CHARACTERIZATION OF THE INFLUENCE AREA

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TABLE OF CONTENTS

Page

5. CHARACTERIZATION OF THE INFLUENCE AREA**¡Error! Marcador no definido.**

5.2 Biotic environment.....**¡Error! Marcador no definido.**

5.2.1 Ecosystems 17

5.2.2 Onshore Ecosystems..... 52

5.2.3 Continental aquatic ecosystems .....**¡Error! Marcador no definido.**

5.2.4 Offshore-coastal ecosystems .....**¡Error! Marcador no definido.**

5.2.5 Strategic, sensitive ecosystems or protected areas**¡Error! Marcador no definido.**

5.2.6 Areas of ecological importance and conservation**¡Error! Marcador no definido.**

LISTA DE FIGURES

Page

Figure No. 5.1 Offshore ecosystems identified in the area of biotic influence of the project 20

Figure No. 5.2 Biomes identified in the area of biotic influence of the project 21

Figure No. 5.3 Onshore ecosystems identified in the area of biotic influence of the project 23

Figure No. 5.4 Land covers within the influence area 25

Figure No. 5.5 Continuous urban tissue, Nueva Colonia township 26

Figure No. 5.6 Discontinuous urban tissue, El Canal settlement 28

Figure No. 5.7 Industrial Zone, infrastructure of the Banacol company identified in the area of biotic influence of the project 29

Figure No. 5.8 Permanent plantain and banana crops identified in the area of biotic influence of the project 31

Figure No. 5.9 Areas with clean grass cover identified in the area of biotic influence of the project 32

Figure No. 5.10 Coverage of wooded pastures identified in the area of biotic influence of the project 33

Figure No. 5.11 High dense mangrove cover identified in the area of biotic influence of the project 35

Figure No. 5.12 Areas of Naidizales identified in the area of biotic influence of the project 37

Figure No. 5.13 Coverage of riparian forest identified in the area of biotic influence of the project 38

Figure No. 5.14 Coverage of forest plantation identified in the area of biotic influence of the project 39

Figure No. 5.15 Dense herbaceous cover of non-wooded mainland identified in the area of biotic influence of the project 40

Figure No. 5.16 Coverage of dense grassland wooded land identified in the area of biotic influence of the project 41

Figure No. 5.17 Coverage of dense flooded non-wooded herbage identified in the area of biotic influence of the project 43

Figure No. 5.18 Coverage of Arracachal identified in the area of biotic influence of the project. 44

Figure No. 5.19 Coverage of helechal l identified in the area of biotic influence of the project 45

Figure No. 5.20 Open shrub coverage identified in the area of biotic influence of the project 46

Figure No. 5.21 Coverage of high secondary mangrove vegetation identified in the area of biotic influence of the project 47

Figure No. 5.22 Coverage of low secondary vegetation identified in the area of biotic influence of the project 48

Figure No. 5.23 Coverage of continental and maritime waters surfaces identified in the area of biotic influence of the project 49

Figure No. 5.24 Life zones within the influence area of the project 51

Figure No. 5.25 Spatial location of the sampling plots 54

Figure No. 5.26 Structural analysis for gallery or riparian forest cover 56

Figure No. 5.27 Value index of importance for riparian forest coverage 57

Figure No. 5.28 Diameter distribution in absolute and accumulated form, for the trees of the gallery or riparian forest cover in the influence area of the project 59

Figure No. 5.29 Stratification trends for the canopy dispersion diagram in the gallery or riparian forest within the influence area of the project..... 60

Figure No. 5.30 Representation by families of gallery or riparian forest latitudes 62

Figure No. 5.31 Structural analysis for gallery or riparian forest laticas 63

Figure No. 5.32 Value index of importance for gallery or riparian forest latitudes 64

Figure No. 5.33 Abundance of the gallery or riparian forest saplings..... 66

Figure No. 5.34 Frequency of the saplings of the gallery or riparian forest. 66

Figure No. 5.35 Spatial location of the sampling plots 69

Figure No. 5.36 Structural analysis for dense grass cover..... 70

Figure No. 5.37 Value index of importance for dense grassland coverage 71

Figure No. 5.38 Diameter distribution in absolute and accumulated form, for dense herbaceous trees..... 72

Figure No. 5.39 Stratification trends for the cup dispersion diagram for mangrove coverage 73

Figure No. 5.40 Forested covers for the year 1983 for a scale of detail 1: 30,000 75

Figure No. 5.41 Forested covers for the year 1989 for a scale of detail 1: 12,000 76

Figure No. 5.42 Forested covers for the year 2014 for a 1: 10,000 scale of detail 77

Figure No. 5.43 Representation of orders belonging to the herpetofauna by percentage of families and species grouped by each..... 92

Figure No. 5.44 Wealth (left axis) and abundance (right axis) of the herpetofauna present in the coverages identified in the influence area. Ara: Open shrub; Arc: Arracachal, Bgr: Gallery or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Palm: Palmares; Pl: clean pastures; Tud: discontinuous urban fabric; Vsa: High secondary vegetation. 94

Figure No. 5.45 Ecological indexes of the coverages identified in the influence area according to the herpetofauna present there. Ara: Open shrub; Arc: Arracachal, Bgr: Gallery or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Palm: Palmares; Pl: clean pastures; Tud: discontinuous urban fabric; Vsa: High secondary vegetation 95

Figure No. 5.46 Possible routes of displacement of the herpetofauna in the influence area of the project 96

Figure No. 5.47 Geographic location of the endemic species and those classified in CITES, in Resolution 0192 and in the red book of reptiles of Colombia present in the influence area 98

Figure No. 5.48 Representation of bird orders by percentage of families and species grouped by each 108

Figure No. 5.49 Wealth (left axis) and abundance (right axis) of the avifauna present in the coverages identified in the influence area. Ara: Open shrub; Arc: Arracachal, Bgr: Gallery or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Sea: Seas and oceans; Palm: Palmares; Pa; Wooded pastures; Pl: clean pastures; Plat: Banana and banana; R: River; Tud: discontinuous urban fabric; Vsa: High secondary vegetation 110

Figure No. 5.50 Ecological indexes of the coverages identified in the influence area according to the bird community present there. Ara: Open shrub, Arc: Arracachal, Bgr: gallery or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Sea: Seas and oceans; Palm: Palmares; Pa; Wooded pastures; Pl: clean pastures; Plat: Banana and banana; R: River; Tud: discontinuous urban fabric; Vsa: High secondary vegetation 111

Figure No. 5.51 Possible routes of displacement of the avifauna present in the influence area of the project 113

Figure No. 5.52 Percentage of occurrence of the trophic guilds according to the bird species present in the influence area 114

Figure No. 5.53 Percentage of migratory species identified in the influence area according to the orientation of their migration and the category of residence in Colombia 116

Figure No. 5.54 Geographic location of the endemic, near-endemic and interesting species and those classified in CITES, IUCN present in the influence area 117

Figure No. 5.55 Representation of orders of medium and large mammals by percentage of families and species grouped by each..... 133

Figure No. 5.56 Wealth (left y-axis) and abundance (right y -axis) of medium and large mammals in hedges identified in the influence area. Arc: Arracachal, Bgr: Gallery or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Pl: clean pastures; Rivers: (R); Tud: discontinuous urban fabric; Vsa: High secondary vegetation 135

Figure No. 5.57 Ecological indexes of the coverages identified in the influence area according to the medium and large mammals present there. Arc: Arracachal, Bgr: Gallery or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Pl: clean pastures; Rivers: (R); Tud: discontinuous urban fabric; Vsa: High secondary vegetation 136

Figure No. 5.58 Geographical location of the endemic species and those classified in CITES, IUCN, Resolution 0192 and red book of mammals of Colombia present in the influence area 137

Figure No. 5.59 trophic associations reported for bats in the study area 152

Figure No. 5.60 Possible routes of displacement of the mastofauna present in the influence area of the project 155

Figure No. 5.61 Fluvial and offshore hydrobiological sampling points..... 156

Figure No. 5.62 Wealth of species of the perifitic community present in points HB1 and HB2 in the León River 157

Figure No. 5.63 Density of the periphytic community present in points HB1 and HB2 on the León River. 162

Figure No. 5.64 Bray-Curtis analysis for the periphytic community present in the sampled points of the León River 164

Figure No. 5.65 Wealth of species of the phytoplankton community present in the sampling points in the influence area of the project in Bahía Colombia 173

Figure No. 5.66 Density of the phytoplankton community present in the sampling points in the influence area of the project in Bahía Colombia..... 174

Figure No. 5.67 Bray-Curtis analysis for the phytoplankton community present in the sampling points in the influence area of the project in Bahía Colombia 177

Figure No. 5.68 Correlation between phytoplankton density and nitrogen concentration (left) and turbidity (right) in the area of offshore influence of the project. 179

Figure No. 5.69 Spatial location of the sampling plots 182

Figure No. 5.70 Structural analysis for mangrove coverage 186

Figure No. 5.71 Value index of importance for mangrove coverage 187

Figure No. 5.72 Diameter distribution in absolute and accumulated form, for mangrove trees 188

Figure No. 5.73 Stratification trends for the cup dispersion diagram for mangrove coverage 189

Figure No. 5.74 Representation by families, latitudes of dense high mangrove 191

Figure No. 5.75 Structural analysis for mangrove saplings 193

Figure No. 5.76 Value index of importance for mangrove latitudes..... 194

Figure No. 5.77 Abundance of tall dense mangrove saplings 196

Figure No. 5.78 Frequence of tall dense mangrove saplings 197

Figure No. 5.79 Representation by families of latitudes of high secondary vegetation 198

Figure No. 5.80 Structural analysis for latitudes of secondary mangrove vegetation..... 200

Figure No. 5.81 Value index of importance for mangrove latitudes..... 201

Figure No. 5.82 Wealth of species of the zooplankton community present in the sampling points in the influence area of the project in Bahía Colombia 210

Figure No. 5.83 Density of the zooplanktonic community present in the sampling points in the influence area of the project in Bahía Colombia..... 213

Figure No. 5.84 Bray-Curtis analysis for the zooplankton community present in the sampling points in the influence area of the project in Bahía Colombia 215

Figure No. 5.85 Correlation between the density of zooplankton and the concentration of dissolved oxygen in the area of offshore influence of the project 216

Figure No. 5.86 Wealth of species of the benthic community present in the sampling points in the influence area of the project in Bahía Colombia 219

Figure No. 5.87 Density of the benthic community present in the sampling points in the influence area of the project in Bahía Colombia 221

Figure No. 5.88 Bray-Curtis analysis for the benthic community present in the sampling points in the influence area of the project in Bahía Colombia 223

Figure No. 5.89 Abundance of the Ichthyofauna by sampling point present in the offshore ecosystem of the influence area..... 228

Figure No. 5.90 Bray-Curtis analysis for the fish community present in the sampling points in the influence area of the project in Bahía Colombia 247

Figure No. 5.91 Protective Forest Reserve of the wetlands between León and Suriquí rivers 249

Figure No. 5.92 Zoning of the Protective Forest Reserve of the wetlands between León and Suriquí rivers..... 251

Figure No. 5.93 Location of the Darién Coastal Environmental Unit 257

Figure No. 5.94 Coastal Environmental Unit Zoning - Darién 258

Figure No. 5.95 Conservation objects identified in the influence area and nearby 260

LIST OF TABLES

Page

Table No. 5.1 Offshore ecosystems identified in the area of biotic influence of the project 20

Table No. 5.2 Terrestrial ecosystems identified in the area of biotic influence of the project **¡Error! Marcador no definido.**

Table No. 5.3 Coverage of the land present in the influence area of the project 24

Table No. 5.4 Floristic composition for gallery or riparian forest cover 53

Table No. 5.5 Structural analysis for gallery or riparian coverage. 54

Table No. 5.6 Distribution of frequencies for the variable normal diameter, in the gallery or riparian forest in the influence area of the project. 58

Table No. 5.7 Distribution of the number of species and their abundances (number of trees) in each stratum (altimetric position) for the trees inventoried in the gallery or riparian forest. 60

Table No. 5.8 Indices of Wealth and Plant Diversity for the coverage of gallery or riparian forest, present in the influence area of the project..... 61

Table No. 5.9 Floristic composition, gallery forest latitudes or riparian..... **¡Error! Marcador no definido.**

Table No. 5.10 Structural analysis for gallery or riparian forest laticas 62

Table No. 5.11 Floristic composition of the riparian forest seedlings 65

Table No. 5.12 Floristic composition for dense grass cover..... 68

Table No. 5.13 Structural analysis for dense grass cover 70

Table No. 5.14 Frequency distribution for the variable normal diameter of dense grassland trees. 72

Table No. 5.15 Distribution of the number of species and their abundances (number of trees) in each stratum (altimetric position) for the trees inventoried in the dense grassland cover 73

Table No. 5.16 Wealth and Diversity indices for dense grasslands 74

Table No. 5.17 Multitemporal analysis for forest cover in the influence area of the project **¡Error! Marcador no definido.**

Table No. 5.18 fragmentation degree of forest cover for a period of 31 years in the influence area of the project ..... **¡Error! Marcador no definido.**

Table No. 5.19 Patton diversity index for forest cover within the influence area of the project. **¡Error! Marcador no definido.**

Table No. 5.20 Fractal dimension for forest cover within the influence area of the project 78

Table No. 5.21 Form factor for forest cover within the influence area of the project **¡Error! Marcador no definido.**

Table No. 5.22 Resultados de las métricas realizadas para el paisaje del área de influencia del proyecto..... 80

Table No. 5.23 Taxonomic composition and classification in CITES, IUCN, Resolution 0192 of 2014 and Red Books of Amphibians and Reptiles present in the influence area. 91

Table No. 5.24 Ecological aspects of the arrow puna frog Dendrobates truncatus 98

Table No. 5.25 Ecological aspects of the morrocoy turtle Chelonoidis carbonaria 100

Table No. 5.26 Ecological aspects of the palm tree turtle Rhinoclemmys melanosterna 102

Table No. 5.27 Ecological aspects of the Caiman crocodilus..... 103

Table No. 5.28 Taxonomic composition and classification in CITES and IUCN of the avifauna present in the influence area..... 105

Table No. 5.29 Orientation, migration policy and category of residence in Colombia of the 19 species identified as migratory in the influence area 115

Table No. 5.30 Ecological aspects of the Caribbean guacharaca Ortalis garrula 119

Table No. 5.31 Ecological aspects of *Chauna chavaria* 120

Table No. 5.32 Ecological aspects of *Cyanocorax affinis* 122

Table No. 5.33 Ecological aspects of *Ramphocelus dimidiatus* 123

Table No. 5.34 Ecological aspects of *Amazona farinosa* 125

Table No. 5.35 Ecological aspects of *Coccycua pumila* 126

Table No. 5.36 Taxonomic composition and classification in CITES, IUCN, Resolution 0192 of 2014 and Red Book of mammals (medium and large) present in the influence area 132

Table No. 5.37 Ecological aspects of *Saguinus oedipus* 138

Table No. 5.38 Ecological aspects of *Lontra longicaudis* 141

Table No. 5.39 Ecological aspects of *Puma yagouaroundi* 143

Table No. 5.40 Ecological aspects of *Bradypus variegatus* 145

Table No. 5.41 Ecological aspects of *Cuniculus paca* 147

Table No. 5.42 Taxonomic composition and threat category of bat species 149

Table No. 5.43 Abundance of bats by plant cover 150

Table No. 5.44 Diversity index of flying mammals 153

Table No. 5.45 Taxonomic species composition of the community periphytic sampling points in the influence area of the project on the Leon River. **¡Error! Marcador no definido.**

Table No. 5.46 Density (ind / cm2) of the perifitic community at the points sampled on the León River 162

Table No. 5.47 Ecological index for the perifitic community present in HB1 and HB2 in the León River 163

Table No. 5.48 Composition of species of the community of benthic macroinvertebrates present in points HB1 and HB2 in the León River 165

Table No. 5.49 Taxonomic composition and abundance of the ichthyofauna present in the continental aquatic ecosystem 167

Table No. 5.50 Biological and ecological information of *Astyanax* sp. 168

Table No. 5.51 Taxonomic composition of phytoplanktonic species identified in the sampling points in the influence area of the project in Bahía Colombia 172

Table No. 5.52 Density (ind / L) of the phytoplanktonic community present in the points sampled in Bahía Colombia 173

Table No. 5.53 Ecological index for the phytoplankton community present at the sampling points in Bahía Colombia 176

Table No. 5.54 Correlation of phytoplankton density and physical-chemical parameters in the area of offshore influence of the project 179

Table No. 5.55 Floristic composition for Mangrove coverage 181

Table No. 5.56 Structural analysis for mangrove coverage..... 183

Table No. 5.57 Frequency distribution for the variable normal diameter for mangrove trees. 188

Table No. 5.58 Distribution of the number of species and their abundances (Number of trees) in each stratum (Sociological position), for the trees inventoried in the mangrove cover..... **¡Error! Marcador no definido.**

Table No. 5.59 Wealth and Diversity indices for mangrove vegetation 190

Table No. 5.60 Floristic composition, latitudes of dense mangrove 191

Table No. 5.61 Structural analysis for mangrove saplings 192

Table No. 5.62 Floristic composition of tall dense mangrove saplings. 195

Table No. 5.63 Floristic composition, latitudes of high secondary vegetation .. 198

Table No. 5.64 Structural analysis for latitudes of high secondary vegetation. 199

Table No. 5.65 Taxonomic composition of zooplankton species identified in the sampling points in the influence area of the project in Bahía Colombia. 208

Table No. 5.66 Density (ind / L) of the zooplankton community present in the sampling points in Bahía Colombia 213

Table No. 5.67 Ecological indices for the zooplankton community at the points sampled in Bahía Colombia..... 214

Table No. 5.68 Correlation of zooplankton density and physicochemical parameters in the area of offshore influence of the project 216

Table No. 5.69 Taxonomic composition of benthic species identified in the sampling points in the influence area of the project in Bahía Colombia 218

Table No. 5.70 Density of the benthic community present in the sampling points in Bahía Colombia..... 219

Table No. 5.71 Ecological indices for the benthic community at the sampling points in Bahía Colombia..... 222

Table No. 5.72 Correlation of fish abundance and physical-chemical parameters in the area of offshore influence of the project..... 223

Table No. 5.73 Taxonomic composition of the Ichthyofauna present in the offshore ecosystem. 224

Table No. 5.74 Abundance of the Ichthyofauna in the offshore ecosystem of the influence area… 227

Table No. 5.75 Uses, endemism, type of migration and trophic guild of the ichthyofauna identified in the area of offshore influence..... 230

Table No. 5.76 Biological and ecological information of *Anchovia clupeoides*. 230

Table No. 5.77 Biological and ecological information of *Anchovia sp.* 231

Table No. 5.78 Biological and ecological information of *Caranx hippos*..... 232

Table No. 5.79 Biological and ecological information of *Centropomus* sp..... 233

Table No. 5.80 Biological and ecological information of *Dasyatis* sp 234

Table No. 5.81 Biological and ecological information of *Etropus* sp..... 235

Table No. 5.82 Biological and ecological information of *Harengula sp.*..... 236

Table No. 5.83 Biological and ecological information of *Larimus* sp 237

Table No. 5.84 Biological and ecological information of *Lobotes* sp. 239

Table No. 5.85 Biological and ecological information of Morfos 7, 8 y 9 240

Table No. 5.86 Biological and ecological information of *Oligoplites saurus* 241

Table No. 5.87 Biological and ecological information of *Pachyurus* sp. 242

Table No. 5.88 Biological and ecological information of *Polydactylus virginicus*. 242

Table No. 5.89 Biological and ecological information of *Selene vomer*..... 243

Table No. 5.90 Biological and ecological information of *Trichiurus lepturus* 244

Table No. 5.91 Biological and ecological information of *Umbrina coroides*..... 245

Table No. 5.92 Ecological index for the fish community at the sampling points in Bahía Colombia 246

Table No. 5.93 Correlation of fish abundance and physicochemical parameters in the area of offshore influence of the project 248

Table No. 5.94 Areas and zones established in the zoning of the Protective Forest Reserve of the wetlands between the León and Suriquí rivers 251

Table No. 5.95 Conservation objects identified in the vicinity of the influence area 259

LIST OF PHOTOGRAPHS

Page

Photo No. 5.1 Resettlement plot of the El Canal village 26

Photo No. 5.2 Panoramic view of the El Canal settlement 27

Photo No. 5.3 Infrastructure of the Banacol company identified in the area of biotic influence of the project 29

Photo No. 5.4 Plantain and banana crops within the area of biotic influence of the project 30

Photo No. 5.5 Aquatic vegetation associated with clean pastures and uses. 1. Buffalos within the León River (upper left), 2. Windswept grasses (upper right), 3. Aquatic vegetation (lower) 33

Photo No. 5.6 Overview of Mangle coverage 34

Photo No. 5.7 Naidizales area identified in the area of biotic influence of the project 36

Photo No. 5.8 Riparian forest on the shore of the León River 38

Photo No. 5.9 Forest plantation of Tectona grandis 39

Photo No. 5.10 Coverage of densely wooded land with wooded land 41

Photo No. 5.11 Panoramic coverage of dense, flooded, non-wooded grassland 42

Photo No. 5.12 Overview of the coverage of Arracachal on the canal of Nueva Colonia 44

Photo No. 5.13 Ferny Coverage l 45

Photo No. 5.14 Sweet pithecellobium open shrub (chiminango) 46

Photo No. 5.15 Panoramic coverage of high secondary mangrove vegetation 47

Photo No. 5.16 The León River 49

Photo No. 5.17 Overview of Bahía Colombia 50

Photo No. 5.18 *Sweet pithecellobium* in the cover of gallery or riparian forest 53

Photo No. 5.19 Influence of natural grasses on the natural regeneration of the gallery or riparian forest 65

Photo No. 5.20 Dense herbaceous coverage within the influence area of the project 68

Photo No. 5.21 *Pachira aquatica* 83

Photo No. 5.22 *Pithecellobium dulce* 84
Photo No. 5.23 *Tabebuia rosea* 85
Photo No. 5.24 Some species of amphibians observed in the influence area of the project 89
Photo No. 5.25 Some species of reptiles observed in the influence area of the project 90
Photo No. 5.26 Some species of birds observed in the influence area of the project. 107
Photo No. 5.27 Mouse Melanomys caliginosus and Dense Forest (place of capture) 129
Photo No. 5.28 Some species of mammals observed in the influence area of the project. 131
Photo No. 5.29 Traces of mammals traps traces. 1) Dasyprocta punctata; 2,4,7,9) Cuniculus paca; 3,6) Didelphis marsupialis; 5,8) Procyon cancrivorus 132
Photo No. 5.30 *Carollia perspicillata* y *Platyrrhinus brachicephalus* bats. 151
Photo No. 5.31 *Artibeus lituratus* y *Uroderma bilobatum* bats..... 153
Photo No. 5.32 Some species of the perifitic community found at the points sampled on León River 161
Photo No. 5.33 Individual of the family Chironomidae found in León River 165
Photo No. 5.34 Some species of the phytoplankton community found at the sampling points in Bahía Colombia 171
Photo No. 5.35 Mangrove vegetation present in the influence area..... 180
Photo No. 5.36 Affectation observed in the mangrove cover 181
Photo No. 5.37 *Avicennia germinans* in the influence area of the project 184
Photo No. 5.38 *Rhizophora mangle* in the influence area of the project 185
Photo No. 5.39 ¨Mata Tigre¨ Fern in the influence area of the project ..... **¡Error! Marcador no definido.**
Photo No. 5.40 *Rhizophora mangle* 203
Photo No. 5.41 *Avicennia germinans* 205
Photo No. 5.42 *Laguncularia racemosa* 206

Photo No. 5.43 Some species of the zooplankton community found at the sampling points in Bahía Colombia 208

Photo No. 5.44 Some species of the offshore benthic community found at the sampling points in Bahía Colombia 218

LIST OF ATTACHMENTS

Attachment No. 5.2.1. Field data, floristic characterization for gallery or riparian forest cover

Attachment No. 5.2.2. Field data, floristic characterization dense grass cover

Attachment 5.2.3. Field formats completed in the taking of the information of the terrestrial fauna (herpes, birds and mammals (medium and large)

Attachment 5.2.4. Abundance of the herpetofauna by unit of coverage identified in the influence area of the project

Attachment 5.2.5. Geographic location of endemic species and the degree of threat of the herpetofauna present in the influence area

Attachment 5.2.6. Abundance of avifauna by unit of coverage identified in the influence area of the project

Attachment 5.2.7. Trophic guilds and uses of avifauna present in the influence area

Attachment 5.2.8. Geographical location of endemic species and the degree of threat of the avifauna present in the influence area

Attachment 5.2.9. Abundance of medium and large mammals per unit of coverage identified in the influence area of the project

Attachment 5.2.10. Geographic location of endemic and threatened species of medium and large mammals present in the influence area

Attachment 5.2.11. Field data, floristic characterization for mangrove coverage.

LIST OF MAPS

Map code Theme

	Onshore, coastal and offshore
MOD_LA_PTO_ANT_33_ Ecosystem	Ecosystems
MOD_LA_PTO_ANT_34_ OCoverage	Land cover
MOD_LA_PTO_ANT_35_Fauna	Wildlife sampling
MOD_LA_PTO_ANT_36_Spe_Distrib	Distribution of species
MOD_LA_PTO_ANT_37_WildlifeRoutes	Wildlife movement routes
MOD_LA_PTO_ANT_38_Flora	Flora sampling
MOD_LA_PTO_ANT_39_ProtecAreas	Protected areas and strategic ecosystems

5. CHARACTERIZATION OF THE INFLUENCE AREA

5.2 Biotic environment

In general terms, the following is a description of the influence area following the guidelines outlined in the map of Onshore, Coastal and Offshore Ecosystems of Colombia [1] and it is established to which great biome and biome corresponds the influence area of the project in the onshore and coastal - offshore area.

Subsequently, the ecosystems in the identified biomes are described, as well as their biome associated ecosystems and land cover. The coverage of the land was analyzed taking into account an adapted version for Colombia of the Corine Land Cover classification[2], and then crossed it with the cartographic information and updates of satellite images.

Additionally, the Tremarctos tool (Tremarctos Colombia Early Warning System) was used.[3] to identify the sensitive species that could be affected by the project.

Finally, the description of the ecosystem and coverage of the land is presented at a resolution with more detail, limited to the project area. Finally, the characterization of fauna and flora according to the Onshore, coastal and Offshore environment is presented.

5.2.1 Ecosystems

In its terrestrial part, the area of influence belongs to the great biome of the tropical humid forest, which has a total extension of 105,632,472ha with zones that have hot humid or very humid warm climates, with annual average rainfall greater than 2,000 mm.

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[1] INSTITUTE OF HYDROLOGY, METEOROLOGY AND ENVIRONMENTAL STUDIES, AGUSTÍN CODAZZI GEOGRAPHIC INSTITUTE, RESEARCH INSTITUTE OF BIOLOGICAL RESOURCES WITH HUMBOLDT, MARINE AND COASTAL RESEARCH INSTITUTE JOSÉ BENITO VIVES DE ANDRÉIS, AMAZON INSTITUTE OF SCIENTIFIC INVESTIGATIONS and JHON VON NEUMAMM PACIFIC INSTITUTE OF ENVIRONMENTAL RESEARCH. Onshore, coastal and offshore ecosystems of Colombia. Bogotá, D.C: 2007, 276 p. + 37 cartographic sheets.

[2] INSTITUTE OF HYDROLOGY, METEOROLOGY AND ENVIRONMENTAL STUDIES. National Legend of Coverage of the Earth. CORINE Land Cover methodology adapted for Colombia. Scale 1: 100,000. Bogotá: IDEAM, 2010. 72 p. ISBN: 978-958-806729-2.

[3] RODRÍGUEZ-MAHECHA, JV, ARJONA-HINCAPIÉ, F., MUTO, T., URBINA-CARDONA, JN, BEJARANO-MORA, P., RUIZ-AGUDELO, C., DÍAZ GRANADOS, MC, PALACIOS, E., MORENO, MI, GÓMEZ, A. and. GEOTHINKING LTDA. 2015. Ara Colombia. Geographic Information System for the Analysis of State Institutional Management (OtusColombia Module) and the Affectation to Sensitive Biodiversity and Cultural Heritage (Tremarctos Module-Colombia). Version 2.0 (28; 01; 2013) Conservation International-Colombia & Ministry of Environment and Sustainable Development. Online information system available at http://www.tremarctoscolombia.org/ [Quoted on July 29, 2015].

This great biome is between 0 and 1,800 meters above sea level, so its vegetation is equivalent to humid tropical forests, very humid and rainy, as well as tropical rainforest. According to UNESCO, it belongs to the ombophilous montane and submontane tropical forest; Holdridge's life zone classification system classifies it as low montane and premontane forest.[4].

The great biome of the tropical humid forest has three types of biome (Zonobiome, Orobiome, Pedobiome), being the tropical humid zonobiome of Magdalena and the Caribbean the one that is in the area of influence, which covers 3.22% of this big biome and it lies in a geoform of alluvial plain[5].

In this zonobiome for the area of influence, two ecosystems are identified at a scale of 1: 500,000, namely: Natural forests of the tropical humid zone of Magdalena-Caribbean (1531) and Herbaceous and shrublands of the Magdalena-Caribbean tropical moist zonobiome (1542). Likewise, the following coverages are identified and described at a scale of 1: 100,000 according to the CORINE Land Cover methodology adapted for Colombia:

- Mosaic of pastures and crops (2.4.2)

It includes the lands occupied by pastures and crops, in which the size of the parcels is very small (less than 25 ha) and the distribution pattern of the plots is too intricate to represent them cartographically individually[6].

- Dense low flood forest (3.1.1.1.2)

It corresponds to areas with arboreal vegetation characterized by a more or less continuous stratum, which area of tree cover represents more than 70% of the total area of the unit, and with height of the canopy between 5 and 15 meters and which is located in the fringes adjacent to the bodies of water (lotic), which correspond mainly to the digression watermeadows and overflow plains with periodic flooding processes, lasting more than two months[7].

- Secondary or transition vegetation (3.2.3)

It includes that vegetal cover originated by the process of succession of the natural vegetation that appears either after the intervention or by the destruction of the primary vegetation, which can be in recovery leading to its original state. It is developed in dismantled areas for different uses, in abandoned agricultural areas

[4] INVEMAR et al. (2007). Op. Cit.
[5] Ibíd.
[6] IDEAM. National Legend of Earth Coverage, Op. cit. p. 36.
[7] Ibíd., p. 43.

and in areas where, due to the occurrence of natural events, the natural vegetation was destroyed. Elements intentionally introduced by man are not presented[8].

- Rivers (5.1.1)

A river is a natural stream of water that flows with continuity, has a considerable flow and flows into the sea, into a lake or into another river. It is considered as a minimum cartographic unit, those rivers that have a channel width greater than or equal to 50 meters[9].

Towards the offshore part, the influence area is located in the province of the Caribbean Sea, in the Caribbean Continental Biogeographic realm platform, within the coastal system Darién -DAR-, in the Atrato ecoregion -at-

The Offshore ecosystem identified in the influence area corresponds to the sedimentary bottoms in the continental platform of the Atrato ecoregion, which are mobile bottoms of thin non-carbonated grain of the sub-littoral and mobile funds of coarse non-carbonated grains of the sub-littoral (Figure No. 5.1, Table No. 5.1)

This ecosystem is formed by the accumulation of particles (sands, clays, silts) forming unstable substrata of low topographic complexity, according to the sedimentary facies the conformation is of lithoclastic sands or muddy lithoclastic sands[10]. Housing organisms of the offshore benthic communities.

[8] Ibíd., p. 54.
[9] Ibíd., p. 65.
[10] POSADA, Blanca Oliva., HENAO, William. Diagnosis of erosion in the coastal zone of the Colombian Caribbean. Santa Marta.: INVEMAR, 2008. 124 p. (Special publications series No. 13). ISBN 978-958-98104-9-1.

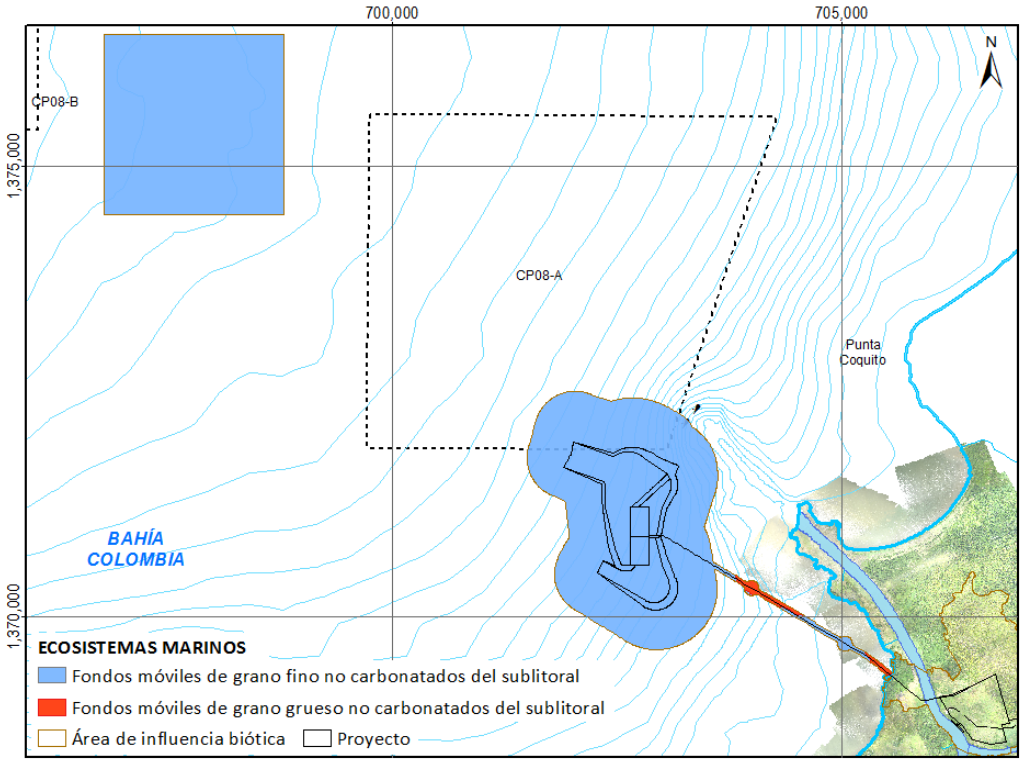

Figure No. 5.1 Offshore ecosystems identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

The ecosystem of thin-grained, non-carbonate mobile bottoms of the sub-littoral is the one with the highest representation (866.46 ha) in the influence area of the project.

Table No. 5.1 Offshore ecosystems identified in the area of biotic influence of the project

Biogeographic realm	Ecoregion	Nomenclature	Offshore ecosystem	Substratum	Área (ha)
Caribbean Continental Shelf	Atrato	Fm-gf	Non-carbonated thin grain mobile funds from the sublittoral	Sandy mud	866,46
		Fm-gg	Non-carbonated coarse-grained mobile funds from the sublittoral	Sandy	6,82

- *Ecosystems identified in the influence area of the project*

Next, the ecosystems identified in the influence area of the project are specified, once the baseline survey and verification in the field have been carried out.

When making the respective crossings of the layers (geomorphology, climate and coverage) with the GIS tool, the biome corresponding to the Caribbean Halobiome was identified, which is characterized by lying in geomorphs of fluvial - offshore plains, presenting natural forests, coastal lagoons, pastures, bare areas, secondary

vegetation and continental hydrophytes. This biome is characteristic of the Great Tropical Dry Forest Biome (scale 1: 500,000), however it was identified within the Great Biome to which the area of influence of the project belongs (Great biome of the tropical humid forest), given the climatic characteristics of the area

For the terrestrial area of influence, 18 ecosystems (scale 1: 10,000, Table No. 5.2, Figure No. 5.3 and map MOD_LA_PTO_ANT_33_Ecosystem) grouped into two biomes were identified: Caribbean Halobiome and the tropical moist zonobiome of Magdalena and the Caribbean (Figure No. 5.2) In which two of them are transformed ecosystems (urban and industrial areas), two are part of agricultural crops and the rest are part of natural ecosystems in differentiated transitional states.

Of these ecosystems, the most representative within the area of influence were the palm groves of the tropical humid zone of the Magdalena-Caribbean, clean pastures of the humid tropical zone of the Magdalena-Caribbean and the dense non-wooded flooded herbaceous zone of the humid tropical zone of the Magdalena-Caribbean, each with 147.59 ha, 92.29 ha and 51.31 ha, respectively; the other ecosystems represented less than 15 ha (Table No. 5.2)

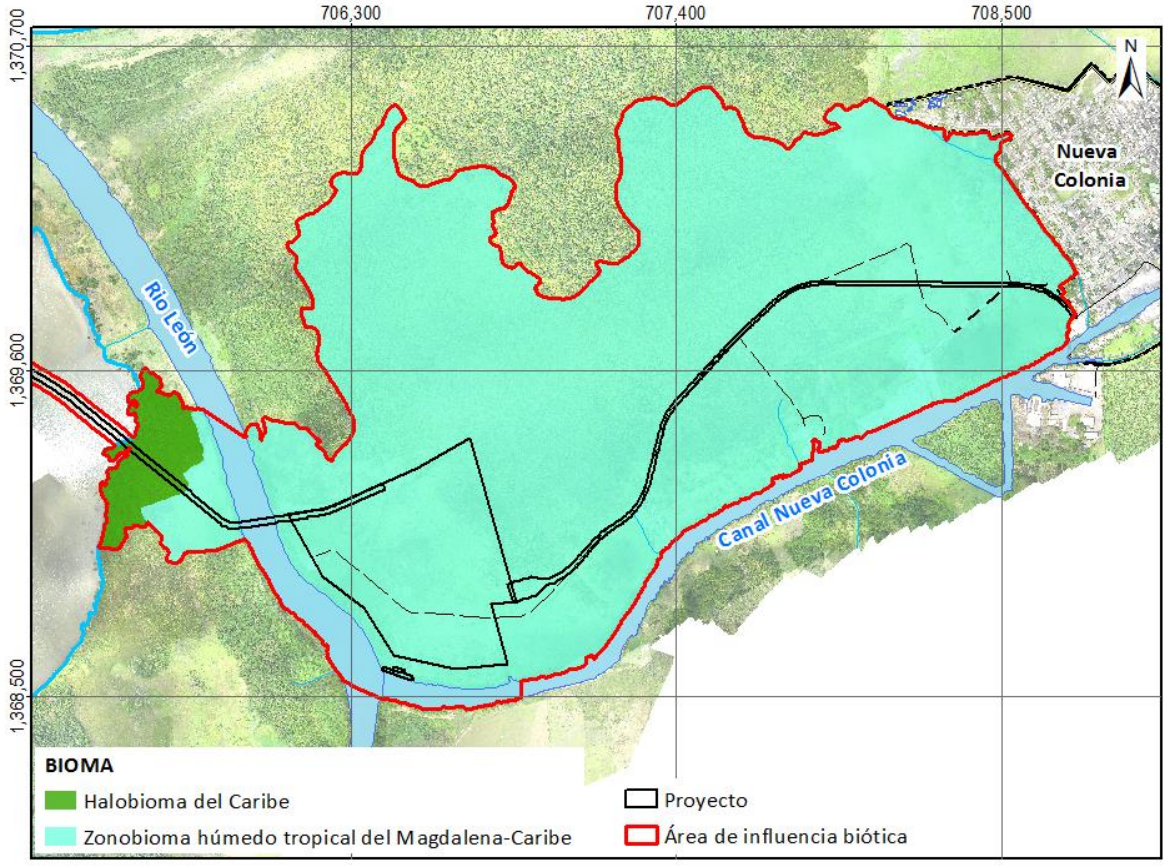

Figure No. 5.2 Biomes identified in the area of biotic influence of the project

Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.2 Terrestrial ecosystems identified in the area of biotic influence of the project

Biome	Description	Code	Ecosystem	Área(ha)
Caribbean Halobiome	Very humid warm weather Deltaic plane. offshore effluvium.	Mda_HC	Dense high mangrove of the Caribbean Halobiome	6,98
		Vsa_HC	High secondary vegetation of the Caribbean Halobiome	4,12
Wet tropical Zonobiome of the Magdalena -Caribbean	Warm humid and very humid climate. Active flooding plan for the Mendoric River (Alluvial Plain) and deltaic Plane for the fluvial offshore system.	Ara_ZHTMC	Open arbustal of the tropical humid Zonobiome of the Magdalena-Caribbean	4,26
		Arc_ZHTMC	Arracachal of the tropical humid Zonobiome of Magdalena-Caribbean	2,81
		Bgr_ZHTMC	Gallery or riparian forest of the tropical humid Zonobiome of Magdalena-Caribbean	9,06
		Plat_ZHTMC	Banana and banana crops of the tropical humid Zonobiome of Magdalena-Caribbean	11,17
		Hlc_ZHTMC	Helechal l of the tropical humid Zonobiome of the Magdalena-Caribbean	0,60
		Hdtfa_ZHTMC	Dense wooded ground of the humid tropical Zonobiome of the Magdalena-Caribbean	4,87
		Hdtfna_ZHTMC	Dense, flooded dense forest of the Magdalena-Caribbean tropical humid Zonobiome	2,12
		Hdina_ZHTMC	Palmares of the tropical humid Zonobiome of the Magdalena-Caribbean	51,31
		Palm_ZHTMC	Woody pastures of the tropical moist Magdalena-Caribbean Zonobiome	147,59
		Pa_ZHTMC	Clean pastures of the tropical humid Zonobiome of the Magdalena-Caribbean	0,79
		Pl_ZHTMC	Plantation of hardwoods of the humid tropical Zonobiome of Magdalena-Caribbean	92,26
		Pllat_ZHTMC	Plantation of hardwoods of the humid tropical Zonobiome of the Magdalena-Caribbean	0,04
		R_ZHTMC	Low secondary vegetation of the tropical humid Zonobiome of the Magdalena-Caribbean	15,42
		Vsb_ZHTMC	Industrial zones	3,80
		ZI	Urbanized areas	4,52
		ZU	Dense, flooded dense forest of the Magdalena-Caribbean tropical humid Zonobiome	2,63

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

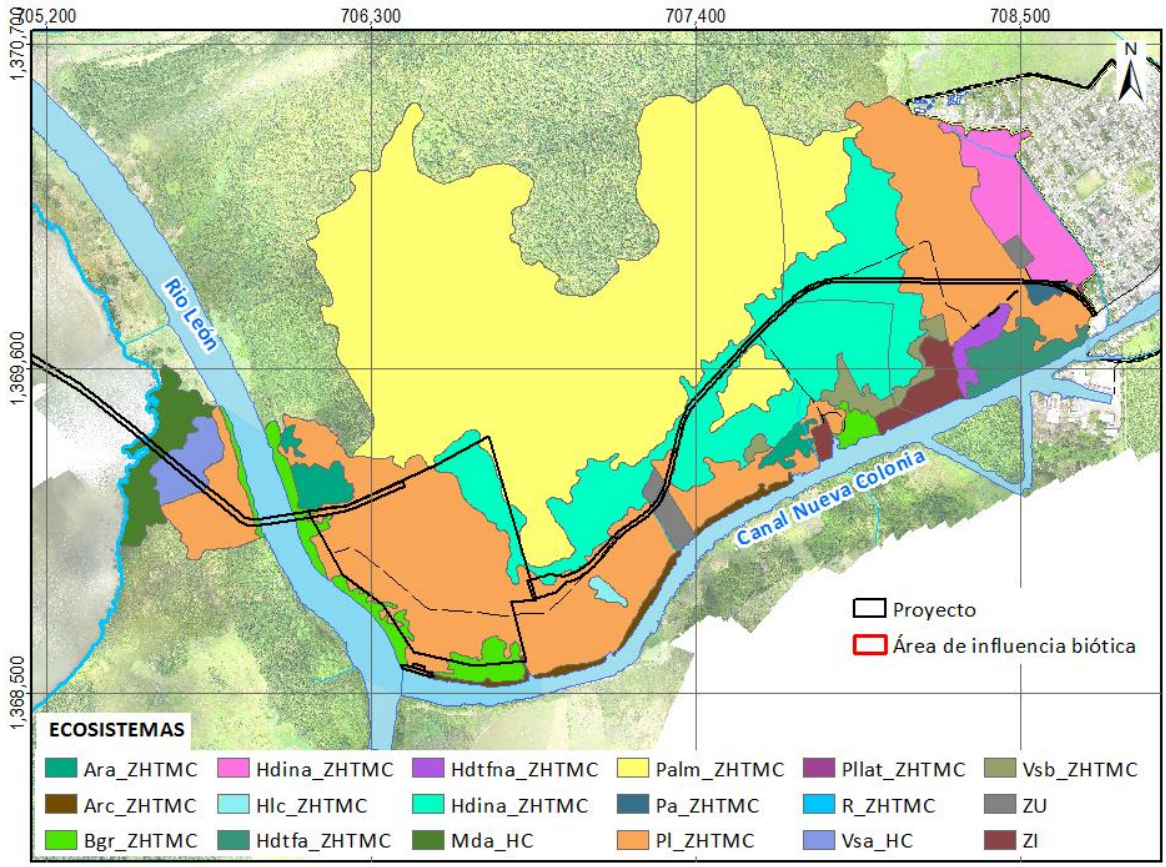

Figure No. 5.3 Onshore ecosystems identified in the area of biotic influence of the project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

- *Coverage of land in the influence area of the project*

The interpretation of the coverage units was generated from a visual classification, using an October 2014 orthophoto and field verification, for a 1: 10,000 scale of detail. Likewise, the legend of the CORINE Land Cover methodology adapted for Colombia at 1: 100,000 scale was adopted and adjusted for the particular case of this study at a scale of 1: 10,000.

