project	X
	Odontophoridae	*Colinus cristatus*	Perdíz	Semi open zones	El Bagre- EBAS Project	X
		Odontophorus dialeucos	Corcovado del Tarcacuna	Primary forest, secondary forest	El Bagre- EBAS Project	
		Odontophorus erythrops	Corcovado frentirojo	Semi open zones, secondary forest	El Bagre- EBAS Project	X
		Odontophorus gujanensis	Corcovado común	Secondary forest	El Bagre- EBAS Project	
Gruiformes	Raliidae	*Anurolimnas viridis*	Polluela coronirufa	Open and semi open zones	El Bagre- EBAS Project	
		Aramides cajaneus	Chilacó	Primary forest,	El Bagre- EBAS	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
				secondary forest	Project	
		Laterallus albigularis	Polluela charrasqueadora	Semi open zones	El Bagre- EBAS Project	
		Porphyrio martinicus	Tingua azul	Open and semi open zones	El Bagre- EBAS Project	
Passeriformes	Cardinalidae	*Chlorothraupis olivacea*	Guayabero oliváceo	Semi open zones secondary forest	Nechí river basin	
		Cyanocompsa cyanoides	Picogrueso negriazul	Secondary forest	El Bagre- EBAS Project	
		Habia gutturalis	Habia sombría	Primary forest, secondary forest	Provincia Nechi-San Lucas	
		Pheucticus ludovicianus	Piquigrueso degollado	Semi open zones	Territorial Zenufaná	
		Piranga flava	Quitrique avispero	Semi open zones	Territorial Zenufaná	
		Piranga olivacea	Piranga alinegra	Semi open zones	Valle del rio Magdalena	
		Piranga rubra	Piranga roja	Semi open zones	Territorial Zenufaná	X
	Corvidae	*Cyanocorax affinis*	Carriquí pechiblanco	Semi open zones secondary forest	El Pescado footpath	X
	Cotingidae	*Cotinga nattererii*	Cotinga azul	Primary forest, secondary forest	Nechí river basin	
		Lipaugus unirufus	Guardabosques rojizo	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Querula purpurata	Cotinga	Primary forest, secondary forest	El Bagre- EBAS Project	X
	Dendrocolaptidae	*Campylorhamphus trochilirostris*	Picoguadaña piquirojo	Primary forest, secondary forest	El Bagre- EBAS Project	
		Dendrocincla fuliginosa	Trepatroncos fuliginoso	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Dendrocolaptes certhia	Trepatroncos	Primary forest, secondary forest	El Pescado footpath	
		Dendroplex picus	Trepatroncos piquirecto	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Glyphorhynchus spirurus	Trepatroncos picocuña	Primary forest, secondary forest	El Pescado footpath	X
		Lepidocolaptes souleyetii	Trepatroncos cabecirayado	Primary forest, secondary forest	El Bagre- EBAS Project	
		Sittasomus griseicapillus	Trepatroncos olivaceo	Primary forest, secondary forest	El Pescado footpath	X
		Xiphocolaptes promeropirhynchus	Trepatroncos de pico fuerte	Primary forest, secondary forest	Nechi-San Lucas province	
		Xiphorhynchus guttatus	Trepatroncos pegón	Primary forest, secondary forest	El Pescado footpath	X
		Xiphorhynchus lachrymosus	Trepatroncos pinto	Primary forest, secondary forest	El Bagre- EBAS project	
		Xiphorhynchus susurrans	Trepatroncos cacao	Primary forest, secondary forest	Territorial Zenufaná	X

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
	Donacobiidae	*Donacobius atricapilla*	Angú	Semi open zones secondary forest	Territorial Zenufaná	
	Emberizidae	*Arremon atricapillus*	Cerquero cabecinegro	Secondary forest	Nechí river basin	
		Arremonops conirostris	Cerquero negrilistado	Semi open zones secondary forest	El Bagre- EBAS Project	
	Formicariidae	*Formicarius analis*	Chululú enmascarado	Primary forest, secondary forest	El Bagre- EBAS Project	
	Fringillidae	*Euphonia fulvicrissa*	Eufonia ventricanela	Semi open zones secondary forest	Nechíriver basin	
		Euphonia laniirostris	Eufonia	Semi open zones	El Bagre- EBAS Project	X
		Euphonia minuta	Eufonia culiblanca	Open and semi open zones	Territorial Zenufaná	
		Euphonia trinitatis	Eufonia de Trinidad	Open and semi open zones	Territorial Zenufaná	
		Euphonia xanthogaster	Eufonia ventriamarilla	Open and semi open zones	Territorial Zenufaná	
		Spinus psaltria	Jilguero menor	Open and semi open zones	Territorial Zenufaná	
	Furnariidae	*Automolus ochrolaemus*	Ticotico gorjiblanco	Primary forest, secondary forest	El Bagre- EBAS project	
		Automolus rubiginosus	Hojarasquero canela	Primary forest, secondary forest	Magdalena river valley	
		Clibanornis rubiginosus	Hojarasqueco castaño	Primary forest, secondary forest	Territorial Zenufaná	
		Furnarius leucopus	Cucarachero canelo	Primary forest, secondary forest	Territorial Zenufaná	
		Philydor fuscipenne	Ticotico aligris	Primary forest, secondary forest	Territorial Zenufaná	
		Sclerurus guatemalensis	Tirahojas guatemalteco	Primary forest, secondary forest	El Bagre- EBAS Project	
		Sclerurus mexicanus	Tirahojas mexicano	Primary forest, secondary forest	El Bagre- EBAS project	
		Synallaxis albescens	Pijuí pechiblanco	Primary forest, secondary forest	El Bagre- EBAS Project	
		Synallaxis azarae	Pijui	Primary forest, secondary forest	Territorial Zenufaná	
		Synallaxis brachyura	Chamicero pizarra	Primary forest	Magdalena river valley	
		Synallaxis candei	Rastrojero bigotudo	Primary forest, secondary forest	Nechí river basin	
		Xenerpestes minslosi	Colagris norteño	Primary forest, secondary forest	Nechí river basin	
		Xenops minutus	Picolezna menudo	Primary forest, secondary forest	El Bagre- EBAS Project	
	Grallaridae	*Hylopezus perspicillatus*	Tororoi de anteojos	Primary forest	Territorial Zenufaná	
	Hirundinidae	*Atticora tibialis*	Golondrina patiblanca	Semi open zones	El Pescado footpath	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		Progne chalybea	Golondrina	Open and semi open zones	Territorial Zenufaná	
		Progne tapera	Golondrina parda	Open and semi open zones	El Bagre- Projecto EBAS	X
		Pygochelidon cyanoleuca	Golondrina barranquera	Open and semi open zones	El Bagre- EBAS Project	X
		Stelgidopteryx ruficollis	Golondrina gorgirufa	Open and semi open zones	El Bagre- EBAS project	X
		Tachycineta albiventer	Golondrina aliblanca	Open and semi open zones	El Pescado footpath	
	Icteridae	*Cacicus cela*	Cacique lomiamarillo	Semi open zones	El Bagre- EBAS Project	
		Chrysomus icterocephalus	Turpial capuchino	Semi open zones	El Bagre- EBAS Project	
		Icterus auricapillus	Turpial coroninaranja	Open and semi open zones	Territorial Zenufaná	X
		Icterus chrysater	Turpial dorsidorado	Semi open zones	El Bagre- EBAS Project	X
		Icterus mesomelas	Turpial coliamarillo	Semi open zones	Territorial Zenufaná	X
		Icterus nigrogularis	Turpial amarillo	Semi open zones	Territorial Zenufaná	
		Leistes militaris	Soldadito pechirojo	Open and semi open zones	Territorial Zenufaná	X
		Molothrus bonariensis	Chamón	Semi open zones	Territorial Zenufaná	X
		Psarocolius decumanus	Gulungo, Oropéndola	Semi open zones,secondary forest	El Bagre- EBAS Project	X
		Psarocolius guatimozinus	Cacique negro	Semi open zones	El Pescado footpath	
		Psarocolius wagleri	Cacique cabecicastaño	Semi open zones, secondary forest	Nechi-San Lucas province	
		Sturnella magna	Turpial oriental	Semi open zones	Territorial Zenufaná	
	Mimidae	*Mimus gilvus*	Sinsonte	Open and semi open urban zones	Magdalena river valley	X
	Onychorhynchidae	*Myiobius atricaudus*	Moscareta colinegra	Secondary forest	El Pescado footpath	X
		Myiobius barbatus	Moscareta barbada	Primary forest, secondary forest	Nechi-San Lucas province	
	Oxyruncidae	*Oxyruncus cristatus*	Picoagudo	Semi open zones, secondary forest	Magdalena river valley	
	Parulidae	*Basileuterus rufifrons*	Reinita coronirufa	Semi open zones	Territorial Zenufaná	
		Cardellina canadensis	Reinita canadiense	Zonas semiabiertas	Territorial Zenufaná	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		Geothlypis philadelphia	Reinita plañidera	Semi open zones	Territorial Zenufaná	
		Leiothlypis peregrina	Reinita peregrina	Semi open zones	Territorial Zenufaná	
		Myiothlypis fulvicauda	Reinita culiparda	Open and semi open zones	El Bagre- EBAS Project	
		Protonotaria citrea	Reinita cabecidorada	Semi open zones	Territorial Zenufaná	
		Setophaga petechia	Reinita	Semi open zones	Territorial Zenufaná	
		Setophaga pituayumi	Reinita tropical	Semi open zones	Territorial Zenufaná	
	Passerellidae	*Arremon aurantiirostris*	Cerquero piquinaranja	Primary forest, secondary forest	Territorial Zenufaná	
	Pipridae	*Ceratopipra erythrocephala*	Saltarin cabecidorado	Primary forest, secondary forest	El Pescado footpath	X
		Corapipo leucorrhoa	Saltarín gorguiblanco	Primary forest, secondary forest	Magdalena river valley	
		Dixiphia pipra	Saltarin coroniblanco	Primary forest, secondary forest	Nechi-San Lucas province	
		Lepidothrix coronata	Manaquín coroniazul	Primary forest, secondary forest	Territorial Zenufaná	X
		Machaeropterus regulus	Manaquín franjeado	Primary forest, secondary forest	Territorial Zenufaná	
		Manacus manacus	Saltarin barbiblanco	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Pipra velutina	Manaquín	Primary forest, secondary forest	El Bagre- EBAS Project	
		Piprites chloris	Piprita verde	Secondary forest	Territorial Zenufaná	
	Pipromorphidae	*Atalotriccus pilaris*	Mosquerito ojiblanco	Secondary forest	Magdalena river valley	
		Cnemotriccus fuscatus	Mosquero parduzco	Semi open zones, secondary forest	Magdalena river valley	
		Cnipodectes subbrunneus	Mosquero pardo	Semi open zones, secondary forest	Territorial Zenufaná	
		Euscarthmus meloryphus	Tiranuelo pico de tuna	Semi open zones, secondary forest	Magdalena river valley	
		Hemitriccus margaritaceiventer	Titirijí perlado	Semi open zones, secondary forest	Territorial Zenufaná	
		Leptopogon amaurocephalus	Orejero coronipardo	Semi open zones, secondary	Territorial Zenufaná	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
				forest		
		Leptopogon superciliaris	Orejero coronigris	Semi open zones, secondary forest	Territorial Zenufaná	X
		Lophotriccus pileatus	Cimerillo andino	Semi open zones, secondary forest	Territorial Zenufaná	X
		Mionectes oleagineus	Mosquerito aceitunado	Secondary forest	El Pescado footpath	X
		Myiopagis viridicata	Fiofio verdoso	Semi open zones, secondary forest	Magdalena river valley	
		Myiornis ecaudatus	Cimerillo	Secondary forest	Vereda El Pescado	
		Oncostoma olivaceum	Pico de gancho olivaceo	Semi open zones, secondary forest	Nechí river basin	X
		Poecilotriccussylvia	Titirijí gris	Semi open zones, secondary	Territorial Zenufaná	
		Pogonotriccus lanyoni	Orejerito antioqueño	Primary forest, secondary forest	Nechi-San Lucas province	
		Rhynchocyclus olivaceus	Picoplano olivaceo	Semi open zones, secondary forest	Territorial Zenufaná	
		Tolmomyias flaviventris	Picoplano pechiamarillo	Semi open zones, secondary forest	Territorial Zenufaná	
	Platyrinchidae	*Platyrinchus coronatus*	Picoplano coronado	Primary forest, secondary forest	Territorial Zenufaná	
	Polioptilidae	*Microbates cinereiventris*	Soterillo caricastaño	Primary forest, secondary forest	Nechi-San Lucas province	X
		Polioptila schistaceigula	Curruca pizarra	Semi open zones, secondary	Nechí river basin	X
		Ramphocaenus melanurus	Soterillo picudo	Primary forest, secondary forest	El Bagre- EBAS project	
	Rhinocryptidae	*Scytalopus atratus*	Churrín coroniblanco	Primary forest, secondary forest	Territorial Zenufaná	
		Scytalopus micropterus	Churrín colilargo	Primary forest, secondary forest	Magdalena river valley	
	Sapayoidae	*Sapayoa aenigma*	Sapayoa	Primary forest, secondary forest	Nechí basin	
	Thamnophilidae	*Cercomacra*	Hormiguero	Primary forest,	Magdalena	X

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		nigricans	azabache	secondary forest	river basin	
		Cercomacroides tyrannina	Hormiguero tirano	Primary forest, secondary forest	El Bagre- EBAS Project	
		Clytoctantes alixii	Batará piquicurvo	Primary forest, secondary forest	Nechi-San Lucas province	
		Cymbilaimus lineatus	Batará lineado	Primary forest, secondary forest	Territorial Zenufaná	
		Dysithamnus mentalis	Batarito cabecigris	Secondary forest	Territorial Zenufaná	
		Epinecrophylla fulviventris	Hormiguero	Primary forest, secondary forest	El Pescado footpath	X
		Formicivora grisea	Hormiguerito coicorita	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Gymnocichla nudiceps	Hormiguero calvo	Primary forest, secondary forest	Territorial Zenufaná	
		Gymnopithys bicolor	Hormiguero	Primary forest, secondary forest	Nechi-San Lucas province	
		Gymnopithys leucaspis	Hormiguero	Primary forest, secondary forest	El Pescado footpath	X
		Herpsilochmus rufimarginatus	Tiluchí alirufo	Primary forest, secondary forest	El Bagre- EBAS Project	
		Hylophylax naevioides	Hormiguero	Primary forest, secondary forest	El Pescado footpath	X
		Microrhopias quixensis	Hormiguerito del quijos	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Myrmeciza longipes	Hormiguero ventriblanco	Primary forest, secondary forest	Magdalena river valley	
		Myrmotherula axillaris	Hormiguerto flanquialbo	Primary forest, secondary forest	El Bagre- EBAS Project	
		Poliocrania exsul	Hormiguero	Primary forest, secondary forest	El Pescado footpath	X
		Pyriglena leuconota	Hormiguero ojirojo	Primary forest, secondary forest	Magdalena river valley	
		Sipia palliata	Hormiguero del Magdalena	Primary forest, secondary forest	Nechi-San Lucas province	X
		Taraba major	Batara mayor	Primary forest, secondary forest	Territorial Zenufaná	
		Thamnophilus atrinucha	Batará pizarroso	Primary forest, secondary forest	El Bagre- EBAS Project	
		Thamnophilus doliatus	Hormiguero	Primary forest, secondary forest	El Pescado footpath	
		Thamnophilus multistriatus	Batará crestibarrado	Primary forest, secondary forest	El Bagre- EBAS Project	
		Thamnophilus nigriceps	Batará negro	Primary forest, secondary forest	Nechí river basin	
		Thamnophilus punctatus	Hormiguero	Primary forest, secondary forest	El Pescado footpath	X
	Thraupidae	*Chlorophanes spiza*	Mielerito verde	Semi open zones, secondary	El Pescado footpath	X

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
				forest		
		Chlorospingus flavigularis	Tángara goliamarillo	Semi open zones, secondary forest	El Pescado footpath	
		Chrysothlypis salmoni	Tángara rojiblanca	Semi open zones, secondary forest	Nechi-San Lucas province	
		Coereba flaveola	Bananerito	Semi open zones, crops	El Pescado footpath	X
		Conirostrum leucogenys	Conirrostro orejiblanco	Secondary zones	Magdalena river valley	
		Cyanerpes caeruleus	Mielerito cerúleo	Semi open zones, secondary forest	El Bagre- EBAS Project	
		Dacnis cayana	Dacnis azul	Semi open zones, secondary forest	Territorial Zenufaná	X
		Dacnis lineata	Mielero de cara negra	Semi open zones, secondary forest	Nechi-San Lucas province	
		Dacnis viguieri	Dacnis verdoso	Semi open zones, secondary forest	Nechí river basin	
		Eucometis penicillata	Tángara cabecigris	Primary forest, secondary forest	Territorial Zenufaná	X
		Hemithrapis guira	Tángara guira	Semi open zones, secondary forest	Territorial Zenufaná	
		Hemithraupis flavicollis	Tángara gorjigualda	Semi open zones, secondary forest	Nechi-San Lucas province	X
		Heterospingus xanthopygius	Tángara cejiroja	Semi open zones, secondary forest	El Bagre- EBAS Project	X
		Melanospiza bicolor	Semillero pechinegro	Open and semi open zones	Territorial Zenufaná	X
		Mitrospingus cassinii	Tángara carineguzca	Semi open zones, secondary forest	El Bagre- EBAS Project	
		Ramphocelus	Toche	Open and semi	El Pescado	X

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		dimidiatus	piquiplateado	open zones	footpath	
		Ramphocelus flammigerus icteronotus	Tangara lomo de fuego	Semi open zones	El Pescado footpath	X
		Saltator coerulescens	Pepitero grisáceo	Semi open zones, secondary forest	El Bagre- EBAS Project	
		Saltator maximus	Pepitero gorjicanelo	Semi open zones, secondary forest	El Bagre- EBAS Project	
		Saltator striatipectus	Pepitero	Semi open zones	Territorial Zenufaná	X
		Sicalis flaveola	Canario	urban open zones and semi open zones	Nechí river basin	X
		Sporophila angolensis	Semillero curió	Open and semi open zones	El Bagre- EBAS Project	
		Sporophila crassirostris	Semillero	Open and semi open zones	El Bagre- EBAS Project	X
		Sporophila intermedia	Semillero intermedio	Open and semi open zones	Territorial Zenufaná	
		Sporophila minuta	Espiguerito	Open and semi open zones	Territorial Zenufaná	X
		Sporophila nigricollis	Semillero ventriamarillo	Open and semi open zones	Vereda El Pescado	
		Sporophila schistacea	Semillero pizarroso	Open and semi open zones	Territorial Zenufaná	X
		Sporophilla minuta	Semillero pechirufo	Open and semi open zones	El Bagre- EBAS Project	X
		Sporophilla nigricollis	Semillero ventriamarillo	Open and semi open zones	El Bagre- EBAS Project	
		Tachyphonus delatrii	Tángara de Delattre	Semi open zones, secondary forest	El Bagre- EBAS Project	
		Tachyphonus luctuosus	Tangara luctuosa	Semi open zones	El Bagre- EBAS Project	X
		Tachyphonus rufus	Tángara negra	Semi open zones	El Pescado footpath	
		Tangara arthus	Tángara dorada	Primary forest, secondary forest	El Bagre- EBAS Project	
		Tangara gyrola	Tángara cabcibaya	Secondary forest	Territorial Zenufaná	
		Tangara inornata	Tángara cenicienta	Semi open zones, secondary forest	Territorial Zenufaná	
		Tangara larvata	Tangara cabecidorada	Secondary forest	El Pescado footpath	
		Tangara vitriolina	Tangara	Semi open zones	El Bagre- EBAS	X

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
			matorralera		Project	
		Tangara xanthocephala	Tángara coronigualda	Semi open zones, secondary forest o	Territorial Zenufaná	X
		Tersina viridis	Azulejo golondrina	Semi open zones	Territorial Zenufaná	X
		Thraupis episcopus	Azulejito	Open and semi open zones	Vereda El Pescado	X
		Thraupis palmarum	Azulejo palmero	Open and semi open zones	El Pescado footpath	X
		Volatinia jacarina	Espiguerito	Open and semi open zones	El Pescado footpath	X
		Zonotrichia capensis	Chíngolo	Urban open zones and semi open zones	Territorial Zenufaná	
	Tityridae	*Laniocera rufescens*	Plañidera	Primary forest, secondary forest	El Pescado footpath	
		Pachyramphus cinnamomeus	Anambé	Semi open zones	El Pescado footpath	X
		Pachyramphus homochrous	Amambé unicolor	Primary forest, secondary forest	Nechí river basin	
		Pachyramphus polychopterus	Cabezón aliblanco	Secondary forest	Territorial Zenufaná	
		Pachyramphus rufus	Amambé cinereo	Semi open zones, secondary forest	El Bagre- EBAS Project	
		Schiffornis turdina	Llorón turdino	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Tityra inquisitor	Titira piquinegro	Semi open zones	El Bagre- EBAS Project	
		Tityra semifasciata	Titira enmascarado	Semi open zones	El Bagre- EBAS Project	X
	Troglodytidae	*Campylorhynchus albobrunneus*	Cucarachero cejiblanco	Semi open zones, secondary forest	Nechí river basin	
		Campylorhynchus griseus	Chupahuevos	Open and semi open zones	El Pescado footpath	X
		Campylorhynchus zonatus	Cucarachero barrado	Open and semi open zones	El Bagre- EBAS Project	
		Cantorchilus nigricapillus	Cucarachero cabecinegro	Primary forest, secondary forest	El Bagre- EBAS Project	
		Cyphorhinus phaeocephalus	Cucarachero canoro	Primary forest, secondary forest	El Bagre- EBAS Project	
		Cyphorhinus thoracicus	Cucarachero pechicastaño	Primary forest, secondary forest	Nechi-San Lucas province	
		Henicorhina leucophrys	Hormiguero	Primary forest, secondary forest	San Lucas mountain range	
		Henicorhina	Cucarachero	Primary forest,	El Bagre- EBAS	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		leucosticta	pechiblanco	secondary forest	project	
		Microcerculus marginatus	Cucarachero	Secondary forest	El Pescado footpath	
		Pheugopedius fasciatoventris	Cucarachero	Secondary forest	El Pescado footpath	
		Troglodytes aedon	Cucarachero	Semi open zones	El Pescado footpath	X
	Turdidae	*Catharus minimus*	Zorzalito carigirs	Secondary forest	Territorial Zenufaná	
		Catharus ustulatus	Buchipecosa	Secondary forest	Territorial Zenufaná	X
		Turdus ignobilis	Zorzal piquinegro	Urban open zones and semi open zones	Territorial Zenufaná	X
		Turdus leucolemas	Zorzal sabia	Secondary forest	Territorial Zenufaná	
		Turdus obsoletus	Mirla selvática	Primary forest, secondary forest	Nechí river basin	
	Tyrannidae	*Aphanotriccus audax*	Mosquero piquinegro	Primary forest, secondary forest	Nechi-San Lucas basin	X
		Arundinicola leucocephala	Viudita cabeciblanca	Secondary forest	Magdalena river valley	
		Attila spadiceus	Atila polimorfo	Primary forest, secondary forest	El Bagre- EBAS project	
		Camptostoma obsoletum	Mosquerito silbon	Semi open zones. Secondary forest	Territorial Zenufaná	
		Capsiempis flaveola	Mosquerito amarillo	Semi open zones. Secondary forest	Territorial Zenufaná	
		Colonia colonus	Mosquero colilargo	Semi open zones	El Pescado footpath	
		Contopus cinereus	Pibi tropical	Semi open zones	Magdalena river valley	X
		Contopus sordidulus	Atrapamoscas occidental	Semi open zones	Magdalena river valley	X
		Contopus virens	Pibi oriental	Semi open zones	Magdalena river valley	
		Elaenia flavogaster	Copetona	Semi open zones. Secondary forest	El Pescado footpath	X
		Fluvicola pica	Viudita pía	Semi open zones	Territorial Zenufaná	
		Legatus leucophaius	Mosquero pirata	Semi open zones	El Bagre- EBAS Project	
		Machetornis risoxa	Picabuey	Open and semi open zones	El Bagre- EBAS project	X
		Megarynchus pitangua	Bienteveo pitangua	Open and semi open zones	Territorial Zenufaná	
		Mionectes	Mosquerito	Semi open	El Bagre- EBAS	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		olivaceus	olivaceo	zones. Secondary forest	project	
		Myiarchus apicalis	Atrapamoscas apical	Semi open zones	Nechí river basin	
		Myiarchus crinitus	Copetón migratorio	Open and semi open zones	Territorial Zenufaná	
		Myiarchus panamensis	Atrapamoscas panameño	Semi open zones	Nechí river basin	
		Myiarchus tuberculifer	Copetón capirotado	Semi open zones	El Bagre- EBAS province	X
		Myiarchus tyrannulus	Copetón tiranillo	Open and semi open zones	Territorial Zenufaná	
		Myiodynastes maculatus	Bienteveo rayado	Semi open zones. Secondary forest	El Bagre- EBAS Project	X
		Myiopagis gaimardii	Fiofio selvático	Secondary forest	Territorial Zenufaná	
		Myiornis atricapillus	Mosquera capirotada	Secondary forest	El Bagre- EBAS Project	
		Myiotriccus ornatus	Mosquerito adornado	Primary forest, secondary forest	Territorial Zenufaná	
		Myiozetetes cayanensis	Sirirí, bichofue	Open and semi open zones	El Pescado footpath	X
		Myiozetetes granadensis	Sirirí, bichofue	Open and semi open zones	Territorial Zenufaná	
		Myiozetetes similis	Sirirí, bichofue	Open and semi open zones	Territorial Zenufaná	X
		Ornithion brunneicapillus	Mosquerito coronipardo	Primary forest, secondary forest	El Bagre- EBAS Project	
		Phyllomyias griseiceps	Mosquerito cabecigris	Secondary forest	Territorial Zenufaná	
		Pitangus lictor	Sirirí, bichofue	Open and semi open zones	El Pescado footpath	X
		Pitangus sulphuratus	Bichofue	Open and semi open zones	El Pescado footpath	X
		Pitangus sulphuratus	Bichofue	Urban open zones and semi open zones	El Bagre- EBAS Project	X
		Pyrocephalus rubinus	Mosquero pechirojo	Urban open zones and semi open zones	Territorial Zenufaná	
		Rhytipterna holerythra	Plañidera rufa	Semi open zones	Magdalena river valley	
		Sayornis nigricans	Mosquero negro	Urban open zones and semi open zones	Territorial Zenufaná	
		Terenotriccus erythrurus	Mosquerito colirojo	Primary forest, secondary forest	Territorial Zenufaná	X
		Todirostrum cinereum	Abaníco, pibi	Semi open zones,	El Pescado footpath	X

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
				secondary forest		
		Todirostrum nigriceps	Espatulilla cabecinegra	Semi open zones	Nechí river basin	
		Tolmomyias sulphurescens	Pico plano sulfuroso	Secondary forest	El Pescado footpath	
		Tyrannulus elatus	Mosquerito coronado	Primary forest, secondary forest	El Bagre- EBAS Project	
		Tyrannus melancholicus	Sirirí	Open and semi open zones	El Pescado footpath	X
		Tyrannus savana	Tijereto	Open and semi open zones	El Pescado footpath	X
		Tyrannus tyrannus	Sirirí migratorio	Open and semi open zones	Territorial Zenufaná	X
		Tyrannys dominicensis	Tiranido dominicano	Semi open zones	Magdalena river valley	
	Vireonidae	*Cyclarhis gujanensis*	Vireón cejirrufo	Secondary forest	El Bagre- EBAS Project	
		Hylophilus decurtatus	Verdillo menos	Secondary forest	El Pescado footpath	
		Hylophilus flavipes	Verdillo paticlaro	Semi open zones, secondary forest	Territorial Zenufaná	
		Vireo olivaceus	Vireo chivi	Secondary forest	El Pescado footpath	X
		Vireolanius eximius	Vireón cejiamarillo	Primary forest, secondary forest	Nechí river basin	
Pelecaniformes	Ardeidae	*Agamia agami*	Garza agami	Semi open zones	Magdalena river valley	X
		Ardea alba	Garza modesta	Open and semi open zones	Magdalena river valley	X
		Ardea cocoi	Garza cuca	Open zones	El Bagre- EBAS project	
		Ardea herodias	Garza azulada	Open and semi open zones	Magdalena river valley	
		Bubulcus ibis	Garcita bueyera	Open and semi open zones	El Bagre- EBAS Project	X
		Butorides striata	Martín pescador	Open and semi open zones	El Bagre- EBAS Project	X
		Butorides virescens	Garcita verde	Open and semi open zones	Territorial Zenufaná	
		Cochlearius cochlearius	Martinete cucharon	Semi open zones	Magdalena river valley	
		Egretta caerulea	Garceta azul	Open and semi open zones	Territorial Zenufaná	
		Egretta thula	Garceta nivea	Open zones	El Bagre- EBAS project	
		Pilherodius pileatus	Garza crestada	Semi open zones	El Pescado footpath	X
		Tigrisoma fasciatum	Garza	Semi open zones	El Pescado footpath	X

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		Tigrisoma lineatum	Garza	Semi open zones	El Pescado footpath	X
	Ciconiidae	*Jabiru mycteria*	Jabirú americano	Open and semi open zones	Magdalena river valley	
		Mycteria americana	Tántalo americano	Open and semi open zones	El Bagre- EBAS Project	
	Phalacrocoracidae	*Phalacrocorax brasilianus*	Cormorán aguja	Open zones	El Bagre- EBAS Project	
	Threskiornithidae	*Eudocimus albus*	Corocoro blanco	Open zones	El Bagre- EBAS Project	
		Mesembrinibis cayennensis	Ibis verde	Open and semi open zones	Territorial Zenufaná	
		Phimosus infuscatus	Ibis	Open and semi open zones	El Pescado footpath	
		Platalea ajaja	Espátula rosada	Open zones	El Bagre- EBAS Project	
		Theristicus caudatus	Bandurria común	Open and semi open zones	Magdalena river valley	
Piciformes	Capitonidae	*Capito hypoleucos*	Cabezón dorsiblanco	Primary forest, secondary forest	Nechi-San Lucas province	
		Capito maculicoronatus	Cabezón pechiblanco	Primary forest, secondary forest	El Bagre- EBAS Project	X
	Galbulidae	*Brachygalba salmoni*	Jacamarán	Semi open zones, secondary forest	Nechi-San Lucas province	
	Picidae	*Campephilus haematogaster*	Carpintero ventirojo	Secondary forest	El Bagre- EBAS Project	
		Campephilus melanoleucos	Carpintero real	Semi open zones, secondary forest	El Pescado footpath	X
		Celeus loricatus	Carpintero canelo	Primary forest, secondary forest	El Bagre- EBAS Project	X
		Colaptes punctigula	Carpintero moteado	Semi open zones	El Bagre- EBAS Project	X
		Dryocopus lineatus	Carpintero	Semi open zones, secondary forest	Territorial Zenufaná	X
		Melanerpes pucherani	Carpintero	Secondary forest	Territorial Zenufaná	
		Melanerpes pulcher	Carpintero	Semi open zones, secondary forest	Nechi-San Lucas province	
		Melanerpes rubricapillus	Carpintero coronirojo	Open and semi open zones	El Pescado footpath	X
		Melanerpes rubricapillus	Carpintero coronirojo	Semi open zones	El Bagre- EBAS Project	X
		Piculus chrysochloros	Carpintero verdiamarillo	Secondary forest	El Bagre- EBAS Project	
		Piculus litae	Carpintero de Lita	Semi open zones,	Nechí river province	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
				secondary forest		
		Picumnus cinnamomeus	Carpintero castaño	Semi open zones, secondary forest	Nechí river basin	
		Picumnus olivaceus malleolus	Carpinterito	Primary forest, secondary forest	Nechi-San Lucas province	
		Veniliornis kirkii	Carpinterito	Semi open zones	El Pescado footpath	
	Ramphastidae	*Pteroglossus torquatus*	Diostedé	Semi open zones, secondary forest	El Pescado footpath	X
		Ramphastos citrolaemus	Tucán, diostedé	Primary forest, secondary forest	El Pescado footpath	X
		Ramphastos swainsonii	Tucán, diostedé	Primary forest, secondary forest	El Pescado footpath	X
Psittaciformes	Psittacidae	*Amazona amazonica*	Lora alinaranja	Secondary forest	El Bagre- EBAS project	X
		Amazona autumnalis	Lora frentiroja	Semi open zones, secondary forest	El Bagre- EBAS project	X
		Amazona farinosa	Lora real	Primary forest, secondary forest	El Pescado footpath	
		Amazona ochrocephala	Lora	Semi open zones	Nechí river basin	X
		Ara ambiguus	Guacamaya verdilimón	Primary forest, secondary forest	Territorial Zenufaná	
		Ara ararauna	Guacamaya	Secondary forest	El Pescado footpath	X
		Ara macao	Guacamaya	Semi open zones, secondary forest	El Pescado footpath	X
		Ara militaris	Guacamaya	Semi open zones, secondary forest	El Pescado footpath	
		Brotogeris jugularis	Periquitos	Semi open	Nechi-San Lucas province	X
		Eupsittula pertinax	Aratinga pertinaz	Semi open zones	Nechí river basin	
		Forpus conspicillatus	Periquito de anteojos	Semi open zones, secondary forest	El Pescado footpath	X
		Pionus menstruus	Loro cabeciazul	Semi open zones	El Pescado footpath	X
		Pyrilia pyrilia	Loro cabeciamarillo	Semi open zones	Nechí river basin	X
		Touit dilectissimus	Cotorrita cariazul	Semi open zones, secondary forest	Magdalena river valley	
Strigiformes	Strigidae	*Asio stygius*	Buho negruzco	secondary forest	Magdalena river valley	

ORDER	FAMILY	SPECIES	VERNACULAR NAME	HABITAT	REGISTRATION SITE	REGISTERED IN THE AID
		Athene cunicularia	Mochuelo de madriguera	secondary forest	Magdalena river valley	
		Bubo virginianus	Buho común	secondary forest	El Pescado footpath	X
		Ciccaba virgata	Cárabo café	secondary forest	El Bagre- EBAS Project	
		Lophostrix cristata	Buho crestado	secondary forest	Territorial Zenufaná	
		Megascops choliba	Buho común	Semi open zones, secondary forest	El Pescado footpath	X
		Pseudoscops clamator	Buho gritón	secondary forest	Magdalena river valley	
		Pulsatrix perspicillata	Buho de anteojos	Semi open zones, secondary forest	El Pescado footpath	X
	Tytonidae	*Tyto alba*	Lechuza	Semi open zones, secondary forest	El Pescado footpath	
Suliformes	Anhingidae	*Anhinga anhinga*	Pato aguja	Open and semi open zones	Territorial Zenufaná	
Tinamiformes	Tinamidae	*Crypturellus erythropus*	Tinamú patirojo	Primary forest	Territorial Zenufaná	
		Crypturellus soui	Gallineta	secondary forest	El Pescado footpath	
		Tinamus major	Tinamú, Gallineta	secondary forest	El Pescado footpath	X
Trogoniformes	Trogonidae	*Trogon caligatus*	Trogon	Primary forest, secondary forest	Magdalena river valley	
		Trogon chionurus	Trogón coliblanco	Primary forest, secondary forest	Nechí river basin	X
		Trogon comptus	Trogón coliazul	Primary forest	Nechi-San Lucas basin	
		Trogon melanurus	Trogón colinegro	Primary forest, secondary forest	Territorial Zenufaná	X
		Trogon rufus	Trogón amarillo	Primary forest, secondary forest	El Bagre- EBAS Project	
		Trogon violaceus	Trogón violáceo	Primary forest	El Bagre- EBAS Project	
		Trogon viridis	Trogon	Primary forest, secondary forest	El Pescado footpath	X

Source: ASAM 2011, Chaparro-Herrera et al 2013; Cuervo et al 2007; Cuervo et al 2008a; Cuervo et al 2008b; Donegan & Salaman 2014; Lara 2012; Restrepo-Llano et al 2010; Salaman et al 2001; Salaman & Donegan 2009.

Additionally, 18 species were recorded with some degree of threat of extinction; 11 are in almost threatened category (NT), 2 vulnerable to extinction (VU), 4 are endangered (EN) and one of them, *Crax alberti*, in critical danger of extinction (CR) (See Table 4.2 -64).

Table 4.24.2-64. Species of birds with some degree of threat, registered in the region and nearby geographical areas.

ORDER	FAMILY	*SPECIES*	VERNACULAR NAME	THREAT STATUS
Galliformes	Cracidae	*Crax alberti*	Paujíl	CR
Apodiformes	Trochilidae	*Amazilia castaneiventris*	Colibrí, chupaflor	EN
Passeriformes	Pipromorphidae	*Pogonotriccus lanyoni*	Orejerito antioqueño	
	Thamnophilidae	*Clytoctantes alixii*	Batará piquicurvo	
Psittaciformes	Psittacidae	*Ara ambiguus*	Guacamaya verdilimón	
Anseriformes	Anhimidae	*Chauna chavaria*	Chajá	NT
Apodiformes	Trochilidae	*Chlorostilbon gibsoni*	Esmeralda piquiroja	
Charadriiformes	Charadriidae	*Charadrius collaris*	Chortilejo	
Columbiformes	Columbidae	*Zentrygon goldmani*	Paloma perdíz de Goldman	
Galliformes	Cracidae	*Ortalis columbiana*	Chalalaca colombian	
	Cracidae	*Ortalis garrula*	Chalalaca aliroja	
	Odontophoridae	*Odontophorus gujanensis*	Corcovado común	
Passeriformes	Cardinalidae	*Habia gutturalis*	Habia sombría	
	Tyrannidae	*Aphanotriccus audax*	Mosquero piquinegro	
Psittaciformes	Psittacidae	*Amazona farinosa*	Lora real	
	Psittacidae	*Pyrilia pyrilia*	Loro cabeciamarillo	
Galliformes	Odontophoridae	*Odontophorus dialeucos*	Corcovado del Tarcacuna	VU
Psittaciformes	Psittacidae	*Ara militaris*	Guacamaya	

Source: ASAM 2011, Chaparro-Herrera et al 2013; Cuervo et al 2007; Cuervo et al 2008a; Cuervo et al 2008b; Donegan & Salaman 2014; Lara 2012; Restrepo-Llano et al 2010; Salaman et al 2001; Salaman & Donegan 2009.

In the region and surrounding areas, a total of 48 almost endemic species and 17 endemic species have been recorded for the country (See Table 4.2-64).

Table 4.24.2-65. Species of endemic and almost endemic birds in the region and in nearby geographical areas.

ORDER	FAMILY	*SPECIES*	VERNACULAR NAME	REGISTRATION AREA	STATUS
Apodiformes	Trochilidae	*Amazilia saucerrottei*	Amazilia coliazul	Nechi river basin	
		Androdon aequatorialis	Colibrí piquidentado	Nechi river basin	
		Campylopterus falcatus	Colibrí lazulita	Nechi river basin	
		Juliamyia julie	Colibrí de julia	Nechi river basin	
		Lepidopyga coeruleogularis	Colibrí gorjizafiro	Nechi river basin	
Columbiformes	Columbidae	*Patagioenas goodsoni*	Paloma oscura	Nechi river basin	
		Zentrygon goldmani	Paloma perdíz de Goldman	Nechi river basin	
Galbuliformes	Bucconidae	*Nonnula frontalis*	Monjita carigris	Nechi river basin	
		Nystalus radiatus	Buco barrado	Nechi river basin	

ORDER	FAMILY	*SPECIES*	VERNACULAR NAME	REGISTRATION AREA	STATUS
Galliformes	Odontophoridae	*Odontophorus erythrops*	Corcovado frentirojo	Nechi river basin	Casi endémica
Passeriformes	Cotingidae	*Cotinga nattererii*	Cotinga azul	Nechi river basin	
	Fringillidae	*Euphonia fulvicrissa*	Eufonia ventricanela	Nechi river basin	
	Furnariidae	*Philydor fuscipenne*	Ticotico aligris	Territorial Zenufaná	
		Synallaxis candei	Rastrojero bigotudo	Nechi river basin	
		Xenerpestes minslosi	Colagris norteño	Nechi river basin	
	Grallaridae	*Hylopezus perspicillatus*	Tororoi de anteojos	Territorial Zenufaná	
	Icteridae	*Psarocolius guatimozinus*	Cacique negro	Nechi-San Lucas province	
	Pipromorphidae	*Cnipodectes subbrunneus*	Mosquero pardo	Territorial Zenufaná	
		Lophotriccus pileatus	Cimerillo andino	Territorial Zenufaná	
		Oncostoma olivaceum	Pico de gancho olivaceo	Nechi river basin	
	Sapayoidae	*Sapayoa aenigma*	Sapayoa	Nechi river basin	
	Thamnophilidae	*Epinecrophylla fulviventris*	Hormiguero	El Pescado footpath	
		Gymnopithys bicolor	Hormiguero	Nechi-San Lucas province	
		Gymnopithys leucaspis	Hormiguero	El Pescado footpath	
		Hylophylax naevioides	Hormiguero	El Pescado footpath	
		Poliocrania exsul	Hormiguero	El Pescado footpath	
		Sipia palliata	Hormiguero del Magdalena	Nechi-San Lucas province	
		Thamnophilus nigriceps	Batará negro	Nechi river basin	
	Thraupidae	*Ramphocelus dimidiatus*	Toche piquiplateado	El Pescado footpath	
		Ramphocelus flammigerus icteronotus	Tangara lomo de fuego	El Pescado footpath	
		Tangara inornata	Tángara cenicienta	El Pescado footpath	
	Tityridae	*Pachyramphus homochrous*	Amambé unicolor	Nechi river basin	
	Troglodytidae	*Campylorhynchus albobrunneus*	Cucarachero cejiblanco	Nechi river basin	
		Cyphorhinus thoracicus	Cucarachero pechicastaño	Nechi-San Lucas province	
		Pheugopedius fasciatoventris	Cucarachero	El Pescado footpath	
	Tyrannidae	*Aphanotriccus audax*	Mosquero piquinegro	Nechi-San Lucas province	
		Fluvicola pica	Viudita pía	Territorial Zenufaná	
		Myiarchus panamensis	Atrapamoscas panameño	Nechi river basin	
		Myiotriccus ornatus	Mosquerito adornado	Territorial Zenufaná	Almost endemic
		Todirostrum nigriceps	Espatulilla cabecinegra	Nechi river basin	
	Vireonidae	*Vireolanius eximius*	Vireón cejiamarillo	Nechi river	

ORDER	FAMILY	*SPECIES*	VERNACULAR NAME	REGISTRATION AREA	STATUS
				basin	
Piciformes	Picidae	*Piculus litae*	Carpintero de Lita	Nechi river basin	
Piciformes		*Picumnus cinnamomeus*	Carpintero castaño	Nechi river basin	
Piciformes	Ramphastidae	*Ramphastos citrolaemus*	Tucán, diostedé	Vereda El Pescado	
Psittaciformes	Psittacidae	*Brotogeris jugularis*	Periquitos	Vereda El Pescado	
Psittaciformes		*Forpus conspicillatus*	Periquito de anteojos	Nechi river basin	
Psittaciformes		*Touit dilectissimus*	Cotorrita cariazul	Nechi river basin	
Trogoniformes	Trogonidae	*Trogon chionurus*	Trogón coliblanco	Nechi river basin	
Anseriformes	Anhimidae	*Chauna chavaria*	Chajá	El Bagre-Project EBAS	Endemic
Apodiformes	Trochilidae	*Amazilia castaneiventris*	Colibrí, chupaflor	Nechi-San Lucas province	
		Chlorostilbon gibsoni	Esmeralda piquiroja	El Bagre-Project EBAS	
Galbuliformes	Bucconidae	*Hypnelus ruficollis*	Chacurú	El Pescado footpath	
Galliformes	Cracidae	*Crax alberti*	Paujíl	El Pescado footpath	
		Ortalis columbiana	Chalalaca colombian	Territorial Zenufaná	
		Ortalis garrula	Chalalaca aliroja	El Bagre-Project EBAS	
	Odontophoridae	*Odontophorus dialeucos*	Corcovado del Tarcacuna	Nechi river basin	
Passeriformes	Cardinalidae	*Habia gutturalis*	Habia sombría	Nechi-San Lucas province	
	Pipromorphidae	*Pogonotriccus lanyoni*	Orejerito antioqueño	Nechi-San Lucas province	
	Thamnophilidae	*Clytoctantes alixii*	Batará piquicurvo	Nechi-San Lucas province	
	Thraupidae	*Chrysothlypis salmoni*	Tángara rojiblanca	Nechi-San Lucas province	
	Tyrannidae	*Myiarchus apicalis*	Atrapamoscas apical	Nechi river basin	
Piciformes	Capitonidae	*Capito hypoleucos*	Cabezón dorsiblanco	Nechi-San Lucas province	Endemic
	Picidae	*Melanerpes pulcher*	Carpintero	Nechi-San Lucas province	
Psittaciformes	Psittacidae	*Pyrilia pyrilia*	Loro cabeciamarillo	El Pescado footpath	
Trogoniformes	Trogonidae	*Trogon comptus*	Trogón coliazul	Nechi-San Lucas province	

Source: ASAM 2011, Chaparro-Herrera et al 2013; Cuervo et al 2007; Cuervo et al 2008a; Cuervo et al 2008b; Donegan & Salaman 2014; Lara 2012; Restrepo-Llano et al 2010; Salaman et al 2001; Salaman & Donegan 2009

In addition, a total of 23 species of non-breeding migratory birds have been recorded for the country (See Table 4.2-65).

Table 4.24.2-66. Species of migratory birds in the region and nearby geographical areas.

Order	Family	*Species*	Vernacular name	Status
Accipitriformes	Accipitridae	*Elanoides forficatus*	Elanio tijereta	Wintering with occasional reproductive populations
Falconiformes	Falconidae	*Falco peregrinus*	Halcón peregrino	Wintering with occasional and permanent reproductive populations
Accipitriformes	Cathartidae	*Cathartes aura*	Gualo, gallinazo	Wintering with permanent reproductive populations
Anseriformes	Anatidae	*Anas discors*	Cerceta aliazul	
Caprimulgiformes	Caprimulgidae	*Chordeiles acutipennis*	Chotacabras	
Passeriformes	Cardinalidae	*Piranga rubra*	Piranga roja	
	Hirundinidae	*Pygochelidon cyanoleuca*	Golondrina barranquera	
	Parulidae	*Protonotaria citrea*	Reinita cabecidorada	
	Tyrannidae	*Myiodynastes maculatus*	Bienteveo rayado	
		Tyrannus melancholicus	Sirirí	
		Tyrannus savana	Tijereto	
Pelecaniformes	Ardeidae	*Ardea alba*	Garza modesta	Wintering with permanent reproductive populations
		Egretta caerulea	Garceta azul	
		Egretta thula	Garceta nivea	
	Phalacrocoracidae	*Phalacrocorax brasilianus*	Cormorán aguja	
	Threskiornithidae	*Platalea ajaja*	Espátula rosada	
Accipitriformes	Accipitridae	*Buteo platypterus*	Busardo aliancho	Wintering non reproductive
		Buteo swainsoni	Busardo chapulinero	
	Pandionidae	*Pandion haliaetus*	Aguila pescadora	
Anseriformes	Anatidae	*Anas clypeata*	Pato cucharo	
		Mareca americana	Pato americano	
Caprimulgiformes	Caprimulgidae	*Chordeiles nacunda*	Añapero nacunda	
Cuculiformes	Cuculidae	*Coccyzus americanus*	Cuclillo migratorio	
Falconiformes	Falconidae	*Falco columbarius*	Esmerejón	

Order	Family	*Species*	Vernacular name	Status
Passeriformes	Cardinalidae	*Pheucticus ludovicianus*	Piquigrueso degollado	Wintering non reproductive
		Piranga olivacea	Piranga alinegra	
	Hirundinidae	*Progne tapera*	Golondrina parda	
	Parulidae	*Cardellina canadensis*	Reinita canadiense	
		Geothlypis philadelphia	Reinita plañidera	
		Leiothlypis peregrina	Reinita peregrina	
		Setophaga petechia	Reinita	
	Turdidae	*Catharus minimus*	Zorzalito carigirs	
		Catharus ustulatus	Buchipecosa	
	Tyrannidae	*Contopus sordidulus*	Atrapamoscas occidental	
		Contopus virens	Pibi oriental	
		Myiarchus crinitus	Copetón migratorio	
		Pyrocephalus rubinus	Mosquero pechirojo	
		Tyrannus tyrannus	Sirirí migratorio	
Pelecaniformes	Ardeidae	*Butorides virescens*	Garcita verde	
Anseriformes	Anatidae	*Dendrocygna autumnalis*	Pisingo común	Local migratory
Apodiformes	Apodidae	*Chalybura urochrysia*	Colibrí colibronceada	
	Trochilidae	*Amazilia amabilis*	Amazilia amable	
		Amazilia franciae	Colibrí, chupaflor	
		Amazilia tzacatl	Colibrí, chupaflor	
		Chlorostilbon mellisugus	Esmeralda de cola azul	
		Florisuga mellivora	Colibrí, chupaflor	
		Florisuga mellivora	Colibrí nuquiblanco	
		Heliothryx barroti	Colibrí hada occidental	
		Klais guimeti	Colibrí, chupaflor	
		Phaethornis anthophilus	Colibrí, chupaflor	

Order	Family	*Species*	Vernacular name	Status
		Phaethornis guy	Colibrí, chupaflor	Local migratory
		Phaethornis longirostris	Ermitaño piquilargo	
		Phaethornis longuemareus	Ermitaño piquilargo	
		Phaethornis striigularis	Colibrí, chupaflor	
Columbiformes	Columbidae	*Patagioenas fasciata*	Paloma collareja	
Gruiformes	Raliidae	*Porphyrio martinicus*	Tingua azul	
Passeriformes	Thamnophilidae	*Dysithamnus mentalis*	Batarito cabecigris	
	Thraupidae	*Tangara larvata*	Tangara cabecidorada	
	Cardinalidae	*Piranga flava*	Quitrique avispero	
	Turdidae	*Turdus obsoletus*	Mirla selvática	
Trogoniformes	Trogonidae	*Trogon viridis*	Trogon	

Source: ASAM 2011, Chaparro-Herrera et al 2013; Cuervo et al 2007; Cuervo et al 2008a; Cuervo et al 2008b; Donegan & Salaman 2014; Lara 2012; Restrepo-Llano et al 2010; Salaman et al 2001; Salaman & Donegan 2009

4.2.5 HYDROBIOLOGICAL GROUP

Next, the hydro-biological communities studied are presented from two (2) approaches, that is, ecological and water quality. Because these organisms function as biological indicators of aquatic ecosystems in space-time, providing information on the state of water through variations in abundance, richness and presence (Roldan, 1992 and Caicedo et al, 2004).

In the Table 66, eleven sampling stations are presented, which were selected taking into account the following criteria: (1) Topography and ease of access to the sampling point; (2) Stretch of the current with the appropriate conditions to carry out gauging by floating means by means of the area-velocity methodology; (3) Possible incidence (contamination or deterioration of water quality) by activities generated in the studied area; (4) Benchmarks for the evaluation of the quality of the surface sources before and after the mining project; (5) Suitable conditions for taking hydrobiological and physicochemical samples; (6) Habitats suitable for the formation of benthic, ictic, perifitic, planktonic and aquatic plants.

Table 4.24.2-67. Geographical location of the sampling stations.

MONITORING POINT	EAST (X)	NORTH (Y)
P-01	929897	1293967
P-02	929835	1294248

P-03	929988	1294547
P-04	930350	1293575
P-05	930973	1293276
P-06	930621	1293966
P-07	930353	1294082
P-08	930337	1293999
P-09	930180	1294290
P-10	930100	1294551
P-11	929963	1294706

Source: Merceditas Corporation, 2012.

This item presents only the interpretation of the presence and abundance of the periphyton, plankton, macrophytes, aquatic macroinvertebrates and fish communities.

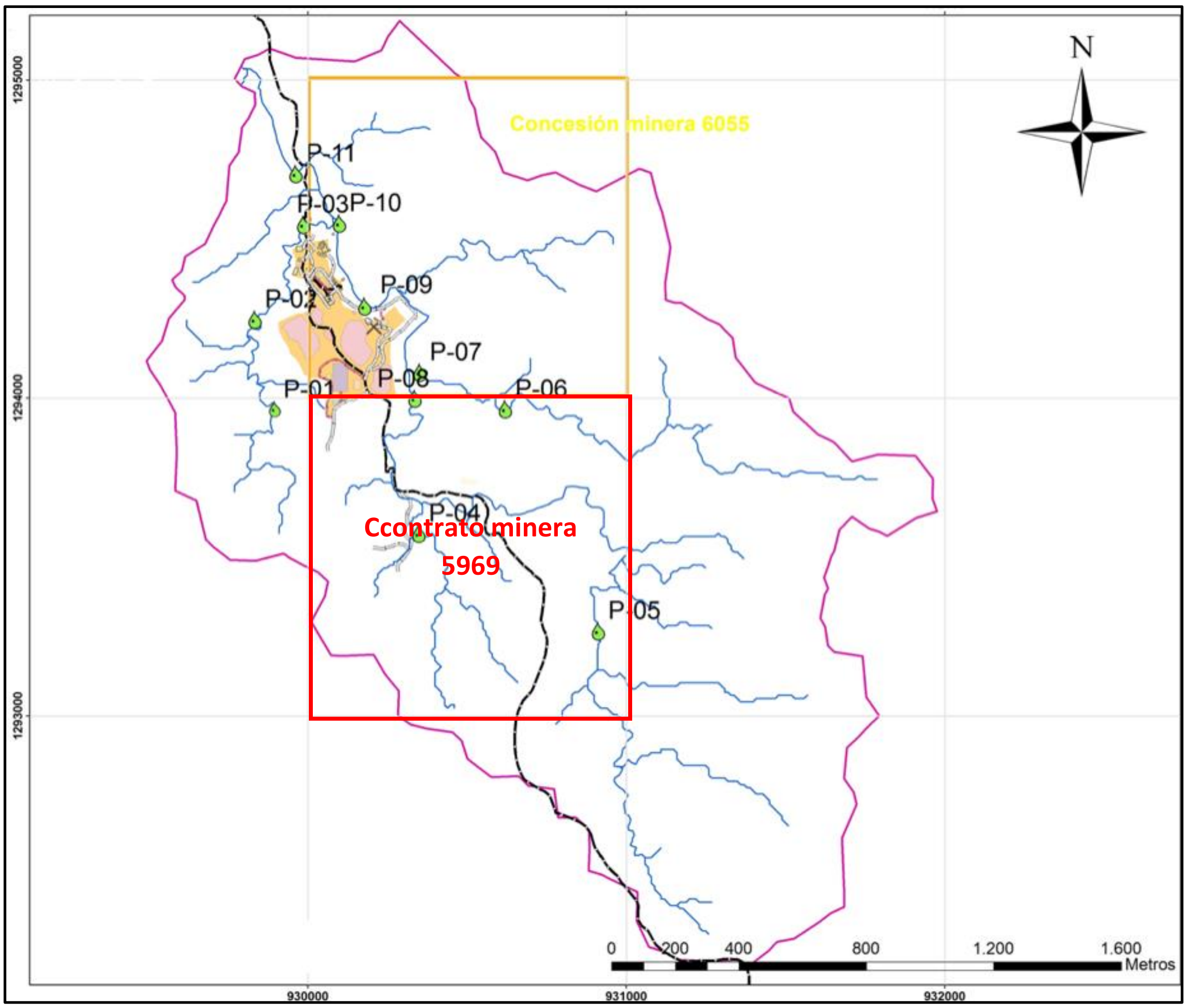

Illustration 4.24.2-157 Geographical location of hydrobiological sampling stations.
Source: INGEX, 2016.

4.2.5.1 ICHTHYOFAUNA

Fish are considered as the largest community of vertebrates in aquatic ecosystems because of their abundance and diversity (Margalef, 1983) with 33,201 species worldwide (Eschemyer Fong, 2014). Ecological studies on this community are considered important by Pérez & Prada (2011) given that they are subject to various environmental or fishing factors that affect their structure (composition and abundance) with respect to the degree of exploitation or modification of their environments by anthropic activities Likewise, Maldonado et al., (2005) consider that this water resource is in high degree of threat due to its inadequate use. In general, these organisms are considered useful for the detection of eutrophy, water contamination, loss of oxygen and toxicity due to algae (Jiménez et al., 2014).

The country has one of the most diverse freshwater fish species in the world and many of the species have some kind of importance (Mojica et al., 2002). In Colombia 1,558 species of fish are reported (Maldonado personal communication Taken from: Jiménez et al., 2014); where in the Magdalena-Cauca river basin 213 species are reported (Maldonado et al., 2008). On the other hand, Mojica et al. (2012) in his work on the red book of freshwater fishes of Colombia, affirms that in the last ten years the threats to the fish communities have increased mainly due to pollution, deforestation and over exploitation. Going from the year 2002 with 45 species with degrees of extinction, critical danger, danger, vulnerable and threatened to 81 in the year 2012 (See Table 67).

Table 4.24.2-68. Quantities of extinct species, critical danger, vulnerable and threatened, reported by year.

YEAR	# EXTINCT SPECIES	# SPECIES IN CRITICAL DANGER	#ENDANGERED SPECIES	# VULNERABLE SPECIES	# ALMOST THREATENED SPECIES	# MINOR CONCERN
2002	1	1	11	22	10	0
2012	1	1	4	48	24	3

Source: Mojica et al. 2012.

4.2.5.1.1 Curve of accumulation of species

For the characterization of fish, a total of 11 days of sampling were established, where 639 individuals were found, distributed in 5 orders, 11 families, 19 genera and 19 species in the mentioned sampling points (INGEX, 2016).

(Table 4.2-68). The accumulation curve of fish species is stabilized, meaning that the sampling effort was statistically valid to find a significant and representative number of fish species. In addition, the confidence intervals of the accumulation curve overlap with those of the non-parametric CHAO estimator, indicating that the number of species found could not have been greater in that sampling time (Illustration 4.2-157).