As a result, the map of land cover for the influence area of the project was obtained, 2015, with 20 coverage units (map MOD_LA_PTO_ANT_34_Tcoverage) classified within 4 levels of the CORINE Land Cover methodology: 1. Artificialized territories, 2 Agricultural territories, 3. Forests and semi-natural areas and 5. Water surfaces

Table 5.3 shows the structure of the legend and the map of the land cover for the influence area of the project (Figure No. 5.4).

Table No. 5.3 Land cover in the influence area of the project

LAND COVER Corine Land Cover Methodology								
Nomenclature	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**	**Level 6**	**Área (ha)**	**Área (%)**
111	Artificialized Territories	Urbanized areas	Continuous urban tissue				0,6	0,12%
112			Discontinuous urban tissue				2,0	0,41%
1211		Industrial or commercial areas and communication networks	Industrial or commercial areas	Industrial zones			4,5	0,92%
2213	Artificialized Territories	Permanent crops	Herbaceous permanent crops	Banana and plantain			11,17	2,26%
231		Pastures	Clean pastures				92,33	18,71%
232			Woodland pastures				0,79	0,16%
311122	Forests and Semi natural Areas	Forests	Dense forest	High dense forest	Dense high flood forest	Dense high mangrove	6,98	1,42%
311123						Palmares	147,59	29,91%
314			Gallery or riparian forest				9,06	1,84%
3152			Forest plantation	Plantation of hardwoods			0,04	0,01%
321111		Areas with herbaceous or shrubby vegetation	Herbazal	Dense grassland	Grassy dense ground	Dense grassland of non-wooded land	2,12	0,43%
321112						Dense grassland wooded ground	4,87	0,99%
321121					Dense flooded herbazal	Dense flooded herbage not wooded	51,31	10,40%
321123						Arracachal	2,81	0,57%
321124			Herbazal	Dense grassland	Dense flooded herbazal	Helechal l	0,60	0,12%
3222			Arbustal	Open shrub			4,26	0,86%
3231			Secondary or transition vegetation	High secondary vegetation			4,12	0,83%

LAND COVER Corine Land Cover Methodology								
Nomenclature	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**	**Level 6**	**Área (ha)**	**Área (%)**
3232				Low secondary vegetation			3,80	0,77%
511	Water Surfaces	Inland waters	Rivers (50 m)				4,39	0,89%
522		Maritime waters	Seas and oceans				140,14	28,40%

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

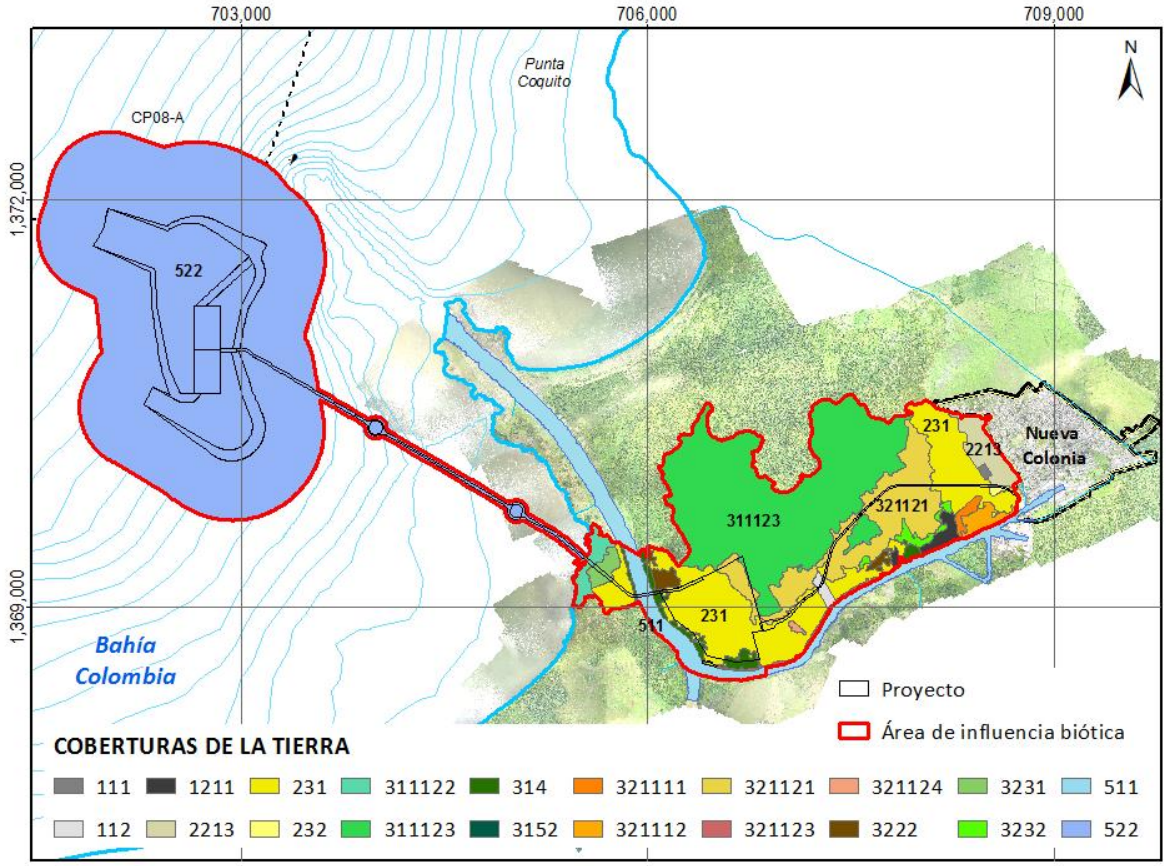

Figure No. 5.4 Covers of the land within the influence area
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The following describes each of the coverages identified and verified within the influence area:

Continuous urban tissue (Tuc): According to the Corine Land Cover classification methodology, this coverage is part of the artificialized territories, subdivided into urbanized areas. It is characterized for being spaces conformed by buildings and spaces adjacent to the built infrastructure. Vegetation and bare soil represent a low proportion of the urban fabric tissue.

Within the influence area, this coverage corresponds to the plot where the resettlement of the community of El Canal village will take place, where the assigned houses are being built, as shown in Photo No. 5.1. This property is located within the urban perimeter of Nueva Colonia township (Figure No. 5.5). This unit has a surface of 0.6 ha.

Photo No. 5.1 Resettlement plot of the El Canal village
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Figure No. 5.5 Continuous urban tissue, Nueva Colonia township
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Discontinuous urban tissue (Tud): According to the Corine Land Cover classification, this coverage is part of the artificialized territories, subdivided into urbanized areas. It is characterized for being a space made up of buildings and green areas.

The buildings, roads and constructed infrastructure cover the surface of the land in a dispersed and discontinuous manner, since the rest of the area is covered by vegetation. Within the influence area this coverage has an area of two (2) ha, corresponding to the El Canal settlement, as shown in Photo No. 5.2 and Figure No. 5.6.

Photo No. 5.2 Panoramic view of the El Canal settlement
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

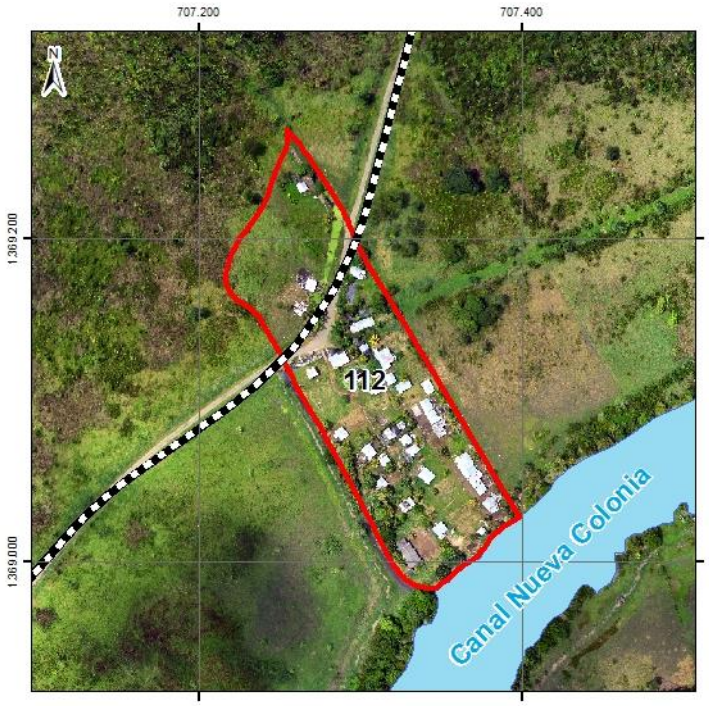

Figure No. 5.6 Discontinuous urban tissue, El Canal settlement
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Industrial zones (Zi): These are the areas covered by artificial infrastructure without the presence of dominant green areas, which are also used for commercial or industrial activities. Within the influence area, these refer to the container deposits of the company Banacol, located on the right margin of Nueva Colonia Canal (Photo No. 5.3).

This covers an area of 4.5 ha and corresponds to two properties, one dedicated to the jetty of the Banacol company and another for maintenance and where a fuel station operates, as shown in Figure No. 5.7.

Photo No. 5.3 Infrastructure of the Banacol company identified in the area of biotic influence of the project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

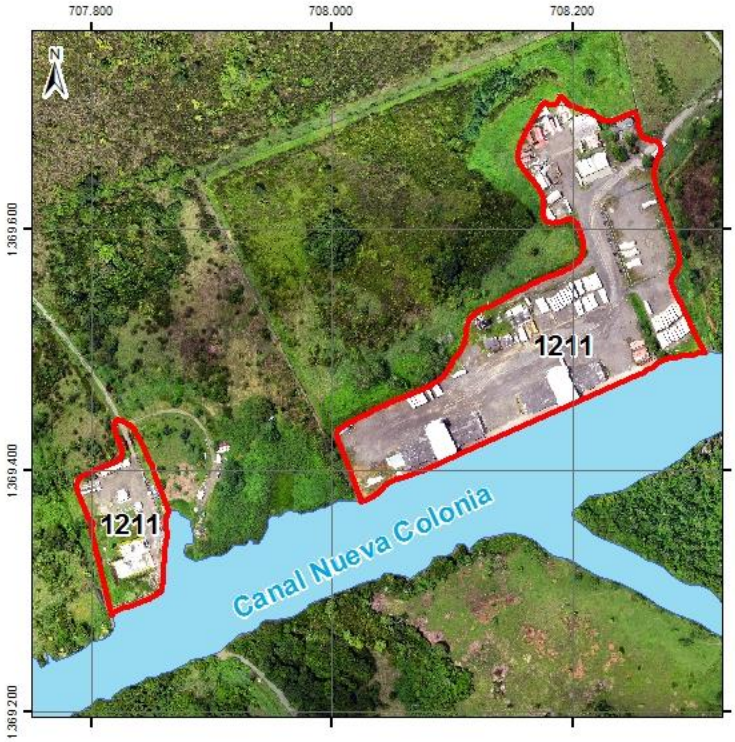

Figure No. 5.7 Industrial Zone, infrastructure of the Banacol company identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Banana and banana (Plat): Coverage composed of banana (Musa sapientum L.) and plantain (Musa paradisiaca L.). These are giant perennial herbaceous plants

belonging to the family Musaceae, consisting of a short rhizome and an apparent stem, which results from the union of the leaf sheaths, presents a conical shape and heights that vary between 3.5 and 7.5 m, the crown of these plants ends in a crown of leaves. The leaves are large and elongated, arranged in a spiral shape (Photo No. 5.4). These crops in the influence area are preferentially destined for export.

Photo No. 5.4 Banana and banana crops within the area of biotic influence of the project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

This coverage is associated with other permanent crops of smaller area, corresponding to bread crops, which serve as the livelihood of each farm. Within the influence area, this coverage occupies an area of 11.17 ha and is contiguous with the town center of Nueva Colonia, as shown in Figure No. 5. 8..

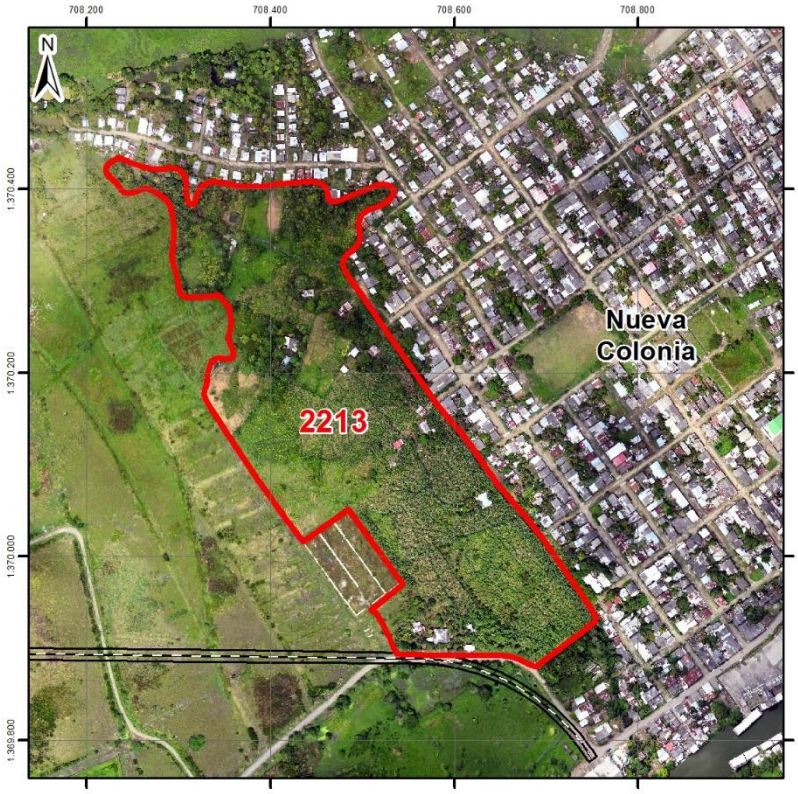

Figure No. 5.8 Permanent plantain and banana crops identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Clean Pastures (Pl): Includes coverings occupied mostly by clean pastures where management practices impede the presence or development of other coverings. For the influence area this coverage has an area of 92.3 ha as shown in Figure No. 5.9.

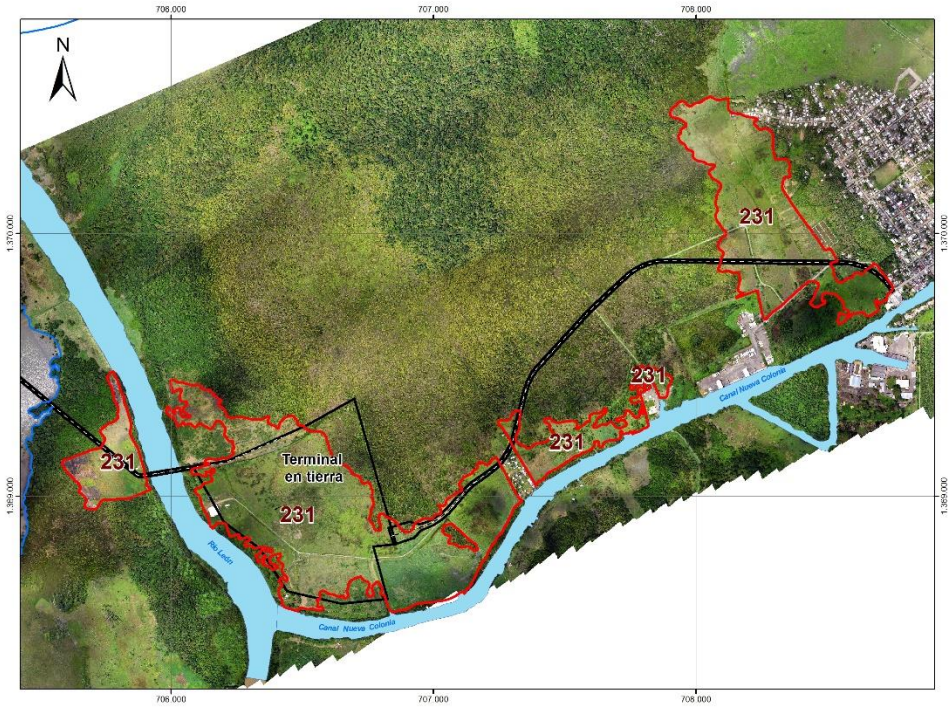

Figure No. 5.9 Areas with clean grass cover identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

The dominant grass species in these areas are urare grasses *(Brachiaria arrecta),* dedicated mainly for the breeding of bucephala and vendeaguja grasses (Imperata sp.), Used for traditional livestock (Photo No. 5.5). These pastures are adapted to flooded areas such as the floodplains that make up the influence area, where flooded soils and water saturation problems occur. Some aquatic plants grow on these areas, as can be seen in Photo No. 5.5.

Photo No. 5.5 Aquatic vegetation associated with clean pastures and uses. 1. Buffalos within the León River (upper left), 2. Windswept grasses (upper right), 3. Aquatic vegetation (lower))
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Tree pastures (Pa): this cover corresponds to land surfaces with trees taller than five (5) meters distributed scattered over the pastures, used mainly as shade trees for livestock. This coverage represents a small area equivalent to 0.8 ha, as shown in Figure No. 5.10.

Figure No. 5.10 Coverage of wooded pastures identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

High dense mangrove (Mda): According to the Corine Land Cover classification, this unit is part of the Forests and Semi natural Areas, subdivided into dense high-flood forest, this coverage is within the regional forest reserve of the wetlands

between León and Suriquí rivers declared by the agreement No 100-02-02-01-0010-2011 by CORPOURABÁ,11, and which was subtracted from a strip of 437.6 m long and 20 m wide (9.832,7 m2) through the agreement No 100-02-02-01-0004-2011 by CORPOURABÁ [12], in order to build the viaduct that will lead from the land terminal to the dock.

Among the characteristic species of this cover are *Avicennia germinans* (Black Mangrove), *Rhizophora mangle* (Red Mangrove) and *Laguncularia racemosa* (White Mangrove) as shown in Photo No. 5.6. It has an area of seven (7) ha and is adjacent to the secondary high vegetation, corresponding to the natural regeneration of this mangrove (Figure No. 5.11).

Photo No. 5.6 Overview of Mangle coverage
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

[11] CORPORATION FOR THE SUSTAINABLE DEVELOPMENT OF URABÁ - CORPOURABA. Agreement No 100-02-02-01-0010-2011 (June 16, 2011). By means of which the category of protected area of the Protective Forest Reserve of the Wetlands is certified between the rivers León and Suriquí in the municipality of Turbo, created in the agreement of the directive council No 100-02-02-01-011-2009 with the category of protected area Regional Natural Park (Decree 2372 of 2010). Apartadó, 7 p.

[12] CORPORATION FOR THE SUSTAINABLE DEVELOPMENT OF URABÁ - CORPOURABA. Agreement No 100-02-02-01-0004-2011 (March 17, 2011). By means of which an area of the Protective Forest Reserve of the wetlands between León and Suriquí rivers is partially and temporarily subtracted and a season is partially lifted. Apartadó, 6 p.

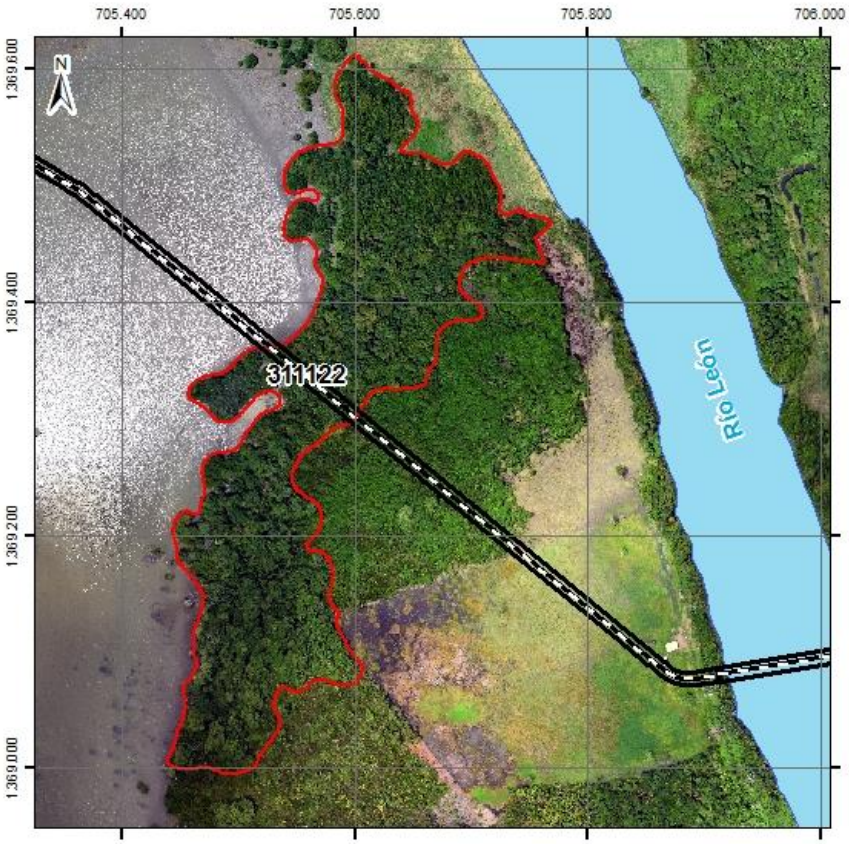

Figure No. 5.11 High dense mangrove cover identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Palmares (Palm): This cover is constituted by communities dominated by the species Euterpe oleracea Mart., Commonly known as Naidi palm, located mainly in marshy areas constituting the naidizales, as shown in Photo No. 5.7. Within the influence area, this coverage covers 147.6 ha, located mainly in the floodplain of this zone (Figure No. 5.12).

Photo No. 5.7 Naidizales area identified in the area of biotic influence of the project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

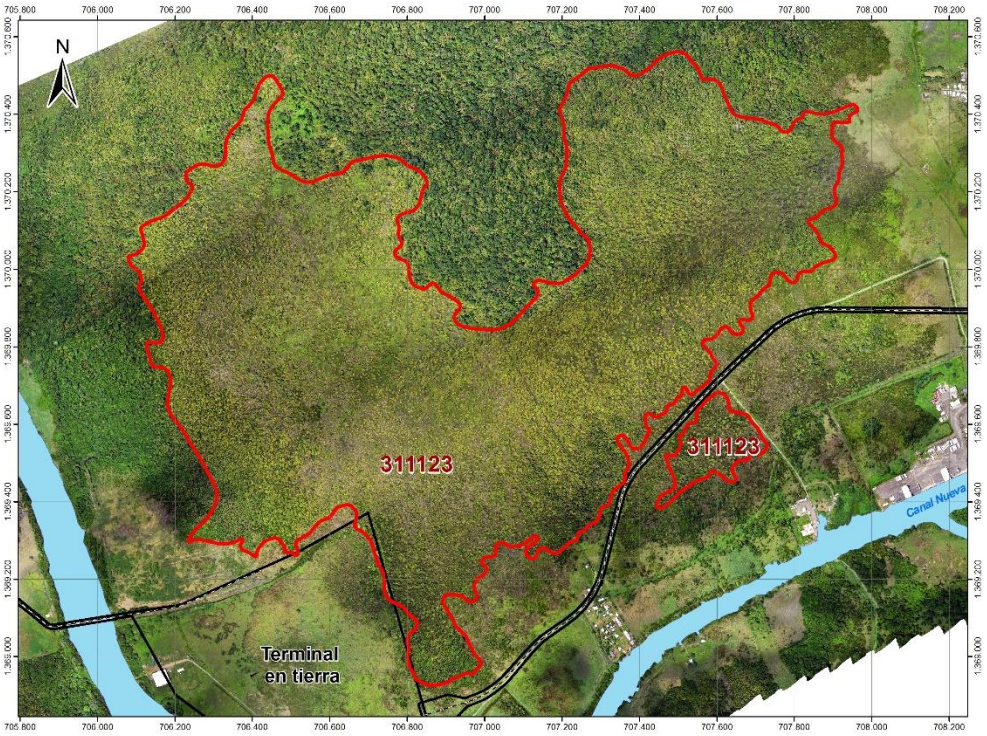

Figure No. 5.12 Naidizales Areas identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Gallery or riparian forest (Bgr): This cover is mainly composed of herbaceous vegetation located on the banks of the León River and the Nueva Colonia canal and covers nine (9) ha of the influence area. These zones present a high degree of intervention due to the expansion of the agricultural frontier for livestock use, limited to small strips on the river margin (Figure No. 5.13), dominating species of medium and low size of saplings and saplings as observed in Photo No. 5.8.

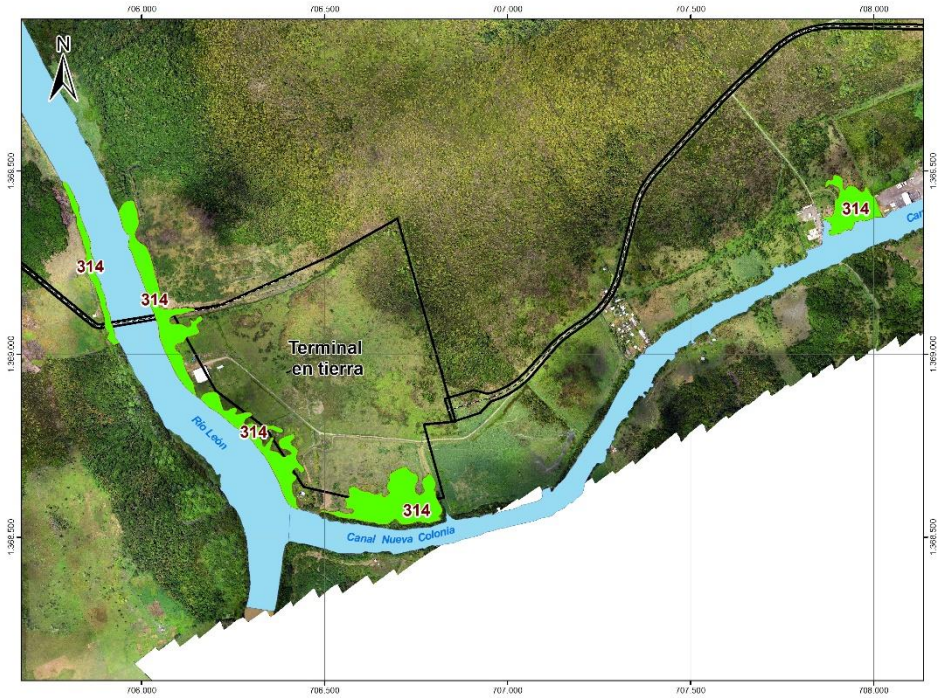

Figure No. 5.13 Coverage of riparian forest identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Photo No. 5.8 Riparian forest on the shore of the León River
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Plantation of hardwoods (Pf): This cover is constituted by teak trees (Tectona grandis), is in the age of shift (about 12 years) and is in the forest harvesting phase, as seen in Photo No 5.9. Therefore, this coverage only represents a minimum surface of the influence area equivalent to 0.04 ha, which is adjacent to the center

of Nueva Colonia and plantain and banana crops, as can be seen in Figure No. 5.14.

Photo No. 5.9 *Tectona grandis* forest plantation
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Figure No. 5.14 Coverage of forest plantation identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Dense grassland of non-wooded land (Hdtfna): Coverage constituted by a plant community dominated by typically herbaceous elements developed naturally in

different substrates. In this area the presence of arboreal or shrubby individuals is minimal, located adjacent to intervened areas such as Banacol deposits and clean grasses (Figure No. 5.15), has an area of 2.1 ha and is an area that was used for livestock, but now it is without productive use.

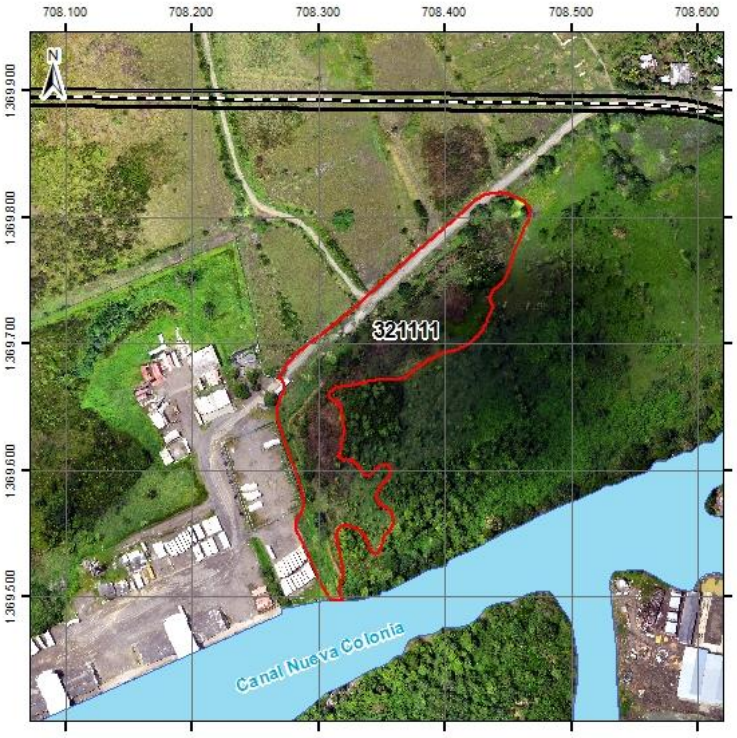

Figure No. 5.15 Coverage of dense grassland of non-wooded mainland identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Dense grassland wooded dense (Hdtfa): This coverage corresponds to surfaces dominated by natural herbaceous vegetation with the presence of arboreal or shrubby individuals, scattered among them. Within the influence area, this coverage is located on the right margin of the Nueva Colonia canal (Figure No. 5.16), covers an area of 4.9 ha and is mainly constituted by individuals in a successional state, which form different natural substrates, as can be seen in Photo No. 5.10.

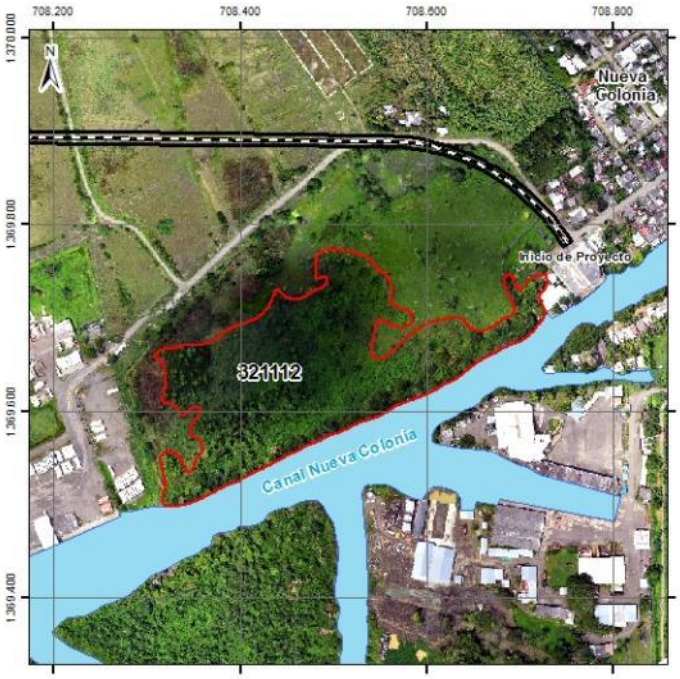

Figure No. 5.16 Dense grassland cover of wooded land identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Photo No. 5.10 Dense grassland cover of wooded land
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Herbazal dense floodable non-wooded (Hdina): This coverage corresponds to areas naturally constituted by a dense herbazal, which develops in areas that remain flooded or supersaturated water, as are the floodplains that are within the

influence area. This coverage presents some arboreal individuals that make patches and areas with communities of palms (Euterpe oleracea Mart) scattered among them, as can be seen in Photo No. 5.11.

Photo No. 5.11 Panoramic coverage of dense, flooded, non-wooded grassland
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Within the influence area, this cover has an area of 51.3 ha, and corresponds to those areas adjacent to the coverage of naidizales as can be seen in Figure No. 5.17.

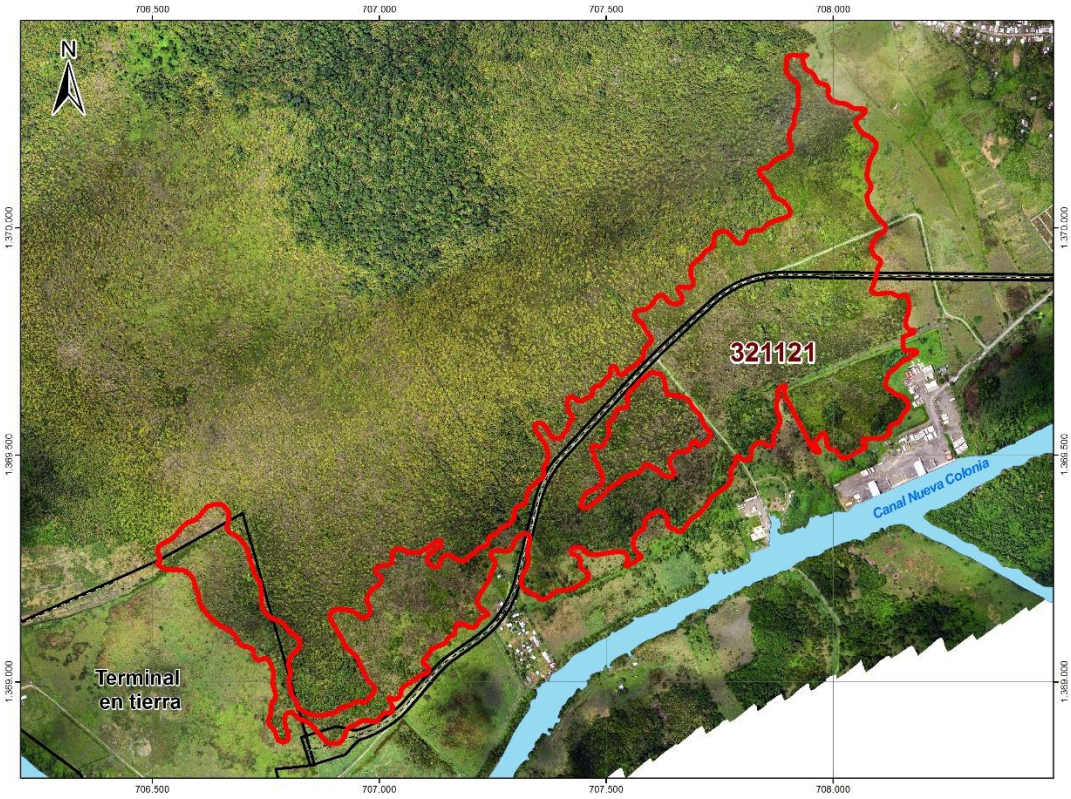

Figure No. 5.17 Coverage of dense flooded non-wooded grassland identified in the area of biotic influence of the project

Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Arracachal (Arc): This cover is constituted by a plant community dominated by macrophyte herbaceous elements of tall size, whose stems emerge up to three or four meters above the water level. They are broadleaf, which form a continuous and dense cover of leaves, with a predominance of the species arracacho (Montricha rdia arborescens Schott.), It can present arboreal elements or dispersed shrubs, as can be seen in Photo No. 5.12.

Photo No. 5.12 Overview of Arracachal's coverage of the Nueva Colonia canal
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

This type of vegetation cover has not been intervened or its intervention has been selective, without altering its original structure or its functional characteristics. It covers an area of 2.8 ha and is located mainly in the floodplains of the influence area and on the banks of the Nueva Colonia canal, as shown in Figure No. 5.18

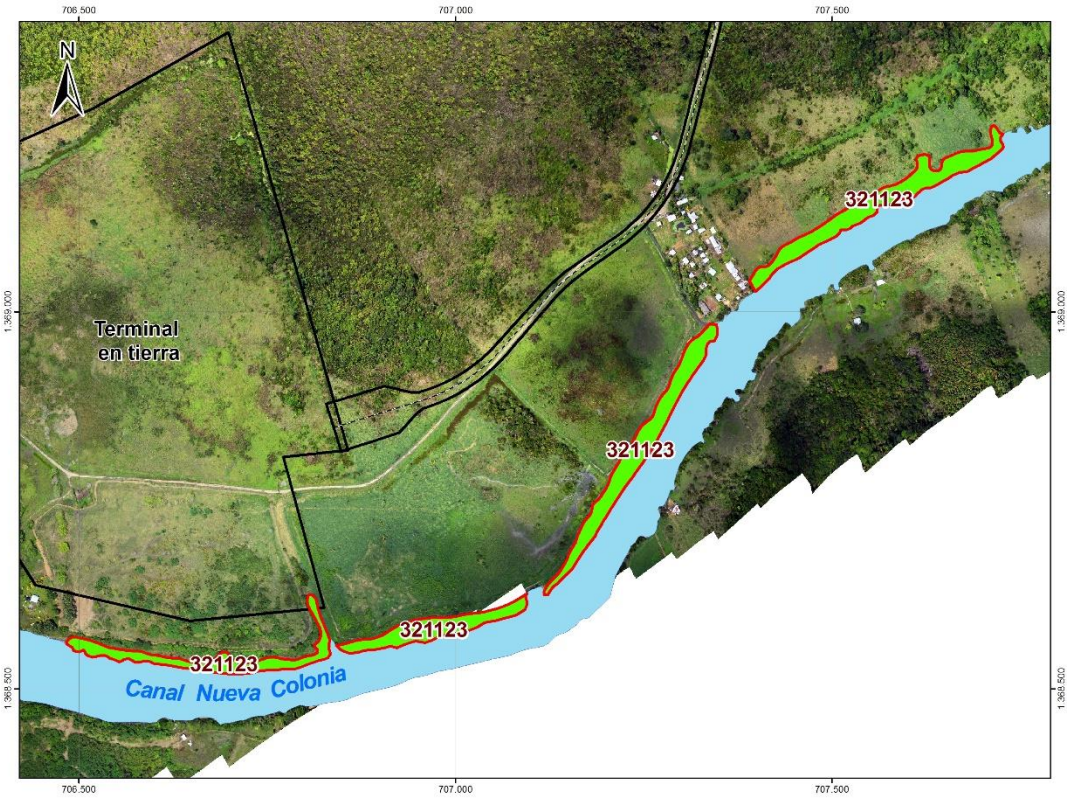

Figure No. 5.18 Coverage of Arracachal identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Helechal I (Hlc): Areas dominated by the species of tropical fern Acrostichum aureum L., a low plant that reaches up to two (2) meters in height. This coverage refers to vegetation typical of plant succession that quickly invades clearings within

the forest and areas of fluvial influence as can be seen in Figure No. 5.19. This fern is known as "cat's claw or crabeater" and within the study area 0.6 ha are found with this vegetation, although it was also found associated with other plant coverings as can be seen in Photograph No. 5.13.

Figure No. 5.19 Coverage of helechal l identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Photo No. 5.13 Helechal Coverage l
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Open shrub (Ara): This cover is constituted by a vegetal community dominated by regularly distributed shrub elements, which form a discontinuous strata (canopy). This cover has an area of 4.3 ha (Figure No. 5.20) and is mainly formed by the sweet *Pithecellobium species* (Chiminango) as can be seen in Photograph No. 5.14.

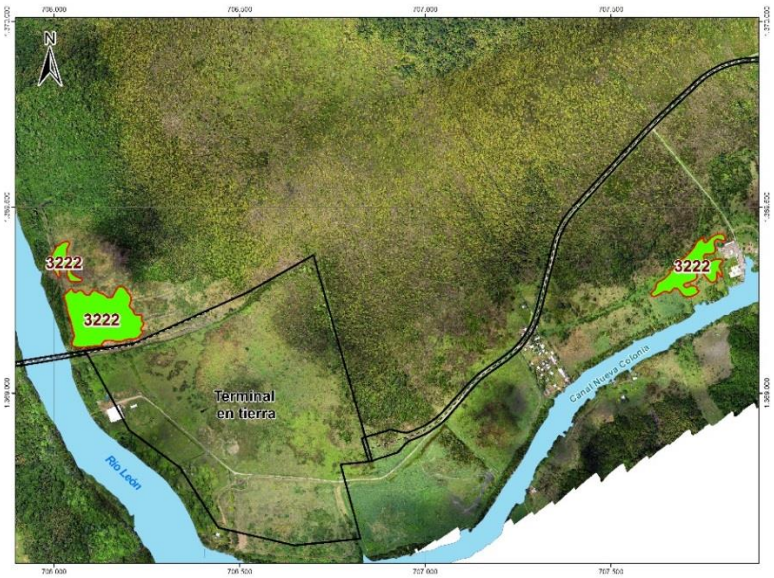

Figure No. 5.20 Coverage of open shrub identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Photo No. 5.14 Sweet *pithecellobium* open shrub (chiminango)
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

High secondary vegetation (Vsa): It consists of those areas covered by mainly arboreal vegetation with irregular canopy and occasional presence of shrubs and vines. This coverage corresponds to the intermediate stages of the plant succession, after presenting a process of deforestation of the original forests belonging to the mangrove zones, as can be seen in Figure No. 5.21.

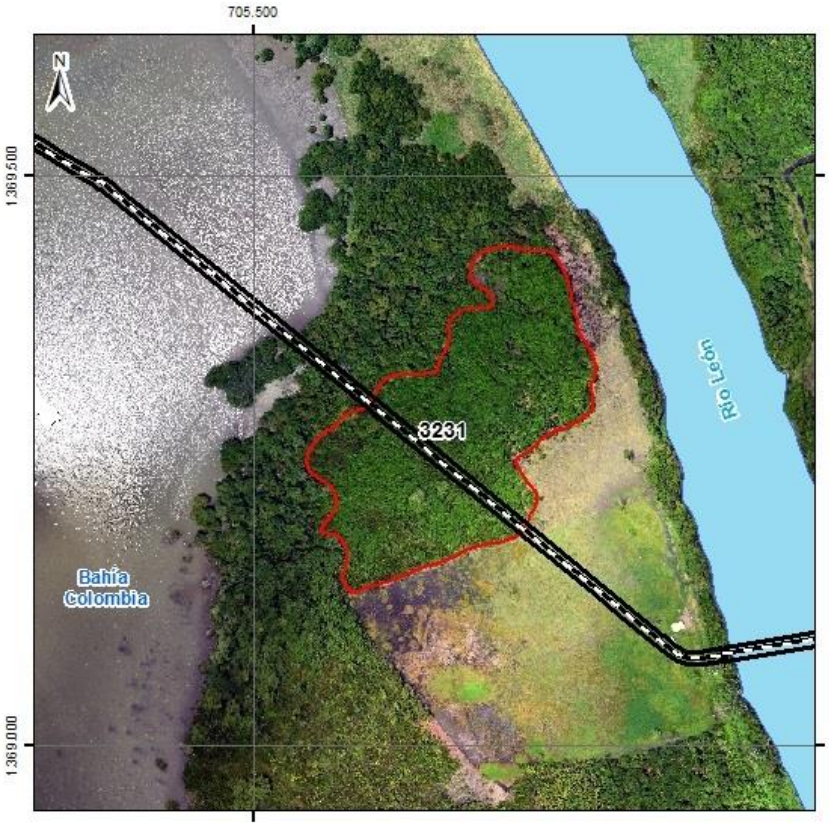

Figure No. 5.21 Coverage of high secondary mangrove vegetation identified in the area of biotic influence of the Project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

This coverage has been affected mainly by the growth of the agricultural frontier for the sowing of pastures for livestock purposes (Photo No. 5.15). This area has an area of 4.1 ha and among the characteristic species are *Avicennia germinans* (Black Mangrove), *Rhizophora mangle* (Red Mangrove) and *Laguncularia racemosa* (White Mangrove).

Photo No. 5.15 Panoramic coverage of high secondary mangrove vegetation
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Low secondary vegetation (Vsb): This cover corresponds to a shrub-herbaceous vegetation of short cycle, with heights that do not exceed five (5) meters and dense cover. It usually corresponds to a phase of colonization of inducers of natural regeneration, where species of a more advanced phase are established and begin to emerge. These zones belong to one of the initial stages of the plant succession after presenting a deforestation process of the initial forest, they present a sheet of water to be adjacent to the dense flooded herbazales and cover a surface of 3.8 ha as can be observed in Figure No. 5.22.

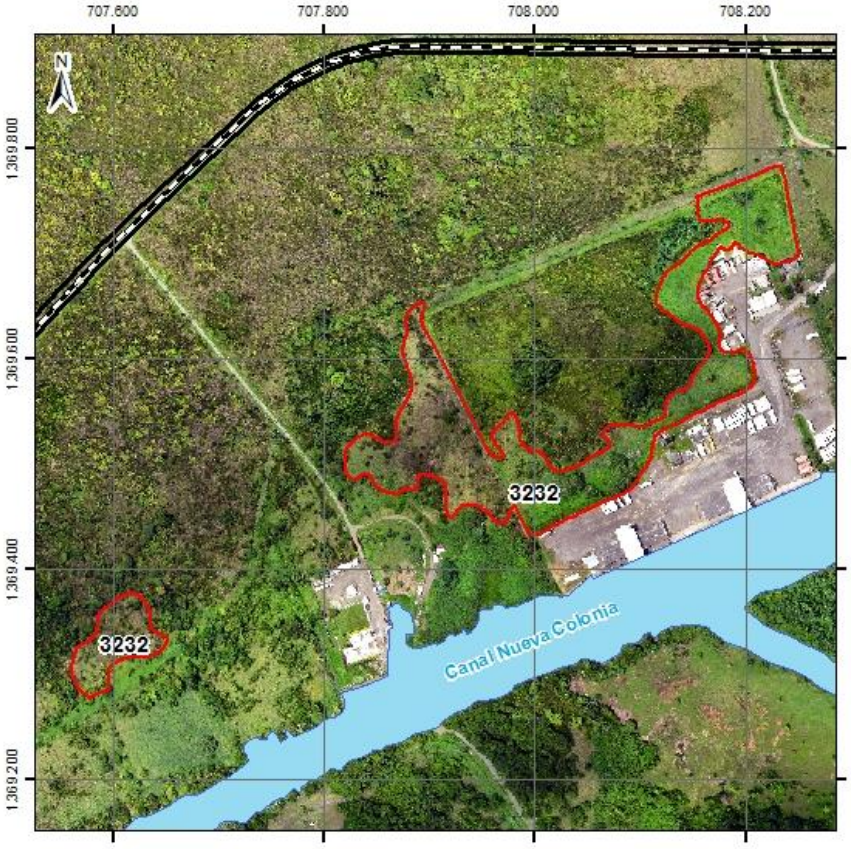

Figure No. 5.22 Coverage of low secondary vegetation identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Rivers (R): A river is a natural stream of water that flows with continuity, has a considerable flow and empties into the sea, into a lake or into another river. For the case of the influence area, this has reference to the León River (Photo No. 5.16) which is considered within the influence area with an area of 4.4 ha, as shown in Figure No. 5.23.

Photo No. 5.16 León River
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

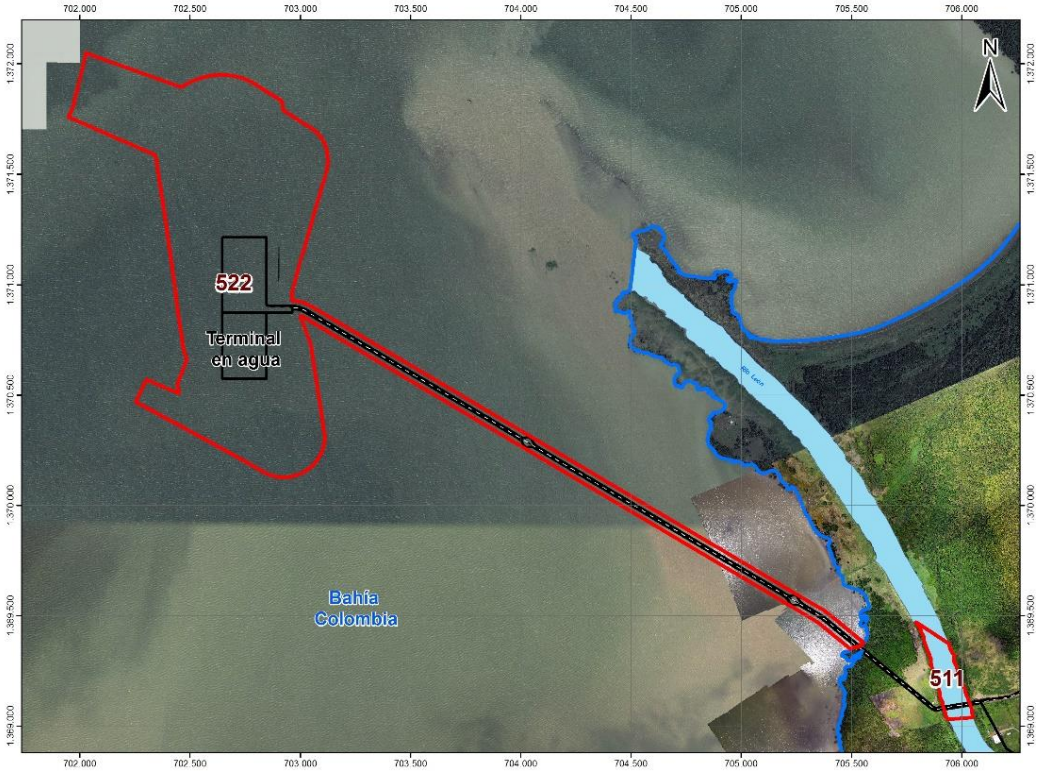

Figure No. 5.23 Coverage of inland and offshore water surfaces identified in the area of biotic influence of the project
Source: Made by Aqua & Terra Consultores Asociados S.A.S., 2015

Seas and oceans (Sea): Includes the bodies of salt water that border the littoral zone and extend from the coastline in the low tide period. These belong to the sea

surface considered within the influence area, found in the waters of Bahía Colombia (Photo No. 5.17), with an area of 140.1 ha, as shown in Figure No. 5.23.

Photo No. 5.17 Panoramic view of Bahía Colombia
Source: by Aqua & Terra Consultores Asociados S.A.S., 2015

- *Life zones in the Project's influence area*

Colombia is considered one of the South American countries with the greatest biological diversity; the knowledge of the flora through inventories or analysis of structure and composition, has thrown a vegetal wealth that oscillates between 35,000 - 55,000 species. This, because it exhibits a complex mosaic of ecosystems defined by the life zones and the geomorphological and edaphic characteristics of the area[13].

According to L.R. Holdridge classification[14], the central unit, is the life zone which includes temperature, precipitation, altitude and evapotranspiration. These parameters allow life forms to develop depending on the biogeographic region in which they are located. The purpose of this zoning is to determine areas where the

[13] CHAVES M.E. & N. ARANGO (eds) National report on the state of biodiversity 1997 - Colombia, Research Institute of Biological Resources Alexander von Humboldt, UNEP, Ministry of the Environment, Santafé de Bogotá, D.C., Colombia. 1998.
[14] HOLDRIDGE, Leslie. Ecology based on life zones. San Jose Costa Rica: IICA.1978. 216 p.

environmental conditions are similar, in order to group and analyze the different populations and biotic communities, in order to make better use of natural resources without damaging them and conserving the ecological balance.

According to Holdridge [15] and the association of bioclimatic variables of primary and secondary information considered for this study, the life zones for the influence area of the project are Tropical Humid Forest (bh-T) and Very Humid Tropical Forest (bmh - T).) as shown in Figure No. 5.24.

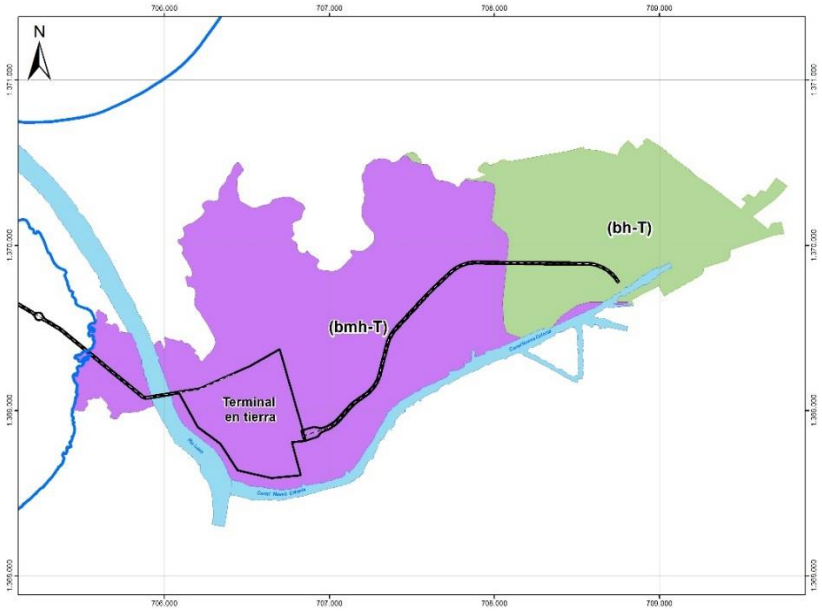

Figure No. 5.24 Life zones within the influence area of the Project
Source: IDEAM, 2007[16]

Humid and very humid tropical forests are one of the most complex ecosystems on earth, due to their structure and diversity of species of fauna and flora. The permanent humidity and heat favor natural processes, as is the recycling of nutrients. Fungi, microorganisms and insects quickly break down organic waste and the

[15] Ibíd.

[16] AGUSTÍN CODAZZI GEOGRAPHIC INSTITUTE (IGAC), ALEXANDER VON HUMBOLDT BIOLOGICAL RESEARCH INSTITUTE (IAVH), JHON VON NEUMANN PACIFIC RESEARCH INSTITUTE (IIAP), JOSÉ BENITO VIVES DE ANDRÉIS INSTITUTE OF MARINE AND COASTAL RESEARCH (INVEMAR) AND INSTITUTE AMAZON OF SCIENTIFIC INVESTIGATIONS (SINCHI). Continental, coastal and marine ecosystems of Colombia. Institute of Hydrology, Meteorology and Environmental Studies (IDEAM). Climate Zoning Republic of Colombia. Year 2007

materials thrown into the forest floor and reintegrate them into the chain of nutrients that plants absorb[17].

According to the two zones of life identified, the influence area of the project has a climate that varies from hot to very humid warm, depending on the average annual rainfall, which is between 2,500 and 6,000 mm per year. The average monthly temperature is higher than 24 ° C and altitudeally it is located between 0-100 msnm.

5.2.2 Terrestrial ecosystems

According to the methodology proposed in the chapter on Generalities, the results obtained for the characterization of the terrestrial flora and fauna present in the influence area are shown below.

- *Flora*

1. Floristic composition and structure analysis

The horizontal structure is the way in which species and their populations are organized and distributed on the surface of the forest. Below is the structural analysis per unit of coverage within the influence area of the project. The sampling plots are shown on the map MOD_LA_PTO_ANT_38_Flora.

Gallery or riparian forest

In the corresponding coverage of gallery or riparian forest a floristic composition was found represented in six (6) families and seven (7) species with a total of 67 individuals; the Fabaceae family being the most abundant within the sample, with the species *Apuleia leiocarpa* and *Pithecellobium dulce* (Appendix 5.2.1)

This forest cover has been affected by the expansion of the agricultural frontier, a factor that caused the displacement of native vegetation by trees of P. dulce and A. leiocarpa, to shade the livestock, as can be seen in Photo No. 5.18.

[17] PALACIOS, P.A. 2001. Some aspects of the structure and diversity of the arboreal vegetation of a forest of non-flooding alluvial origin of the Amazon River. In: Franky C, and C. Zárate Imani world. Studies in the Colombian Amazon. Part three pp. 337-372.

Photo No. 5.18 *Pithecellobium* sweet in the coverage of gallery or riparian forest
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.4 shows the floristic composition for gallery or riparian forest cover, present in the influence area of the project.

Table No. 5.2 Floristic composition for gallery or riparian forest cover

Family	Scientific name	Vulgar name
Bignoniaceae	*Crescentia cujete L*	Totumillo
Bombacaceae	*Pachira aquatica*	Salero
Cecropiaceae	*Cecropia telenitida*	Yarumo
Combretaceas	*Terminalia catappa L*	Almendro
Fabaceae	*Apuleia leiocarpa*	Combita
	Pithecellobium dulce	Chiminango
Moraceae	*Ficus glabrata*	Higuerón

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

It became necessary to establish two (2) plots of 50m x 50m (Figure No. 5.25) as a sample unit, to achieve a reliability of 95% and a sampling error of no more than 15%, taking an average volume of 9.47 m3 / ha, a standard deviation of 1.23 m3 / ha and a coefficient of variation of 12%.

In this sample, 67 individuals were identified in 0.50 ha, that is, per hectare of gallery or riparian forest cover, approximately 134 individuals could be found, corresponding to the class of trees.

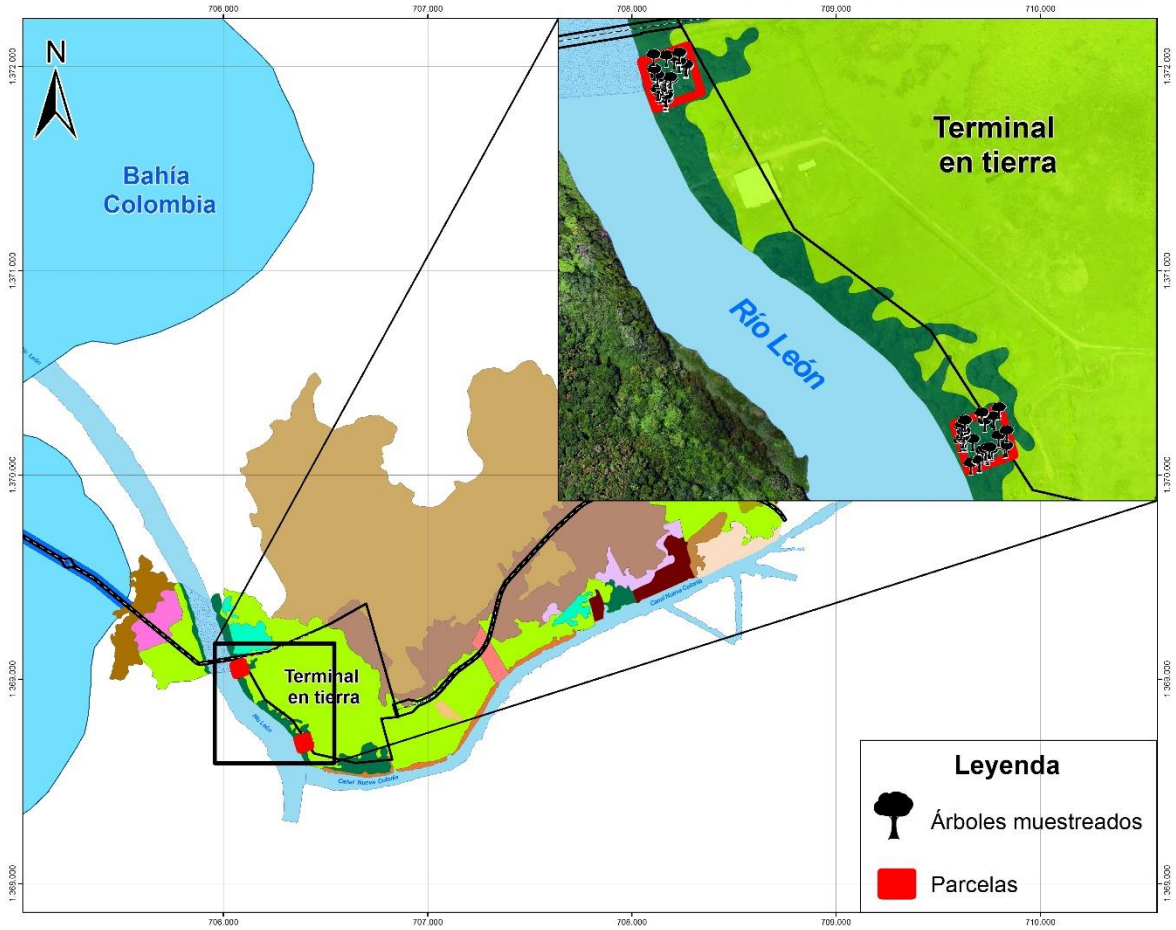

Figure No. 5.25 Spatial location of the sampling plots
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Table 5.5 shows the structural analysis for gallery or riparian forest cover, where the Importance Value Index (I.V.I) was determined. This index is calculated for each species from the sum of relative abundance, relative frequency and relative dominance. With this index it is possible to compare, the ecological weight of each species within the coverage.

Table No. 5.5 Structural analysis for gallery or riparian coverage.

Species	Abundance		Frequency		Dominance		I.V.I
	A.a	A.r	F.a	F.r	D.a	D.r	
Pithecellobium dulce	44	65,7	66,7	25,0	2,5	58,5	149,2
Apuleia leiocarpa	18	26,9	33,3	12,5	1,6	37,5	76,9
Terminalia Catappa L	1	1,5	33,3	12,5	0,1	1,8	15,8
Cecropia telenitida	1	1,5	33,3	12,5	0,0	1,0	15,0
Crescentia Cujete L	1	1,5	33,3	12,5	0,0	0,5	14,5
Ficus glabrata	1	1,5	33,3	12,5	0,0	0,4	14,4
Pachira aquatica	1	1,5	33,3	12,5	0,0	0,3	14,3
Total general	67	100,0	266,7	100,0	4,3	100,0	300,0

A.a: Absolute abundance**; A.r%:** Relative abundance**; F.a:** Absolute frequency**; F.r%:** Relative frequency**; D.a:** Absolute dominance**; D.r%:** Relative Dominance**; I.V.I:** Importance value index**.**

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The values recorded in Table No. 5.5 indicate that there are differences in the composition, structure and dynamics of the coverage unit, because the importance value index differs between each of the species. This indicates that there are dominant species within the gallery or riparian forest cover and that this is characterized as a vegetation of a forest ecosystem with a tendency to homogeneity of species

P. dulce (Chiminango) is the species with the greatest abundance represented by 44 individuals, corresponding to 65.7% of the total sample. This species adapts very well to poorly drained flat lands, as are the soils of the area of influence, it is frequent on the banks of the river beds and areas in a state of early succession. The greatest representativeness in terms of frequency corresponds to this species, since it was found in the two established sampling plots. The other species were found in a single parcel.

The species with the largest domain are P. dulce (Chiminango) with 58.5% (2.5 m2) and A. *leiocarpa* (Combita) with 37.5% (1.6 m2), given its high value of area basal compared to the other species.

The distribution of the species according to their abundance, frequency and relative dominance, is represented in Figure No. 5.26. In turn, Figure No. 5.27 shows the species with the highest ecological weight, with the rest of the species classified as rare species, due to their low importance value index.

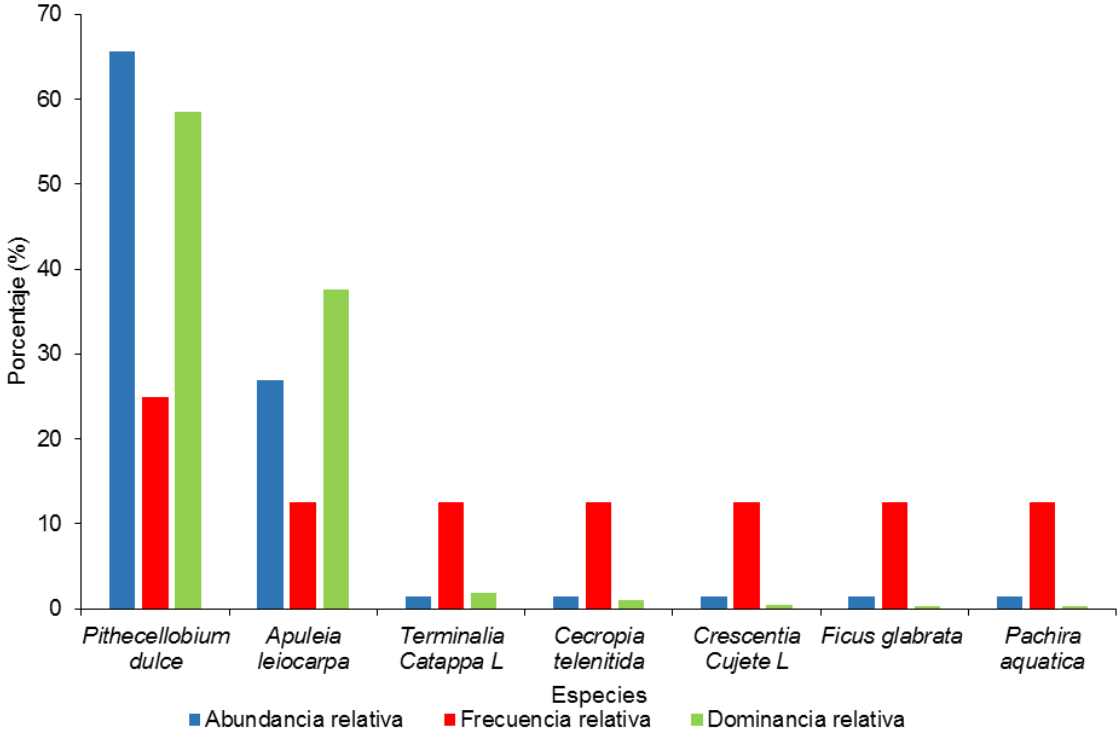

Figure No. 5.26 Structural analysis for gallery or riparian forest cover
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

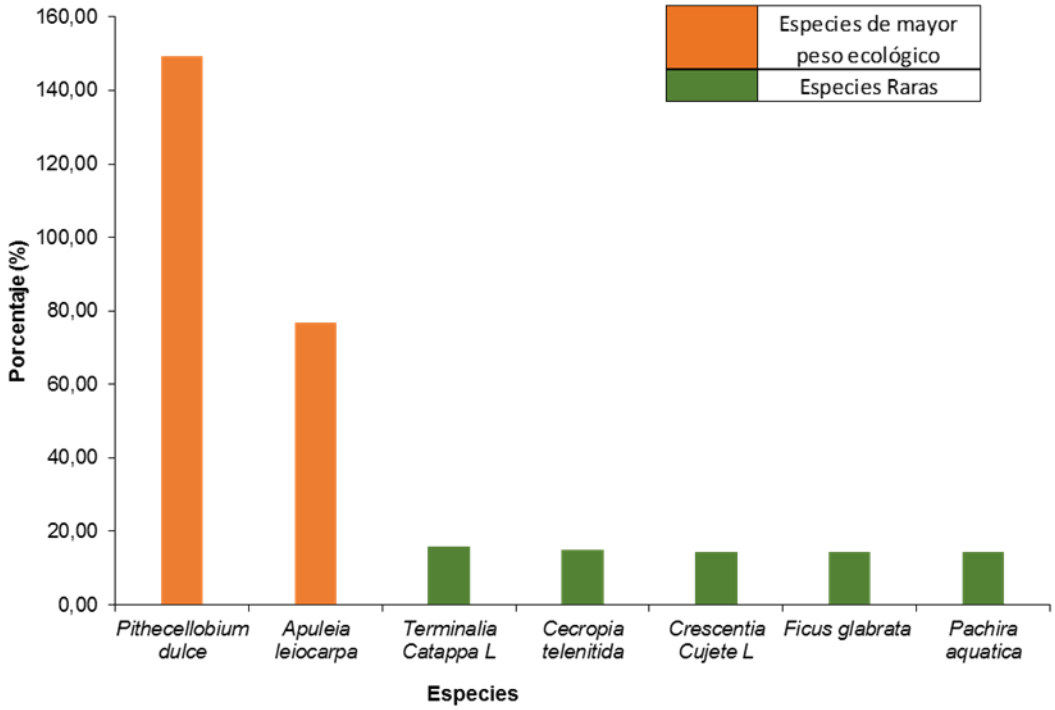

Figure No. 5.27 Value index of importance for riparian forest coverage
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The most important ecological species is P. dulce (Chiminango) with 149.2%, followed by A. leiocarpa (Combita) with 76.9%; because these are species with greater number of individuals and dominance in the floristic sampling units.

On the other hand, according to the mix ratio (CM), the vegetation belonging to the gallery or riparian forest cover within the area of influence of the project, is characterized by presenting an arboreal community with a low mixing intensity and quite intervened, in which it can be observed that its mixing ratio was 1:10, which indicates that, on average, each species is represented by 10 individuals. The density of this forest is considered low, since the average number of individuals per hectare with a diameter greater than or equal to 10 centimeters is approximately 134, which confirms the high degree of anthropic intervention that the remaining riparian forest relicts are suffering. on the banks of the León River and the Nueva Colonia Canal.

Distribution by diametric and altimetry classes of the gallery or riparian forest

The total structure for the gallery or riparian forest within the influence area was analyzed based on the grouping of species by diametric classes. Table 5.6 shows the frequency distribution for the normal diameter variable. This variable has a decreasing tendency, that is, the number of trees decreases as the DAP (Diameter to the Breast Height) increases.

Table No. 5.3 Frequency distribution for the normal diameter variable, in the gallery or riparian forest in the influence area of the project

Diameter class	Class interval	Class mark	Frequency		
			F.a	F.ac	F.r
1	10 - 20 cm	15	22	22	32,8
2	20,1 - 29 cm	24,5	24	46	35,8
3	29,1 - 38 cm	33,55	8	54	11,9
4	38,1 - 47 cm	42,55	6	60	9,0
5	47,1 - 56 cm	51,55	6	66	9,0
6	56,1 - 65 cm	60,55	0	66	0,0
7	65,1 - 74 cm	69,55	0	66	0,0
8	74,1 - 83 cm	78,5	1	67	1,5
Total			67		100,0

F. a: Absolute frequency; F.ac Cumulative frequency; F.r: Relative frequency.
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Figure No. 5.28 shows the trend of the diametric distribution for the trees that are within the gallery or riparian forest in the influence area of the project. It is observed that, as the normal diameter increases, the number of individuals per diameter class decreases. Likewise, the presence of a single emergent tree corresponding to class 8 is evident, which characterizes heterogeneous forest ecosystems or with a tendency to heterogeneity.

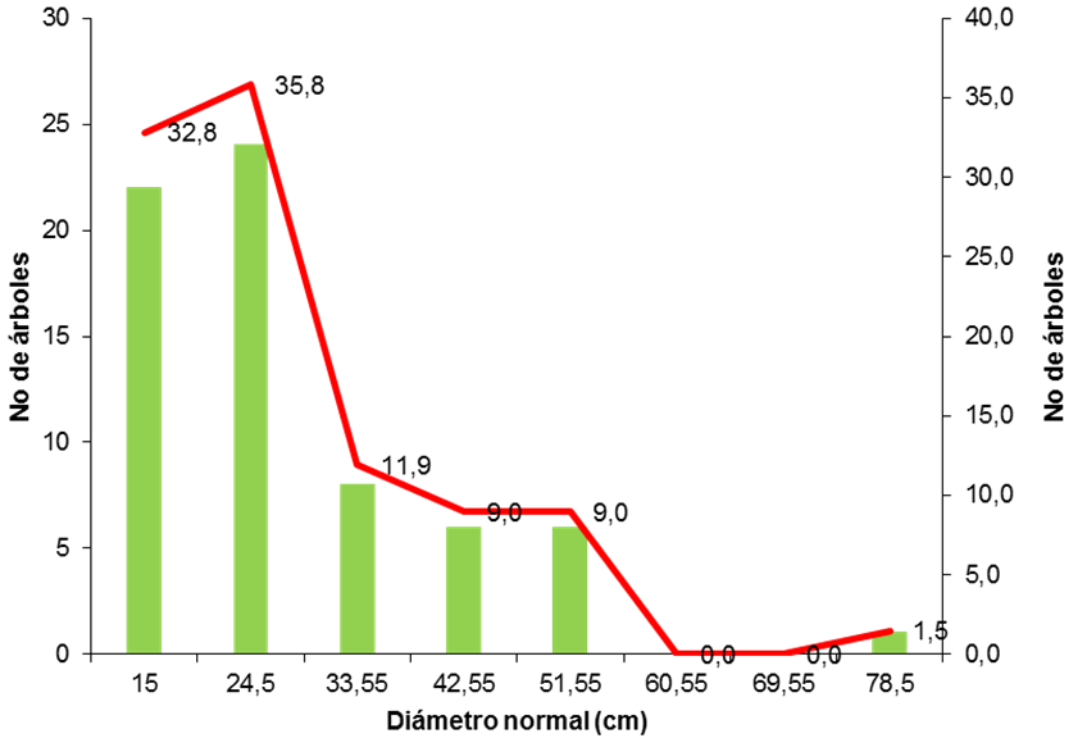

Figure No. 5.28 Diameter distribution in absolute and accumulated form, for the trees of the gallery or riparian forest cover in the influence area of the project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The distribution by diametric classes of the individuals measured in the gallery or riparian forest cover within the influence area of the project, shows greater representation in the two (2) first diametric classes. In class one (1) (diameters between 10 to 20 cm) with a total of 22 (32.8%) individuals belonging to five (5) species and four (4) families; followed by class two (2) (diameters between 20.1 to 29 cm) with 24 (35.8%) individuals belonging to three (3) species and two (2) families.

Figure No. 5.29 shows the tree dispersal diagram for the arboreal individuals identified in the gallery or riparian forest cover. There the tendency of stratifications can be evidenced from clusters of well-defined points. The number of strata in the forest is equivalent to the number of conglomerates.

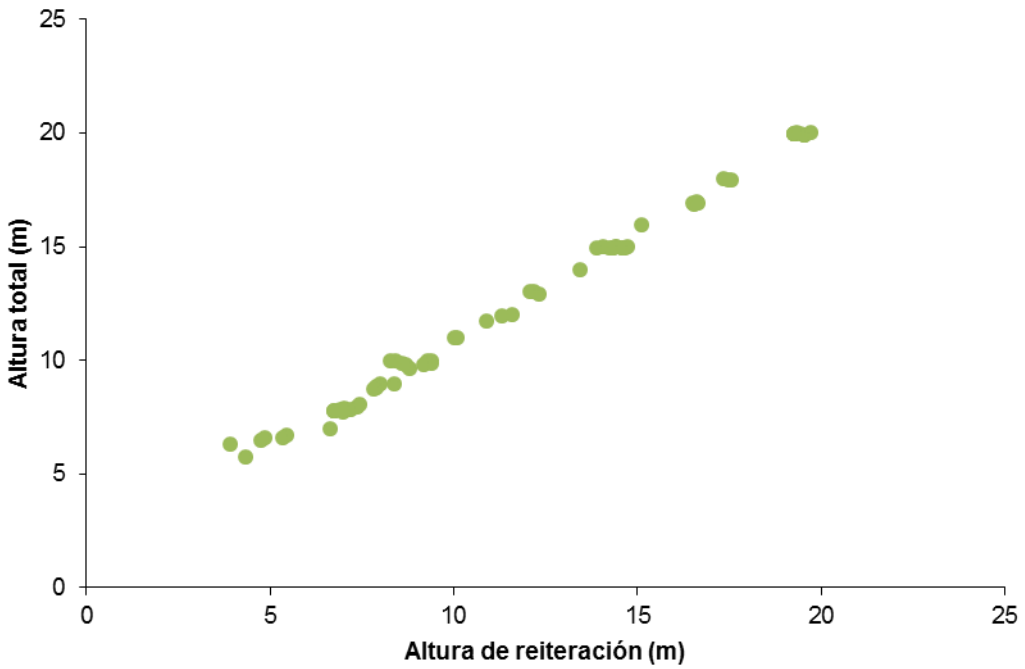

Figure No. 5.29 Stratification trends for the crown dispersal diagram in the gallery or riparian forest within the influence area of the project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.7 shows the altimetry position for each species identified in the gallery or riparian forest cover within the influence area of the project. There is observed the grouping of these species by forest stratum from their respective intervals of total height.

Table No. 5.7 Distribution of the number of species and their abundances (number of trees) in each stratum (altimetry position) for the trees inventoried in the gallery or riparian forest.

Stratum	Interval	No trees	No. of species	Species
Stratum I	1,5 m - 5 m	4	2	Combita
				Salero
Stratum II	5,1 m - 10 m	28	5	Almendro
				Chiminango
				Combita
				Higuerón
				Totumillo
Stratum III	10,1 m - 15 m	18	2	Chiminango
				Yarumo
Stratum IV	15,1 m - 20 m	17	1	Chiminango

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Ecological index

Diversity is composed of two elements, variety or richness and relative abundance of species, its expression is achieved by registering the number of species, the description of relative abundance or by using a measure that combines the two components[18]. Table No. 5.8 shows the values for the indices of species richness and diversity found in the influence area of the project.

Table No. 5.4 Wealth and Plant Diversity indices for the coverage of gallery or riparian forest, present in the influence area of the Project

Wealth	Margalef	1,43
	Menhinick	0,86
Diversity	Shannon	0,94
	Simpson	0,50
	Berger-Parker	0,66

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The Margalef index is 1.43 and the Menhinick index is 0.86, which indicates that for gallery or riparian forest cover there is low species richness. The diversity indices of Shannon (0.94) of Simpon (0.50) and Berger - Parker (0.66), characterize a biotic community with low diversity and presence of dominant species.

Analysis of the natural regeneration of gallery or riparian forest cover

Latizal of gallery forest or riparian of very hot warm climate

This category is made up of the latizales that are found within the riparian forests located on the banks of the León River and the Nueva Colonia canal. The lower strata of this forest are colonized by natural pastures characteristic of the flat plain landscape. Within the study area, this vegetation has a floristic composition corresponding to six (6) species, six (6) families and five (5) orders; as shown in Table No. 5.9, being the Fabaceae family the one with the highest number of individuals with the species A. leiocarpa.

Table No. 5.9 Floristic composition, latitudes of gallery or riparian forest

Order	Family	Species	Common name	No. Individuals
Malvales	Bombacaceae	Pachira aquatica	Salero	24
Fabales	Fabaceae	Apuleia leiocarpa	Combita	25
Alismatales	Araceae	Montricha rdia arborescens Schott	Arracacho	9
Rosales	Moraceae	Ficus sp.	Caucho	5
Lamiales	Bignoniaceae	Tabebuia rosea	Roble	3
Fabales	Caesalpiniaceae	Prioria copaifera	Cativo	1
Total				67

[18] MELO CRUZ, O. A. Y R. VARGAS RIOS. 2002. Ecological and silvicultural evaluation of forest ecosystems. University of Tolima, CRQ, Corpocaldas and Cortolima, Ibagué. 207 p.

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Figure No. 5.30 shows the number of individuals by families present in the latitudes of the gallery or riparian forest, corresponding to the vegetation of the banks of the bodies of water within the influence area of the project.

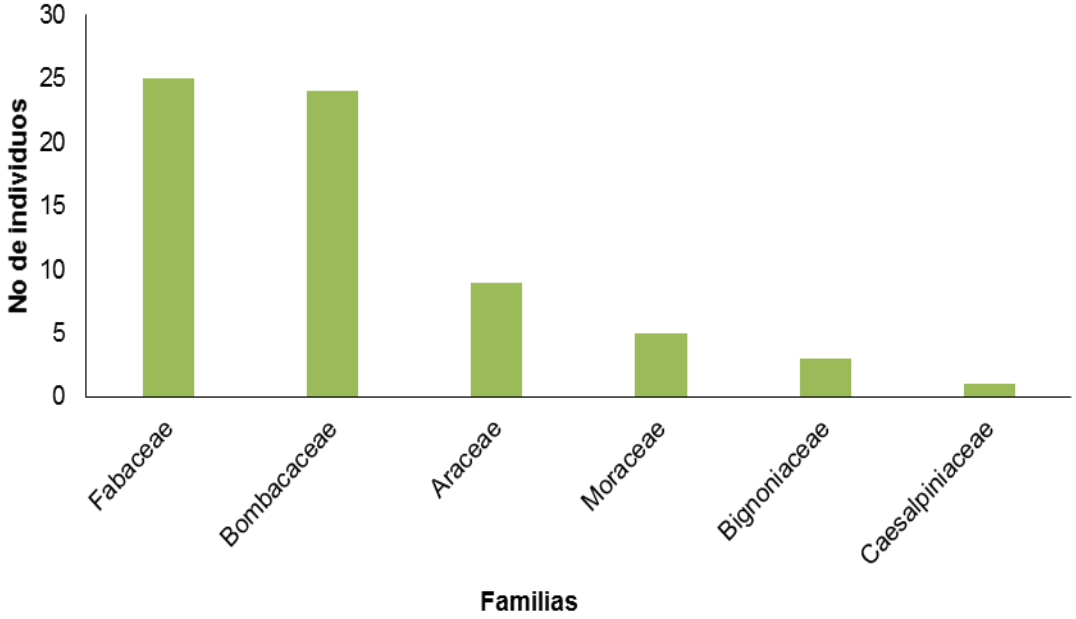

Figure No. 5.30 Representation by families of gallery or riparian forest latitudes
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

In Table No. 5.10, the structural analysis for gallery or riparian forest latitudes is shown, where the Importance Value Index (I.V.I) was determined. The registered values indicate that the species *Pachira aquatica* is the species with the greatest ecological importance in the vegetation belonging to the latitudes of the gallery or riparian forest community; This is because its index of importance value is the highest compared to the indexes of the other species.

Table No. 5.5 Structural analysis for gallery or riparian forest laticas

Species	Abundance		Frequency		Dominance		I.V.I
	A.a	A.r	F.a	F.r	D.a	D.r	
Pachira aquatica	24	35,82	69,57	36,36	0,083	46,85	119,03
Apuleia leiocarpa	25	37,31	52,17	27,27	0,071	40,08	104,67
Montricha rdia arborescens Schott	9	13,43	34,78	18,18	0,012	7,01	38,63
Ficus sp.	5	7,46	17,39	9,09	0,004	2,33	18,89
Tabebuia rosea	3	4,48	13,04	6,82	0,001	0,45	11,74
Prioria copaifera	1	1,49	4,35	2,27	0,006	3,28	7,04
Total	67	100	191	100	0,177	100	300

A.a: Absolute abundance; A.r%: Relative abundance; F.a: Absolute frequency; F.r%: Relative frequency; D.a: Absolute dominance; D.r%: Relative Dominance; I.V.I: Importance value index.
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Of the total species found in the forest, the most abundant is *A. leiocarpa* with 25 individuals corresponding to 37.31%, followed by *P. aquatica* with 24 individuals corresponding to 35.82%. The greatest representativeness in terms of frequency corresponds to the species *P. aquatica*, which was found in 69.57% of the sampling quadrants, followed by the species *A. leiocarpa*, which was found in 52.17% of the sampling quadrants established for the characterization of this vegetation.

Given its high value of basal area in comparison with the other species, the species with the greatest domain space were *P. aquatica*, with 46.85% coverage corresponding to 0.083 m²; followed by the species *A. leiocarpa* with 40.08% coverage corresponding to 0.071 m².

The distribution as abundance, frequency and dominance of gallery or riparian forest latifolia species are shown in Figure No. 5.31. In Figure No. 5.32, the distribution of the species according to their ecological weight is graphically observed, with the species P. aquatica with 119.03% and A. leiocarpa with 104.67%, the most significant in comparison with the rest of the species. species classified as rare species due to their low value index of importance within gallery or riparian forest cover.

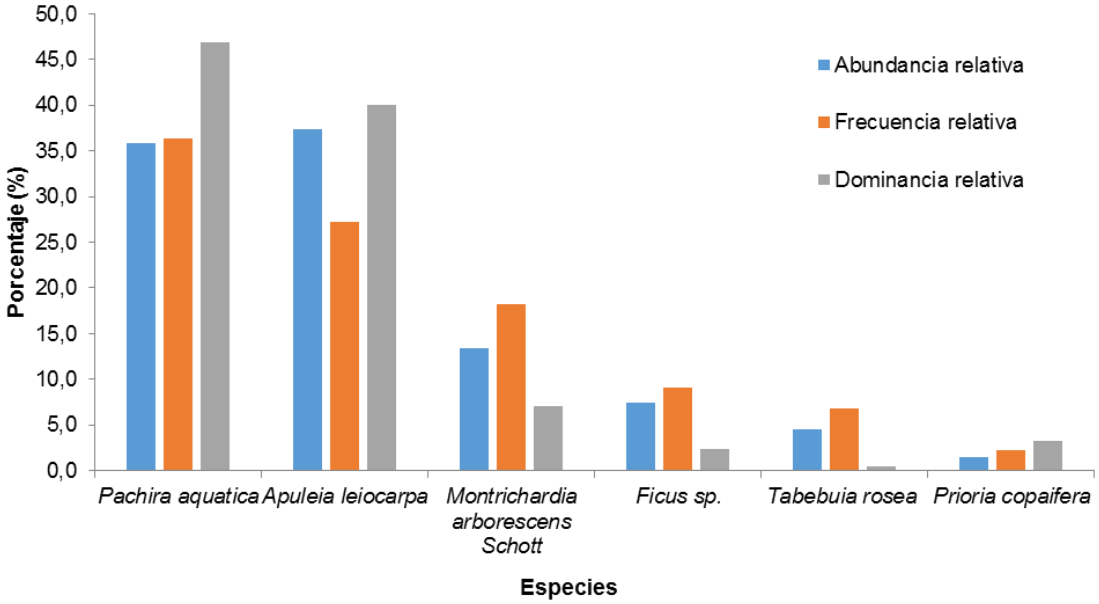

Figure No. 5.31 Structural analysis for gallery or riparian forest laticas
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

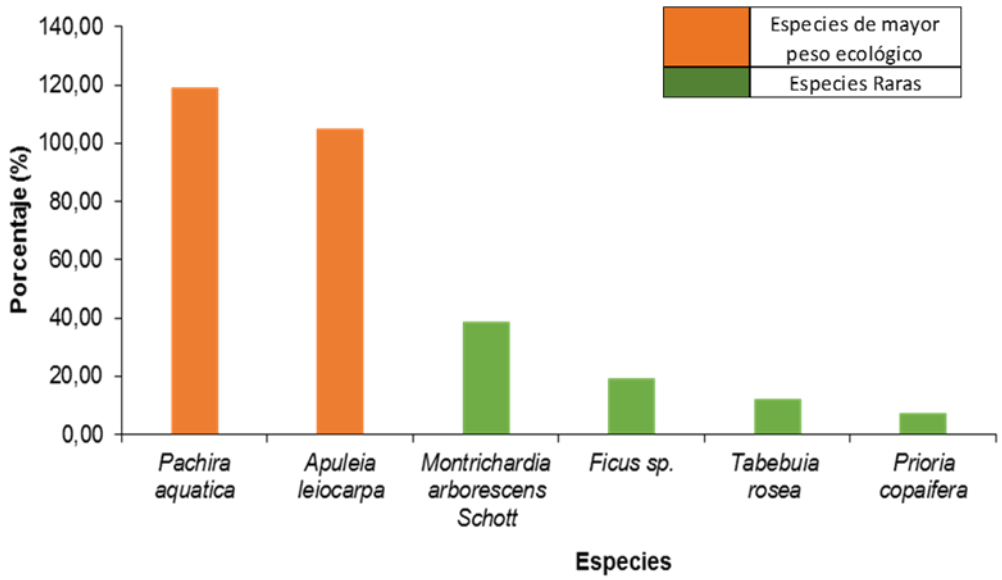

Figure No. 5.32 Value index of importance for gallery or riparian forest latitudes
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The mixing ratio indicates that the species found in gallery or riparian forest latitudes are represented on average by 11 individuals.

A vegetation that tends to homogeneity is observed where the species that predominate are A. leiocarpa and P. aquatica. The density of this forest is on average 291 individuals per hectare, which indicates the high degree of anthropic intervention suffered by the relicts of gallery or riparian forests that still remain on the banks of the León River and the Nueva Colonia Canal.

Saplings of gallery forest or riparian of very humid warm climate

The natural regeneration allows the development of those seeds that leave the remnants of the native vegetation of the area. It is composed mostly of local genetic material and allows the development of new seedlings, which are called saplings, which grow, compete and survive to become physiologically functional trees.

The saplings that make up the gallery or riparian forest of the study area, have influence of natural grasses characteristic of the plains plain landscape and which are used in some areas for grazing, as seen in Photo No. 5.19.

Photo No. 5.19 Influence of natural grasses on the natural regeneration of the gallery or riparian forest
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

In the classification of saplings of the gallery or riparian forest, a total of 32 individuals belonging to five (5) species and five (5) families were recorded as shown in Table No. 5.11.

Table No. 5.6 Floristic composition of the riparian forest seedlings

Family	Species	Common name	Abundance		Frequency	
			A.a	A.r	F.a	F.r
Fabaceae	Apuleia leiocarpa	Combita	21	65,6	100,0	61,5
Bombacaceae	Pachira aquatica	Salero	6	18,8	31,3	19,2
Moraceae	Ficus sp.	Caucho	2	6,3	12,5	7,7
Araceae	Montricha rdia arborescens Schott	Arracacho	2	6,3	12,5	7,7
Bignoniaceae	Tabebuia rosea	Roble	1	3,1	6,3	3,8
Total			32	100	163	100

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The species A. leiocarpa is the most abundant with a total of 21 individuals corresponding to 65.6% of the total sample (Figure No. 5.33).