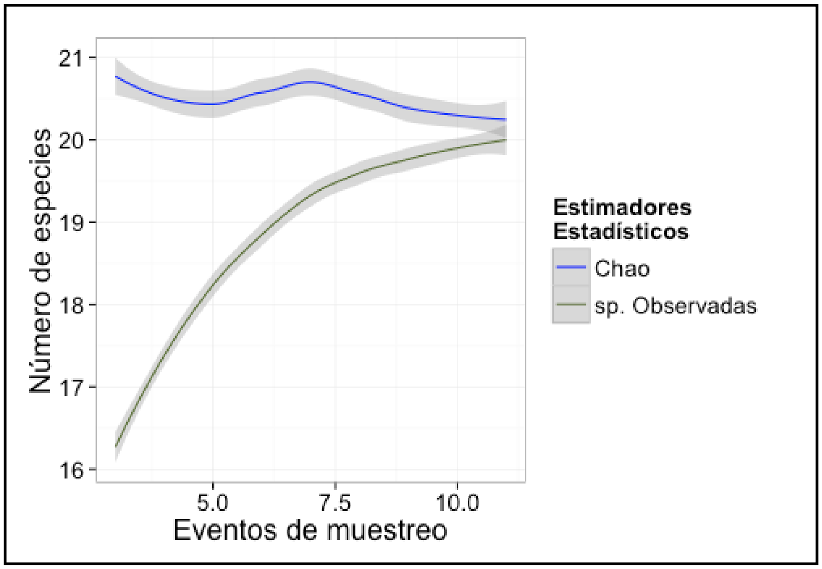

Illustration 4.24.2-158. Graph of the fish species accumulation curve with the non-parametric CHAO estimator (Shaded regions represent 95% confidence intervals).
Source: INGEX, 2016

Table 4.24.2-69. Ichthyc community registered in the micro-basin.

ORDER	FAMILY	SPECIES AND/OR GENRE	VERNACULAR NAME
Characiformes	Prochilodontidae	*Prochilodus magdalenae* Steindachner, 1879	Bocachico
	Characidae	*Bryconamericus sp*	Sardina, Colinegra
		Astyanax fasciatus (Cuvier, 1819)	Tota, Coliroja
		Roeboides dayi Steindachner, 1878	Changuito
	Erythrinidae	*Hoplias malabaricus* (Bloch, 1794)	Moncholo
	Lebiasinade	*Lebiasina Sp*	Media luna, Guabina Lomo de oro
	Bryconinae	*Brycon henni* Eigenmann, 1913	Sabaleta
	Parodontidae	*Saccodon dariensis* Meek and Hildebrando, 1913	Mazorco
Siluriformes	Loricariidae	*Hypostomus hondae* Regan, 1912	Corroncho tigre
		Lasiancistrus caucanus Eigenmann, 1912	Corroncho barbado
		Chaetostoma brevilabiatum Dahl, 1941	corroncho
	Heptapteridae	*Pimelodella chagresi* Steindachner, 1876	Capitanejo
		Rhamdia quelen Quoy & Gaimard, 1824	Barbudo negro
Gymnotiformes	Sternopygidae	*Sternopygus aequilabiatus* Humboldt, 1811	Mayupa, Guayupa Peinilla
Synbranchiformes	Synbranchidae	*Synbranchus marmoratus* Bloch, 1975	Culebra de agua Anguila
Perciformes	Cichlidae	*Andinoacara pulcher* (Gill, 1858)	Mojarra azul

ORDER	FAMILY	SPECIES AND/OR GENRE	VERNACULAR NAME
Perciformes	Cichlidae	*Caquetaia kraussii* (Steindachner, 1879)	Mojarra amarilla, Mula
		Caquetaia umbrifera (Meek y Hildebrand 1913)	Mojarra
		Geophagus steindachneri Eigenmann &Hildebrand, 1910	Jorobada

Source: Corporación Merceditas, 2012

4.2.5.1.2 Composition, abundance and taxonomic wealth by sampling station

No significant differences were found between sampling stations where fish were recorded (X^2=7.1544, p=0.62). The stations with the highest abundance (P-02, P-07 and P-05) did not show significant differences between them (X^2=0.7576, p=0.68) (Illustration 4.2-158). The order with greater richness within the sampling period was the order Charadiformes with 8 registered species, followed by the orders Siluriformes and Perciformes with 5 and 4 species, respectively. The other orders presented less than 4 species. The most representative family was Cichlidae with 4 species.

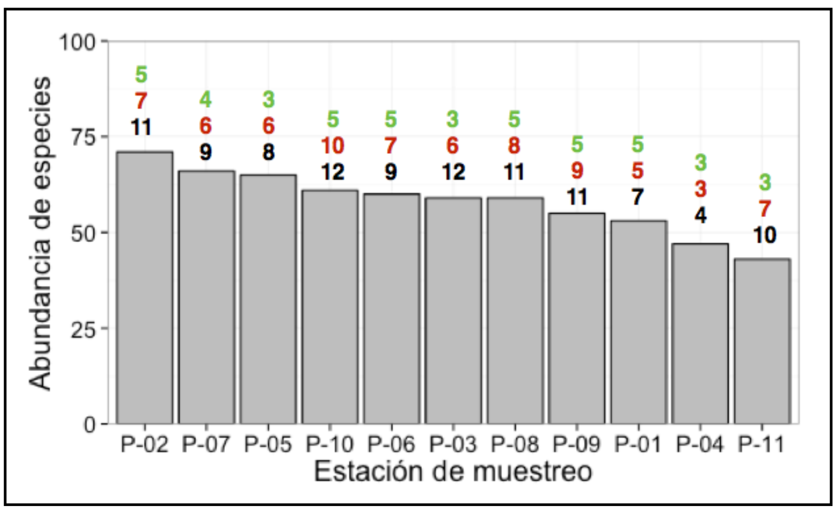

Illustration 4.2-159. Graph of the abundance and wealth of the species of fish by sampling station
Source: INGEX, 2016.

In terms of relative abundance, taking into account the categorization of abundance for species (see methodology), the most abundant species were Caquetaia kraussii, Andinoacarpa pulcher and Brycon henni (Relative abundance> 10%). On the other hand, 3 common species were found (Relative abundance between 2 and 10%) (Illustration 4.2-159) and the remaining 13 are uncommon (Relative abundance between 0.1 and 2%).

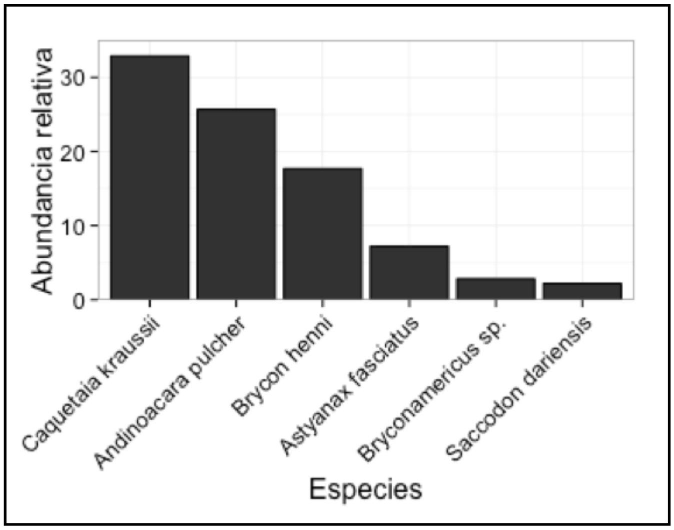

Illustration 4.2 4.2-160. Graph of the relative abundance of the abundant and common species.
Source: INGEX, 2016

4.2.5.1.3 Patterns of habitat use and relationship with sampling stations

It is worth noting the presence in the studied area of species such as *Bryconamericus sp* (sardine colinegra) registered in the sampling stations P-01, P-02, P-03, P-05 and P-07. This genus is characterized by living in environments of sandy-clay bottoms with the presence of riparian vegetation. The genus Bryconamericus is found on all the flanks of the mountain ranges and is dispersed in the rivers of the low and high zones (Maldonado et al., 2005). It can be found between 200 and 2300 meters above sea level (Jiménez et al., 2014). It is an omnivorous species with preference for insects.

Another of the identified species of this family was *Astyanax fasciatus* (Sardine coliroja) (See Illustration 4.2-160), which was found in the upper, middle and lower part of the basin. (In the 11 monitoring stations). It inhabits in clear and muddy waters of rocky-sandy substratum (Vargas, 1989), it is located between 1030 and 1650 meters of altitude but prefers the habitats below 500 meters. It is a vector controller (Chironomidae-mosquito) and its omnivorous diet consists of aquatic plants, phytoplankton, periphyton and some macroinvertebrates (Maldonado et al., 2005). It has a wide distribution in the basins of the Magdalena, Cauca, Sinú, Cesar, San Jorge, Atrato, Catatumbo and San Juan rivers (Dahl, 1971, Galvis et al, 1997, Mojica, 1999, Ortega et al, 2000). .

This species does not have any degree of danger since it is not reported in the red book. However, it is very important for the diet of some fish that have some degree of threat.

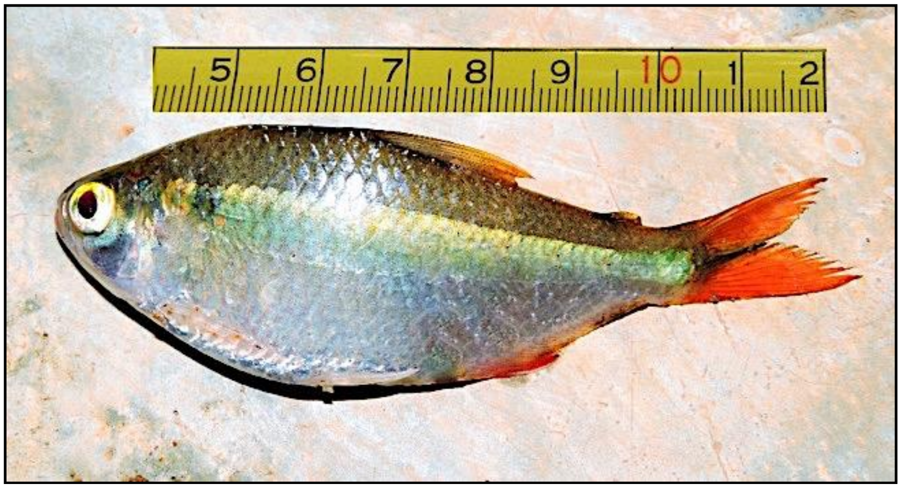

Illustration 4.24.2-161. *Astyanax fasciatus* (Sardina coliroja).
Source: Merceditas Corporation, 2012

On the other hand, *Roeboides dayi* (Changuito) (See Illustration 4.2-161) belonging to the order Characiformes of the family Characidae and was registered in the station P-11 (Lower part of the basin). This species is characterized by an omnivorous diet of scales, earthworms, zooplankton and aquatic insects, of the latter especially Ephemeroptera, Odonata and Diptera, making it a good controller of vectors of human diseases (Ortaz & Cano, 2003). Likewise, this fish is found in lotic systems such as lentics where leaf litter and plant material proliferate (Ortega et al., 2000). The range of distribution extends from Central America to the Paraná basin in South America. In Colombia it is found in the basins of the Magdalena, Cesar, San Jorge, Atrato, Cauca, Catatumbo, Cesar, San Juan and Sinu rivers (Maldonado et al., 2005; Jiménez et al., 2014).

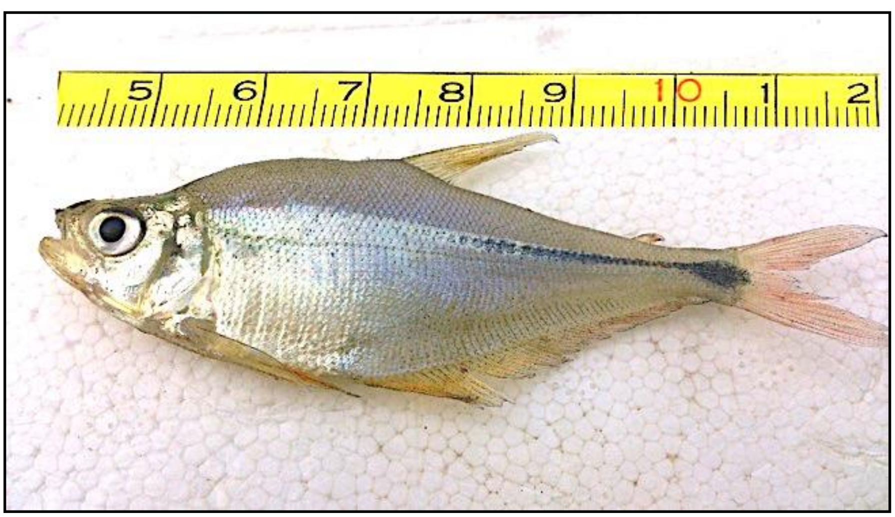

Illustration 4.2-162*.* *Roeboides dayi* (Changuito).
Source: Merceditas Corporation, 2012

In the sampling stations P-02, P-03, P-10 and P-11 the family Erythrinidae was recorded with only the species *Hoplias malabaricus* (Moncholo) (See Illustration 4.2-162). This fish is identified by its carnivorous diet where, in its juvenile state, it feeds on insects and crustaceans (Salinas & Agudelo, 2010), and in its adult state is an ichthyophagous fish, that is, it feeds on other fish. Its preferred habitat is in shallow waters and with good vegetation. It is located in Argentina, Brazil, Costa Rica, Ecuador, French Guiana, Guyana, Paraguay, Suriname, Trinidad, Tobago, Uruguay, Venezuela, Amazonia, Peru, Bolivia and in Colombia it is located in the basins of the Magdalena River and the Cauca River, among others

Illustration 4.24.2-163. *Hoplias malabaricus* (Moncholo).
Source: Merceditas Corporation, 2012

Lebiasina Sp (Half Moon, wolf fish or Golden Lomo) (See Illustration 4.2- 163) belonging to the family Lebiasinadae was captured between the stations P-05, P-08, P-09, P-10 and P-11. This genus is considered omnivorous, but its food preference makes it entomophagous (feeds on insects) (Maldonado et al., 2005). It prefers streams of clear and calm waters, with sandy bottoms and vegetation composed of pastures and cocoa crops

Illustration 4.2-164. *Lebiasina Sp* (Half-moon, wolf fish or Golden Lomo).
Source: Merceditas Corporation, 2012

The species *Saccodon dariensis* (Mazorco) (See Illustration 4.2- 164) of the family Parodontidae was observed in sampling stations P-06, P-07, P-08 and P-09. This is a little studied species and according to Mojica et al. (2012) in 2002 was considered an almost threatened species and in 2012 its category of threat to minor concern decreased because it was synonymized with another species, expanding its distribution area and therefore its abundance in the population, by it reduces its threat category.

Illustration 4.2-165. *Saccodon dariensis* (Mazorco).
Source: Merceditas Corporation, 2012

The species *S. dariensis* it is distributed from Central America to South America. In Colombia they have been recorded in the high Cauca River and in the Magdalena river basin (Jiménez et *al.,* 2014). It is located in fast currents, with rocky substrates covered with Periphyton. In Antioquia (Middle Magdalena) its diet is composed of algae, vegetative material and aquatic macroinvertebrates such as Trichopteros, Dipteran, Odonates and Lepidoptera (Restrepo & Mancera, 2011).

In the stations P-02 and P-03 the Loricariidae family was identified with the species *Hypostomus hondae* (Janitor fish) (see Illustration 4.2-166). This species is distributed in Colombia and it is located in all the lower parts of the Magdalena basin, the Sinu, Pechillin, among others (Dahl, 1971). Its diet consists of consuming detritus with algae content found in rocks, leaf litter and submerged trunks (Galvis *et al.,* 1997). The janitor fish can grow up to 66 cm and according to Dahl (1971) Magdalena River they grow up to 30 cm in length.

Illustration 4.2-166. *Hypostomus hondae* (Janitor fish).
Source: Merceditas corporation, 2012

It is worth mentioning that according to the red book of Dulceacuicolas fish of Colombia (Mojica, *et al.*, 2012) this species was considered in 2002 with a risk of vulnerability (Vu), while in 2012 its degree of threat decreased. This is because there is no known population estimate and an anthropogenic activity which is causing environmental deterioration where this species is present generates some threat (Mojica, *et al*., 2012). However, Resolution 0192 of February 10 - 2014 from Ministry of environment and sustainable development, this species does not present any degree of vulnerability.

In addition, the species *Lasiancistrus caucanus* (Corroncho barbado) was identified from the Loricariidae family (see Illustration 4.2-167) at the stations P-02, P-03, P-05, P-06 y P-08. This species is distributed in the basin Magdalena River, high level and bellow Cauca, high and Middle Sinu (Ortega *et al*. 2000, 2002). Inhabits small and medium rivers depths between 0.10- 1.20 meters (Villa *et al.,* 2007). With rocky-clayey-sandy bottoms, with presence of river vegetal which is substrated, fallen leaves, trunks and submerged branches. Its feeding habits are not known, but due to the characteristics of its habitat it is apparently detritivore (Ortega *et al.*, 1999, 2002).

Illustration 4.2-167. *Lasiancistrus caucanus* (Corroncho barbado).
Source: Merceditas Corporation, 2012

Finally, the *Chaetostoma brevilabiatum* (Corroncho) (see Illustration 4.2-168) belonging to the Loricariidae family was registered at stations P-03, P-10 y P-11. This species is found in rivers and streams rich in oxygen and moderate currents. It is located in tributaries of the Magadalena River, between Nare and Ite Rivers (Municipality of Remedios, Antioquia) (Maldonado *et al.,* 2005). Although this species has been little studied since there are no studies of its habitat and diet.

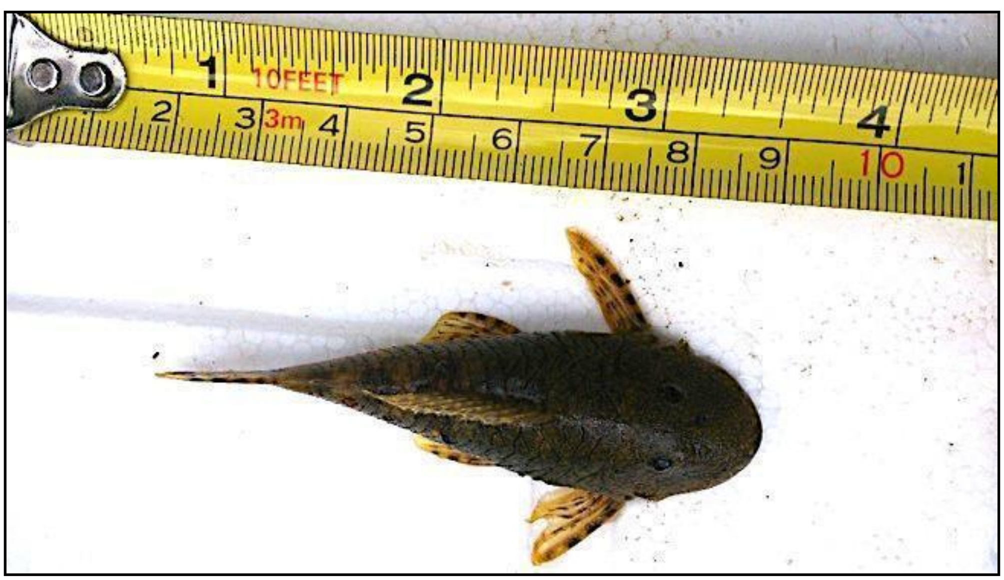

Illustration 4.2-168. *Chaetostoma brevilabiatum* (Corroncho).
Source: Merceditas Corporation, 2012.

The results gotten for the species *Philomela charges* (Capitate) (Illustration 4.2-169) of the Eupatridae family were recorded between sampling points P-09, P-10 y P-11. This species especies is located in the basin of Magdalena River and its tributaries (Catatumbo River, Black river, Rancheria River, San Jorge River, San Juan River and Sinu River (Dahl, 1971; Galvis *et al.,* 1997; Mojica, 1999).

P. charges prefers the moderate current, clear waters with predominance of rocky substratum, thick gravels or palisades. On the other hand, it is considered that the diet of this fish is omnivorous according to López (2013). It should be noted that no risk of vulnerability is considered, neither in the red book of fish of Colombia (Mojica, et al., 2012), nether in the resolution 0192 of February 10, 2014 of the Ministry of environment and sustainable Development.

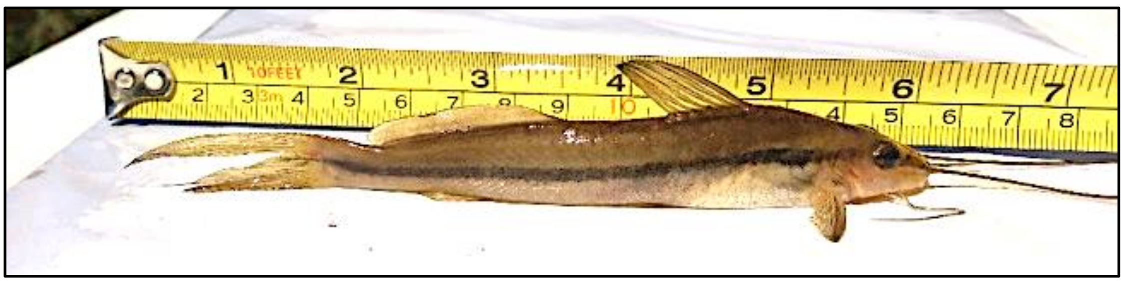

Illustration 4.2-169. *Philomela charges* (Capitate).
Source: Merceditas corporation, 2012.

On the other hand, the species *Rhamdia quelen* (Black bearded) (see Illustration 4.2- 170) of Eupatridae family was recorded in most of the sampling points except stations P-01, P-04, P-05 y P-06. The Black bearded is located in habitats with strong currents as well as lentic waters of small streams, medium and large rivers. This species has nocturnal habits and has an omnivorous diet which consists in aquatic macroinvertebrates, other fish and vegetative material (fruits, seeds and flowers) that fall into the water, which is evidence by a very flexible diet (Ortega *et al*., 1999, 2000, 2002).

The species *R. quelen* it is found in the northern región of South America and in Colombia it is distributed in the Magdalena, Cauca, Sinu, San Jorge, Patía, San Juan, Atrato, Telembí, Dagua, Truandó, Sucio, Condoto, Catatumbo, Orinoco and Amazonas rivers. That implies a high spatial distribution in all the main basins of the country.

As well as, the Sternopygidae family was identified with the species *Sternopygus aequilabiatus* (Mayupa, Guayupa or Peinilla) (see Illustration 4.2-171) in the sampling stations P-01, P-02, P-06, P-07, P-08, P-09 y P-10. Mayupa is characterized by living in rocky bottom habitats with river vegetation and fast water flows with a depth 0.30 m a 0.60 m. Its omnivorous diet is composed of unidentified organic matter, fish of the *Astyanax magdalenae species*, vegetative material and aquatic macroinvertebrates (Maldonado et al., 2005). Its distribution is along the basins of the Magdalena and Cauca rivers.

Illustration 4.2- 170. *Rhamdia quelen* (Black bearded).
Source: Merceditas Corporation, 2012

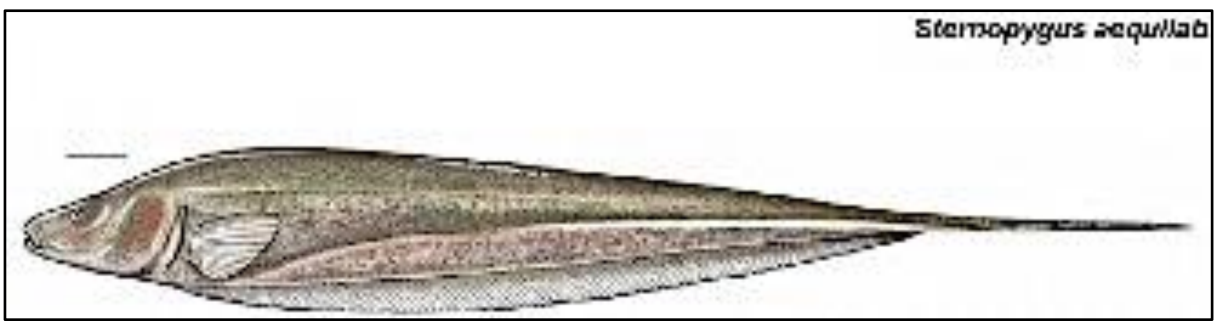

Illustration 4.2-171. *Sternopygus aequilabiatus* (Mayupa, Guayupa or Peinilla).
Source: Maldonado et al., 2005.

Another species identified in the micro basin was *Synbranchus marmoratus* (Water Snake or Anguilla) (see Illustration 4.2-172) belonging to Synbranchidae family, it was recorded at sampling stations P-01, P-02, P-06, P-07, P-08, P-09 y P-10. The *S. marmoratus* is distributed from Mexico Northern Argentina (Kullander, 2003). In Colombia they appear in the lower parts of the Magdalena and Sinú River and are absent in the upper Cauca and in the Andean torrential waters. Their habitats are rocky, Sandy-clayey bottom in order to hide in the day between the substrate, since it is a nocturnal fish (active during the night). They are found in the banks of streams and rivers which moderated and low water flows. Its carnivorous diet consists of small fish, tadpoles and aquatic microinvertebrates (Maldonado et al., 2005). This species can subsist in water as on land because they have facultative breathing which allows them to move a short distance out of the water.

Illustration 4.2-172. *Synbranchus marmoratus* (Water Snake or Anguilla).
Source: Merceditas Corporation, 2012

The species *Andinoacara pulcher* (blue Mojarra) (see Illustration 4.2-173) of the Cichlidae family was identified in the eleven sampling stations being this one of the species that predominated in the sampling made for its high frequency. *A. pulcher* is distributed throughout Magdalena-Cauca basin having its greatest distribution in Magdalena, Atrato, San Juan, Sinú, San Jorge, Cauca, Cesar, Catatumbo rivers and in the highest Magdalena basins (Mojica, 1999). Its omnivorous-insectivorous diet consists diet of feeding in annelids, crustaceans, insects, fish remains and vegetative matter. The blue mojarra is found in low current lenticels and loticos environments.

Illustration 4.2-173. *Andinoacara pulcher* (Blue Mojarra).

Source: Merceditas corporation, 2012

According to the captured organisms it was proved the presence of Ciclidae family with *Caquetaia kraussii* (yellow mojarra or Mulita) (see Illustration 4.2-174) in all the sampling stations having a greater predominance compared with the other species. *C. kraussii* is native to Venezuela and Colombia, and is found in the Atrato, Sinú, San Jorge, Cesar, Cauca, Magdalena, Catatumbo rivers among others (Dahl, 1971; Galvis *et al.,* 1997; Mojica, 1999; Ortega *et al*., 2002; Kullander, 2003).

Yellow Mojarra is considered a voracious species because it is and aggressive and territorial fish, they are located in lentic Zones where they catch their prey. Its carnivorous diet consists of fish, insects and aquatic macroinvertebrates (Ortega *et al.,* 2002).

The species *Caquetaia umbrifera (*Mojarra) (see Illustration 4.2-175) of the Cichlidae family, which was located in the sampling stations P-02, P-03, P-07, P-08, P-09, P-10 y P-11 is distributed from Panama to Colombia; in our country it has been reported in the Atrato river and in the Magdalena river basin, it is found in certain tributaries and in the middle and high of Sinú (Dahl, 1971; Miles, 1971; Eigenmann, 1922 From Maldonado *et al.,* 2005). Despite its high geographic distribution in northern South America, it is nowhere abundant and has a low frequency of capture in the basins of the country.

Illustration 4.2-174. *Caquetaia kraussii* (Yellow Mojarra or Mulita).
Source: Merceditas corporation, 2012

The *C. umbriefera* prefers small rivers with slow waters formed by gravel, sand and clay. It is an omnivorous species and feeds on fish, aquatic macroinvertebrates, fruits and seeds that reach the water. This species is distinguished for its quality and meat.

It is to indicate that according to the red book of dulceacuicolas fish of Colombia (Mojica, *et al.*, 2012) this species was considered in the 2012 almost threatened. This is due to the fact that a population estimate it is not known and due to its high selectivity in the micro-habitats it restricts its presence in particular areas of the basins (Mojica, *et al*., 2012). On the other hand, in Resolution 0192 of February 10, 2014 of the ministry of environment and sustainable development, the *Caquetaia umbrifera* species is not considered with any degree of vulnerability because it does not appear in the resolution stipulated in 2014.

At the end, the last identified organism belongs to the Cichlidae family with the species *Geophagus steindachneri* (hunchback) (see Illustration 4.2-176). It is distributed in the Magdalena river basin and considered an omnivorous species.

Illustration 4.2-175. *Caquetaia umbrifera* (Mojarra).
Source: Merceditas corporation, 2012

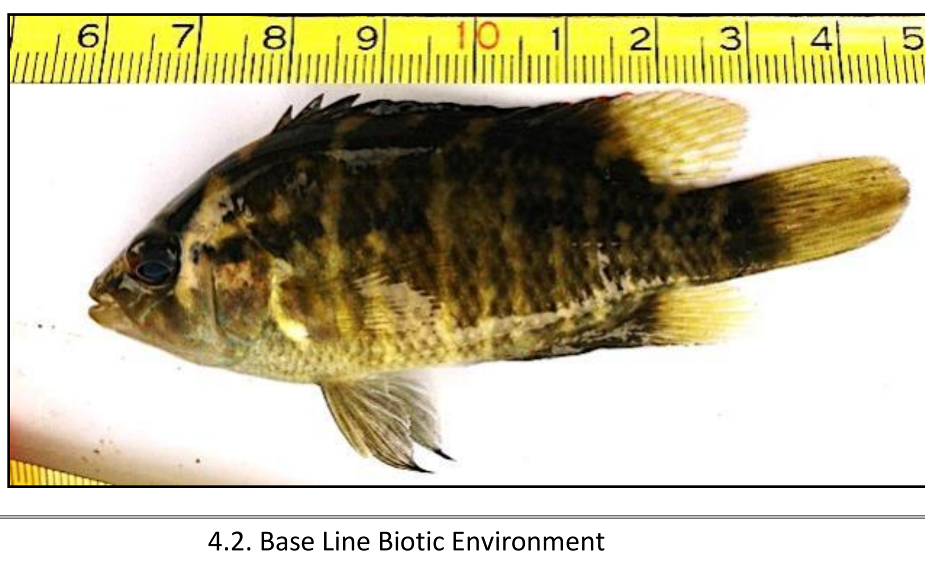

Illustration 4.2-176. *Geophagus steindachneri* (hunchback).
Source: Merceditas corporation, 2012

4.2.5.1.4 Diversity Rates

Below are alpha and beta rates

Alpha Diversity

In general terms, no meaningful differences were found in the alpha diversity rates evaluated (Simpson, Shannon y Margalef) between the sampling stations studied. The Margalef rate for all stations oscillated between 0,77 y 2,69 without significant differences between them (X^2=1,6528; p=0,99) (Illustration 4.2-177). This similarity may be due to the bias introduced by the large number of characiform species found in all the sampling stations.

For the Simpson diversity rate, no significant differences were found between the sampling stations (X^2=2,8908; p=0,98) neither for Shannon rate (X^2=0,6852; p=1) (Illustration 4.2-177). Possibly the lack of fish diversity in the study is due to the fact that they are micro basins that supply larger basins, where few species use them to feed or reproduce. (Mojica et al., 2012).

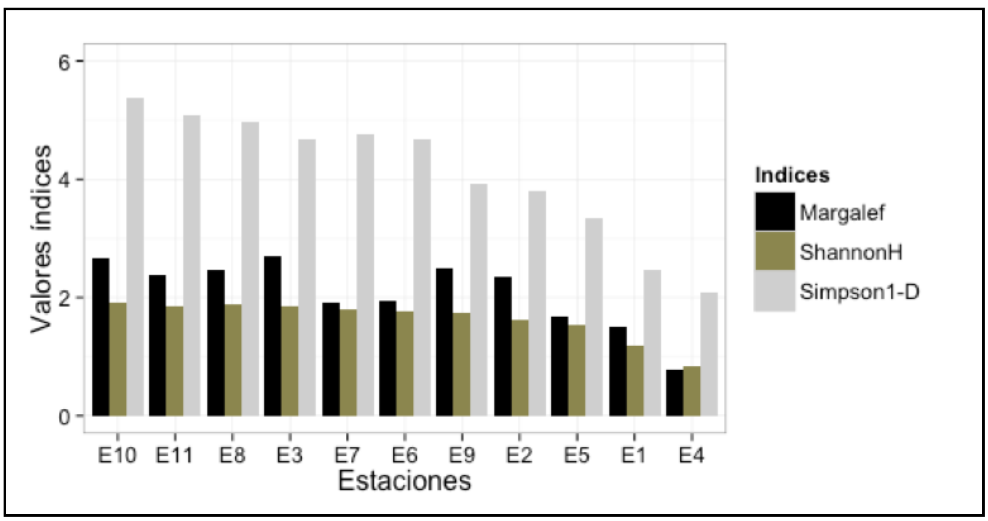

Illustration 4.2-177. Graph of diversity rates, heterogeneity and dominance (Margalef, Shannon y Simpson) in fish per sampling station
Source: INGEX, 2016

Beta Diversity

The analysis of similarity between sampling stations for fish, based on the dendrogram of the similarity distances of Bray-Curtis showed that there is a greater similarity between the stations

P-02 and P-05, being two of the most diverse. In general, all the stations show a high similarity in fish composition, taking into account the movement patterns of this taxon (Illustration 4.2-178).

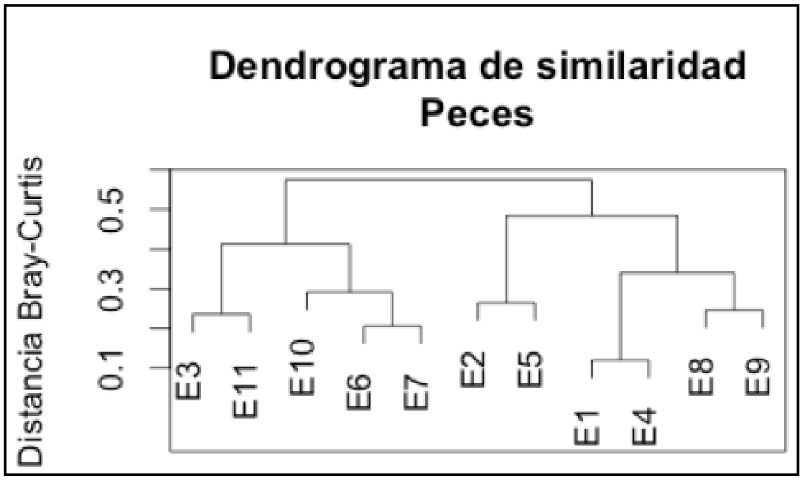

Illustration 4.2-178. Graph of analysis of the beta diversity of fish between sampling stations based on a dendrogram.
Source: INGEX, 2016

4.2.5.1.5 Trophic Guilds

The ichthyofaunal has a very varied diet; they are generally omnivorous (53% of the recorded species). For this sampling was used secondary information about the diet of individuals (Perdomo, 1978; Galvis et al., 1997; Jiménez et al., 1998; Mojica, 1999; Ortega et al., 1999; Ortega et al., 2000; Ortega et al., 2002; Kullander, 2003; Ortaz et al., 2003; Maldonado et al., 2005; Maldonado et al., 2008; Pérez and Prada, 2011; Restrepo and Mancera, 2011; Mojica et al., 2012; López, 2013; Jiménez et al., 2014) (see Table 4.2-1).

Table 4.2-1. Food of the reported fish species group

SPECIES	TROPHIC GUILDS	ITEMS
Prochilodus magdalenae Steindachner, 1879	Detritivore	Detritus, decomposition of organic matter
Bryconamericus sp	Omnivorous	Periphyton, Insects
Astyanax fasciatus (Cuvier, 1819)	Omnivorous	Aquatic plants, phytoplankton and macroinvertebrate
Roeboides dayi Steindachner, 1878	Omnivorous	Falkes, worms, Zooplankton and aquatic Macroinvertebrates (Ephemeroptera, Odonata and Diptera)
Hoplias malabaricus (Bloch, 1794)	Carnivore	Insects, Crustaceans and fish
Lebiasina Sp	Omnivorous	Periphyton, Phytoplankton e Insects
Brycon henni Eigenmann, 1913	Omnivorous	Vegetable material, Seeds, Insects and aquatic Macroinvertebrates (Ephemeroptera, Diptera and trichoptera), Crustaceans and fish
Saccodon dariensis Meek y Hildebrand, 1913	Omnivorous	Falkes, vegetable material and aquatic Macroinvertebrates (Trichoptera, Diptera, Odonata and Lepidoptera)

SPECIES	TROPHIC GUILDS	ITEMS
Hypostomus hondae Regan, 1912	Detritivore	Detritus and Falkes
Lasiancistrus caucanus Eigenmann, 1912	Detritivore	Their diet is not known
Chaetostoma brevilabiatum Dahl, 1941	Their diet is not known	Their diet is not known
Philomela charges Steindachner, 1876	Omnivorous	Periphyton, phytoplankton and Insects
Rhamdia quelen Quoy & Gaimard, 1824	Omnivorous	Aquatic Macroinvertebrates, other fish, and vegetable material (fruits, seeds and flower)
Sternopygus aequilabiatus Humboldt, 1811	Omnivorous	Unidentified organic matter, fish of the species astyanax magdalenae, vegetable material and aquatic macroinvertebrates
Synbranchus marmoratus Bloch, 1975	Omnivorous	Fish, tadpoles and aquatic Macroinvertebrates
Andinoacara pulcher (Gill, 1858)	Omnivorous	Annelids, Crustaceans, Insects, remains of fish and vegetable
Caquetaia kraussii (Steindachner, 1879)	Carnivore	Fish, Insects and aquatic Macroinvertebrates
Caquetaia umbrifera (Meek y Hildebrand 1913)	Omnivorous	Fish, aquatic Macroinvertebrates, Fruits and Seeds
Geophagus steindachneri Eigenmann &Hildebrand, 1910	Omnivorous	Periphyton, phytoplankton Insects and fish

Source: FuPerdomo, 1978; Galvis et al., 1997; Jiménez et al., 1998; Mojica, 1999; Ortega et al., 1999; Ortega et al., 2000; Ortega et al., 2002; Kullander, 2003; Ortaz et al., 2003; Maldonado et al., 2005; Maldonado et al., 2008; Pérez & Prada, 2011; Restrepo & Mancera, 2011; Mojica et al., 2012; López, 2013; Jiménez et al., 2014

4.2.5.1.6 Migratory and endemic species

In order to identify migratory species of fish in the field were previously consulted sources as of Jiménez-Segura *et al*. 2010 From Mojica *et al.,* 2012 and Perdomo 1978, Jiménez *et al.* 1998.

Additionally, in the samplings carried out, the species *Prochilodus magdalenae was identified (*Bocachico) between the stations P-09 y P-10. In the area this fish is only seen in rainy season, mainly due to the increase in flow. This species is considered endemic to Colombia in the Magdalena basin (Maldonado et al., 2008), and is one of the most studies fish in the country for its great economic importance. This is mainly due to the reproductive, genetic, population and migratory aspects in the Magdalena and Atrato basins. The high fecundity rate of the female allows this species to have populations that recover drastically for a high mortality where there is spawning. However, according to Mojica *et al.* (2012) this species was considered vulnerable in 2012 and according to resolution 0192 of 2014 of the Ministry of environment and sustainable development, currently is one of the species with a high degree of vulnerability for its importance in the commercial distribution and consumption.

The life cycle of this species is closely related to the hydrological patterns of flooding and low levels affecting factors such as feeding, growth and reproduction. In general, during the high waters it remains in the swamps feeding on the detritus coming for the decomposition of the organic matter contributed mainly by the aquatic vegetation (macróphyites) and in low waters they go to rivers or the deeper areas where they feed on algae adhered to rocks and submerged trunks (Mojica *et al.,* 2012).

It is worth nothing that the life cycle of this species is due to migration in the months of December to January, with the beginning of low waters, where there is a massive migration known as ¨la subienda¨. In months of March to April, with rainy season, they return to the marshes known as ¨bajanza¨, during their displacement the spawning take place. On the other hand, for the Magdalena river basin, this species carries out a second annual migration upstream, on a smaller scale, during the months of July and August, with return in September and October (Valderrama Et al. 2011 taken from Mojica *et al.,* 2012). Both annual migrations coincide with reproductive terms, evidenced by increases in the concentrations of larvae of the species in the waters of the Magdalena River, during the two annual terms of water rise (Jiménez-Segura Et al. 2010 taken from Mojica *et al.,* 2012).

On the other hand, Bryconinae subfamily with the species *Brycon henni* (Sabaleta) (see Illustration 4.2-179) appeared in most sampling stations, except P-01 y P-04, and is one of the most important endemic migratory species of the central mountain range of Colombia. Its spatial distribution shelters the rivers that descend towards the valleys formed by the Magdalena river, by the right margin towards the center-east of the National territory, and the Cauca river, by the left margin towards the center –west of the country (Dahl, 1971; Mojica, 1999), where it is located in the departments as Antioquia, Cauca, Caldas and Valle.

B. henni has an omnivorous diet and its vital source of food is vegetative material, seeds and aquatic macroinvertebrates: mainly ephemerae, diptera and tricoptera, as well as crustaceans and fish (Jiménez *et al*., 2014). The last coincides with the abundance and richness found in the community of aquatic invertebrates recorded in all the sampling stations. Its habitat are rivers with fast and turbulent zones that flow through channels with rocky substratum and clean waters for the captured of food. In addition, it is a prefered species for sport fishing for its intense fighting behaviour before catching it with Hood, in addition to its good taste and quality of it meat.

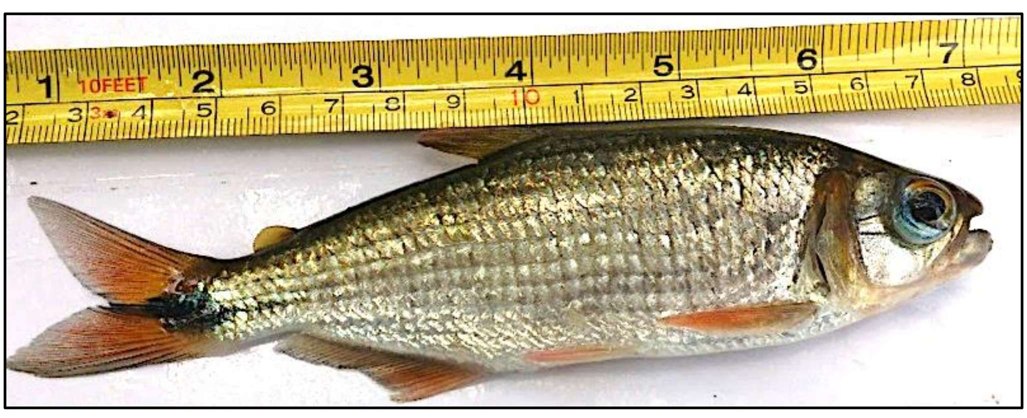

Illustration 4.2-179. *Brycon henni* (Sabaleta)
Source: Merceditas corporation, 2012

It is noteworthy that the migration of the species *B. henni* is lateral displacements, main channels to streams or movement upstream. These migrations are short distances and occur mainly as protection movements, since it is considered that it moves in search of ideal water conditions (transparency and temperature), por this is considered a migration of protection and not neccesarily of reproduction (Perdomo 1978, Jiménez et al. 1998).

4.2.5.1.7 Fish conservation status

In the Table 4.2-2 species with degrees of threat are presented according to resolution 0192 of 2014 and the red book (Resolution 0192 of 2014 - Mojica et al, 2012) (see Table 4.2-2).

Table 4.2-2. Species of fish with some degree of recorded threat

ORDER	FAMILY	SPECIES	RESOLUTION 0192 OF 2014	RED BOOK (MOJICA et al, 2012)
Characiformes	Prochilodontidae	Prochilodus magdalenae Steindachner, 1879	Vulnerable	Vulnerable
	Parodontidae	Saccodon dariensis Meek y Hildebrand, 1913	N. R	Least concern
Siluriformes	Loricariidae	Hypostomus hondae Regan, 1912	N. R	Nearly threatened
Perciformes	Cichlidae	Caquetaia umbrifera (Meek y Hildebrand 1913)	N. R	Nearly threatened

Source: Resolution 0192 of 2014 - Mojica et al, 2012.

4.2.5.2 AQUATIC MACROINVERTEBRATES

In Table 4.2-3 the data on taxonomic distribution, richness and number of aquatic macroinvertebrates organism collected in the quantitative sample are presented. As well as, in the sourceTable *4.2-4* The taxonomic distribution and wealth in the eleven stations of the qualitative sampling.

Table 4.2-3 Spatial distribution of aquatic macroinvertebrates collected in the quantitative sample.

ORDER	FAMILY	GENUS	SAMPLING STATIONS IN THE MICROBASIN										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
Haprotaxida	Tubificidae	*undetermined*			2								
Hemiptera	Naucoridae	*Limnocoris*				3							
		Cryphocricos					1		1				
		Pelocoris				1	1						
	Vellidae	*Rhagovelia1*	1					1	1				
		Microvelia					1						
	Notonectidae	*Notonecta*										3	
Ephemeroptera	Leptophlebiidae	*Thraulodes*		1	3		3	8	10	2	2	5	11
	Baetidae	*undetermined*									5		
		Camelobaetius			3							4	

ORDER	FAMILY	GENUS	SAMPLING STATIONS IN THE MICROBASIN										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
		Baetodes					21	5				1	
		Baetis	3	9	2	1	1	4	5	3	1	4	1
	Tricorythidae	*Tricorythodes*								1		1	
		Leptohyphes	7	6	2		6	2	2	1	3		2
Odonata	Coenagrionidae	*Argia*				2							
	Calopterygidae	*Hetaerina*		1									
	Libellulidae	*Macrothemis*		1					1				
		Brechmohoga			1		1				1	3	
		undetermined					1						
Coleóptera	Elmidae	*Cylloepus(ad)*					4					1	
		Mrcrocylloepus								1			
		Heterelmis (ad)	1	1		2							
		Pseudodisersus					1						
	Ptilodactylinidae	*Tetraglossa*					1						
	Psephenidae	*Psephenops*								2			
	Hydrophilidae	*Enochrus*											1
Trichoptera	Helicopsichidae	*Helicopsyche*				1							
	Hydropsychidae	*Leptomena*	1	2	2	1	3				1		1
		Smicridea	1	7		2	6	5	2	1	8	1	15
	Leptoceridae	*Atanatólica*	1			1							
	Philopotamidae	*Chimarra*	1	4	6		2	4			4		9
	Polycentropodidae	*Polycentropus*							1	2			
Plecoptera	Perlidae	*Anacroneuria*					2	3	1				
Neuroptera	Corydalidae	*Corydalus*		1									
Lepidoptera	Pyralidae	*undetermined*	5	4			1	4	1				
Díptera	Chironomidae	*undetermined*	38	12			22	1	2	2	4	3	4
		Chironomus								2			
	Simuliidae	*Simullium*	26	3	11		31	2		3	5	2	
	Tipulidae	*Limoniinae*				1							
		Hexatoma			1	1	2						
		Molophilus			1							2	
	Culicidae	*Anopheles*								2			
TOTAL NUMBER OF ORGANISMS			85	52	34	16	111	39	27	22	34	30	44
WEALTH			11	13	11	11	20	11	11	12	10	12	8

Source: Merceditas corporation, 2012

Table 4.2-4. Spatial distribution of aquatic macroinvertebrates collected in the qualitative sample.

ORDER	FAMILY	GENUS	SAMPLING STATIONS IN THE MICROBASIN										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
Haplotaxida	Tubificidae	*undetermined*			x								
Hemiptera	Naucoridae	*Limnocoris*	x	x		x							
		Cryphocricos					x		x				
		Pelocoris				x	x						
	Vellidae	*Rhagovelia*	x		x	x		x	x		x		
		Microvelia			x		x		x				
	Notonectidae	*Notonecta*										x	
Ephemeroptera	Leptophlebiidae	*Thraulodes*	x	x	x		x	x	x	x	x	x	x
	Baetidae	*Sin determinar*									x		
		Camelobaetius			x				x	x		x	
		Baetodes					x	x		x	x	x	
		Baetis	x	x	x	x	x	x	x	x	x	x	x
	Tricorythidae	*Tricorythodes*								x		x	
		Leptohyphes	x	x	x		x	x	x	x	x	x	x
	Euthyplociidae	*Campylocia*						x					
Odonata	Coenagrionidae	*Argia*	x			x	x						
		Telebasis		x	x				x				x
	Calopterygidae	*Hetaerina*		x					x		x		x
	Gomphidae	*Phyllogomphoides*									x		
	Libellulidae	*Macrothemis*		x	x				x				
		Brechmohoga			x		x			x	x	x	x
		Dythemis							x				
		Sin determinar					x						
Coleóptera	Elmidae	*Cylloepus(ad)*			x		x					x	
		Mrcrocylloepus								x		x	
Coleóptera	Elmidae	*Heterelmis (ad)*	x	x		x							
		Pseudodisersus					x						
	Ptilodactylinidae	*Tetraglossa*					x	x					
	Psephenidae	*Psephenops*								x		x	
	Hydrophilidae	*Enochrus*										x	x
Trichoptera	Helicopsichidae	*Helicopsyche*				x							
	Hydropsychidae	*Leptomena*	x	x	x	x	x				x		x
		Smicridea	x	x		x	x	x	x	x	x	x	x
	Leptoceridae	*Atanatólica*	x	x		x							
	Philopotamidae	*Chimarra*	x	x	x		x	x		x	x	x	x
	Polycentropodidae	*Polycentropus*							x	x			
Plecoptera	Perlidae	*Anacroneuria*					x	x	x	x	x	x	
Neuroptera	Corydalidae	*Corydalus*		x			x					x	
Lepidoptera	Pyralidae	*undetermined*	x	x			x	x	x				
	Noctuidae	*undetermined*	x										
Díptera	Chironomidae	*undetermined*	x	x		x	x	x	x	x	x	x	x

ORDER	FAMILY	GENUS	SAMPLING STATIONS IN THE MICROBASIN										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
		Chironomus								x			
	Simuliidae	*Simullium*	x	x	x		x	x	x	x	x	x	
	Tipulidae	*Limoniinae*				x							
		Hexatoma			x	x	x						
		Molophilus			x						x	x	
	Culicidae	*Anopheles*								x			
Basommatophora	Ampullariidae	*Pomacea*				x	x						
Acarina	Hydrachnidae	*hidracarido*						x					
WEALTH			**15**	**16**	**16**	**14**	**23**	**14**	**17**	**17**	**16**	**19**	**11**

Source: Merceditas corporation, 2012

According to the tableTable 4.2-3 and source: Table *4.2-4* it is observed that in the eleven sampling stations a total of 49 morphotypes were identified, of which 23 were identified in the station P-05, 19 in P-10, 17 in stations P-07 y P-08, 16 in stations P-02, P-03 y P-09, 15 at station P-01, 14 at stations P-04 y P-06, and 11 at the site stablished downstream of the microbasin as P-11. This indicates tha there are significant differences between sampling stations with respect to quantitative and qualitative methods in relation to taxonomic wealth.

4.2.5.2.1 Spatial distribution of aquatic macroinvertebrates collected in the different sampling stations

Significant differences were found between stations P-05 y P-01 and the other sampling stations where macroinvertebrates were recorded (X2=182, 6559; p=<0,001). The stations with the highest abundance (P-05 y P-01) did not show significant differences between them (X2=3,449; p=0,06) (Illustration 4.2-180). The orders with greater wealth within the sampling term were Ephemeroptera, Coleopterous y Dipterous with 7 registered species each. The Most representative family was Baetidae with 4 species.

Regarding relative abundance, taking into account the categorization of abundance for species (see methodology) the most abundant genus were *Simulium* sp and *an* unidentified genus (relative abundance >10%). On the other hand, 8 common genera were found (relative abundance between 2 and 10%) (Illustration 4.2-180). The remaining 32 genera were uncommon (relative abundance between 0,1 y 2%)

P-01 Station

In Illustration 4.2-181 it can be seen that in P-01 station, the highest contributions of organisms correspond to the dipterous Chironimidae (38 ind) and Simullium (26 ind), followed by Leptohyphes (7 ind), Pyralidae (5 ind) and Baetis (3 ind); in addition, the smallest contribution was given to a single individual Atanatólica, Heterelmis (ad), Chimarra, Rhagovelia1, Leptomena y Smicridea.

Families Chironomidae and Simuliidae (See Illustration 4.2-182 and Illustration 4.2-183) according to Caicedo *et al* (2004) are aquatic macroinvertebrates which have a high degree of saprobity. In the relation to the above and to the composition of the collected simple in P-01 it can be inferred that this site presents a water quality established in a range of good to slightly contaminated.

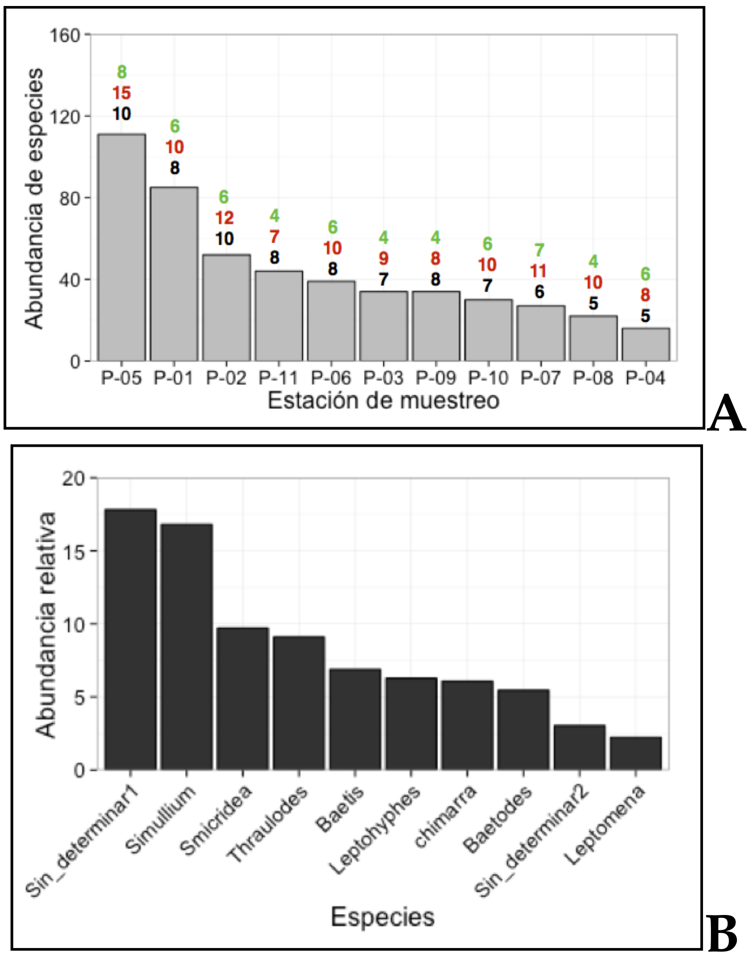

Illustration 4.2-180. A. Graph of the abundance and wealth of macroinvertebrates species by sampling stations (The black numbers above indicate the species wealth of families; red numbers indicate wealth of families and the green numbers show wealth of orders of orders for each coverage). B. Graph of the relative abundance of abundant And common macroinvertebrate species.

Source: INGEX, 2016

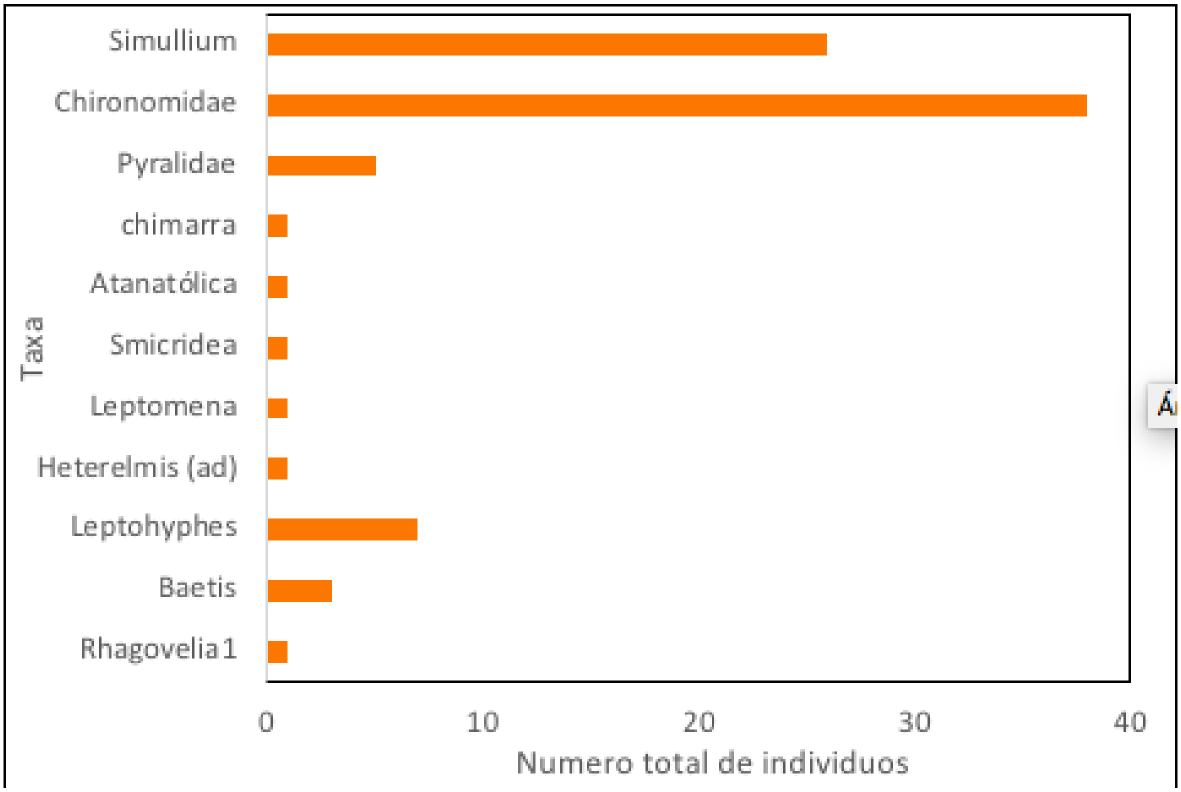

Illustration 4.2-181. Number of individuals found at stations P-01.
Source: INGEX, 2016.