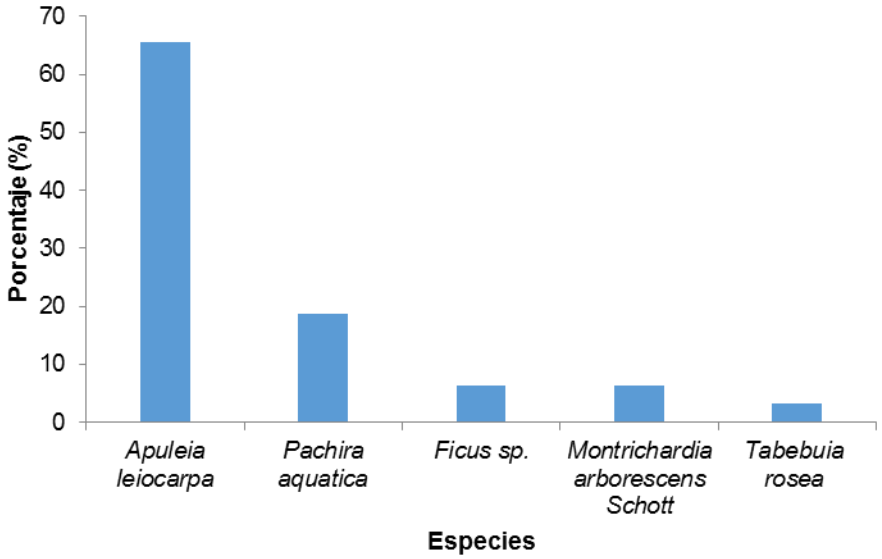

Figure No. 5.33 Abundance of the saplings of the gallery and / or riparian forest
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The highest representativeness in terms of frequency also corresponds to the species *A. leiocarpa* (Combita) which was identified in 100% of the sampling subplots, followed by the species *P. aquatica (*Salero) which was found in 31, 3% of the sampling area (Figure No. 5.34).

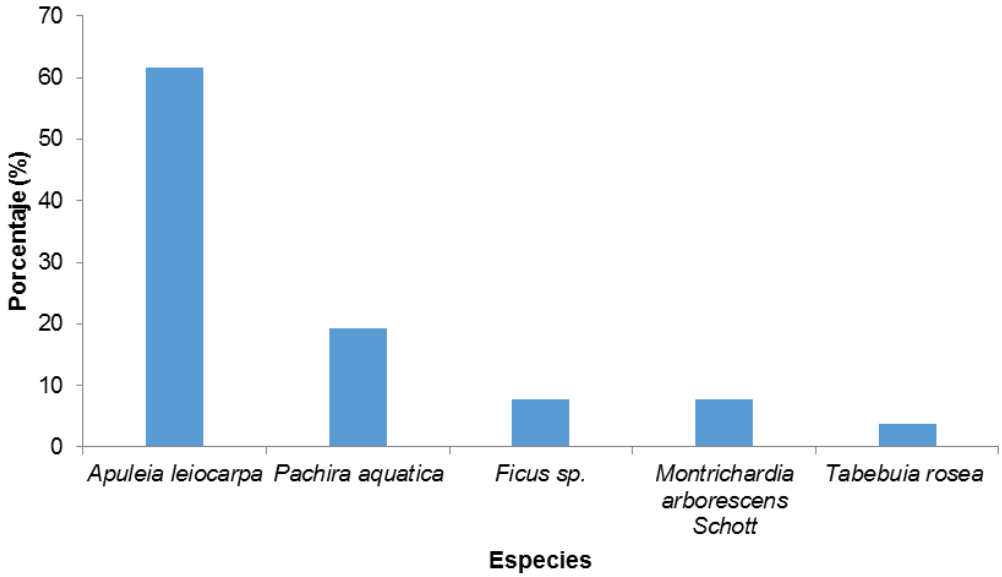

Figure No. 5.34 Frequency of the saplings of the gallery or riparian forest
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The saplings belonging to the gallery or riparian forest cover have a mixture ratio equivalent to 1: 6, which indicates that 6 individuals are found for each species found. A vegetation that tends to homogeneity is observed, where the species that predominates is *A. leiocarpa* (Combita). The density of this forest is on average 800 individuals per hectare; which indicates that this forest has a potential to recover by means of natural regeneration; but due to the frequent anthropic intervention, very few shoots reach the adult stage.

Dense grassland

In the coverage corresponding to the dense grasslands of the mainland, a floristic composition was found represented in three (3) families and four (4) species in a total of 16 individuals; the Fabaceae family being the most abundant within the sample, with the species A. *leiocarpa* and B. *ariza* (Appendix 5.2.2).

This coverage corresponds to the plant community dominated mainly by typically herbaceous elements such as tiger bush ferns (Acrostichum aureum), arracachos (Montrichardia arborescens), among other plants developed naturally in different substrates, for this reason the inclusion of small trees within this category is minimum, as can be seen in Photo No. 5.20.

Photo No. 5.20 Coverage of dense grassland within the influence area of the Project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

In Table No. 5.12, the floristic composition for dense grass cover present in the influence area of the project is shown.

Table No. 5.7 Floristic composition for dense grass cover

Family	Scientific name	Vulgar name
Bombacaceae	Pachira aquatica	Salero
Cecropiaceae	Cecropia telenitida	Yarumo
Fabaceae	Apuleia leiocarpa	Combita
	Brownea ariza	Ariza

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Two (2) parcels of 50m x 50m were established (Figure No. 5.35) as a sample unit, to achieve a reliability of 95% and a sampling error of no more than 15%, taking an

average volume of 25.52 m3 / ha, a standard deviation of 3.55 m3 / ha and a coefficient of variation of 14%.

In this sampling, 16 individuals were identified in 0.50 ha, that is to say, per hectare of dense grass cover, 32 individuals could be found approximately, corresponding to the class of small trees.

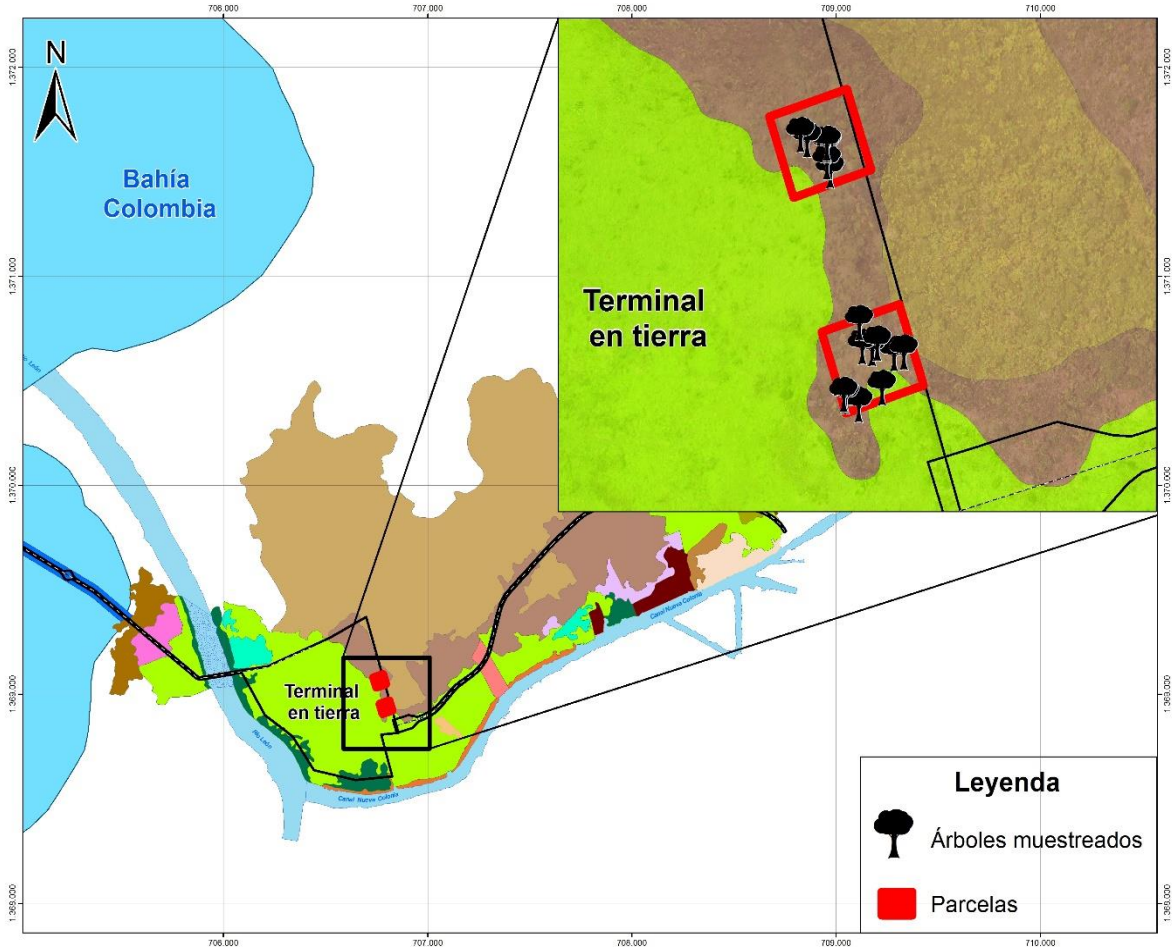

Figure No. 5.35 Spatial location of the sampling plots
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

In Table No. 5.13, the structural analysis for dense grass cover is shown. There, the Value of Importance Index (I.V.I) was determined. The registered values indicate that the species *A. leiocarpa* (Combita) is the species with the greatest ecological importance in the dense herbaceous ecosystem, because its importance value index is the highest in comparison with the indexes of the other species.

Table No. 5.8 Structural analysis for dense grass cover

Species	Abundance		Frequency		Dominance		I.V.I
	A.a	A.r	F.a	F.r	D.a	D.r	
Apuleia leiocarpa	9	56,3	100	40	0,4	63,9	160,1
Pachira aquatica	4	25,0	50	20	0,2	29,1	74,1
Cecropia telenitida	2	12,5	50	20	0,0	4,6	37,1
Brownea ariza	1	6,3	50	20	0,0	2,4	28,7
Total general	16	100,0	250	100	0,6	100,0	300,0

A.a: Absolute abundance; A.r%: Relative abundance; F.a: Absolute frequency; F.r%: Relative frequency; D.a: Absolute dominance; D.r%: Relative Dominance; I.V.I: Importance value index.
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

A. leiocarpa is the species with the highest abundance represented by nine (9) individuals corresponding to 56.3% of the total sample. This species grows very well in plant coverings in successional processes or where forested strata are low. This species was the one that presented the greatest representation in terms of frequency, since it was found in the two sampling plots established for the characterization of this coverage. The other species are found in a single parcel.

Given its high basal area value compared to the other species, the species with the greatest domain space was also *A. leiocarpa* with 63.9% (0.4 m2). The distribution of the species according to their abundance, frequency and relative dominance is represented in Figure No. 5.36. Figure No. 5.37 shows the species with the highest ecological weight with the rest of the species classified as rare species due to their low importance value index.

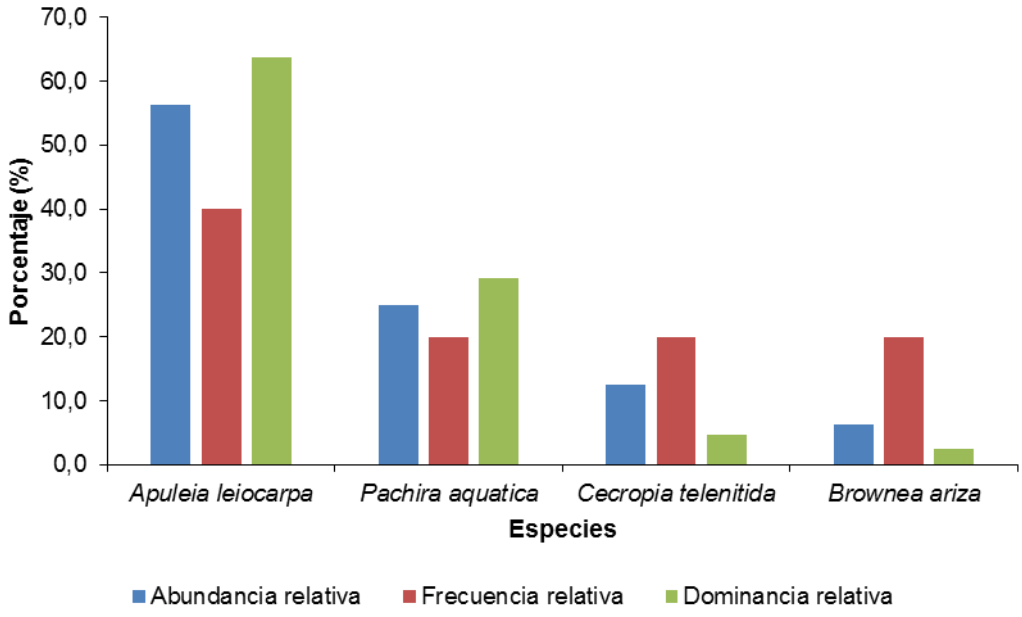

Figure No. 5.36 Structural analysis for dense grass cover
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

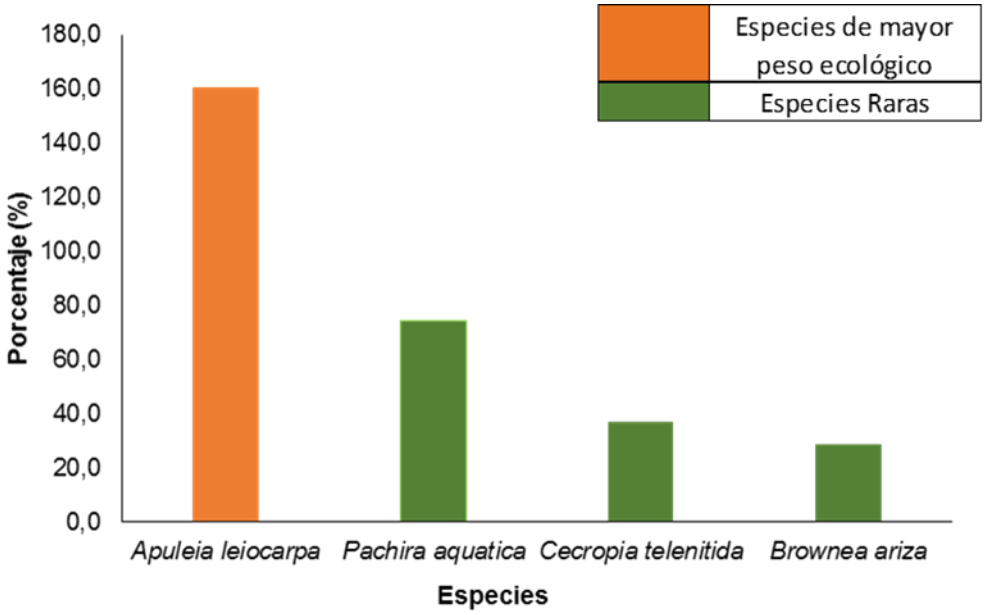

Figure No. 5.37 Value Index of importance for dense grassland coverage
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The species of greatest ecological importance is A. leiocarpa (Combita) with 160.1% importance value index; because this was the species with the highest number of individuals and with the highest dominance in floristic sampling units.

On the other hand, according to the mix ratio (CM), the vegetation that belongs to the dense grass cover within the influence area of the project, is characterized by presenting an arboreal community with a low mixing intensity (homogeneous in species) and quite intervened, in which the mixture ratio of 1: 4 is calculated, which indicates that, on average, each species is represented by 4 individuals. The density of this forest is considered low, since the average of arboreal individuals per hectare is approximately 32, which evidences the anthropic intervention that this coverage has been supporting.

Distribution by diametric and altimetry classes of dense grassland

The total structure is the extension of tree species. In tropical forests this phenomenon is reflected in the distribution of individuals by diametric classes. In Table No. 5.14, a uniform distribution is shown for the six (6) diametric classes, where it is observed that there is not and a dominant class within this coverage

Table No. 5.9 Frequency distribution for the normal diameter variable of dense grassland trees

Diameter class	Class interval	Class mark	Frequency		
			F.a	F.ac	F.r
1	10 - 15 cm	12,5	3	3	18,8
2	15,1 - 19 cm	17	4	7	25,0
3	19,1 - 23 cm	21	3	10	18,8
4	23,1 - 27 cm	25	2	12	12,5
5	27,1 - 31 cm	29	3	15	18,8
6	31,1 - 35 cm	33	1	16	6,3
Total			16		100,0

F. a: Absolute frequency; F.ac Cumulative frequency; F.r: Relative frequency.
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Figure No. 5.38 shows the trend of the uniform distribution for the diameter classes of the trees that are within the dense grass cover, characteristic of homogenous forest ecosystems or with a tendency to homogeneity.

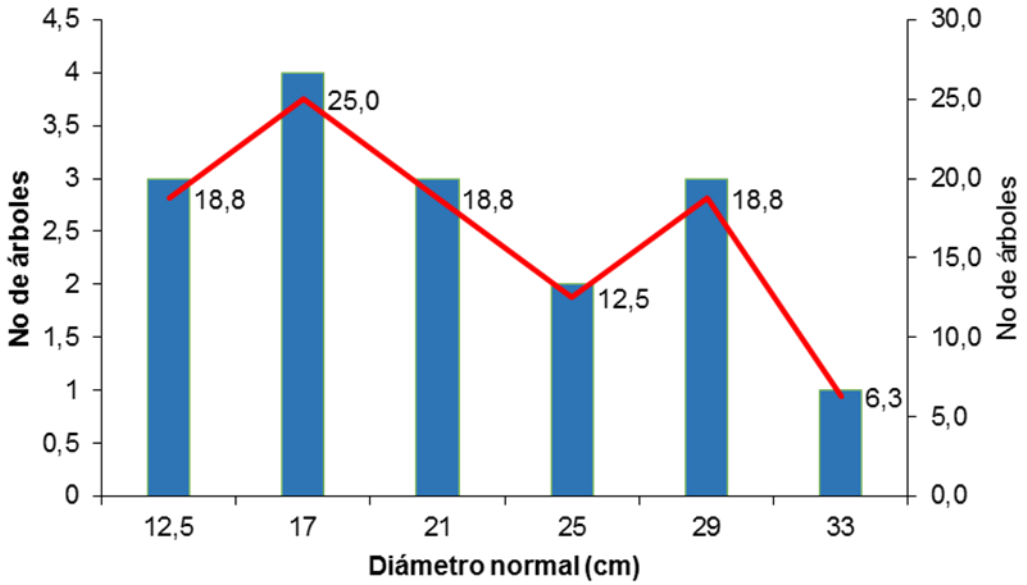

Figure No. 5.38 Diameter distribution in absolute and accumulated form, for dense herbaceous trees
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Figure No. 5.39 shows the tree dispersion diagram for the arboreal individuals identified in the dense grass cover. There it can be observed that only a generalized dispersion of points appears, without groupings which evidences the lack of strata in the forest.

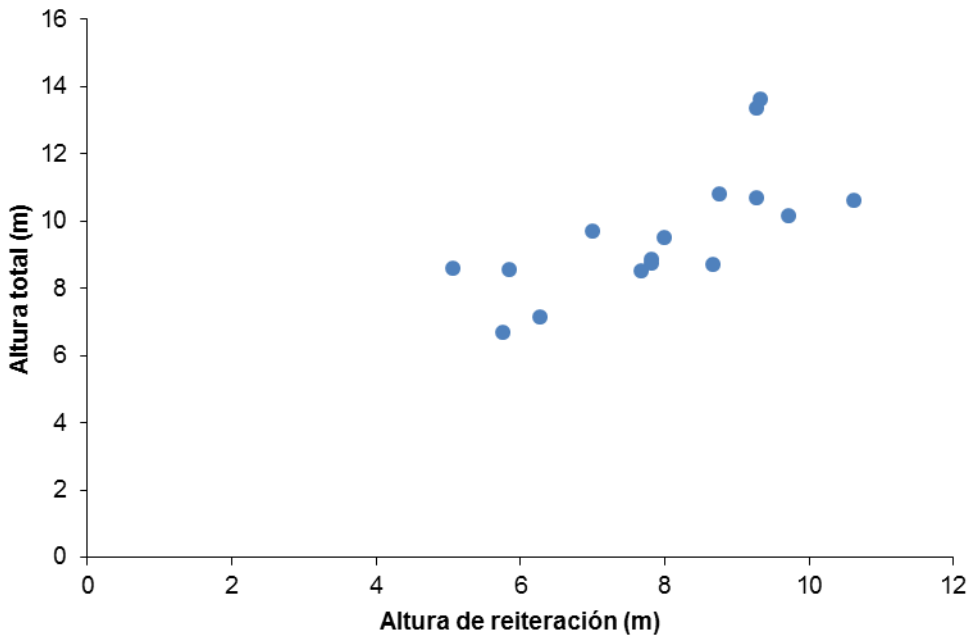

Figure No. 5.39 Stratification trends for the cup dispersion diagram for mangrove coverage
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Table 5.15 shows the altimetry position for the species identified in the dense grass cover. There, the grouping of these species by forest stratum is observed from their respective total height ranges.

Table No. 5.10 Distribution of the number of species and their abundances (number of trees) in each stratum (altimetry position) for the trees surveyed in the dense grass cover

Stratum	Interval	No trees	No of species	Species
Stratum I	5 m - 7 m	1	1	Apuleia leiocarpa
Stratum II	7,1 m - 9 m	7	3	Apuleia leiocarpa
				Brownea ariza
				Pachira aquatica
Stratum III	9,1 m - 11 m	6	3	Apuleia leiocarpa
				Cecropia telenitida
				Pachira aquatica
Stratum IV	11,1 m - 14 m	2	2	Apuleia leiocarpa
				Cecropia telenitida

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Ecological index of dense grassland

Table No. 5.16 shows the values for the indices of species richness and diversity found in dense grass cover. The Margalef and Menhinick index indicates that this ecosystem has low wealth, corresponding to only four (4) species and three (3) families. For diversity measures, the Shannon index is 1.10, Simpson reciprocal (1

/ D) is 0.60, and Berger-Parker reciprocal (1 / d) is 0.56; indicating that there is and low diversity and that the dominance of the species identified in this coverage is high. These indices define a homogeneous community with low diversity and high dominance of the species that characterize dense herbaceous cover.

Table No. 5.16 Wealth and Diversity indices for dense grasslands

Wealth	Margalef	1,08
	Menhinick	1,00
Diversity	Shannon	1,10
	Simpson	0,60
	Berger-Parker	0,56

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Temporal dynamics and analysis of forest cover fragmentation

The estimation of the change in the coverage of forests and semi-natural areas within the area of influence of the project over time, showed that the landscape has been modified by anthropic disturbance regimes, which are generating a landscape divided into fragments.

Table No. 5.17 shows that the coverage of dense high-flood forest disappeared in a period of 31 years. It also shows that a small fraction of the dense forest became gallery or riparian forest, which is located in thin strips on the banks of the water bofdies.

The mangrove forest decreased by 4.22 ha (the characterization of the dense mangrove forest is found in offshore-coastal ecosystems 5.2.4) and the palm forest consisting mainly of Naidi palm (Euterpe oleracea) lost 33.39 has, what could be suggested as a rate of deforestation of one hectare per year (-1ha / year).

Similarly, it is observed that as forest cover is lost, agricultural territories increase, as do industrial and urban zones classified at the level of artificialized territories.

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Table No. 5.17 Multi temporal analysis for forest cover in the influence area of the project

Coverage	**Year 1983**		**Year 1989**		**Year 2014**	
	Área (ha)	Área (%)	Área (ha)	Área (%)	Área (ha)	Área (%)
Dense high flood forest	79,23	23	83,92	24	0,00	0
Gallery or riparian forest	0,00	0	0,00	0	9,06	3
Dense high mangrove	11,20	3	9,62	3	6,98	2
Palmares	180,98	52	163,28	47	147,59	42
Secondary vegetation	6,74	2	21,98	6	9,64	3
Herbazales and Arbustales	0,00	0	0,00	0	65,98	19
Artificial territory	0,00	0	0,00	0	6,53	2
Dense high flood forest	71,92	21	71,27	20	104,29	30

Coverage	Year 1983		Year 1989		Year 2014	
	Área (ha)	Área (%)	Área (ha)	Área (%)	Área (ha)	Área (%)
TOTAL	350,08	100	350,08	100	350,08	100

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

In total, 16 forest fragments were counted in 1983, 12 fragments in 1989 and 22 fragments in 2014, where forest relicts are evidenced because of the fragmentation that the dense forest mainly had. This coverage suffered a high degree of fragmentation, with the time that it disappeared and was replaced by the gallery or riparian forest (Figure No. 5.40, Figure No. 5.41, Figure No. 5.42).

The temporal dynamics of the fragmentation, revealed that this process within the influence area of the project increased, that is, a greater number of fragments was recorded in the time interval analyzed. Likewise, the disappearance of forest cover (dense high-flood forest) suggests that there is a different anthropic impact on native vegetation, demonstrating that the process of deforestation in the area has been constant.

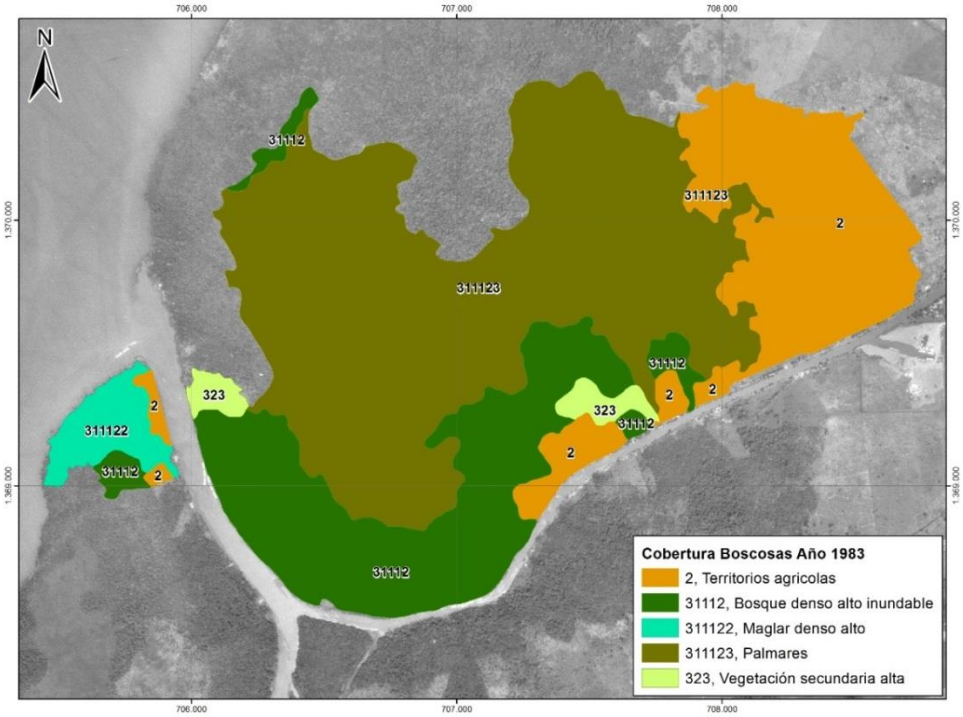

Figure No. 5.40 Forestry cover for the year 1983 for a scale of detail 1: 30,000
Source: Photo taken by the IGAC in 1983, land cover interpreted by Aqua & Terra Consultores Asociados S.A.S., 2015

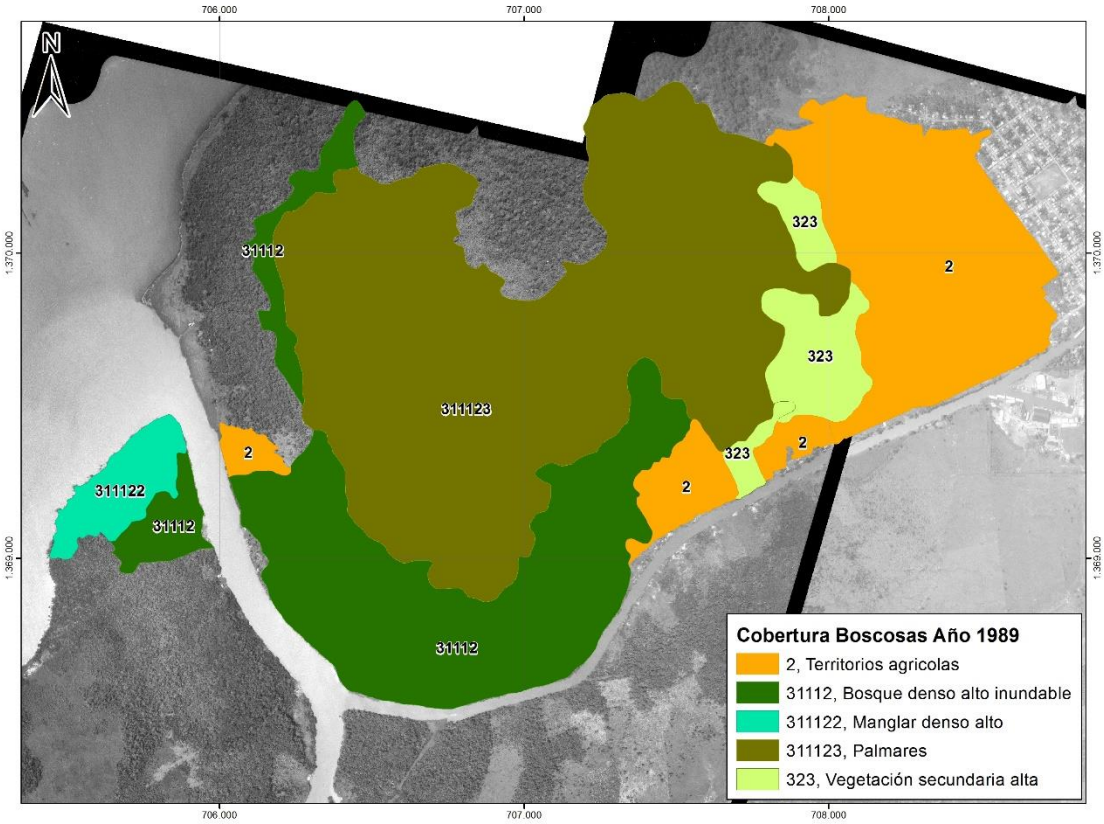

Figure No. 5.41 Forestry cover for the year 1989 for a scale of detail 1: 12,000
Source: Photo taken by the IGAC in 1983, land cover interpreted by Aqua & Terra Consultores Asociados S.A.S., 2015

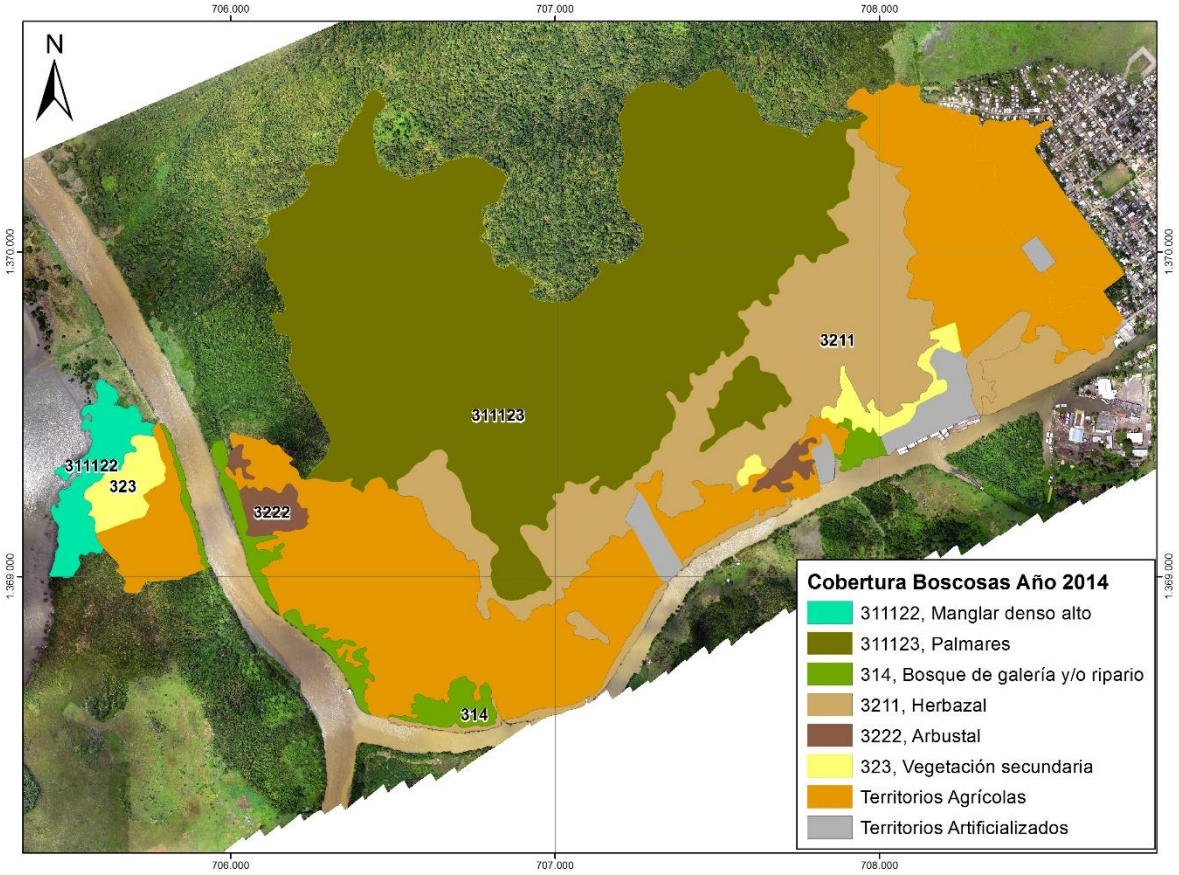

Figure No. 5.42 Forestry cover for the year 2014 for a 1: 10,000 scale of detail
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The average value of the area of the forest fragments registered a decrease between 1989 and 2014, since it varied from 70.02 to 50.01 ha, respectively; however, the total area occupied by the remnants of native vegetation decreased significantly (loss of perimeter of -783.07 m), which could be due to the fact that between 1989 and 2014 there was a greater percentage of fragmentation and the disappearance of the coverage of high-flooding dense forest (Table No. 5.18).

Table No. 5.18 Degree of fragmentation of forest cover for a period of 31 years in the influence area of the project

Statistical	Year	Media	Minimum value	Maximum value
Perimeter (m)	1983	2060,03	308,75	10713,30
	1989	2521,34	760,51	8316,26
	2014	1738,27	83,40	9098,50
Área (ha)	1983	70,02	6,74	180,98
	1989	70,02	9,62	163,28
	2014	50,01	6,53	147,59
Diversity index Patton (Di)	1983	1,56	1,07	2,25
	1989	1,65	1,31	2,70

Statistical	Year	Media	Minimum value	Maximum value
	2014	2,21	1,19	3,58
Fractal dimension (D)	1983	1,32	1,28	1,41
	1989	1,30	1,25	1,40
	2014	1,41	1,29	1,57
Form factor (Ff)	1983	0,68	0,44	0,94
	1989	0,63	0,37	0,76
	2014	0,51	0,28	0,84

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The Patton diversity index, the fractal dimension and the form factor reflected a difference in the increase in the complexity of the shape of the fragments over time (Table No. 5.18). Patton's diversity index (Table No. 5.19) showed that in average the shape of the fragments of the year 1989 was round (Di <1.25) whereas the year 1989 was round Oval (Di = 1.25 - 1, 5) and for the year 2014 it was amorphous (Di >2).

Table No. 5.19 Patton diversity index for forest cover within the influence area of the project

Classification Index	Rank	Year 1983		Year 1989		Year 2014	
		No Fragments	%	No Fragments	%	No Fragments	%
Round	< 1,25	5	31%	0	0%	1	5%
Round oval	1,25 - 1,5	2	13%	6	1%	5	23%
Oval oblong	1,51 - 175	4	25%	2	17%	2	9%
Rectangular oblong	1,76 - 2	2	13%	3	25%	1	5%
Amorphous	> 2	3	19%	1	8%	13	59%
Total		16	100%	12	51%	22	100%

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The fractal dimension, D, shows that the highest percentage of fragments in 1983 is located in the range 1.30 - 1.34 (63%), in the year 1989 in the range 1.25 - 1.29 (50%) and for the year 2014 in the range 1.35 - 1.39 (32%), which indicates that the shape of the fragments of the years 1983 and 1989 was less complex than that of the year 2014 (Table No. 5.20).

Table No. 5.11 Fractal dimension for forest cover within the influence area of the project

Rank D	Year 1983		Year 1989		Year 2014	
	No Fragments	%	No Fragments	%	No Fragments	%
< 1,19	0	0%	0	0%	0	0%
1,20 - 1,24	0	0%	0	0%	0	0%
1,25 - 1,29	4	25%	6	50%	2	9%
1,30 - 1,34	10	63%	4	33%	2	9%
1,35 - 1,39	1	6%	1	8%	7	32%
1,40 - 1,44	1	6%	1	8%	2	9%
1,45 - 1,49	0	0%	0	0%	5	23%
> 1,5	0	0%	0	0%	4	18%

Rank D	Year 1983		Year 1989		Year 2014	
	No Fragments	%	No Fragments	%	No Fragments	%
Total	16	100%	12	100%	22	100%

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The Factor form (Table No. 5.21) shows that 69% of the 1983 fragments were circular since their form factor was close to 1, in 1989 67% of the fragments remained circular, but in the in 2014, 72% of the fragments moved away from this form (Ff <0.59), which agrees with the results of the Patton index and the fractal dimension.

Table No. 5.21 Form factor for forest cover within the influence area of the project

Rank of Ff	Year 1983		Year 1989		Year 2014	
	No Fragments	%	No Fragments	%	No Fragments	%
< 0,19	0	0%	0	0%	0	0%
0,2 - 0,39	0	0%	1	8%	8	36%
0,4 - 0,59	5	31%	3	25%	8	36%
0,6 - 0,7	6	38%	8	67%	5	23%
0,8 - 1	5	31%	0	0%	1	5%
Total	16	100%	12	100%	22	100%

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The shape indexes evaluated previously (diversity index, fractal dimension and shape factor) showed that there are differences in the shape of the fragments over time. In general, the indices showed that the shape of the fragments in 1983 and 1989 was less complex or closer to the ideal circular shape; in contrast to the shape of the fragments for the year 2014, which were characterized by being amorphous and elongated.

The elongated and amorphous fragments are more susceptible to the processes that are generated by the "edge effect", the loss of species and the action of the surrounding matrix. The increase in the perimeter of the fragments benefits some species, but harms others, which indicates that species with ecological conditions inside the forests could be being harmed, in such a way that they would be favoring helophytes or exotic species that would compete with the native species. The above can be observed in the invasion of the tiger bush (Acrostichum aureum) on the mangrove cover and the grassland areas.

Analysis of metrics for forest cover in the influence area of the project

The fragmentation that is evident in the study area, corresponds to a dynamic process at the landscape scale, in which the covers have been losing area, as shown above, reducing to smaller size and increasing the distance between them with the passage of time, which has caused the isolation and loss of continuity of homogeneous elements.

The analysis of landscape metrics was made for the forest cover that make up the influence area of the project (Table No. 5.22).

Table No. 5.12 Results of the metrics made for the landscape of the influence area of the project

Forest cover	Nomenclature	CA (m²)	NumP	PRD	MPS
Dense high mangrove	311122	69845,34	1	0,01	69845,34
Palmares	311123	1475886,54	2	0,02	737943,27
Gallery or riparian forest	314	90613,98	4	0,44	22653,50
Plantation of hardwoods	3152	387,72	1	0,14	387,72
Dense grassland of non-wooded land	321111	21228,34	1	0,21	21228,34
Dense grassland wooded ground	321112	48690,14	1	0,70	48690,14
Dense flooded herbage not wooded	321121	513077,05	1	0,24	513077,05
Arracachal	321123	28110,28	4	0,53	7027,57
Helecha l	321124	6021,75	1	1,42	6021,75
Open shrub	3222	42636,04	3	0,47	14212,01
High secondary vegetation	3231	41202,82	1	1,66	41202,82
Low secondary vegetation	3232	37990,56	2	25,79	18995,28

CA: area by coverage, NumP: number of patches per coverage, PRD: Density and richness per patch, MPS: average patch size.
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

According to Table No. 5.22, the forest patches that are within the area of influence of the project have a total of 2,375,690.56 m² (237.56 ha), where two (2) patches differ. to its largest surface coverage.

The coverage of palmares with an area of 1,475,886.54 m² (147.59 ha) and the coverage of dense flooded non-wooded Herbazal, with an area of 513,077.05 m² (51.31 ha). These patches are located on the eastern side of the project's area of influence.

The biggest threat factor in these patches is the transformation of coverage by anthropogenic activities, since these are further away from the banks of the León River, being independent of the river's water and fluvial dynamics. Something that should be mentioned and highlighted is that one of the patches is much larger in area than the other (237.56 ha vs. 51.31 ha), and they are continuous one from the other.

Regarding the patch density and diversity metric (PRD), when the value is close to zero (0) it indicates that the largest patch is insignificant with respect to the total

area of the landscape, while the closer it is to 100% , occupies more area with respect to the total of the landscape analyzed; For the study area, high dense mangrove and palm grove coverings have a density of 0.01% and 0.02% on 100 ha, these two categories are the lowest density patches in relation to the rest of the landscape.

Regarding the landscape category, the metric of Shannon diversity index shows the marked difference in area between landscape patches with a value of 1.25; although if we take into account that the landscape analysis corresponds to the set of forested coverings, we can be favoring the continuous and permanent flow of processes, functions and matter in the landscape in general, behaving as a single element of high heterogeneity, thus decreasing the value of the index.

Endangered Species

According to Resolution No. 0192 of 2014 "Endangered species is defined as the one that has been declared as such by international treaties or agreements approved and ratified by Colombia or has already been declared in some threat category by the Ministry of Environment, housing and territorial development"[19]. Once this resolution is reviewed [20], two degrees of threats are identified within the area of influence: vulnerable (VU) and endangered (EN) species. The species that are in these categories are: Colombian Tapura (Nacedero) in vulnerable degree (VU) and P. copaifera (Cativo) in degree of danger (EN).

The CITES databases[21], the UICN[22] red list, the red books of the Alexander von Humboldt[23] Biological Resources Research Institute were reviewed, it is identified that for the project's area of influence, the species Prioria copaifera (Cativo) was categorized as endangered (EN), because two thirds of its natural population has disappeared, product of intense logging, according to the red book of Colombian plants[24].

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[19] COLOMBIA. MINISTRY OF ENVIRONMENT, HOUSING AND TERRITORIAL DEVELOPMENT. Resolution 0192 (February 22, 2014). By which declared wild species that are threatened in the national territory and other determinations are made. Bogotá: The Ministry, 2014. 2 p.
[20] COLOMBIA. MINISTRY OF ENVIRONMENT, HOUSING AND TERRITORIAL DEVELOPMENT. Resolution 0129., Op cit. 2 p.
[21] http://www.cites.org/eng/resources/species.htm
[22] http://www.iucnredlist.org/search/search-basic
[23] http://www.humboldt.org.co/humboldt/mostrarpagina.php?codpage=300001102
[24] CÁRDENAS, Dairon & SALINAS, Nelson. Red book of plants of Colombia. Volume 4. Threatened timber species: First part. Red books series of threatened species of Colombia. Amazon Scientific Research Institute SINCHI - Ministry of Environment, Housing and Territorial Development. 2007. 232 p. ISBN: 978-958-8317-19-9

It was also found in the CORPOURABÁ database the ban Resolution Number B 076395 August 4, 1995[25] for the species P. copaifera (Cativo). But that, through agreement No 100-02-02-01-0004-2011 the ban was lifted by CORPOURABÁ [26].

In turn, the Panganales are identified as endemic vegetation of the area, these are found covering the basin of the Atrato River and part of the Litoral Caribbean, where almost pure formations of the species Raphia taedigera (Pangana) are found, locally called "Panganales"". They are also found in the low areas of the main rivers, in the areas periodically flooded by freshwater or freshwater and saltwater mix, and in the areas that were exploited for timber extraction[27].

It is important to note that the species that comprise the mangrove are essential for the stability and fixation of the soil, as well as for the incursion of other species and for the flow of energy and nutrients[28].

Species of ecological, economic, and cultural importance

Pachira aquatica Aubl. (Salero)

Their vulgar names are Pachira, Castaña de Agua, Castaña de la Guayana, Castaño de Guayana, Ceibo de Agua, Cacao Silvestre, Castaño de Agua, Apompo, Ceiba de Agua, Ceibo de Agua, Ceibón de Agua, Zapote de Agua, Zapotón de Agua.