P-02 Station

The number of organisms collected in the station P-02 (see Illustration 4.2-184), was 52 individuals, where the taxons with the highest prevalence were Chironomidae (12), Baetis (9), Smicridea (7 ind) (See Illustration 4.2-185 and Illustration 4.2-186), Letohyphes (6 ind), Chimarra (4 ind) and Perlydae (4 ind). likewise, the lowest contribution of aquatic macroinvertebrates in P-02 was of the morph *Simullium* (3 ind), *Leptomena* (2 ind), *Corydalus* (1 ind), *Heterelmis* (1 ind), *Thraulodes* (1 ind), *Macrothemis* (1 ind) and *Hetaerina* (1 ind).

Illustration 4.2-182. Chironomidae.
Source*: Merceditas corporation, 2012*

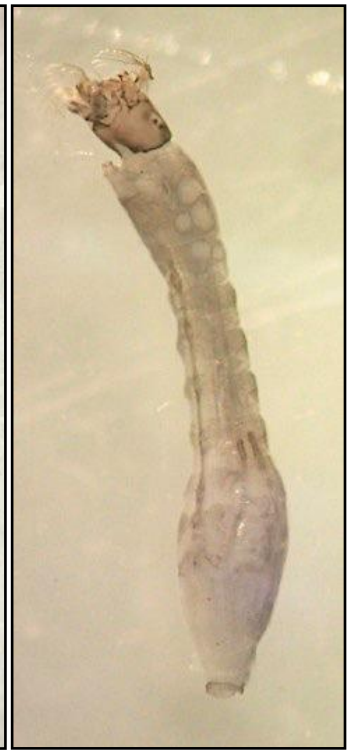

Illustration 4.2-183. Simuliidae.
Source: Merceditas corporation, 2012

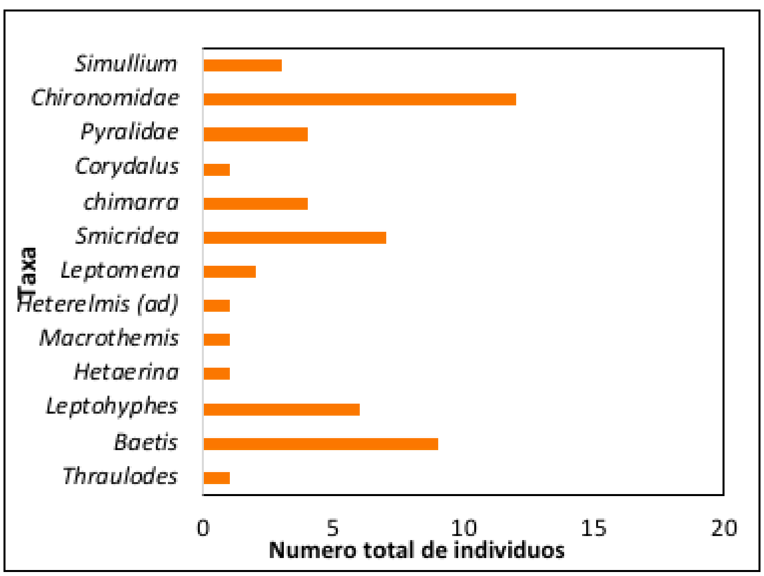

Illustration 4.2-184. Number of individuals found at station P-02
Source*: Merceditas Corporation, 2012*

Illustration 4.2-185. Smicridea.
Source: Merceditas corporation, 2012

Illustration 4.2-186. Baetis.
Source: Merceditas corporation, 2012
.

Based on the characteristics of captured organisms and their eco-phyisiology. It can be stimated that the P-02 station represents good quality environments with a begining stage of contamination.

P-03 Station

Of the 34 individuals collected at the station P-03 (see

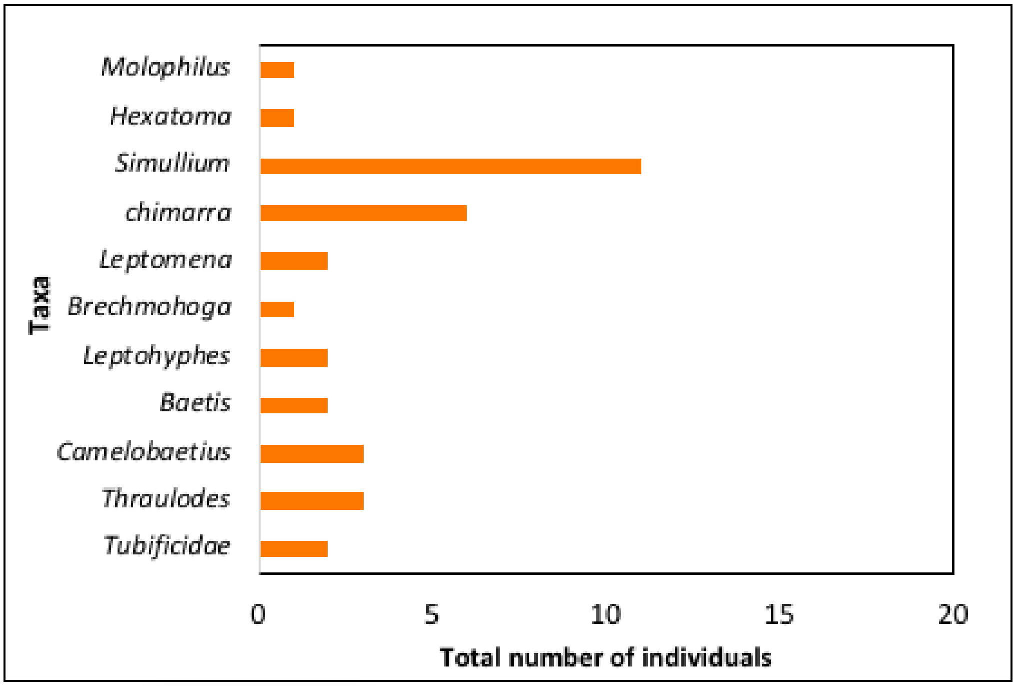

Illustration 4.2-187), the organisms with the highest representation were *Simullium* (11 ind) and *Chimarra* (6 ind), followed by *Camelobaetius* and *Thraulodes* with three individuals each one. Likewise, the smallest contribution of aquatic macroinvertebrates was found in the morphotypes Tubificidae (2 ind), *Baetis* (2 ind), *Letohyphes* (2 ind), *Leptonema* (2 ind), *Molophilus* (1 ind), *Hexatoma* (1 ind) y *Brechmorhoga* (1 ind).

According to Caicedo *et al* (2004) and Roldan (1992, 1999 y 2003) Philopotamidae and Leptophlebiidae families are representives of clean waters. However, the rest of the registered families in this simpling station are indicators of environments slightly contaminated, such as Tipulidae and Tubificidae (See Illustration 4.2-188) that are specific reveals of contamination by organic matter.

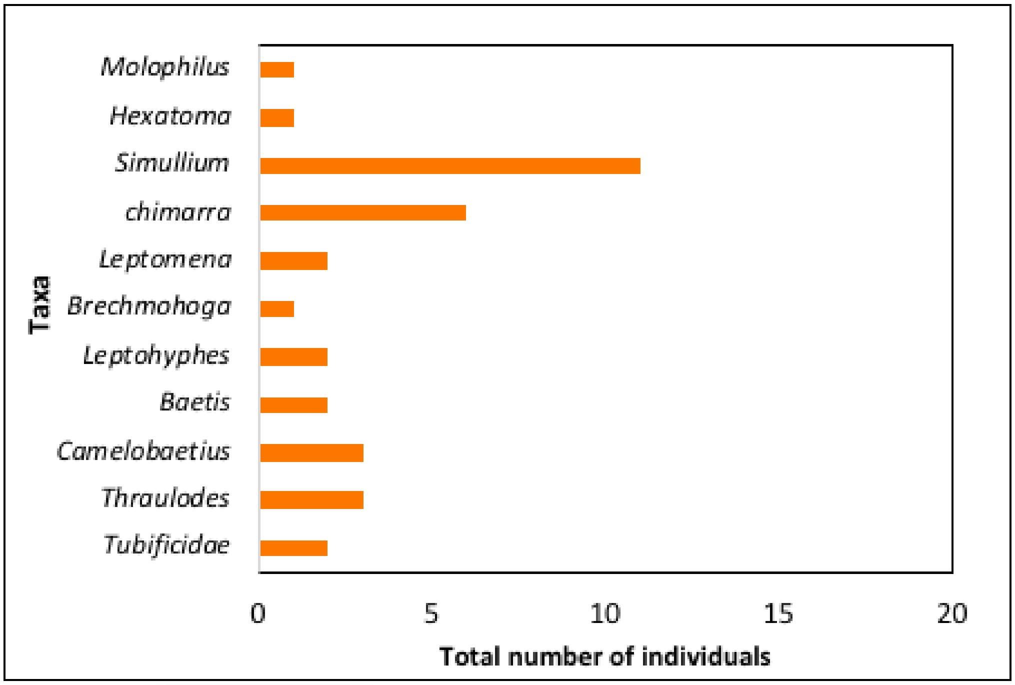

Illustration 4.2-187. Number of individuals found at station P-03.
Source: INGEX, 2016.

Illustration 4.2-188. Tubificidae
Source: Merceditas corporation, 2012

P-04 Station

The station P-04 presented the lowest number of organisms collected (16 ind), where *Limnocoris* (3 ind), *Argia* (2 ind), *Smicridea* (2 ind) and *Heterelmis* (2 ind) were the most representative in the collected sample. While Pelocoris, *Baetis*, *Helicopsyche*, *Leptomena*, *Atanatolica*, Limoniinae and *Hexatoma* were just reported with a single individual collected.

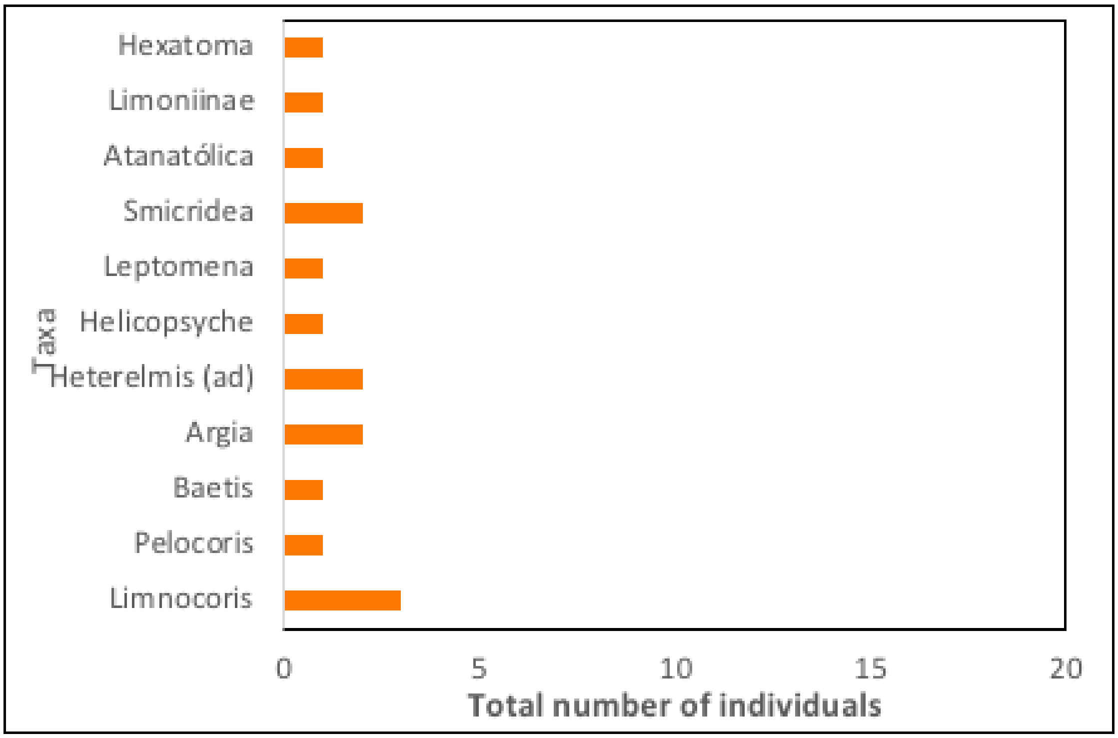

Illustration 4.2-189. Number of individuals found at station P-04.
Source: INGEX, 2016.

P-05 Station

In this station, the largest number of organisms collected in the microbasin was reported, with a total of 111 individuals. Where S*imullium* (31 ind), Chironomidae (22 ind) and *Baetodes* (21 ind) were the main contributors to this sample. On the other hand, they are followed by the morphs Smicridea (6 ind), Leptohyphes (6 ind), *Cylloepus* (ad) (4 ind) and *Leptomena* (3 ind). Finally the organisms Pyralidae (1 ind), *Brechmohoga* (1 ind), *Cryphocricos* (1 ind), *Pelocoris* (1 ind), *Thraulodes* (3 ind), *Baetis* (1 ind), *Pseudodisersus* (1 ind), *Tetraglossa* (1 ind), *Chimarra* (2 ind), *Microvelia* (1 ind), *Anacroneuria* (2 ind) and *Hexatoma* (2 ind) had the lowest contribution of organisms (See Illustration 4.2-190, Illustration 4.2-191 and Illustration 4.2-192).

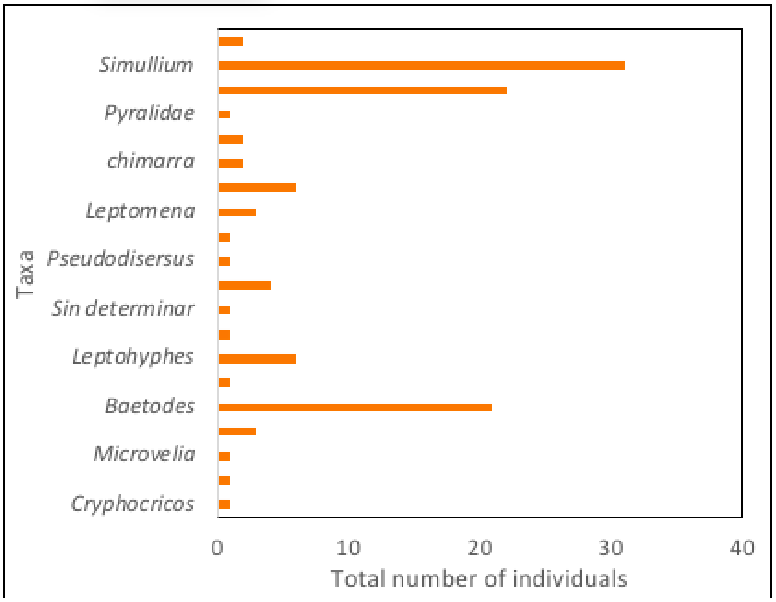

Illustration 4.2-190. Number of individuals found at station P-05.
Source: INGEX, 2016.

Illustration 4.2-191. *Anacroneuria*. *Source: Merceditas Corporation, 2012*

Illustration 4.2-192. *Chimarra*. *Source: Merceditas corporation, 2012*

P-06 station

In the illustration Illustration 4.2-194 the number of individuals per organism is shown. Where the main contributor to the sample of the P-06 station was *Thraulodes* (8 ind) followed by the organisms Baetodes (5 ind), *Smicridea* (5 ind), *Pyralidae* (4 ind), *Baetis* (4 ind), *Chimarra* (4 ind), *Anacroneuria* (3 ind), *Leptohyphes* (2 ind), *Simullium* (2 ind), *Chironomidae* (1 ind) and *Rhagovelia* (1 ind). According to the above, the composition of the sample is more related with organisms from clean environments and without the presence of contamination.

Illustration 4.2-193. *Thraulodes*.
Source: Merceditas Corporation, 2012

P-07 Station

According to the composition of aquatic macroinvertebrates quantified in the P-07 station (Illustration 4.2-196) it was that observed that the most outstanding organisms were *Thraulodes* (10 ind), *Leptothyphes* (2) and *Baetis* (5 ind). Followed by Smicridea and Chironomidae with two organisms while the morphs Pyralidae, *Anacroneuria*, *Polycentropus*, *Macrothemis*, *Rhagovelia* sp1 and *Cryphocricos* were reported with a single individual.

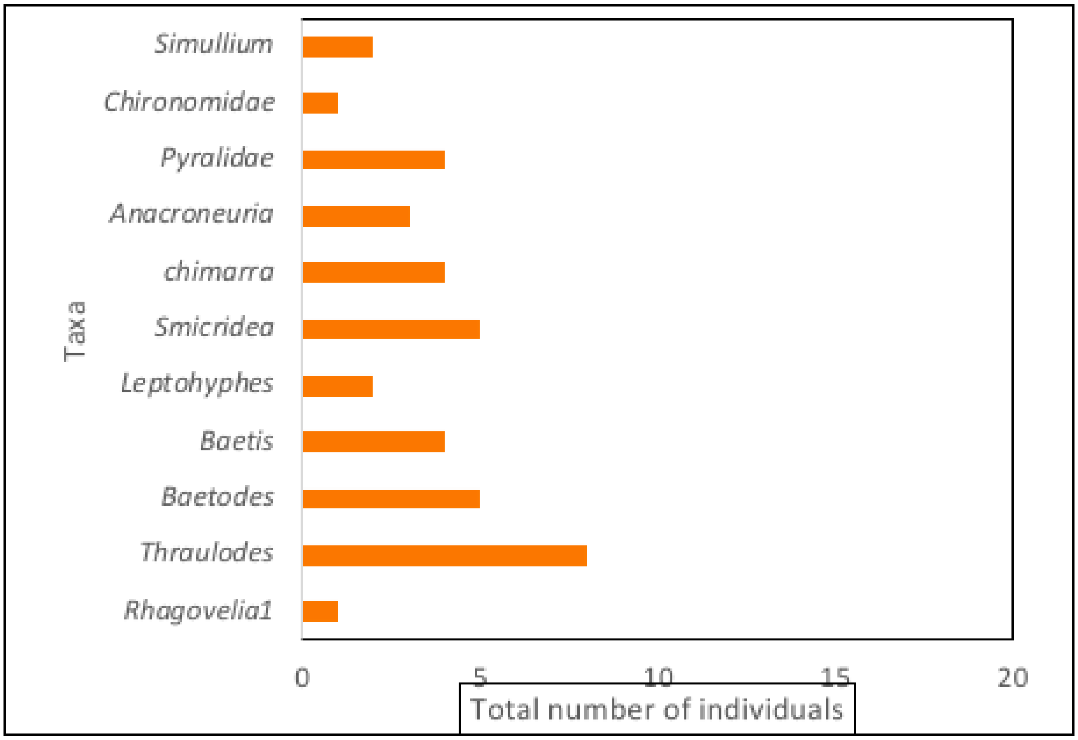

Illustration 4.2-194. Number of individuals found at station P-06.
Source: INGEX, 2016.

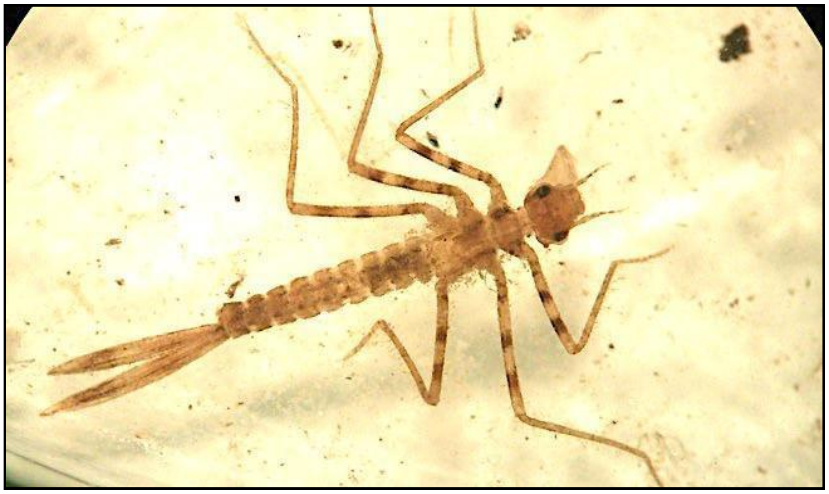

Illustration 4.2-195. *Hetaerina*
Source: Merceditas Corporation, 2012

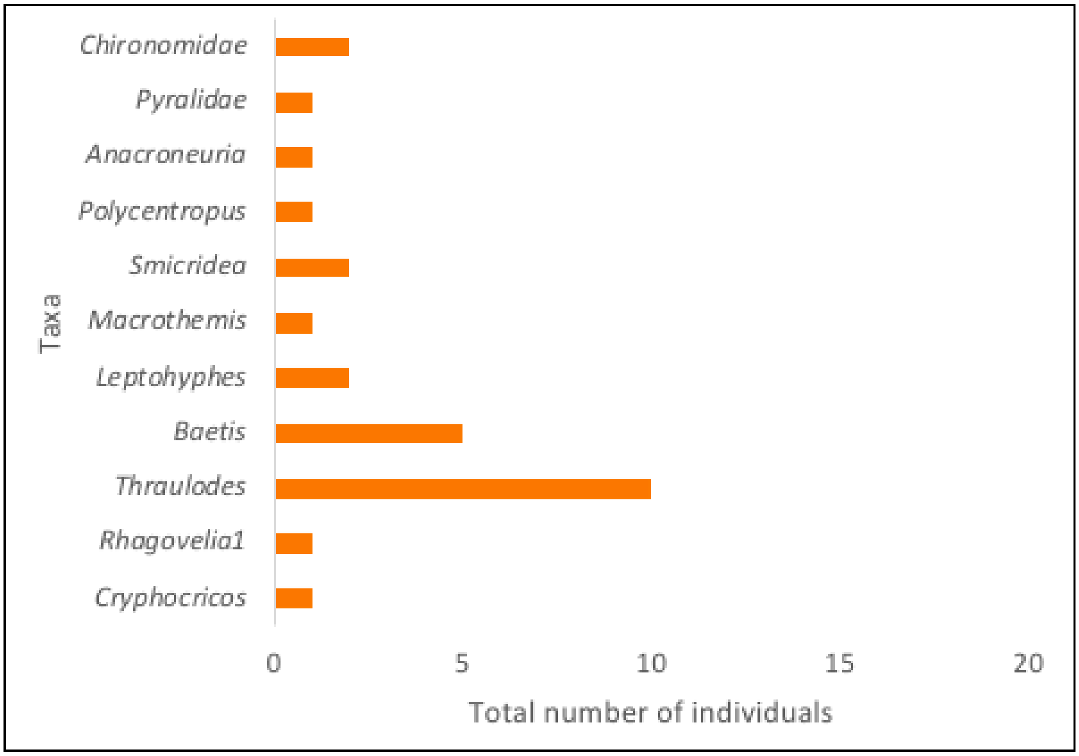

Illustration 4.2-196. Number of individuals found at station P-07.
Source: INGEX, 2016.

P-08 Station

On the other hand, the composition of the simple in station P-08 (See Illustration 4.2-197) did not show a significant amount between organisms, where the largest contributors were *Simullium* and *Baetis* with three individuals each, followed by *Thraulodes, Psephenops, Polycentropus*, Chironomidae, *Chironomus* and *Anopheles* with two individuals per organisms, while *Tricorythodes, Leptohyphes, Mrcrocylloepus* and Smicridea only recorded a single organism.

The P-08 sampling station presented, for the most part, the same biological composition as in the P-06 station, where the most influential taxa were from good quality to slightly contaminated environments. However, an organisms of the family Culicidae was found (*Anopheles*) (see illustration Illustration 4.2-198) that appears in contaminated environments andits indicator of doubful quality due to organic contamination (Roldán, 1998).

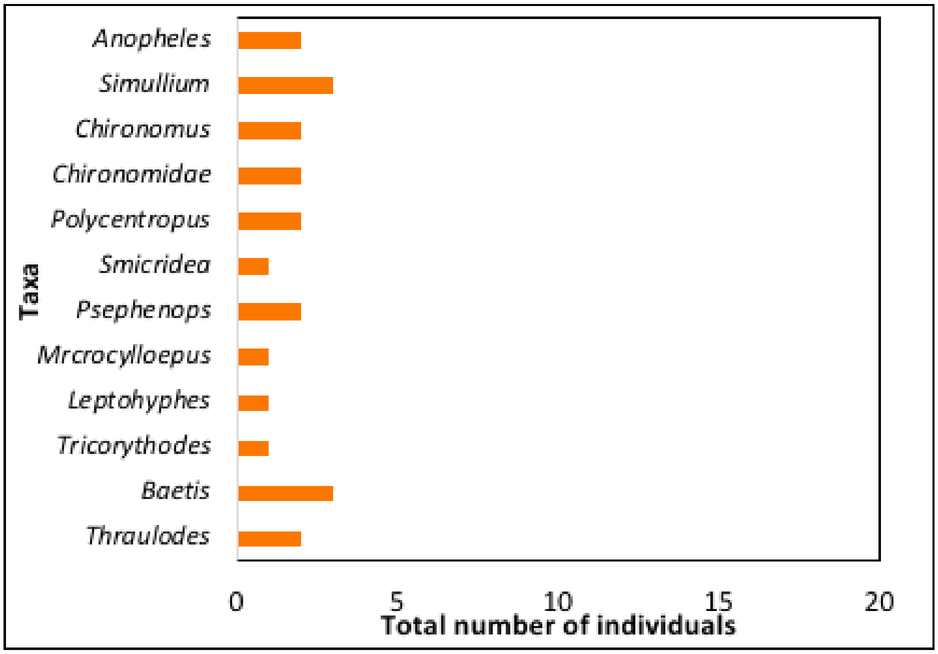

Illustration 4.2-197. Number of individuals found at station P-07 in 2016 year
Source: INGEX, 2016.

Illustration 4.2-198. *Anopheles*
Source: Merceditas corporation, 2012

P-09 station

Regarding the composition of the P-09 station (see Illustration 4.2-199), the most representative morphotypes were Smicridea (8 ind), *Simullium* (5 ind), Baetidae (5 ind), and *Chimarra* (4 ind). Followed by Chironomidae (4 ind), *Leptohyphes* (3 ind), *Thraulodes* (2 ind,) *Baetis* (1 ind), *Brechmohoga* (1 ind) and *Leptomena* (1 ind).

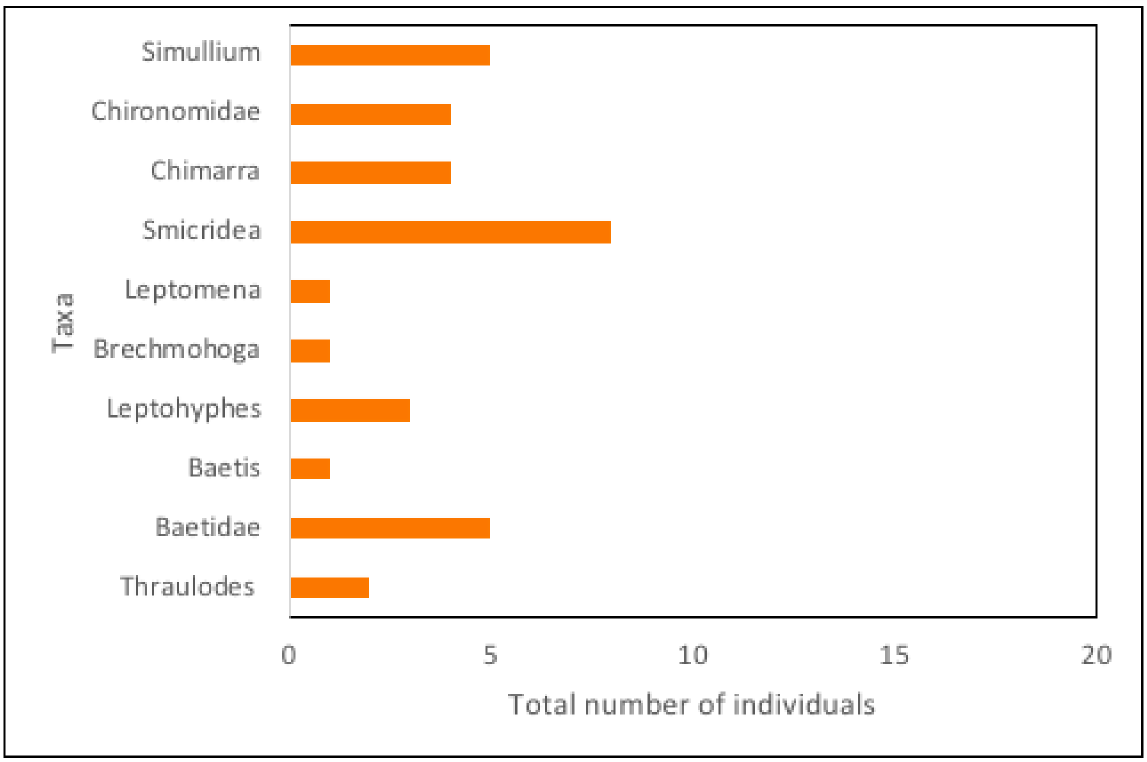

Illustration 4.2-199. Number of individuals found at P-09 station.
Source: INGEX, 2016.

According to the general register in the P-09 station and according to Works by Roldán et al (1998) and Caicedo et al (2004), these organisms are associated with certain organic contamination such as *Baetodes* genus (see Illustration 4.2-200), however the composition of the sample, these genres are from light to modern polluted environments.

Illustration 4.2-200. *Baetodes*
Source: Merceditas Corporation, 2012

P-10 Station

Of the twelve morphotypes registered the p-10 station (See Illustration 4.2-201) the organisms which reported the greatest number were *Thraulodes* (5 ind), *Camelobaetius* (4 ind), *Baetis* (4 ind), *Notonecta* (3 ind) *Brechmohoga* (3 ind) and Chironomidae (3 ind), while *Simullium* (2 ind), *Molophilus* (2 ind), *Baetodes* (1 ind), *Tricorythodes* (1 ind), *Cylloepus* (1 ind) and Smicridea (1 ind) reported the lowest abundances.

Regarding the composition of the p-10 station, the indications of most families are from good to slightly contaminated environments. But families like Chironomidae and Tipulidae are indicative of contamination by organic matter (<biblio>).

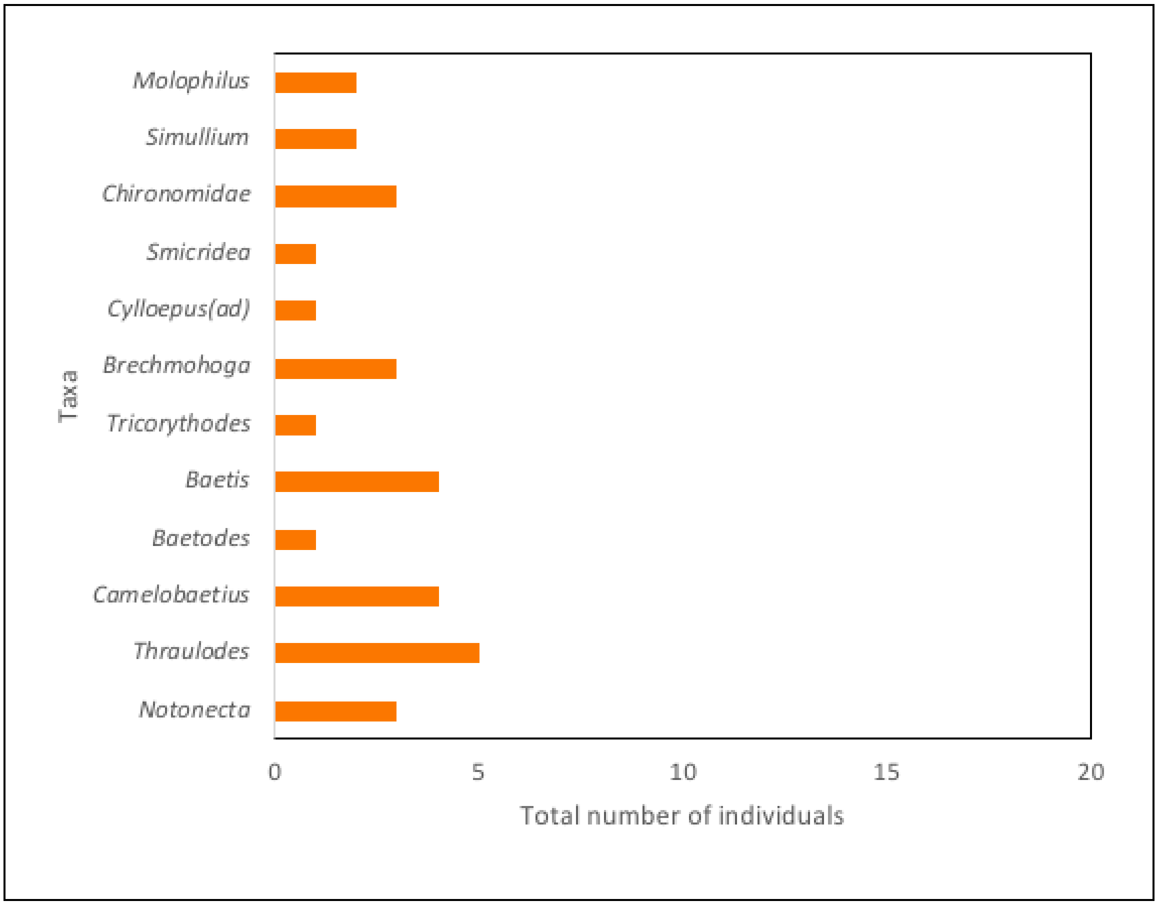

Illustration 4.2-201. Number of individuals found at P-10. Station
Source: INGEX, 2016.

P-11 Station

Finally, in P-11 Station the largest number of individuals captured belonged to the morphs Smicridea (15 ind), Thraulodes (11 ind) and chimarra (9 ind), as well as Chironomidae (4 ind), *Leptohyphes* (2 ind), *Baetis* (1 ind), *Enochrus* (1 ind) and *Leptomena* (1 ind) were reported in smaller quantities (

Illustration 4.2-202). According to the above, most of these organisms infer a bio indication of slightly contaminated environments.

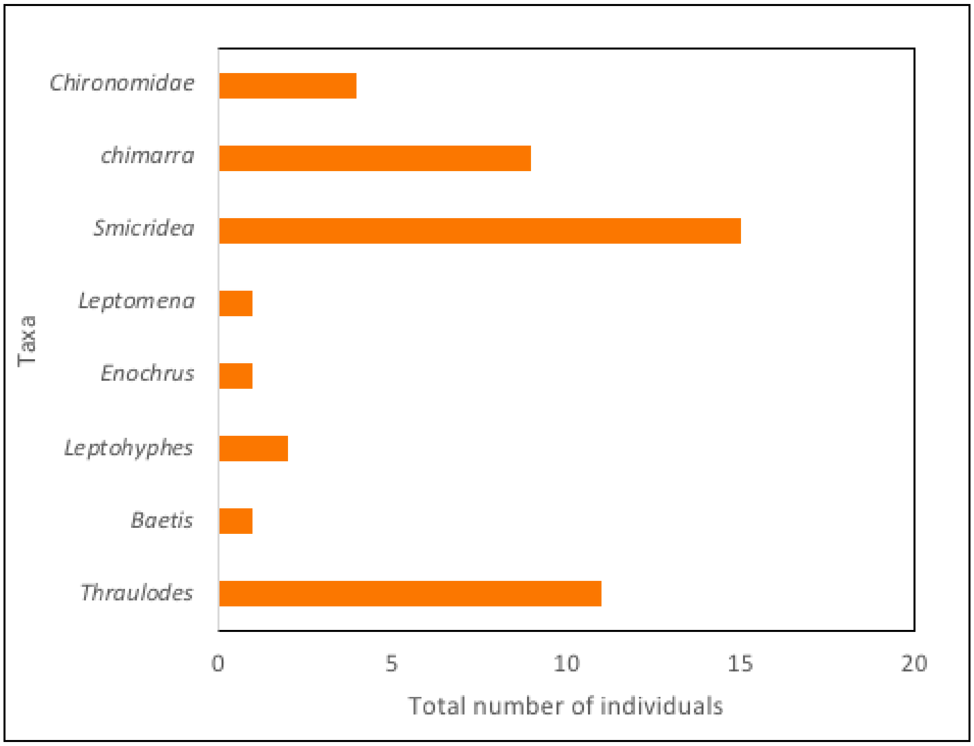

Illustration 4.2-202. Number of individuals found at P-11 Station.
Source: INGEX, 2016.

4.2.5.2.2 Diversity indices

Alpha Diversity

In general terms, no significant differences were found in the alpha diversity indices evaluated (Simpson, Shannon & Margalef) between sampling stations studied. The Margalef index for all stations ranged between 1.29 y 1.98 without presenting significant differences between them (X^2=0,449; p=1) (Illustration 4.2-203). This similarity may be due to the bias introduced by large number of species of the Ephemeroptera, Coleoptera and Díptera orders found in all sampling stations. For the Simpson diversity index, no significant differences were found between the sampling stations (X^2=7,3786; p=0,68) nor for the Shannon index (X^2=0,3762; p=1) (Illustration 4.2-203).

This indicates that macroinvertebrates community is not being affected by environments other than natural origin (Roldán, 1992; Caicedo & Palacio, 1998). However, the microbasin presents a change in the water quality by some organisms found in the different sampling points. Where according to Aguirre & Caicedo (2013) these organisms are indicators of contaminated water by organic matter.

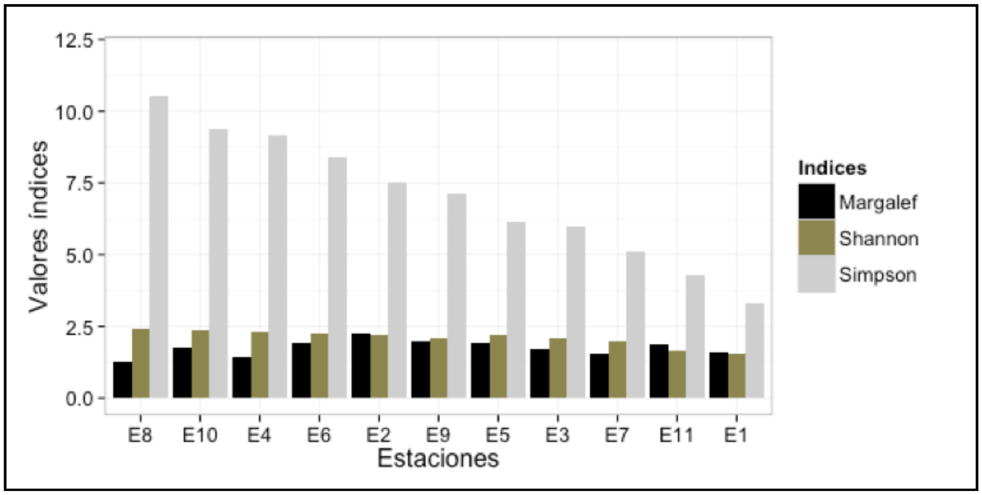

Illustration 4.2-203. Graph of indices of diversity, heterogeneity and dominance (Margalef, Shannon and Simpson) in macro invertebrates by sampling station.
Source: INGEX, 2016

Beta Diversity

The analysis of similarity between sampling stations for macroinvertebrates, based on the dendrogram of the similarity distances of Bray-Curtis showed that there is a great similarity between stations P-01, P-02 y P-05, being two of the most various (Illustration 4.2-204).

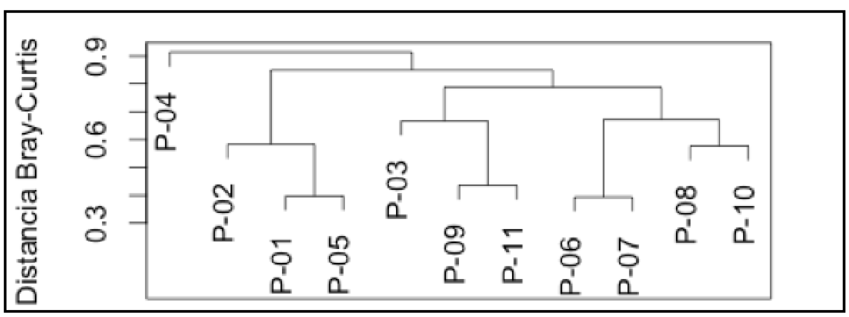

Illustration 4.2-204. Graph of analysis of beta diversity of macroinvertebrates between sampling stations based on a dendrogram.
Source: INGEX, 2016

4.2.5.2.3 Water quality conditions according to macroinvertebrate monitoring

According to the composition of the aquatic macroinvertebrates in the different sampling stations. It can be deduced that stations P-05 y P-06 (18,18%: 2/11) presented a good quality, while P-01, P-

02, P-7, P-08, P-09 and P-10 (54,54%: 6/11) presented a taxonomic composition, which are between good and slightly contaminated. Finally, the Stations P-03, P-04 and P-11 (27,27%: 3/11) presented a moderate to doubtful contamination quality due to the fact that in these areas the highest anthropic activity was observed.

The presence of the Chironomidae family of the order Diptera, indicates that the microbasin presents a degree of contamination by organic matter caused by anthropogenic activities that develop in it.

According to the composition and count of the tax of aquatic macroinvertebrates collected in all sampling stations of the microbasin, it can be concluded that their waters are in an environmental range of good quality to moderately contaminated, this may be due to the fact that the whole micro-basin is intervened by anthropic activities, mainly cattle ranching and dumping without even primary treatment.

4.2.5.2.4 BMWP/Col Index

The biotic indices allow describe different environmental situations and present information about the biological quality of water (Salusso & Moraña, 2002), biotic indices establish the concept of organisms as indicators. According to Aguirre & Caicedo, (2013) an organism or group of organisms is assigned a value according to their eco-physiological characteristics, in relation to sensitivity or tolerance to contamination.

On the other hand, the spatial results of the BMWP/Col index obtained during the samplings are presented in Table 4.2-5 and Illustration 4.2-205.

Table 4.2-5. Results of BMWP/Col index in the micro basin.

SAMPLING STATIONS	VALUE	QUALITY	MEANING AND COLOR
P-01	98	ACCEPTABLE	Slightly polluted waters
P-02	102	GOOD	Very clean waters
P-03	75	ACCEPTABLE	Slightly polluted waters
P-04	69	ACCEPTABLE	Slightly polluted waters
P-05	123	GOOD	Very clean waters
P-06	96	ACCEPTABLE	Slightly polluted waters
P-07	99	ACCEPTABLE	Slightly polluted waters
P-08	90	ACCEPTABLE	Slightly polluted waters
P-09	89	ACCEPTABLE	Slightly polluted waters
P-10	96	GOOD	Very clean waters
P-11	63	ACCEPTABLE	

Source: INGEX, 2016.

The score of the BMWP/Col index allows to see that the highest scores (102 and 123 points) are found in P-05 and P-02, being classified as good quality or very clean waters. These results may be due to the low anthropic activity in these areas.

Similarly, at points P-01, P-06, P-07, P-08, P-09 and P-10 the levels found are in a range of 89 to 99 points classifying them as slightly polluted waters (acceptable). However, it should be noted that from upstream of P-08, P-09 and P-10 there is a contamination by artisanal mining that is not evidenced by dilution, due to the entry of other tributaries.

Finally, in the sampling stations P-03, P-04 and P-11 the lowest bio indication score was obtained, which was in a range of 63 to 75 points, categorizing them as slightly contaminated waters (acceptable) approaching moderately contaminated waters (Doubtful). These scores are due to the fact that there is contamination in the P-04 station by informal mining and other anthropogenic activities developed in that area; while in P-03 it receives all the contamination by organic matter of domestic discharges without treatment and of the cattle present in that area of the micro-basin. Finally, in the P-11 station, it is the one with the lowest bio indication because it receives all the tributaries of the micro-basin; therefore, all the anthropic pollution that is generated in it.

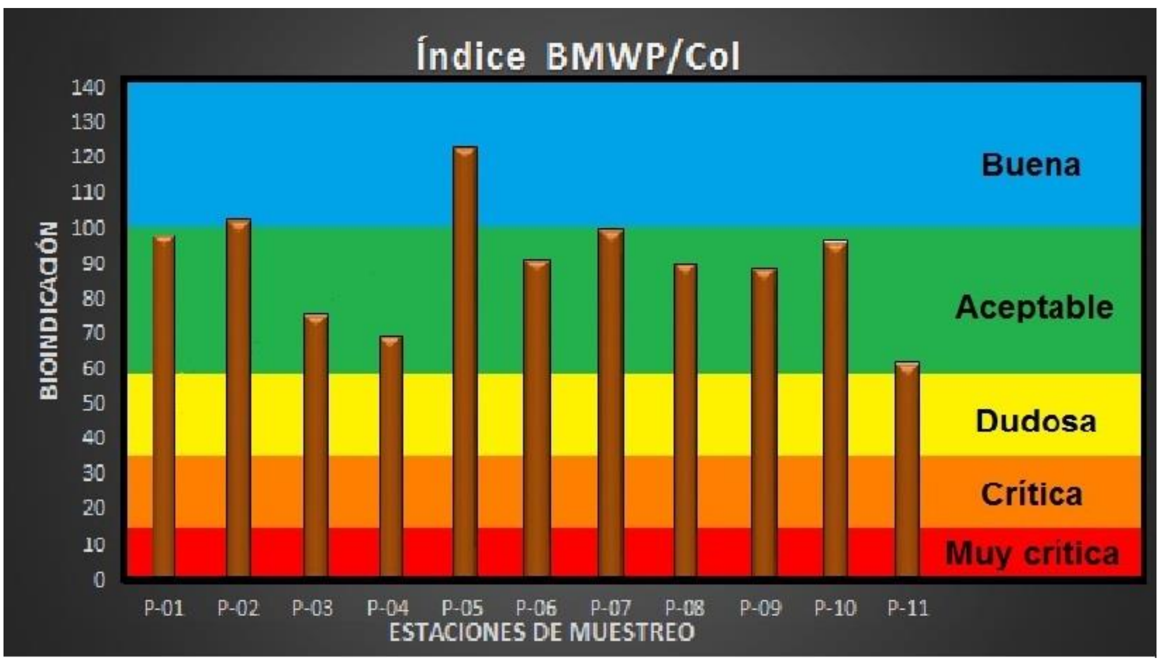

Illustration 4.2-205. Value of the BMWP/Col in the different sampling stations in the 2016 monitoring.
Source: INGEX, 2016.

According to the results of the BMWP/Col biotic index, the basin is related to environments of good quality to moderately polluted. However, the greatest deterioration is found in nearby points where artisanal mining takes (P-04) and in the camp (P-03) where the greatest anthropic activity takes place.

4.2.5.3 MACROPHITES

Three (3) aquatic plants were qualitatively identified (See Table 4.2-6), found on the shores, flood zones and swamps near the sampling stations.

Table 4.2-6. Aquatic plants found.

ORDER	FAMILY	SPECIES
Poales	Cyperaceae	*Eleocharis acutangula*
		Eleocharis elegans
Commelinales	Pontederiaceae	*Heteranthera reniformis*

Source: Merceditas corporation, 2012

In the sampling carried out, the species *Eleocharis acutangula* (See Illustration 4.2-206) was found in the vicinity of stations P-02 y P-11. This aquatic plant is located in the tropics or subtropics of the world and is found in flood areas or swamps, forest and roadsides; it stems are from 35 to 80 cm by a width of 2 a 7 mm (Posada & López, 2011).

On the other hand, the species *Eleocharis elegans* (See Illustration 4.2-207) belonging to the same family previously mentioned was identified in stations P-01, P-02 y P-11. This macrophyte is considered to be an exotic invasive vascular aquatic plant due to its rapid growth, as well as its great affinity in various bodies of water. This plant was introduced, from central Mexico to tropical South America and in the Antilles according to McVaugh (1993) and Villaseñor & Espinosa (1998). It grows on the edges of bodies of water, intervened areas, grasslands, paddocks or areas with secondary vegetation (Posada & López, 2011).

Finally, the species *Heteranthera reniformis* (See Illustration 4.2-208) is an emerging rooted macrophyte found only at the P-11 station. This plant is considered invasive and can be found in marshy areas, rivers, canals, ditches, wet ditches and shores of lakes (Posada & López, 2011).

The presence of these aquatic plants is a good indicator of the quality of water.

In sampling stations P-03, P-04, P-05, P-06, P-07, P-08, P-09 y P-10 no macrophyte was identified because the areas surrounding these points of samplings have a vegetation cover of clean grasses without flood valleys, disfavoring the growth of this aquatic community.

Illustration 4.2-206. *Eleocharis acutangula*.
Source: Merceditas corporation, 2012

Illustration 4.2-207. *Eleocharis elegans.*
Source: Merceditas corporation, 2012

Illustration 4.2-208. *Heteranthera reniformis*.
Source: Merceditas corporation, 2012
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4.2.5.4 PHYTOPLANKTON

Phytoplankton is the set of autotrophic aquatic organisms of plankton, which have photosynthetic capacity and live scattered in water. Currently, these organisms are classified as bacteria, blue-green algae or protists. Phytoplankton is found at the base of the food chain of aquatic ecosystems, since it serves as food for larger organisms; that is, it performs the main part of primary production in aquatic environments.

The table and sourceSource: *Merceditas Corporation,* ***2012***

Table 4.2-8 Present the composition and distribution among the sampling stations of the organisms that make up the phytoplankton according to the qualitative and quantitative sample.

Table 4.2-7. Spatial distribution of phytoplankton algae collected in qualitative sample

ORDER	FAMILY	MORPHOSPECIES	STATIONS										
Eunotiales	Eunotiaceae	*Actinella sp*	P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
	Eunotiaceae	*Eunotia sp*								X	X		
Cocconeidales	Achnanthaceae	*Achanthes sp*	X	X		X							
	Achnanthaceae	*Achnanthidium minutissimum*					X						
	Achnanthaceae	*Achnanthidium sp*			X		X						
Aulacoseirales	Aulacoseiraceae	*Aulacoseira sp*	X	X	X								
Naviculales	Brachysiraceae	*Brachysira sp*	X			X							
Cymbellales	Cymbellaceae	*Placoneis sp*			X								
	Cymbellaceae	*Cymbella sp*	X										
	Cymbellaceae	*Encyonema sp*		X	X	X	X	X	X	X	X		
	Cymbellaceae	*Encyonema alargado*			X								
	Stephanodiscaeae	*Cyclotella sp*		X									
	Gomphonemataceae	*Gomphonema parvulum*			X								
	Gomphonemataceae	*Gomphonema sp*	X	X									
Licmophorales	Fragilariaceae	*Ulnaria aff ulna*	X	X	X	X	X	X	X	X	X	X	X
	Fragilariaceae	*Fragilaria goulardii*	X						X	X	X	X	X
	Fragilariaceae	*Fragilaria sp*		X	X		X						
	Fragilariaceae	*Fragilaria teratogénica*	X										
Naviculales	Naviculaceae	*Navicula sp*			X	X	X						
	Diadesmidaceae	*Diadesmis sp*									X		
Surirellales	Surirellaceae	*Surirella sp*				X							
Chlorellales	Scenedesmaceae	*Actinastrum sp*						X					
Desmidiales	Desmidiaceae	*Micrasterias sp*					X						
	Closteriaceae	*Closterium sp*		X									
	Gonatozygaceae	Gonatozygon sp		X									
Oscillatoriales	Oscillatoriaceae	*Oscillatoria sp*			X								
	Oscillatoriaceae	*Lyngbya sp*			X								
Tribonematales	Zygnemataceae	*Mougeotia sp*								X	X	X	X
Oedogoniales	Oedogoniaceae	*Oedogonium sp*		X									
Ulotrichales	Verdes	*Alga filamentosa*	X							X	X		X
Zygnematales	Zygnemataceae	*Spirogyra sp*	X							X		X	X
Nostocales	Rivulariaceae	*Rivularia sp*								X		X	

ORDER	FAMILY	MORPHOSPECIES	STATIONS										
Cladophorales	Cladophoraceae	*Rhizoclonium sp*								X			

Source: Merceditas Corporation, 2012

Table 4.2-8. Spatial distribution of phytoplankton algae collected in quantitative sample

ORDER	FAMILY	*MORPHOSPECIES*	STATIONS										
Eunotiales	Eunotiaceae	*Actinella sp*	P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
	Eunotiaceae	*Eunotia sp*								X	X		
Cocconeidales	Achnanthaceae	*Achanthes sp*	X	X		X							
	Achnanthaceae	*Achnanthidium minutissimum*					X						
	Achnanthaceae	*Achnanthidium sp*			X		X						
Aulacoseirales	Aulacoseiraceae	*Aulacoseira sp*	X	X	X								
Naviculales	Brachysiraceae	*Brachysira sp*	X			X							
Cymbellales	Cymbellaceae	*Placoneis sp*			X								
	Cymbellaceae	*Cymbella sp*	X										
	Cymbellaceae	*Encyonema sp*		X	X	X	X	X	X	X	X		
	Cymbellaceae	*Encyonema alargado*			X								
	Stephanodiscaeae	*Cyclotella sp*		X									
	Gomphonemataceae	*Gomphonema parvulum*			X								
	Gomphonemataceae	*Gomphonema sp*	X	X									
Licmophorales	Fragilariaceae	*Ulnaria aff ulna*	X	X	X	X	X	X	X	X	X	X	X
	Fragilariaceae	*Fragilaria goulardii*	X						X	X	X	X	X
	Fragilariaceae	*Fragilaria sp*		X	X		X						
	Fragilariaceae	*Fragilaria teratogénica*	X										
Naviculales	Naviculaceae	*Navicula sp*			X	X	X						
	Diadesmidaceae	*Diadesmis sp*									X		
Surirellales	Surirellaceae	*Surirella sp*				X							
Chlorellales	Scenedesmaceae	*Actinastrum sp*						X					
Desmidiales	Desmidiaceae	*Micrasterias sp*					X						
	Closteriaceae	*Closterium sp*		X									
	Gonatozygaceae	Gonatozygon sp		X									
Oscillatoriales	Oscillatoriaceae	*Oscillatoria sp*			X								
	Oscillatoriaceae	*Lyngbya sp*			X								
Tribonematales	Zygnemataceae	*Mougeotia sp*								X	X	X	X
Oedogoniales	Oedogoniaceae	*Oedogonium sp*		X									
Ulotrichales	verdes	*Alga filamentosa*	X							X	X		X
Zygnematales	Zygnemataceae	*Spirogyra sp*	X							X		X	X
Nostocales	Rivulariaceae	*Rivularia sp*								X		X	
Cladophorales	Cladophoraceae	*Rhizoclonium sp*								X			

Source: Merceditas corporation, 2012

For this study, the same species were presented in both the qualitative and quantitative samples, because this community is not very diverse for this lotic aquatic ecosystem or the drainage network sampled and also in comparison with the peripheral community that will be presented later. However, in some stations there is a greater wealth of registered algal species.

The predominant taxonomic family was the Fragilariaceae, belonging to the division Bacillarophyta (diatomeas), showing that it is the community best adapted to this ecosystem.

Below is a photographic mosaic of the main phytoplankton species recorded (See Illustration 4.2-209)

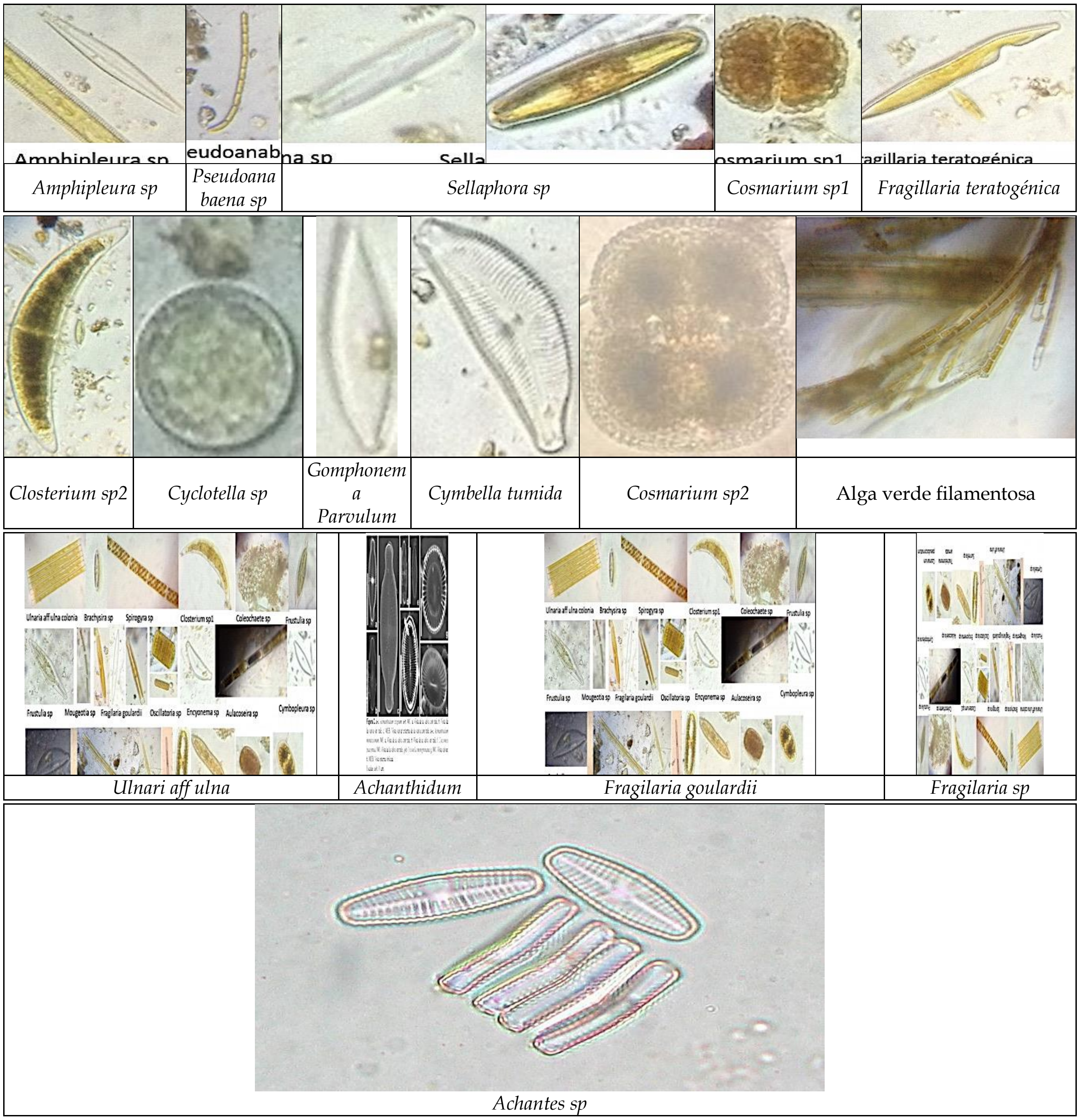


Illustration 4.2-209. Phytoplankton organisms found in the sampling stations
Source: Merceditas corporation, 2012

The bio indication of phytoplankton algae occurs in the Table 4.2-9.