It belongs to the family of Bombacáceas (Bombacácea). It has its origin in marshy areas of Mexico and northern South America (northern Brazil, Ecuador, Guyana, Peru).

It is an evergreen tree that in its natural environment reaches 15-20 m in height, with large leaves of 25-35 cm (Photo No. 5.21), coriaceous, bright, clapped and very perfumed flowering throughout the year, although It is ephemeral. Its seeds are edible, fresh or roasted; and young flowers and leaves can be eaten like a vegetable[29].

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[25] COLOMBIA**.** CORPORACIÓN PARA EL DESARROLLO SOSTENIBLE DEL URABÁ - CORPOURABA. Resolution 076395B (August, 4, 2014). By means of which the amounts of the rates for the use of public and private forests are fixed. Apartado, 2014. 5p.

[26] CORPORACIÓN PARA EL DESARROLLO SOSTENIBLE DEL URABÁ – CORPOURABA. Agreement No 100-02-02-01-0004-2011., Op cit. 6 p

[27] NATURAL NATIONAL PARKS. Nature and Science of Los Katíos Natural National Park. [Online] https://www.parquesnacionales.gov.co/PNN/portel/libreria/php/decide.php.patron=01.014003 [cited October 15, 2015]

[28] OIMT. OIMT Work Plan on Mangroves. 2002 – 2006.

[29] GEOGRAPHICAL SOCIETY OF COLOMBIA, 2006. Op Cit

Photo No. 5.21 Salero (*Pachira aquatica)*
Source: Araújo Ibarra & Asociados S.A, ,2010 [30]

Pithecellobium dulce (Roxb.) Benth. (Chiminango)

It is a thorny, evergreen and hermaphrodite tree or shrub, 15 to 20 m high and with a diameter at breast height of 80 cm (up to 1 m), with branches fitted with thorns.

Presents pyramidal or elongated, wide and extended diameter of 30 m), very leafy (Photo No. 5.22). Leaves in spiral, agglomerated, bipinnate, 2 to 7 cm long, with a pair of primary leaflets, each with a pair of secondary sessile leaflets; has pale green matte z. It has a straight trunk. Thin and ascending branches fitted with thorns. The outer bark is smooth or slightly fissured, gray to grayish gray with horizontal protruding bands and pale lenticels in longitudinal lines. The inner bark is light cream in color, turns pinkish pink with time, fibrous, with a slight garlic smell.

Its inflorescences are axillary from 5 to 30 cm long, pendulous panicles of tomentose heads, each head on a branch of 2 to 5 mm; flower heads 1 to 1.5 cm in diameter; small flowers slightly perfumed, actinomorphic, creamy-white or green. The fruits are thin pods of up to 20 cm long by 10 to 15 mm wide, curled, tomentose, pendulous, reddish or pink, constricted between the seeds and dehiscent. They open on both sides to release numerous seeds, which are 7 to 12 mm long, flattened, brown ovoids, surrounded by a sweet, whitish or pink aril. Thin and water-

[30] ARAÚJO IBARRA & ASOCIADOS S.A, ,2010. Op Cit.

permeable head. Its root system is extensive especially in those areas where precipitation is low [31].

Photo No. 5.22 Chiminango (*Pithecellobium dulce)*
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

This tree has multiple uses in traditional medicine, known to be used in kidney diseases, as an anti-inflammatory and especially its diuretic property for the treatment of kidney stones.

Due to this last property is that it is also commonly known by the name of "chanca piedra" or "stone breaker". It is also used for Hepatitis B. This species is also used as an adhesive, from the stem a rubber is extracted that makes a good sticky solution, similar to arabic rubber. The plant can be used as a flavouring since it contains aromatic essential oils[32].

Tabebuia rosea DC. (Roble)

Deciduous, hermaphroditic tree, from 15 to 25 m (up to 30 m) in height, with a diameter at breast height of up to 1 m. Stratified, convex cup (Photo No. 5.23). Decussed leaves, fingered compound, 10 to 35 cm long, including the petiole; leaflets 5, the lower two smaller, the terminal is larger, lanceolate or elliptical, with

[31] Ibíd.
[32] ARRIAGA MARTÍNEZ, V. Phenology of 12 Species from "La Montaña" in Guerrero, Mexico: Elements for Management in a Peasant Community. Professional Thesis (Biology). Faculty of Sciences, Universidad Nacional Autónoma de México. México, D.F. 1991.

the entire margin. The species disappoints in its initial phase of growth because of its dichotomous ramification that augurs a malformed trunk. Eventually the tree can form an excellent stem, especially if it has a lateral shade of the same species or a nursing tree. Straight trunk, slightly grooved at times. Sympodial branching. Fissured and suberised external bark, compact in appearance, with the kind of superficial longitudinal fissures that intertwine forming a reticulum; dark gray to yellowish coffee color. Internal bark of light color to pink cream, fibrous, with bitter to bittersweet flavor. Total thickness from 16 mm to 30 mm.

Photo No. 5.23 Oak (*Tabebuia rosea)*
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Flowers in short panicles with cimosa branches, axillary, up to 15 cm long, scaly; greenish white calyx, tubular, 2 to 2.5 cm long; corolla 7 to 10 cm long, tubular at the base and expanded at the top in a bilabiate limbus; white corolla tube; lilac color to pale pink reddish purple lobes. Fruits in narrow capsules 22 to 38 cm long by 0.9 to 1.5 cm wide, smooth, with 2 lateral sutures, pendulous, dark brown, covered by numerous scales, with persistent calyx; containing numerous seeds, which are winged and thin, whitish, 2 to 3 cm long, the hyaline-membranous wings, conspicuously demarcated from the body of the seed[33].

Species characteristic of secondary vegetation. It is found preferably in secondary communities, abounds in secondary vegetation of hot land and pastures [34].

[33] FOURNIER, L.A. The dendrophenogram, a graphic representation of the phenological behavior of trees. Tutrialba, 1976 p.96-97
[34] ibíd.

It has several uses to know: elaboration of musical instruments, like fuel, in rural construction, manufacture of agricultural implements or tools handles. Excellent quality wood. It is also used to manufacture furniture and cabinets, poles, interior decoration, oars, veneer for plywood, lambrín, triplex, parquet, butts for firearms, joinery. Its leaves and bark also have medicinal uses: dysentery, accelerates labor, diarrhea, fever (plant); the infusion of the leaves is used as a febrifuge; the cooked bark serves for diabetes, malaria, typhoid, parasitosis. Its flower can be used in beekeeping[35].

Anacardium excelsum (Caracolí)

Tree 20 to 40 m tall, trunk with gray or black outer bark, laminar or fissured; simple and alternate leaves, 10 to 35 cm long and 4 to 12 cm wide, obovate, with rounded, emarginated or sharp apex, entire borders and cuneate base. Green or yellowish flowers. Fruits in kidney-shaped walnuts, 2 to 3.5 cm long, hanging from an arched peduncle and in the shape of an "S"; This fruit has a floury consistency, called noses for its pear shape, it is used as food, consumed cooked and ground to make a kind of edible bread, called conch bread[36].

Its wood was formerly used to build canoes and some kitchen tools such as rafts, bongos, trays and plates. Currently it is also used for veneers and floors of modern buildings and some fine furniture.

It is a very fibrous wood suitable for general use and not as structural wood or for exteriors, due to the variability in the wood, great proportion of sapwood, uncertain drying, and sometimes badly finished. In tropical conditions and under cover its best use is general carpentry and junction, furniture underparts, for light constructions, boxes and crates.

Ochroma pyramidale (Balso)

Evergreen tree, from 15 to 30 m (up to 35 m) in height, with a diameter at chest height of 20 to 40 cm (up to 60 cm). Wide, open, rounded or irregular cup. Leaves arranged in spiral, simple; sheets of 13 by 13 to 35 by 35 cm, large, almost round, heart-shaped, entire margin; main nerves 7 to 9, very prominent on the underside, red brown petiole. Straight and cylindrical trunk, with small tubular roots in the large trunks (abutments). Few thick ascending, extended and spaced branches. Bark. External smooth with some protruding linear scars, brown to grayish brown, with small, suberized and protruding lenticels. Inner cream yellowish to pink, changing

[35] Ibíd.
[36] Ibid.

to brownish pink, fibrous. Total thickness: 8 to 12 mm. Large flowers, solitary, axillary, on peduncles up to 20 cm long; slightly perfumed, actinomorphic, 10 to 17 cm long; cherry red calyx; pale yellow petals with reddish edges. Fruit in capsules of 15 to 25 cm long by 3 to 5 cm wide, greenish semi-wood, black when ripe, elongated, with 8 to 10 prominent longitudinal ribs, show grooves and are divided into 5 parts; containing from 500 to 800 seeds. Elongated seeds very small, 2.5 to 4 mm long and 1 to 1.5 wide, with an acuminate end, are very light, brown, opaque, surrounded by an abundance of silky yellowish-brown fuzz[37].

Very light but resistant and durable wood that was formerly used to make canoes and rafts (hence its name) as well as barbecues frames where the hammocks were hung to carry sick people by horseshoe paths, rustic toys of popular imagery and homemade ornaments. In the summer season, the flowering starts, which produces flecks full of soft filaments very similar to wool, which are used to fill pillows and mattresses. [38].

Raphia taedigera (Pangana)

As a domestic and social use, the Pangana fruit is used in the manufacture of soft drinks, wines and handicrafts by the natives of the Pacific Coast. Other domestic and social uses of the Panganazales refer to the use given to the trunk and the leaves of the palm in the manufacture of houses and rural buildings, although these materials have low durability[39].

As an economic use, palms are obtained from the apical bud located at the upper end of the stem, responsible for the growth of the palm tree, as an advantageous substitute for asparagus. For industrial use, the buds are taken to the processing plants, where they finish removing all the pods or natural wrappings, to subject them to a cooking, chilling, cutting, selection and canning process.

In addition to the use of fruits and buds for human consumption, the residues of the production of palmettos are used in the feeding of bovines and swine. The fruit is also used as a medicine for kidney problems. Another perspective of commercial and economic use of the Panganazales resides in its value as raw material of excellent quality to take advantage of the byproducts obtained from the palmetto industry, as it is currently given in Brazil to the remaining leaves and stipes, for manufacturing of pulps and papers[40].

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[37] Ibid.
[38] Ibid.
39 FAO. Report No. 1 Expert Consultation on Non-Wood Forest Products for Latin America and the Caribbean., Santiago de Chile, July 8, 1994
[40] Ibid.

Prioria copaifera (Cativo)

Large tree, up to 40 m in height and 1.5 m in diameter, with straight and cylindrical shaft, without prawns. Open, rounded cup. Rough, gray or reddish brown, thick bark. Composite leaves, alternate, with two pairs of leathery leaflets, with translucent dots, dark green, asymmetric base. Small flowers (4mm in diameter), without petals, creamy or white, fragrant, sessile. They are produced in large numbers in terminal spiked inflorescences up to 30 cm long. The fruits are brown pods, rounded, 6-12 cm long, woody, they do not open at maturity. They contain a single large flattened seed. It is a gregarious species in lowland regions, on fertile soils of alluvial plains periodically flooded by fresh water. They form large stands known as "cativales". This species has a light and easy to handle wood, very pale pink and sometimes it is reddish, soft and with pronounced veining, which allows to carry out carpentry works with luxurious finishes. It is used mainly for interior decoration, the manufacture of boxes, sheets for triplex, furniture, doors and pulp.

- *Fauna*

Below are the results obtained for the characterization of the terrestrial fauna present in the area of influence of the construction and operation project of a large solid bulk cargoes port terminal in Bahía Colombia, focusing on herpetofauna, avifauna and mastofauna. In Annex 5.2.3 is the information collected in the field (field sheets) for the three faunal groups sampled. On the map MOD_LA_PTO_ANT_35_Fauna, you can see the sampled areas.

1. Herpetofauna

In the project's area of influence, 25 species of reptiles were recorded, nine of them belonging to the Amphibia class (Photo No. 5.24) and 16 to the Reptilia class (Photo No. 5.25, Table No. 5.23). The order of greatest representativeness was Squamata, comprising 50% of the families and 48% of the registered species, followed by Anura with 27.8% of the families and 36% of the species (Figure No. 5.43).

Hypsiboas pugnax

Dendropsophus microcephalus

Leptodactylus bolivianus

Leptodactylus spp2

Photo No. 5.24 Some species of amphibians observed in the project's influence area
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Basiliscus basiliscus

Anolis auratus

Marisora alliacea

Salvator merianae

Caiman crocodilus

Rhinoclemmys melanosterma

Corallus ruschenbergerii

Photo No. 5.25 Some species of reptiles observed in the project's influence area
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.13 Taxonomic composition and classification in CITES, IUCN, Resolution 0192 of 2014 and Red Books of Amphibians and Reptiles present in the influence area

Class	Order	Family	Species	Common name	CITES	UICN	Res.0192/2014	Red Book
Amphibia	Anura	Dendrobatidae	*Dendrobates truncatus***	Arrowhead frog	Appendix II	Lc	No	No
		Leptodactylidae	*Leptodactylus bolivianus*	Bolivian toad	No	Lc	No	No
			Leptodactylus spp2	Frog	NA	NA	NA	NA
			Leptodactylus spp1	Frog	NA	NA	NA	NA
			Engystomops spp	Sapito	NA	NA	NA	NA
		Craugastoridae	*Craugastor spp*	Frog	NA	NA	NA	NA
		Hylidae	*Dendropsophus microcephalus*	Measly little frog	No	Lc	No	No
			Hypsiboas pugnax	Banana tree frog	No	Lc	No	No
		Bufonidae	*Rhinella humboldti*	Toad	No	Lc	No	No
Reptilia	Squamata	Dactyloidae	*Anolis tropidogaster*	Lizard	No	No	No	No
			Anolis auratus	Lizard	No	No	No	No
		Gekkonidae	*Lepidodactylus spp*	Gecko	NA	NA	NA	NA
			Hemidactylus frenatus	Common Gecko	No	Lc	No	No
		Iguanidae	*Iguana iguana*	Iguana	Appendix II	No	No	No
		Scincidae	*Marisora alliacea*	Lizard	No	Lc	No	No
		Teiidae	*Cnemidophorus lemniscatus*	Rainbow Lizard	No	No	No	No
			Salvator merianae	Lobo pollero	Appendix II	Lc	No	No
		Corytophanidae	*Basiliscus basiliscus*	Basilisk	No	No	No	No
		Viperidae	*Bothrops spp.*	Viper	NA	NA	NA	NA
		Boidae	*Corallus ruschenbergerii*	Dormilona	Appendix II	No	No	No
		Dipsadidae	*Leptodeira spp.*	Snake	NA	NA	NA	NA
	Crocodylia	Alligatoridae	*Caiman crocodilus*	Alligator	Appendix II	Lc	No	LC
	Testudines	Kinosternidae	*Kinosternon spp.*	Tapacula turtle	NA	NA	NA	NA
		Testudinidae	*Chelonoidis carbonaria*	Morrocoy	Appendix II	No	CR	CR A1acd+A2cd
		Geoemydidae	*Rhinoclemmys melanosterna*	Hicotea palmera	No	No	No	NT

NA: It does not apply because the taxonomic identification was possible to realize it up to gender; Lc: species considered to be of minor concern; CR: species considered critically endangered; A1acd and A2cd: Species that show a rapid reduction in their population size

** Endemic species

Source: prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

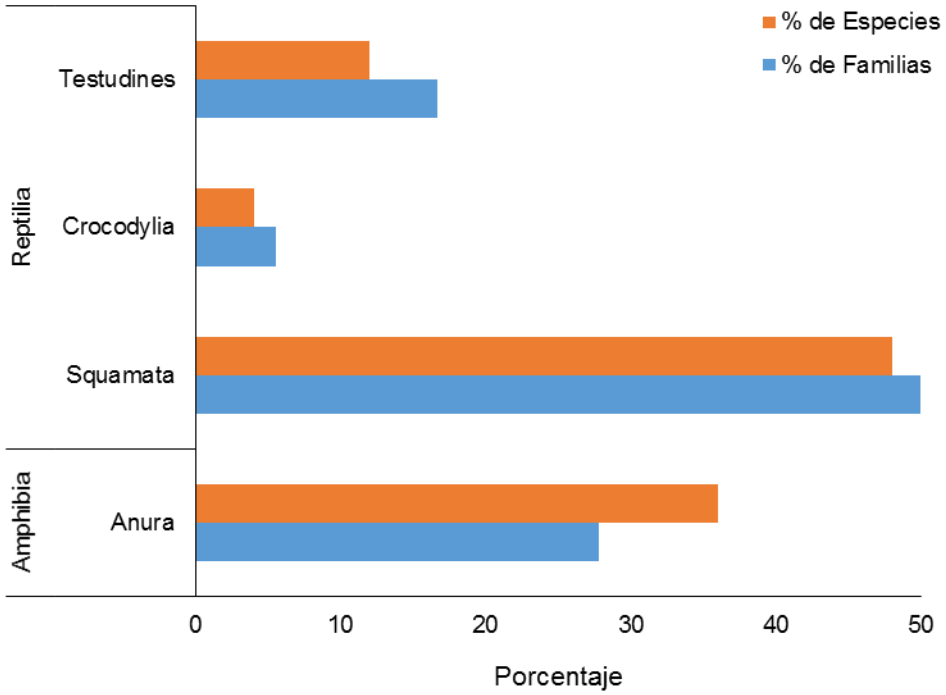

Figure No. 5.43 Representation of orders belonging to the herpetofauna by percentage of families and species grouped by each
Source: prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

In terms of abundance, 197 individuals were recorded, of which the species Basiliscus basiliscus, Salvator merianae and Hypsiboas pugnax were the most abundant with 35, 25, and 24 individuals observed. The remaining 22 species had less than 20 individuals (Annex 5.2.4).

The sampling of amphibians and reptiles was limited by climate, this group of animals are very seasonal and the climate is a conditioning factor, the dry environment and high temperatures at the beginning of the sampling day caused little activity to be observed, the nights 5 and 6 of the session had heavy rains, which favored the sampling of amphibians increasing the frequency of encounters and the auditory record of frogs, the species found are common in the area and recognized by locals. Among the reptiles, especially the turtles, it was identified that they are part of the species of hunting use of the Canal community and they consider snakes unwanted, hunting them for control and there are beliefs that the poisonous mate and reproduce with non-poisonous and therefore mostly "would be poisonous". Among the lizards the most common is the jump-run or Jesus Christ and the lobo pollero; the iguanas are hunted for their eggs and meat, the geckos are tolerated in

the houses for the service they provide in the control of insects, the chicks are hunted for meat consumption, no use or trade of the skin is made.

On the other hand, the three (3) species of turtles registered during the study according to the secondary information collected from the local "tortugueros" hunters of the channel community, report hunting activities of 25 individuals in a single area of the species such as the pothole, the terrapin and the hicotea in the rainy season between March, April and May.

As far as snakes are concerned, the community controls all species, sometimes the big boa constrictors are frequently seen crossing the secondary road and on the roofs of the houses; the collection of secondary information reports some corals, patoco, mapaná, hunters. In the Canal community no snake accidents have occurred, there are no "traditional botanists or traders" nor are the traditional plants that are used culturally in the treatment of known snake accidents.

When carrying out the analysis by identified coverage unit in the area of influence, in ten of them, amphibians and reptiles were recorded, being the clean pastures (Pl) those that presented greater wealth and abundance, followed by the gallery and / or riparian forest (Bgr) and the dense, flooded, non-wooded herbage (Hdina). The remaining seven (7) identified coverages presented a wealth of less than 15 species and 25 individuals (Figure No. 5.44, Annex 5.2.4).

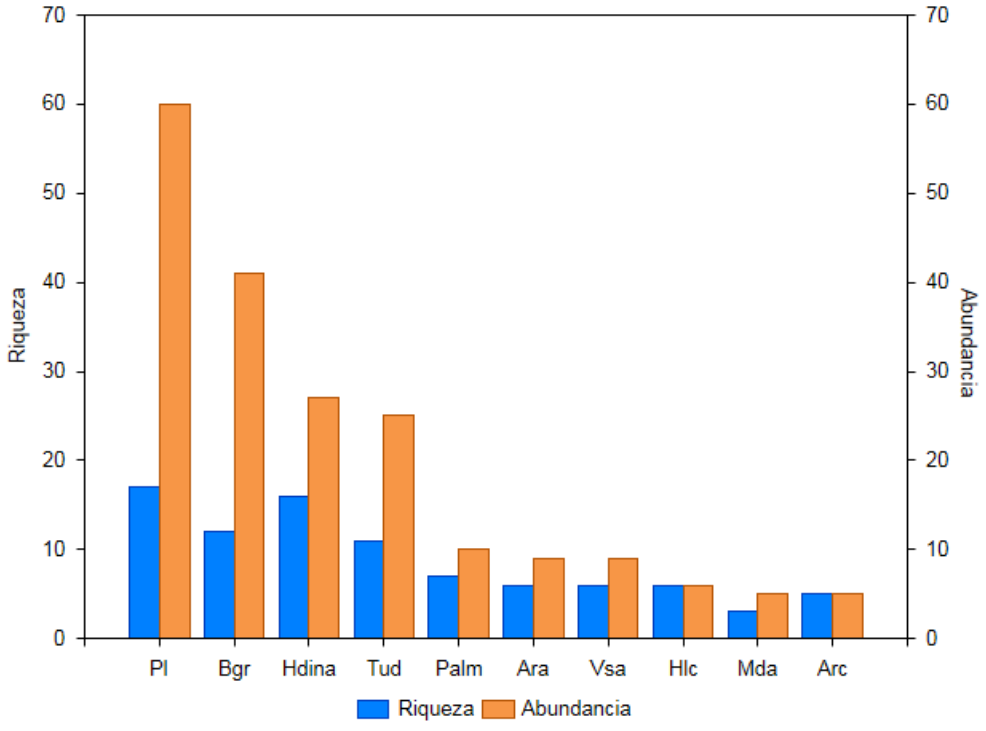

Figure No. 5.44 Wealth (left axis) and abundance (right axis) of the herpetofauna present in the coverages identified in the area of influence. Ara: Open shrub; Arc: Arracachal, Bgr: Gallery and / or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Palm: Palmares; Pl: clean pastures; Tud: discontinuous urban fabric; Vsa: High secondary vegetation
Source: prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

The ecological indexes for vegetal coverage indicate that the dense flooded non-wooded herbage (Hdina) and the clean pastures (Pl) were the coverages that presented a greater specific wealth and diversity of species and were dominated by several species, which presented a homogeneous distribution in terms of its abundance. The coverage that presented the lowest specific wealth, diversity and a dominance of few species, although with a homogeneous distribution in terms of abundance, was the dense high mangrove swamp (MDA). The foregoing, because in this coverage few species and individuals were recorded per species (Figure No. 5.45, Annex 5.2.4).

The difference between the species distribution between coverages is probably due to the climatic conditions at the time of sampling, different degrees of anthropic intervention in the area of interest. Additional coverage of Pl and Hdina are sites of forced passage of the fauna towards coverings such as the arracachal and riparian forest, which may be offering more refuge and food supply.

Another important aspect that could be setting guidelines in relation to the distribution of wealth and abundance (MOD_LA_PTO_ANT_36_DistribucionEsp) is that many of the amphibians that inhabit the tropics tend to present more activity at night, as an adaptive response to avoid high temperatures of the day; so that each natural group presents a range of thermal tolerance, behavioral and physiological adaptation[41] [42]. This allows amphibians and reptiles to inhabit pastures, on the edge or inside the forest and in fragmented environments, responding in diverse and complex ways to changes in the microhabitat[43].

On the other hand, according to the change of the coverage to which the area has been exposed, going from a dense forest to pastures resulting from a secondary ecological succession, it is probable that remaining species have supported the

[41] HERRERA, A., L.A. OLAYA & F. CASTRO. 2004. Incidence of anthropic disturbance in the diversity, wealth and distribution of Eleutherodactylus (Anura: Leptodactylidae) in a cloud forest in southwestern Colombia. Caldasia 26(1): 265-274

[42] SALOMÓN RAMÍREZ J.1, PAÚL MEZA-RAMOS, MARIO YÁNEZ-MUÑOZ & JUAN REYES. Interspecific associations of anurans in four altitudinal gradients of the Tapichalaca Biological Reserve, Zamora-Chinchipe, Ecuador. 2009. Sagolquí Ecuador. Technical bulletin zoological series 4-5: 35-49. IASA Laboratory.

[43] C

changes, while other populations probably have disappeared from the area because of disturbances.

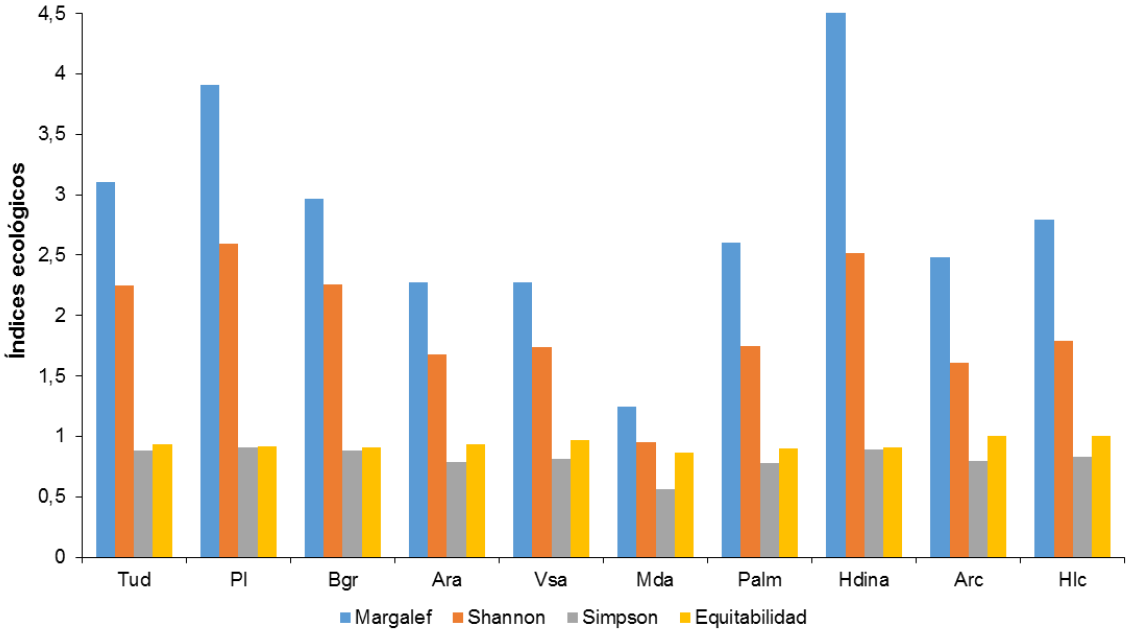

Figure No. 5.45 Ecological indexes of the coverages identified in the area of influence according to the herpetofauna present there. Ara: Open shrub; Arc: Arracachal, Bgr: Gallery and / or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Palm: Palmares; Pl: clean pastures; Tud: discontinuous urban fabric; Vsa: High secondary vegetation
Source: prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

The possible displacement routes considered for amphibians and reptiles are established according to the distribution or association of species found in the project's intervention area (map MOD_LA_PTO_ANT_36_Distrib_Esp). These steps or routes may be related to the ethology of the species and the ecology of the landscape. Herpetos will usually move to areas that offer areas of refuge and availability of food, in relation to amphibians these will move between coverings (herbazal, arrachal, riparian forest) that maintain a certain degree of humidity and therefore more invertebrates (insects) primary source for amphibians with insectivorous eating habits.

On the other hand, due to the mobility of some reptiles and their strong association with the continental aquatic ecosystem, as they are; the turtles hicotea palmera and tapcaula, the iguana and the alligator, it is inferred that these organisms would be moving between the riparian vegetation towards the water and less disturbed areas

(eg Suriquí reserve and León River) to find rest areas, perch and sun for its ectothermic conditions.

In Figure No. 5.46 and the map MOD_LA_PTO_ANT_37_RutasFauna, the possible routes of displacement of the herpetofauna are shown. These routes go through the following coverages: clean pastures (code: 231), gallery and / or riparian forests (code: 314), rivers (code: 511), palmares (code: 311123), dense floodplain not forested (code: 321123) and Arracachal (code: 321123).

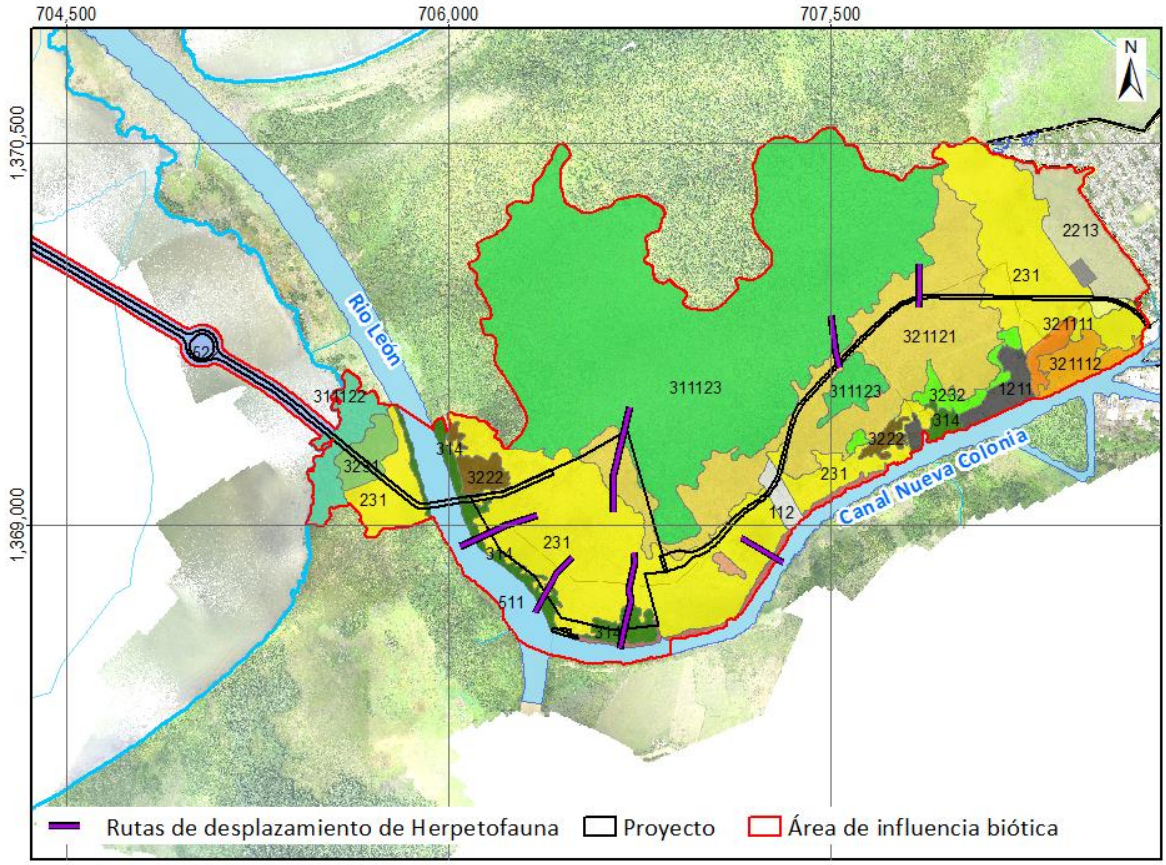

Figure No. 5.46 Possible displacement routes of the herpetofauna in the project's influence area
Source: prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

Of the 25 species of herpetofauna identified in the area of influence, only one, the arrowhead frog, Dendrobates truncatus, is considered endemic to Colombia. This species was registered in two coverages, palmares (Palm) and helechal l (Hlc), with an individual in each of them. At the national level, the morrocoy turtle, Chelonoidis carbonaria, is categorized as a critically endangered species in Resolution 0192 of

2014[44] as in the red book of Reptiles of Colombia [45]. Additionally, as an almost endangered species is the hicotea palmera, Rhinoclemmys melanosterna, and in minor concern is the aligator Caiman crocodilus, the foregoing according to the red book of Reptiles of Colombia[46] (Table No. 5.13). The endemic, critically endangered and near-threatened species were observed in the area where the port terminal would be located. On the other hand, worldwide, six (6) species of herpetofauna registered in the area of influence, are classified in Appendix II of CITES and were observed on the access road to the port terminal, in the port terminal and on the way of the viaduct (Table No. 5.23, Figure No. 5.47 and Annex 5.2.5). Likewise, nine (9) of the species identified are classified in a state of minor concern in the IUCN red list.[47] (Table No. 5.13).

The species found in Appendix II of CITES means that they are species that are threatened but not to the point of extinction but could reach it, so their commercialization is controlled. At the same time, the species categorized as a minor concern in the IUCN red list are species that are not at risk of decreasing their populations to the point of being in one of the danger categories.

[44] COLOMBIA. MINISTRY OF ENVIRONMENT AND SUSTAINABLE DEVELOPMENT. Resolution 0192 (10, February, 2014). By which the list of threatened wild species of Colombian biological diversity found in the national territory is established, and other provisions are established". Bogotá, 2014. 36 p.

[45] CASTAÑO-MORA, Olga Victoria. Red book of reptiles of Colombia. Red books of threatened species of Colombia. Institute of Natural Sciences - National University of Colombia, Ministry of the Environment, International-Colombia Conservation. Bogotá. 2002. 162 p. ISBN: 958-701-187-2

[46] Ibíd., p. 116-117, 127

[47] INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE - IUCN. The IUCN Red List of Threatened Species. 2015 Version. [online] http://www.iucnredlist.org/search [Cited on August 5, 2015]

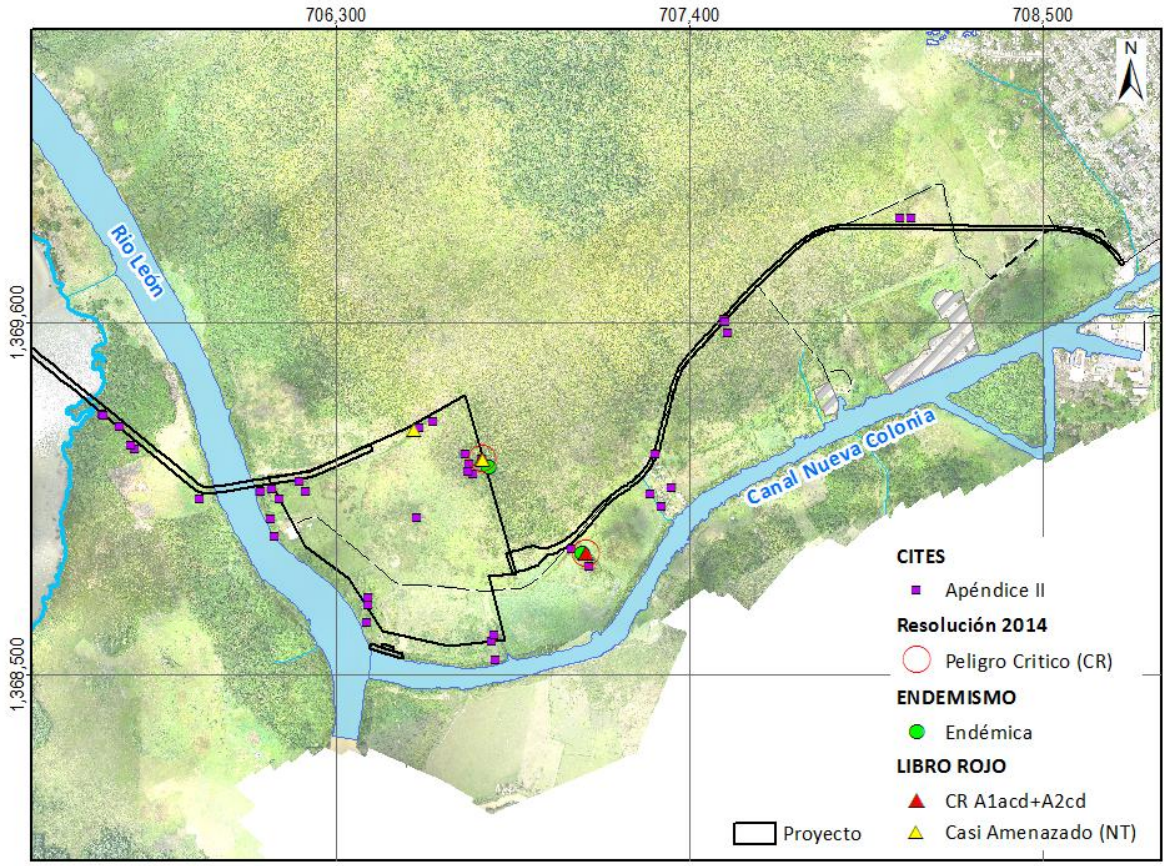

Figure No. 5.47 Geographic location of the endemic species and those classified in CITES, in Resolution 0192 and in the red book of reptiles of Colombia present in the area of influence
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

Below are some ecological aspects for the species identified as endemic, critically endangered and those that are considered ecologically important:

Table No. 5.14 Ecological aspects of the arrowhead frog *Dendrobates truncatus*

Scientific name: *Dendrobates truncatus*
Common name: arrowhead frog

Coverages where it was identified:

Palmares (Palm - 311123)
Helechal (Hlc – 321124)

Habitat and areas of importance for breeding and reproduction

It lives in the forests between very dry and humid tropical, in the low strata of the forests of the Andean region and the Caribbean.
The males are territorial, they attract the females thanks to characteristic sounds they emit. They lay their eggs on the ground, adults carry the tadpoles to temporary puddles, where they develop. They are also commonly found in banana or banana plantations.

Habits and behavior

This species presents diurnal and terrestrial habits occurring in habitat with different degree of intervention and usually near the drainages of banana plantations. When they are threatened they secrete toxic substances through the skin, which are believed to be produced from the diet, especially rich in *Hylomyrma, Wasmannia and Microcepurus* ants. The presence of several alkaloids with different elimination rates is suggested[48].

Individuals of this species feed on insects.

Threats

IUCN Red List: Low Concern - LC
CITES: Appendix II

This species was quite popular as a pet, however it is currently listed on CITES. It is a difficult species to breed in captivity.
Although currently not threatened according to the IUCN Red List, it could be threatened if CITES status is lifted

Distribution

The arrowhead frog, D. truncatus, endemic species is distributed from 10 to 1,100 meters above sea level, it is found from the department of Tolima to the Caribbean coast and in the lowlands

[48] Available online at: http://www.biodiversidad.co/fichas/3248. [Cited 10.15.2015]

Scientific name: *Dendrobates truncatus* **Common name:** arrowhead frog Coverages where it was identified: Palmares (Palm - 311123) Helechal (Hlc – 321124)	
north of the Central and Western Cordilleras west of the Gulf of Urabá, and it is common to find it in the humid forest and tropical dry forest [49].	

Table No. 5.15 Ecological aspects of the morrocoy turtle *Chelonoidis carbonaria*

Scientific name: *Chelonoidis carbonaria* Common name: Morrocoy Coverages where it was identified: Palmares (Palm - 311123) Helechal (Hlc – 321124)	
Habitat and areas of importance for breeding and reproduction Accustomed to being in large meadows and wet savannahs. It likes spacious and open environments, with high humidity and little heat. Habits and behavior It feeds mainly on fruits during the rainy season and flowers during the dry season. Throughout the year, they also consume dead and living foliage, soil, fungi, stems, sand, pebbles and carrion. Males consume higher amounts of fruit compared to females. G. carbonaria occasionally ingests sand, which has hypothesized to act as an abrasive agent to improve the digestion of plant materials[50]. These turtles tend to be active in the morning and afternoon, in the hottest hours they are usually hidden among the herbs, they enjoy the rain a lot; this species does not hesitate to cross some rivers by swimming, looking for new areas to feed. This species is maintained as it should be, it is usually quite resistant	

[49] DE LA OSSA, Jaime, CONTRERAS-GUTIÉRREZ, Jorge & CAMPILLO-CASTRO, Jorge. Conspicuous behaviors of Dendrobates truncatus (Cope, 1861) in captivity. In: Munibe (Natural Sciences – Natur Zientziak). 2012. no. 60. p. 101-111.

[50] MOSKOVITS D.K., BJORNDAL, K.A. 1990. Diet and Food Preferences of the Tortoises Geo*chelone carbonaria* and G. *denticulata* in Northwestern Brazil. Herpetologica. Vol 46(2):207-218

Scientific name: *Chelonoidis carbonaria*	
Common name: Morrocoy	
Coverages where it was identified: Palmares (Palm - 311123) Helechal (Hlc – 321124)	

Threats

IUCN Red List: Critical

CITES: Appendix II

Red Book of Colombia: CR A1acd + A2cd
Resolution 0192 of 2014: CR

Apart from humans, there is no information available on specific predators for *Chelonoidis carbonaria*[51]. As frugivores, red-legged turtles can be important seed dispersers of tropical plants such as figs and bromeliads. One study found that viable seeds of the two types of plants are found in the feces of several red-legged turtles in Brazil[52]. *Chelonoidis carbonaria has not been evaluated by the International Union for the Conservation of Nature (IUCN), however, many island populations are likely to seriously decline as habitat loss and hunting constitute a serious threat throughout its geographic range. C. carbonaria reproduces in numerous wildlife reserves and national parks throughout its range of distribution. Without current population estimates, it is difficult to predict the possible conservation and management needs for this species*[53].

Distribution

The morrocoy turtle C. carbonaria, is a critically endangered species found in the north of Chocó, the coastal plain of the Caribbean, the basin of the Magdalena River and in the Eastern Plains. The main threats to which this species is exposed, for which its populations are considered critically endangered, are its commercial, nutritional and cultural value, which has led to its illegal hunting. The palm hibiscus, R. melanosterna, is in category of almost threatened due to indiscriminate hunting that has suffered especially in the Chocoan region[54]. These two species are commonly used by communities as a source of food and decorative objects.

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[51] SPIESS, P. 1997. "The Red-Footed Tortoise (*Geochelone carbonaria*), a South American Treasure" (On-line). Accessed March october, 2015 en http://www.kingsnake.com/rockymountain/RMHPages/RMHredfoot.htm.
[52] STRONG, J. M., FRAGOSO J. M. V. 2006. Seed dispersal by *Geochelone carbonaria* and Geochelone denticulata in northwestern Brazil. Biotropica 38: 683-686.
[53] SPIESS. Op. cit.
[54] Ibíd., p. 68-70, 116-117

Table No. 5.16 Ecological aspects of the hicotea palmera turtle *Rhinoclemmys melanosterna*

Scientific name: *Rhinoclemmys melanosterna*	
Common name: Hicotea palmera	
Coverages where it was identified: Palmares (Palm - 311123) Dense flooded herbage not wooded (Hdina - 321121)	

Habitat and areas of importance for breeding and reproduction

The habitat of the palmera turtle is made up of low, overflow ponds, lagoons and backwaters, in general waters with little or no current within the forest[55].

Habits and behavior
Medem's reports (1962) [56] indicate that the species is of diurnal habits. During the day it is common to observe the assembled adults coming out to breathe on the surface of the water, they have not been observed sunning themselves.

The reproduction of R. melanosterna can occur throughout the year; the observations also indicated that the posture consists of only one egg, which is deposited on the forest floor and is sometimes covered with leaves[57].

Individuals often leave water bodies to look for wild fruits, especially figs (Ficus sp.). It feeds on aquatic plants, grass, seeds and fruits, which allows us to infer that it is a mainly herbivorous species[58].

Threats
Amphibians and reptiles red book: NT

The palmera turtle is widely distributed and is considered scarce in places where it should normally be found, however it is very common in the Choco region. In this department, economically depressed, with rivers of low productivity, this turtle is a very appreciated hunting piece, if to this

[55] CASTAÑO MORA O, MEDEM F. 1983. Preliminary data on the reproduction of Rhinoclemmys melanosterna Gray (Reptilia: Quelonia: Emydidae). LOZANIA (Colombian Zoological Record) 1983;47:1
[56] MEDEM, F., 1962.- The geographical distribution and ecology of the Crocodylia and Testudinata in the Department of Chocó. Journal of the Colombian Academy of Exact, Physical and Natural Sciences, 11: 279-303
[57] Ibíd.
[58] Ibíd.

Scientific name: *Rhinoclemmys melanosterna*	
Common name: Hicotea palmera	
Coverages where it was identified: Palmares (Palm - 311123) Dense flooded herbage not wooded (Hdina - 321121)	
is added the ease of its capture in still and shallow waters, the situation of this species can be delicate[59]. Distribution Its located in Colombia, Ecuador and Panama. They inhabit the area of the Pacific coastal plain at elevations less than 175 meters above sea level [60] [61].	

Table No. 5.17 Ecological aspects of the *Caiman crocodilus*

Scientific name: *Caiman crocodilus*	
Common name: Cayman	
Coverages where it was identified: Gallery and / or riparian forest (Bgr - 314) Open shrub (Ara - 3222) Dense high mangrove (Mda - 311122) Dense flooded not wooded herbage (Hdina - 321121)	
Habitat and areas of importance for breeding and reproduction This species is found in a wide variety of open habitats such as: savannahs, swamps, pipes and rivers; of hot thermal floor areas. In addition, they are found in water wells and man-made drainage areas[62].	

[59] CASTAÑO MORA O, MEDEM F. Op. cit.
[60] CARR, J.L. & ALMENDÁRIZ, A., 1990.- Contribution to the knowledge of the geographical distribution of the chelonians of western Ecuador. Polytechnic, 14 (3): 75-103
[61] CORREDOR-LONDOÑO, G., AMOROCHO, D. & GALVIS-RIZO, C.A., 2006.- Action Plan for the Conservation of Continental and Marine Turtles of the Department of Valle del Cauca. Regional Autonomous Corporation of Valle del Cauca (CVC), Santiago de Cali, Colombia.
[62] RUEDA-A., J. V., J. L. CARR, R. A., MITTERMEIER, J. V. RODRÍGUEZ-M., R. B. MAST, R. C. VOGT, A. G. RHODIN, J. DE LA OSSA, J. N. RUEDA & C. G. MITTERMEIER. 2007. Turtles and crocodilians from the Andean countries of the Tropic. International Conservation. 537p. Bogotá.

Scientific name: *Caiman crocodilus* Common name: Cayman Coverages where it was identified: Gallery and / or riparian forest (Bgr - 314) Open shrub (Ara - 3222) Dense high mangrove (Mda - 311122) Dense flooded not wooded herbage (Hdina - 321121)	

Habits and behavior

The alligator deposited its eggs in nests built with plant material under wooded areas near the edge of bodies of water or in open areas with very dense herbaceous vegetation.
The females commonly spawn in the same nest since they do not have territorial behavior on the nests after the laying of the eggs.

The young feed on crustaceans, snails and insects, while adults are opportunistic predators, so they feed on anything they can kill. [63].

The alligators, thanks to their level of specialization allows them to be on the lookout for their prey exposing their eyes, ears and the end of the nasal passages thanks to the linear location of these, also have a separation of the respiratory passages and the mouth, allowing him to breathe even if his mouth is open under the water's surface.

Threats

Amphibians and reptiles red book: Minor concern (Lc)
CITES: Appendix II

The alligator population is affected by illegal trafficking, contamination of water sources, habitat fragmentation and hunting.

Distribution
This species is distributed in the systems of the Magdalena, Sinú, Atrato and Ranchería rivers and in the plains of the Colombian Caribbean coast.

[63] Ibíd.

In relation to the species of economic, ecological and cultural importance as mentioned above, turtles are hunted by locals in times of greatest rainfall (March - April) for consumption; they also take advantage of alligator meat in accidental hunts and consider geckos as natural mosquito controllers in populated areas. Due to the above, there are marked pressures towards the turtles and alligator populations present in the area by the inhabitants, this being one of the main threats to these species. From the ecological point of view, the group of herpetofauna play an important role in the ecosystem, such as seed dispersers, pest and insect control and soil enrichment with organic matter from faeces; therefore, all reported species are considered to be of ecological importance.

2. Avifauna

In the project's area of influence, 83 species of birds were grouped into 17 orders and 41 families (Table No. 5.28, Photo No. 5.26). The order of greatest representativeness was Passeriformes, comprising 24.4% of the families and 26.5% of the species present, followed by Pelecaniformes (14.6% of the families and 21.7% of the species). The remaining orders presented less than 10% of the families and species recorded (Figure No. 5.48).

Table No. 5.18 Taxonomic composition and classification in CITES and IUCN of the avifauna present in the area of influence

Order	Family	Species	Common name	CITES	UICN
Accipitriformes	Accipitridae	*Busarellus nigricollis*	Cinaguero Hawk	Appendix II	Lc
		Buteogallus anthracinus	Black crabber	Appendix II	Lc
		Buteogallus meridionalis	Savannah Hawk	Appendix II	Lc
	Cathartidae	*Cathartes aura*	Red headed Guala	No	Lc
		Coragyps atratus	Black vulture	No	Lc
	Pandionidae	*Pandion haliaetus*	Fishing eagle	Appendix II	Lc
Anseriformes	Anatidae	*Dendrocygna autumnalis*	Pisingo	Appendix II	Lc
	Anhimidae	*Chauna chavaria**	Chavarrí	No	NT
Apodiformes	Trochilidae	*Amazilia tzacatl*	Amazilia colirrufa	Appendix II	Lc
		Anthracothorax nigricollis	Mango pechinegro	Appendix II	Lc
		Phaethornis longirostris	Colilargo Hermit	Appendix II	Lc
Caprimulgiformes	Caprimulgidae	Nyctidromus albicollis	Bujío	No	Lc
Charadriiformes	Charadriidae	*Vanellus chilensis*	Pellar teru-teru	No	Lc
	Laridae	*Thalasseus maximus*	Royal Gull	No	Lc
	Scolopacidae	*Actitis macularius*	Andaríos	No	Lc
		Numenius phaeopus	whimbrel	No	Lc
Ciconiiformes	Jacanidae	*Jacana jacana*	Moorhen	No	Lc
Columbiformes	Columbidae	*Columbina talpacoti*	Reddish dove	No	Lc
		Leptotila verreauxi	Red tail Turtle dove	No	Lc
Coraciiformes	Alcedinidae	*Chloroceryle aenea*	Kingfisher	No	Lc
		Chloroceryle americana	Kingfisher	No	Lc
		Megaceryle torquata	Big Kingfisher	No	Lc
Cuculiformes	Cuculidae	*Coccycua pumila*	Dwarf Cuckoo	No	Lc
		Coccyzus americanus	American Cuckoo	No	Lc
		Crotophaga ani	Garrapatero piquiliso	No	Lc

Order	Family	Species	Common name	CITES	UICN
Falconiformes	Falconidae	*Caracara cheriway*	Crested caracara	No	Lc
		Falco sparverius	American Kestrel	Appendix II	Lc
		Milvago chimachima	Pigua	Appendix II	Lc
Galliformes	Cracidae	*Ortalis garrula***	Caribbean Guacharaca	No	Lc
Gruiformes	Aramidae	*Aramus guarauna*	Carrao	No	Lc
	Rallidae	*Aramides cajaneus*	Black tail Chilacoa	No	Lc
		Porphyrio martinicus	Moorhen	No	Lc
Passeriformes	Corvidae	*Cyanocorax affinis**	White chested Carriquí	No	Lc
	Donacobiidae	*Donacobius atricapilla*	Lagoon wren	No	Lc
	Emberizidae	*Sporophila nigricollis*	Seedbed bird	No	Lc
		Volatinia jacarina	Jumping espiguero	No	Lc
	Furnariidae	*Dendroplex picus*	Woodcreepers	No	Lc
	Hirundinidae	*Tachycineta albiventer*	Swallow	No	Lc
	Icteridae	*Chrysomus icterocephalus*	Yellow-headed monjita	No	Lc
		Icterus nigrogularis	Toche	No	Lc
		Psarocolius decumanus	Gulungo	No	Lc
		Quiscalus mexicanus	Mariamulata	No	Lc
		Sturnella militaris	Little Soldier	No	Lc
	Thamnophilidae	*Thamnophilus doliatus*	Carcajada	No	Lc
	Thraupidae	*Ramphocelus dimidiatus**	Silver beak toche	No	Lc
		Sicalis flaveola	Crowned Canary	No	Lc
		Thraupis episcopus	Common Azulejo	No	Lc
	Troglodytidae	*Campylorhynchus griseus*	Egg-eating wren	No	Lc
		Troglodytes aedon	Common wren	No	Lc
	Tyrannidae	*Fluvicola pica*	Viudita	No	Lc
		Myiozetetes cayanensis	flycatcher	No	Lc
		Pitangus sulphuratus	Bichofué	No	Lc
		Tyrannus melancholicus	common Sirirí	No	Lc
		Tyrannus savana	Sirirí tijeretón	No	Lc
Pelecaniformes	Ardeidae	*Ardea alba*	Regal heron	No	Lc
		Ardea cocoi	Blue Heron	No	Lc
		Ardea herodias	Bluish heron	No	Lc
		Bubulcus ibis	Garcita bueyera	No	Lc
		Egretta caerulea	Blue Heron	No	Lc
		Egretta thula	Gray heron	No	Lc
		Nyctanassa violacea	Mangrove Guaco	No	Lc
		Pilherodius pileatus	Crested Heron	No	Lc
		Tigrisoma lineatum	Red Vaco	No	Lc
		Tigrisoma mexicanum	Mexican Vaco	No	Lc
	Ciconiidae	*Mycteria americana*	Bone head	No	Lc
	Fregatidae	*Fregata magnificens*	Magnificent frigate	No	Lc
	Pelecanidae	*Pelecanus occidentalis*	Brown Pelican	No	Lc
	Phalacrocoracidae	*Phalacrocorax brasilianus*	Cormorán	No	Lc
	Threskiornithidae	*Eudocimus albus*	White Ibis	No	Lc
		Phimosus infuscatus	Coquito	No	Lc
		Platalea ajaja	Pink spatula	No	Lc
		Plegadis falcinellus	sickle peak ibis	No	Lc
Piciformes	Bucconidae	*Hypnelus ruficollis*	Bobo punteado	No	Lc
	Galbulidae	*Galbula ruficauda*	Jacamar colirrufo	No	Lc
	Picidae	*Campephilus melanoleucos*	Martial carpenter	No	Lc
		Colaptes punctigula	Carpenter	No	Lc
		Melanerpes rubricapillus	Carpenter	No	Lc
	Ramphastidae	*Pteroglossus torquatus*	Tucaneta	No	Lc
Psiitaciformes	Psittacidae	*Amazona farinosa*	Regal Parrot	Appendix II	NT
		Amazona ochrocephala	Yellow-headed parrot	Appendix II	Lc
		Brotogeris jugularis	Tanned Parakeet	Appendix II	Lc
Strigiformes	Strigidae	Megascops guatemalae	Autillo vermiculado	Appendix II	Lc
	Tytonidae	*Tyto alba*	Owl	Appendix II	Lc

NT: species in category of almost threatened; Lc: species considered to be of minor concern
** Endemic, * Almost endemic
Source: prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

Chauna chavaria

Huevos y nido de *Chauna chavaria*

Aramides cajaneus

Mycteria americana

Milvago chimachima

Hypnetus ruficollis

Photo No. 5.26 Some species of birds observed in the project's area of influence
Source: prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

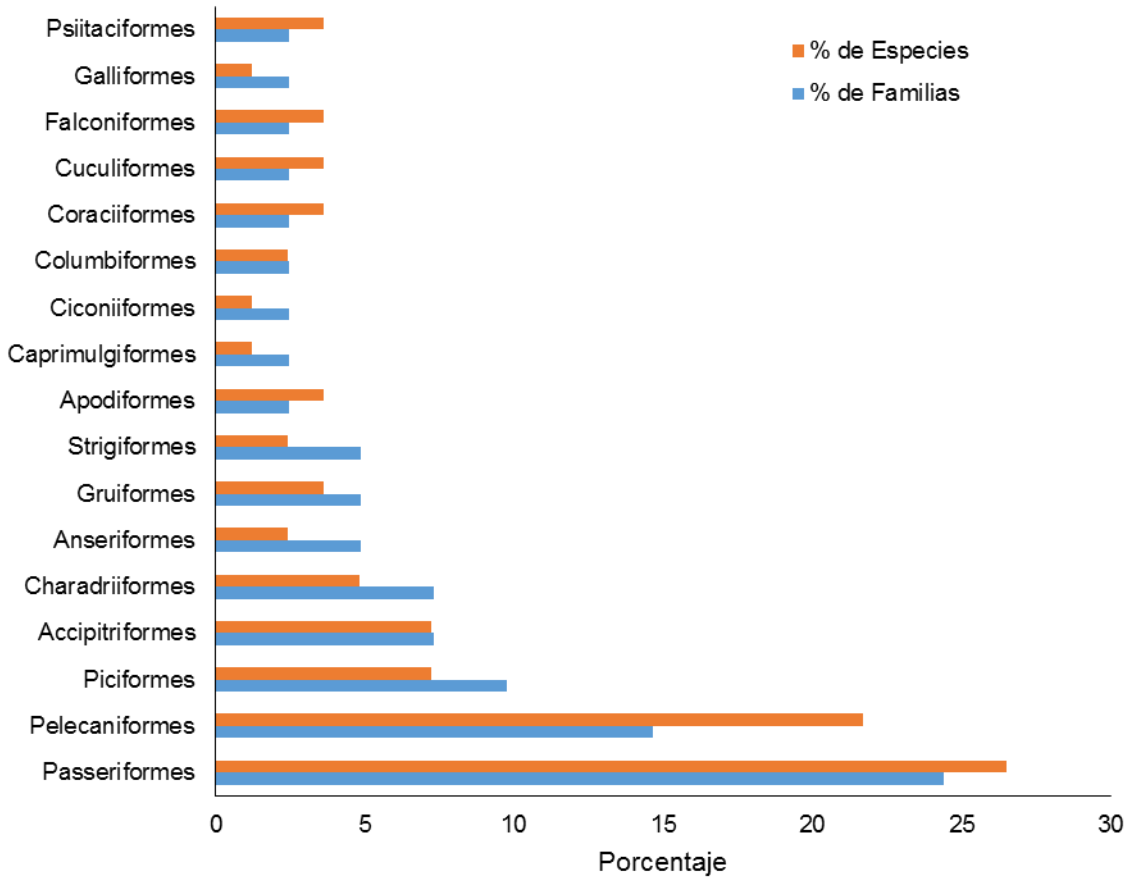


Figure No. 5.48 Representation of bird orders by percentage of families and species grouped by each
Source: Produced by Aqua & Terra Consultores Asociados S.A.S., 2015

In terms of abundance, 1,277 individuals were recorded, of which the coitus Phimosus infuscatus had the highest abundance with 362 individuals, is a species of gregarious behavior that lives in humid and coastal ecosystems, crosses the study area during dawn and dusk, some straggling individuals settle on the banks of the river and in flooded areas with grasses. The next species that showed the greatest abundance was the swallow Tachycineta albiventer with 103 individuals observed, corresponds to a group of swallows that were recorded while resting on the high voltage electrical wiring that crosses the study area. The remaining 81 species presented less than 50 individuals, of which 33.7% of the species were registered between one (1) and five (5) individuals, 28.9% between six (6) and 10 individuals, 22.9% between 11 and 20 individuals and 12.0% between 20 and 50 individuals (Annex 5.2.6). Among these are the Yellow-headed Parrot Amazona ochrocephala and the Amazona Farinosa Lora real that were observed in small groups of 8 and 10 individuals on average were constant and frequent with routine

behaviors throughout the days of sampling; It was also common to observe the *Tyrannus savanna* and *Tyrannus melancholicus*.

The wealth of bird species found in the area is probably due to the presence of nearby wetlands and to the fact that the area is part of a "hotspot" corridor called Tumbes-Chocó-Magdalena. These wetlands are areas of obligatory passage for gregarious, local and migratory species, sediment and migration routes of many other species, locating the Gulf of Urabá as an area with high biodiversity of avifauna.

The registration of the *Aramides cajanea* and *Chauna chavaria* species was carried out through video sequences with camera traps to observe the natural behavior, highlighting the importance of breeding areas for waterfowl *Dendrocygna autumnalis, Tigrisoma mexicanum, Tigrisoma lineatum, Aramides cajanea and Chauna chavaria* (ducks, herons, colas de agua and the chavarri) in the flood zones with grasses, fern and arracachales.

When carrying out the analysis by identified coverage unit in the area of influence, it is found that in 14 of them birds were recorded, being the clean pastures (Pl) those that presented the greatest wealth and abundance, followed by the dense, flooded, non-wooded herbage (Hdina) and the gallery and / or riparian forest (Bgr). It should be noted that in the portion of the river (R) sampled, a high abundance of birds was observed, but the species wealth was less than 20. The remaining ten (10) identified coverages presented less than 20 species and 30 individuals (Figure No 5.49, Annex 5.2.6).

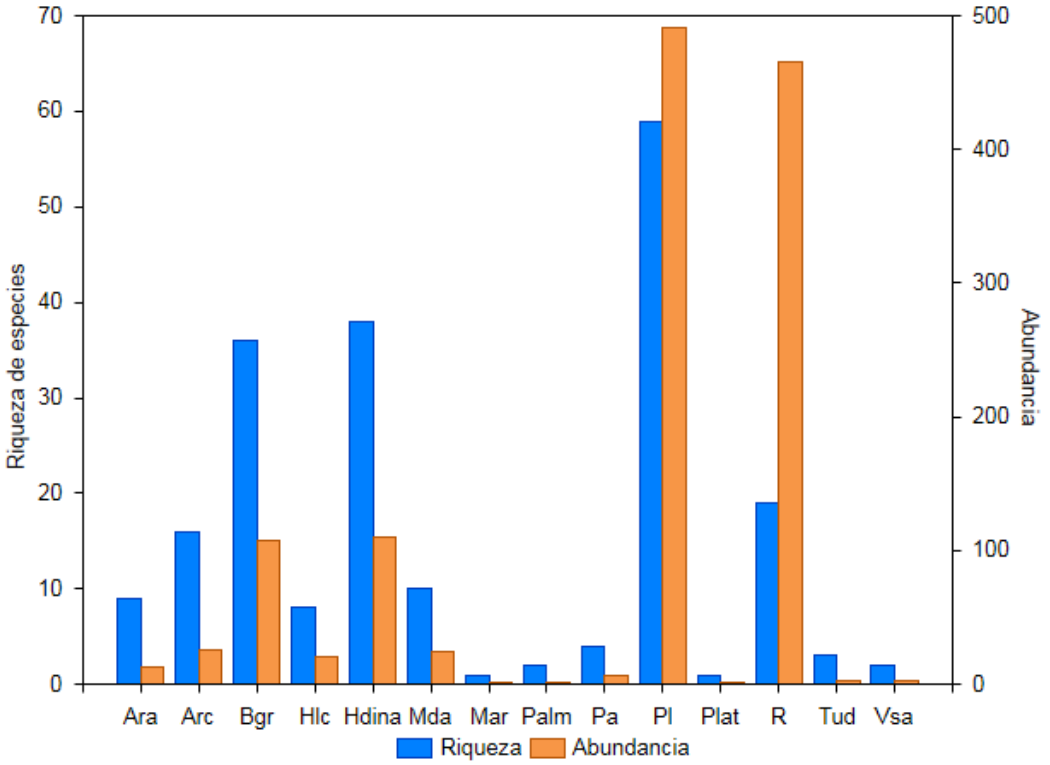


Figure No. 5.49 Wealth (left axis) and abundance (right axis) of the avifauna present in the coverages identified in the area of influence. Ara: Open shrub; Arc: Arracachal, Bgr: Gallery and / or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Sea: Seas and oceans; Palm: Palmares; Pa; Wooded pastures; Pl: clean pastures; Plat: Banana; R: River; Tud: discontinuous urban fabric; Vsa: High secondary vegetation
Source: Produced by Aqua & Terra Consultores Asociados S.A.S., 2015

The ecological indexes by vegetal cover indicate that the clean grasses (Pl) was the cover that presented a greater specific wealth and diversity of species and was dominated by several species which presented a homogeneous distribution in terms of their abundance. The second coverage with high specific wealth, diversity and dominance of several species with homogeneous distribution was the dense flooded non-wooded herbage (Hdina). The coverages that presented the lowest specific wealth and diversity were seas and oceans (Mar) and banana plantations (Plat), the foregoing because in these two coverages only one species was registered with a single individual (Figure No. 5.50, Annex 5.2.6).

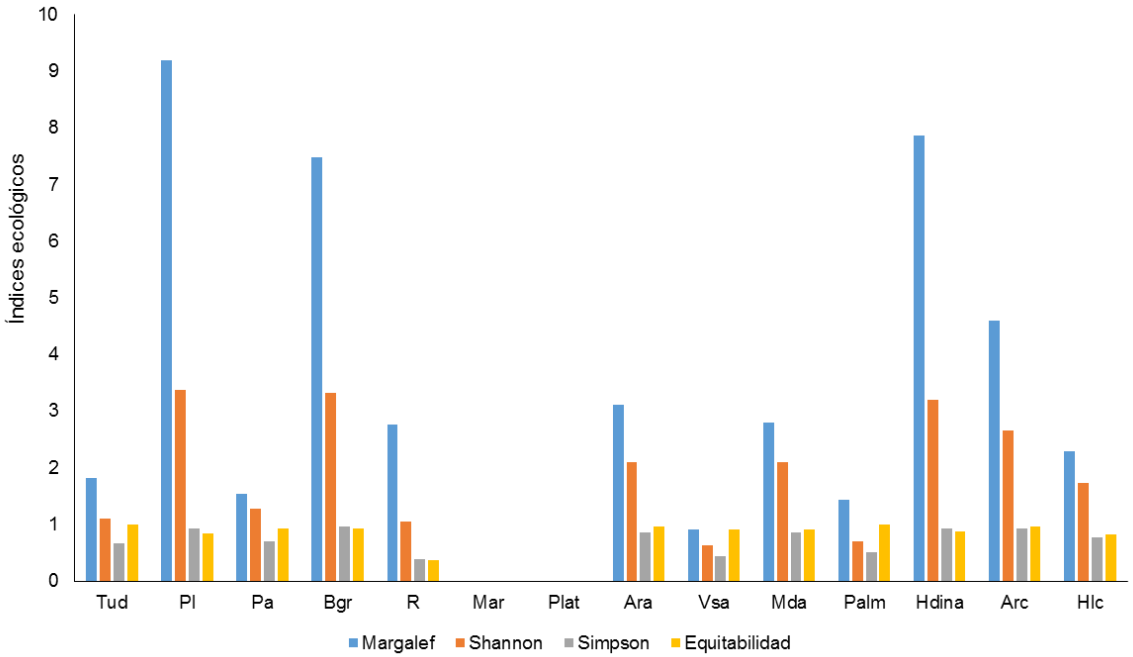


Figure No. 5.50 Ecological indexes of the coverages identified in the area of influence according to the bird community present there. Ara: Open shrub, Arc: Arracachal, Bgr: gallery and / or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Sea: Seas and oceans; Palm: Palmares; Pa; Wooded pastures; Pl: clean pastures; Plat: Banana; R: River; Tud: discontinuous urban fabric; Vsa: High secondary vegetation
Source: Produced by Aqua & Terra Consultores Asociados S.A.S., 2015

The difference between the distribution of species between coverages is probably related to the flood dynamics that occur in the area, finding according to observations in the field that pastures retain water and can maintain humid and dry areas, generating optimal zones of hanger and food (insects and invertebrates parasites associated with livestock, among others), as well as nesting areas, among the most frequent species in this coverage are the heron of cattle, the tick and the swallow. Likewise, Hdina coverage because it is adjacent to the pastures would be housing these species, developing microhabitats and small corridors between these two coverages. The coverages that presented less diversity among them are the Palmares is probably due to the fact that these forests are homogeneous, offering a smaller variety of food and refuge areas.

On the other hand, the riparian forest and arracachal by their structure are harboring species associated with the continental bodies of water, these species mostly correspond to organisms of the Pelecaniformes, Anseriformes, Charadriiformes, Ciconiiformes order, and depend on these systems for different daily activities.

Among the species belonging to these orders are highlighted, using mangrove areas and the shallows formed by the tidal change, the Numenius phaeopu, the herons and the sandpiper; Among the important species in wetland areas or floodplains are the Chavarri, the Pinsingo pellar, the water cock, ibis among others. On the other hand, species such as the pelican and the frigate were found, which are considered marine birds, but which make use of the mangrove as resting, feeding, perching and nesting sites.

The possible routes of displacement considered for birds are established according to the possible places of passage of these organisms of nearby wetlands located to the north of the project and to the south of it (reservoir of the Suriquí and León rivers). Since they identified birds that have some dependence on these ecosystems such as mangroves where they find more food and areas of overnight and night rest.

Figure No. 5.51 shows the four (4) possible avifauna displacement routes identified in the project's area of influence. These routes go through the following coverages: clean pastures (code: 231), gallery and / or riparian forests (code: 314), rivers (code: 511), seas and oceans (code: 522), open shrubs (code: 3222), high secondary vegetation (code: 3231), palmares (code: 311123), and Arracachal (code: 321123). You can see these possible routes on the MOD_LA_PTO_ANT_37_RutasFauna map.

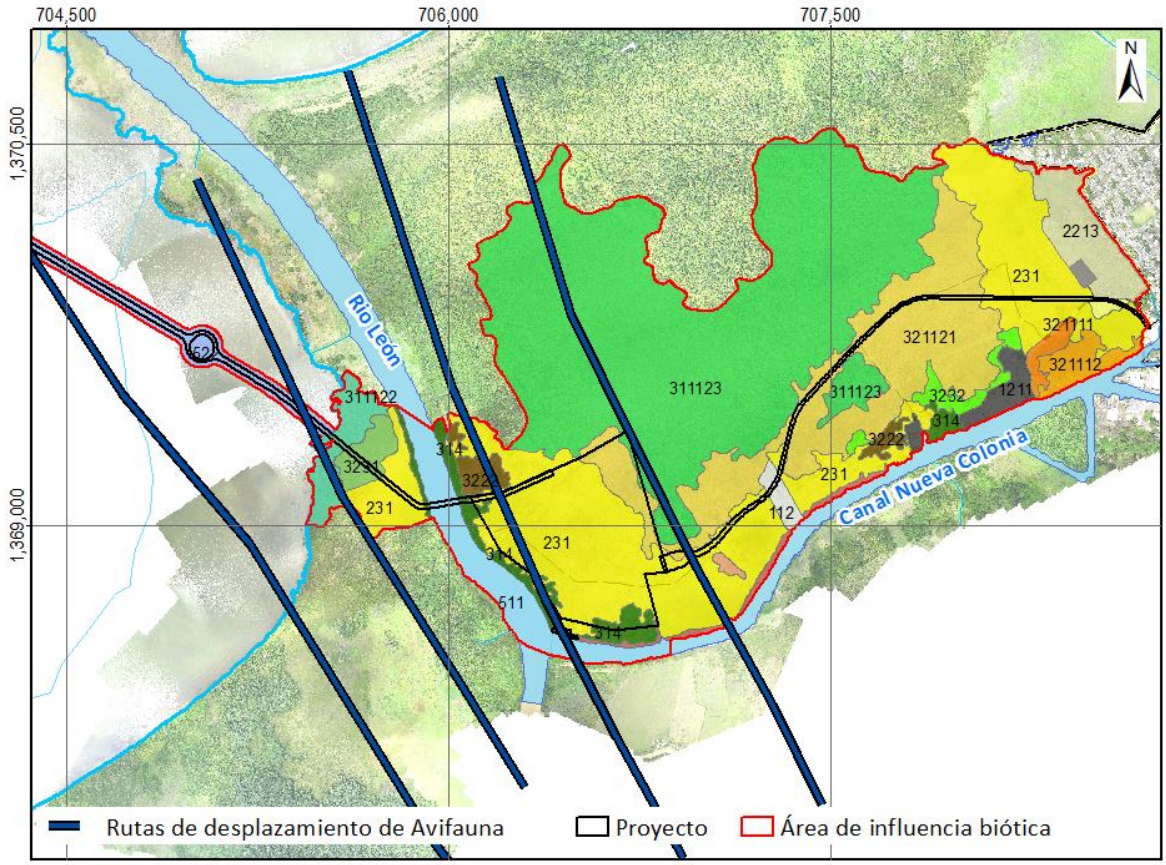


Figure No. 5.51 Possible displacement routes of the avifauna present in the project's area of influence
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

On the other hand, the registered species were distributed in eight (8) trophic guilds: insectivore, piscivore, carnivore, omnivore, frugivorous, granivore, scavenger and nectarivorous. Of them, the insectivores were the most abundant, with 32.5% of the species observed belonging to this guild, while the species considered as scavengers were the least representative (2%, Figure No. 5.52). At coverage level, insectivores were the dominant species followed by carnivorous and piscivorous species in eight (8) of the coverages, except for wooded pastures (Pa), rivers (R), secondary high vegetation (Vsa), mangrove dense high (Mda), palmares (Palm) and Arracachales (Arc; Annex 5.2.7).

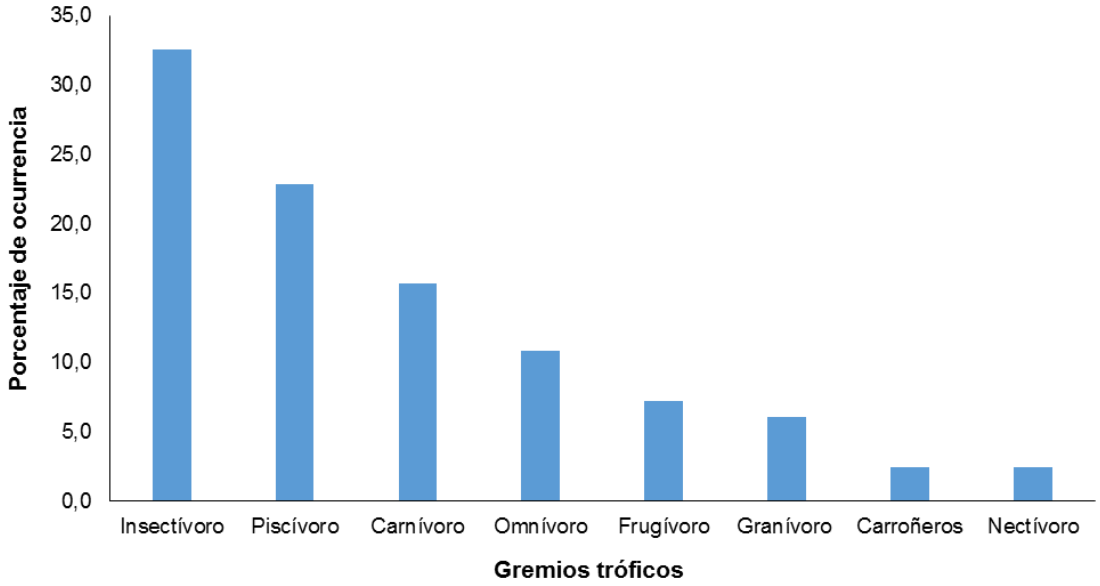


Figure No. 5.52 Percentage of occurrence of the trophic guilds according to the bird species present in the area of influence
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

According to BirdLife International, two main uses were identified for the birds observed in the area: food and pets. According to the above, 54.2% of registered birds are used as pets, 2.4% have an exclusive use of food for man and 24.1% can be used in both ways. The remaining 19.3% of the species do not have a known use (Annex 5.2.7).

Following the guide of the migratory species of the biodiversity in Colombia, of the 83 species of registered birds, 19 are considered migratory. These 19 species present an intragenerational life cycle, which means that they have a strategy of sequential occupation of habitats, where each selected habitat presents the appropriate conditions to carry out one of its vital processes to complete its life cycle.

The type of migration of these species is cyclical and seasonal. 52.6% of the species presented a latitudinal migration and 15.8% presented it in the three orientations (latitudinal, longitudinal and altitudinal). Finally, 47.4% of the identified migratory species are wintering with permanent breeding populations in the country (Table No. 5.29, Figure No. 5.53)[64].

[64] Ibíd., p. 49-52, 19-101, 107-114, 120-126, 129-134, 162-164, 194-196, 200-202, 299-301, 321-322, 420-424

Table No. 5.19 Orientation, migration policy and category of residence in Colombia of the 19-species identified as migratory in the area of influence

Migratory species	Orientation	Policy	Residence category in Colombia
Actitis macularius	Latitudinal	Transborder	Wintering No reproductive
Ardea alba	Latitudinal andLongitudinal	Transborder	Wintering with permanent breeding populations
Ardea herodias	Latitudinal	Transborder	Wintering with permanent breeding populations
Bubulcus ibis	Latitudinal, Longitudinal and Altitudinal	Transborder	Wintering with permanent breeding populations
Cathartes aura	Latitudinal	Transborder	Wintering No reproductive
Chauna chavaria	Longitudinal	National	Local migration
Coccyzus americanus	Latitudinal	Transborder	Wintering No reproductive
Dendrocygna autumnalis	Altitudinal andLongitudinal	National	Local migration
Egretta caerulea	Latitudinal and Altitudinal	Transborder and national	Wintering with permanent breeding populations
Egretta thula	Latitudinal, Longitudinal and Altitudinal	Transborder and national	Wintering with permanent breeding populations
Numenius phaeopus	Latitudinal	Transborder	Wintering No reproductive
Pandion haliaetus	Latitudinal	Transborder	Wintering No reproductive
Pelecanus occidentalis	Latitudinal	Transborder	Wintering No reproductive
Phalacrocorax brasilianus	Latitudinal, Longitudinal and Altitudinal	Transborder and national	Wintering with permanent breeding populations
Plegadis falcinellus	Latitudinal	Transborder	Wintering No reproductive
Porphyrio martinicus	Altitudinal andLongitudinal	National	Local migration
Thalasseus maximus	Latitudinal	Transborder	Wintering with permanent breeding populations
Tyrannus melancholicus	Latitudinal and Altitudinal	Transborder and national	Wintering with permanent breeding populations
Tyrannus savana	Latitudinal	Transborder	Wintering with permanent breeding populations

Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

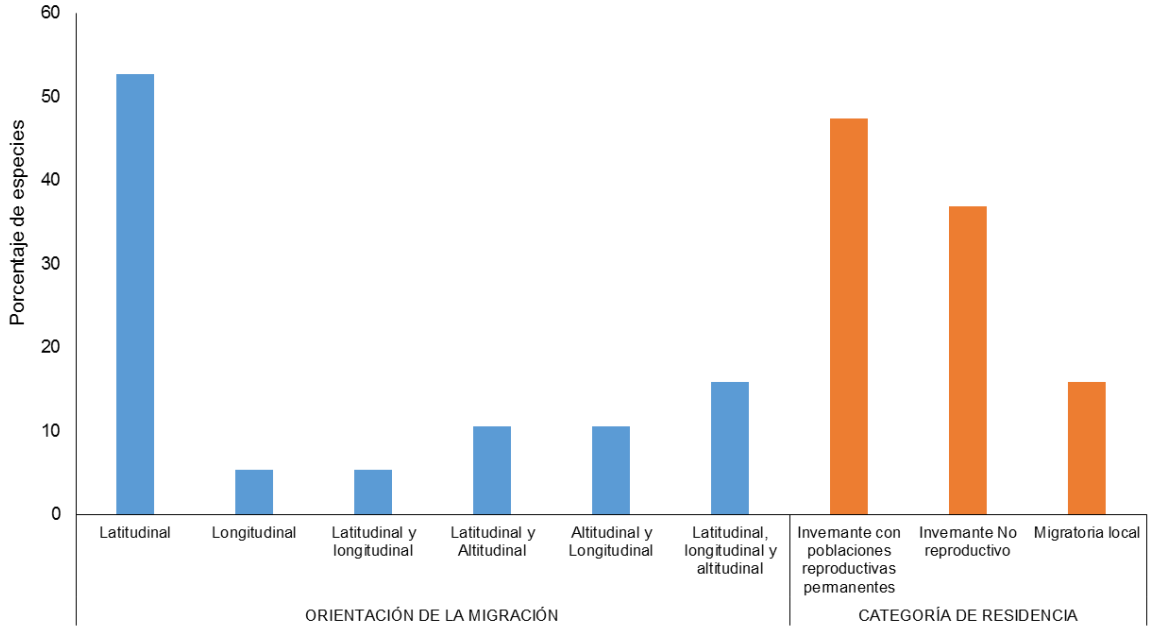


Figure No. 5.53 Percentage of migratory species identified in the area of influence according to the orientation of their migration and the residence category in Colombia
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

Of the 83-registered species, only one, the Caribbean racha guaca Ortalis garrula, is an endemic species for Colombia and three species, the Chavarri chauna chavaria, the pechiblan carriquí Cyanocorax affinis and the silver toche Ramphocelus dimidiatus, are considered to be almost endemic[65] [66]. On the other hand, two (2) of the registered species, the lora real Amazona farinosa and the chavarri C. chavaria are classified as almost threatened species in the IUCN red list [67].

Likewise, 14 species are classified in Appendix II and one in the Appendix III of CITES (Table No. 5.28). The above means that the species found in the Appendix II of CITES, are those that are threatened, but not to the point of extinction but could reach it, so its marketing is controlled. Those found in appendix III are those that,

[65] SALAMAN, Paul, DONEGAN, Thomas & CARO, David. List of Birds of Colombia. In: Colombian Conservation. May, 2009. no. 8, p. 3-79
[66] CHA PARRO-HERRERA, Sergio, ECHEVREEY-GALVIS, María Ángela, CÓRDOBA-CÓRDOBA, Sergio & SUA-BECERRA, Adriana. Updated list of endemic and near-endemic birds of Colombia. In: Colombian Biota. 2013. vol. 14. No. 2. 235-272
[67] UNIÓN INTERNACIONAL PARA LA CONSERVACIÓN DE LA NATURALEZA – UICN. The IUCN Red List of Threatened Species. Version 2015. [online] http://www.iucnredlist.org/search [Cited July 30, 2015]

although marketing is locally controlled, requires the cooperation of other countries to prevent illegal marketing [68].

The endemic species was observed where the port terminal would be located, the almost endemic species were observed in the access road to the port terminal. The species listed as Near Threatened in IUCN and in the Appendix II of CITES were observed in the access road, the port terminal and in the viaduct, while the species located in the Appendix III of CITES was observed in the port terminal and the viaduct (Figure No. 5.54 and Annex 5.2.8).

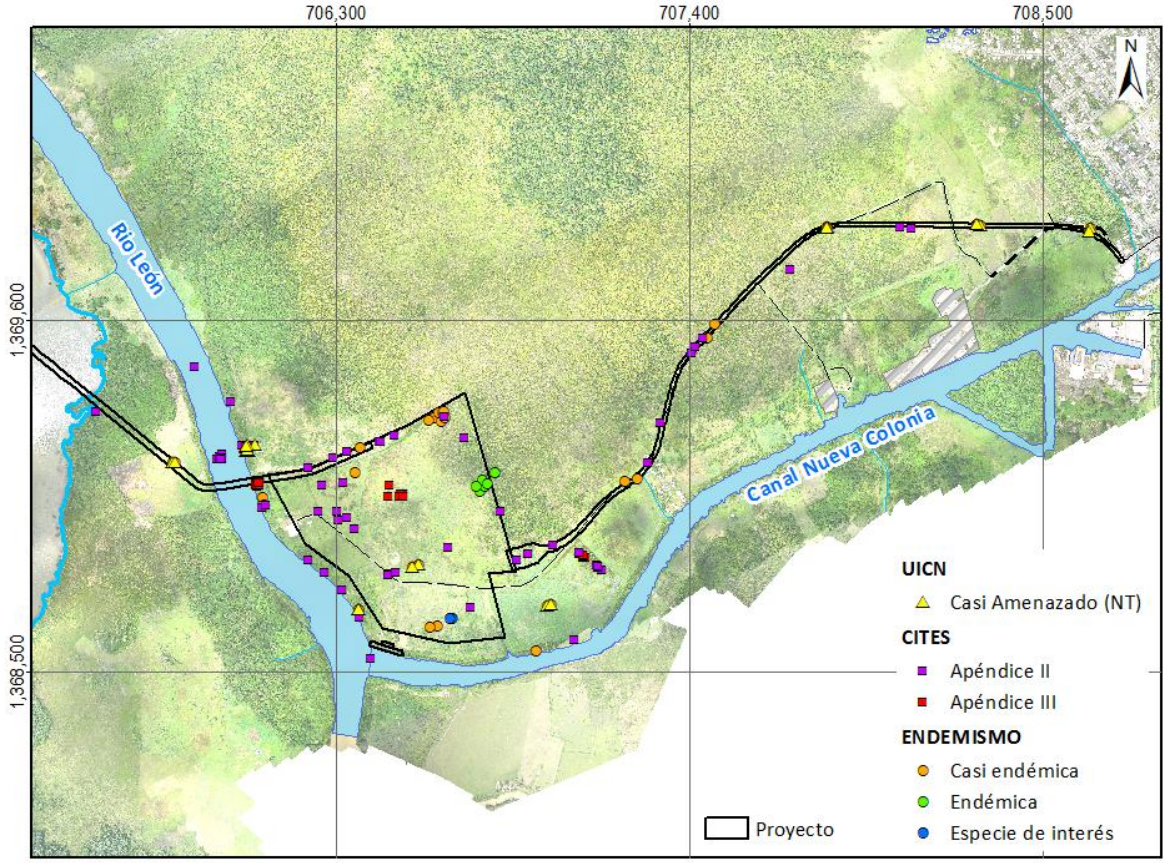


Figure No. 5.54 Geographic location of the endemic, near-endemic and interesting species and those classified in CITES, IUCN present in the area of influence
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

The remaining 81 identified species are classified as species in minor concern, which indicates that they do not meet the evaluation criteria to classify them in any

[68] CONVENTION ON INTERNATIONAL TRADE IN THREATENED WILDLIFE SPECIES- CITES. List of CITES species. [online] http://checklist.cites.org/#/es [cited July 30, 2015]

category of threat (Table No. 5.28). It should be noted that none of the species registered in the area was reported in Resolution 0192 of 2014[69] nor in the red book of Birds of Colombia [70].

The Caribbean guacharaca O. garrula and the pechiblanco carrion C. affinis were found only in the dense flooded non-wooded herbage (Hdina) and the other two species were found in clean pastures (Pl), wooded pastures (Pa, except R. dimidiatus), gallery and / or riparian forest (Bgr) and dense flooded, non-wooded herbage (Hdina).

The Caribbean guacharaca O. garrula, an endemic species of Colombia, is distributed in lowlands around 1,000 - 1,200 meters above sea level, mainly in the North Caribbean zone, which goes from the Gulf of Urabá to the La Guajira peninsula and from the lower Atrato River to the middle part of the Magdalena River valley.

The chavarri C. chavaria, the pechiblanco carriquí C. affinis and the toche silver peak R. dimidiatus, are considered almost endemic species because their geographic distribution in Colombia is at least 50% of their known geographical distribution and they are distributed in low lands around 1,000 - 1,200 meters above sea level and at medium elevations ranging from 800 to 2400 meters above sea level. It is common to find these species in the North Caribbean Zone, Sierra Nevada de Santa Marta, Serrania de Perijá-Motilones, Western slope of the Western Cordillera, slopes of the Valle del Cauca, slopes of the Central Cordillera and slopes of the high valley of the Magdalena River. It should be noted the presence of Coccycua pumila, a species that is considered of interest to Colombia, since between 40 and 49% of its known geographical distribution is in the country [71].

The lora real Amazona farinosa and El chavarriA. Chavarria are classified as Near Threatened Species in the IUCN Red List [72]. The reason why these species are classified in this category is that, worldwide, their populations have a tendency to decrease due to the loss of habitat due to forest deforestation (for A. farinosa) and

[69] COLOMBIA. MINISTRY OF ENVIRONMENT AND SUSTAINABLE DEVELOPMENT. Resolution 0192 (February 10, 2014). Op. cit.
[70] RENJIFO, Luis Miguel, FRANCO-MAYA, Ana maría, AMAYA-ESPINEL, Juan David, KATTAN, Gustavo & LÓPEZ-LANÚS, Bernabé. Red book of birds of Colombia. Research Institute of Biological Resources Alexander von Humboldt. Ministry of Environment. Series of red books of threatened species of Colombia. Bogotá. 2002. p. 554. ISBN: 958-8151-08-2
[71] Ibíd., p. 238-240

drainage of wetlands (for C. chavaria), as well as the increase of hunting for commercialization to be used as food and as pets[73] [74].

Below are some ecological aspects for the species identified as endemic, critically endangered and those that are considered ecologically important:

Table No. 5.20 Ecological aspects of the Caribbean guacharaca *Ortalis garrula*

Scientific name: *Ortalis garrula*	
Common name: Caribbean Guacharaca	
Coverages where it was identified: Dense flooded not wooded herbage (Hdina -321121)	
Habitat and areas of importance for breeding and reproduction They live in dense thickets, in squat deciduous forests, secondary growth forests, arid scrub, forests along rivers and mangroves. They are common in humid forest edges at the northern base of the Andes. Habits and behavior Its diet consists mainly of fruits (Simaruba glauca, Hamelia patens, Psidium guajava, Cecropia sp and Phytolacca rivinoides) and plants leaves such as Vernonia patens and Oyedaea verbesinoides [75]. The postures consist of three (3) rough-textured white eggs whose incubation takes approximately 26 days; they are noisy animals, they form large groups of more than six (6) individuals. They are mainly arboreal, they go down to the ground with little frequency in search of food[76].	

[73] UNION INTERNACIONAL PARA LA CONSERVACIÓN DE LA NATURALEZA – UICN. *Amazona farinosa*. The IUCN Red List of Threatened Species. 2015 Version. [online] http://www.iucnredlist.org/search [cited July 30, 2015]

[74] UNION INTERNACIONAL PARA LA CONSERVACIÓN DE LA NATURALEZA – UICN. *Cha una cha varia*. The IUCN Red List of Threatened Species. Version 2015. [online] http://www.iucnredlist.org/search [cited July 30, 2015]

[75] HILTY, S. L., BROWN, W. L. 2001. A guide to the birds of Colombia. Princeton University Press, Princeton.