Table 4.2-9 List of algae registered in phytoplankton and their characteristics of bio indication

MORPHOSPECIES	CHARACTERISTICS OF BIOINDICATION AND ECOLOGICAL ROLE
Actinella sp	Indicator of acid waters and oligotrophic environments (Montoya-Moreno and Aguirre, 2013)
Aulacoseira sp	Low water electrical conductivity (Montoya-Moreno and Aguirre, 2013)
Alga filamentosa	Power supply for zooplankton and aquatic macroinvertebrates; It can be used as a substrate for colonization by other algae.
Achanthes sp	Partially tolerant to organic contamination and to the low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Achnanthidium exiguum	Moderately polluted waters
Achnanthidium sp	Indicator of contaminated and intermediate waters (Lobo, Callegaro and Bender, 2002)
Actinastrum sp	Indicates eutrophic environments (Pinilla 2000)
Brachysira sp	Indicator of slightly acid, warm waters, low conductivity and transparency (Vouilloud et al., 2014)
Cymbella sp	High environmental variability, many species
Closterium sp1	Hard waters (Ramírez 2000).
Cyclotella sp	Indicators of clean water (Ramírez 2000).
Diadesmis sp	Clean waters, low conductivity and slightly acidic waters (Ramírez 2000).
Diatomea filamentosa	High environmental variability, many species
Eunotia sp	Low water electrical conductivity, slightly acid waters (Montoya-Moreno and Aguirre, 2013)
Encyonema sp	Tolerance to low concentrations of ammonia nitrogen (Montoya-Moreno and Aguirre, 2013)
Encyonema alargado	Tolerance to low concentrations of ammonia nitrogen (Montoya-Moreno and Aguirre, 2013)
Fragilaria goulardii	High transparency of water, neutral waters (Montoya-Moreno and Aguirre, 2013)
Fragilaria sp	High transparency of water, neutral waters (Montoya-Moreno and Aguirre, 2013)
Fragilaria teratogénica	Indicator of mutations, which in this case with very low density, obey to questions of chance
Gomphonema parvulum	Tolerance to low concentrations of total solids (Montoya-Moreno and Aguirre, 2013)
Gomphonema sp	Tolerance to low concentrations of total solids (Montoya-Moreno and Aguirre, 2013)
Gonatozygon sp	Oligotrophic waters (Ramírez 2000).
Micrasterias sp	Oligotrophic waters (Ramírez 2000).
Lyngbya sp	Mesotrophic waters (Pinilla, 2000)
Mougeotia sp	Surface algae, can clog filters, predominate in acidic environments (Ramírez 2000).
Navicula sp	This genus is very variable in terms of environmental tolerance, since it has more than 14,000 species that make it up
Oedogonium sp	Tolerance to low electrical conductivity (Montoya-Moreno and Aguirre, 2013)
Oscillatoria sp	They can form blooms, support organic and industrial pollution (Ramírez 2000).
Placoneis sp	Tolerant to organic contamination and low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Rhizoclonium sp	Mesotrophic waters (Pinilla, 2000)
Rivularia sp	Mesotrophic waters (Pinilla, 2000)
Spirogyra sp	Oligotrophic and cold waters (Pinilla, 2000)
Surirella sp	Tolerant to organic contamination and low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Ulnaria aff ulna	In swamps, it may indicate a low concentration of dissolved oxygen, a water temperature greater than 29 ° C and a wide tolerance to pH variations (Montoya-Moreno and Aguirre, 2013). In tropical rivers it is considered little tolerant to pollution (Lobo et al, 2004).

Source: INGEX, 2016.

Next, we present the diversity of morphotypes, abundance and density (individuals / mL) obtained quantitatively and qualitatively.

4.2.5.4.1 Composition, abundance and taxonomic richness by sampling station

As already shown, 34 phytoplankton species were identified in the 11 sampling stations of the study area (Table 4.2-9). Significant differences were found between the P-08 station and the other sampling stations where phytoplankton were recorded (X^2=3652,845; p=<0,001). The stations with lowest abundance were P-03, P-06 and P-04 (Illustration 4.2-210).

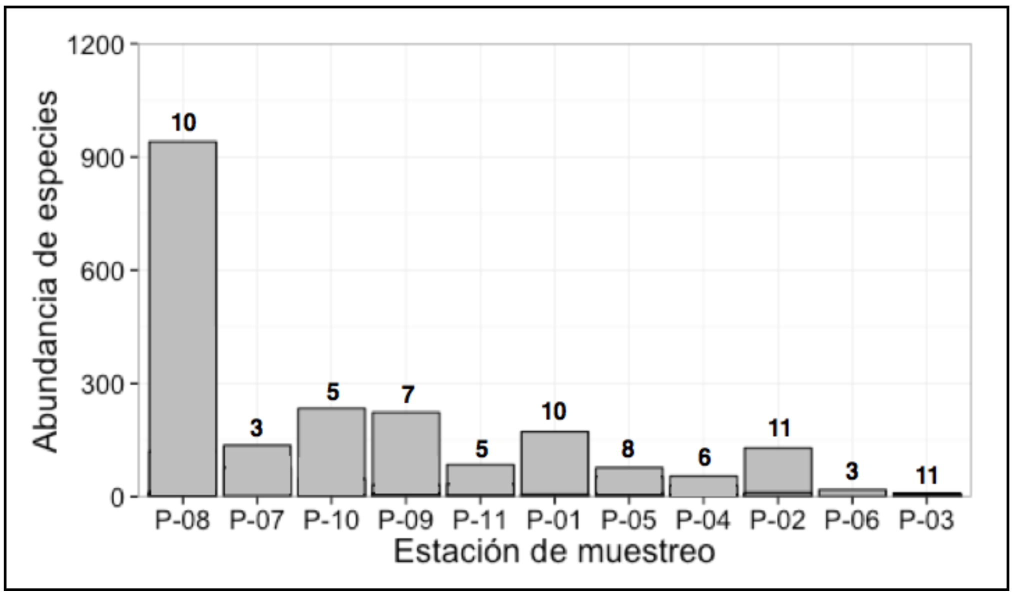


Illustration 4.2-210. Graph of the abundance and richness of phytoplankton species by sampling stations. The black numbers above the bars indicate the number of species.

Source: INGEX, 2016

In terms of relative abundance, taking into account the categorization of abundance for species (see methodology), more generally, the most abundant species were *Ulnaria* aff. *ulna* and *Fragilaria goulardii* (Relative Abundance >10%) (Illustration 4.2-211). On the other hand, the species Achantes sp. and Fragillaria sp were common in the sampling points (Relative abundance between 2 and 10%) (Illustration 4.2-211). The remaining 30 species were rare or rare (relative abundance between 2 and 0%)

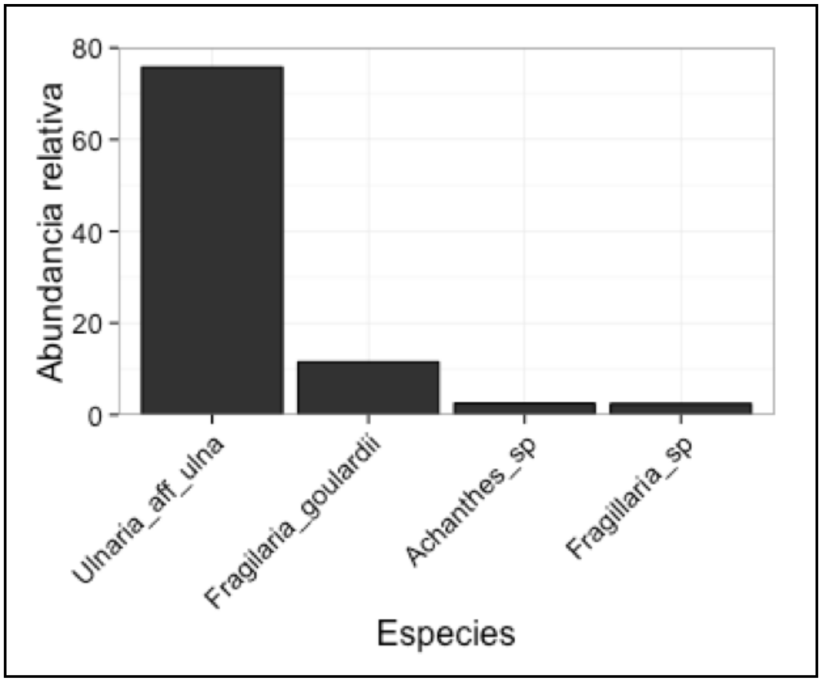


Illustration 4.2-211. Graph of the relative abundance of abundant and common phytoplankton species.
Source: INGEX, 2016

P-01 Station

Table 4.2-10 shows the abundance and density of the organisms registered in the qualitative and quantitative analyzes (See Illustration 4.2-212).

Table 4.2-10. Abundance and density for morphotypes registered in station P-01.

MORPHOTYPE	ABUNDANCE	DENSITY
Ulnaria aff ulna	85,5721393	195,01
Gomphonema sp	0,99502488	2,27
Brachysira sp	1,49253731	3,40
Cymbella sp	0,99502488	2,27
Achanthes sp	1,49253731	3,40
Aulacoseira sp	1,99004975	4,54
Alga filamentosa	2,98507463	6,80
Fragilaria goulardii	1,49253731	3,40
Fragillaria teratogénica	0,99502488	2,27
Spirogyra sp	1,99004975	4,54

Source: Merceditas corporation, 2012

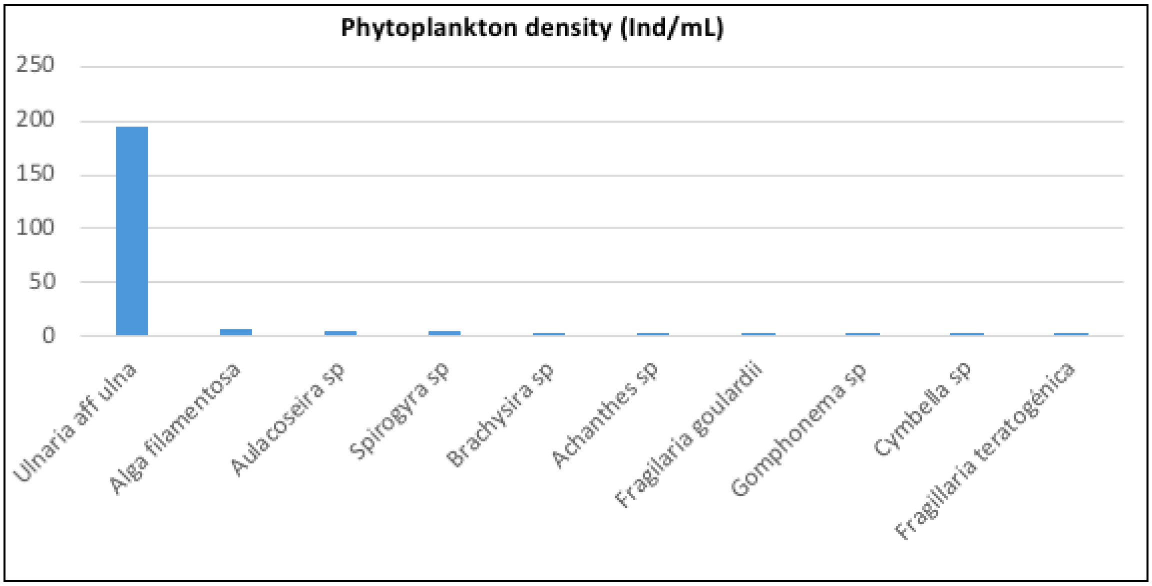


Illustration 4.2-212 Relative density of phytoplankton organisms, station P-01.
Source: INGEX, 2016.

The most dominant species in this sampling station was *Ulnaria aff ulna* of the Fragilariaceae family, which reached 85.57% relative abundance within the community (See Illustration 4.2-213) in this sampling station.

This species is considered to not be very tolerant to contamination, which indicates that the P-01 station has good water quality. This species inhabits mainly substrates and high water current sites.

The composition of the epilithic algae varies according to the size of the substrate since its way of adhering and form of growth condition its distribution and displacement. There are free algae in the sediment, with greater or lesser mobility depending on the hours of the day and are those that periodically give rise to regular pulses of drift and that can be part of the algal drifts (Allan, 1995).

Illustration 4.2-213. *Ulnaria aff ulna* predominant phytoplankton community, P-01 Station
Source: Merceditas corporation, 2012

Emigration-immigration and subsequent colonization, are important processes that regulate the composition of periphytic diatoms and the primary productivity of streams and influence the attributes of algal communities and the fluvial river network (Merrit & Wallace, 1981; Allan, 1995

Gari and Corigliano (2004) stated that diatoms, predominant in periphyton, constitute 80% of the relative abundance of drift in the streams studied, indicating that truly planktonic species participate with lower density.

In general, the work on the algal component in transport and in streams has not been devoted to relating how much of this is true plankton and how much corresponds to periphyton organisms carried by the downstream current (Gari and Corigliano, 2004).

P-02 Station

Table Table 4.2-11 shows the abundance and density of the registered organisms in the qualitative and quantitative analyses (See Illustration 4.2-214).

Table 4.2-11. Abundance and density of the morphotypes registered at station P-02.

MORPHOTYPE	ABUNDANCE	DENSITY
Ulnaria aff ulna	76,3313609	146,26
Aulacoseira sp	1,18343195	2,27
Achanthes sp	5,32544379	10,20
Gomphonema sp	1,18343195	2,27
Closterium sp1	1,77514793	3,40
Fragillaria sp	2,36686391	4,54

MORPHOTYPE	ABUNDANCE	DENSITY
Gonatozygon sp	2,36686391	4,54
Encyonema sp	1,77514793	3,40
Diatomea filamentosa	6,50887574	12,47
Cyclotella sp	0,59171598	1,13
Oedogonium sp	0,59171598	1,13

Source: Merceditas corporation, 2012

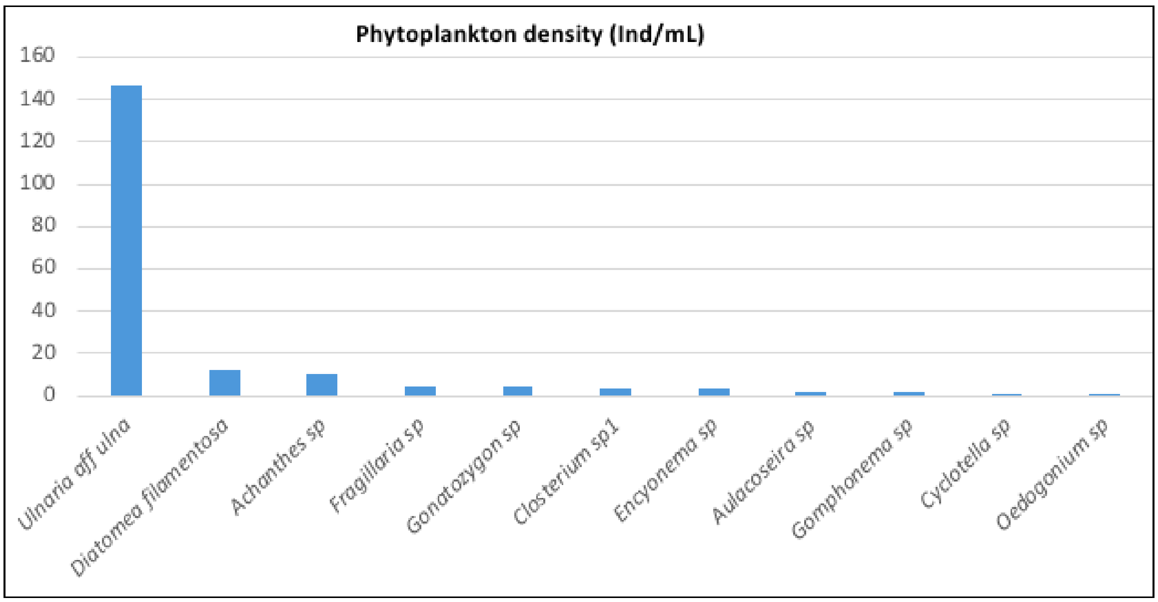


Illustration 4.2-214. Relative density of phytoplankton organisms, station P-02.
Source: INGEX, 2016.

The dominant species was also *Ulnaria aff ulna*, but with lower abundance (76,31%) of the community compared to station P-01 (Illustration 4.2-214) in this sampling station. Therefore, good water quality is presented.

P-03 Station

Table 4.2-12 shows the abundance and density of the registered organisms within the qualitative and quantitative analyses (See Illustration 4.2-215).

Table 4.2-12. Abundance and density of the morphotypes registered in the P-03 station

MORPHOTYPE	ABUNDANCE	DENSITY
Oscillatoria sp	6,81818182	3,40
Navicula sp	4,54545455	2,27
Fragillaria sp	18,1818182	9,07
Achnanthidium sp	18,1818182	9,07
Encyonema sp	2,27272727	1,13
Ulnaria aff ulna	20,4545455	10,20
Placoneis sp	2,27272727	1,13

MORPHOTYPE	ABUNDANCE	DENSITY
Gomphonema parvulum	9,09090909	4,54
Encyonema alargado	4,54545455	2,27
Aulacoseira sp	2,27272727	1,13
Lyngbya sp	11,3636364	5,67

Source: Merceditas corporation, 2012

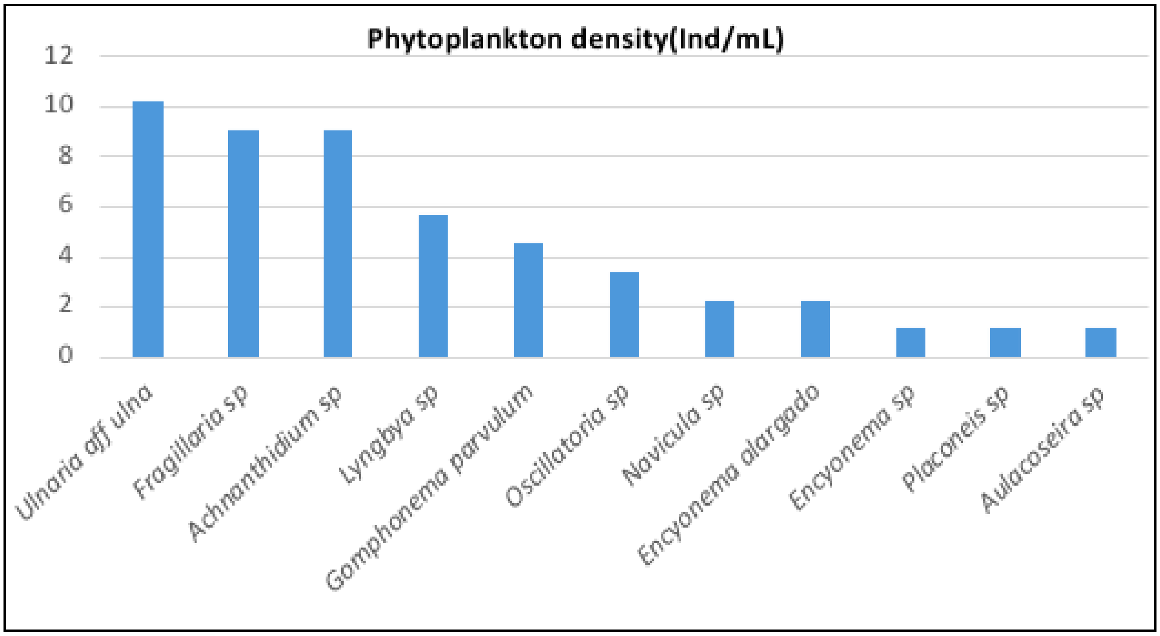


Illustration 4.2-215. Relative density of phytoplankton organisms, station P-03.
Source: INGEX, 2016.

Among the most abundant species within this season are *Ulnaria aff ulnas* (20%), *Fragilaria* sp (19%) & *Achanthidium* sp (19%) (See Illustration 4.2-216).

These species are considered not very tolerant to contamination, which may indicate that the P-03 station presents good water quality. Some of the interspecific variations in the rates of early immigration can be explained by interspecific variations in the abundance of algal transport (Müller Hackel, 1976, Stevenson, 1983).

Ulnaria aff ulna	*Gomphonema*	*Achanthidium sp*

Illustration 4.2-216. Predominant phytoplankton organisms, station P-03.
Source: Merceditas Corporation, 2012

P-04 Station

TableTable 4.2-13 presents the abundance and density of the organisms registered in qualitative and quantitative analyzes (See Illustration 4.2-217).

Table 4.2-13. Lists of morphotypes registered at P-04 station

MORPHOTYPE	ABUNDANCE	DENSITY
Navicula sp	2,04081633	2,27
Achanthes sp	56,122449	62,36
Surirella sp	6,12244898	6,80
Ulnaria aff ulna	29,5918367	32,88
Encyonema sp	3,06122449	3,40
Brachysira sp	3,06122449	3,40

Source: Merceditas Corporation, 2012

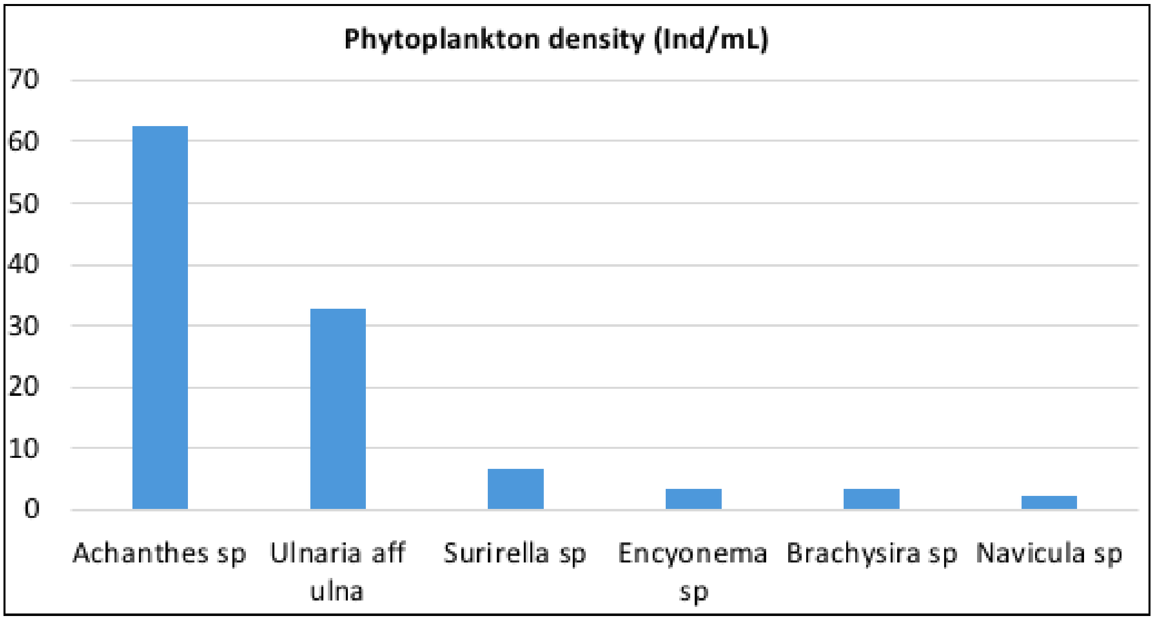


Illustration 4.2-217. Relative density of phytoplankton organisms, station P-04.
Source: INGEX, 2016.

There was no predominant taxonomic family, given that the six (6) registered species belong to six different families, indicating that in this season there is greater equity and it is the community best adapted to this ecosystem compared to the previous seasons. It is worth mentioning that species such *Achanthes sp* (56,12%) (See Illustration 4.2-218) and *Ulnaria aff ulna* (29,6%) (See Illustration 4.2-213).

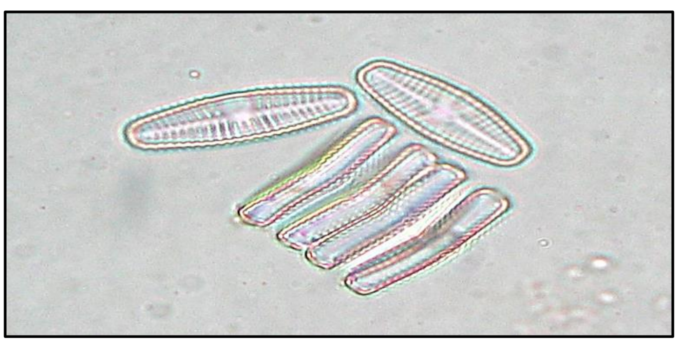


Illustration 4.2-218. Achanthes sp, predominant in phytoplankton community, station P-04.
Source: INGEX, 2016.

Also, the presence of the species *Achanthes sp* y *Ulnaria ulna*, suggests waters with good quality.

P-05 Station

Table 4.2-14 presents the abundance and density of the organisms registered in quantitative and qualitative analyzes (See Illustration 4.2-219).

Table 4.2-14. Abundance and density of the morphotypes registered, P-05 station

MORPHOTYPE	ABUNDANCE	DENSITY
Navicula sp	0,62893082	1,13
Ulnaria aff ulna	57,1235	87,30
Fragillaria sp	33,3333333	60,09
Encyonema sp	5,03144654	9,07
Micrasterias sp	0,62893082	1,13
Achnanthidium sp	1,88679245	3,40
Achnanthidium exiguum	1,25786164	2,27

Source: Merceditas corporation, 2012

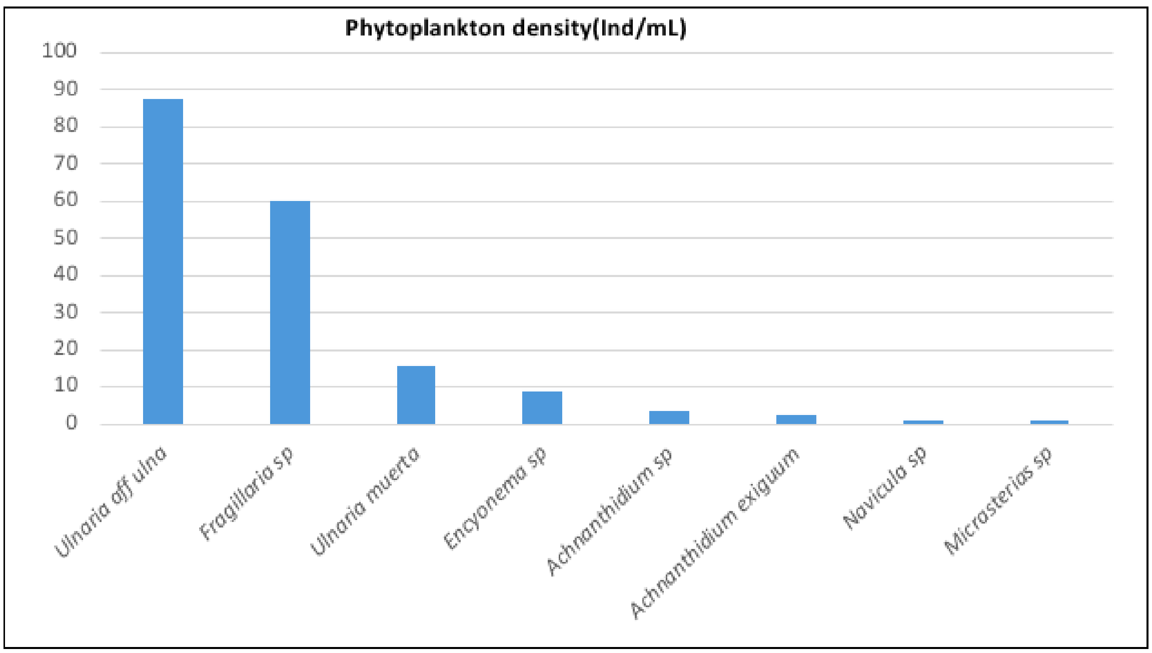


Illustration 4.2-219. Relative density of phytoplankton organisms, station P-05.
Source: INGEX, 2016.

The dominant species for this season was *Ulnaria aff ulna* with 57% abundance of the community and shared dominance of potamoplankton with *Fragillaria* sp con un 33% relative abundance (See Illustration 4.2-220); adding 90% of the algal population in the ecosyste. Both species are considered as not very tolerant to pollution, indicating that the P-05 station presents good water quality.

Illustration 4.2-220. *Ulnaria aff ulna* and *Fragilaria sp*, predominant in phytoplankton community of station P-05.
Source: Merceditas corporation, 2012

P-06 Station

Table 4.2-15 presents the abundance and density of the organisms registered in qualitative and quantitative analyses (Ver Illustration 4.2-221).

Table 4.2-15. Lists of morphotypes registered in station P-06.

MORPHOTYPE	ABUNDANCE	DENSITY
Actinastrum sp	5	1,13
Ulnaria aff ulna	90	20,41
Encyonema sp	5	1,13

Source: Merceditas corporation, 2012

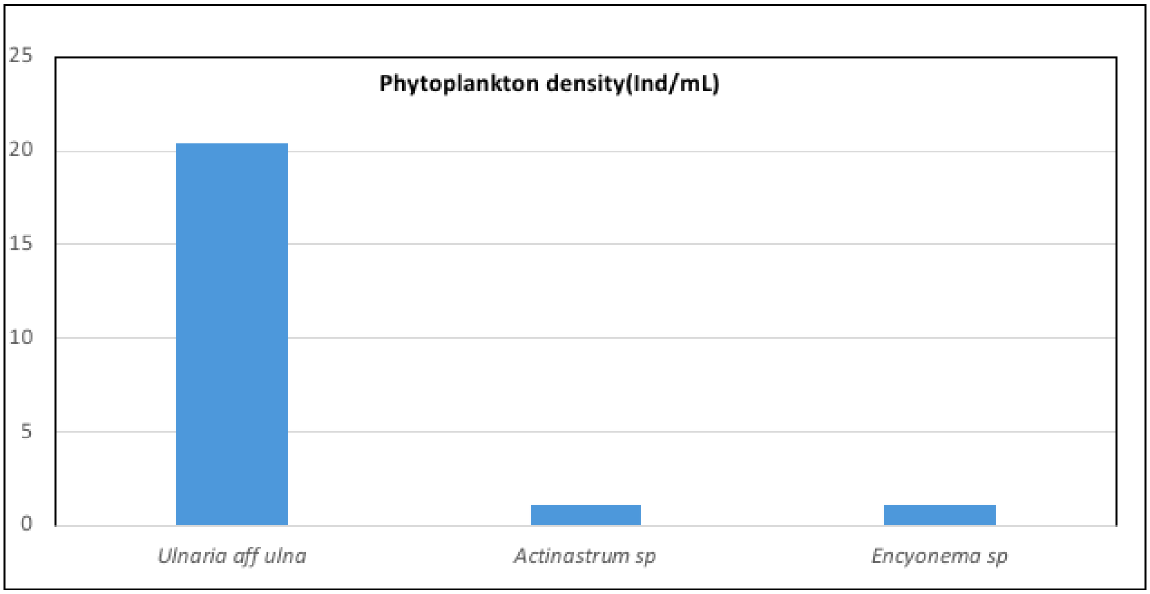


Illustration 4.2-221. Relative density of phytoplankton organisms, station P-06.
Source: INGEX, 2016.

The dominant species was *Ulnaria aff ulna* of Fragilariaceae family, which reached to 90% abundance of the community (See Illustration 4.2-213) in thissampling station. The presence of this species suggests good water quality in this season.

P-07 Station

Table 4.2-16 shows the abundance and density of the organisms registered in the qualitative and quantitative analyzes (See Illustration 4.2-222).

Table 4.2-16. List of morphotypes recorded in station P-07

MORPHOTYPE	ABUNDANCE	DENSITY
Ulnaria aff ulna	63,255814	154,20
Fragilaria goulardii	35,8139535	87,30
Encyonema sp	0,93023256	2,27

Source: Merceditas corporation, 2012

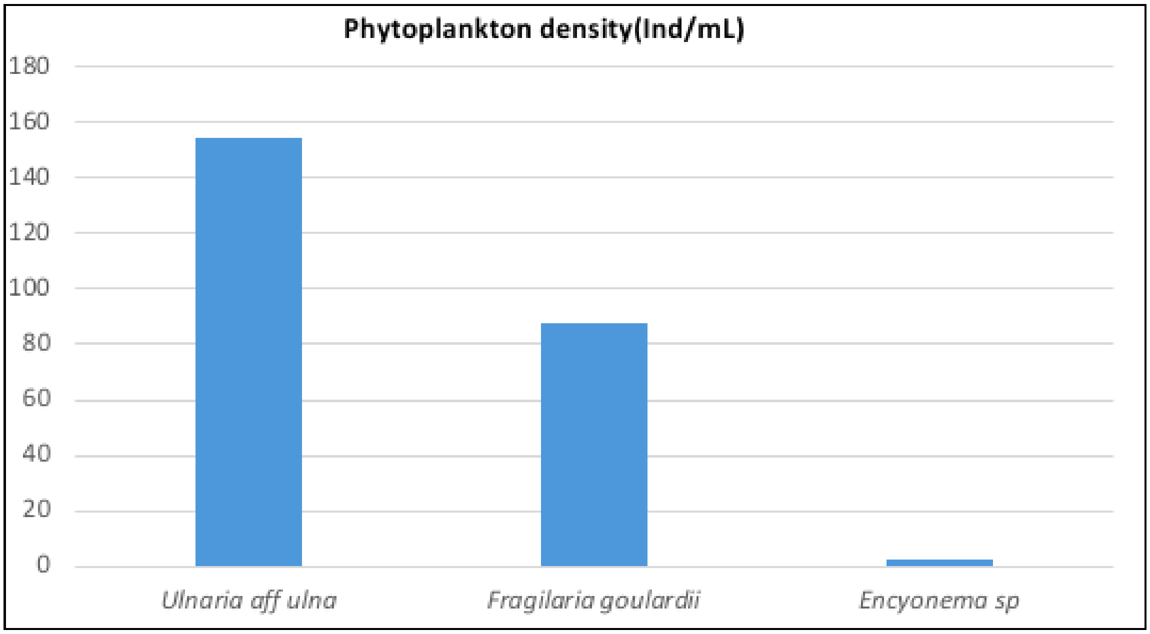


Illustration 4.2-222. Relative density of phytoplankton organisms, station P-07.
Source: INGEX, 2016.

The predominant species was *Ulnaria aff ulna* with 63%, of the abundance of the community followed by *Fragilaria goulardii* with 35.8%, both considered as not very tolerant to contamination, which suggests good water quality in the P-station. 07 (Illustration 4.2-222).

Illustration 4.2-223. *Ulnaria aff ulna* and *Fragilaria goulardii*, predominant in phytoplankton community of station P-07.
Source: Merceditas Corporation, 2012.

P-08 Station

Table 4.2-17 shows the abundance and density of the organisms registered in the qualitative and quantitative analyzes (See Illustration 4.2-224).

Table 4.2-17. List of morphotypes registered in station P-08.

MORPHOTYPE	ABUNDANCE	DENSITY
Ulnaria aff ulna	84,4564241	1065,76
Fragilaria goulardii	10,7816712	136,05
Mougeotia sp	0,80862534	10,20
Rhizoclonium sp	1,16801438	14,74
Alga filamentosa	0,17969452	2,27
Spirogyra sp	0,71877808	9,07
Rivularia sp	0,08984726	1,13
Eunotia sp	0,53908356	6,80
Encyonema sp	0,08984726	1,13

Source: Merceditas corporation, 2012

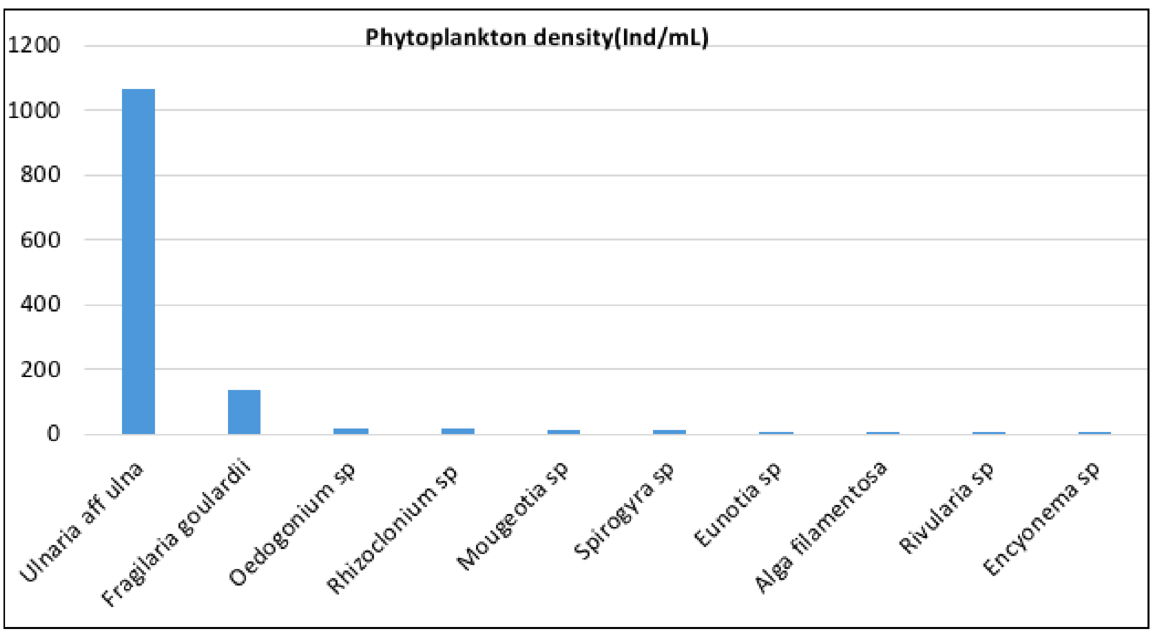


Illustration 4.2-224. Relative density of phytoplankton organisms, station P-08.
Source: INGEX, 2016.

The predominant species was *Ulnaria aff ulna* with 84% of the abundance of the community, followed by *Fragilaria goulardii* with 10%, both considered as not very tolerant to contamination, which may indicate that season 8 presents a good quality of life.

In this station some representatives of the division Chlorophyceae, signs of heavy rain and/or detachment of filaments by chance within the station were found.

P-09 Station

Table 4.2-18 the abundance and density of the registered organisms is presented in the qualitative and quantitative analyzes (See Illustration 4.2-225).

Table 4.2-18. List of morphotypes registered in station P-09.

MORPHOTYPE	ABUNDANCE	DENSITY
Ulnaria aff ulna	79,6428571	252,83
Fragilaria goulardii	11,0714286	35,15
Diadesmis sp	2,85714286	9,07
Alga filamentosa	0,35714286	1,13
Eunotia sp	2,85714286	9,07
Encyonema sp	1,07142857	3,40
Mougeotia sp	2,14285714	6,80

Source: Merceditas corporation, 2012

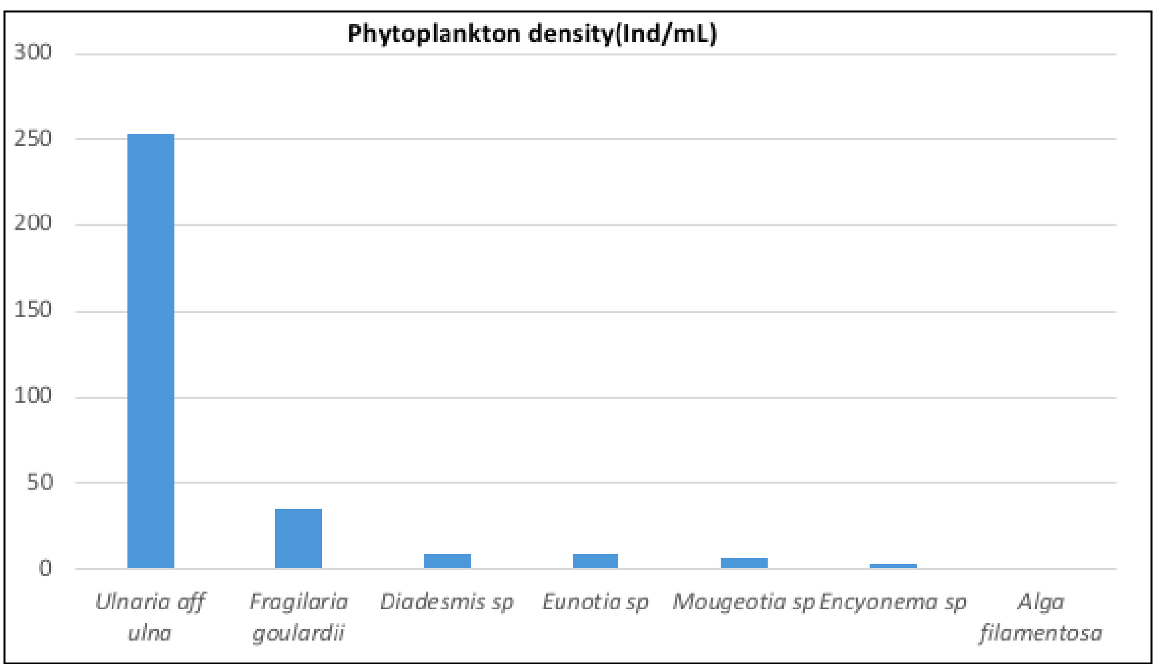


Illustration 4.2-225. Relative density of phytoplankton organisms, station P-09.
Source: INGEX, 2016.

Within this sampling station, the species that presented the greatest importance was *Ulnaria aff ulna, with* 79,6%, followed by *Fragilaria goulardii* with 11%; both species are considered as not very tolerant to contamination, which indicates that station 9 presents good water quality.

Adicionalmente se encontraron representantes de la división Clorofícea (2 especies, con muy baja densidad), que podrían indicar que se presentó lluvia fuerte y/o desprendimiento de los filamentos por azar en esta estación.

P-10 Station

Table 4.2-19 the abundance and density of the registered organisms is presented in the qualitative and quantitative analyzes (See Illustration 4.2-226).

Table 4.2-19. Abundance and density of the morphotypes registered in the P-10 station.

MORPHOTYPES	ABUNDANCE	DENSITY
Ulnaria aff ulna	81,8181818	265,31
Fragilaria goulardii	16,4335664	53,29
Mougeotia sp	0,6993007	2,27
Spirogyra sp	0,34965035	1,13
Rivularia sp	0,6993007	2,27

Source: Merceditas corporation, 2012

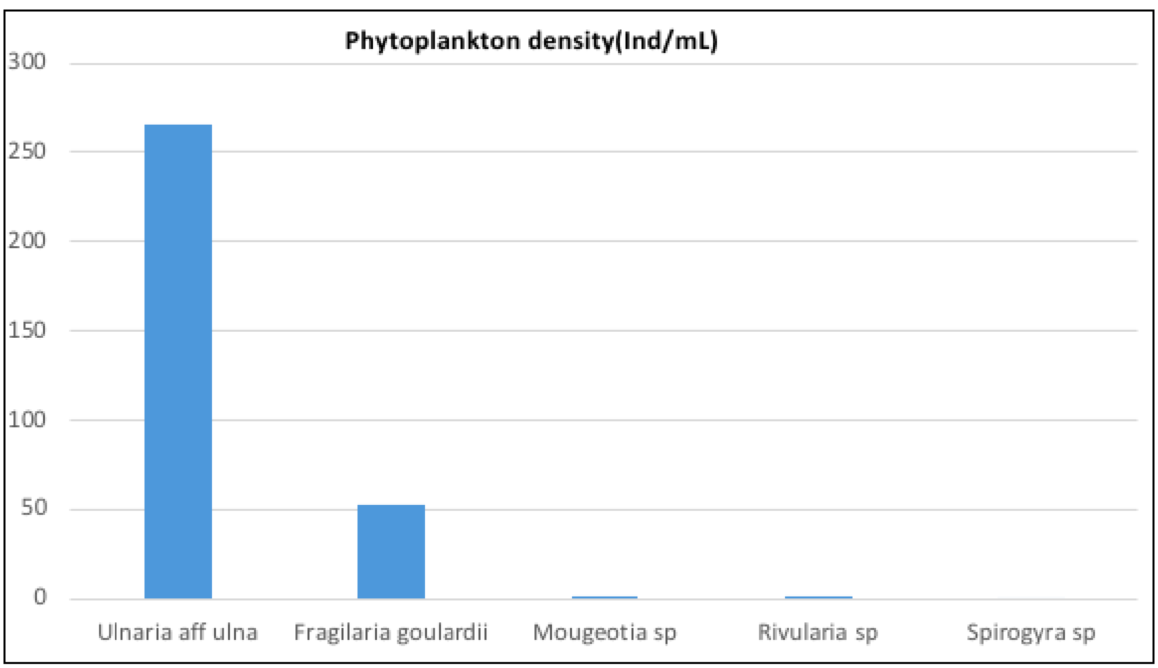


Illustration 4.2-226. Relative density of phytoplankton organisms, station P-10.
Source: INGEX, 2016.

Within this sampling station, the most abundant species was *Ulnaria ulna* which reached 81,8%, followed by *Fragilaria goulardii* with 16,4%; both species are considered as not very tolerant to contamination, which may indicate that station 10 presents good water quality.

In this station representatives of the division Chlorophyceae (3 species, with very low density), sign of heavy rain and/or detachment of the filaments by chance were also found.

P-11 Station

Table 4.2-20 shows the abundance and density of the organisms registered in the qualitative and quantitative samples. As in stations p-07, P-08, p-09 and p-10, the same species predominate, which would indicate that they are ecologically similar sites (See Illustration 4.2-227).

Table 4.2-20. List of morphotypes recorded in station P-11.

MORPHOYPES	ABUNDANCE	DENSITY
Ulnaria aff ulna	68,5483871	96,37
Fragilaria goulardii	26,6129032	37,41
Mougeotia sp	2,41935484	3,40
Spirogyra sp	1,61290323	2,27
Alga filamentosa	0,80645161	1,13

Source: Merceditas corporation, 2012

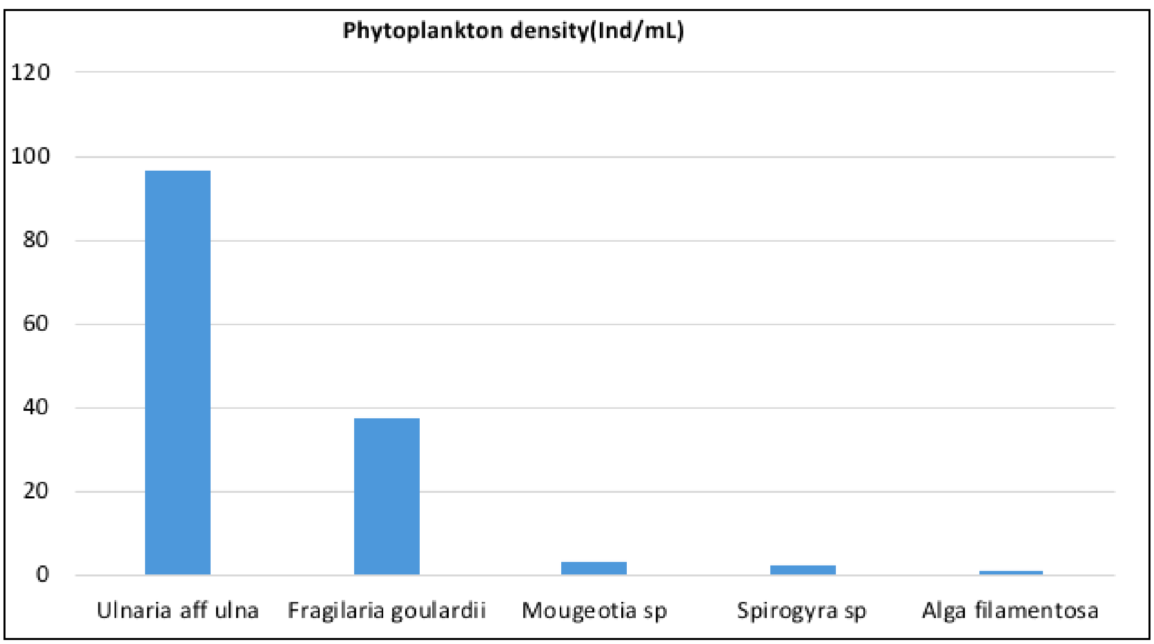


Illustration 4.2-227. Relative density of phytoplankton organisms, station P-11.
Source: INGEX, 2016.

4.2.5.4.2 Diversity indices

Next, the alpha and beta diversity indices are presented.

Alpha diversity (α)

In general terms, no significant differences were found in the alpha diversity indices evaluated (Simpson, Shannon and Margalef) between the sampling stations studied. The Margalef index for all stations oscillated between 0.37 and 2.63 without significant differences between them (X^2=3.4348, p=0.96) (Illustration 4.2-228). For the Simpson diversity index, no significant differences were found between the sampling stations (X^2=0.9305, p=0.99) nor for the Shannon index (X^2=2.4794, p=0.99). (Illustration 4.2-228). The similarity between these diversity indices can be due to the fact that the flow condition considerably restricts the distribution of the organisms; There are many species that are part of the periphyton and that are probably found in the water column as a product of drift.

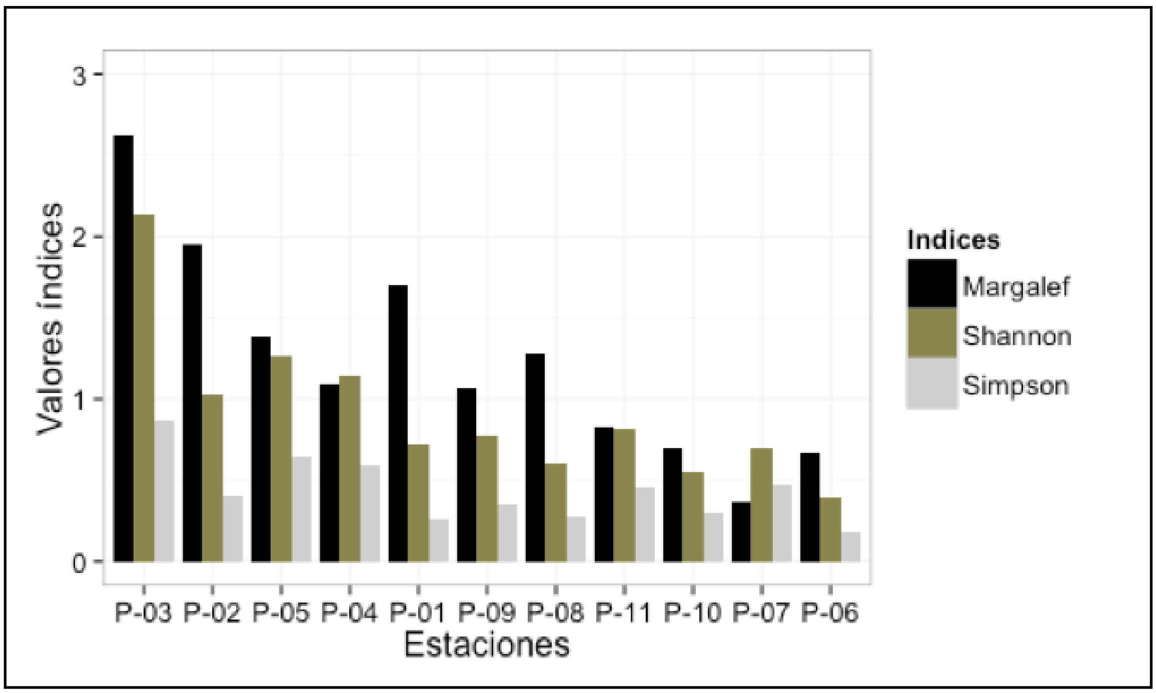


Illustration 4.2-228. Graph of indices of diversity, heterogeneity and dominance (Margalef, Shannon and Simpson) in phytoplankton by sampling station.
Source: INGEX, 2016

Beta diversity (β)

The analysis of similarity between sampling stations for phytoplankton, based on the dendrogram of the similarity distances of Bray-Curtis, showed that there is a great similarity between stations P-01 and P-02, being two the most diverse (See Illustration 4.2-229).

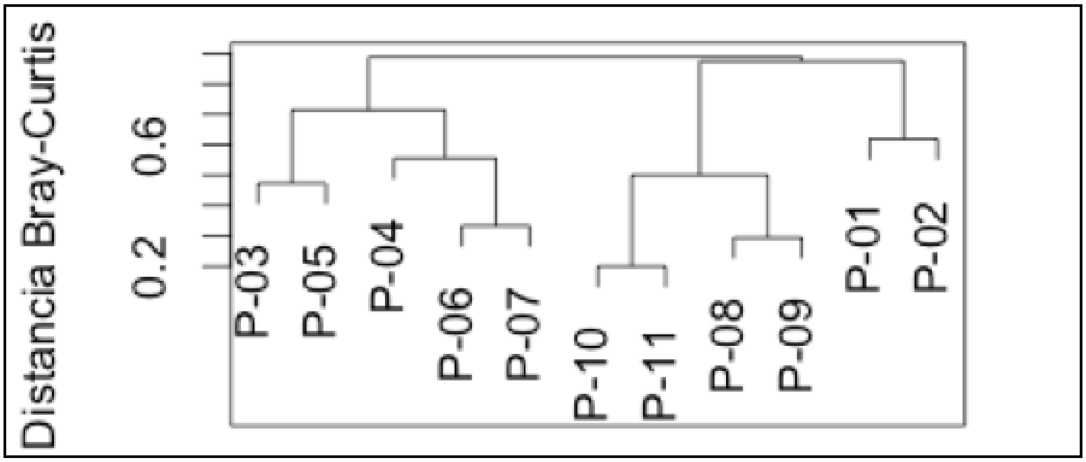


Illustration 4.2-229. Graph of analysis of phytoplankton beta diversity between sampling stations based on a dendrogram.
Source: INGEX, 2016

4.2.5.5 ZOOPLANKCTON

The zooplankton is the fraction of the plankton constituted by beings that are fed, by ingestion, of organic matter already elaborated. It is constituted by protozoa, that is to say, diverse protists, phagotroph that engulf the food phagocytizing it. Also, by larvae of larger animals, such as sponges, worms, echinoderms, mollusks or crustaceans, and other aquatic arthropods, as well as adult forms of small size crustaceans such as copepods or cladoceran, rotifers and youthful stages of fish (fry). They are heterotrophs that in the trophic chain occupy the first positions of consumers, feeding on primary producers (components of phytoplankton), particular organic waste, and decomposer organisms, such as bacteria or other components of zooplankton.

Zooplankton is also quite revealing of eutrophication and pollution (in particular of water with organic contents and nitrates), in addition, among zooplankton there are also representatives of pathogenic flora, which limits the use of some bodies of water. Table 4.2-90 Source: Merceditas Corporation, 2012.

Table 4.2-21 presents the composition and distribution among the sampling stations of the organisms that make up the zooplankton according to the qualitative and quantitative sample.

Table 4.2-21. Spatial distribution of zooplankton collected in the quantitative sample.

Order	Family	Morphospecies	STATIONS										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
Euamoebida	Amoebidae	*Ameba*	X		X	X	X			X	X		X
Euamoebida	Amoebidae	*Tecameba*		X						X			X
Diptera	Chironomidae	*Tanytarsini sp*	X							X			
Diptera	Chironomidae	*Dolicopodidae sp*								X			
Diptera	Chironomidae	*Pupa diptero*			X	X							
Diptera	Chironomidae	*Chironomido*	X						X	X	X	X	X
Diptera	Chironomidae	*Simullium sp*			X								
Trichoptera	Hydropsychidae	*Hydropsychidae sp*								X			X
Coleoptera	Elmidae	*Elmidae sp*				X			X	X			
Coleoptera	Elmidae	*Coleoptero*	X										
Efemeroptera	Baetidae	*Efemeroptero*						X	X	X			
Efemeroptera	Baetidae	*Baetidae sp*						X	X		X		
Ostracoda		*Ostracodo*							X				
Trombidiformes	Hydracarina	*Acari*			X						X		
Trombidiformes	Hydracarina	*Acari sp*								X			
Pulmonata		*Babosa*					X						
Ploima	Lecanidae	*Lecane sp*									X		
Nematoda		*Nematodo*		X		X	X	X				X	

Source: Merceditas corporation, 2012

Table 4.2-22. Spatial distribution of zooplankton collected in the qualitative sample.

Order	Family	Morphospecies	STATIONS										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
Euamoebida	Amoebidae	*Ameba*	X		X	X	X			X	X		X
Euamoebida	Amoebidae	*Tecameba*		X						X			X
Diptera	Chironomidae	*Tanytarsini sp*	X							X			
Diptera	Chironomidae	*Dolicopodidae sp*								X			
Diptera	Chironomidae	*Pupa diptero*			X	X							
Diptera	Chironomidae	*Chironomido*	X						X	X	X	X	X
Diptera	Chironomidae	*Simullium sp*			X								
Trichoptera	Hydropsychidae	*Hydropsychidae sp*								X			X
Coleoptera	Elmidae	*Elmidae sp*				X			X	X			
Coleoptera	Elmidae	*Coleoptero*	X										
Efemeroptera	Baetidae	*Efemeroptero*						X	X	X			
Efemeroptera	Baetidae	*Baetidae sp*						X	X		X		
Ostracoda		*Ostracodo*							X				
Trombidiformes	Hydracarina	*Acari*			X						X		
Trombidiformes	Hydracarina	*Acari sp*								X			
Pulmonata		*Babosa*					X						
Ploima	Lecanidae	*Lecane sp*									X		
Nematoda		*Nematodo*		X		X	X	X				X	

Source: Merceditas corporation, 2012

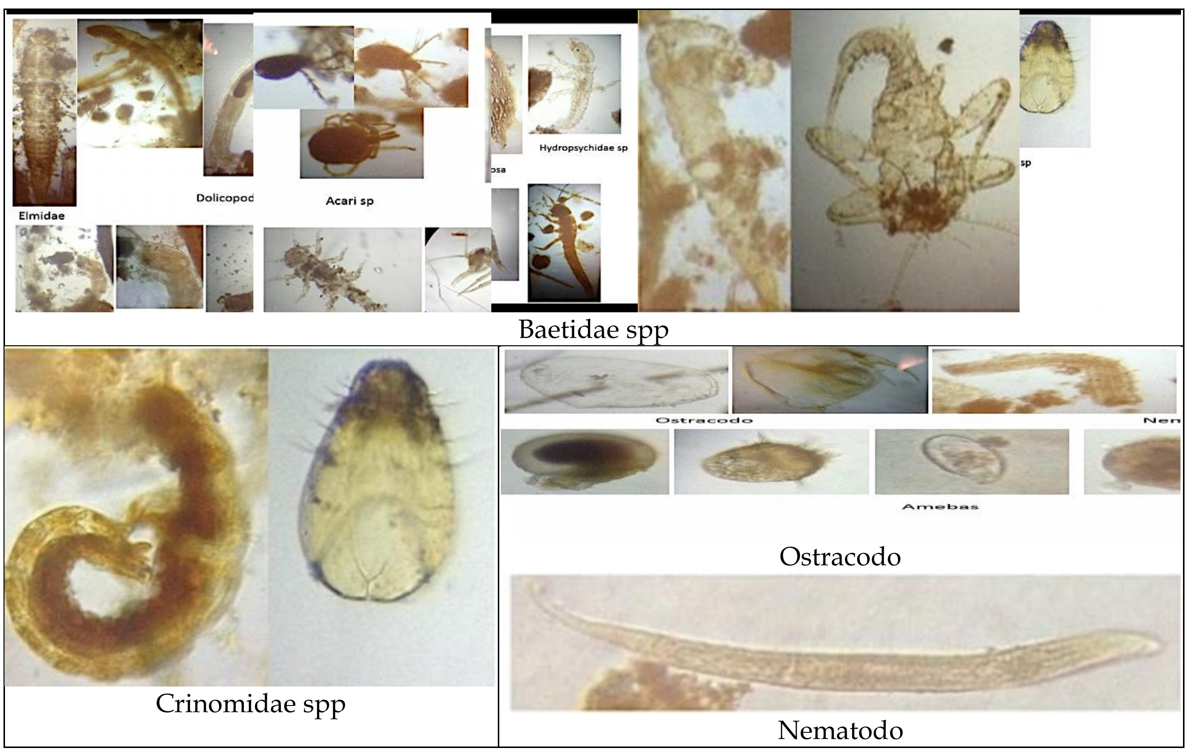
For this study, the same species were presented in both the qualitative and quantitative samples, because this community is not very diverse for this lotic aquatic ecosystem or the drainage network sampled.

Drift seems to be the phenomenon that controls the presence of phytoplankton and in the case of zooplankton it is more evident, given that the organisms found in both qualitative and quantitative sampling are dominantly aquatic macro invertebrate larvae.

There is evidence of a reduction in species richness, in comparison with the periphytic community and phytoplankton because this community does not find favorable conditions in lotic systems, so only organisms derived from the community of aquatic macroinvertebrates were found.

The balance between the different trophic levels of an aquatic ecosystem and its impact on water quality has been discussed and led to raise the models of "top-down" and "bottom-up" effects (Lampert & Somer, 1997). So, a low wealth like this would allow to define an environment as disturbed, however, being a current water system, the greatest ecological weight at the time of making decisions and analysis falls on perifiton.

The majority of registered organisms are aquatic macroinvertebrates. Below is a photographic mosaic with some of these species (See Illustration 4.2-230).



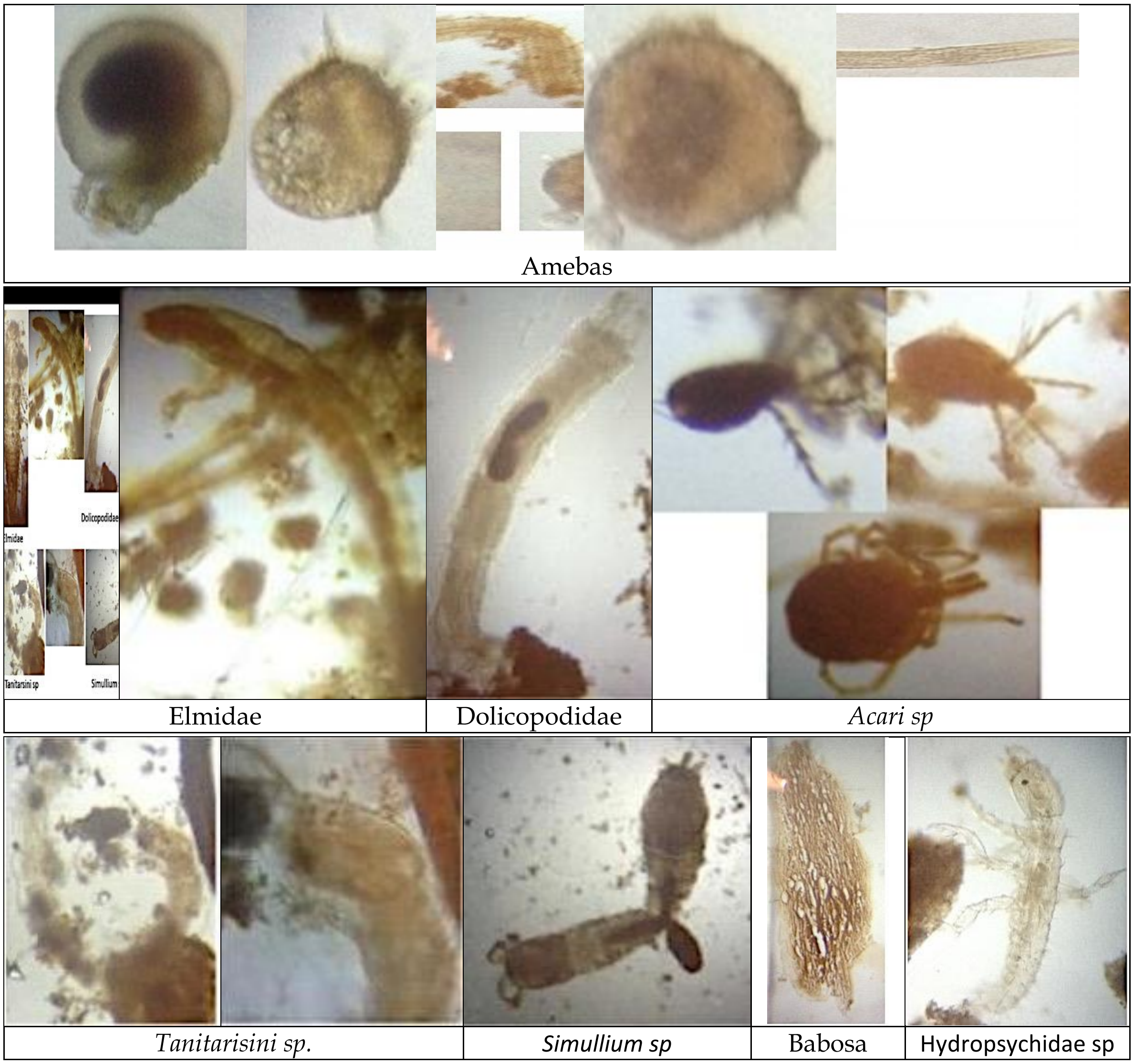


Illustration 4.2-230. Main zooplankton morphotypes found in the sampling stations.
Source: Merceditas Corporation, 2012

The bio indication of zooplankton organisms is presented in Table 4.2-23., although it is worth mentioning that the best classification for this type of environment is given by the periphytic community.

Table 4.2-23. Bio indicator Character of zooplankton organisms.

MORPHOSPECIES	CHARACTERISTICS OF BIOINDICATION OR THEIR ORGANIC ROLE
Ameba	Waters with organic contamination of animal type (Roldán, 2003)
Tecameba	Waters with organic contamination of animal type (Roldán, 2003)
Tanitarsini sp	Waters with organic load (Roldán, 2003)
Dolicopodidae sp	Waters with organic load (Roldán, 2003)

MORPHOSPECIES	CHARACTERISTICS OF BIOINDICATION OR THEIR ORGANIC ROLE
Hydropsychidae sp	Waters with little organic load (Roldán, 2003)
Elmidae sp	Waters with little organic load (Roldán, 2003)
Coleoptero	Waters with little organic load (Roldán, 2003)
Chironomido	Waters with organic load (Roldán, 2003)
Efemeroptero	Waters with little organic load (Roldán, 2003)
Baetidae sp	Waters with little organic load (Roldán, 2003)
Ostracodo	Waters of all kinds of quality (Pinilla 2000)
Simullium sp	Good quality waters (Roldán, 2003)
Acari	Good quality waters (Roldán, 2003)
Acari sp	Good quality waters (Roldán, 2003)
Babosa	Indicates environments of varied water quality (Pinilla 2000)
Lecane sp	Good quality waters (Roldán, 2003)
Nematodo	Indicates environments of varied water quality (Pinilla 2000)

Source: INGEX, 2016.

4.2.5.5.1 Composition, abundance and taxonomic richness by sampling station

As already evidenced, 19 zooplankton specimens were identified in the 11 sampling stations for the study area. Significant differences were found between stations P-01, P-08 and P-09 and the other sampling stations where zooplankton was recorded (X^2= 60.3654, p=<0.001). The stations with the lowest abundance were P-10, P-07 and P-02 (Illustration 4.2-231).

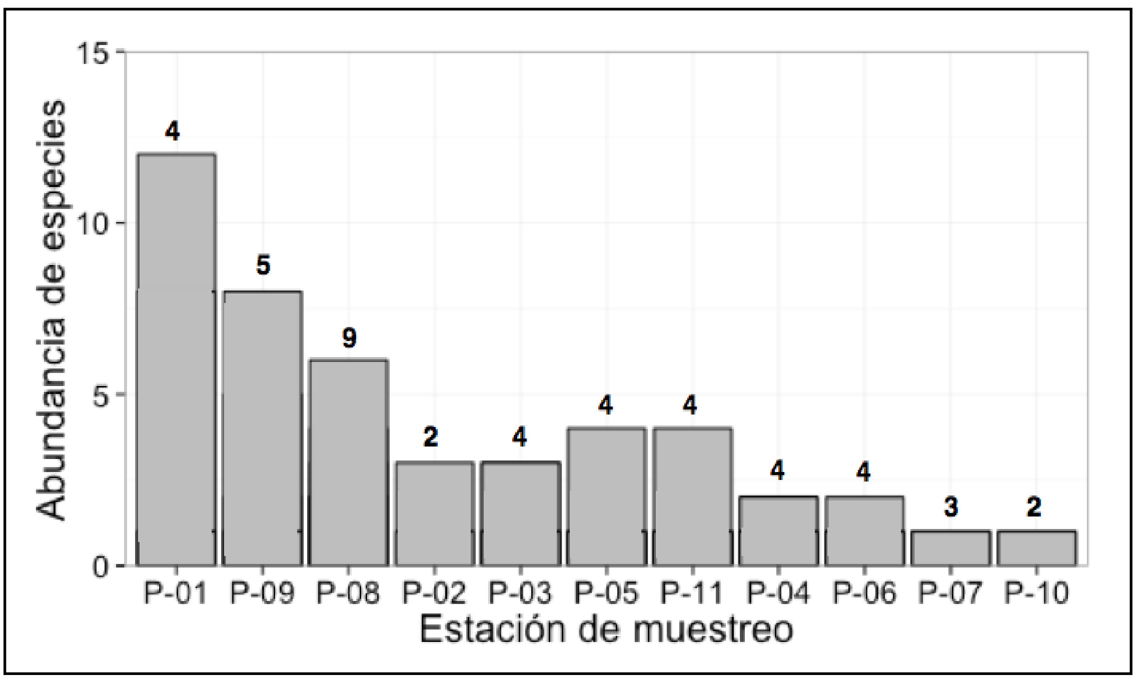


Illustration 4.2-231. Graph of the abundance and richness of Zooplankton species by sampling stations. The black numbers above the bars indicate the number of species.
Source: INGEX, 2016

In terms of relative abundance, taking into account the categorization of abundance for species (see methodology), the most abundant genus was *Amoeba*, as well as specimens belonging to the Chironomidae family (Relative abundance> 10%) (Illustration 4.2-232). On the other hand, there were 7 species with common occurrence in the sampling stations (relative abundance between 2 and 10%) (Illustration 4.2-232). The remaining 10 species were uncommon (relative abundance between 0.1 and 2%).

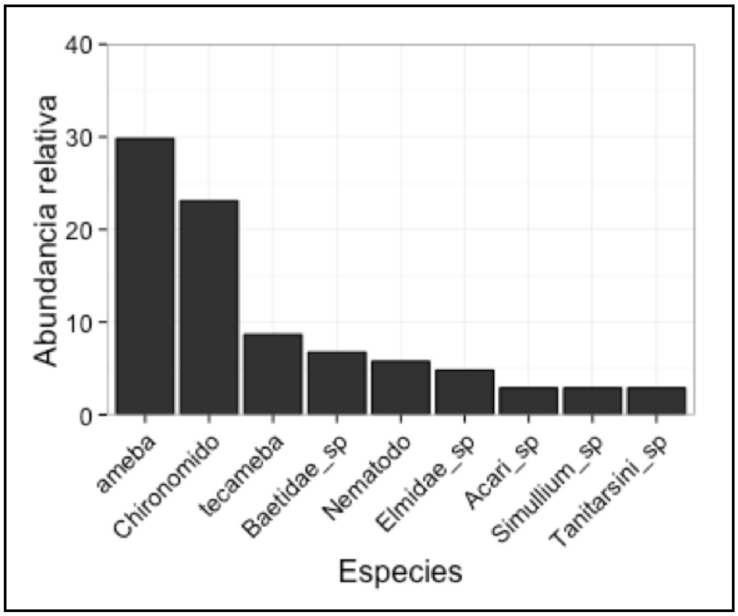


Illustration 4.2-232. Graph of the relative abundance of abundant and common zooplankton species.
Source: INGEX, 2016

P-01 Station

The predominant taxonomic family was Amoebidae, indicating the presence of human organic matter or animal origin.

In Table 4.2-24 the abundance and density of the registered organisms are presented in the qualitative and quantitative analyzes in the P-01 station (See Illustration 4.2-233).

Table 4.2-24. Abundance and density of morphotypes recorded in station P-01.

MORPHOTYPE	ABUNDANCE	DENSITY
Ameba	54,5454545	13,61
Chironomido	36,3636364	9,07
Coleoptero	4,54545455	1,13
Tanitarsini sp	4,54545455	1,13

Source: Merceditas corporation, 2012

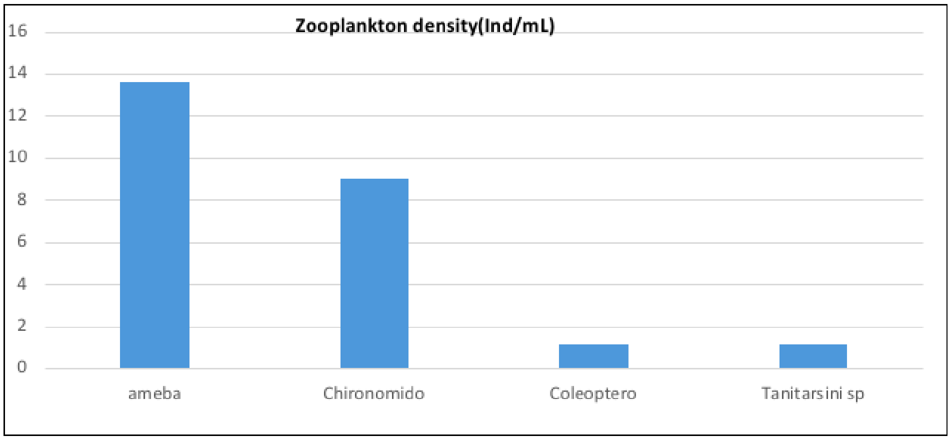


Illustration 4.2-233. Relative density of zooplankton organisms, station P-01.
Source: INGEX, 2016.

Dominant organisms were *Ameba spp* (See Illustration 4.2-237) with a 54.5% abundance of the community, followed by the Chironomids with 36.4%, both considered as tolerant to contamination, indicating that this station presents a regular water quality.

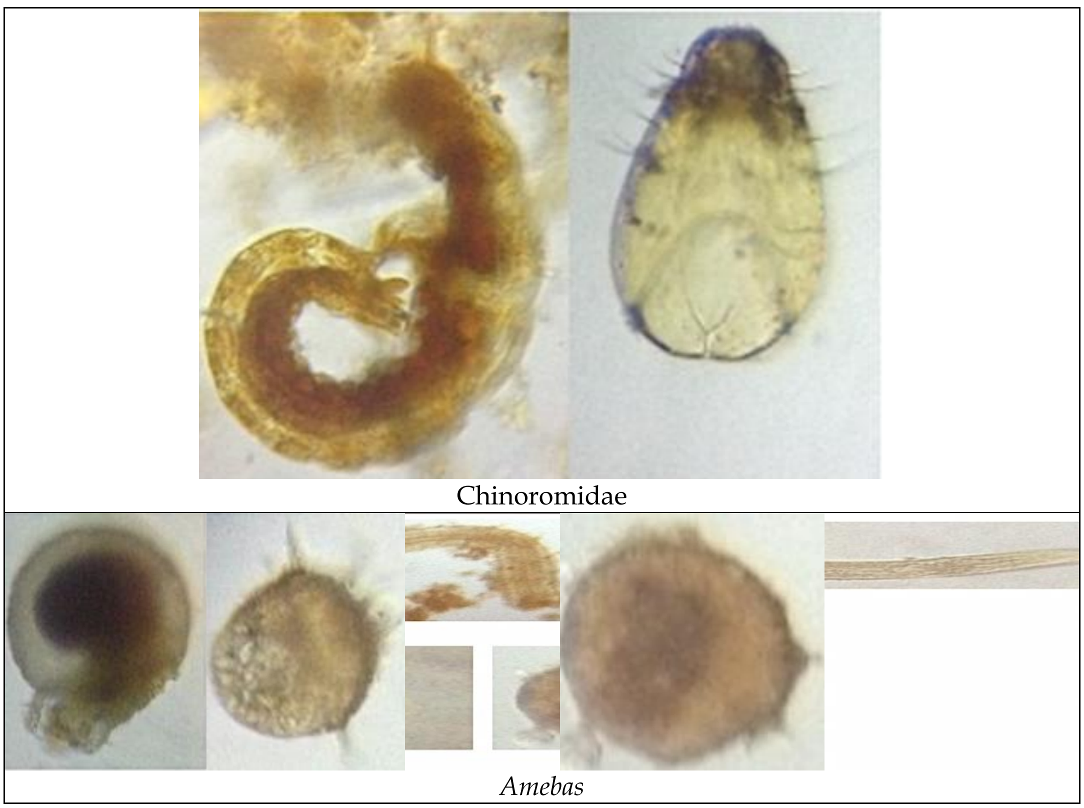


Illustration 4.2-234. Predominant zooplankton organisms, station P-01.
Source: Merceditas corporation, 2012

P-02 Station

The predominant taxonomic family was Amoebidae, indicating the presence of human organic matter or animal origin.

In Table 4.2-25 the abundance and density of the organisms registered in the qualitative and quantitative analyzes in this station is presented (See Illustration 4.2-235).

Table 4.2-25. Abundance and density of morphotypes recorded in station P-02.

MORPHOTYPE	ABUNDANCE	DENSITY
Tecameba	75	3,40
Nematodo	25	1,13

Source: Merceditas corporation, 2012

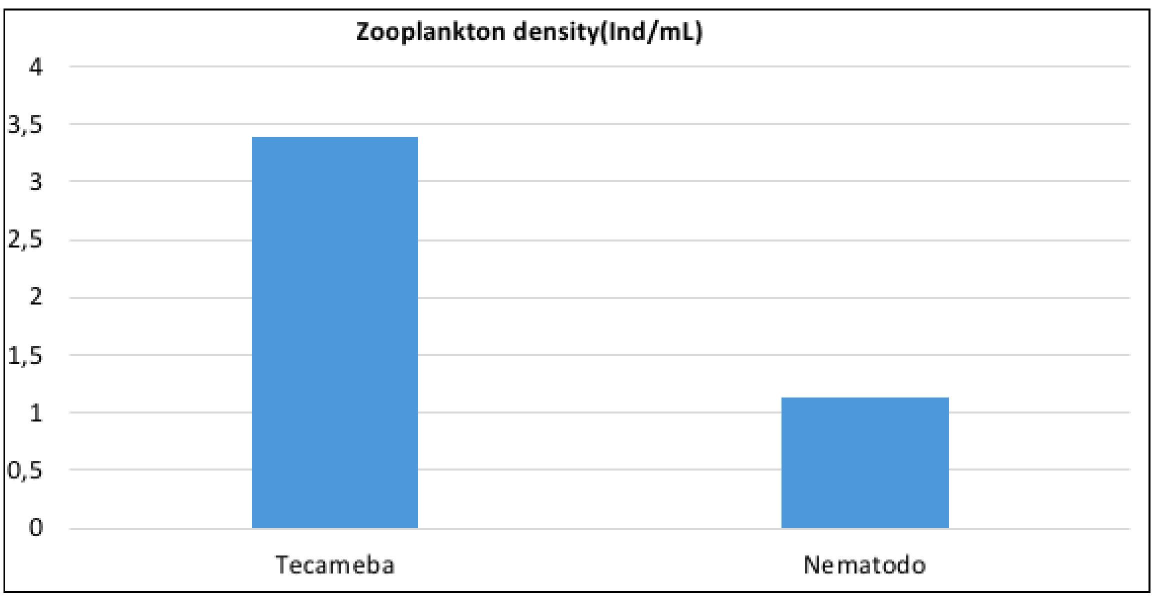


Illustration 4.2-235. Relative density of zooplankton organisms, station P-02.
Source: INGEX, 2016.

The dominant organisms were belonging to *Amoeba* with 75% (See Illustration 4.2-236), followed by the Nematodes with 25%, both considered as tolerant to contamination, indicating that this station presents a regular water quality.

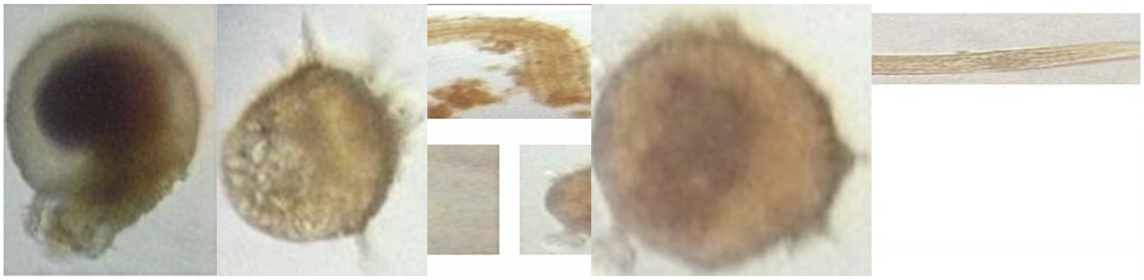


Illustration 4.2-236. Predominant zooplankton organisms (Amebas), station P-02.
Source: Merceditas Corporation, 2012

P-03 Station

The predominant taxonomic family was Amoebidae, indicating the presence of human organic matter or animal origin. This predominance was shared with the Simuliidae family, which is an indicator of clean waters (Roldán, 2003).

In Table 4.2-26 the abundance and density of the organisms registered in the qualitative and quantitative analyzes in this station is presented (See Illustration 4.2-237).

Table 4.2-26. Abundance and density of the morphotypes registered in the P-03 station.

MORPHOTYPE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Ameba	37,5	3,40	ameba
Simullium sp	37,5	3,40	Simullium sp
Acari	12,5	1,13	Acari
Pupa díptero	12,5	1,13	pupa diptero

Source: Merceditas corporation, 2012

As mentioned, the predominant organisms belong to the *Amoeba* genus with 37,5% of the abundance of the community, this was followed by the Simuliidae with 37.5% (See Illustration 4.2-241), being the first considered tolerant to pollution unlike the second; which suggests that this station presents a questionable quality (between good and regular) of water.

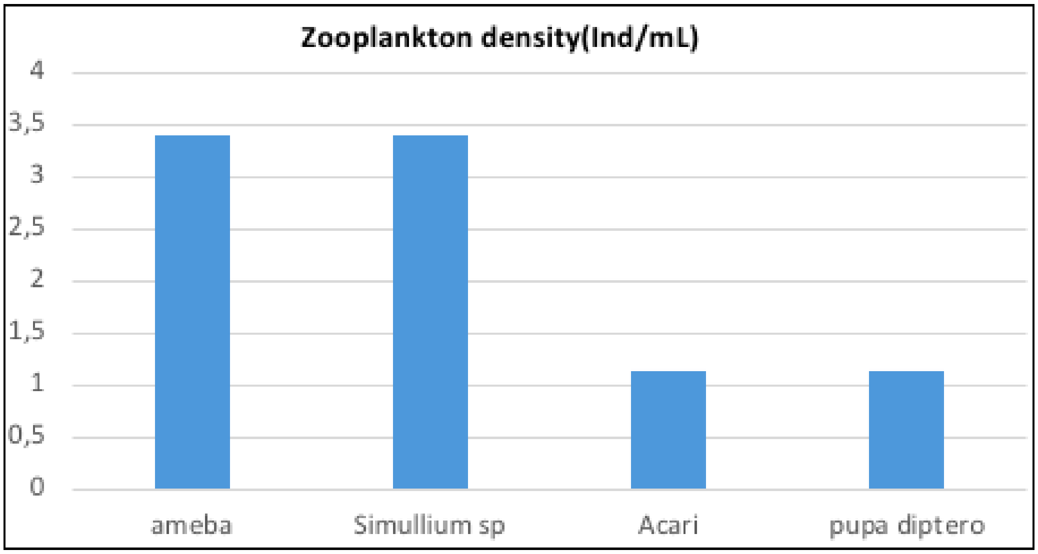


Illustration 4.2-237. Relative density of zooplankton organisms, station P-03.
Source: INGEX, 2016.

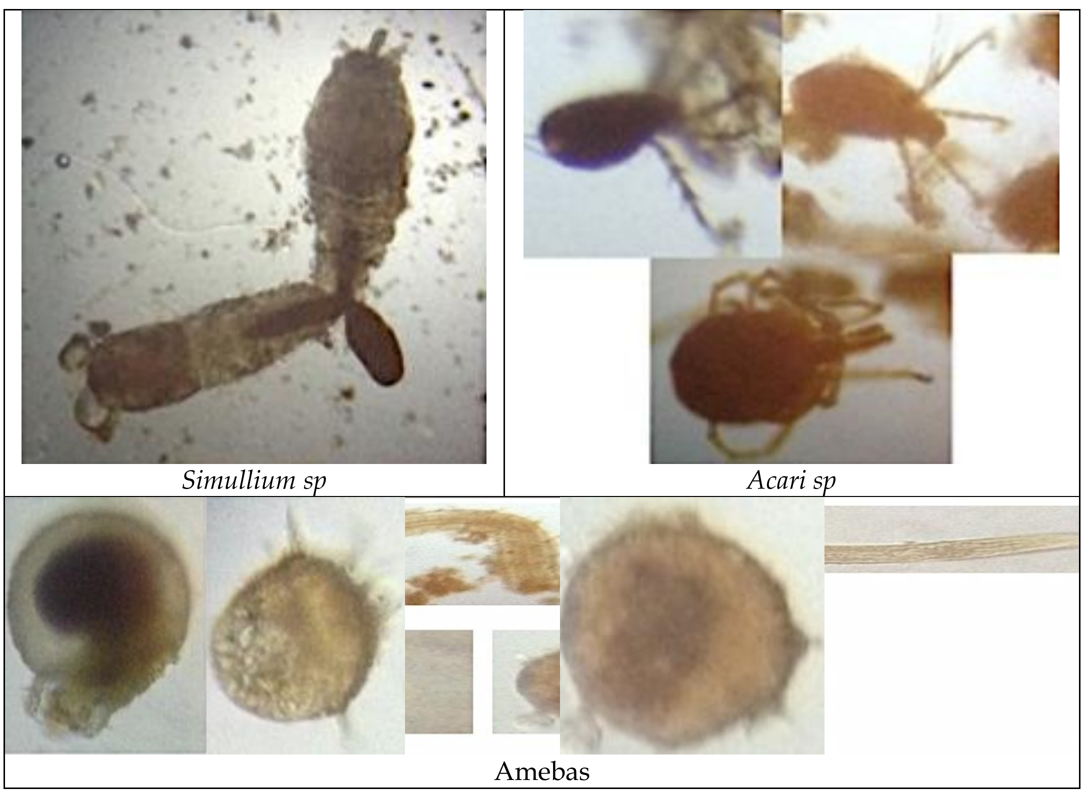


Illustration 4.2-238. Predominant zooplankton organisms, station P-03.
Source: Merceditas corporation, 2012

P-04 Station

Also, in this station, the predominant taxonomic family was Amoebidae, indicating the presence of human organic matter or animal origin. This predominance was shared with the Elmidae family, which is an indicator of clean waters (Roldán, 2003). Table 4.2-27 presents the organisms registered in the qualitative and quantitative analyzes, their abundance and density (See Illustration 4.2-236).

Table 4.2-27. Abundance and density of morphotypes registered in station P-04**.**

MORPHOTYPE	ABUNDANCE	DENSITY
Ameba	33,3333333	2,27
Elmidae sp	33,3333333	2,27
Nematodo	16,6666667	1,13
pupa díptero	16,6666667	1,13

Source: Merceditas corporation, 2012

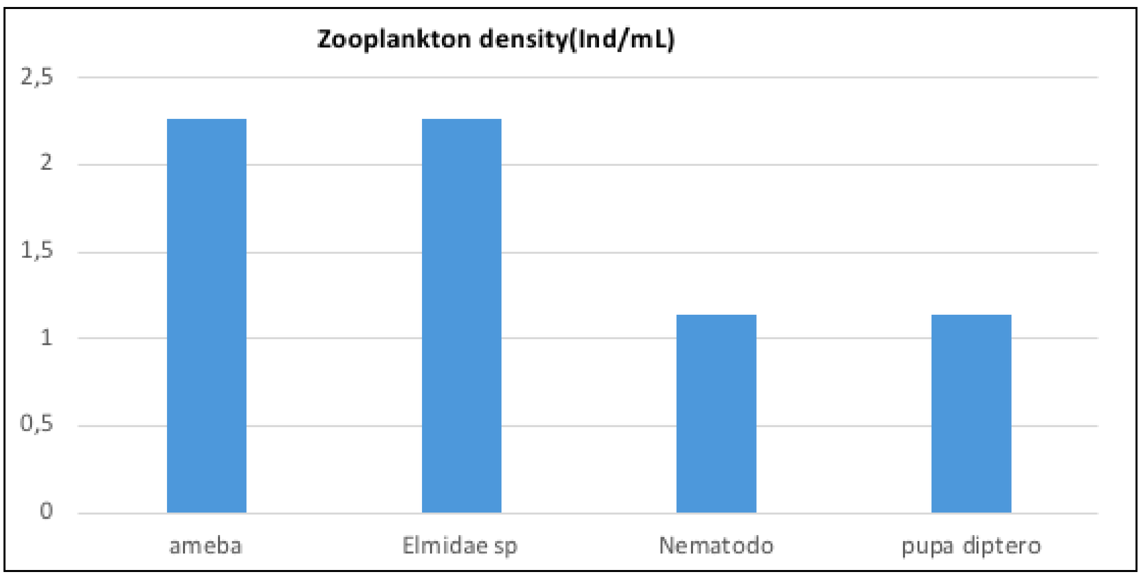
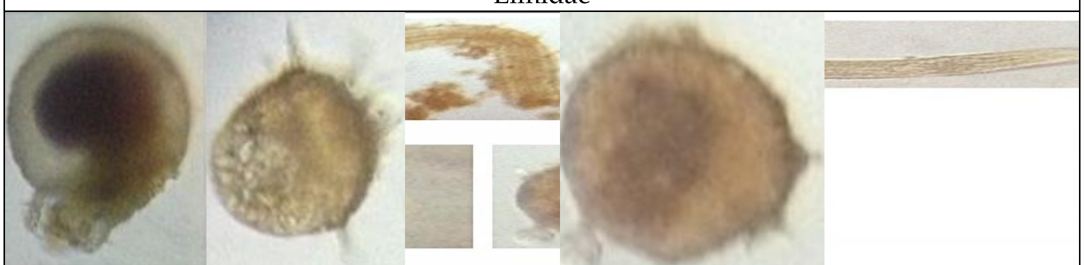


Illustration 4.2-239. Relative density of zooplankton organisms, station P-04.
Source: INGEX, 2016.

In the same way, the predominant organisms are the appurtenant to *Amoeba* genus with 33,3% abundance of the community, this dominance was shared with the Coleoptera of the Elmidae family with 33.3% (See Illustration 4.2-242), where the first is considered to be tolerant to contamination, unlike the second, which indicates that this station presents a questionable quality (between good and regular) of water.

Elmidae



Amebas

Illustration 4.2-240. Predominant zooplankton organisms, station P-04.
Source: Merceditas corporation, 2012

P-05 Station

In Table 4.2-28 the abundance and density of the registered organisms is presented in the qualitative and quantitative analyzes (See Illustration 4.2-238).

Table 4.2-28. Abundance and density of morphotypes recorded in station P-05.

MORPHOTYPE	ABUNDANCE	DENSITY
Ameba	57,1428571	4,54
Nematodo	14,2857143	1,13
Baetidae sp	14,2857143	1,13
Babosa	14,2857143	1,13

Source: Merceditas corporation, 2012

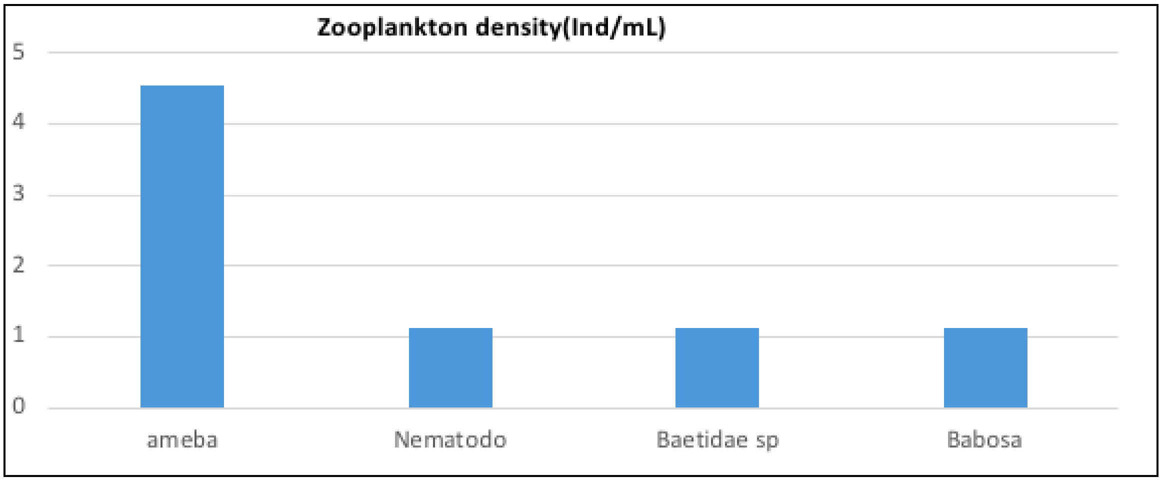


Illustration 4.2-241. Relative density of zooplankton organisms, station P-05.
Source: INGEX, 2016.

The most predominant organisms in the area correspond to the *Amoeba* genus, which reached 57.1% of the abundance of the community, being considered as tolerant to contamination, which may indicate that this station presents a regular water quality.

P-06 Station

The predominant group in this station was the phylum Nematoda (See Illustration 4.2-243), an indicator of the presence of human organic matter or animal origin, and it is also considered to be tolerant to contamination, which may indicate that this station has a regular quality of Water.

In Table 4.2-29 the abundance and density of registered organisms are presented in the qualitative and quantitative analyzes (See Illustration 4.2-242).

Table 4.2-29. Abundance and density of morphotypes recorded in station P-06.

MORPHOTYPE	ABUNDANCE	DENSITY
Efemeroptero	20	1,13
Nematodo	40	2,27
Baetidae sp	20	1,13
Ostracodo	20	1,13

Source: Merceditas corporation, 2012

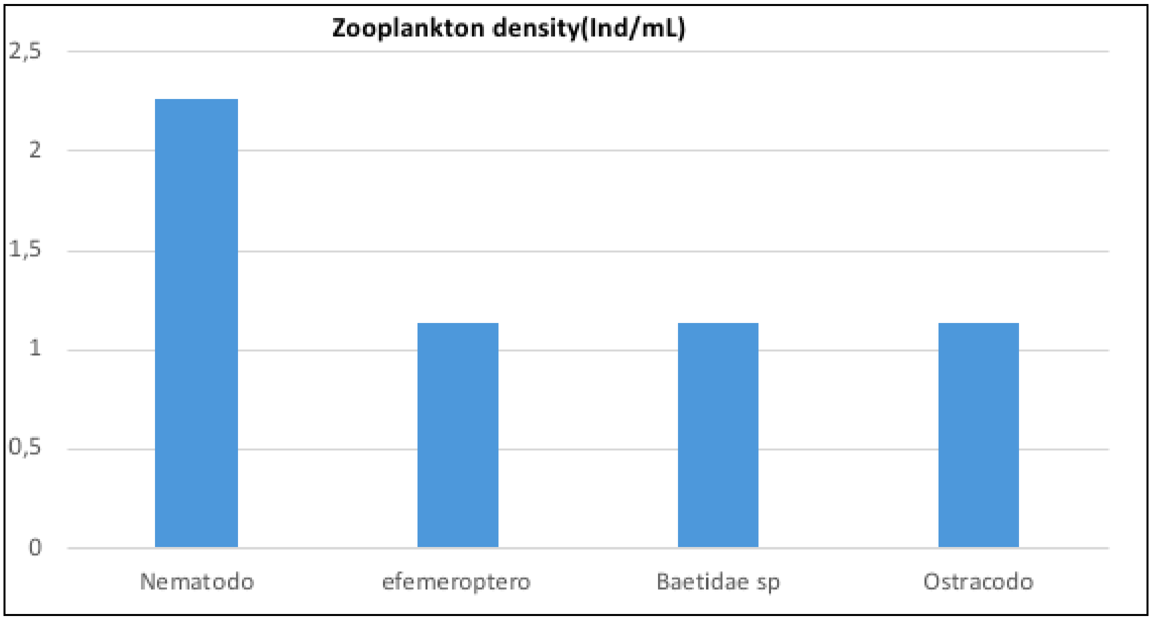


Illustration 4.2-242. Relative density of zooplankton organisms, station P-06.
Source: INGEX, 2016.

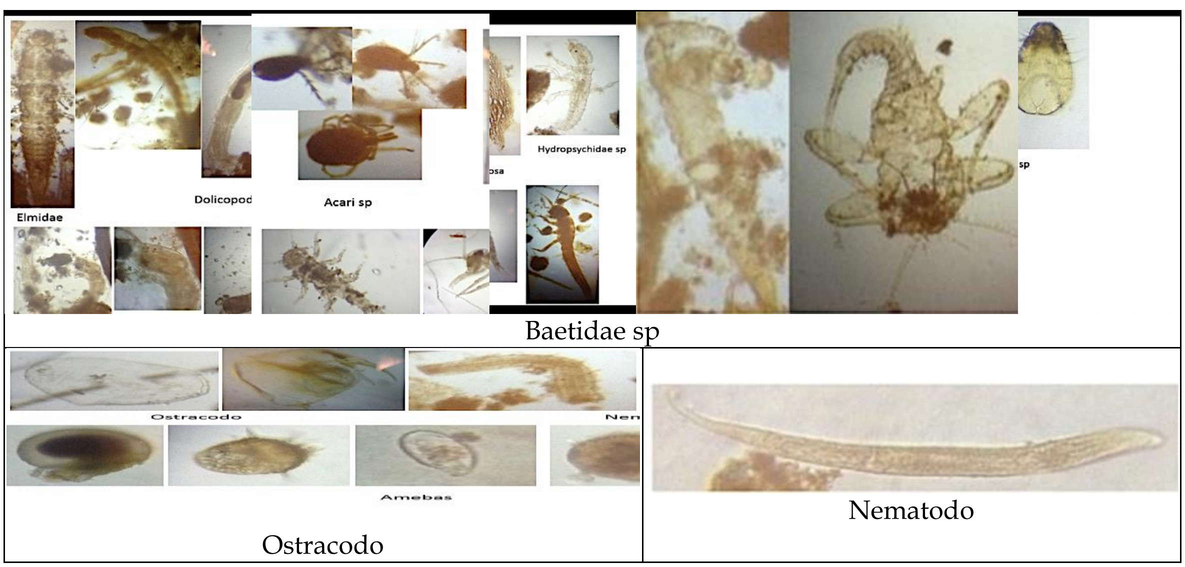


Illustration 4.2-243. Predominant zooplankton organisms, station P-06.
Source: Merceditas corporation, 2012

P-07 Station

No predominant taxonomic family was found, given that the three (3) registered families presented the same percentage of abundance.

In Table 4.2-30 the abundance and density of the registered organisms is presented in the qualitative and quantitative analyzes (See Illustration 4.2-244 and Illustration 4.2-245).

Table 4.2-30. List of morphotypes recorded in station P-07.

MORPHOTYPE	Abundance	density	Qualitative sample
Efemeroptero	33,3333333	1,13	efemeróptero
Elmidae sp	33,3333333	1,13	Elmidae sp
Crinonomidae sp	33,3333333	1,13	Crinonomidae sp

Source: Merceditas corporation, 2012

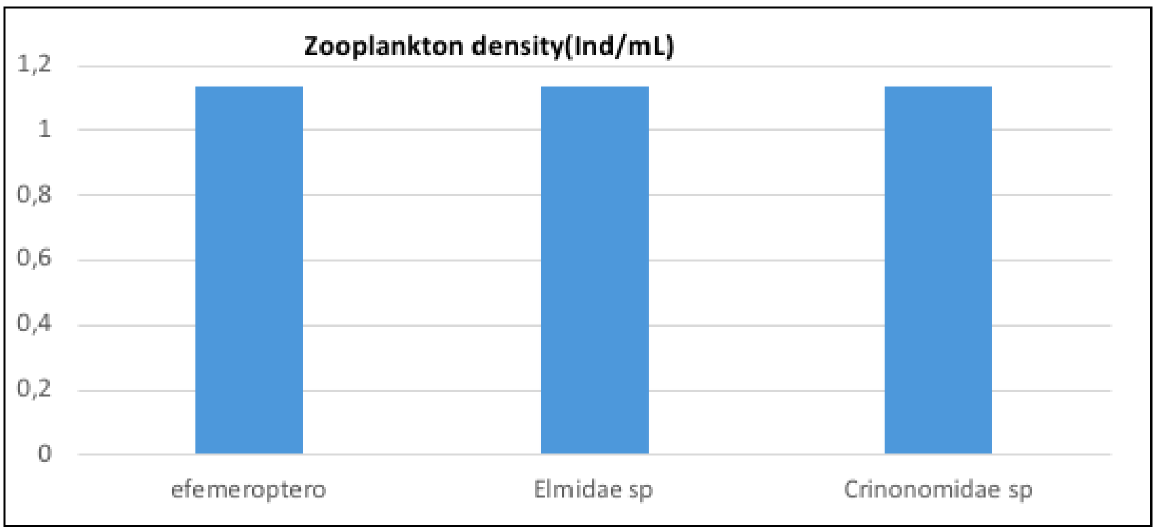
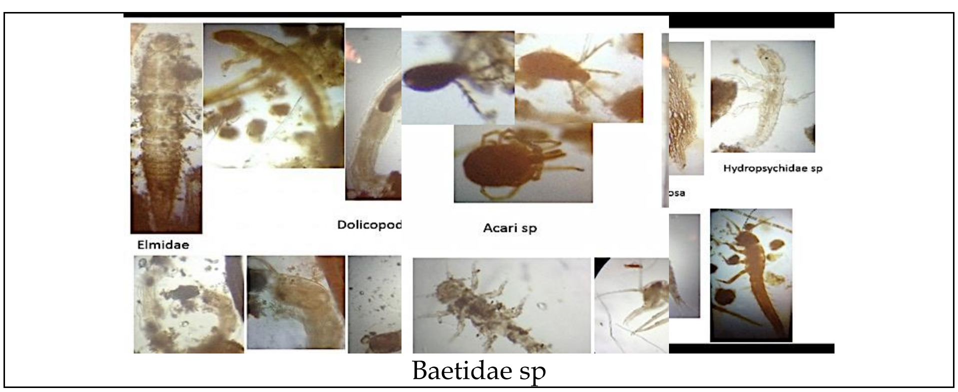


Illustration 4.2-244. Relative density of zooplankton organisms, station P-07. *Source: INGEX, 2016.*



Crinomidae sp	Elmidae

Illustration 4.2-245. Predominant zooplankton organisms, station P-07.
Source: Merceditas Corporation, 2012

P-08 Station

The predominant taxonomic family was Chironomidae, indicating the presence of human organic matter or animal origin, which reached 26% of the abundance of the community, followed by the abundance of amoebas with 17.4%, being considered as tolerant to pollution, indicating that this station presents a regular water quality.

In Table 4.2-31 we present the abundance and density of the organisms registered in the qualitative and quantitative analyzes (See Illustration 4.2-246).

Table 4.2-31. List of morphotypes registered in station P-08.

MORPHOTYPE	ABUNDANCE	DENSITY
Ameba	17,3913043	4,54
Tecameba	8,69565217	2,27
Tanitarsini sp	8,69565217	2,27
Dolicopodidae sp	4,34782609	1,13
Baetidae sp	13,0434783	3,40
Hydropsychidae sp	4,34782609	1,13
Elmidae sp	8,69565217	2,27
Acari sp	8,69565217	2,27
Chironomido	26,0869565	6,80

Source: Merceditas corporation, 2012

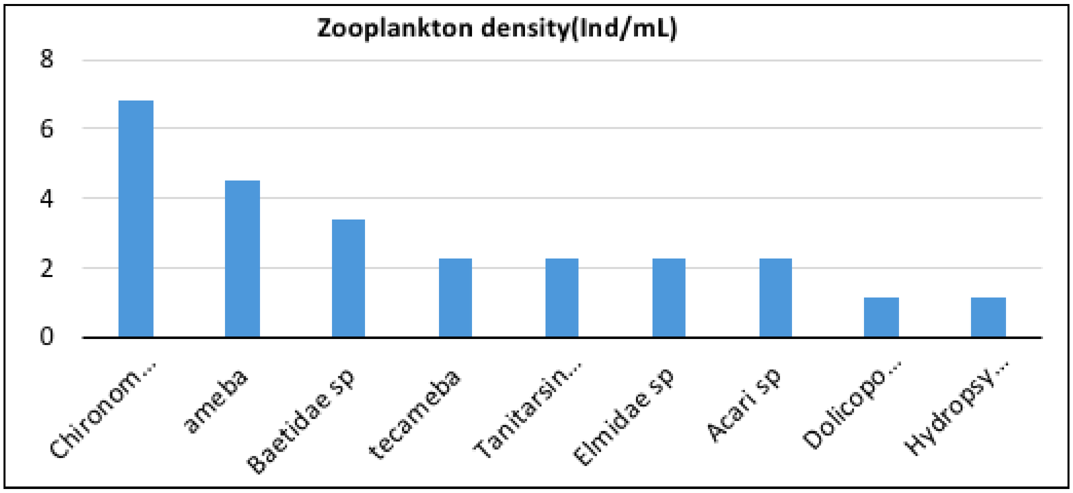


Illustration 4.2-246. Relative density of zooplankton organisms, station P-08.
Source: INGEX, 2016.

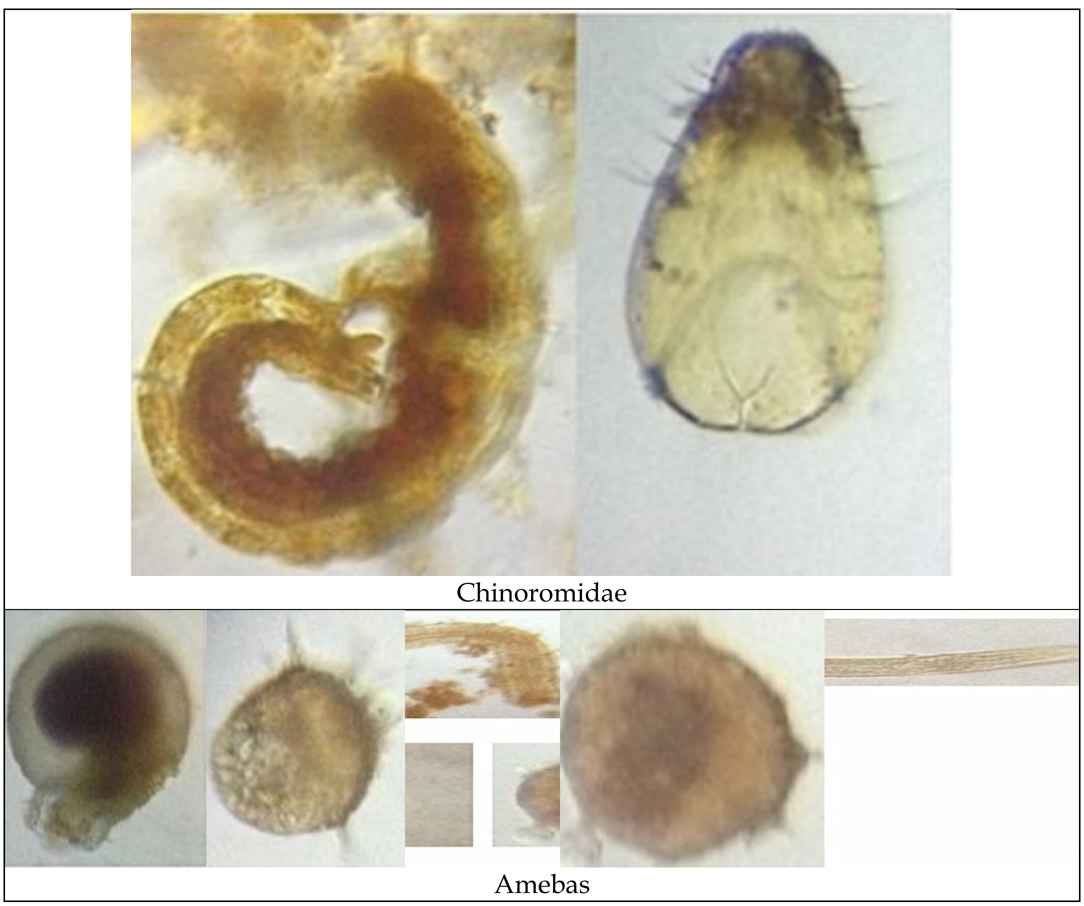


Illustration 4.2-247.. Predominant zooplankton organisms, station P-08
Source: Merceditas corporation, 2012

P-09 Station

The predominant taxonomic family was Chironomidae, indicating the presence of human organic matter or animal origin, with 47% of the abundance of the community, followed by amoebas with 29%, being considered as tolerant to contamination, indicating that this station presents a regular water quality.

In Table 4.2-32 the abundance and density of the registered organisms is presented in the qualitative and quantitative analyzes (See Illustration 4.2-245).

Table 4.2-32. List of morphotypes registered in station P-09.

MORPHOTYPE	ABUNDANCE	DENSITY
Ameba	29,4117647	5,67
Baetidae sp	11,7647059	2,27
Acari sp	5,88235294	1,13
Chironomido	47,0588235	9,07
Lecane sp	5,88235294	1,13

Source: Merceditas corporation, 2012

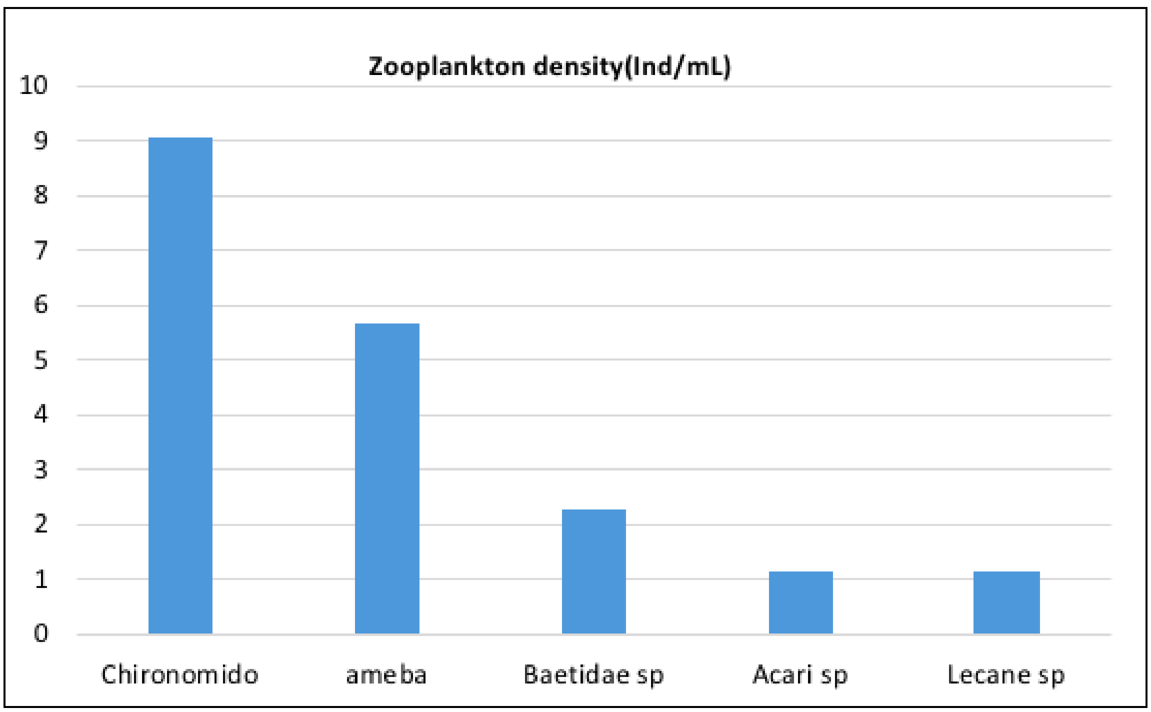


Illustration 4.2-248. Relative density of zooplankton organisms, station P-09
Source: INGEX, 2016.

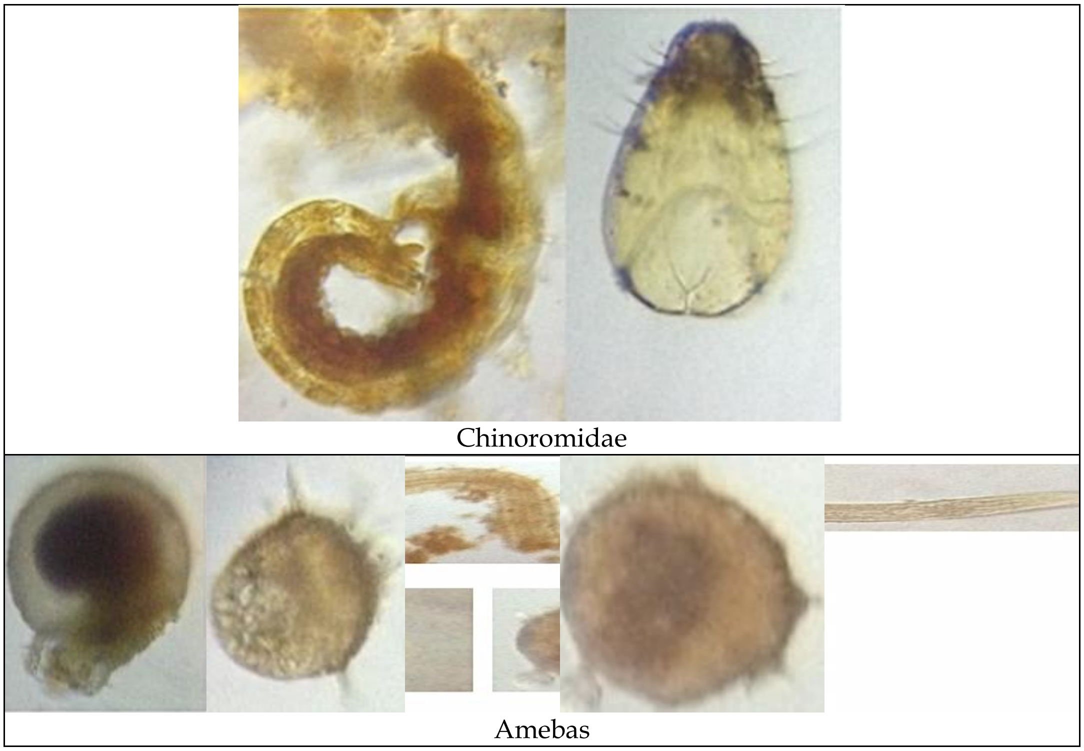


Illustration 4.2-249. Predominant zooplankton organisms, station P-09.
Source: Merceditas Corporation, 2012

P-10 Station

In this station, the predominant taxonomic family was Chironomidae (See Illustration 4.2-251), indicating the presence of human organic matter or animal origin, with 50% of the abundance of the community, followed by nematodes with 50%, being considered as tolerant to contamination, which may indicate that this station presents a regular water quality.

In Table 4.2-33 we present the abundance and density of the organisms registered in the qualitative and quantitative analyzes (See Illustration 4.2-250).

Table 4.2-33. List of morphotypes registered in the P-10 station.