[76]AVIBASE. 2015. Ortalis garrula. Available on the internet at: http://avibase.bsc-eoc.org/species.jsp?lang=EN&avibaseid=B679EB0CC3CE7D58. [Cited on 16/10/2015].

Scientific name: *Ortalis garrula* **Common name:** Caribbean Guacharaca Coverages where it was identified: Dense flooded not wooded herbage (Hdina -321121)	

Threats
IUCN: Minor concern - LC

Although it is not in threat category and was considered as common until 1986. It is still considered common in its range of distribution

Distribution

It is an endemic species of Colombia, its distribution is restricted to the northwest of Colombia, between the western slope of the Sierra Nevada de Santa Marta, the basin of the Sinú river and the lower valley of the Cauca river and the Magdalena river[77].

Table No. 5.21 Ecological aspects of the Chavarrí *Chauna chavaria*

Cientific name: *Chauna chavaria* **Common name**: Chavarrí Coverages where it was identified: Clean Pastures (Pl - 231) Wooded pastures (Pa - 232) Gallery and / or riparian forest (Bgr - 314) Dense flooded not wooded herbage (Hdina - 321121)	

Habitat and areas of importance for breeding and reproduction

[77] Ibíd

Cientific name: *Chauna chavaria* **Common name**: Chavarrí Coverages where it was identified: Clean Pastures (Pl - 231) Wooded pastures (Pa - 232) Gallery and / or riparian forest (Bgr - 314) Dense flooded not wooded herbage (Hdina - 321121)	

This species is associated with areas of marshes, lakes and swamps associated with slow-flowing rivers or floodplains surrounded by forests [78] (del Hoyo *et al.* 1992).

The nests are formed by leaf litter obtained from the marshes, normally they lay between 2 and 7 eggs between the months of October and November, although the upbringing continues during the year.

Habits and behavior

They can be found from solitaires to couples or small groups. When they are in heat or taking care of chicks their character is quite aggressive

This species is exclusively vegetarian, feeding mainly on the green parts of succulent plants, such as the Swamp Nail (Ludwigia leptocarpa) and watercress (L*udwigia helminthorrhiza*)[79].

Threats
IUCN: Almost Threatened - NT

It is in NT Category (IUCN), for presenting small populations and being in restricted areas. The main threats are associated with the loss of habitats for agricultural and livestock use[80]. Among other threats can be identified the collection of eggs, the capture as pets and the possible illegal hunting in some areas

Distribution

[78] DEL HOYO, J., A. ELLIOT Y J. SARGATAL (Eds.). 1992. Handbook of the Birds of the World. Volume 1, Ostrich to Ducks. Lynx Edicions, Barcelona, España.
[79] UNIVERSIDAD ICESI. Wiki Birds of Colombia. Available on the internet at: <https://www.icesi.edu.co/wiki_aves_colombia/tiki-index.php?page=Chavarria>. [citado el 16/10/2015].
[80] NARANJO, L. G. 1986. Aspects of the biology of the Horned Screamer in southwestern Colombia. *Wilson Bulletin* 98: 243-256.

Cientific name: *Chauna chavaria* **Common name**: Chavarrí Coverages where it was identified: Clean Pastures (Pl - 231) Wooded pastures (Pa - 232) Gallery and / or riparian forest (Bgr - 314) Dense flooded not wooded herbage (Hdina - 321121)	
Chauna chavaria is found in northwestern Venezuela (near Lake Maracaibo) and northern Colombia (between the Atrato valley to the east of the Santa Marta marsh, and close to the Cesar valley and south of Bolivar)[81].	

Table No. 5.22 Ecological aspects of the pechiblanco carriquí *Cyanocorax affinis*

Scientific name: *Cyanocorax affinis* **Common name**: carriquí pechiblanco Coverages where it was identified: Dense flooded not wooded herbage (Hdina - 321121)	
Habitat and areas of importance for breeding and reproduction It inhabits in dry forests to humid and pluvial; prefers edges, secondary forest and open mountains (Hilty & Brown 2001) They are monogamous animals; their postures consist of four eggs which are incubated by the female and hatch after 17 days Habits and behavior It is a shy and discreet bird that is generally maintained among the dense vegetation, although it is commonly found in groups of up to six (6) individuals [82] (Hilty & Brown 2001)	

[81] HILTY & BROWN. Op. cit.
[82] Ibíd

Scientific name: *Cyanocorax affinis* **Common name**: carriquí pechiblanco Coverages where it was identified: Dense flooded not wooded herbage (Hdina - 321121)	

They feed mainly on insects, lizards, small frogs and different types of fruits.

Threats

IUCN: Minor concern - LC

The population is stable and there is no evidence of substantial decline or threats.

Distribution
Its range of distribution includes Colombia, Costa Rica, Panama and Venezuela.

Table No. 5.23 Ecological aspects of the silver peak toche *Ramphocelus dimidiatus*

Scientific name: *Ramphocelus dimidiatus*

Common name: Toche pico de plata

Coverages where it was identified:

Clean Pastures (Pl - 231)

Dense flooded non-wooded herbage (Hdina - 321121)

Gallery and / or riparian forest (Bgr - 314)
Arracachal (Arc - 321123)

Habitat and areas of importance for breeding and reproduction

This species lives in clearings with bushes, cultivated areas and jungle edges.

Habits and behavior

This species is usually found in understory groups, along gardens and clearings, of diurnal behavior and that feeds mainly on fruits and insects.[83].

There are records of nests of this species between January and March with two blue eggs with dark spots.

Threats

IUCN: Minor Concern - LC

The population is stable and there is no evidence of substantial decline or threats.

Distribution

[83] Ibíd.

Scientific name: *Ramphocelus dimidiatus*	
Common name: Toche pico de plata	
Coverages where it was identified: Clean Pastures (Pl - 231) Dense flooded non-wooded herbage (Hdina - 321121) Gallery and / or riparian forest (Bgr - 314) Arracachal (Arc - 321123)	
This species is distributed throughout the Magdalena Valley, Cordillera Occidental and the Caribbean region up to Sierra Nevada Santa Marta up to 1500 masl.	

Table No. 5.24 Ecological aspects of the lora real *Amazona farinosa*

Cientific name: *Amazona farinosa*	
Common name: Lora Real or Silver eye lora	
Coverages where it was identified: Gallery and / or riparian forest (Bgr - 314) Open shrub (Ara - 3222)	
Habitat and areas of importance for breeding and reproduction It inhabits humid and very humid forests, edges of forests, gallery forests and semi-open areas with vegetation in secondary succession. [84]. Habits and behavior It feeds on fruits of various species, some of them are: Euterpe sp., Brosimum sp., Inga sp., Dussia sp., Eschweilera sp., Pithecellobium sp., Tetragastris sp., Dialium guianensis, Peritassa compta, Sloanea grandiflora and Corima macrocarpa. It also consumes flowers, arios of Cassearia sp. and nectar of Tabebuia insignis[85].	

[84] AVIBASE. Op. cit.
[85] HILTY & BROWN. Op. cit.

Cientific name: *Amazona farinosa* **Common name**: Lora Real or Silver eye lora Coverages where it was identified: Gallery and / or riparian forest (Bgr - 314) Open shrub (Ara - 3222)	

Evidence of reproduction at the beginning of January. They nest in hollows of palms and trees. They usually put three (3) to four (4) eggs whose incubation period is 26 to 27 days. A nest in the cavity in a stone wall has also been reported[86]. Generally, it remains in large groups or in pairs.

Threats

IUCN: Near Threatened - NT
CITES: Appendix II

The main threat is the loss of habitat, combined with the susceptibility to hunting and capture.

Distribution

From Mexico and throughout Central America to Brazil. In Colombia it reaches up to 1100 m above sea level in the lowlands of the Pacific Coast. Also, in the middle valley of the Magdalena River and east of the Andes in the Serrania de San Jacinto, western base of the Serrania de Perijá and the department of Sucre[87].

Table No. 5.25 Ecological aspects of the cuclillo enano *Coccycua pumila*

[86] Ibid
[87] DEL HOYO, J., COLLAR, N.J., CHRISTIE, D.A., ELLIOTT, A. and Fishpool, L.D.C. 2014. HBW and BirdLife International Illustrated Checklist of the Birds of the World. Lynx Edicions BirdLife International.

Scientific name: *Coccycua pumila* Common name: Cuclillo enano o rabicorto Coverages where it was identified: Clean pastures (Pl - 231)	

Habitat and areas of importance for breeding and reproduction

It inhabits deciduous tropical forests, gallery forests, open areas, grasslands with scattered trees, dry scrub and secondary forests. Nowadays, it is observed in deforested forests in humid and very humid regions[88].

Habits and behavior

It probably reproduces throughout the year. It is a monogamous or polyandric species and sometimes two females can lay in the same nest. Its nest is a shallow and flimsy platform built with sticks, leaves and tendrils in the crown of a low tree. The size of its posture is 2 or 3 white eggs which coulb be incubated by both sexes. Both parents are responsible for the care of the chicks who acquire almost all the plumage close to day 12 after hatching and leave the nest from day 14 to day 21[89].

It feeds on insects, especially caterpillars and nymphs of the Membracidae family. It also includes beetles, dragonflies and cicadas in its diet.

It is a generally solitary and little active bird that goes unnoticed much of the time. It looks for prey in internal and external branches of the vegetation and sometimes feeds on the ground. Like other cuckoos it shakes and jaws its prey before ingesting it which allows it to eliminate some type of defensive secretion[90].

Threats
IUCN: Minor concern – LC

The population is believed to be increasing, because the degradation of habitats has generated new habitats for their development.

[88] HILTY & BROWN. Op. cit.
[89] PAYNE, R. B. *Coccycua pumila* Pp 595. In: DEL-HOYO, J., ELLIOT, A. Y SARDATAL, J. 1992. Handbook of the Birds of the Wold. Vol 3. Ostrich to Ducks. Lynx editions. Barcelona. 821p.
[90] Ibid

Scientific name: *Coccycua pumila* Common name: Cuclillo enano o rabicorto Coverages where it was identified: Clean pastures (Pl - 231)	
Distribution It is in Colombia, Venezuela and the northwest part of Brazil, it is distributed in the Caribbean region from the eastern department of Atlántico to the western base of the Sierra Nevada de Santa Marta. Also, in the north of the Serrania del Perijá, the middle valley of the Magdalena River and from the savannah of Bogotá to the south of Tolima. Its located East of the Andes from Norte de Santander to Arauca, Meta and west of Caquetá.	

In relation to the species of economic, ecological and cultural importance, in Annex 5.2.7 the uses of the avifauna present in the area can be observed, where they are mostly used as companion animals and as a source of secondary food. In relation to the birds of cultural and economic importance for their use as pets are the royal lora, the yellow-headed parrot and the tanned parakeet as the most important. From an ecological point of view, the group of birds play an important role within the ecosystem, as they are considered natural seed dispersers, promoting the natural regeneration of floristic species of the area and colonization of new places.

3. Mastofauna

In the area of influence of the project in question, small, medium and large and flying mammals were identified. Below are the results by group.

Small mammals

The group of small non-flying mammals is composed of rodents and small marsupials, to show that species belonging to this group are in the project area, a total of 60 Sherman traps were installed, arranged in the different coverages present in the area. Obtaining a total sampling effort of 360 traps / night.
During the six nights that the traps were active in the different coverages of the area, only the individual Melanomys caliginosus mouse was recorded (Photo No. 5.27). Animal captured in the High Flood Dense Forest (mangrove), this species is

characterized by being common throughout its range, inhabiting primary and secondary forests, edges, and adjacent highly intervened areas such as pastures and crops[91].

Small rodents have relatively small areas of action almost always below 10,000 m^2 [92], in the project area and due to the conditions of the terrain (flood areas), the movements of the Melanomys caliginosus mouse can be influenced by these conditions, thus presenting small use areas.

Photo No. 5.27 *Melanomys caliginosus* mouse and dense forest (place of capture)
Source: SAG S.A.

The low number of species, one, reported in the AID of the project, can be influenced by several factors, among which the type of trap, the arrangement and disposition of the same and the type of bait can influence the measures of abundance and diversity of this group[93]. Additionally, habitat characteristics condition the attributes of said communities, relating greater wealth to greater complexity of the habitat [94].

[91] ANDERSON, R.P., GÓMEZ-LAVERDE, M. & TIMM, R. 2008. *Melanomys caliginosus*. The IUCN Red List of Threatened Species 2008: e.T13046A3407104. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T13046A3407104. Downloaded on 02 October 2015.
[92] WOOD, B. A., CAO, L., Y DEARING, M. D. (2010). Deer mouse (Peromyscus maniculatus) home-range size and fidelity in sage-steppe ha bitat. Western North American Naturalist, 70(3), 345–354.
[93] PEARSON, D. E. AND L. F. RUGGIERO. 2003. Transect versus Grid Trapping Arrangements for Sampling Small-Mammal Communities. Wildlife Society Bulletin. 31(2): 454-459.
[94] VIVEIROS C.E. 2003. Forest Structure and Vertical Stratification of Small Mammals in a Secondary Atlantic Forest, Southeastern Brazil. Studies on Neotropical Fauna and Environment. Vol. 38, No. 2, pp. 81–85

Medium and large mammals

In the project's area of influence in question, 13 species of medium and large mammals were recorded (Photo No. 5.28, Photo No. 5.29) grouped into 5 orders and 11 families (Table No. 5.36). The most representative order was Carnivora, comprising 36.4% of the families and 38.5% of the species present, followed by Rodentia (27.3% of the families and 23.1% of the species). The remaining orders presented less than 20% of the families and species recorded (Figure No. 5.55).

Photo No. 5.28 Some species of mammals observed in the area of influence of the project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Photo No. 5.29 Traces of mammals in traps. 1) *Dasyprocta punctata;* 2,4,7,9) *Cuniculus paca* ; 3,6) *Didelphis marsupialis*; 5,8) *Procyon cancrivorus*
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.26 Taxonomic composition and classification in CITES, IUCN, Resolution 0192 of 2014 and Red Book of mammals (medium and large) present in the area of influence

Order	Family	Species	Common name	CITES	UICN	Res. 0192 / 2014	Red Book
Carnívora	Canidae	*Cerdocyon thous*	Crab-eating fox	Appendix II	Lc	No	No
	Felidae	*Puma yagouaroundi*	Puma	Appendix II	Lc	No	No
	Mustelidae	*Eira barbara*	Tayra	Appendix III	Lc	No	No
		Lontra longicaudis	Neotropical otter	Appendix I	NT	VU	VU
	Procyonidae	*Procyon cancrivorus*	Raccoon	No	Lc	No	No
Didelphimorphia	Didelphidae	*Chironectes minimus*	Water puppy	No	Lc	No	No

Order	Family	Species	Common name	CITES	UICN	Res. 0192 / 2014	Red Book
		Didelphis marsupialis	Possum	No	Lc	No	No
Pilosa	Bradypodidae	*Bradypus variegatus*	Three-toed sloth	Appendix II	Lc	No	No
Primates	Callitrichidae	*Saguinus oedipus*	Tití cabeciblanco	Appendix I	CR	CR	VU
	Cebidae	*Cebus capucinus*	Capuchin monkey	Appendix II	Lc	No	No
Rodentia	Caviidae	*Hydrochoerus hydrochaeris*	Capibara, Chigüiro	No	Lc	No	No
	Cuniculidae	*Cuniculus paca*	common Paca, guagua	Appendix III	Lc	No	No
	Dasyproctidae	*Dasyprocta punctata*	Agouti	Appendix III	Lc	No	No

NT: species in category of almost threatened; Lc: species considered to be of minor concern; CR: species considered Critically Endangered
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

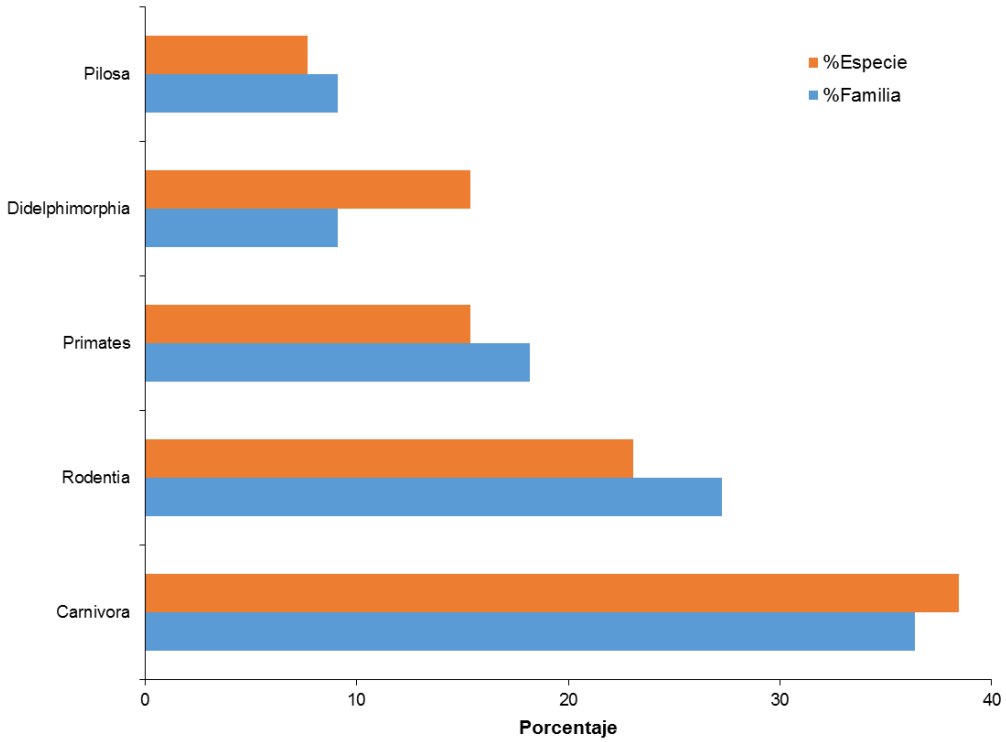


Figure No. 5.55 Representation of orders of medium and large mammals by percentage of families and species grouped by each
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

In terms of abundance, 98 individuals were recorded, of which the Hydrochoerus hydrochaeris, Procyon cancrivorus, Cebus capucinus and Didelphis marsupialis species were the most abundant with 29, 17, 11 and 11 individuals observed respectively. The remaining nine (9) species presented less than 10 individuals (Appendix 5.2.9).

In relation to the mammals reported, the presence of Lontra longicaudis represents, for the study area, an umbrella species in the aquatic ecosystem which places it at a level of vulnerability to the intervention of its habitat, H. hydrochaeris occupies a large part of the study area for all its ecological requirements, shelters, baths, food areas, trails, and females with young were found, it also becomes the species with greater hunting use by the Nueva Colonia Canal and Puerto Girón communities.

As for primates Cebus capucinus and Saguinus oedipus were observed in different activities such as grooming and feeding; the presence of Ateles fusciceps and Alouatta seniculus is also highlighted in the surrounding areas with mangrove coverings, wooded and palm groves and that due to the fragmentation of the forest cover towards the areas with grasses and grassland these species do not cross into these areas.

When performing the analysis by identified coverage unit in the area of influence, nine (9) of them recorded medium and small mammals, being the dense flooded non-wooded herbage (Hdina) which presented greater wealth and abundance, followed by clean pastures (Pl) and the gallery and / or riparian forest (Bgr). The remaining six (6) coverages where mammals were observed had a wealth lower than five (5) species and 10 individuals (Figure No. 5.56, Annex 5.2.9).

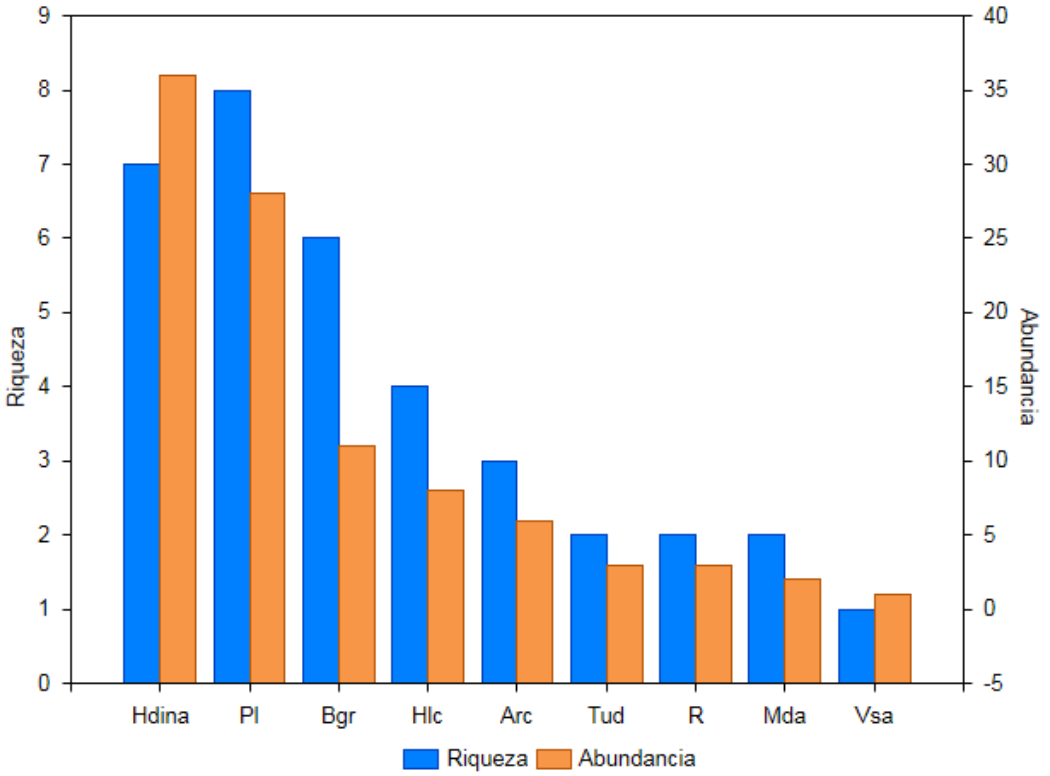


Figure No. 5.56 Wealth (axis and left) and abundance (axis and right) of the medium and large mammals present in the coverages identified in the area of influence. Arc: Arracachal, Bgr: Gallery and / or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Pl: clean pastures; Rivers: (R); Tud: discontinuous urban fabric; Vsa: High secondary vegetation
Source: prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

The ecological indexes for vegetation cover indicate that the clean grasses (Pl) and the gallery and / or riparian forest (Bgr) were the coverages that presented a greater specific wealth and diversity of species and were dominated by several species which presented a homogeneous distribution in terms of its abundance. The coverage that presented the lowest specific wealth and diversity was the secondary high vegetation (Vsa), since in this coverage a single species was registered with a single individual (Figure No. 5.57, Annex 5.2.9).

The report of species with greater wealth and diversity in the pastures and riparian forests present in the area, is probably due to the fact that the greater abundance was attributed to species that are dependent on the aquatic environment for different activities such as chigüiro and guagua, other mammals such as the three-toed sloth depend heavily on riparian vegetation, always seeking to have nearby water sources

to come down from the trees to drink water, perform their physiological needs and move from one place to another.

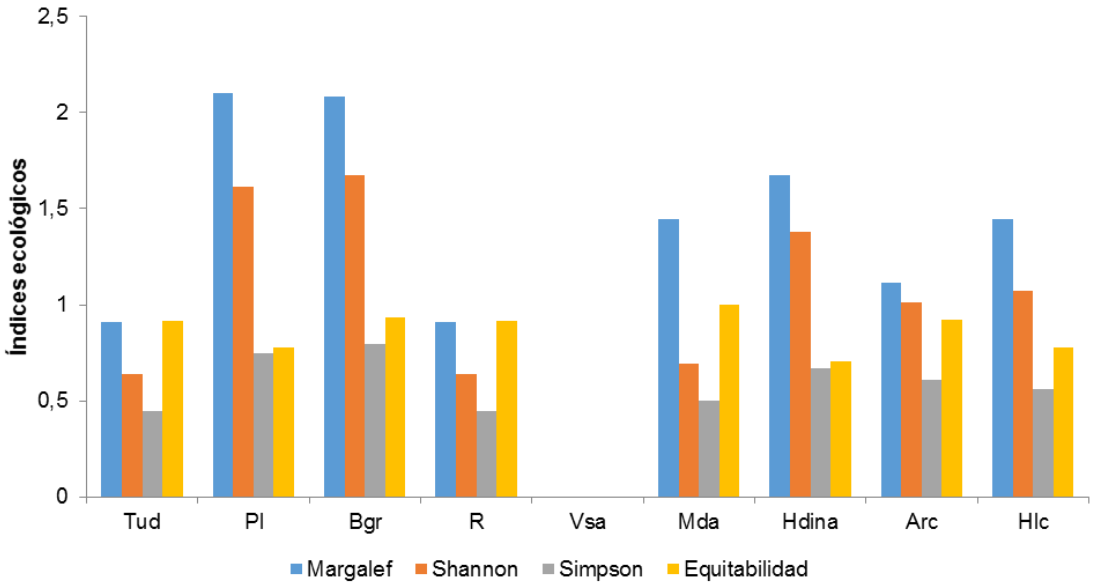


Figure No. 5.57 Ecological indexes of the coverages identified in the area of influence according to the medium and large mammals present there. Arc: Arracachal, Bgr: Gallery and / or riparian forest; Hlc: Helechal l; Hdina: dense, flooded, non-wooded herbaceous; Mda: Dense high mangrove; Pl: clean pastures; Rivers: (R); Tud: discontinuous urban fabric; Vsa: High secondary vegetation
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

Of the 13 species of medium and large mammals identified in the area of influence, only one, the cotton-top tamarin Saguinus oedipus, is considered an endemic species for Colombia. At the national level in Resolution 0192 of 2014[95] this species is categorized as a critically endangered species (CR), along with the otter, Lontra longicaudis, which is in the almost threatened category (NT). In the red book of mammals in Colombia the cotton-top tamarin, S. oedipus and the otter, L. longicaudis are in the category of vulnerable species (VU)[96]. Globally within the

[95] COLOMBIA. MINISTRY OF ENVIRONMENT AND SUSTAINABLE DEVELOPMENT. Resolution 0192 (February 10, 2014). Op. cit.
[96] RODRÍGUEZ-MAHECHA, José Vicente, ALBERICO, Micha el, TRUJILLO, Fernando & JORGENSON, Jeff. Red book of mammals of Colombia. Research Institute of Biological Resources Alexander von Humboldt. Ministry of Environment. Series of red books of threatened species of Colombia. Bogotá. 2006. 430 p. ISBN 978-958-97690-7-2

IUCN red list [97] these two species are in the same threat categories as nationally. Finally according to CITES the cotton-top tamarin S. oedipus and the nutria L. longicaudis,are found in Appendix I, the capuchin monkey, C. capucinus, the puma Puma yagouaroundi, the three-toed sloth Bradypus variegatus and the crab-eating fox Cerdocyon thous are found in Appendix II and the Cuniculus paca, Agouti Dasyprocta punctata and Tara Eira barbara are found in Appendix III (Figure No. 5.58 and Appendix 5.2.10).

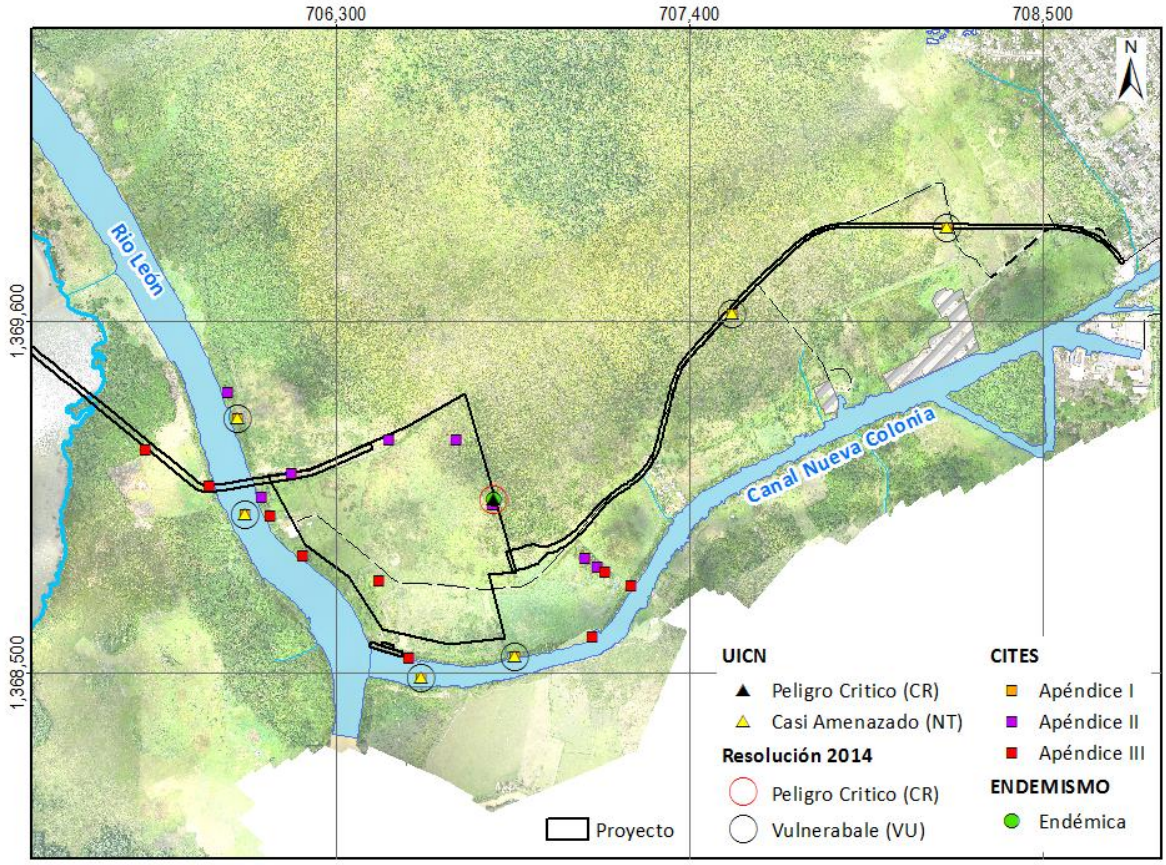


Figure No. 5.58 Geographical location of the endemic species and those classified in CITES, IUCN, Resolution 0192 and red book of mammals of Colombia present in the area of influence
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

Regarding their registration in the study area, the endemic, critically endangered species and within Appendix I of CITES, was observed in the port terminal, while the almost endangered species was observed in the access route to the port

[97] UICN. Op. cit. [cited August 5, 2015]

terminal. In turn, the species classified within Appendix II of CITES were found in the port terminal and those that are classified in appendix III in the viaduct (Figure No. 5.58).

Below are some ecological aspects for the species identified as endemic, critically endangered and those that are considered ecologically important:

Table No. 5.27 Ecological aspects of cotton-top tamarins *Saguinus oedipus*

Scientific name: *Saguinus oedipus*	
Common name: cotton-top tamarin	
Coverages where it was identified: Dense flooded non-wooded herbaceous (Hdina - 321121)	
Habitat and areas of importance for breeding and reproduction The titi monkey presents a family group, its displacement is carried out through an area called the action area, which has an approximate extension of 7 to 10 ha., However areas of up to 32 ha have been reported. In general, it is assumed that the action areas adjoin or overlap with those of other family groups of titi monkeys.[98]. The reproduction of the titi monkey is dominated by a dominant female, which depending on its nutritional status produces a variable number of ovules, usually the female produces dizygotic twins, and the gestation period is approximately 184 days, the gravidity is characterized by ovulation. 3 to 5 weeks after birth, the offspring represent 14 to 25% of the female at birth[99]. The breeding system is cooperative, consisting of assistance in surveillance, food and mainly transport of the offspring. Habits and behavior	

[98] Available on the internet at: <http://damisela.com/zoo/mam/primates/callitrichidae/oedipus/>. [cited on 15/10/2015].
[99] ibid

Scientific name: *Saguinus oedipus* **Common name:** cotton-top tamarin Coverages where it was identified: Dense flooded non-wooded herbaceous (Hdina - 321121)	

This primate presents daytime and arboreal habit. They communicate using the smell with which they identify by scent marks if this belongs to the family or an external group, their populations usually develops in secondary vegetation forests, and in the margins of humid forests and dry forests, there are also records that locate them in areas that have presented agricultural intervention[100].

Threats

CITES: Appendix I

IUCN: CR

Resolution 0192 of 2014: CR
Endemic

The habitat of the titi cabeciblanco, due to the services offered at the environmental, economic and development level in terms of colonization, presents intensive intervention, mainly destined to agricultural activities (agriculture and livestock), and in the present the greatest threat that presents is due to infrastructure projects (hydroelectrics, roads among others)[101].

The use of the cotton-top tamarin as a research model and the study of colon adenocarcinoma represents a serious risk for its population since these are

[100] ibid
[101] Available online at: <http://recursosbiologicos.eia.edu.co/ecologia/estudiantes/titicabeciblanco.htm.> [citado el 15/10/2015]

Scientific name: *Saguinus oedipus* **Common name:** cotton-top tamarin Coverages where it was identified: Dense flooded non-wooded herbaceous (Hdina - 321121)	

exported for research purposes, in 1973 the export was canceled because it was declared as an endangered species[102][103].

Distribution

The cotton-top tamarin monkeys are found only in Colombia, from the east bank of the Atrato River, the eastern bank of the Cauca River, and the lower Magdalena bounded by the northern coast of the Colombian Caribbean. In the south, the 1500 meters are counted from the East to the west starting in the Cauca River and crossing the Serrania de Ayapel and the Serrania de San Jerónimo[104].

[102] NEAL, K. CLAPP. A primate model for the study of colitis and colonic carcinoma the cotton-top tamarin (*Saguinus oedipus*). CRC Press; 1 edition (July 6, 1993). ISBN-10: 0849353637

[103] Available online at: <http://recursosbiologicos.eia.edu.co/ecologia/estudiantes/titicabeciblanco.htm.> [cited on 15/10/2015]

[104] Available online at: <http://recursosbiologicos.eia.edu.co/ecologia/estudiantes/titicabeciblanco.htm.> [cited on 15/10/2015]

Table No. 5.28 Ecological aspects of the otter *Lontra longicaudis*

Scientific name: *Lontra longicaudis*	
Common name: Nutria neotropical	
Coverages where it was identified: Clean Pastures (Pl - 231) Gallery and / or riparian forest (Bgr - 314) Rivers (R - 511) Dense flooded non-wooded herbaceous (Hdina - 321121) Arracachal (Arc - 321123)	
Habitat and areas of importance for breeding and reproduction The river otter uses shelters that are flooded or associated with bodies of water, they could be natural cavities between rocks or under the roots of large trees, or could be excavated by these or other mammals. In general they prefer little intervened habitats, in forests and savanna areas, in those areas they select rivers, lakes, swamps, pipes, lagoons, coastal areas and streams, preferably clear waters with fast course, however they have been observed in large rivers with high sediment load. Reproduction occurs mainly in September, or spring in the southern hemisphere. The gestation lasts up to 70 days, after which around 3 offspring are born. The male does not participate in the breeding, the female being the one that presents parental care, the same offspring become independent after a year of life. Habits and behavior It is a species usually solitary or in pairs, it is assumed that they have overlapping habitats, presents its highest level of activity during the day, however its current classification is diurnal with twilight hours. Additionally, this species prefers	

Scientific name: *Lontra longicaudis* **Common name:** Nutria neotropical	
Coverages where it was identified: Clean Pastures (Pl - 231) Gallery and / or riparian forest (Bgr - 314) Rivers (R - 511) Dense flooded non-wooded herbaceous (Hdina - 321121) Arracachal (Arc - 321123)	

habitats that are rarely intervened in the jungle and areas of the savannah, where it selects rivers and streams and clear waters.[105]

Threats

CITES: Appendix I

IUCN: NT
Resolution 0192 of 2014: VU

Among the causes that have led to this species to become vulnerable are hunting, to market their skin, the degradation of habitats, water pollution and the decrease in the food supply, intensive fishing[106].

Distribution
There are sightings in Colombia, for most of the departments, usually on the flanks of the Western, Eastern and Central Cordilleras and in low areas with warm and temperate temperatures. Its highest frequency of sightings has occurred in the Amazon, Orinoquia, the Serrania de La Macarena, the Magdalena River Valley, swamp areas between Barranquilla and Santa Marta, the western flank of the

[105] ibid
[106] ibid

Scientific name: *Lontra longicaudis* **Common name:** Nutria neotropical	
Coverages where it was identified: Clean Pastures (Pl - 231) Gallery and / or riparian forest (Bgr - 314) Rivers (R - 511) Dense flooded non-wooded herbaceous (Hdina - 321121) Arracachal (Arc - 321123)	
Sierra Nevada de Santa Marta, central and southern Guajira, Chocó, Cauca and Nariño[107]. In general, The otter, L. longicaudis is distributed particularly in the flanks of the three mountain ranges, as well as low areas in warm and temperate places, reaching altitudes of up to 3,000 m, however most of the reports are from 300 to 2800 m.	

Table No. 5.29 Ecological aspects of the *Puma yagouaroundi*

[107] ibid

Scientific name: *Puma yagouaroundi*

Common name: Puma

Coverages where it was identified:

Gallery and / or riparian forest (Bgr - 314)
Helechal (Hlc – 321124)

Habitat and areas of importance for breeding and reproduction

It presents a great variety of habitats, among these dry forests, pastures and savannas, gallery forests, scrub and montane forests, as well as more open environments compared to other felines [108].
It has been proven that it tolerates habitats that have been intervened by agricultural activity and its general distribution is below 2000 m. up to 3200 m. The gestation lasts between 70 and 75 days, being born from one to four young, two puppies being more common[109].

Habits and behavior

It is a solitary predator, of daytime habitat, its shelters are usually hollow trunks or dense thickets, subsistence hunting is done terrestrially, although it usually climbs trees to improve the visual field, in general its diet consists of small mammals, especially rodents, followed by land birds and reptiles, including poisonous snakes, fish and occasionally plant material[110].

Threats

CITES: Appendix II
IUCN: LC (minor concern)

According to the IUCN, at a global level the species is categorized as LC minor concern, although it has disappeared from some areas of its original distribution

[108] Available online at: <http://www.metropol.gov.co/mamiferos/especies/OrdenCarnivora/FamiliaFelidae/Pumayagouaroundi/Puma_yagouaroundi.pdf>
[109] ibid
[110] ibid

Scientific name: *Puma yagouaroundi* **Common name**: Puma Coverages where it was identified: Gallery and / or riparian forest (Bgr - 314) Helechal (Hlc – 321124)	

and in general seems to be less abundant than was traditionally believed. For the above and for the possible impact of the fragmentation of their habitat[111].

Distribution

The Puma yagouaroundi, presents distribution from the south of the United States to the center of Argentina, it is likely that they have inhabited most of the Colombian territory from 0 to 3200 meters above sea level, however its current distribution in the country is unknown, in general only they have two recent documented records, one of them corresponds to an individual run over on the hill of the escobero in 2012, and sightings have been reported in the south of the Aburra Valley[112].

Table No. 5.30 Ecological aspects of the three-toed sloth *Bradypus variegatus*

Scientific name: *Bradypus variegatus* **Common name:** three-toed sloth Coverages where it was identified: Clean Pastures (Pl - 231) Gallery and / or riparian forest (Bgr – 314)	

Habitat and areas of importance for breeding and reproduction

B. variegatus is susceptible to habitat destruction due to its reduced mobility, reduced home environment, its gregarious and diurnal habits and its timid nature. This makes this species more vulnerable and has contributed to the

[111] ibid
[112] ibid

Scientific name: *Bradypus variegatus* **Common name:** three-toed sloth Coverages where it was identified: Clean Pastures (Pl - 231) Gallery and / or riparian forest (Bgr – 314)	

disappearance of this species from many of its original distribution zones. Habitat fragmentation has isolated many populations from their seasonal feeding places and from potential breeding pairs which leads to local extinctions. It is unlikely that small fragments of isolated forests will contain viable populations in the long term, given the small genetic pool[113].

Habits and behavior

The sloths are of an arboreal habit rarely seen on land, they are cautious, silent, discreet and peaceful. They are of great importance for the health of ecosystems. These arboreal herbivores can reach branches inaccessible to other species and play an important role as recyclers of forest nutrients[114].

Threats

CITES: Appendix II
IUCN: LC (minor concern)

In general, it does not present, according to IUCN, the greatest danger worldwide. However, in the Colombian Pacific and Atlantic, its main threat is deforestation, which has led to severe degradation and fragmentation of its habitat. In addition to this, the species is exploited for its meat, by the black and indigenous communities. As well as for the illegal trafficking of the offspring, increasing the

[113]Available online at: https://www.minambiente.gov.co/images/BosquesBiodiversidadyServiciosEcosistemicos/pdf/Planes-para-la-conservacion-y-uso-de-la-biodiversidad/4022_100909_estrategia_oso_perezoso.pdf [citado el 15/10/2015]
[114] ibid

Scientific name: *Bradypus variegatus*	
Common name: three-toed sloth	
Coverages where it was identified: Clean Pastures (Pl - 231) Gallery and / or riparian forest (Bgr – 314)	

mortality rate since to obtain the offspring and commercialize them they must kill the parents [115].

Distribution

The distribution area of B. variegatus once occupied almost the entire

national territory; today it is marginalized to some coastal regions,

some low localities of the inter-Andean valleys and to the regions of Orinoco and Amazonas[116].

Table No. 5.31 Ecological aspects of the guagua *Cuniculus paca*

Scientific name: *Cuniculus paca*	
Common name: Guagua	
Coverages where it was identified: Gallery and / or riparian forest (Bgr – 314) Arracachal (Arc – 321123) Helechal (Hlc – 321124)	

Habitat and areas of importance for breeding and reproduction

They are usually located in natural environments, using burrows on the ground or fallen trees as shelter, these generally with one to three ports of entry and exit,

[115] MORAES-BARROS, N., CHIARELLO, A. & PLESE, T. 2014. *Bradypus variegatus*. The IUCN Red List of Threatened Species 2014: e. T3038A47437046. Available online at: <http://dx.doi.org/10.2305/IUCN.UK.2014-1.RLTS.T3038A47437046.en> [cited on 15/10/2015].
[116] ibid

Scientific name: *Cuniculus paca*	
Common name: Guagua	
Coverages where it was identified: Gallery and / or riparian forest (Bgr – 314) Arracachal (Arc – 321123) Helechal (Hlc – 321124)	

and one to four for the circumstantial escape and an internal cavity for daytime sleep[117].

Its habitat includes humid areas of warm earth and mountain, deciduous marshes, brackish and morichales, secondary forest or scrub vegetation and cultivated patches in wooded areas [118].

The family circle is conformed by the males, the gestation is of around 155 days, with a feeding period (lactation) of 15 to 30 days and reach the maturity from 8 to 12 months [119].

Habits and behavior

They are usually of solitary, territorial, nocturnal habit, with silvicultural eating habits, they usually inhabit places far from water bodies most of the time [120].

Threats

CITES: Appendix III
IUCN: LC (minor concern)

The main threat that this species faces is hunting for sustenance and commercial purposes, by the indigenous and rural population, however the creation of large-scale breeding sites has reduced this anthropogenic pressure[121].

[117] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS – FAO. Use of wildlife in Latin America. Situation and perspectives for sustainable management. Ojasti, Juhani. FAO (January 30, 1993). ISBN-10: 9253033169
[118] ibid
[119] ibid
[120] ibid
[121] ibid

Scientific name: *Cuniculus paca* Common name: Guagua Coverages where it was identified: Gallery and / or riparian forest (Bgr – 314) Arracachal (Arc – 321123) Helechal (Hlc – 321124)	
Distribution Lapa (Cuniculus paca) is a rodent of the neo-tropical region distributed from southeastern Mexico to northern Argentina, especially in humid tropical forests, reaching a vertical distribution of up to 3000 m.s. with a minimum of 2300 m.[122]	

Flying Mammals

This group is comprised exclusively of the order Chiroptera (bats), in order to report the largest number of species belonging to this group, four fog nets were installed per plant cover in the project area, presenting a sampling effort of 60 hours /net.

This group was represented by seven species, all belonging to the family Phyllostomidae (bats of the nasal leaf) (Table No. 5.42), considered the most important family of bats in the Neotropics both by the number of species and by their function to be large dispersers of seeds. The most abundant species during this characterization was Carollia perspicillata, presenting eight (8) individuals, this species is considered as the most abundant in our environment, and considered one of the species that contributes most in the regeneration of neotropical forests, due to its role as seed disperser. Following this, Platyrrhinus brachycephalus was reported, with five individuals, an important species in the ecosystems where it inhabits for its role as a seed disperser. The other species reported had less than three (3) individuals (Table No. 5.42).