MORPHOTYPE	ABUNDANCE	DENSITY
Chironomido	50	1,13
Nematodo	50	1,13

Source: Merceditas corporations, 2012

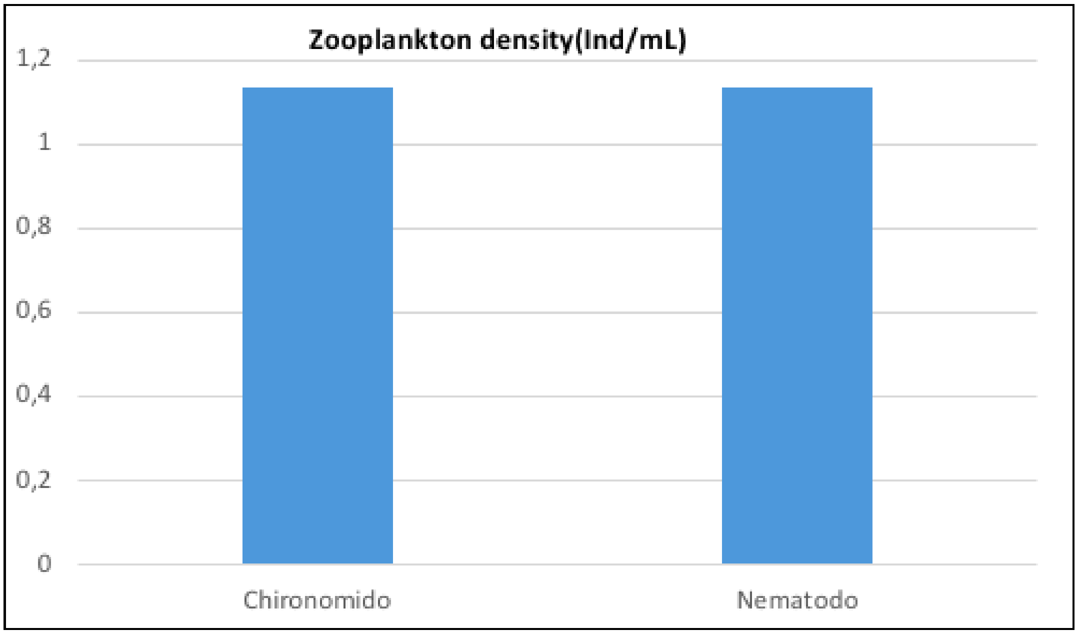


Illustration 4.2-250. Relative density of zooplankton organisms, station P-10.
Source: INGEX, 2016.

Illustration 4.2-251. Predominant zooplankton organisms, station P-10.
Source: Merceditas corporation, 2012

P-11 Station

The predominant taxonomic family was Amoebidae, indicating the presence of human organic matter or animal origin.

In Table 4.2-34 the abundance and density of the registered organisms is presented in the qualitative and quantitative analyzes (See Illustration 4.2-252 and Illustration 4.2-253).

Table 4.2-34. List of morphotypes recorded in station P-11.

MORPHOTYPE	ABUNDANCE	DENSITY
Ameba	14,2857143	1,13
Tecameba	57,1428571	4,54
Hydropsychidae sp	14,2857143	1,13
Chironomido	14,2857143	1,13

Source: Merceditas corporation, 2012

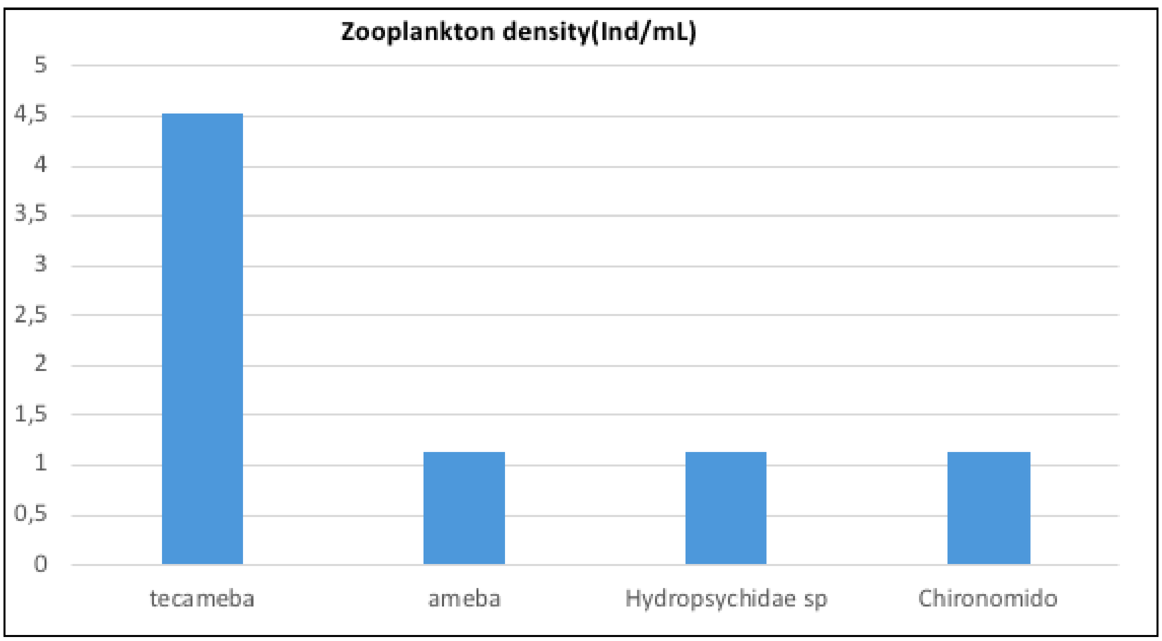


Illustration 4.2-252. Relative density of zooplankton organisms, station P-11.
Source: INGEX, 2016.

On a lower level; the dominant species was *Tecameba sp* that reached 57.1% of the abundance of the community, being considered as tolerant to contamination, which may indicate that this station presents a regular water quality.

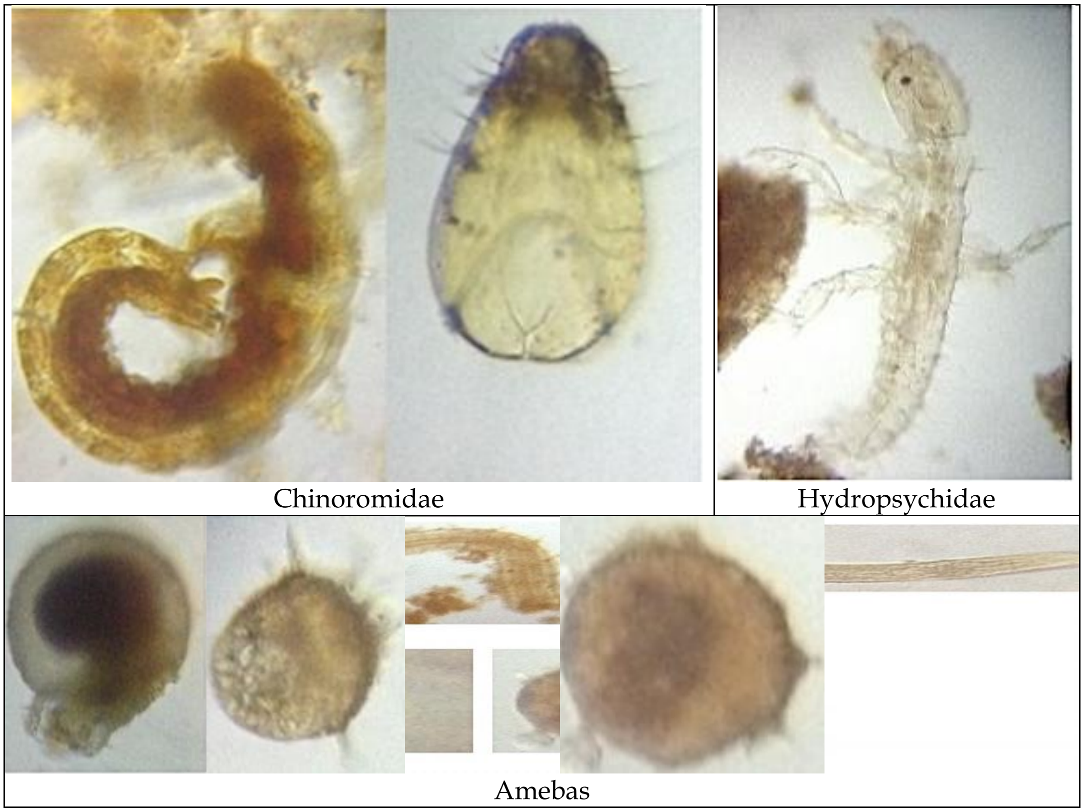


Illustration 4.2-253. Predominant zooplankton organisms, station P-11.
Source: Merceditas Corporation, 2012

4.2.5.5.2 Diversity indices

The alpha and beta diversity indices are presented below.

Alpha (α) Diversity

In general terms, no significant differences were found in the alpha diversity indices evaluated (Simpson, Shannon and Margalef) between the sampling stations studied (Illustration 4.2-254). The Margalef index for all stations oscillated between 0.72 and 2.55, without significant differences between them (X^2=1.4557, p=0.99). For the Simpson diversity index, no significant differences were found between the sampling stations (X^2=0.2425, p=1) nor for the Shannon index (X^2=1.2865, p=0.99). The similarity between these diversity indices may be due to the fact that the zooplankton communities are very adapted to the lentic ecosystems.

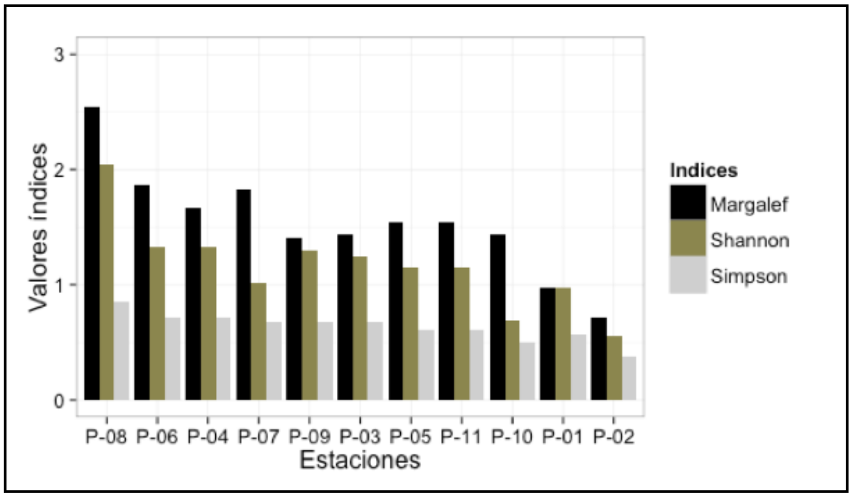


Illustration 4.2-254. Graph of indices of diversity, heterogeneity and dominance (Margalef, Shannon and Simpson) Zooplankton by sampling station.

Source: INGEX, 2016

Beta (β) Diversity

The analysis of similarity between sampling stations for zooplankton, based on the dendrogram of the similarity distances of Bray-Curtis, showed that there is a great similarity between stations P-08 and P-11, being two of the most diverse (See Illustration 4.2-255).

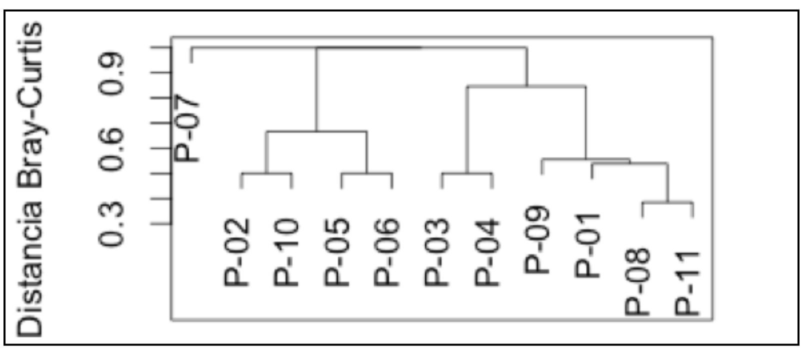


Illustration 4.2-255. Graph of analysis of Zooplankton beta diversity between sampling stations based on a dendrogram.

Source: INGEX, 2016

On the diversity of zooplankton species, a strange structure was registered, where the organisms that were found in the first place are almost all aquatic insects; On the other hand, the primary group has two subgroups (Stations P-03 and P-04, and P-08 and P-11), with similarities in the order of 79 and 72% respectively. Almost all stations are in a large block with 67% environmental similarity.

4.2.5.6 PERIPHYTON

Periphyton is important both from the ecological perspective to understand the functioning of aquatic ecosystems, and from the environmental point of view, in factors such as water quality and pollution processes that may be affecting ecosystems.

Due to its position in the substrate-water interface, periphyton plays a fundamental role in some biogeochemical cycles and in the dynamics of the ecosystems where they are present (Amblart et al., 1990, Hansson, 1990 in Masseret et al., 1998). Since the periphytic forms are sessile and their composition and abundance reflect the environmental conditions of the recent past; consequently, they can be used as indicators of water quality (Wetzel, 1979 in Masseret et al., 1998).

In Table 4.2-35 and SourceSource: *Merceditas corporation,* ***2012***

Table 4.2-36 the organisms present in the periphyton and their distribution among the sampling stations are evident.

Table 4.2-35. Spatial distribution of the peripheral organisms collected in the quantitative sample.

ORDER	FAMILY	MORPHOSPECIES	STATIONS										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
Eunotiales	Eunotiaceae	*Actinella sp*											
	Eunotiaceae	*Eunotia sp*	X										
Cocconeidales	Achnanthaceae	*Achanthes sp*					x						
	Achnanthaceae	*Achnanthidium exiguum*	X	X		X		X					
	Achnanthaceae	*Achnanthidium minutissimum*						X					
	Achnanthaceae	*Achnanthidium sp*		X			X		X				X
Aulacoseirales	Aulacoseiraceae	*Aulacoseira sp*	X										
Naviculales	Amphipleuraceae	*Amphipleura sp*	X										
	Amphipleuraceae	*Frustulia sp*		X				X					X
	Amphipleuraceae	*Frustulia aff vulgaris*					X			X			
	Brachysiraceae	*Brachysira sp*	X	X	X	X					X	X	X
Cocconeidales	Cocconeidaceae	*Cocconeis sp*					X	X					
Cymbellales	Cymbellaceae	*Placoneis sp*						X	X				
	Cymbellaceae	*Cymbella sp*							X	X		X	
	Cymbellaceae	*Cymbella tumida*	X	X	X	X	X	X	X	X	X		
	Cymbellaceae	*Cymbopleura sp*		X			X	X		X	X		X
	Cymbellaceae	*Encyonema sp*		X		X	X	X		X	X	X	X
	Cymbellaceae	*Encyonema alargado*											X
	Stephanodiscaeae	*Cyclotella sp*				X	X			X	X	X	
	Gomphonemataceae	*Gomphonema parvulum*		X		X		X					X
	Gomphonemataceae	*Gomphonema aff lagenula*					X						
	Gomphonemataceae	*Gomphonema sp*					X			X			
Licmophorales	Fragilariaceae	*Ulnaria aff ulna*	x	x	x	x	x	x	x	x	x	x	x

ORDER	FAMILY	MORPHOSPECIES	STATIONS										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
	Fragilariaceae	*Fragilaria goulardii*	x	x	x	x	x	x	x		x	x	x
	Fragilariaceae	*Fragilaria sp*	X							X			
	Fragilariaceae	*Fragilaria teratogénica*	X										
	Fragilariaceae	*Fragilariforma sp*	X										
Naviculales	Naviculaceae	*Luticola sp*				X		X				X	
	Naviculaceae	*Eolimna sp*					X						
	Naviculaceae	*Navicula radiosa*	X	X				X				X	
	Naviculaceae	*Navicula aff digitoradiata*				X							
	Naviculaceae	*Navicula sp*	X				X	X	X	X			X
	Naviculaceae	*Mayamaea sp*	X	X		X	X	X					
	Bacillariaceae	*Nitzschia sp*				X							X
	Bacillariaceae	*Nitzschia aff denticula*	X	X		X	X				X		
	Brachysiraceae	*Nupela sp*		X		X		X					
	Pinnulariaceae	*Pinnularia sp*					X						
	Sellaphoraceae	*Sellaphora sp*		X		X		X		X			
	Sellaphoraceae	*Sellaphora pupula*		X									
	Stauroneidaceae	*Stauroneis sp*					X						
	Stauroneidaceae	*Staurosira sp*								X			
Rhopalodiales	Rhopalodiaceae	*Rhopalodia sp*	X										
Surirellales	Surirellaceae	*Surirella sp*	X		X	X							
	Surirellaceae	*Surirella sp2*	X										
Chlorellales	Scenedesmaceae	*Actinastrum sp*				X							
Coleochaetales	Coleochaetaceae	*Coleochaete sp*					X			X			
Nostocales	Nostocaceae	*Anabaena sp*		X					X				X
Chroococcales	Chroococcaceae	*Chroococcus sp*				X							
Desmidiales	Desmidiaceae	*Cosmarium sp1*					X	X		X	X		
	Desmidiaceae	*Cosmarium sp2*					X					X	
	Desmidiaceae	*Cosmarium pseudoconnatum*										X	
	Desmidiaceae	*Desmidium sp*	X										
	Desmidiaceae	*Euastrum sp*				X							X
	Desmidiaceae	*Actinotaenium SP*		X					X			X	X
	Closteriaceae	*Closterium sp1*				X	X			X		X	X
	Closteriaceae	*Closterium sp2*			X					X			
Oscillatoriales	Oscillatoriaceae	*Oscillatoria sp*	X	X	X	X	X		X	X	X		X
	Phormidiaceae	*Phormidium sp*						X					
Peridiniales	Peridiniaceae	*Peridinium sp*					X						
Euglenales	Euglenaceae	*Phacus sp*								X			
Euglenales	Peridiniaceae	*Trachelomona armata*	X										
	Peridiniaceae	*Trachelomona volvocina*	X										
	Tribonemataceae	*Tribonema sp*						X	X				
Tribonematales	Zygnemataceae	*Mougeotia sp*		X		X				X			
Oedogoniales	Oedogoniaceae	*Oedogonium sp*		X	X		X	X		X			
Synechococcales	Pseudanabaenaceae	*Pseudoanabaena sp*	X	X		X		X				X	
Ulotrichales	Ulotrichaceae	*Ulothrix sp*	X			X							
	verdes	*Alga filamentosa*	X							X			

ORDER	FAMILY	MORPHOSPECIES	STATIONS										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
Zygnematales	Zygnemataceae	*Spirogyra sp*										X	
Chlorellales	Oocystaceae	*Oocystis sp*										X	
Mischococcales	Characiopsidaceae	*Characiopsis sp*				X					X	X	
Euamoebida	Amoebidae	*Ameba sp*		X	X								

Source: Merceditas corporation, 2012

Table 4.2-36. Spatial distribution of the peripheral organisms collected in the qualitative sample.

ORDER	FAMILY	MORPHOSPECIES	STATIONS										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
Eunotiales	Eunotiaceae	*Actinella sp*	1	1	1	1		1					
	Eunotiaceae	*Eunotia sp*						1					
Cocconeidales	Achnanthaceae	*Achanthes sp*		1	1		1		1				1
	Achnanthaceae	*Achnanthidium exiguum*	1										
	Achnanthaceae	*Achnanthidium minutissimum*		1	1					1			1
	Achnanthaceae	*Achnanthidium sp*					1						
Aulacoseirales	Aulacoseiraceae	*Aulacoseira sp*	1	1	1	1					1	1	1
Naviculales	Amphipleuraceae	*Amphipleura sp*				1						1	
	Amphipleuraceae	*Frustulia sp*					1						
	Amphipleuraceae	*Frustulia aff vulgaris*	1	1	1			1				1	
	Brachysiraceae	*Brachysira sp*				1							
Cocconeidales	Cocconeidaceae	*Cocconeis sp*	1				1	1	1	1			1
Cymbellales	Cymbellaceae	*Placoneis sp*		1		1							
	Cymbellaceae	*Cymbella sp*	1			1	1						
	Cymbellaceae	*Cymbella tumida*					1						
	Cymbellaceae	*Cymbopleura sp*				1							1
	Cymbellaceae	*Encyonema sp*	1	1	1	1	1				1		
	Cymbellaceae	*Encyonema alargado*		1	1	1		1					
	Stephanodiscaceae	*Cyclotella sp*			1								
	Gomphonemataceae	*Gomphonema parvulum*					1						
	Gomphonemataceae	*Gomphonema aff lagenula*								1			
	Gomphonemataceae	*Gomphonema sp*					1	1					
Licmophorales	Fragilariaceae	*Ulnaria aff ulna*						1	1				
	Fragilariaceae	*Fragilaria goulardii*							1	1		1	
	Fragilariaceae	*Fragilaria sp*	1	1	1	1	1	1	1	1	1		
	Fragilariaceae	*Fragilaria teratogénica*		1	1		1	1		1	1		1
	Fragilariaceae	*Fragilariforma sp*		1	1	1	1	1		1	1	1	1
Naviculales	Naviculaceae	*Luticola sp*											1
	Naviculaceae	*Eolimna sp*		1	1	1	1			1	1	1	
	Naviculaceae	*Navicula radiosa*		1	1	1		1					1
	Naviculaceae	*Navicula aff digitoradiata*					1						
	Naviculaceae	*Navicula sp*					1						
	Naviculaceae	*Mayamaea sp*	1	1	1	1	1	1	1	1	1	1	1
	Bacillariaceae	*Nitzschia sp*	1	1	1	1	1	1	1	1	1	1	1

ORDER	FAMILY	MORPHOSPECIES	STATIONS										
			P-01	P-02	P-03	P-04	P-05	P-06	P-07	P-08	P-09	P-10	P-11
	Bacillariaceae	*Nitzschia aff denticula*								1			
	Brachysiraceae	*Nupela sp*	1			1							
	Pinnulariaceae	*Pinnularia sp*				1							
	Sellaphoraceae	*Sellaphora sp*					1						
	Sellaphoraceae	*Sellaphora pupula*		1	1					1			
	Stauroneidaceae	*Stauroneis sp*				1							
	Stauroneidaceae	*Staurosira sp*					1	1		1	1		
Rhopalodiales	Rhopalodiaceae	*Rhopalodia sp*										1	
Surirellales	Surirellaceae	*Surirella sp*										1	
	Surirellaceae	*Surirella sp2*				1							
Chlorellales	Scenedesmaceae	*Actinastrum sp*		1	1								
Coleochaetales	Coleochaetaceae	*Coleochaete sp*	1						1			1	
Nostocales	Nostocaceae	*Anabaena sp*		1					1				
Chroococcales	Chroococcaceae	*Chroococcus sp*	1	1	1	1	1		1	1	1		
Desmidiales	Desmidiaceae	*Cosmarium sp1*											
	Desmidiaceae	*Cosmarium sp2*		1									
	Desmidiaceae	*Cosmarium pseudoconnatum*								1			
	Desmidiaceae	*Desmidium sp*	1										
	Desmidiaceae	*Euastrum sp*	1										
	Desmidiaceae	*Actinotaenium SP*		1	1	1				1			
	Closteriaceae	*Closterium sp1*		1	1		1	1	1	1			
	Closteriaceae	*Closterium sp2*	1	1	1	1		1				1	
Oscillatoriales	Oscillatoriaceae	*Oscillatoria sp*											
	Phormidiaceae	*Phormidium sp*					1						
Peridiniales	Peridiniaceae	*Peridinium sp*										1	
Euglenales	Euglenaceae	*Phacus sp*				1					1	1	
Euglenales	Peridiniaceae	*Trachelomona armata*		1	1								
	Peridiniaceae	*Trachelomona volvocina*	1	1	1	1		1					
	Tribonemataceae	*Tribonema sp*						1					
Tribonematales	Zygnemataceae	*Mougeotia sp*		1	1		1		1				1
Oedogoniales	Oedogoniaceae	*Oedogonium sp*	1										
Synechococcales	Pseudanabaenaceae	*Pseudoanabaena sp*		1	1					1			1
Ulotrichales	Ulotrichaceae	*Ulothrix sp*					1						
	verdes	*Alga filamentosa*	1	1	1	1					1	1	1
Zygnematales	Zygnemataceae	*Spirogyra sp*				1						1	
Chlorellales	Oocystaceae	*Oocystis sp*					1						
Mischococcales	Characiopsidaceae	*Characiopsis sp*	1	1	1			1				1	
Euamoebida	Amoebidae	*Ameba sp*				1							

Source: Merceditas Corporation, 2012

In the eleven (11) sampling stations a total of 72 morphotypes were identified, of which 25 were identified at station P-01, 29 at P-02, 27 at stations P-03 and P-04, 25 at P-05, 22 in P-06, 12 in P-07 and P-09, 21 in P-08, 17 in P-10 and 16 in P-11. Significant differences were found between the P-10 station and the other sampling stations where periphyton was recorded (X^2=25.1729, p=<0.001). The stations with the lowest abundance were P-1, P-07 and P-11 (Illustration 4.2-4.2-256).

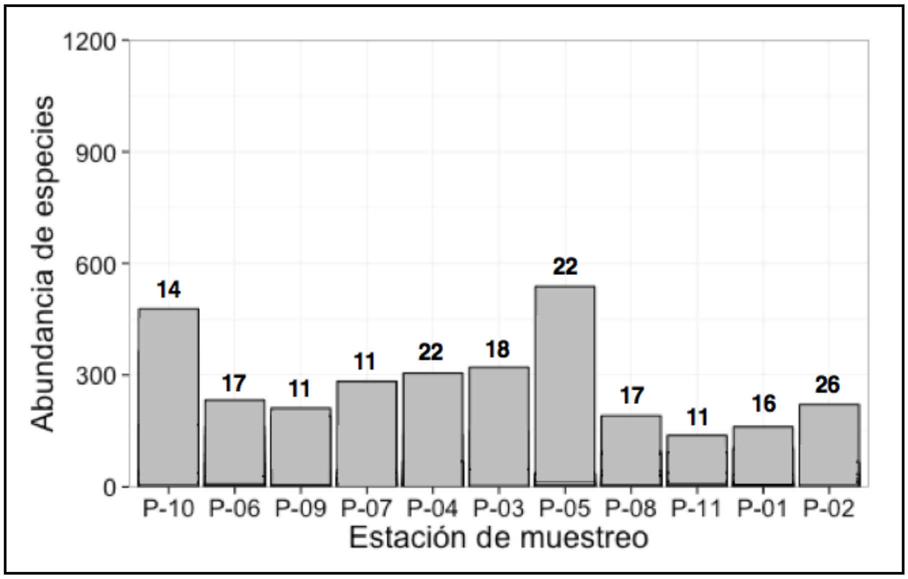
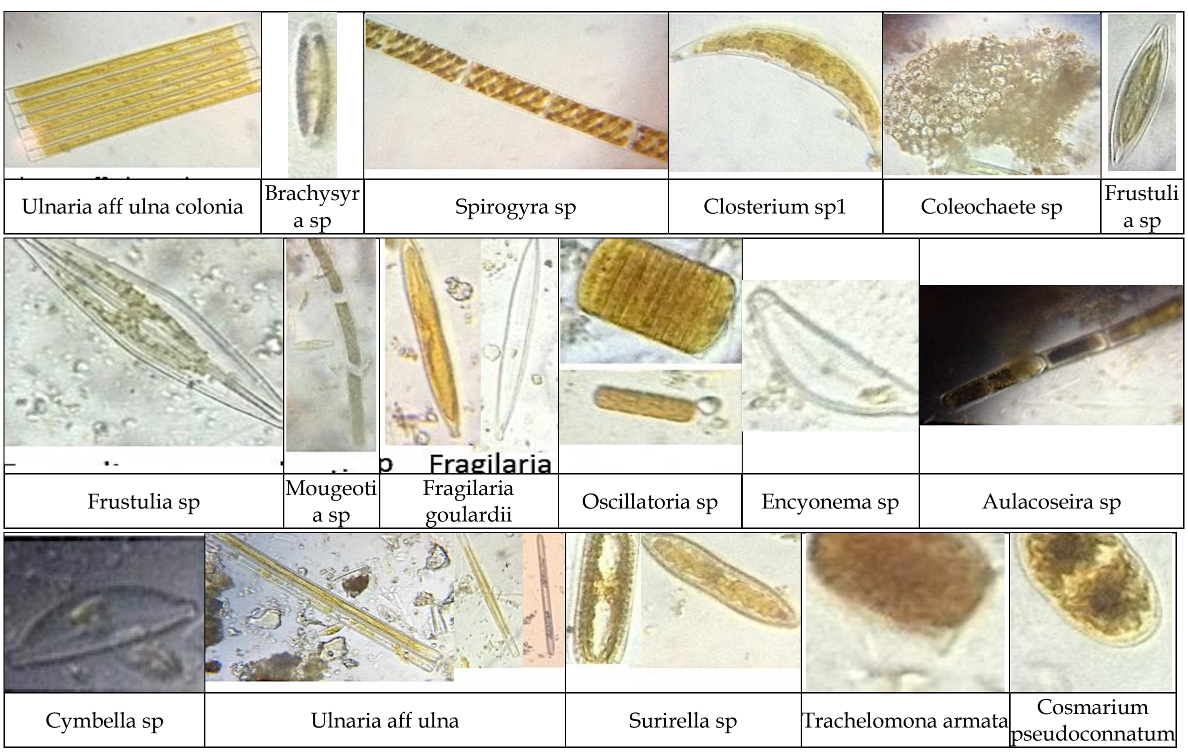
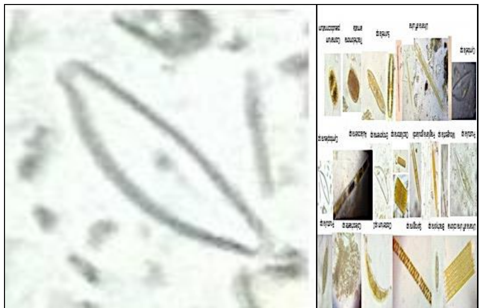


Illustration 4.2-4.2-256. Graph of the abundance and wealth of periphyton species by sampling stations. The black numbers above the bars indicate the number of species.
Source: INGEX, 2016

Below is a photographic mosaic of the main recorded periphyton species (See Illustration 4.2-257)





Cymbopleura sp	Fragilaria sp

Illustration 4.2-257. Peripheral organisms found in the sampling stations.
Source: Merceditas Corporation, 2012

Regarding the bio indication of the algae components of periphyton, the following can be highlighted: (See Table 4.2-37).

Table 4.2-37. List of algae registered in periphyton and its characteristics of bio indication

MORPHOSPECIES	CHARACTERISTICS OF BIOINDICATION OR THEIR ORGANIC ROLE
Actinella sp	Indicator of acid waters and oligotrophic environments (Montoya-Moreno and Aguirre, 2013)
Aulacoseira sp	Low water electrical conductivity (Montoya-Moreno and Aguirre, 2013)
Alga filamentosa	Power supply for zooplankton and aquatic macroinvertebrates; It can be used as a substrate for colonization by other algae.
Achanthes sp	Partially tolerant to organic contamination and to the low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Achnanthidium exiguum	Moderately polluted waters
Achnanthidium minutissimum	Indicator of contaminated and intermediate waters (Lobo, Callegaro and Bender, 2002)
Achnanthidium sp	Indicator of contaminated and intermediate waters (Lobo, Callegaro and Bender, 2002)
Actinastrum sp	Indicates eutrophic environments (Pinilla 2000)
Amphipleura sp	Oligo-mesotrophic environments (Lobo, Callegaro and Bender, 2002)
Anabaena sp	It produces cucumber smell in the water, they are indicators of water with organic contamination (Ramírez 2000).
Brachysira sp	Indicator of slightly acid, warm waters, low conductivity and transparency (Vouilloud et al., 2014)
Chroococcus sp	A predominantly planktonic species, it can abound in soft waters (Ramírez 2000).
Characiopsis sp	Mesotrophic environments (Lobo, Callegaro and Bender, 2002)
Coconeis sp	Mesotrophic environments (Lobo, Callegaro and Bender, 2002)
Coleochaete sp	Indicator of environments without pollution (Ramírez 2000).
Cosmarium sp1	Some species can produce cucumber smell and be resistant to chlorination (Ramírez 2000).
Cosmarium sp2	Some species can produce cucumber smell and be resistant to chlorination (Ramírez 2000).
Cosmarium pseudoconnatum	Water slightly acidic and poor in nutrients and low electrical conductivity (Ramírez 2000)
Cymbella sp	High environmental variability, many species
Cymbella tumida	Tolerant to pollution (Lobo, Callegaro and Bender, 2002)
Cymbopleura sp	Indicator of low electrical conductivity and low alkalinity (Lobo, Callegaro and Bender, 2002)
Closterium sp1	Hard waters (Ramírez 2000).
Closterium sp2	Hard waters (Ramírez 2000).
Cyclotella sp	Indicators of clean water (Ramírez 2000).
Desmidium sp	Clean and oligotrophic waters (Ramírez 2000).

MORPHOSPECIES	CHARACTERISTICS OF BIOINDICATION OR THEIR ORGANIC ROLE
Eolimna sp	Tolerant to pollution (Lobo, Callegaro and Bender, 2002)
Eunotia sp	Low water electrical conductivity, slightly acid waters (Montoya-Moreno and Aguirre, 2013)
Encyonema sp	Tolerance to low concentrations of ammonia nitrogen (Montoya-Moreno and Aguirre, 2013)
Encyonema alargado	Tolerance to low concentrations of ammonia nitrogen (Montoya-Moreno y Aguirre, 2013)
Euastrum sp	Tolerance to low concentrations of ammonia nitrogen (Montoya-Moreno and Aguirre, 2013)
Fragilaria goulardii	High transparency of water, neutral waters (Montoya-Moreno and Aguirre, 2013)
Fragilaria sp	High transparency of water, neutral waters (Montoya-Moreno and Aguirre, 2013)
Fragilaria teratogénica	Indicator of mutations, which in this case with very low density, obey to questions of chance.
Fragilariforma sp	Moderately polluted waters (Lobo, Callegaro and Bender, 2002)
Frustulia sp	Low water electrical conductivity, slightly acid waters (Montoya-Moreno and Aguirre, 2013)
Frustulia aff vulgaris	Indicator of good quality water, low water electrical conductivity, slightly acid waters (Montoya-Moreno and Aguirre, 2013)
Gomphonema parvulum	Tolerance to low concentrations of total solids (Montoya-Moreno and Aguirre, 2013)
Gomphonema aff lagenula	Tolerance to low concentrations of total solids (Montoya-Moreno and Aguirre, 2013)
Gomphonema sp	Tolerance to low concentrations of total solids (Montoya-Moreno and Aguirre, 2013)
Luticola sp	Tolerant to organic contamination and low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Mougeotia sp	Surface algae, can clog filters, predominate in acidic environments (Ramírez 2000).
Navicula radiosa	Tolerant to low concentration of dissolved oxygen (Montoya-Moreno and Aguirre, 2013)
Navicula aff digitoradiata	Tolerant to low concentration of dissolved oxygen (Montoya-Moreno and Aguirre, 2013)
Navicula sp	This genus is very variable in terms of environmental tolerance, since it has more than 14,000 species that make it up
Nitzschia sp	Tolerant to organic contamination and low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Nitzschia aff denticula	Tolerant to organic contamination and low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Nupela sp	High electrical conductivity and slightly acid waters (Montoya-Moreno and Aguirre, 2013)
Oedogonium sp	Tolerance to low electrical conductivity (Montoya-Moreno and Aguirre, 2013)
Oocystis sp	Surface algae prefer soft waters rich in organic matter (Ramírez 2000).
Oscillatoria sp	They can form blooms, support organic and industrial pollution (Ramírez 2000).
Peridinium sp	They produce cucumber odor in small quantities and in large quantities, produce fish odor in the water (Ramírez 2000).
Phacus sp	Indicator of organic matter, resist to oil spills (Pinilla, 2000).
Phormidium sp	Tolerant to organic contamination and low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Pinnularia sp	They grow in clean waters (Ramírez 2000).
Placoneis sp	Tolerant to organic contamination and low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Pseudoanabaena sp	Tolerates organic contamination (Ramírez 2000).
Rhophalodia sp	Indicator of contamination by agriculture (Round, Crawford and Mann, 1990)
Spirogyra sp	Oligotrophic and cold waters (Pinilla, 2000)
Sellaphora sp	Tolerant to organic contamination and low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Surirella sp	Tolerant to organic contamination and low concentration of dissolved oxygen (Prygiel and Coste, 2000)
Surirella sp2	Tolerant to organic contamination and low concentration of dissolved oxygen (Prygiel and Coste, 2000)

MORPHOSPECIES	CHARACTERISTICS OF BIOINDICATION OR THEIR ORGANIC ROLE
Stauroneis sp	Excellent water quality (Prygiel and Coste, 2000)
Staurosira sp	Slightly tolerant to organic contamination (Round, Crawford and Mann, 1990)
Trachelomona armata	Eutrophic environments (Pinilla, 2000)
Trachelomona volvocina	Eutrophic environments (Pinilla, 2000)
Tribonema sp	Oligotrophy (Pinilla, 2000)
Ulnaria aff ulna	In swamps, it may indicate a low concentration of dissolved oxygen, a water temperature greater than 29 ° C and a wide tolerance to pH variations (Montoya-Moreno and Aguirre, 2013). In tropical rivers it is considered little tolerant to pollution (Lobo et al, 2004)
Ulothrix sp	Supports acidity, industrial contamination and plug filters, indicator of eutrophic environments

Source: INGEX; 2016

The most abundant species were *Ulnaria* aff. *ulna*, *Brachysira* sp. And *Fragilaria goulardii* (Relative abundance> 10%). On the other hand, there were 6 species with common occurrence in the sampling points (Relative abundance between 2 and 10%). The remaining 57 species were rare and rare (relative abundance between 0 and 2%) (Illustration 4.2-258)

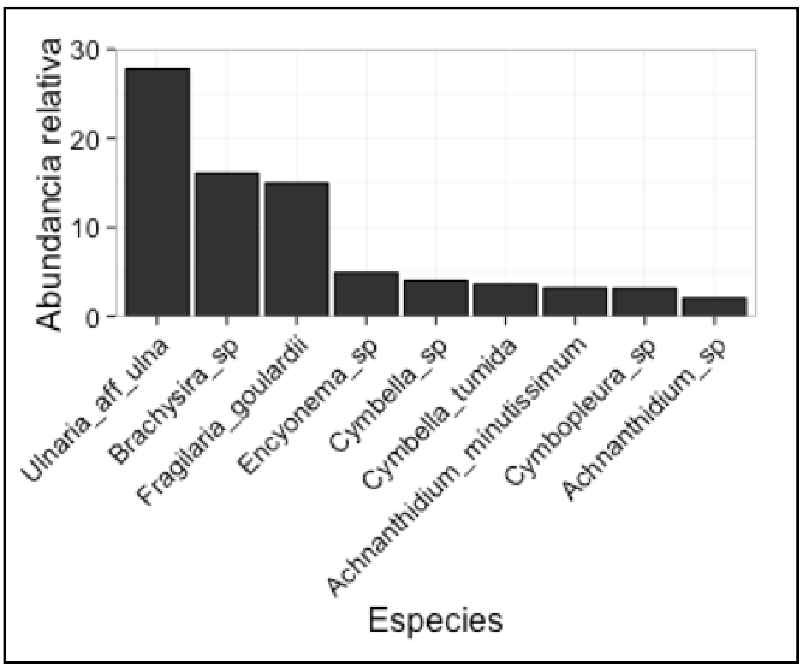


Illustration 4.2-258. Graph of relative abundance of abundant and common periphyton species
Source: INGEX, 2016

4.2.5.6.1 Composition, abundance and taxonomic wealth by sampling composition

P-01 Station

The predominant taxonomic families were Fragilariaceae, Naviculaceae and Surirellaceae, all diatoms; that was the community better adapted to this ecosystem.

In Table 4.2-38 we present the abundance and density of the organisms registered in the qualitative and quantitative analyzes (See Illustration 4.2-259).

Table 4.2-38. Abundance and density of morphotypes recorded in station P-01.

QUANTITATIVE SAMPLE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Ulnaria aff ulna	35,3070175	182,54	*Ulnaria aff ulna*
Fragilaria goulardii	23,0263158	119,05	*Fragilaria goulardii*
Brachysira sp	21,9298246	113,38	*Brachysira sp*
Oscillatoria sp	7,23684211	37,41	*Oscillatoria sp*
Cymbella tumida	3,28947368	17,01	*Cymbella tumida*
Navicula radiosa	2,19298246	3,40	*Achnanthidium exiguum*
Gomphonema parvulum	1,53508772	2,27	*Amphipleura sp*
Navicula sp	1,53508772	2,27	*Surirella sp*
Pseudoanabaena sp	0,87719298	4,54	*Navicula radiosa*
Pinnularia sp	0,65789474	4,54	*Pseudoanabaena sp*
Achnanthidium exiguum	0,65789474	1,13	*Trachelomona volvocina*
Nitzschia sp	0,43859649	1,13	*Trachelomona armata*
Amphipleura sp	0,43859649	7,94	*Navicula sp*
Surirella sp	0,43859649	2,27	*Nitzschia sp*
Trachelomona volvocina	0,21929825	2,27	*Gomphonema parvulum*
Trachelomona armata	0,21929825	2,27	*Pinnularia sp*
			Fragilaria sp
			Eunotia sp
			Fragilariforma sp
			Rophalodia sp
			Desmidium sp
			Spirogyra sp
			Fragilaria teratogénica
			Aulacoseira sp
			Surirella sp2
			Alga filamentosa

Source: Merceditas Corporation, 2012

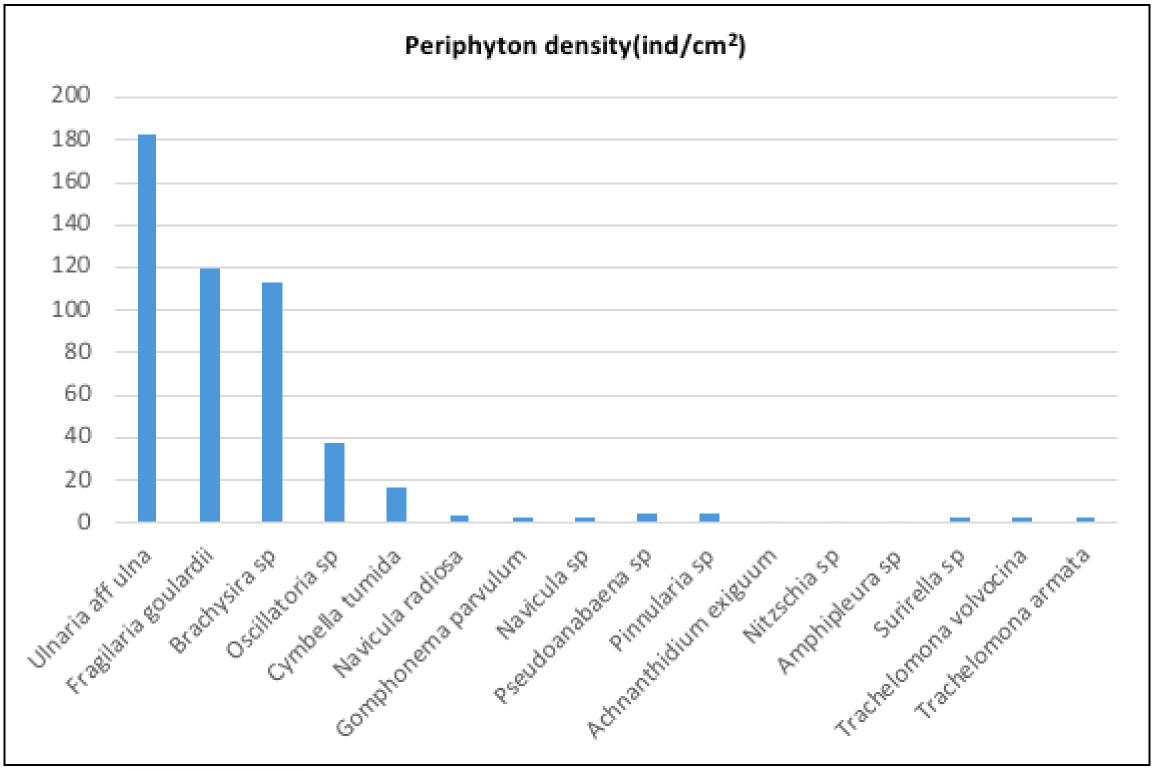
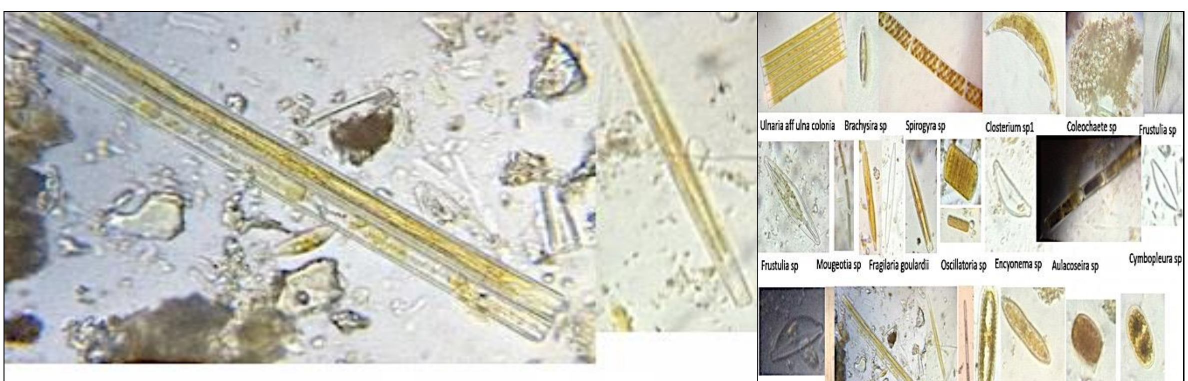


Illustration 4.2-259. Relative density of peripheral organisms, station P-01.
Source: INGEX, 2016.

The dominant species for this station were *Ulnaria ulna* and *Fragilaria goulardii,* which reach a 58% abundance in the community and are considered as not very tolerant to contamination, indicating that this station has good water quality (Illustration 4.2-260).



Ulnaria aff ulna	Fragilaria goulardii

Illustration 4.2-260. Predominant phytoplankton organisms, station P-01.
Source: Merceditas corporation, 2012

P-02 Station

The predominant taxonomic families for this station were *Fragilariaceae*, *Acanthaceae* and *Cymbellaceae*, being all diatoms, indicating that it is the community best adapted to this ecosystem.

In Table 4.2-39 the abundance and density of the organisms registered in the qualitative and quantitative analyzes are presented (See **Error! Reference source not found.**).

Table 4.2-39. Abundance and density of morphotypes recorded in station P-02.

QUANTITATIVE SAMPLE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Ulnaria aff ulna	35,5877617	250,57	*Ulnaria aff ulna*
Oscillatoria sp	1,28824477	9,07	*Oscillatoria sp*
Brachysira sp	0,32206119	2,27	*Brachysira sp*
Fragilaria goulardii	10,45183575	108,85	*Fragilaria goulardii*
Cymbella tumida	4,18679549	29,48	*Cymbella tumida*
Oedogonium sp	3,54267311	24,94	*Oedogonium sp*
Closterium sp	1,12721417	7,94	*Closterium sp*
Anabaena sp	0,64412238	4,54	*Anabaena sp*
Achnanthidium sp	3,8647343	27,21	*Achnanthidium sp*
Gomphonema parvulum	10,7890499	75,96	*Gomphonema parvulum*
Encyonema sp	3,22061192	22,68	*Encyonema sp*
Mougeotia sp	1,12721417	7,94	*Mougeotia sp*
Pseudoanabaena sp	5,47504026	38,55	*Pseudoanabaena sp*
Sellaphora sp	0,32206119	2,27	*Sellaphora sp*
Mayamea sp	0,32206119	2,27	*Mayamea sp*
Achnanthidium exiguum	0,80515298	5,67	*Achnanthidium exiguum*
Navicula radiosa	2,41545894	17,01	*Navicula radiosa*
Pseudoanabaena sp	0,32206119	2,27	*Pseudoanabaena sp*
Cymbopleura sp	0,32206119	2,27	*Cymbopleura sp*
Actinotaenium sp	3,38164251	23,81	*Actinotaenium sp*
Sellaphora pupula	0,64412238	4,54	*Sellaphora pupula*
Pinnularia sp2	1,12721417	7,94	*Pinnularia sp2*
Frustulia sp	2,09339775	14,74	*Frustulia sp*
Cyclotella sp	1,12721417	7,94	*Pinnularia sp1*
			Euglena sp

Source: Merceditas Corporation, 2012

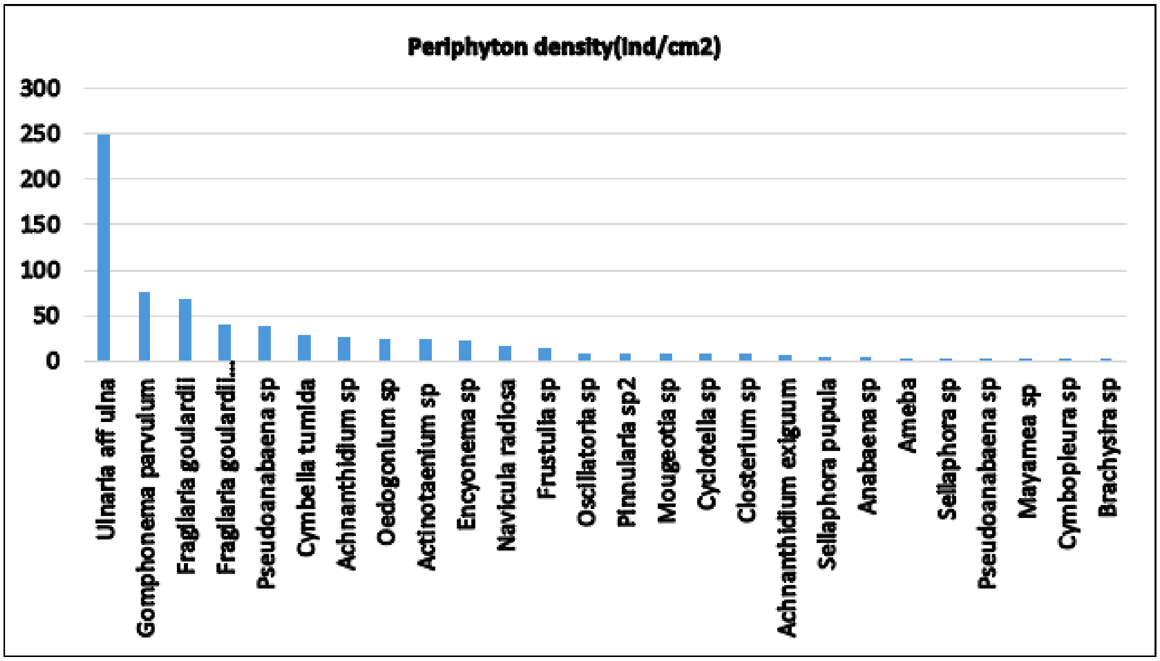
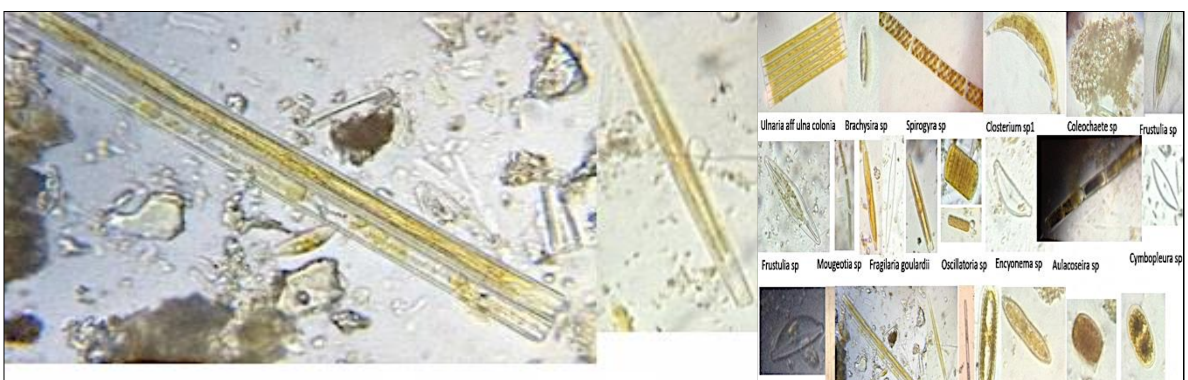


Illustration 4.2-261. Relative density of peripheral organisms, station P-02.
Source: INGEX, 2016.

The dominant species for this station were *Ulnaria ulna* and *Fragilaria goulardii* (Illustration 4.2-262), they reach a 45% abundance of the community and are considered as not very tolerant to pollution, indicating that this station has good water quality.



Ulnaria aff ulna	Fragilaria goulardii

Illustration 4.2-262. Predominant phytoplankton organisms, station P-02.
Source: Merceditas corporation, 2012

P-03 Station

The predominant taxonomic families in the sampling were Desmidiaceae, Achnanthaceae and Fragilariaceae, being the two (2) last diatoms; community better adapted to this ecosystem.

In Table 4.2-40 the abundance and density of the registered organisms is presented in the qualitative and quantitative analyzes (See Illustration 4.2-263).

Table 4.2-40. Abundance and density of the morphotypes registered in the P-03 station.

QUANTITATIVE SAMPLE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Fragilaria goulardii	20,8913649	170,07	*Ulnaria aff ulna*
Ulnaria aff ulna	4,03899721	32,88	*Cosmarium sp*
Cosmarium aff pseudoconnatum	8,77437326	71,43	*Brachysira sp*
Brachysira sp	44,7075209	363,95	*Fragilaria goulardii*
Navicula radiosa	0,8356546	6,80	*Charapsiosis sp*
Navicula aff digitoradiata	1,67130919	13,61	*Cymbella sp*
Gomphonema parvulum	1,11420613	9,07	*Oscillatoria sp*
Oedogonium sp	0,27855153	2,27	*Oedogonium sp*
Achnanthidium exiguum	1,39275766	11,34	*Oocystis sp*
Cosmarium sp	0,27855153	2,27	*Desmidium sp*
Cymbella sp	1,67130919	13,61	*Achnanthidium sp*
Oscillatoria sp	1,25348189	10,20	*Filamentosa sp*
Closterium sp	0,55710306	4,54	*Closterium sp*
Euglena sp	0,27855153	2,27	*Euglena sp*
Fragilaria goulardii teratogenica	0,13927577	1,13	*Gomphonema parvulum*
Luticola sp	5,29247911	43,08	*Achnanthidium exiguum*
Achnanthidium sp	6,545961	53,29	*Navicula radiosa*
Cyclotella sp	0,27855153	2,27	*Sellaphora sp*

Source: Merceditas Corporation, 2012

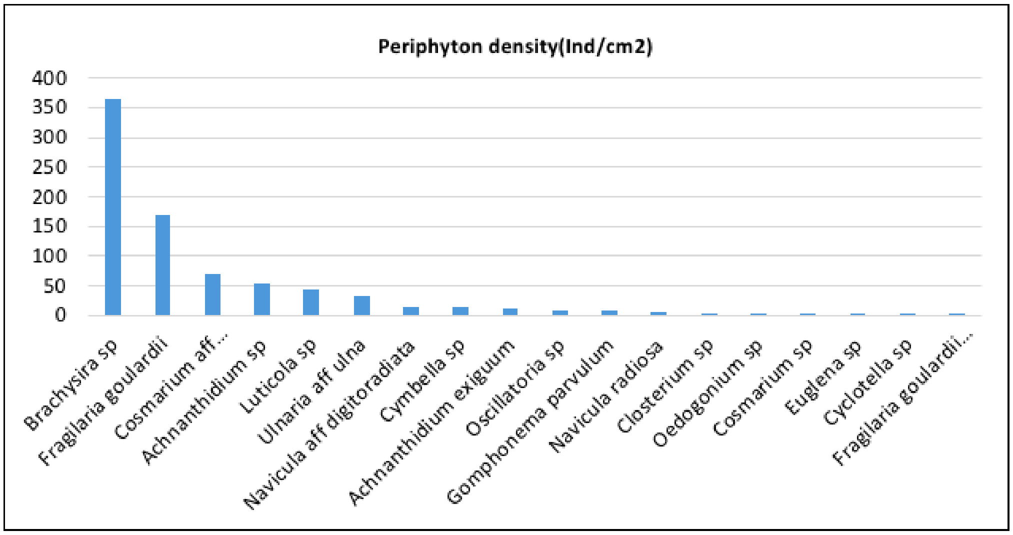


Illustration 4.2-263. Relative density of peripheral organisms, station P-03.
Source: INGEX, 2016.

The dominant species *Fragilaria goulardii* and *Brachysira sp* (Illustration 4.2-264) reach a 64% abundance of the community and are considered to be not very tolerant to contamination, indicating that this station has good water quality.

Brachysyra sp	Fragilaria goulardii

Illustration 4.2-264. Predominant phytoplankton organisms, station P-03
Source: Merceditas corporation, 2012

P-04 Station

For this station the predominant taxonomic families were Fragilariaceae, and Cymbellaceae, being all diatoms, indicating that it is the community best adapted to this ecosystem.

In Table 4.2-41 the abundance and density of the registered organisms is presented in the qualitative and quantitative analyzes (See Illustration 4.2-265).

Table 4.2-41. Abundance and density of morphotypes registered in station P-04.

CUANTITATIVE SAMPLE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Pseudoanabaena sp	1,64835165	17,01	*Achnanthidium exiguum*
Surirella sp	3,62637363	37,41	*Actinastrum sp*
Fragilaria goulardii	15,3846154	158,73	*Brachysira sp*
Mougeotia sp	0,54945055	5,67	*Chroococcus sp*
Chroococcus sp	0,10989011	1,13	*Charapsiosis sp*
Cymbella tumida	1,97802198	20,41	*Cymbella tumida*
Luticola sp	7,47252747	77,10	*Closterium sp*
Oscillatoria sp	1,64835165	17,01	*Cyclotella sp*
Pinnularia sp	0,10989011	1,13	*Encyonema sp*
Brachysira sp	33,5164835	345,80	*Euastrum sp*
Charapsiosis sp	0,21978022	2,27	*Fragilaria goulardii*
Sellaphora sp	5,49450549	56,69	*Gomphonema parvulum*
Nupela sp	3,07692308	31,75	*Luticola sp*
Gomphonema parvulum	1,31868132	13,61	*Mougeotia sp*
Nitzschia sp	0,43956044	4,54	*Navicula aff digitoradiata*
Achnanthidium exiguum	0,76923077	7,94	*Nitzschia sp*
Euastrum sp	0,10989011	1,13	*Nupela sp*

Cyclotella sp	2,41758242	24,94	*Oscillatoria sp*
Encyonema sp	4,61538462	47,62	*Pinnularia sp*
Ulnaria aff ulna	7,36263736	75,96	*Pseudoanabaena sp*
Actinastrum sp	0,65934066	6,80	*Sellaphora sp*
Navicula aff digitoradiata	7,47252747	77,10	*Surirella sp*
			Ulnaria aff ulna

Source: Merceditas Corporation, 2012

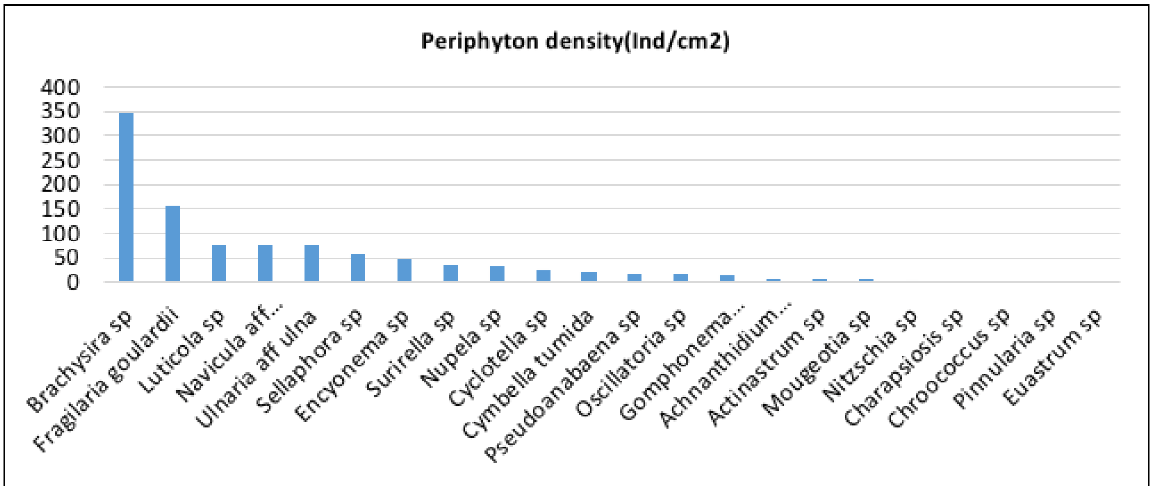


Illustration 4.2-265. Relative density of peripheral organisms, station P-04.
Source: INGEX, 2016.

The dominant species *Fragilaria goulardii* and *Brachysira sp* (Illustration 4.2-266) account for 48% of the community's abundance and are considered as not very tolerant to contamination, indicating that this station has good water quality.

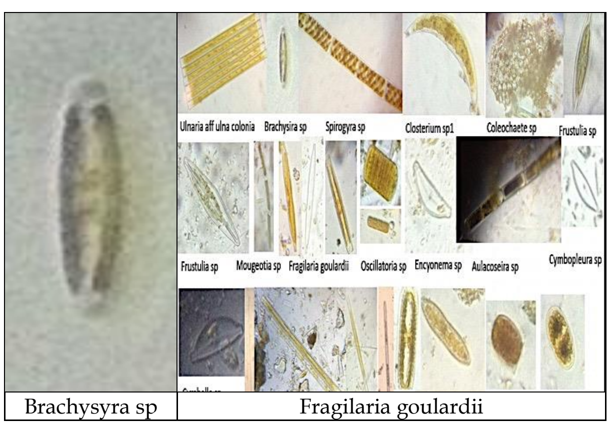


Illustration 4.2-266. Predominant phytoplankton organisms, station P-04.
Source: Merceditas Corporation, 2012

P-05 Station

The predominant taxonomic families in the sampling were Fragilariaceae, Desmidiaceae, Cymbellaceae, Gomphonemataceae, Naviculaceae, Bacillariaceae and Cymbellaceae, being all diatoms, indicating that it is the community best adapted to this ecosystem.

In Table 4.2-42 The abundance and density of the organisms registered in the qualitative and quantitative analyzes are presented (See Illustration 4.2-267).

Table 4.2-42. Abundance and density of morphotypes recorded in station P-05.

QUANTITATIVE SAMPLE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Ulnaria aff ulna	70,05	609,98	*Alga filamentosa*
Cymbella tumida	4,56	39,68	*Achnanthidium sp*
Coconeis sp	0,78	6,80	*Coconeis sp*
Nitzschia sp	0,26	2,27	*Coleochaete sp*
Oedogonium sp	1,43	12,47	*Cosmarium sp1*
Oscillatoria sp	0,39	3,40	*Cosmarium sp2*
Fragilaria goulardii	4,43	38,55	*Cymbella tumida*
Cyclotella sp	1,43	12,47	*Cymbopleura sp*
Encyonema sp	4,95	43,08	*Cyclotella sp*
Navicula sp	2,73	23,81	*Eolimna sp*
Frustulia aff vulgaris	0,26	2,27	*Encyonema sp*
Eolimna sp	1,04	9,07	*Fragilaria goulardii*
Alga filamentosa	0,26	2,27	*Frustulia aff vulgaris*
Stauroneis sp	0,26	2,27	*Gomphonema aff lagenula*
Cosmarium sp	0,13	1,13	*Gomphonema sp*
Gomphonema aff lagenula	0,39	3,40	*Navicula sp*
Pinnularia sp	0,13	1,13	*Nitzschia sp*
Cymbopleura sp	4,43	38,55	*Nitzschia aff denticula*
Achnanthidium sp	2,08	18,14	*Oedogonium sp*
Coleochaete sp	0,13	1,13	*Oscillatoria sp*
Nitzschia aff denticula	0,26	2,27	*Pinnularia sp*
Gomphonema sp	0,39	3,40	*Surirella sp*
			Stauroneis sp
			Ulnaria aff ulna
			Ulothrix sp
			Peridinium sp

Source: Merceditas Corporation, 2012

In this station the dominant species was *Ulnaria ulna* (Illustration 4.2-268) that reaches 70% of the abundance of the community and are considered as not very tolerant to contamination, indicating that this station has good water quality.

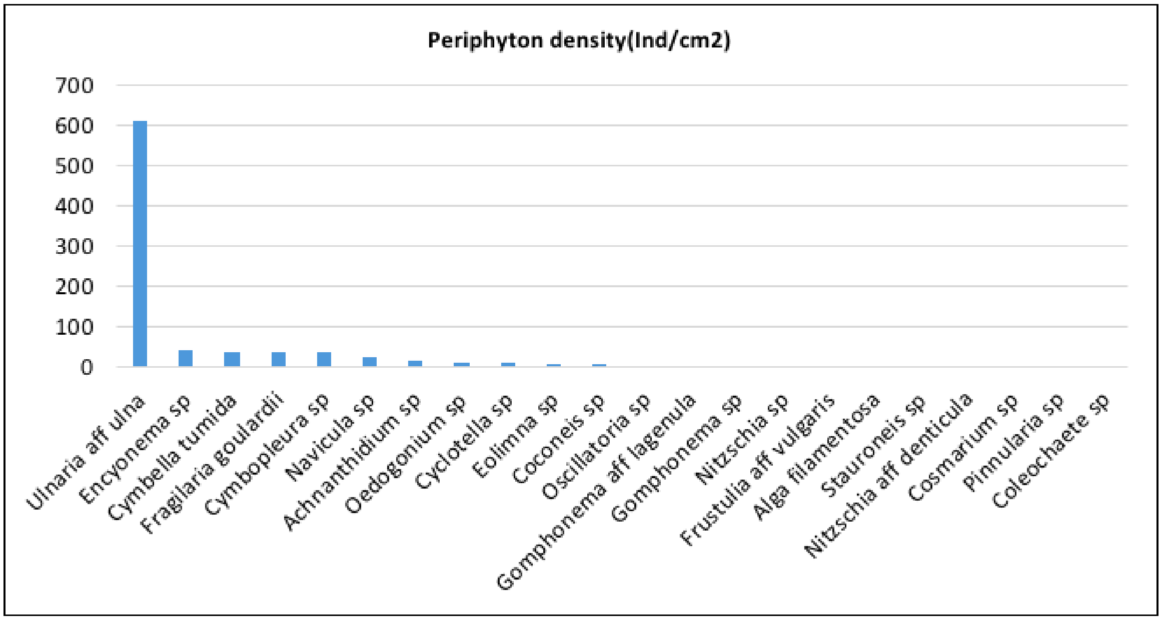
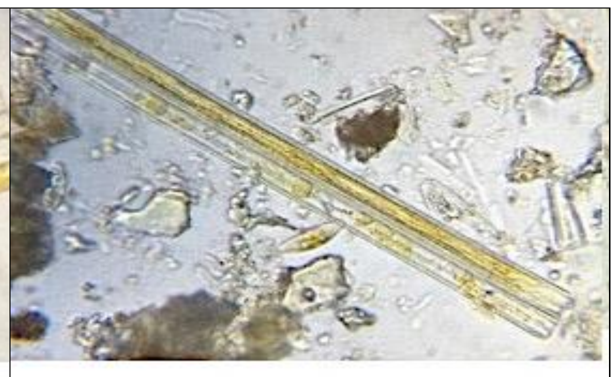


Illustration 4.2-267. Relative density of peripheral organisms, station P-05.
Source: INGEX, 2016.

Ulnaria aff ulna colonia	Ulnaria aff ulna

Illustration 4.2-268. Predominant phytoplankton organisms, station P-05.
Source: Merceditas Corporation, 2012

P-06 Station

The predominant taxonomic families were Cymbellaceae, Fragilariaceae, Naviculaceae and Achnanthaceae, being all diatoms, indicating that they are the communities best adapted to this ecosystem. A large group of representative families of the peripheral flora of the station was also presented.

Table 4.2-43 presents the organisms registered in qualitative and quantitative analyzes, their abundance and density (See Illustration 4.2-269).

Table 4.2-43. Abundance and density of morphotypes recorded in station P-06.

QUANTITATIVE SAMPLE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Ulnaria aff ulna	7,96	73,6961451	*Achnanthidium exiguum*
Encyonema sp	11,14	103,17	*Achnanthidium minutissimum*
Cymbopleura sp	19,83	183,67	*Coconeis sp*
Cymbella tumida	16,89	156,46	*Cosmarium sp1*
Sellaphora sp	7,71	71,43	*Cymbella tumida*
Placoneis sp	0,24	2,27	*Cymbopleura sp*
Navicula sp	0,98	9,07	*Encyonema sp*
Pseudoanabaena sp	0,61	5,67	*Fragilaria goulardii*
Achnanthidium minutissimum	28,52	264,17	*Frustulia sp*
Coconeis sp	3,43	31,75	*Gomphonema parvulum*
Trebonema sp	0,12	1,13	*Luticola sp*
Fragilaria goulardii	0,61	5,67	*Navicula radiosa*
Achnanthidium exiguum	0,37	3,40	*Navicula sp*
Oedogonium sp	0,73	6,80	*Nitzschia sp*
Cosmarium sp1	0,24	2,27	*Oedogonium sp*
Gomphonema parvulum	0,24	2,27	*Phormidium sp*
Navicula radiosa	0,37	3,40	*Placoneis sp*
			Pseudoanabaena sp
			Sellaphora sp
			Trebonema sp
			Ulnaria aff ulna

Source: Merceditas Corporation, 2012

The dominant species were *Achnanthidium minutissimum* and Cymbopleura sp (Illustration 4.2-270) that reach a 50% abundance of the community and are considered as tolerant intermediate to the contamination, indicating that this station presents good water quality.

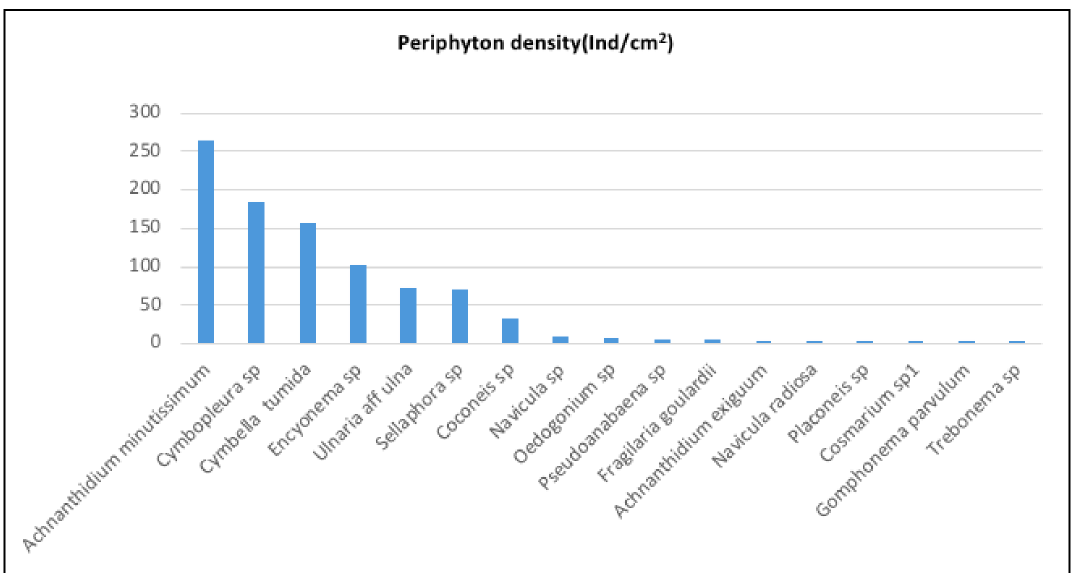
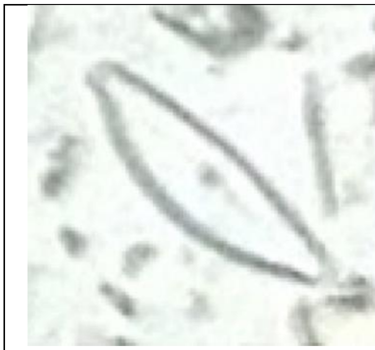


Illustration 4.2-269. Relative density of peripheral organisms, station P-06.
Source: INGEX, 2016.



Cymbopleura sp

Illustration 4.2-270. Predominant phytoplankton organisms, station P-06.
Source: Merceditas Corporation, 2012

P-07 Station

The predominant taxonomic families for this station were Cymbellaceae, and Naviculaceae, being all diatoms, indicating that it is the community best adapted to this ecosystem. A large group of representative families of the peripheral flora of the station was also presented.

In Table 4.2-44 the abundance and density of the organisms registered in the qualitative and quantitative analyzes are presented (See Illustration 4.2-271).

Table 4.2-44. Abundance and density of the morphotypes recorded in the P-07 station.

QUANTITATIVE SAMPLE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Fragilaria goulardii	3,48583878	18,1405896	*Achnanthidium sp*
Ulnaria aff ulna	61,6557734	320,861678	*Cymbella sp*
Cymbella sp	9,80392157	51,0204082	*Cymbella tumida*
Oedogonium sp	0,87145969	4,53514739	*Closterium sp1*
Placoneis sp	1,74291939	9,07029478	*Closterium sp2*
Achnanthidium sp	5,66448802	29,478458	*Eolimna sp*
Oscillatoria sp	1,74291939	9,07029478	*Fragilaria goulardii*
Navicula sp	8,06100218	41,9501134	*Navicula sp*
Closterium sp	1,74291939	9,07029478	*Oedogonium sp*
Closterium sp2	0,65359477	3,40136054	*Oscillatoria sp*
Cymbella tumida	4,5751634	23,8095238	*Placoneis sp*
			Tribonema sp
			Ulnaria aff ulna

Source: INGEX, 2016.

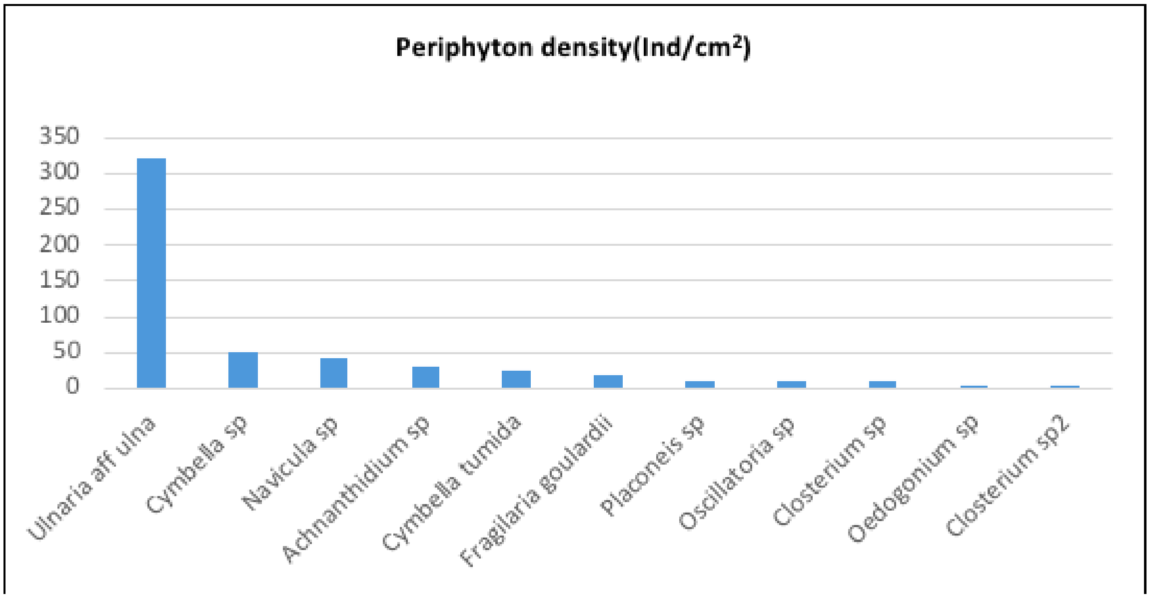
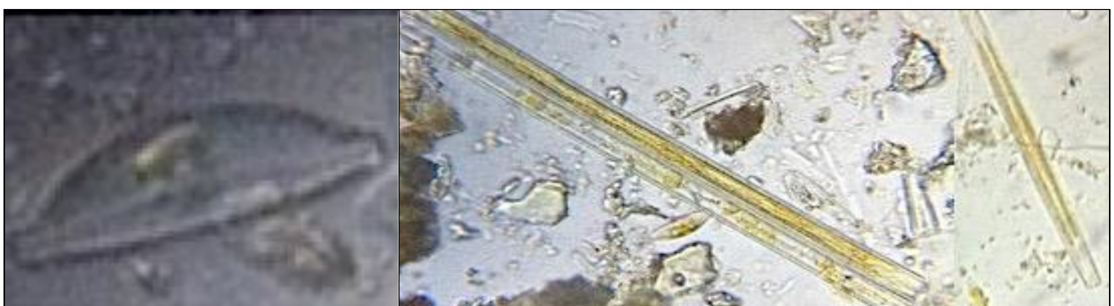


Illustration 4.2-271. Relative density of peripheral organisms, station P-07.
Source: INGEX, 2016.

The dominant species was *Ulnaria* aff *ulna* with a 60% abundance of the community and is considered as tolerant intermediate to the contamination, indicating that this station presents a good water quality (Illustration 4.2-272).



Cymbella sp	*Ulnaria aff ulna*

Illustration 4.2-272. Predominant phytoplankton organisms, station P-07.
Source: Merceditas Corporation, 2012

P-08 Station

The predominant taxonomic families for this station in the sampling were Cymbellaceae and Fragilariaceae (Table 4.2-45), all being diatoms, indicating that it is the community best adapted to this ecosystem.

Table 4.2-45. Abundance and density of the morphotypes registered in the P-08 station.

Quantitative Sample	Abundance	Density	Qualitative Sample
Cymbella sp	32,6495726	216,55	*Achnanthidium exiguum*
Ulnaria aff ulna	3,93162393	26,08	*Anabaena sp*
Cymbella tumida	1,36752137	9,07	*Coleochaete sp*
Fragillaria sp	16,2393162	107,71	*Cosmarium sp1*
Encyonema sp	15,042735	99,77	*Cymbella sp*
Anabaena sp	2,05128205	13,61	*Cymbella tumida*
Cymbopleura sp	2,73504274	18,14	*Cymbopleura sp*
Spirogyra sp	7,35042735	48,75	*Cyclotella sp*
Mougeotia sp	0,68376068	4,54	*Encyonema sp*
Oedogonium sp	0,68376068	4,54	*Fragillaria sp*
Phacus sp	0,34188034	2,27	*Frustulia sp*
Frustulia sp	2,22222222	14,74	*Gomphonema sp*
Oscillatoria sp	2,56410256	17,01	*Mougeotia sp*
Cyclotella sp	5,64102564	37,41	*Navicula sp*
Gomphonema sp	0,51282051	3,40	*Oedogonium sp*
Navicula sp	4,95726496	32,88	*Oscillatoria sp*
Cosmarium sp1	0,51282051	3,40	*Phacus sp*
Staurosira sp	0,51282051	3,40	*Spirogyra sp*
			Staurosira sp
			Ulnaria aff ulna

Source: Merceditas Corporation, 2012

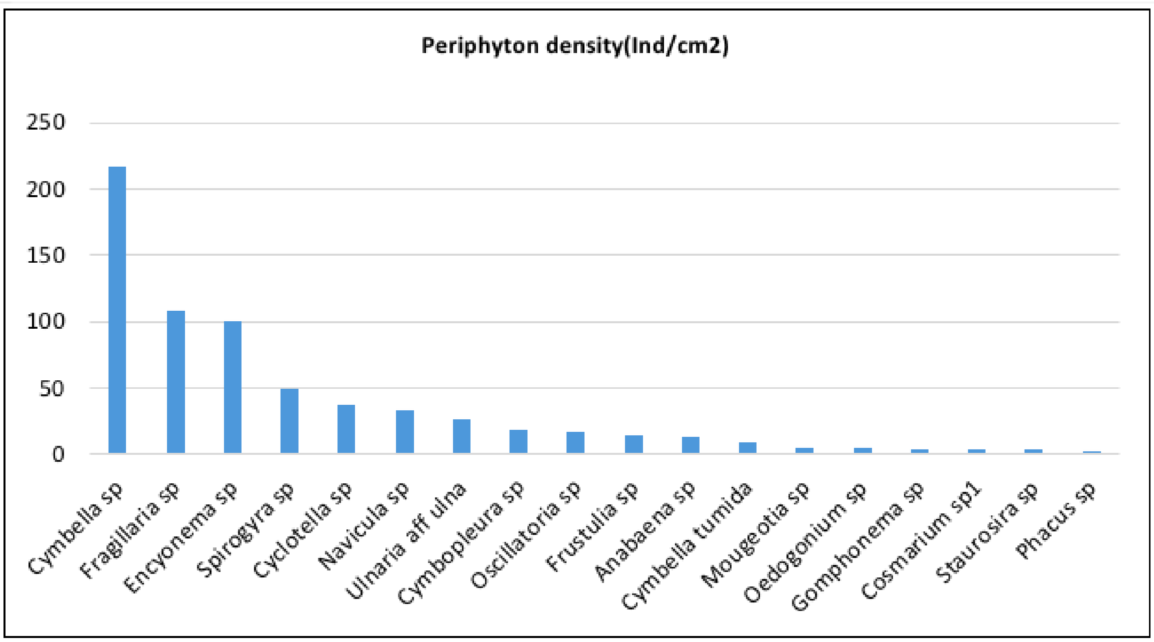


Illustration 4.2-273. Relative density of peripheral organisms, station P-08.
Source: INGEX, 2016.

The dominant species were *Cymbella sp* and *Fragillaria sp* that reach a 48% abundance of the community and are considered as tolerant intermediate to the contamination, indicating that this station presents good water quality.

	
Cymbella sp	*Fragilaria sp*

Illustration 4.2-274. Predominant phytoplankton organisms, station P-08
Source: Merceditas Corporation, 2012

P-09 Station

The predominant taxonomic families were Cymbellaceae and Fragilariaceae, being all diatoms, indicating that it is the community best adapted to this ecosystem. The Closteriaceae family belonging to the group of green algae, demididaceae, indicators of good quality water are also presented.

Table 4.2-46 presents the abundance and density of registered organisms in qualitative and quantitative analyzes (See Illustration 4.2-275).

Table 4.2-46. Abundance and density of the morphotypes recorded in the P-09 station.

QUANTITATIVE SAMPLE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Fragilaria goulardii	40,1904762	239,23	*Brachysira sp*
Ulnaria aff ulna	6,47619048	38,55	*Charapsiosis sp*
Encyonema sp	5,33333333	31,75	*Cosmarium sp1*
Charapsiosis sp	0,38095238	2,27	*Cymbella tumida*
Cosmarium sp1	0,57142857	3,40	*Cymbopleura sp*
Oscillatoria sp	8,95238095	53,29	*Closterium sp1*
Brachysira sp	36,3809524	216,55	*Closterium sp2*
Cyclotella sp	0,38095238	2,27	*Cyclotella sp*
Pinnularia sp	0,38095238	2,27	*Encyonema sp*
Cymbopleura sp	0,57142857	3,40	*Fragilaria goulardii*
Cymbella tumida	0,38095238	2,27	*Fragillaria sp*

Source: Merceditas Corporation, 2012

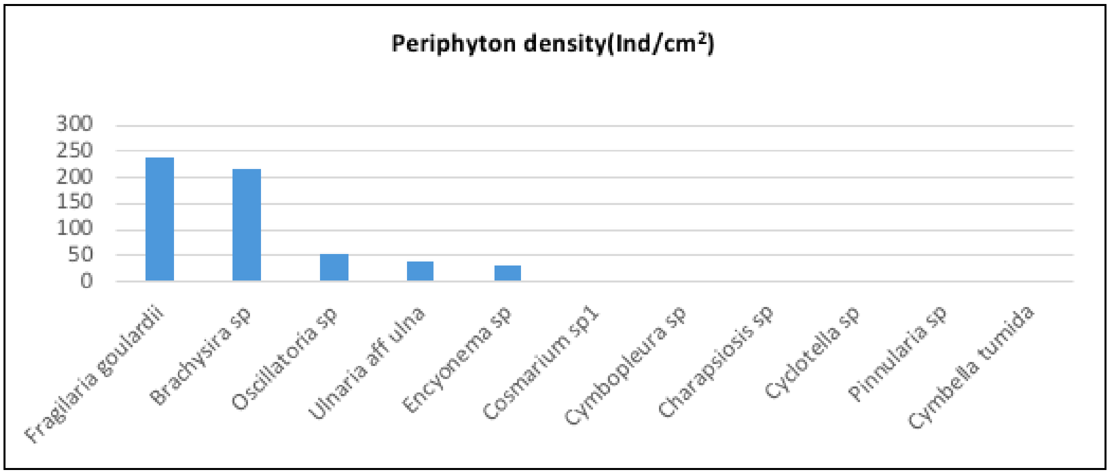


Illustration 4.2-275. Relative density of peripheral organisms, station P-09.
Source: INGEX, 2016.

The dominant species *Fragilaria goulardii* and *Brachysira sp* (Illustration 4.2-276), which reach 76% of the community's abundance and are considered as not very tolerant to contamination, indicating that this station has good water quality.

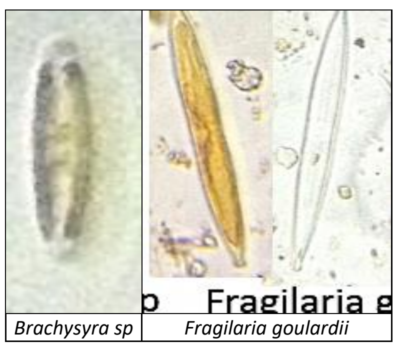


Illustration 4.2-276. Predominant phytoplankton organisms, station P-09.
Source: Merceditas Corporation, 2012

P-10 Station

The predominant taxonomic families were Cymbellaceae and Fragilariaceae, being all diatoms, indicating that it is the community best adapted to this ecosystem. The Closteriaceae family belonging to the group of green algae, demididaceae, indicators of good quality water is also presented. Table 4.2-47 presents the abundance and density of registered organisms in qualitative and quantitative analyzes. (See Illustration 4.2-277).

Table 4.2-47. Abundance and density of the morphotypes registered in the P-10 station**.**

QUANTITATIVE SAMPLE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Fragilaria goulardii	32,0140721	412,70	*Brachysira sp*
Ulnaria aff ulna	42,0404573	541,95	*Charapsiosis sp*
Cymbella sp	4,13368514	53,29	*Cosmarium sp2*
Brachysira sp	14,5998241	188,21	*Cosmarium pseudoconnatum*
Closterium sp1	0,43975374	5,67	*Cymbella sp*
Oocystis sp	0,43975374	5,67	*Closterium sp1*
Cosmarium pseudoconnatum	0,26385224	3,40	*Cyclotella sp*
Pseudoanabaena sp	0,1759015	2,27	*Encyonema sp*
Cosmarium sp2	0,1759015	2,27	*Fragilaria goulardii*
Encyonema sp	3,25417766	41,95	*Luticola sp*
Cyclotella sp	0,61565523	7,94	*Navicula radiosa*
Luticola sp	1,05540897	13,61	*Oocystis sp*
Navicula radiosa	0,1759015	2,27	*Pseudoanabaena sp*
Charapsiosis sp	0,61565523	7,94	*Ulnaria aff ulna*
			alga filamentosa ramificada
			Cymbopleura sp
			Achanthes sp
			oscillatoria sp
			Anabaena sp
			Fragilaria sp

Source: Merceditas Corporation, 2012

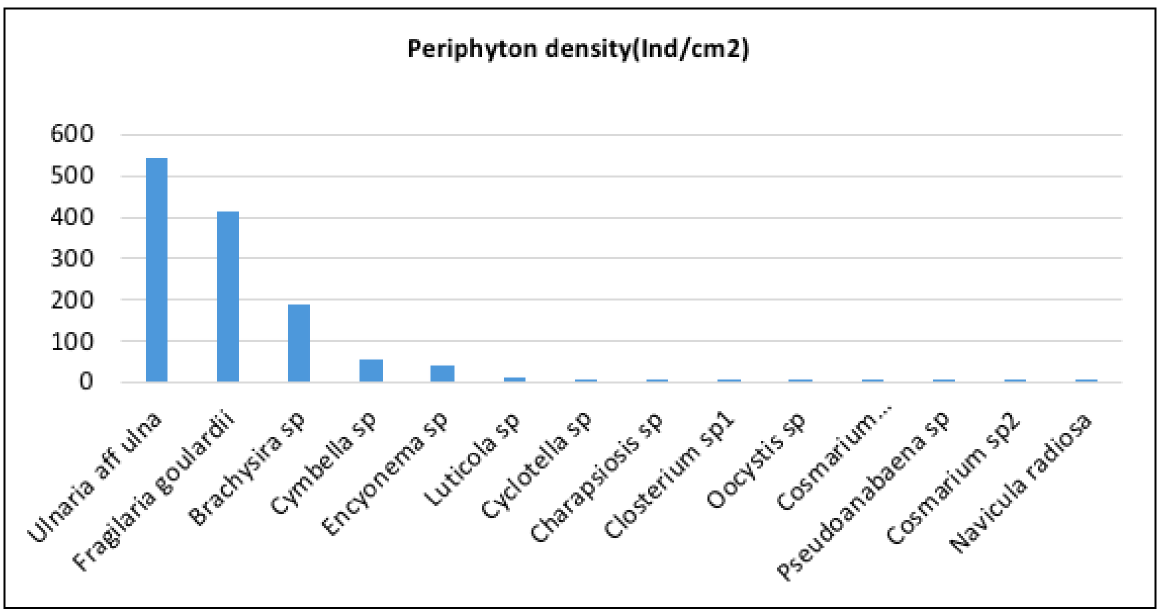
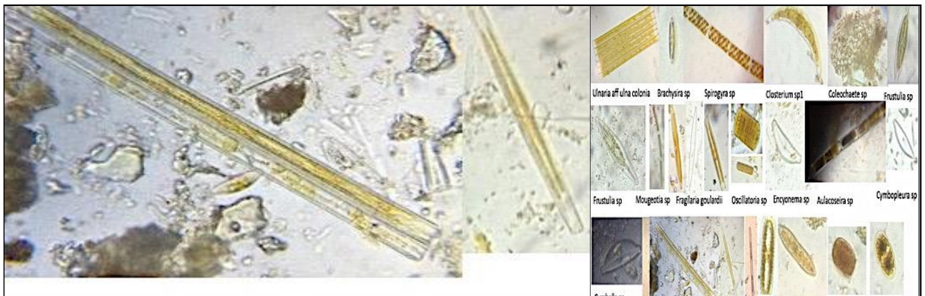


Illustration 4.2-277. Relative density of peripheral organisms, station P-10.
Source: INGEX, 2016.

The dominant species *Ulnaria aff ulna* and *Fragilaria goulardii,* reach a 74% abundance in the community and are considered as not very tolerant to contamination, indicating that this station has good water quality (Illustration 4.2-278).



Ulnaria aff ulna	*Fragilaria goulardii*

Illustration 4.2-278. Predominant phytoplankton organisms, station P-10.
Source: Merceditas Corporation, 2012

P-11 Station

The predominant taxonomic families were Achnanthaceae and Cymbellaceae, being all diatoms, indicating that it is the community best adapted to this ecosystem. The Closteriaceae family belonging to the group of green algae, demididaceae, indicators of good quality water is also presented.

Table 4.2-48 presents the abundance and density of registered organisms in qualitative and quantitative analyzes (See Illustration 4.2-279).

Table 4.2-48. Abundance and density of the morphotypes registered in the P-11 station.

QUANTITATIVE SAMPLE	ABUNDANCE	DENSITY	QUALITATIVE SAMPLE
Ulnaria aff ulna	42,9906542	156,46	*Actinella sp*
Brachysira sp	28,6604361	104,31	*Achanthes sp*
Achnanthidium sp	11,8380062	43,08	*Achnanthidium sp*
Encyonema sp	4,6728972	17,01	*Anabaena sp*
Nupela sp	1,5576324	5,67	*Brachysira sp*
Navicula sp	0,62305296	2,27	*Cymbopleura sp*
Cymbopleura sp	3,73831776	13,61	*Closterium sp1*
Fragilaria goulardii	3,73831776	13,61	*Closterium sp2*
Encyonema alargado	0,62305296	2,27	*Encyonema sp*
Gomphonema parvulum	0,62305296	2,27	*Encyonema alargado*
Frustulia sp	0,93457944	3,40	*Fragilaria goulardii*
			Frustulia sp
			Gomphonema parvulum
			Navicula sp
			Nupela sp
			Ulnaria aff ulna
			Oscillatoria sp

Source: Merceditas Corporation, 2012

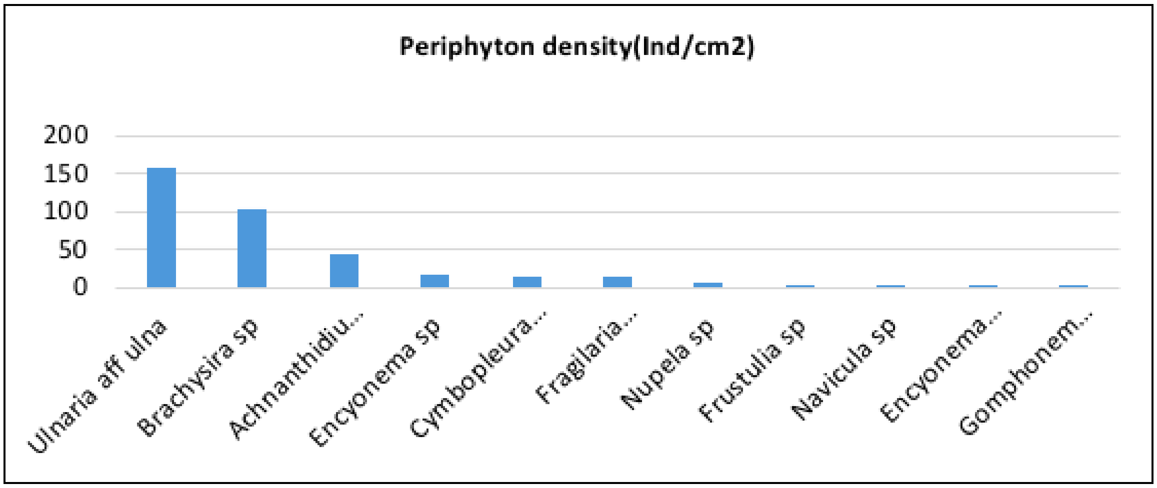


Illustration 4.2-279. Relative density of peripheral organisms, station P-11.
Source: INGEX, 2016.

The dominant species *Fragilaria goulardii* and *Brachysira sp* (Illustration 4.2-280) reach 71% abundance in the community and are considered as not very tolerant to contamination, indicating that this station has good water quality.

Brachysyra sp	*Fragilaria goulardii*

Illustration 4.2-280. Predominant phytoplankton organisms, station P-11.
Source: Merceditas Corporation, 2012

4.2.5.6.2 Diversity indices

The alpha and beta diversity indices are presented below.

Alpha (α) Diversity

In general terms, no significant differences were found in the alpha diversity indices evaluated (Simpson, Shannon and Margalef) between the sampling stations studied (Illustration 4.2-281). The Margalef index for all stations oscillated between 1.60 and 3.89 without presenting significant differences between them (X2 = 2.1666, p = 0.99). For the Simpson diversity index, no significant differences were found between the sampling stations (X2 = 0.1521, p = 1) nor for the Shannon index (X2 = 0.7726, p = 0.99) (Illustration 4.2-281).

In general, the stations showed high dominance of species. Among the dominant species, *Fragillaria goulardii* is reported as an indicator of good water transparency and *Ulnaria aff. Ulna* grows abundantly in waters with temperatures above 29 ° C and with a low concentration of ammoniacal nitrogen (Montoya-Moreno & Aguirre, 2013). *Gomphonema parvulum* is an indicator of low concentration of dissolved solids and sulfates (Montoya-Moreno & Aguirre, 2013), although in Europe it has been found to be highly tolerant to organic contamination, in Brazil it is considered moderately tolerant.

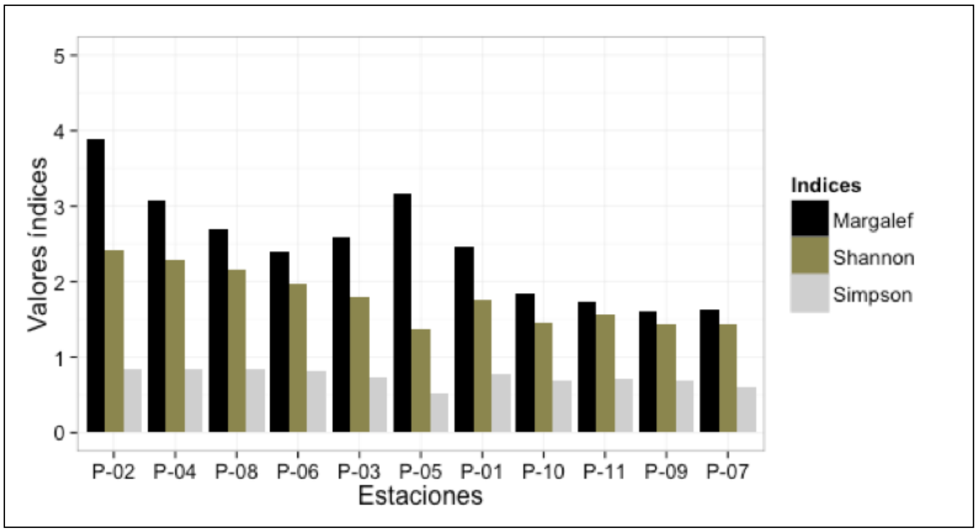


Illustration 4.2-281. Graph of indices of diversity, heterogeneity and dominance (Margalef, Shannon Simpson) periphyton by sampling station.
Source: INGEX, 2016

Beta (β) Diversity

The analysis of similarity between sampling stations for periphyton, based on the dendrogram of the similarity distances of Bray-Curtis, showed that there is a great similarity between stations P-10 and P-11, being two of the most diverse (See Illustration 4.2-282).

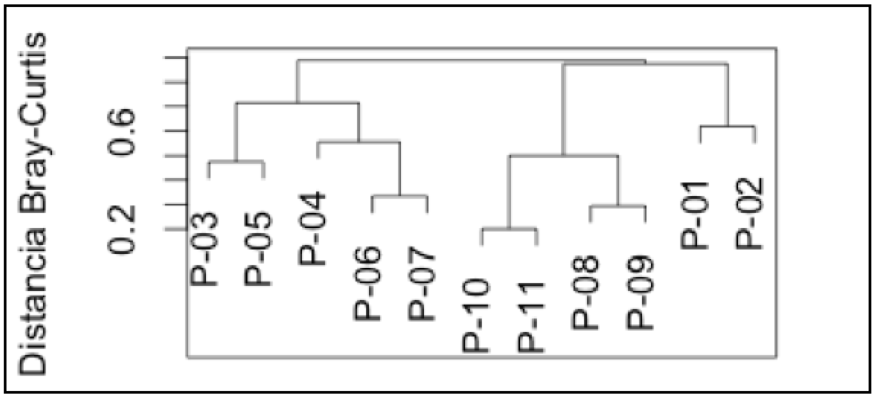


Illustration 4.2-282. Graph of analysis of the beta diversity of periphyton between sampling stations based on a dendrogram
Source: INGEX, 2016

4.2.5.7 CORRELATION ANALYSIS

The species wealth of periphyton and Margalef's diversity index in phytoplankton was related to the concentration of dissolved oxygen. Total suspended solids are related to the density of phytoplankton, as well as the richness, dominance, diversity and density of zooplankton species. The pH is related to the density of phytoplankton and the recorded richness of zooplankton. Iron with the presence of total and fecal coliforms. The concentration of calcium with the diversity of phycoperiphyton. The concentration of phenols, on the other hand, with the equity of zooplankton. Total alkalinity with phytoplankton density (Table 4.2-49).

Table 4.2-49. Correlation between physicochemical variables and community indicators.

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
Total Suspended solids		0.96653	1	0.31094	0.2315	0.0050393	0.48037	1	1
Total dissolved solids	0.014379		1	0.0081802	0.55025	0.5809	0.78387	1	1
Settleable solids	(0)	(0)		1	1	1	1	1	1
Total solids	0.33695	0.7475	-		0.13853	0.058082	0.37232	1	1
Electric conductivity	0.39325	0.20258	0	0.47637		0.049826	0.14841	1	1
pH	0.77547	0.1875	0	0.58614	0.60243		0.23855	1	1
Dissolved oxygen	0.23832	-0.093785	(0)	0.29866	0.46615	0.38785		1	1
DBO	-	-	-	-	-	-	-		1
DQO	-	-	-	-	-	-	-	-	
Bicarbonate of soda	0.34596	-0.12792	(0)	-0.0059779	0.77914	0.42436	0.10815	-	-

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
Chlorides	-	-	-	-	-	-	-	-	-
Nitrites	(0)	(0)	0	-	0	0	(0)	-	-
Nitrates	-	-	-	-	-	-	-	-	-
Ammonia Nitrogen	-	-	-	-	-	-	-	-	-
Total Iron	0.72937	-0.091468	0	0.033111	-0.061927	0.44659	0.067988	-	-
Total Calcium	0.37469	0.10708	(0)	0.55548	0.91068	0.62685	0.50345	-	-
Total manganesium	0.32002	0.14778	0	0.26475	0.90919	0.44837	0.39872	-	-
Total Sodium	0.027884	0.011768	(0)	-0.16975	-0.49445	-0.35599	-0.64484	-	-
Organic phosphorus	(0)	(0)	0	-	0	0	(0)	-	-
Inorganic phosphorus	-0.39198	0.10305	(0)	-0.10169	0.070397	-0.20161	0.53883	-	-
Total hardness	0.48432	0.11018	(0)	0.39088	0.80117	0.59228	0.57173	-	-
Phosphates (orthophosphates)	-	-	-	-	-	-	-	-	-
Total cadmium	(0)	(0)	0	-	0	0	(0)	-	-
Total copper	(0)	(0)	0	-	0	0	(0)	-	-
Total nickel	(0)	(0)	0	-	0	0	(0)	-	-
Total silver	(0)	(0)	0	-	0	0	(0)	-	-
Total lead	(0)	(0)	0	-	0	0	(0)	-	-
Antimony	-	-	-	-	-	-	-	-	-
Total barium	(0)	(0)	0	-	0	0	(0)	-	-
Potassium	0.67995	-0.086903	(0)	0.24321	0.50315	0.74511	0.49915	-	-
Fats and oils	-0.092071	-0.0059333	0	0.30374	0.28806	0.028434	0.08392	-	-
Phenols	-0.17889	-0.61089	(0)	-0.75343	-0.046038	-0.22127	-0.0056095	-	-
Total alkalinity	0.55773	0.076697	(0)	0.31847	0.89433	0.6956	0.25506	-	-
Acidity	-0.21295	-0.46153	0	-0.8023	-0.079981	-0.29295	-0.29727	-	-
Free and dissociable cyanide	(0)	(0)	0	-	0	0	(0)	-	-
Total cyanide	0.52909	-0.10952	0	0.23623	0.28032	0.28379	0.24337	-	-
Total coliforms	0.64214	0.11351	0	0.048037	-0.098758	0.3183	-0.3271	-	-
Fecal coliforms	0.49628	-0.29724	(0)	-0.12074	0.012116	0.15544	-0.030574	-	-
Sperif	-0.078065	0.30136	(0)	-0.099773	-0.36303	-0.052415	-0.78335	-	-
Dperif	0.2376	-0.035031	0	-0.03013	-0.42056	0.15076	-0.24371	-	-
Hperif	0.16402	0.25183	(0)	-0.011412	-0.48252	0.10226	-0.52557	-	-
Jperif	0.25278	0.17693	(0)	0.065643	-0.40898	0.12876	-0.19922	-	-

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
Margalefperif	-0.052824	0.31154	(0)	-0.12633	-0.3131	-0.050721	-0.80197	-	-
Nperif	-0.15643	-0.023814	0	0.1786	-0.31833	0.12121	-0.099418	-	-
Sfito	0.45434	-0.25757	0	-0.35521	0.051358	0.21863	-0.58498	-	-
Dfito	0.010706	-0.076836	0	-0.27131	-0.33293	-0.35344	-0.43822	-	-
Hfito	0.13736	-0.24096	(0)	-0.39724	-0.33243	-0.28144	-0.52738	-	-
Jfito	-0.076397	-0.11991	0	-0.2924	-0.31153	-0.40889	-0.21705	-	-
Margalefito	0.29132	-0.37698	0	-0.50853	-0.16923	-0.04917	-0.61593	-	-
Nfito	0.77389	0.26334	0	0.4961	0.54235	0.90618	0.28017	-	-
Szoo	0.84437	0.26017	0	0.38097	0.40936	0.65577	0.31773	-	-
Dzoo	0.61199	0.2119	0	0.31499	0.089187	0.37689	0.53925	-	-
Hzoo	0.75899	0.30791	0	0.40332	0.23817	0.52	0.38133	-	-
Jzoo	0.048374	0.26245	0	0.48419	-0.18089	0.29023	0.41278	-	-
Margalefzoo	0.55554	0.46329	(0)	0.64344	0.30645	0.60439	0.61722	-	-
Nzoo	0.65147	-0.24491	(0)	-0.14233	0.3526	0.42309	0.18112	-	-
Stations	**Bicarbonate of soda**	**Cloruros**	**Nitrites**	**Nitrates**	**Ammoniacal nitrogen**	**Total Iron**	**Total Calcium**	**Total Magne sium**	**Total Sodium**
Total suspended solids	0.29734	1	1	1	1	0.010859	0.25623	0.33736	0.93514
Total dissolved solids	0.7078	1	1	1	1	0.78911	0.754	0.66456	0.97261
Sedimentable solids	1	1	1	1	1	1	1	1	1
Total Solids	0.98608	1	1	1	1	0.92301	0.07605	0.43142	0.61779
Electric conductivity	0.0047055	1	1	1	1	0.85646	1	0.00010508	0.12209
pH	0.19331	1	1	1	1	0.16852	0.039017	0.16662	0.28259
Dissolved oxygen	0.7516	1	1	1	1	0.84256	0.11439	0.2245	0.03218
DBO	1	1	1	1	1	1	1	1	1
DQO	1	1	1	1	1	1	1	1	1
Bicarbonate of soda		1	1	1	1	0.86162	0.057225	0.00072756	0.19413
Chlorides	-		1	1	1	1	1	1	1
Nitrites	(0)	-		1	1	1	1	1	1
Nitrates	-	-	-		1	1	1	1	1
Ammoniacal nitrogen	-	-	-	-		1	1	1	1
Total Iron	0.059685	-	0	-	-		0.83814	0.78726	0.47076
Total Calcium	0.58776	-	-2.51E-16	-	-	-0.06992		0.013518	0.15438
Total Magnesium	0.85801	-	0	-	-	-0.092287	0.71435		0.057362

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
Sodium Total	-0.42366	-	(0)	-	-	0.24341	-0.46017	-0.5875	
Organic phosphorus	(0)	-	0	-	-	0	(0)	0	(0)
Inorganic phosphorus	-0.090708	-	(0)	-	-	-0.19945	-0.073968	0.22248	-0.46222
Total hardness	0.71288	-	(0)	-	-	0.19175	0.70349	0.88232	-0.6526
Phosphates (orthophosphates)	-	-	-	-	-	-	-	-	-
Total cadmium	(0)	-	0	-	-	0	-2.51E-16	0	(0)
Total copper	(0)	-	0	-	-	0	(0)	0	(0)
Total nickel	(0)	-	0	-	-	0	(0)	0	(0)
Total silver	(0)	-	0	-	-	0	(0)	0	(0)
Total lead	(0)	-	0	-	-	0	(0)	0	(0)
Antimony	-	-	-	-	-	-	-	-	-
Total barium	(0)	-	0	-	-	0	(0)	0	(0)
Potassium	0.49417	-	(0)	-	-	0.54971	0.37401	0.41682	-0.26036
Fats and oils	0.15259	-	0	-	-	-0.072233	0.47541	0.012075	-0.0097379
Phenols	0.35704	-	(0)	-	-	-0.23823	-0.1967	0.15628	-0.34319
Total alkalinity	0.91807	-	(0)	-	-	0.16215	0.74012	0.85481	-0.40712
Acidity	0.34968	-	0	-	-	0.02103	-0.22579	0.09293	-0.031564
Free and dissociable cyanide	(0)	-	0	-	-	0	(0)	0	(0)
Total cyanide	0.061897	-	0	-	-	-0.015981	0.34449	0.25474	0.091412
Total coliforms	0.19677	-	0	-	-	0.80178	-0.21353	-0.055881	0.32671
Fecal coliforms	0.23139	-	(0)	-	-	0.81622	0.031386	-0.041642	0.32047
Sperif	-0.029372	-	(0)	-	-	0.13037	-0.43044	-0.20728	0.23852
Dperif	-0.12272	-	0	-	-	0.2731	-0.50208	-0.32883	0.10625
Hperif	-0.17334	-	(0)	-	-	0.32598	-0.61955	-0.3599	0.26888

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
								2	
Jperif	-0.23292	-	(0)	-	-	0.3291	-0.56057	-0.34277	0.24538
Margalefperif	0.045958	-	(0)	-	-	0.1265	-0.43218	-0.14374	0.25753
Nperif	-0.34526	-	0	-	-	0.029775	-0.0019743	-0.39743	-0.16683
Sfito	0.51447	-	0	-	-	0.4124	-0.065908	0.14678	0.30649
Dfito	-0.23097	-	0	-	-	0.44846	-0.24807	-0.3795	0.67776
Hfito	-0.046687	-	(0)	-	-	0.54674	-0.28663	-0.30255	0.64817
Jfito	-0.2568	-	0	-	-	0.44217	-0.26071	-0.32466	0.57817
Margalefito	0.36895	-	0	-	-	0.49866	-0.25563	-0.024976	0.41513
Nfito	0.37378	-	0	-	-	0.37418	0.49448	0.39694	-0.25461
Szoo	0.31113	-	0	-	-	0.51553	0.3059	0.40727	-0.2135
Dzoo	-0.13162	-	0	-	-	0.56752	0.080262	0.093581	-0.20281
Hzoo	0.084895	-	0	-	-	0.57687	0.17987	0.24635	-0.18164
Jzoo	-0.53804	-	0	-	-	0.33374	0.027623	-0.374	-0.092481
Margalefzoo	-0.076684	-	(0)	-	-	0.46952	0.33408	0.18568	-0.33749
Nzoo	0.51014	-	(0)	-	-	0.22281	0.20665	0.45307	-0.25066
Stations	**Organic phosphorus**	**Inorganic phosphorus**	**Total hardness**	**Phosphates (orthophosphates)**	**Total cadmium**	**Total copper**	**Total nickel**	**Total silver**	**Total lead**
Total suspended solids	1	0.23315	0.13113	1	1	1	1	1	1
Total dissolved solids	1	0.76302	0.74707	1	1	1	1	1	1
Sedimentable solids	1	1	1	1	1	1	1	1	1
Total Solids	1	0.76608	0.23458	1	1	1	1	1	1

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
Electric conductivity	1	0.83704	0.0030346	1	1	1	1	1	1
pH	1	0.5522	0.054867	1	1	1	1	1	1
Dissolved oxygen	1	0.087215	0.066125	1	1	1	1	1	1
DBO	1	1	1	1	1	1	1	1	1
DQO	1	1	1	1	1	1	1	1	1
Bicarbonate of soda	1	0.79083	0.013802	1	1	1	1	1	1
Chlorides	1	1	1	1	1	1	1	1	1
Nitrites	1	1	1	1	1	1	1	1	1
Nitrates	1	1	1	1	1	1	1	1	1
Ammoniacal nitrogen	1	1	1	1	1	1	1	1	1
Total Iron	1	0.55656	0.57219	1	1	1	1	1	1
Total Calcium	1	0.82888	0.015713	1	1	1	1	1	1
Total Magnesium	1	0.51084	0.00032411	1	1	1	1	1	1
Sodium Total	1	0.15232	0.029508	1	1	1	1	1	1
Organic phosphorus		1	1	1	1	1	1	1	1
Inorganic phosphorus	(0)		0.49963	1	1	1	1	1	1
Total hardness	(0)	0.22826		1	1	1	1	1	1
Phosphates (orthophosphates)	-	-	-		1	1	1	1	1
Total cadmium	0	(0)	(0)	-		1	1	1	1
Total copper	0	(0)	(0)	-	0		1	1	1
Total nickel	0	(0)	(0)	-	0	0		1	1
Total silver	0	(0)	(0)	-	0	0	0		1
Total lead	0	(0)	(0)	-	0	0	0	0	
Antimony	-	-	-	-	-	-	-	-	-
Total barium	0	(0)	(0)	-	0	0	0	0	0
Potassium	(0)	0.010875	0.51263	-	(0)	(0)	(0)	(0)	(0)
Fats and oils	0	-0.35603	0.034376	-	0	0	0	0	0
Phenols	(0)	0.12147	-0.056203	-	(0)	(0)	(0)	(0)	(0)
Total alkalinity	(0)	-0.1534	0.75526	-	(0)	(0)	(0)	(0)	(0)
Acidity	0	0.1542	-0.12181	-	0	0	0	0	0
Free and dissociable cyanide	0	(0)	(0)	-	0	0	0	0	0
Total cyanide	0	-0.27657	0.27526	-	0	0	0	0	0
Total coliforms	0	-0.49094	0.085544	-	0	0	0	0	0
Coliformes	(0)	-0.32777	0.16701	-	(0)	(0)	(0)	(0)	(0)

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
totales									
Sperif	(0)	-0.27383	-0.21811	-	(0)	(0)	(0)	(0)	(0)
Dperif	0	-0.36677	-0.20535	-	0	0	0	0	0
Hperif	(0)	-0.2976	-0.29503	-	(0)	(0)	(0)	(0)	(0)
Jperif	(0)	-0.20139	-0.26124	-	(0)	(0)	(0)	(0)	(0)
Margalefperif	(0)	-0.2704	-0.20382	-	(0)	(0)	(0)	(0)	(0)
Nperif	0	-0.193	-0.10465	-	0	0	0	0	0
Sfito	0	-0.58121	0.040908	-	0	0	0	0	0
Dfito	0	-0.2072	-0.32591	-	0	0	0	0	0
Hfito	(0)	-0.34331	-0.22914	-	(0)	(0)	(0)	(0)	(0)
Jfito	0	0.085878	-0.2271	-	0	0	0	0	0
Margalefito	0	-0.48753	-0.032875	-	0	0	0	0	0
Nfito	0	-0.2456	0.40669	-	0	0	0	0	0
Szoo	0	-0.18757	0.49168	-	0	0	0	0	0
Dzoo	0	0.14977	0.34341	-	0	0	0	0	0
Hzoo	0	-0.07273	0.43217	-	0	0	0	0	0
Jzoo	0	0.25596	-0.023004	-	0	0	0	0	0
Margalefzoo	(0)	0.18956	0.42636	-	(0)	(0)	(0)	(0)	(0)
Nzoo	(0)	-0.23926	0.36316	-	(0)	(0)	(0)	(0)	(0)

Stations	Antimony	Total barium	Potasium	Fats and oils	Phenols	Total alkalinity	Acidity	Free and dissociable cyanide	Total cyanide
Total suspended solids	1	1	0.021334	0.78775	0.5987	0.074619	0.52955	1	0.094216
Total dissolved solids	1	1	0.79944	0.98619	0.045874	0.82265	0.15302	1	0.74855
Sedimentable solids	1	1	1	1	1	1	1	1	1
Total Solids	1	1	0.47113	0.36385	0.0074188	0.33984	0.0029633	1	0.48435
Electric conductivity	1	1	0.11465	0.39033	0.89308	0.00020329	0.81517	1	0.40376
pH	1	1	0.0085024	0.93386	0.5132	0.017461	0.38197	1	0.39772
Dissolved oxygen	1	1	0.11803	0.80621	0.98694	0.44908	0.37466	1	0.47084
DBO	1	1	1	1	1	1	1	1	1
DQO	1	1	1	1	1	1	1	1	1
Bicarbonate of soda	1	1	0.12233	0.65423	0.28107	1	0.29182	1	0.85653
Chlorides	1	1	1	1	1	1	1	1	1
Nitrites	1	1	1	1	1	1	1	1	1
Nitrates	1	1	1	1	1	1	1	1	1
Ammoniacal nitrogen	1	1	1	1	1	1	1	1	1
Total Iron	1	1	0.079804	0.83285	0.48054	0.63384	0.95106	1	0.96281

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
Total Calcium	1	1	0.25716	0.13944	0.56212	0.0092042	0.50441	1	0.29953
Total Magnesium	1	1	0.20219	0.97189	0.64633	0.0008004	0.78581	1	0.44968
Sodium Total	1	1	0.43938	0.97733	0.30148	0.21397	0.9266	1	0.78924
Organic phosphorus	1	1	1	1	1	1	1	1	1
Inorganic phosphorus	1	1	0.97468	0.28253	0.72201	0.65248	0.65077	1	0.41035
Total hardness	1	1	0.10688	0.92007	0.86963	0.0071957	0.72126	1	0.41266
Phosphates (orthophosphates)	1	1	1	1	1	1	1	1	1
Total cadmium	1	1	1	1	1	1	1	1	1
Total copper	1	1	1	1	1	1	1	1	1
Total nickel	1	1	1	1	1	1	1	1	1
Total silver	1	1	1	1	1	1	1	1	1
Total lead	1	1	1	1	1	1	1	1	1
Antimony		1	1	1	1	1	1	1	1
Total barium	-		1	1	1	1	1	1	1
Potassium	-	(0)		0.91467	0.91547	0.020583	0.72991	1	0.73296
Fats and oils	-	0	0.036708		0.43569	0.54255	0.50685	1	0.5257
Phenols	-	(0)	0.036365	-0.26239		0.73383	0.010762	1	0.71154
Total alkalinity	-	(0)	0.68282	0.20642	0.11613		0.85061	1	0.56892
Acidity	-	0	-0.1179	-0.22453	0.72996	0.064479		1	0.1957
Free and dissociable cyanide	-	0	(0)	0	(0)	(0)	0		1
Total cyanide	-	0	0.11652	-0.2149	-0.12622	0.19336	-0.42231	0	
Total coliforms	-	0	0.40663	-0.031874	-0.12715	0.24826	0.03073	0	-0.08281
Fecal coliforms	-	(0)	0.40897	0.35404	-0.16526	0.21139	0.1184	(0)	-0.11047
Sperif	-	(0)	-0.33548	-0.33542	-0.060193	-0.13653	0.26615	(0)	-0.3676
Dperif	-	0	0.29876	-0.2442	0.11711	-0.07322	-0.23545	0	-0.018547
Hperif	-	(0)	0.12014	-0.41027	-0.024342	-0.13907	-0.065874	(0)	-0.22503
Jperif	-	(0)	0.35499	-0.3354	-0.029405	-0.11551	-0.29171	(0)	-0.036169
Margalefperif	-	(0)	-0.2798	-0.36477	-0.004543	-0.064785	0.31349	(0)	-0.35703
Nperif	-	0	-0.31849	0.19115	-0.29537	-0.33715	-0.21522	0	-0.22676
Sfito	-	0	0.18675	-0.18938	0.30877	0.40371	0.5195	0	0.06437

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
									2
Dfito	-	0	-0.33476	0.16905	-0.29028	-0.3269	0.30426	0	-0.21527
Hfito	-	(0)	-0.22698	0.080706	-0.14001	-0.19865	0.39346	(0)	-0.1563
Jfito	-	0	-0.24541	0.11451	-0.3118	-0.36456	0.2627	0	-0.2509
Margalefito	-	0	0.044624	-0.11485	0.23268	0.16865	0.54179	0	-0.086112
Nfito	-	0	0.68803	-0.076954	-0.050062	0.65654	-0.17173	0	0.29793
Szoo	-	0	0.5445	-0.15986	-0.016137	0.51276	-0.16783	0	0.39706
Dzoo	-	0	0.34876	-0.16378	-0.17258	0.052438	-0.274	0	0.25072
Hzoo	-	0	0.42427	-0.13997	-0.1567	0.28327	-0.26933	0	0.3214
Jzoo	-	0	0.16352	0.15416	-0.62038	-0.31242	-0.52061	0	-0.22695
Margalefzoo	-	(0)	0.45795	0.044502	-0.39436	0.2107	-0.44182	(0)	0.099211
Nzoo	-	(0)	0.44557	-0.30402	0.55077	0.5344	0.23756	(0)	0.48984

stations	Total coliforms	Fecal coliforms	Sperif	Dperif	Hperif	Jperif	Margalef perif	Nperif	Sfito
Total suspended solids	0.03315	0.1205	0.81953	0.48173	0.62988	0.4533	0.87741	0.646	0.16035
Total dissolved solids	0.73966	0.37472	0.36781	0.91856	0.45506	0.60277	0.35103	0.94459	0.44449
Sedimentable solids	1	1	1	1	1	1	1	1	1
Total Solids	0.88846	0.72361	0.77039	0.92993	0.97344	0.84793	0.71128	0.59929	0.28373
Electric conductivity	0.77267	0.9718	0.2725	0.19776	0.13278	0.21168	0.34849	0.34007	0.88079
pH	0.34012	0.64813	0.87836	0.65816	0.76481	0.70596	0.88227	0.72258	0.51836
Dissolved oxygen	0.32617	0.9289	0.0043438	0.47019	0.096841	0.55702	0.0029837	0.77118	0.058705
DBO	1	1	1	1	1	1	1	1	1
DQO	1	1	1	1	1	1	1	1	1
Bicarbonate of soda	0.56198	0.49359	0.93169	0.71924	0.61026	0.49067	0.89326	0.29837	0.10541
Chlorides	1	1	1	1	1	1	1	1	1
Nitrites	1	1	1	1	1	1	1	1	1
Nitrates	1	1	1	1	1	1	1	1	1
Ammoniacal nitrogen	1	1	1	1	1	1	1	1	1
Total Iron	0.002996	0.0021799	0.70242	0.41647	0.32793	0.32303	0.71091	0.93075	0.20751
Total Calcium	0.52842	0.92701	0.18632	0.11554	0.042058	0.072842	0.18435	0.9954	0.84733
Total Magnesium	0.87037	0.90325	0.54083	0.32347	0.27694	0.30211	0.67329	0.22613	0.66672

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
Sodium Total	0.32677	0.33664	0.47999	0.75587	0.424	0.46706	0.44456	0.62393	0.3593
Organic phosphorus	1	1	1	1	1	1	1	1	1
Inorganic phosphorus	0.12518	0.32511	0.41519	0.26722	0.37412	0.55264	0.42129	0.56965	0.060753
Total hardness	0.80253	0.62356	0.5194	0.54469	0.37845	0.43778	0.54776	0.75945	0.90494
Phosphates (orthophosphates)	1	1	1	1	1	1	1	1	1
Total cadmium	1	1	1	1	1	1	1	1	1
Total copper	1	1	1	1	1	1	1	1	1
Total nickel	1	1	1	1	1	1	1	1	1
Total silver	1	1	1	1	1	1	1	1	1
Total lead	1	1	1	1	1	1	1	1	1
Antimony	1	1	1	1	1	1	1	1	1
Total barium	1	1	1	1	1	1	1	1	1
Potassium	0.21457	0.2117	0.31317	0.37216	0.72496	0.28404	0.40467	0.3398	0.58244
Fats and oils	0.92588	0.28542	0.31327	0.46927	0.21011	0.3133	0.27004	0.57341	0.57705
Phenols	0.70948	0.62725	0.86045	0.73165	0.94337	0.93161	0.98942	0.37788	0.35556
Total alkalinity	0.46168	0.53266	0.68894	0.83059	0.68341	0.73522	0.8499	0.31062	0.21821
Acidity	0.92853	0.72881	0.4289	0.48583	0.84741	0.3841	0.34785	0.52507	0.10147
Free and dissociable cyanide	1	1	1	1	1	1	1	1	1
Total cyanide	0.80874	0.74644	0.26605	0.95684	0.50587	0.91592	0.2811	0.50253	0.85085
Total coliforms		0.015759	0.18405	0.074954	0.031483	0.066915	0.14852	0.8105	0.035536
Fecal coliforms	0.70328		0.93031	0.78044	0.8867	0.82622	0.93781	0.89864	0.20071
Sperif	0.43245	-0.029963		0.34018	0.017838	0.44546	0	0.27505	0.085023
Dperif	0.55721	0.095307	0.31826		0.00068164	1	0.31702	0.80449	0.44361
Hperif	0.64682	0.048798	0.69398	0.86015		0.00047897	0.013562	0.74489	0.22785
Jperif	0.57037	0.075134	0.25704	0.92243	0.87118		0.37812	0.68592	0.66394
Margalefperif	0.46604	-0.026735	0.98963	0.33298	0.71412	0.29522		0.49643	0.051223
Nperif	-0.082034	-0.043632	0.36124	0.084678	0.11116	-0.13792	0.22992		0.67593
Sfito	0.63571	0.41806	0.54198	0.25805	0.39609	0.14807	0.59955	-	

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO
								0.14252	
Dfito	0.33871	0.60708	0.25524	-0.33564	-0.081744	-0.25797	0.23397	0.056257	0.28972
Hfito	0.50884	0.71705	0.37256	-0.13506	0.071914	-0.14113	0.3621	0.058638	0.54079
Jfito	0.20676	0.60714	0.075872	-0.39932	-0.18885	-0.27408	0.054551	-0.020168	0.081441
Margalefito	0.6602	0.6236	0.5408	0.23013	0.35925	0.10923	0.57416	-0.049088	0.90269
Nfito	0.36249	0.032412	-0.037522	0.19322	0.18479	0.23691	-0.0006896	-0.11976	0.28663
Szoo	0.56135	0.22451	-0.073823	0.22172	0.18187	0.27944	-0.034457	-0.2712	0.26199
Dzoo	0.38621	0.26268	-0.24711	0.09748	0.036743	0.2087	-0.26093	-0.089472	-0.17552
Hzoo	0.55372	0.28086	-0.098966	0.19944	0.16587	0.28229	-0.088399	-0.15659	0.064448
Jzoo	-0.032924	0.10021	-0.12275	0.023809	0.034126	0.11028	-0.21766	0.5536	-0.57323
Margalefzoo	0.26553	0.14411	-0.24664	0.0035792	-0.0084537	0.14052	-0.27125	0.055991	-0.32804
Nzoo	0.33529	0.067669	-0.12829	0.23656	0.08206	0.16912	-0.057839	-0.43505	0.50326

Stations	Dfito	Hfito	Jfito	Margalefito	Nfito	Szoo	Dzoo	Hzoo	Jzoo	Margalefzoo	Nzoo
Total suspended solids	0.97508	0.68714	0.82334	0.38476	0.0051884	0.0010767	0.045375	0.0067539	0.88768	0.076015	0.029887
Total dissolved solids	0.82234	0.47538	0.72547	0.2531	0.43399	0.43974	0.53164	0.35697	0.4356	0.15124	0.46794
Sedimentable solids	1	1	1	1	1	1	1	1	1	1	1
Total Solids	0.41966	0.22637	0.38291	0.11019	0.12066	0.24771	0.34543	0.21869	0.13125	0.032679	0.67634
Electric conductivity	0.3171	0.31788	0.35104	0.61889	0.084771	0.21121	0.79427	0.48065	0.59454	0.35937	0.28753
pH	0.2863	0.40181	0.21179	0.88585	0.00012117	0.028463	0.25321	0.10108	0.38662	0.048888	0.19479
Dissolved oxygen	0.17761	0.095488	0.52147	0.043624	0.40402	0.34101	0.086917	0.24721	0.20705	0.043062	0.59407
DBO	1	1	1	1	1	1	1	1	1	1	1
DQO	1	1	1	1	1	1	1	1	1	1	1
Bicarbonate of soda	0.49441	0.89158	0.44589	0.26416	0.25748	0.35169	0.69967	0.804	0.087769	0.82268	0.10888
Chlorides	1	1	1	1	1	1	1	1	1	1	1
Nitrites	1	1	1	1	1	1	1	1	1	1	1

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO		
Nitrates	1	1	1	1	1	1	1	1	1	1	1
Ammoniacal nitrogen	1	1	1	1	1	1	1	1	1	1	1
Total Iron	0.16652	0.081787	0.17328	0.11845	0.25693	0.10457	0.068606	0.063176	0.31586	0.1451	0.51019
Total Calcium	0.46203	0.39281	0.43875	0.44804	0.12207	0.36027	0.81453	0.59665	0.93575	0.31533	0.54209
Total Magnesium	0.24968	0.36583	0.33	0.94189	0.22676	0.21379	0.78433	0.46524	0.25717	0.58463	0.16168
Sodium Total	0.021922	0.031013	0.062443	0.20421	0.44991	0.52848	0.54978	0.59298	0.78682	0.3101	0.45721
Organic phosphorus	1	1	1	1	1	1	1	1	1	1	1
Inorganic phosphorus	0.541	0.3013	0.80177	0.12823	0.46665	0.58077	0.66028	0.83171	0.44743	0.57666	0.47859
Total hardness	0.32803	0.49793	0.50187	0.92356	0.2145	0.12452	0.30114	0.18436	0.94648	0.191	0.27231
Phosphates (orthophosphates)	1	1	1	1	1	1	1	1	1	1	1
Total cadmium	1	1	1	1	1	1	1	1	1	1	1
Total copper	1	1	1	1	1	1	1	1	1	1	1
Total nickel	1	1	1	1	1	1	1	1	1	1	1
Total silver	1	1	1	1	1	1	1	1	1	1	1
Total lead	1	1	1	1	1	1	1	1	1	1	1
Antimony	1	1	1	1	1	1	1	1	1	1	1
Total barium	1	1	1	1	1	1	1	1	1	1	1
Potassium	0.31429	0.5021	0.467	0.89635	0.019266	0.083302	0.29317	0.19342	0.63093	0.15665	0.1696
Fats and oils	0.61926	0.81352	0.73743	0.73669	0.82207	0.63869	0.63037	0.68147	0.65085	0.89663	0.36339
Phenols	0.38654	0.68137	0.3506	0.49113	0.88379	0.96244	0.61186	0.64544	0.041705	0.23007	0.079109
Total alkalinity	0.32647	0.55818	0.27033	0.6201	0.028214	0.10677	0.8783	0.39861	0.3496	0.53401	0.090354
Acidity	0.36299	0.23123	0.43513	0.085152	0.61362	0.62183	0.41489	0.4232	0.10061	0.17367	0.48182
Free and dissociable cyanide	1	1	1	1	1	1	1	1	1	1	1
Total cyanide	0.52497	0.64629	0.45678	0.80124	0.37355	0.22661	0.45711	0.33516	0.50217	0.77165	0.12616
Total coliforms	0.30825	0.10995	0.54186	0.027047	0.27326	0.072361	0.24071	0.077182	0.92344	0.43002	0.31347
Fecal coliforms	0.047625	0.013009	0.047599	0.040351	0.92463	0.50689	0.43517	0.40282	0.7694	0.67248	0.84329
Sperif	0.44875	0.25915	0.82453	0.08584	0.91278	0.82921	0.46382	0.7722	0.71918	0.4647	0.70699
Dperif	0.31293	0.69216	0.22372	0.49603	0.5692	0.51232	0.77554	0.55658	0.9446	0.99167	0.48373
Hperif	0.81116	0.83358	0.57814	0.27789	0.58647	0.5925	0.91459	0.62596	0.92065	0.98032	0.81044
Jperif	0.4437	0.6789	0.41474	0.74919	0.4830	0.4053	0.538	0.40032	0.74	0.68026	0.6191

Stations	Total suspended solids	Total dissolved solids	Settleable solids	Total Solids	Electric conductivity	pH	Dissolved oxygen	DBO	DQO		
	4	5			4				685		
Margalefperif	0.48865	0.27382	0.87343	0.064714	0.99839	0.91989	0.43835	0.79605	0.52026	0.41978	0.86586
Nperif	0.8695	0.86403	0.95307	0.88603	0.72579	0.41986	0.79362	0.64566	0.077264	0.87012	0.18113
Sfito	0.38749	0.085846	0.81185	0.00014208	0.3928	0.43642	0.6057	0.85068	0.065252	0.32469	0.11455
Dfito		0	0	0.093231	0.27891	0.62491	0.96199	0.90284	0.90157	0.70972	0.35005
Hfito	0.93804		0.00093726	0.0046789	0.33979	0.75517	0.91615	0.92447	0.7205	0.46073	0.68665
Jfito	0.9345	0.84935		0.23033	0.13434	0.42526	0.89746	0.7759	0.62536	0.78724	0.18443
Margalefito	0.53043	0.77945	0.39416		0.84234	0.89565	0.56529	0.89961	0.14489	0.19387	0.45521
Nfito	-0.35854	-0.3185	-0.48084	-0.068083		0.0032214	0.16322	0.038655	0.77896	0.04438	0.041227
Szoo	-0.16637	-0.10656	-0.26818	0.044924	0.79832		0.0030733	0	0.9379	0.010558	0.0064222
Dzoo	0.01633	-0.03607	0.044143	-0.19514	0.45159	0.80057		0	0.26224	0.0003847	0.20077
Hzoo	-0.041818	-0.03248	-0.097322	-0.043214	0.62774	0.9448	0.93894		0.60316	0.0012567	0.059735
Jzoo	0.042367	-0.12215	0.16616	-0.46973	0.095964	-0.026697	0.37033	0.17674		0.049862	0.098587
Margalefzoo	-0.12704	-0.24877	-0.092295	-0.42388	0.61422	0.73123	0.87756	0.83862	0.60236		0.54704
Nzoo	-0.31214	-0.13758	-0.43211	0.25175	0.62151	0.76192	0.41801	0.58307	-0.52326	0.20418	

Source: Merceditas Corporation, 2012

4.2.5.8 ECOLOGICAL CONNECTIVITY

The vision and interpretation of connectivity is developed from the ecology of the landscape and is based on an approximation of structural-morphological and functional at the same time; that is to say, the structural and morphological characteristics that make up a territory and its ecosystems at a given moment and / or its evolution over time or the product of a transformation are analyzed, inferring at the same time its incidence at the level of ecological functionality (Forman & Godron, 1986).

The tropical wet forest identified as the ecosystem in which the project is developed, is, according to the National Map of Ecosystems 1: 500,000 (IDEAM et al., 2007), in the lower Orobioma of the Andes, in areas identified to this scale as secondary vegetation and the predominant matrix of natural forests; With a more detailed level of resolution, transformations in coverage are detected through photographs from 2005 to 2012 that have been verified in the field.

The results of the multitemporal analysis presented in the baseline reveal a 36% decrease for the dense forest cover of the mainland, at the same time as an increase of 34% clean pastures in the last 10 years (Table 4.2-50). The dynamics of the other coverings, secondary vegetation, cocoa, plantain and cassava crops are not significant, and correspond to less than 10% of the study area.

Table 4.2-50. Percentage changes in land cover 2005-2016.

VEGETABLE COVERAGE	DETECTION OF CHANGES				Percentage change
	2005	%	2016	%	
Low dense forest of the mainland	424,71	90,52	251,966	53,7	↓ 36%
Clean pastures	27,796	5,924	187,379	39,93	↑ 34%

Source: INGEX, 2015.

The increase, stabilization or reduction of anthropic intervention processes with respect to changes in coverage or land use is the first factor to be taken into account in terms of the fragmentation and loss of functional connectivity. Although this loss seems relevant when evaluating anthropogenic processes on forests, it is the stabilization of these processes that reflects the greatest quantitative intensity (Table 4.2-51).

Table 4.2-51. Areas and degrees of anthropization due to changes in the use of coverages.

DEGREE OF ANTHROPIZATION	AREA (ha)
Stabilization (Remaining coverage or with anthropic interventions)	296,382
Increase (Losses of forests, and gain of pastures, settlements and crops)	172,744
Decrease (Increase in natural regeneration - Vsb)	0,054

Source: INGEX, 2015.

According the dynamics detected, especially the decrease in forest area and taking into account that the project is developed in category B of the Magdalena River National Forest Reserve (RFNRM), connectivity is analyzed in terms of structure and function, with and without activity in the area of influence of the project. The predominant matrix or element is established, in which quantitative calculations are made for the area of direct influence, subtraction, and the basin that constitutes the area of indirect biotic influence.

To achieve with the objective of establishing the relationship between connectivity and the provision of ecosystem services, the composition of species of flora and fauna presented in the baseline is integrally integrated into each patch (habitat availability), in structural terms, and in relation to the functionality it is estimated through a connectivity model.

As it is evidenced in the results, in general terms the connectivity of forest cover is not affected to a great extent, maintaining biodiversity and its representativeness when presenting the highest indices of diversity and species wealth, as it was presented in the flora components and fauna.

4.2.5.8.1 Ecosystem analysis and vegetation coverage, as a basis for the analysis of structural and functional connectivity

The area of influence is dominated mainly by fragments of dense forest structurally connected; the matrix also contains a heterogeneity determined by a mosaic of pastures and secondary or transitional vegetation, product of wood extraction, artisanal mining and the expansion of the agricultural frontier for livestock and crops.

In the basin (area of influence of greater extension used for connectivity analysis), six (6) types of coverage were identified, according to the Corine Land Cover methodology, classified for the case of natural and semi-natural, up to the fourth sub-level (Table 4.2-52), from an orthophoto of the year 2012 and with update with field trips in 2016 by Ingex. The visualization and distribution of coverage as a map is presented in Table 4.2-.

Table 4.2-52. Covers of the earth.

LEVEL				ABv
1	2	3	4	
1. ARTIFICIALIZED TERRITORIES	1.1. Urbanized areas	1.1.2. Discontinuous urban fabric		Tud
2. AGRICULTURAL TERRITORIES	2.2 Permanent crops	2.2.1. Herbaceous permanent crops	2.2.1.3 Plantain and Yucca	Cph
		2.2.2. Permanent bush crops	2.2.2.3. Cocoa	Cpa
	2.3 Pastures	2.3.1. Clean pastures		Pl
3. FORESTS AND SEMI NATURAL AREAS	3.1. Forest	3.1.1. Dense forest	3.1.1.2. Low dense forest	Bdbtf
	3.2. Areas with herbaceous and / or shrubby vegetation.	3.2.3. Secondary vegetation or in transition.	3.2.3.2. Low secondary vegetation	Vsb

Source: INGEX 2015, According methodology from Corine Land Cover.

As shown in Illustration 4.2-283, the Jaguar footprints, focal species for excellence, are an important point in the approach to connectivity. The confirmation of its presence indicates a great wealth and abundance of prey species, which in turn implies the existence of vegetation to maintain them, for which reason it is also considered an umbrella species and key in terms of connectivity, as they exert a profound influence on the structure and composition of the ecosystem (Payán et al., 2011). In terms of functionality, the connectivity before and after the project continues to maintain corridors of more than 10 km, which would guarantee, according to existing studies (Rabinowitz, 2010), the viability of stable populations.

In the calculations of the connectivity of the landscape the layers of roads, drainage, cover and slope were used. The track layer was completed with manual scanning with a buffer of 3,5 m to match what was observed in the high-resolution images. After obtaining the track layer, the Euclidean distances were calculated for the area of analysis (Illustration 4.2-284).

Likewise, a buffer of 5 m was made in the river layer to get the polygons corresponding to the water courses (Illustration 4.2-285).

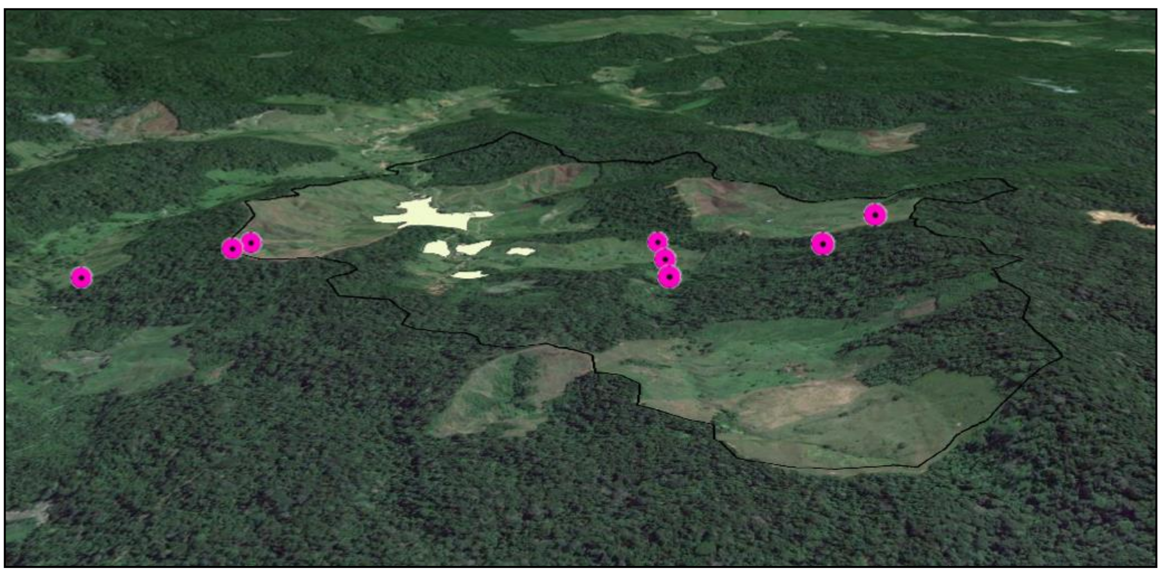


Illustration 4.2-283. Jaguar footprints
Source: INGEX, 2016. Modified by Merceditas corporation, 2012

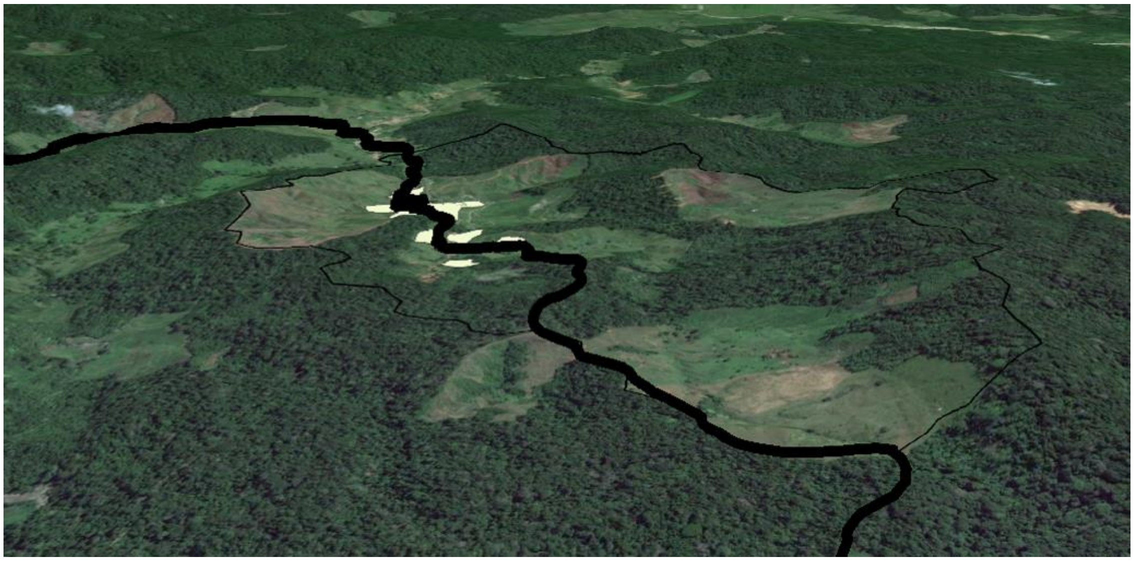


Illustration 4.2-284. Picture Buffer roads.
Source: INGEX, 2016. Modified by Merceditas corporation, 2012

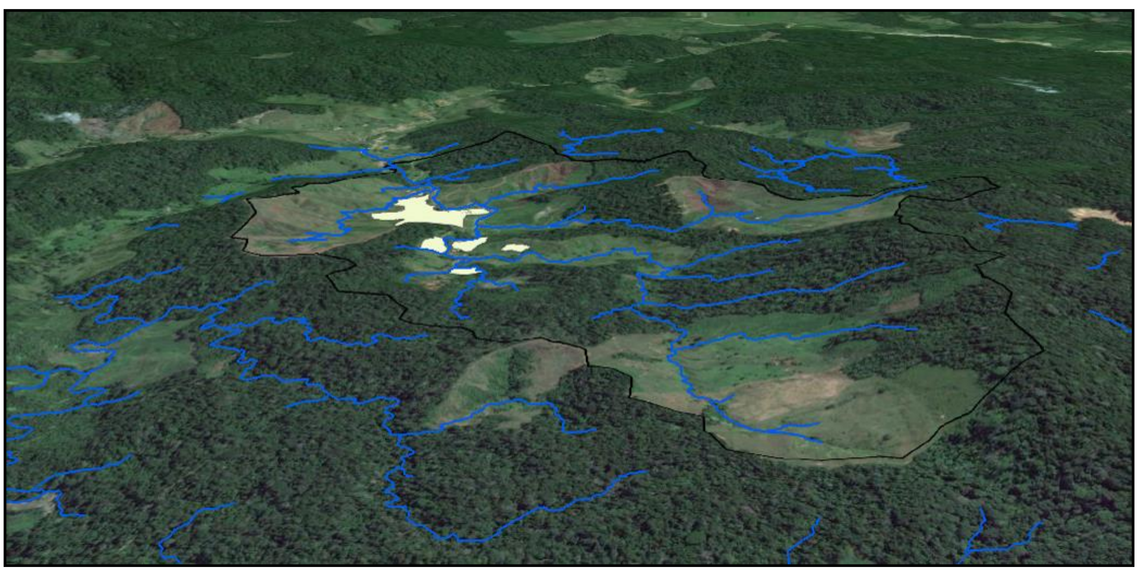


Illustration 4.2-285. Picture Buffer Rivers.
Source: INGEX, 2016. Modified by Merceditas corporation, 2012

Since the gradient is a continuous variable in the landscape, we proceeded to categorize it into 5 groups, according to the natural breaks of the data distribution (Table 4.2-53).

Table 4.2-53. Gradient categorization.

Gradients	Categories
0 - 7,5	1
7,5-15,8	2
15,8-23,4	3
23,4-30,5	4
30-58,5	5

Source: INGEX, 2016

For the calculation of the friction model by connectivity, a layer with different levels of resistance or dislocation cost was obtained. Areas with high viability values have a lower resistance cost, with values from 1 to 100 (Table 4.2-54). These values are added in order to get a friction map with values from 1 to 100, where 1 corresponds to the source areas and 100 to the areas with the greatest friction of the mobility of animal species in the landscape. This calculation was made for the current hedges, as well as for the change of hedges with the projected extraction area.

Table 4.2-54. Reclassification values assigned for each variable.

	Rank	Friction index assigned
gradients	1	1
	2	10
	3	30
	4	50
	5	75
Covers	Cc	20
	Vsb	10
	Tud	90
	Bdbtf	1
	Pl	50
	Pa	30
	Area to subtract	100
Roads	Roads (Euclidean distances)	100
	1	80
	2	70
	3	60
	4	50
	5	40
	6	30
	7	20
	8	10
	9	5
	10	1
Rivers	Rivers	10

Source: INGEX, 2016

4.2.5.8.2 Structural connectivity

The composition of the patches in terms of richness, rarity and diversity, next to their configuration or spatial distribution, are aspects that help define the structural capacity of connectivity.

According to the metrics for the analysis of the structure, in the area of influence of the 6 types of coverage, are the clean pastures (Pl) and the dense low forest of the mainland (Bdbtf), the largest ones; each with 46% of the total area. The previous ones, together with the secondary vegetation, are those that present the most number of patches (

Table 4.2-55).

Table 4.2-55. Number of patches and area by type of coverage.

Type of coverage	Number of patches	Area by type of coverage
Low dense forest of the mainland (Bdbtf)	6	1.795.488,65
Cocoa crops (Cc)	2	12.975,13
Wooded pastures (Pa)	1	27.549,64
Clean pastures (Pl)	4	1.800.069,65
Discontinuous urban territory (Tud)	2	95.958,32
Low secondary vegetation (Vsb)	4	167.520,17
Total landscape area	-	3.899.561,5

Source: INGEX, 2016

This type of quantitative data must be analyzed in its context: although the Bdbtf is one of the two coverage with greater extension, it is also the typology that has the highest number of patches, which does not necessarily make it a fragmented coverage. Understanding fragmentation as "dynamic process by which a certain habitat is being reduced to patches or smaller islands, more or less connected to each other in a matrix of habitats different from the original" (Forman, 1995). It is taken into account that these patches are part of a chain that structurally exceeds the basin (See Illustration 4.2-286), which does not happen with the other types of coverage, immersed in the matrix.

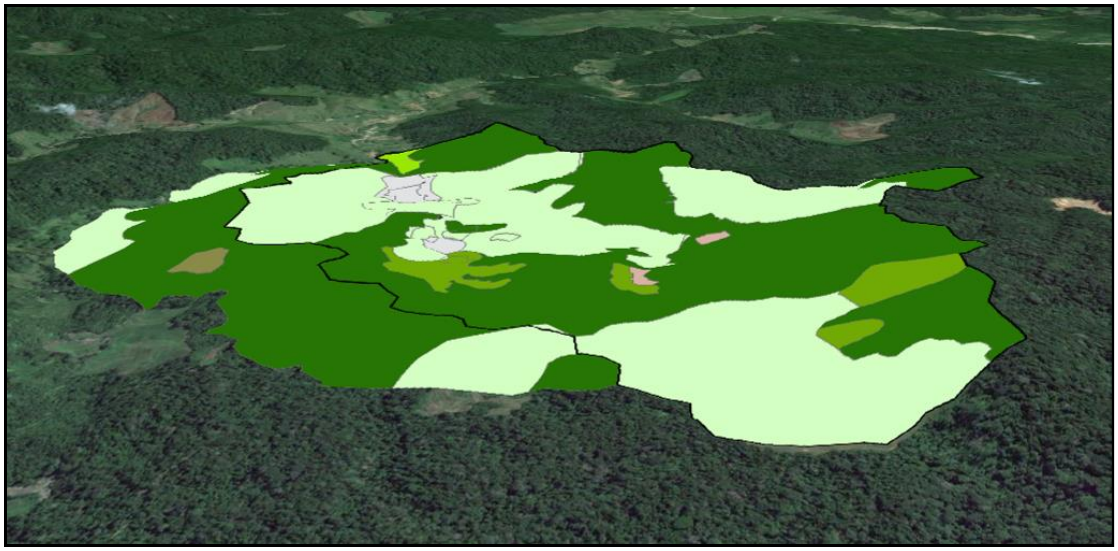


Illustration 4.2-286. Patches of coverage in the Matrix.
Source: INGEX, 2016. Modified by Merceditas Corporation, 2012

With the clarity of the context in which the matrix is found, the following indices are calculated whose main results are represented as an infographic in the Illustration 4.2-288.

Area indices and number of patches: The area by type of patch corresponds to the calculation of the area corresponding to the set of fragments that constitute a specific class. The types of pastures and forests occupy a larger area; structurally the two typologies are connected, although they are also the most numerous classes in terms of the total number of fragments (

Table 4.2-55).

Average patch size: The relationship is minimal between the area occupied by the wooded pastures, class of which there is only one patch; it is equally low in forest cover, since a single patch (which occupies most of the area), actually functions as an internal corridor of the watershed slopes.

Shape indices: As its name is specific, they are based on the shape characteristics of the fragments or patches. This type of calculation is based on the relationship between area and perimeter and facilitates the understanding of this fundamental factor at a morphological and functional level. Calculate the complexity of the shape of the fragments compared to a standard shape, such as the circumference in the vector environment or the pixel in the raster environment (Vila Subirós et al., 2006).

The shape index of the patches indicates how complex these are, the more irregular their shape, the value is far from 1. When a patch has irregular shapes they are more in line with the shapes of the ecosystems and habitats making the change of Abiotic factors are not so wild; consequently, the forest cover has the highest index, for the other coverings this index is very similar.

Table 4.2-56. Index of shape by type of coverage.

Type of coverage	Perimeter area (m)	Index of shape
Low dense forest of the mainland (Bdbtf)	19585,38	4,71
Cocoa crops (Cc)	758,27	1,32
Wooded pastures (Pa)	909,06	1,54
Clean pastures (Pl)	15629,54	1,73
Discontinuous urban territory (Tud)	1761,15	1,17
Low secondary vegetation (Vsb)	4237,00	1,46

Source: INGEX, 2016

Distance to the nearest neighbor: Calculate the distance from the edge habitat and ecotone of a fragment to the nearest fragment of the same type. These are fundamental indices to be able to assess the degree of isolation or structural connectivity existing between the different fragments, on the basis that greater isolation implies a reduction in the possibilities of harboring or maintaining a greater degree of biological diversity (Forman, 1995 Hilty et al., 2006).

An average distance of 246 m was obtained and according to the statistical test, the distribution pattern of the patches is random given that the p value was 0.32. En la Illustration 4.2-287 the pattern of distribution of the patches can be observed according to the possible p values:

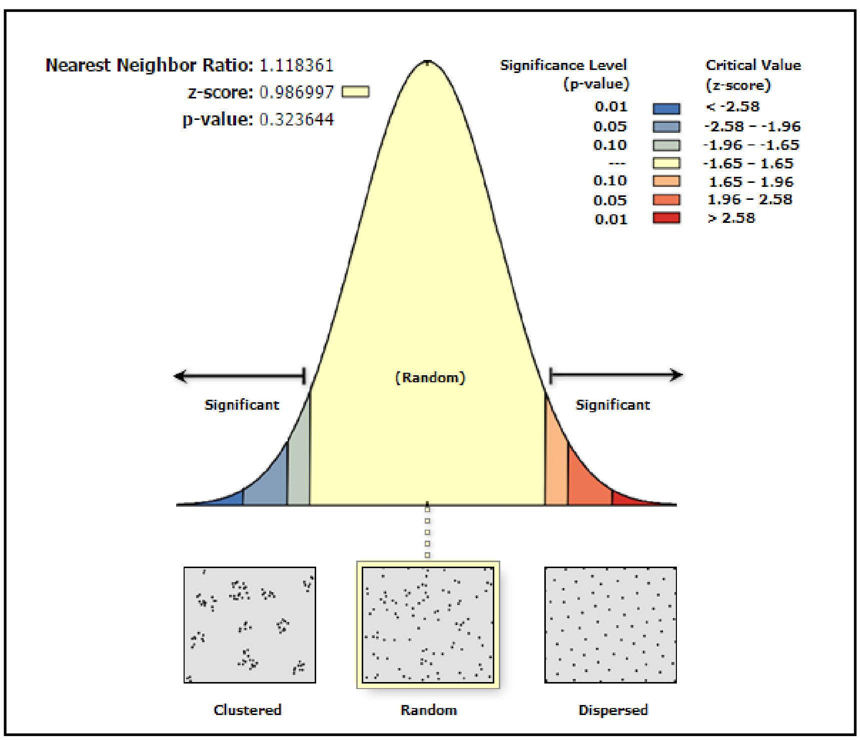


Illustration 4.2-287. Graphs with diversity, shape and neighborhood indices.
Source: INGEX, 2016

Ecotone indices and interior habitat: Allow calculations on the amplitude of the ecotone or edge habitat in relation to the interior habitat. This type of habitat is considered fundamental for the presence and maintenance of fauna and flora specialist, that is, more demanding in their ecological requirements, while the edge habitat facilitates the presence of generalist species (Forman, 1995).

The coverage with the largest indoor area was clean pastures, followed by the forest (Table 4.2-57), however, given that this analysis focuses on the importance of forest cover in the landscape, in terms of structural connectivity, extension of the interior area of the pastures makes the mobility of forest animals that are more demanding in their ecological requirements easier, thus facilitating the presence of generalist species (Forman & Godron, 1986; Forman, 1995). On the other hand, in terms of the density of the edge and according to the results of the shape index of the patches, the forest cover of this landscape still has characteristics that allow forest species to inhabit it, since it has a density of edge a little greater to the other covers allowing that there exists an ecotone of this with the matrix.

Table 4.2-57. Edge density and interior area by type of coverage.

Type of coverage	Edge density (m / ha)	Interior Area
Clean pastures (Pl)	0,00	3907,38
Low dense forest of the mainland (Bdbtf)	0,01	3264,23
Low secondary vegetation (Vsb)	0,00	1059,25
Discontinuous urban territory (Tud)	0,00	880,58
Wooded pastures (Pa)	0,00	909,06
Cocoa crops (Cc)	0,00	379,14

Source: INGEX, 2016

These types of indices, when dealing with habitat capacity, show the transition from structural connectivity to functional connectivity, as they overcome the vision of "mesh" or guarantee of continuity of coverage, to make way for the viability of these being more that of transit. It is important to have clear the magnitudes and the quantified data of areas by patch numbers (Illustration 4.2-288), to relate them to the functional capacity of the modeled landscape.

4.2.5.8.3 Functional connectivity

The approach to functionality continues the territorial and socio-ecological approach in which the delimitation of the area of influence is framed. It is recognized as characteristics of the territorial approach, that their level of resilience or capacity to absorb disturbances, maintaining their structure, functioning and dynamics, are their own and are attributed to a hierarchical organization, which in the case of the area of indirect influence represents the interaction of spatio-temporal scales and translates into ecological integrity (Martín-López, 2013) and is what is sought to be maintained through the analysis of the connectivity model.

Therefore, in addition to describing the structure, composition (wealth indices) and diversity (diversity indices) of the vegetation and fauna in each of the coverage patches, in the baseline, in this chapter we seek to identify by means of a connectivity model the ability to support habitats in terms of friction and vulnerability of the species as they move through the study area.

It is clear that to maintain and improve the natural capital of a territory it is necessary to preserve and / or favor its resilience, maintain the key ecological functions and with them reduce the risk of external disturbances and unforeseen events. A resilient territory that is dynamic and adaptive, is the potentialization of the mosaic that contains different degree of conservation and ecological maturity, heterogeneity that is related to socio-ecological interconnections, allowing its reorganization after natural or anthropic disturbances and thus maintaining the capacity to supply a varied flow of services that contribute to human well-being (Martín-López, 2013).

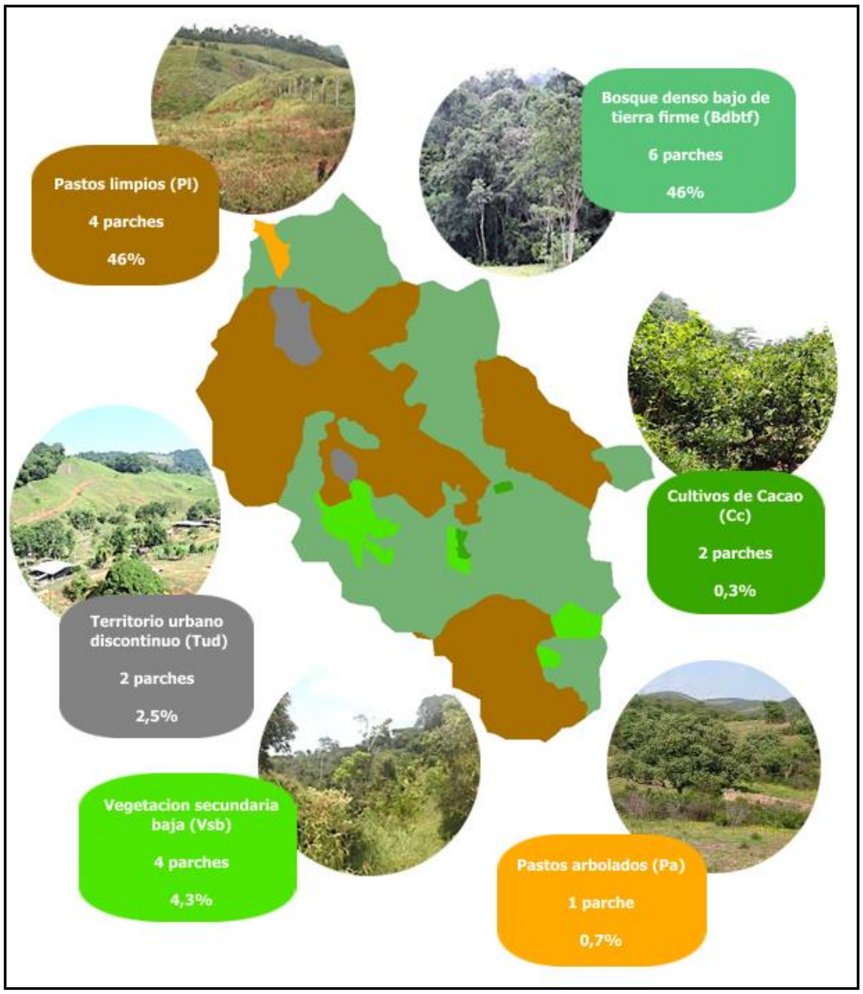


Illustration 4.2-288. Structural connectivity infographics.
Source: INGEX, 2016

Within the framework of functionality, the provision of habitats and the favoring of a structure that converges in a less impermeable or fragmented matrix, the capacity for reorganization of a territory is favored (from different degrees of socio-ecological heterogeneity), after being subjected to to a disturbance regime (Illustration 4.2-289). When the intensification of the uses is low, the reorganization is faster and more effective, in case of not organizing and regulating the activities that are already there (c), the deforestation rates would continue increasing the fragmentation and disfavoring the connectivity and provision of ecosystem services.

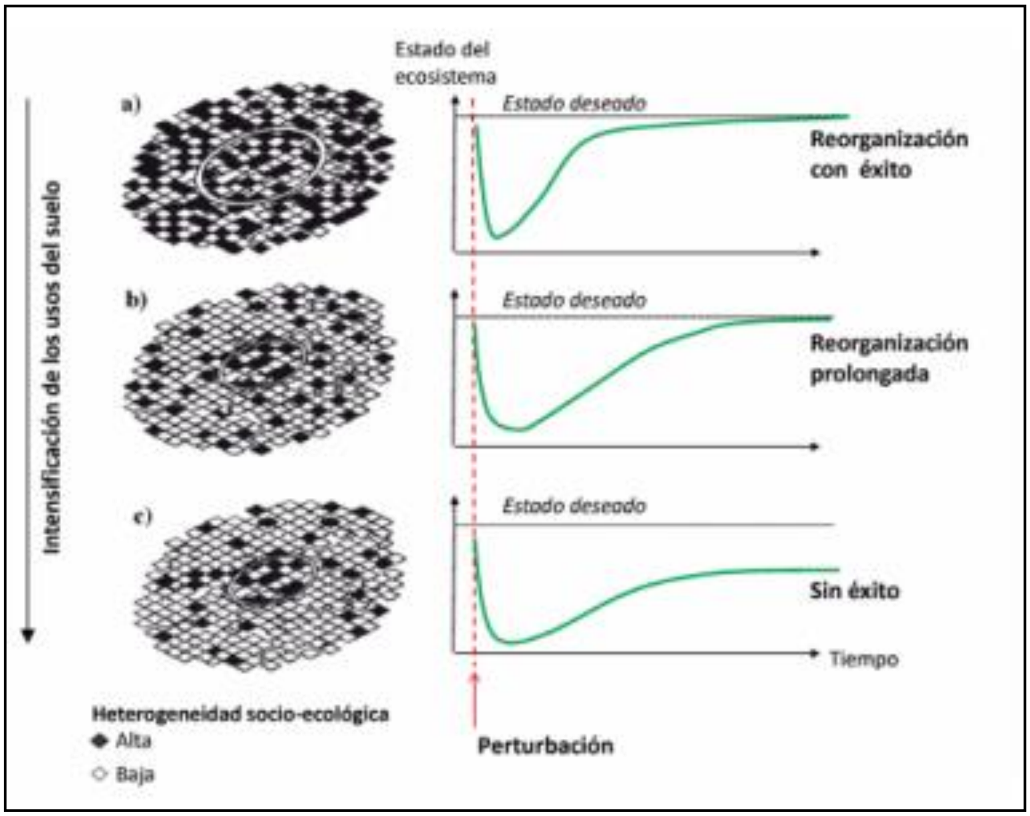


Illustration 4.2-289. Graphic representation of the capacity of reorganization according to the degree of heterogeneity of the territory and the intensification of activities.
Source: Martín-López (2013).

Following this conceptual framework and to analyze the functionality in the ecosystem identified, the landscape metrics and the applied connectivity model are presented below, accompanied by friction maps and costs, which indicate the mobility of the species, to close with a synthesis connectivity associated with ecosystem services.

Landscape diversity indices. These indices provide relevant information to be able to compare different landscapes or the evolution of a landscape at different historical moments (Vila Subirós et al., 2006). Therefore, the diversity of the landscape is understood as the heterogeneity of coverage that can be found in this and given that heterogeneous landscapes harbor a greater amount of biodiversity, it is necessary to analyze these aspects of functional connectivity, in light of the structural, taking into account that the matrix is not very wild to allow the flow of species and ecological processes.

When the value of Shannon average diversity approaches zero, it indicates dominance by one type of coverage; for the study area, it was calculated as index = 2.37, which represents a low heterogeneity in the number of patches in the area, although there is no dominance of any type of coverage.

Binary connectivity model with friction (topography and type of coverage): It is an indicator of the degree of permeability that the territory presents. These are calculated from two friction values, one for sectors favorable to mobility and one for hostile sectors (binary resistance surfaces). The assignment of friction values is based on land uses as favorable dispersive media for animal species (Ruiz-González et al., 2010).

The model presents an indicator of the degree of permeability in the area of influence; This approach allows us to know the movement capacity and dispersion patterns throughout the study area. In this way, the effects and contribution of all possible existing dispersion paths are considered, and not only the one that is closest and least difficult, a noticeable advance of the structural vision. According to the topography and the type of coverage, the best probabilities of connectivity are identified or on the contrary where connectivity is being reduced (Correa Ayram & Salicrup, 2016).

In the map of resistance or lower cost for the functional connectivity of the landscape (Illustration 4.2-290), the lowest costs were found around the coverage of forests, secondary vegetation and agroforestry crops (cocoa) with moderate slopes. The highest cost that impedes the movement was found in clean grasses, with high slopes, close to roads and discontinuous urban fabric.

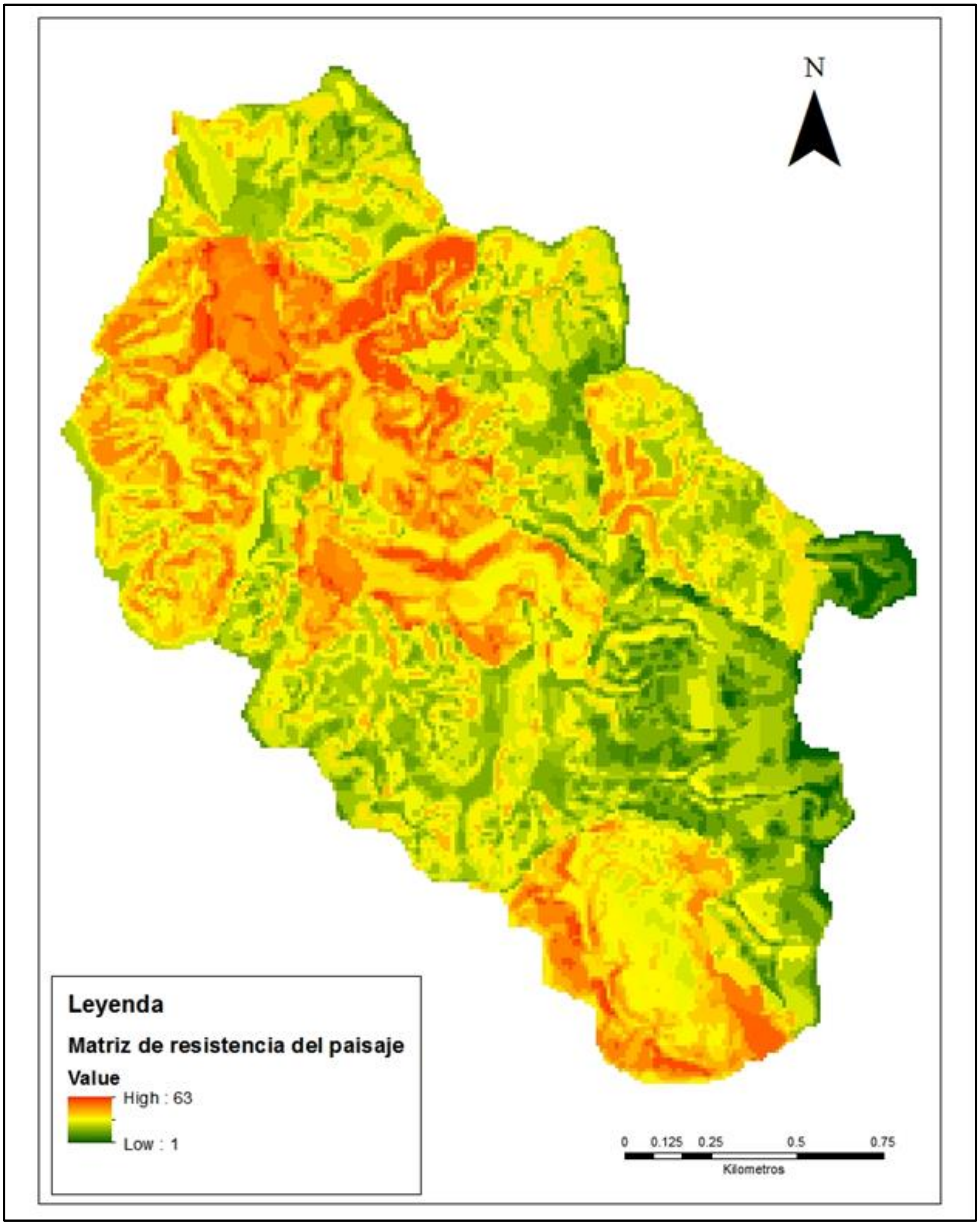


Illustration 4.2-290. Friction cost map.
Source: INGEX, 2016

In the map of the cost of friction due to the change of coverage, in the area to be subtracted (Illustration 4.2-291), the area with greater distance costs is increased, around the area with higher values. There is no evidence of increased cost of distance between forest patches.

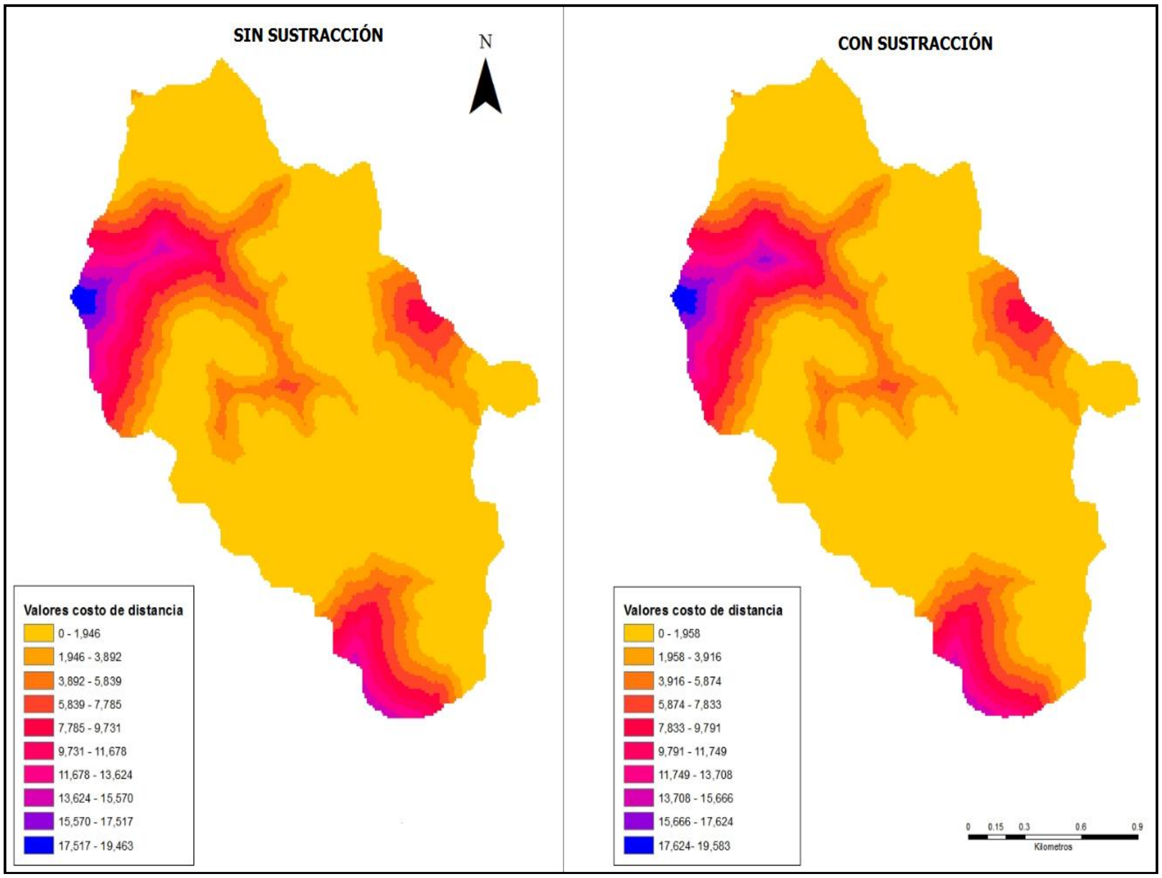


Illustration 4.2-291. Substance cost map with and without subtraction.
Source: INGEX, 2016

The connectivity of the landscape is mainly due to the presence of forest cover, given the structure and habitat that it has, it facilitates the movement and dispersion of species, the genetic exchange and other ecological flows. Although the cost of friction of the landscape does not directly alter the forestry coverings present in the area of influence, due to the already established presence of pastures, it is possible that the impact on the availability and quality of the water resource (due to the confluence of streams), affect in some way the quality of the habitat.