Table No. 5.32 Taxonomic composition and threat category of bat species

TAXAS	Common Name	Trophic Guide	CITES	IUCN	Resolution 0192	Total
CHIROPTERA						
Phyllostomidae						

[122] ibid

TAXAS	Common Name	Trophic Guide	CITES	IUCN	Resolution 0192	Total
Artibeus lituratus	Bat	F	None	LC	No Report	1
Carollia perspicillata	Bat	F	None	LC	No Report	8
Glossophaga longirostris	Bat	I	None	DD	No Report	1
Platyrrhinus helleri	Bat	F	None	LC	No Report	3
Glossophaga gasoricina	Bat	I	None	LC	No Report	2
Platyrrhinus brachycephalus	Bat	F	None	LC	No Report	5
Uroderma bilibatum	Bat	F	None	LC	No Report	2

Source: SAG S.A.

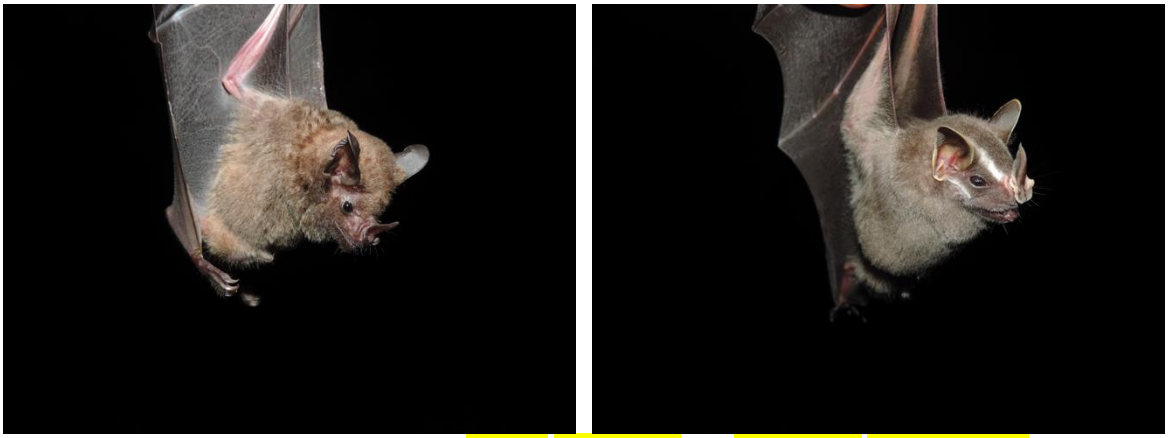
Regarding the results by coverage, of the 22 individuals and seven (7) species reported, the gallery forest was the place where the greatest number of individuals was reported, 18 as well as species four (4), followed by the dense forest with two (2) species, the Arracachal and the tree-lined grasses with one (1), and finally the herbazal, cover in which no captures were obtained (Table No. 5.43).

In terms of abundance, Carollia perspicillata and Platyrrhinus brachicephalus (Photograph No. 5.30) in the gallery forest, with 36.36% equivalent to 8 individuals, and 22.73% 5 individuals respectively, show them as the best represented species in the study area. The others have abundances lower than 13.64% (Table No. 5.43).

Table No. 5.33 Abundance of bats by plant cover

Coverage	Species	Common Name	Total	Ab. relative
Tree-lined grasses	*Glossophaga gasoricina*	Bat	1	4,55
Dense Forrest	*Artibeus lituratus*	Bat	1	4,55
	Glossophaga gasoricina	Bat	1	4,55
Forest Gallery	*Carollia perspicillata*	Bat	8	36,36
	Platyrrhinus helleri	Bat	3	13,64
	Platyrrhinus brachycephalus	Bat	5	22,73
	Uroderma bilibatum	Bat	2	9,09
Arracachal	*Glossophaga galongirostris*	Bat	1	4,55
		Total	22	

Source: SAG S.A.



Photography No. 5.30 Bats *Carollia perspicillata* and *Platyrrhinus brachicephalus*
Source: SAG S.A.

The difference between abundance and richness among the sampled coverages can be influenced by several factors, the first and one of which could most influence was the climate, during four of the five nights in which the samples were taken it rained in the area, a condition that prevents many species from leaving their shelters in search of food. The supply of specific resources (shelter and food) and the structure of the habitat in the area could be the determining factors of the low wealth of bats, in the area that grasslands and herbaceous areas dominate they do not offer refuge to the bats.

All species reported according to Vargas et al., are resistant, tolerate the transformation of the environment, and possibly benefit from fragmentation, since they use both forests, transformed and remnant environments, riparian vegetation, secondary vegetation and even isolated trees and shrubs in the grasslands.

Colombia only reports three species of threatened bats in the red book of mammals and none in resolution 0192, these species present as their main threat the destruction of their habitats, the species reported in this supervision have a wide distribution and are common in all this, nevertheless to continue with the destruction of vegetal coverings their populations in some zones can be diminished. It should be noted that none of the species reported are found in the red book or in Resolution 0192.

The flying mastofauna present in the project area is represented by two (2) trophic guilds, frugivorous represented by five (5) species equivalent to 71%, and the insectivorous guild with two (2) species and 29% (Figure No. 5.59).

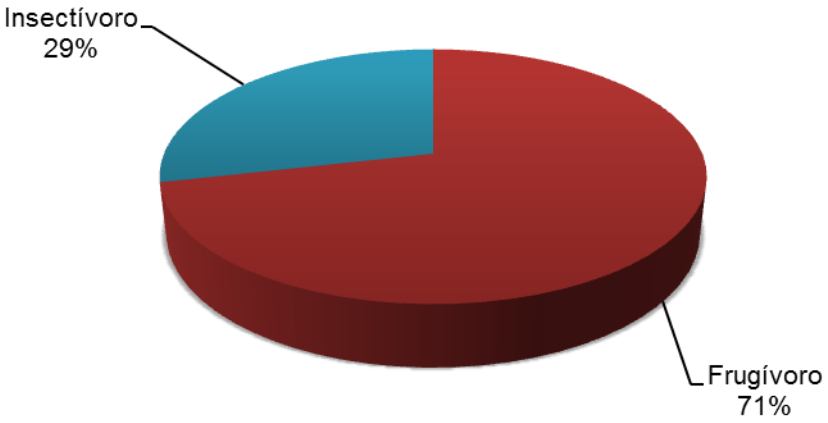


Figure No. 5.59 Trophic guilds reported for bats in the study area
Source: SAG S.A.

Among the frugivores, the best represented species was Carollia perspicillata with eight (8) individuals, followed by the bats of the genus Platyrrhinus also with eight (8) individuals, the other two species had less than two (2) individuals, Artibeus lituratus and Uroderma bilobatum (Photograph No. 5.31). All these species present plants of successional stages in their diet standing out Piper sp., Solanum sp., Cecropia sp. and Ficus sp. Among the insectivores Glossophaga gasoricina I present two (2) individuals, while G.

[1] BONACCORS F J ET AL. 2007. Evidence for Exploit- active Competition : Comparative Foraging Behavior and Roosting Ecology of Short-Tailed Fruit Bats (Phyllostomidae). Biotropica 39:249-256.

longirostris only one (1), species that base their diet on insects but also consume fruits and pollen.

The frugivorous and insectivorous bats, have several ecological interactions, among which stand out, the dispersal of multiple plant species and the consumption of harmful insects, has been widely recognized.

Photography No. 5.31 Bats *Artibeus lituratus* and *Uroderma bilobatum*
Source: SAG S.A.

The diversity indices made corroborate the data obtained in the field, showing a very low diversity in all sampled coverages, this is influenced by the high degree of involvement that the worked area presents, the Margalef index presented the lowest values in the Arracachal and the pastures, cover where only one species was observed, the Shannon index (H '), which presents values below 2.5, in all coverages shows a diversity of low (Table No. 5.44), due to the dominance of the species Carollia perspicillata.

VILLAREAL, H. M. ALVAREZ, S. CÓRDOBA, F. ESCOBAR, G. FAGUA, F. GAST, H. MENDOZA, M. OSPINA Y A.M. UMAÑA. 2004. Manual of methods for the developement of biodiversity inventories. Biodiversity inventories program. Research Institute of Biological Resources Alexander von Humboldt. Bogotá, Colombia. 236 p.

The dominance and Equity indices are inverses, that is to say, as in a community there are dominant species, equitability is lower, which also influences a decrease in diversity. From the results obtained it is observed that the Arracachal and the grasslands are coverings where only one species was observed, showing an absolute dominance, the highest equitability was found in the gallery forest, where a greater number of species was observed with respect to the other coverings (Table No. 5.44).

Table No. 5.34 Diversity indices of flying mammals

	Arracachal	Dense Forrest	Forrest Gallery	Grasslands	Grand Total
Taxa (S)	1	2	4	1	7
Number Of Individuals	1	2	18	1	22
Shannon (H)	0	0,6931	1,259	0	1,693

	Arracacha l	Dense Forrest	Forrest Gallery	Grasslands	Grand Total
Margalef	0	1,443	1,038	0	1,941
Dominance (D)	1	0,5	0,3148	1	0,2231
Equitability (J)	0	1	0,9082	0	0,8702

Source: SAG S.A.

The possible displacement routes considered for the mastofauna are established according to the observations made in the field and the mobility trends of the mammals in relation to the ecology of the landscape and how it maintains a relationship with the Darien corridor as a unit, that currently due to the diverse anthropogenic interventions and economic growth have fragmented this corridor, for which species of great mobility and distributional range (eg the puma) take advantage of relicts of forests and vegetation continues to travel through them and reach more conserved areas with better habitat conditions and food supply. On the other hand, bats, thanks to their ability to travel (flight), can travel long distances in a single night, for the genera Carollia, Glossophaga and Artibeus, they report routes of up to 5 km. mainly in search of food. Thanks to this ability to move the bats to be displaced from their shelter can find others in nearby areas, always looking for similar conditions between shelters so that their needs are not affected. Identifying that one of the greatest threats to this group is the fragmentation of habitat by urban, industrial and agricultural expansion.

FLEMING, T H, & E R. HEITHA US. 1981. Seasonal foraging behavior of the frugivorous bat Carollia perspicillata. J. Mamm. 67: 660-671.

MORRISON, D W. 1980. Efficiency of food utilization by fruit bats. Oecologia 45: 270-273.

SIMMONS N Y T CONWAY. 2003. Evolution of ecological diversity in bats. Pp. 493–535, en: Bat ecology (TH Kunz y MB Fenton, eds.). Chicago University Press, Chicago.

With that in mind, Figure No. 5.60 shows the seven (7) possible routes of displacement of the mastofauna, identified in the area of influence of the project. These routes go through the following coverages: clean grasslands (code: 231), open shrub (code: 3222), high secondary vegetation (code: 3231), dense high mangrove (code: 311122), palm groves (code: 311123) and herbazal dense flooded not wooded (code: 321121). On the map MOD_LA_PTO_ANT_37_RutasFauna, you can see these possible routes.

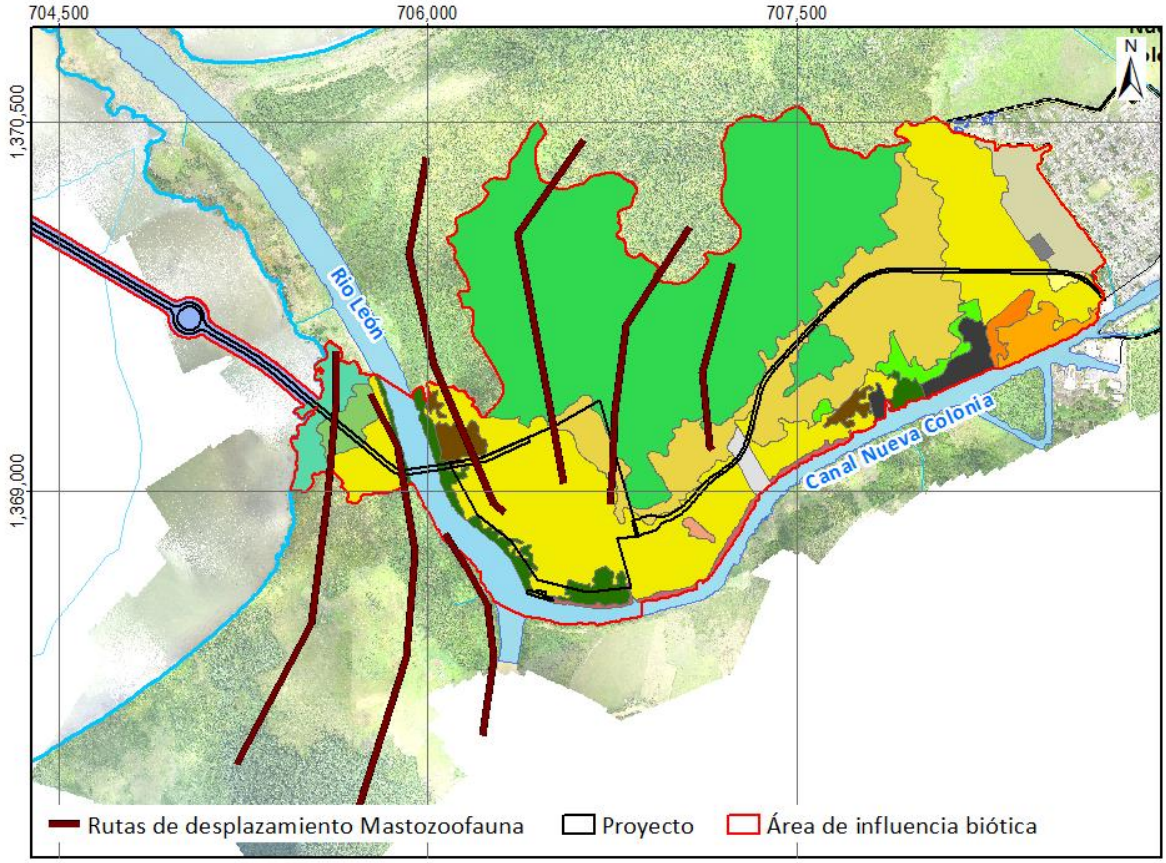


Figure No. 5.60 Possible routes of displacement of the mastofauna present in the area of influence of the project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

5.2.3 Continental aquatic ecosystems

According to the methodology proposed in the chapter on Generalities, the results obtained for the characterization of the vegetation and wildlife present in the continental aquatic ecosystems (Figure No. 5.61) that are part of the area of influence are described below. On the maps MOD_LA_PTO_ANT_38_Vegetation and MOD_LA_PTO_ANT_37_Wildlife, you can observe the sampling points in the aquatic ecosystem.

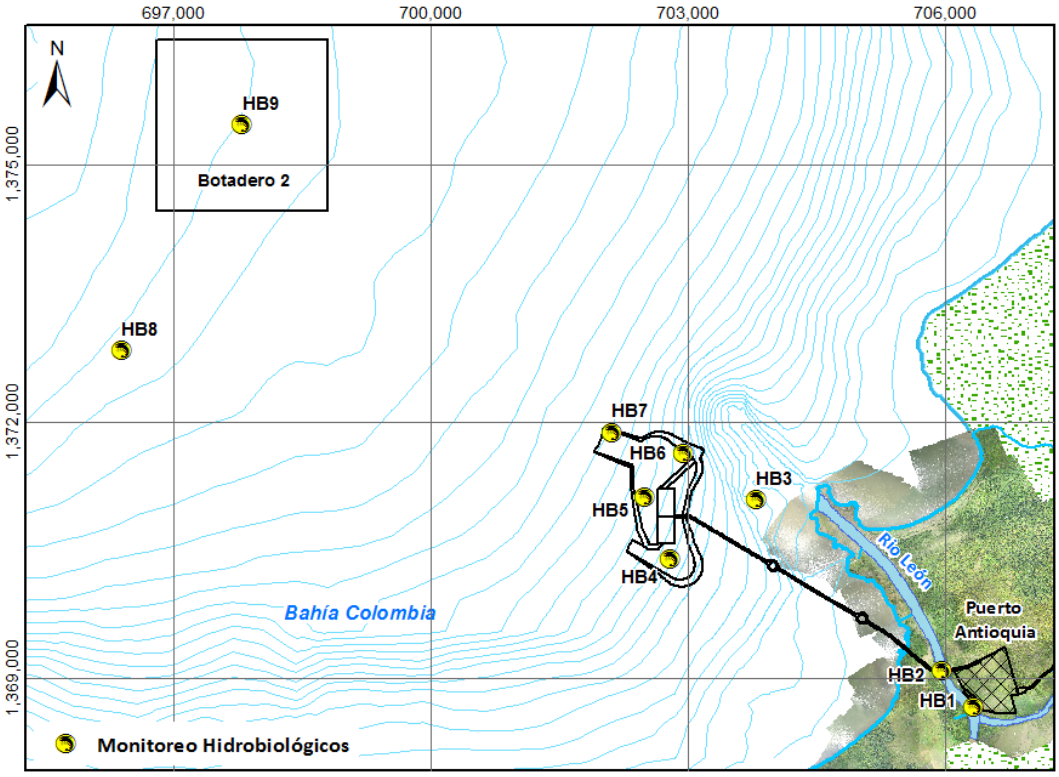


Figure No. 5.61 Rivers and marine hydrobiological sampling points
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

- *Vegetation*

1. Periphyton

Periphyton is one of the most important communities present in aquatic systems; It consists mainly of microalgae that develop on solid submerged surfaces such as rocks, sediment, plant material, sands, leaves and macrophytes.

The main factors that control the dynamics of the periphytic algae are light, the chemical composition of water, herbivores, temperature, speed of the current and type of substrate; As all these factors interact with each other, it is difficult to say which is the factor that limits the growth of algae.

Periphytic algae develop best on substrates that offer stability and where the action of currents is minimal. Even in some cases, the type of substrate, rather than the light intensity or nutrients, is the limiting factor in the production of this community. However, some authors claim that the four primary factors that limit productivity are light, water, temperature and nutrients.

WETZEL, R. G. Opening remarks. In: Periphyton of freshwater ecosystems. 1982. p. 3-4.
ALLAN, J. David. Stream ecology: structure and function of running waters. Illustrated, reprint., Chapman & Ha ll. 1995. 388 p. ISBN 0412355302

The hydrological, physical and chemical characteristics, as well as the disturbances and the space and temporal heterogeneity in the rivers, define the distribution, the dispersion, the colonization and the response of the organisms to the environment.

Composition and abundance

The community of periphytic algae in the waters of the Leon River in the points HB1 and HB2 was made of three large taxonomic groups that are, the Bacillariophyta (Diatomeas), Cyanophycota (Cyanobacteria) and Euglenophycota (Euglenas), where the group of the diatoms was the most representative at the level of species abundance (Photograph No. 5.32) somewhat upstream of the river (HB1: 5 taxa) and downstream (HB2: 4 taxa), and as shown in Figure No. 5.62, the specific abundance of periphytic microalgae at points HB1 and HB2 was the same (7 taxa) although in general terms it is low, which can be attributed mainly to the effect of the current and the turbidity of the water, as a high quantity of suspended solids limiting the incidence of light in the body of water.

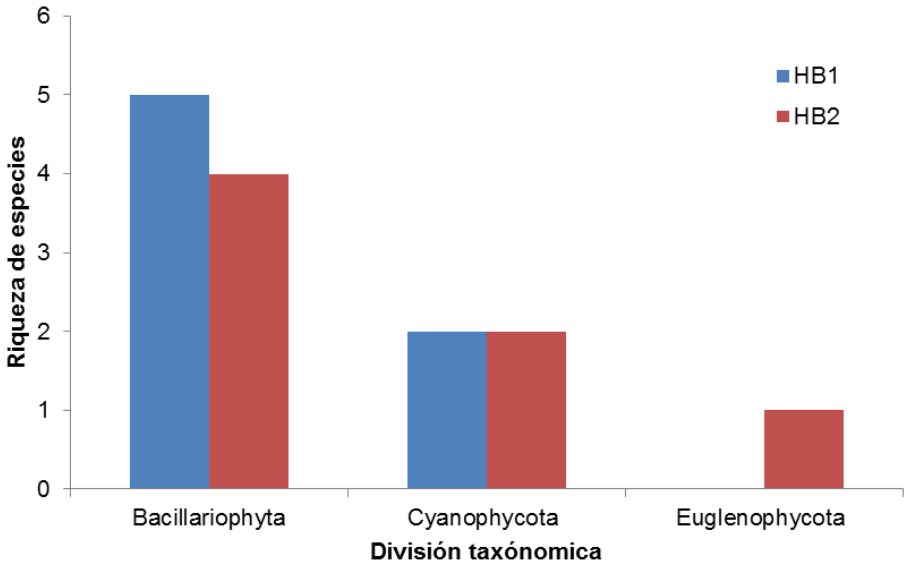


Figure No. 5.62 Abundance of species of the periphytic community present in points HB1 and HB2 in the León River
Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

The Bacillariophyta division is a group that is widely distributed in both lentic and lotic waters, developing unicellular to colonial forms, reaching to grow in planktonic forms (in suspension in free water) and / or benthic (associated with solid substrate). The most important aspect in this group is that the cell is covered by a silica shell of very hard consistency, which has a high weight due to the siliceous nature of its shell. This conditions the planktonic species, since a certain turbulence in the water is necessary to keep them in suspension, so this group is more associated with the periphytic community where it can be anchored by means of a structure called raphe, which is complex in some cases, which is arranged by the surface of the valve, longitudinally.

The function of this one seems to be involved in the movement of the cell on the substrate and its fixation, through the secretion of mucilaginous substances and glycoproteins. Diatoms are an essential part of these systems since they are the main source of energy input to the systems, because they are considered photosynthetic organisms that will act as a food source for invertebrates of zooplankton, macroinvertebrates, scrapers and fish.

On the other hand, microalgae belonging to Phylum Cyanophycota, represented by Oscillatoria sp., Were recorded at both points. This genus is commonly found in eutrophic waters with a high concentration of organic matter; In general, these microalgae are characteristic of temporary environments with variability in the physicochemical conditions of water, generally associated with processes of eutrophication and environmental deterioration of aquatic ecosystems, so in this case the waters of the Nueva Colonia Canal could be directly influencing in the periphytic population structure of the monitored points.

In addition, this group of organisms have the ability to fix atmospheric nitrogen and incorporate it into the system through anatomical structures known as heterocysts, causing these organisms to regulate the N: P ratio, however, when this relationship deviates in favor of phosphate, cyanophytes are developed that introduce nitrogen combined into the system.

Other registered organisms were those belonging to the Euglenophycota group, represented by the genus Trachelomonas in point HB2, which could be indicating an entry of organic matter into the ecosystem, because this type of organisms are closely related to the organic enrichment of aquatic ecosystems.

STREBLE, H., and KRAUTER, D. Atlas of freshwater microorganisms. Barcelona .: Omega editions. 1987. 372 p.

PINILLA, G. A. Biological indicators in continental aquatic ecosystems of Colombia, Bibliographic compilation: UJTL Scientific Research Center. 2000. 76 p.

MARGALEF, Ramón. Limnology. Barcelona, Spain .: Editorial Omega, 1983. 390 p.

According to the results obtained in points HB1 and HB2 (Table No. 5.45), seven (7) genders were determined, of which the most representative were Navicula and Nitzschia, their presence in both areas in general may be due to similarity in the regimes of biophysical and chemical conditions, in general natural stress of water or anthropic, flow regime, which supposes an equal level of disruption at a natural ecological or anthropic level, high similarity with the riparian vegetation or riparian vegetation.

The disparity in richness and abundance found may be due to several factors, both physical-chemical and ecological. In general, and due to the homogeneity found, an ecological behavior can be assumed with periods of relatively constant stabilization, with this it is indicated that the body of water is in continuous purification, which is favored by the development of species with a margin of greater tolerance, which may indicate that there is a margin of contamination which does not allow the healthy performance of the ecosystem, in this sense richness and abundance are affected.

In terms of dominance, it cannot be indicated that there is domination at the intra- and interspecific level, mainly due to the state of abundance that has finally affected richness, therefore the population status of the genders found may be due to variation in the flow , pollution and disruption in the aquatic regime and water quality in physical and chemical sense.

Bearing in mind the above, it is necessary to indicate that the presence of strong currents can influence the aquatic content, for which sediments, and pollutants are carried away more quickly, being part of these deposited in the bottom with what slow removal occurs from the bed to the water column, producing a state of aquatic quality that varies according to the regime of flow and current, to finally produce variation in the composition of populations in microalgae, which in the present is negative or bad.

RAMÍREZ, Jhon Jairo. Freshwater phytoplankton: ecological, taxonomic and health aspects. Medellín .: University of Antioquia. 2000. 207 p.

Table No. 5.45 Taxonomic composition of species from the periphytic community at the sampling points in the area of influence of the project on the León River

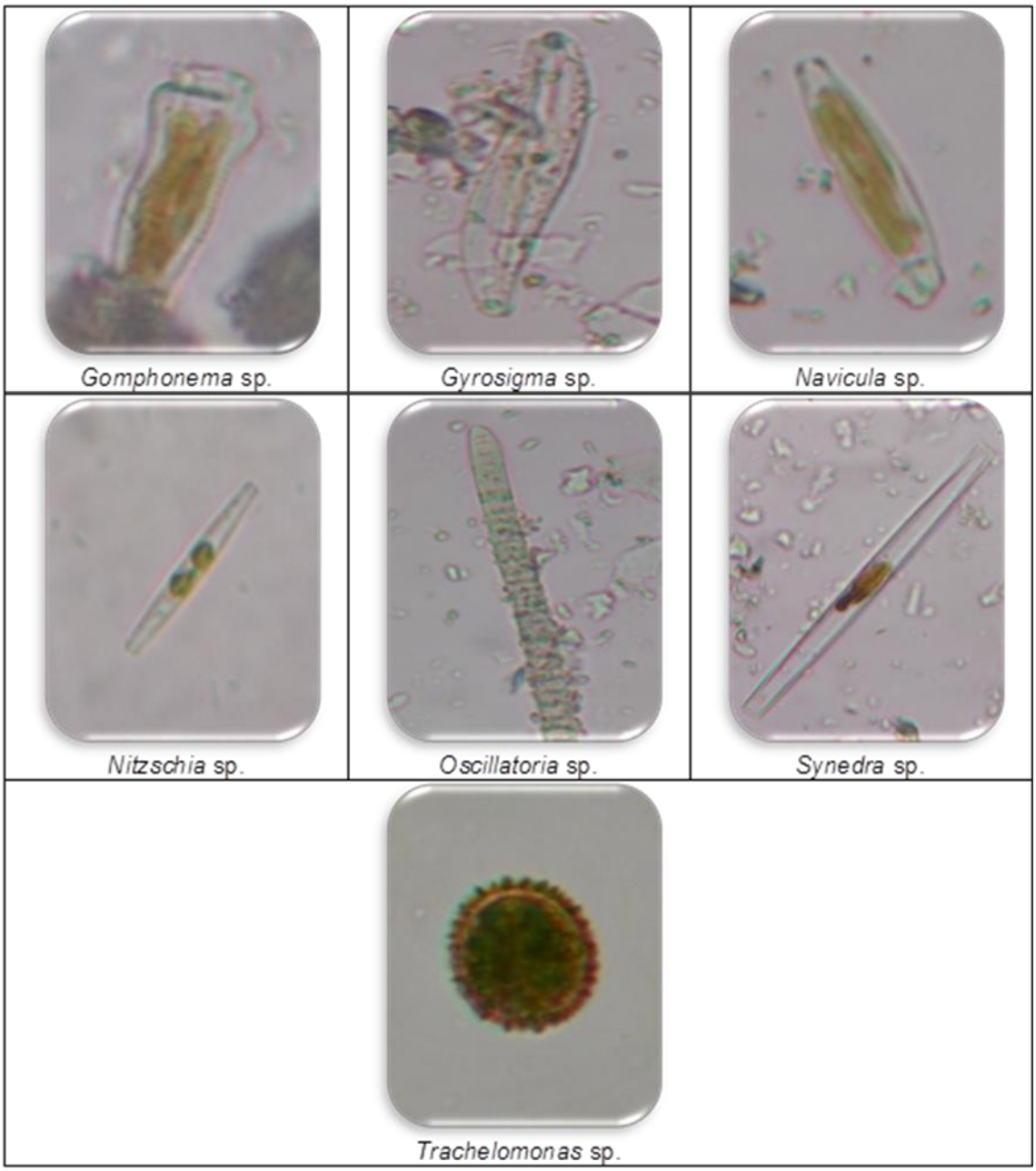
Sampling Points	Division	Class	Order	Family	Taxa
HB1	Bacillariophyta	Bacillariophyceae	Cymbellales	Gomphonemataceae	*Gomphonema* sp.
			Naviculales	Naviculaceae	*Navicula* sp.
			Bacillariales	Bacillariaceae	*Nitzschia* sp.
					Nitzschia sp2.
	Cyanophycota	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.

					Oscillatoria sp2.
	Bacillariophyta	Fragilariophyceae	Fragilariales	Fragilariaceae	*Synedra* sp.
HB2	Bacillariophyta	Bacillariophyceae	Naviculales	Naviculaceae	*Navicula* sp.
				Pleurosigmataceae	*Gyrosigma* sp.
			Bacillariales	Bacillariaceae	*Nitzschia* sp2.
		Fragilariophyceae	Fragilariales	Fragilariaceae	*Synedra* sp.
	Cyanophycota	Cyanophyceae	Nostocales	Oscillatoriaceae	*Oscillatoria* sp.
					Oscillatoria sp2.
	Euglenophycota	Euglenophyceae	Euglenales	Euglenaceae	*Trachelomonas* sp.

Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Density of the periphytic community

The densities results (Table No. 5.46) for the periphytic microalgae show differences between the points HB1 and HB2 for the Cyanophycota group, being that the point HB1 exhibited a greater population of cyanobacteria, having a density of 502.3 Ind / cm2, in relation to downstream (HB2) that registered 244.4 Ind / cm2 (Figure No. 5.63). Regarding diatoms, there is no significant variation in density, however, it can be assumed that this is comparatively greater at the HB1 point (502.3 Ind / cm2). HB2 (686.2 Ind / cm2).



Photography No. 5.32 Some species of the periphytic community found in the sampled points on the León River

Source: SGS Environmental Services, 2015

Table No. 5.35 Density (ind/cm2) of the periphytic community in the points sampled on the León River

Taxa	Station		Total
	HB1	HB2	
Gomphonema sp.	39,58	0,00	39,58
Gyrosigma sp.	0,00	115,93	115,93
Navicula sp.	353,16	451,20	804,36
Nitzschia sp.	9,13	0,00	9,13
Nitzschia sp2.	27,40	47,00	74,40
Oscillatoria sp.	411,00	206,80	617,80
Oscillatoria sp2.	91,33	37,60	128,93
Synedra sp.	73,07	72,07	145,13
Trachelomonas sp.	0,00	3,13	3,13
Total	**1.004,67**	**933,73**	**1.938,40**

Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

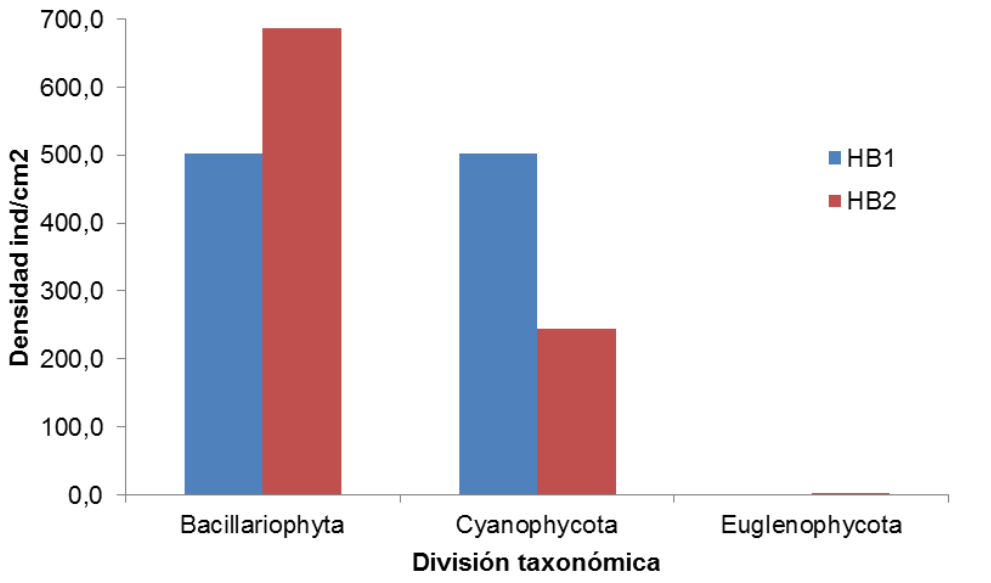


Figure No. 5.63 Density of the periphytic community present in points HB1 and HB2 on the León River
Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

For its part, the Euglens (Euglenophycota) were only registered for HB2, presenting a value of 3.1 Ind / cm2, contributing very little to the population dynamics and primary productivity of this sampling point.

In general, diatoms are indicative of neutral to slightly acidic pH, a high Nitrogen / Phosphorus ratio and low concentrations of Calcium, this in general indicates that there is a process of constant stabilization of water, which is associated with moderate contamination of the body of water, this has significance in what was discussed for periphyton and its population dynamics, since it partially corroborates

a continuous process of direct contamination and slow removal of deposits in the streambed by the effect of the water current or dynamics.

According to the proposal by Ramírez (2000), where the number of diatom species present in a body of water, can give an idea of the quality of it; Eutrophic environments are characterized by presenting a few species of diatoms of high density. While in clean environments, several diatom species with low population density can occur.

According to what has been observed in the results up to this point, it can be indicated that the body of water has vectors of contamination by sewage of domestic and industrial origin such as agriculture, however it can be indicated that these can come from reservoirs at the phreatic level, this assumption is due to the history of agriculture present in the area and the proximity to the urban area, in general it can be indicated that the pollutants are of organic origin, with spatialization vectors spatialized over time, which mainly suggests natural removal due to the effect of current of the streambed, promoting early stabilization events.

Ecological índixes and analysis of similarity for periphyton

In the analysis of diversity indixes, values at the Shannon-Wiener level were obtained below half the value H'<1.5 bits / Ind (Table No. 5.47). The records of Pielou (J') and Simpson (Λ) indicate little variation in the points, conferring characteristics of homogeneity without prevailing dominance of one microalgae group over another, however these values are conditioned by the presence of few species in each of the points, making the ecological indexes do not show much variation.

Table No. 5.36 Ecological indices for the perifitic community present in HB1 and HB2 in the León River

Point Name	S	N	d	J'	H'(loge)	λ
HB1	7	330	1,03	0,72	1,41	0,31
HB2	7	298	1,05	0,74	1,44	0,31

S: Abundance of species, N: Total organisms of the sample, d: Abundance of Margalef, J': Uniformity of Pielou, H': Diversity of Shannon-Wiener, λ Predominance of Simpson

Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

It is important to mention that, the hydrodynamic and morphological conditions at each sampling point are similar, therefore, the microalgal populations behaved homogeneously and the low records obey the normal conditions of this type of ecosystems, where strong currents prevail and a limited light input.

According to the similarity analysis of Bray Curtis for the two monitored points on the León River (Figure No. 5.64) a similarity of more than 70% is observed, generally explained by sharing the general Navicula sp, Oscillatoria sp, Oscillatoria sp2, Synedra sp and Nitzschia sp. Because the sampling points are located on the same river and based on previous analyzes, it can be indicated based on the low richness, density and abundance that there is currently a loss of diversity, or negative variation depending on contaminants and disruptors. At the flow, affecting the ecological dynamic in the section comprising the two points, in general, it can be concluded that the river presents homogeneous conditions with intra and interspecific negative dynamics due to external vectors or pollutants, which are resuspended by the body's water dynamics of water, affecting the process of stabilization of water with what is finally in an early state, without any indication in favor of the positive stabilization of water, in terms of sustenance of the biota that it comprises.

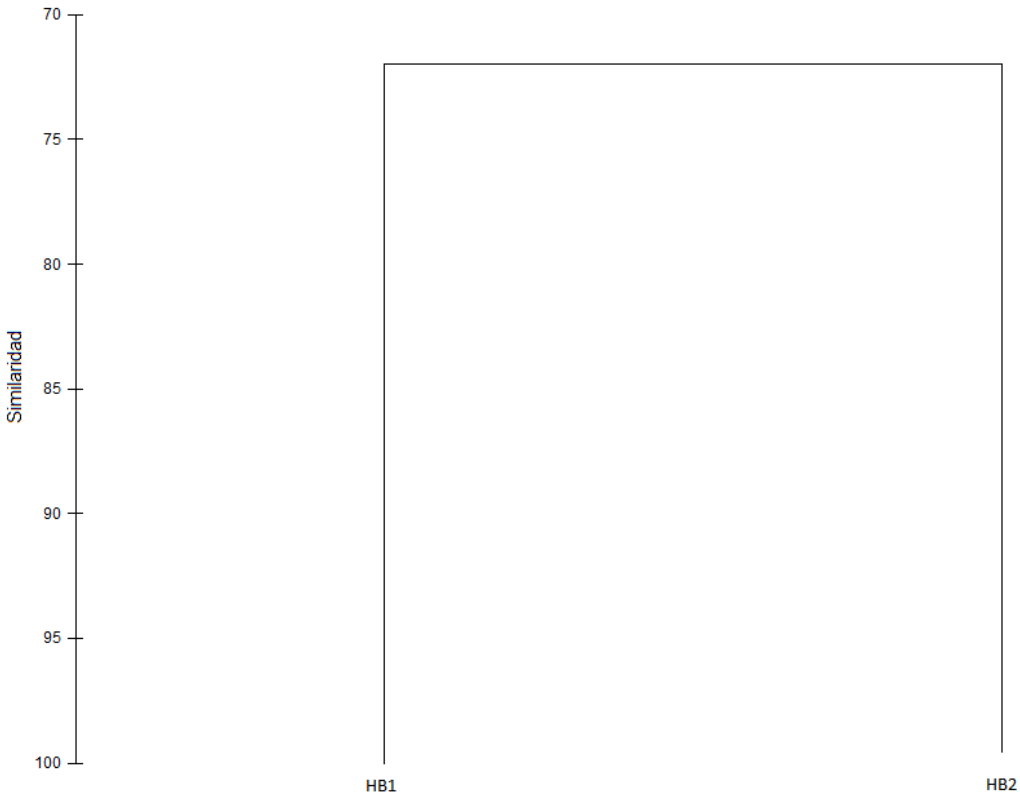


Figure No. 5.64 Bray-Curtis analysis for the periphytic community present in the sampled points of the León River

Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

- *Wildlife*

1. Macroinvertebrates

Composition and Abundance

For this community, only one taxon belonging to the Insecta class was identified: Morfo 1 of the Chironomidae family (Photograph No. 5.33), which was presented only for HB1 (Table No. 5.48). Insects are the most diverse and abundant group of nature with a wide distribution, which is why it is found in all types of ecosystems, both terrestrial and aquatic, since it has a high tolerance to different organoleptic conditions. Many are found mainly in rivers, creeks, streams and lakes, in all depths, most are common in waters with high content of decomposing organic matter, therefore they are resistant to certain levels of contamination.

Table No. 5.37 Composition of species of the community of benthic macroinvertebrates present in points HB1 and HB2 in the León River

Point Name	Phylum	Class	Order	Family	Taxa
HB1	Arthropoda	Insects	Díptera	Chironomidae	Morfo 1
HB2	No organisms were registered				

Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Photography No. 5.33 Individual of the family Chironomidae found in the León River
Source: SGS Environmental Services, 2015

The organisms of the Chironomidae family inhabit mainly under rocks and trunks, especially in places where there is a great accumulation of decaying plant material, although they can occur in all kinds of environments; On the other hand, the larvae and pupae are found in any type of substrate, muddy, sandy, rocky, on submerged vegetation or on other organisms and prefer protected places of the currents; They

are also characterized by their wide distribution in all types of systems and substrates, presenting high tolerance to adverse conditions in water quality, achieving a clean water boom and increasing their density in systems with high loads of organic matter, because most species collect this material, although some are filtering and others feed on periphyton.

Density of the benthic macroinvertebrate community

The community of benthic macroinvertebrates, in terms of density in general, presented a total of 20.0 Ind/m2, which were recorded exclusively for point HB1, represented by Morph 1 of the Chironomidae family.

The component of this community is low for point HB1 and zero for HB2, which can be attributed to various environmental conditions, one of which is the type of soil present, directly influencing the biological composition of these organisms.

In soft streambeds (sand and mud) like the one of the present sampling, there are the organisms that have adaptation to be buried. In this type of substrates the diversity is usually poor, even zero, due to the instability of this. Likewise, the solid materials carried by the Nueva Colonia canal, which flows into the León River, settle and the successive geomorphological changes are accompanied by physical and chemical changes in the water, which produces the establishment of specific communities, adapted to each particular habitat, so that the communities depend to a large extent on allochthonous material.

Ecological indexes and similarity analysis for benthic macroinvertebrates

The ecological indexes are tools that allow to study in a quantitative way the interactions within and between the communities, which together with the physicochemical conditions model the diversity and distribution of the organisms in the ecosystems; as its main objective is to determine the diversity of the communities; to calculate them it is necessary to have more than one or two species (taxa), that is why for this community it was not possible to calculate the different indixes, given that only one species was recorded in point HB1.

CURTIS, Helena., SCHNEK, Adriana. Biology. Ed. Panamericana. Medical 2008. 1160 p. ISBN 9500603349.

The similarity analysis of Bray Curtis is used to compare the composition of species between two or more sampling sites and with this it is also possible to relate a certain percentage of reliability to the sampling stations with similar biotic and similar abiotic conditions in said composition. In this community it was not possible to carry out this analysis, given that of the two points that were sampled for the León River, only HB1 registered organisms.

2. Ichthyofauna

Composition, richness and abundance

The community of fish in the León River was represented by a species of the genus Astyanax sp, with 22 individuals (Table No. 5.49 and Table No. 5.50), indicating a very low species richness and abundance, showing negative effects on population dynamics and ecosystem, in general this may be due to constant fluctuations in the flow, pollution and deficiencies in the carrying capacity of the ecosystem, as mentioned above, the León River has characteristics of the environment intervened, assuming a stationary pollution index, aggravated by the hydric dynamics.

In general, the reported genus is an indicator of tolerance to disruptions to the flow and moderate in the aquatic content by contaminants, however it is necessary to clarify that the species in general are especially sensitive to continuous exposures of non-optimal conditions, or changes in their environment. development, usually this would indicate that the quality of the water for the development of the ichthyofauna is not the best with which historically the process of contamination and anthropic intervention is continued.

It can be concluded that the population dynamics at the infra and interspecific level is affected, by direct anthropic intervention, contaminants and disruption to the flow.

Table No. 5.38 Taxonomic composition and abundance of the ichthyofauna present in the continental aquatic ecosystem

Sampling Point	Division	Class	Order	Family	Species	Common Name	Abundance
A1	Chordata	Actinopterygii	Characiformes	Characidae	*Astyanax sp.*	Sardine	12
A2	Chordata	Actinopterygii	Characiformes	Characidae	*Astyanax sp.*	Sardine	10

Source: Produced by SGS Environmental Services, 2015, Adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

MALDONADO-OCAMPO, Javier, ORTEGA-LARA, Armando, USMA, José, GÁLVIS, Germán, VILLA-NAVARRO, Francisco, VÁSQUEZ, Lucena, PRADA-PEDREROS, Saúl and ARDILA, Carlos.

Fish of the Andes of Colombia. Field Guide Institute of Research and Biological Resources "Alexander von Humboldt" Bogotá, Colombia. 2005. 346 p. ISBN 958-8151-50-3

Table No. 5.39 Taxonomic composition and abundance of the ichthyofauna present in the continental aquatic ecosystem

Sampling Point	Division	Class	Order	Family	Species	Common Name	Abundance
A1	Chordata	Actinopterygii	Characiformes	Characidae	*Astyanax sp.*	Sardine	12
A2	Chordata	Actinopterygii	Characiformes	Characidae	*Astyanax sp.*	Sardine	10

Source : Produced by SGS Environmental Services, 2015, Adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.40 Ecological and ecological information of Astyanax sp.

Classification	Photographic record
Class: Actinopterygii **Order:** Characiformes **Family:** Characidae **Species:** *Astyanax* sp. **Common Name:** Sardine. **Sampling point :** (Continental systems) ✓ HB1 ✓ HB2	

General Characteristics

Characteristics: Deep and robust body, maxillary equal to the face, broad slightly flattened pre-ventral region, rounded post-ventral region, origin of the dorsal equidistant between the end of the face and caudal, anal fin slightly emarginated, the pelvic fins reach the anal fin and the pectoral fins to the pelvis in the juveniles, base of the yellow dorsal fin; It presents a conspicuous black spot, sometimes narrow in adults.

Biology: It is located in the lower parts of the rivers, in large rivers in areas of low current near the surface of the water, as the vast majority of the species of the genus feeds on almost anything nutritious as algae, seeds, leaves, aquatic insects and terrestrial to smaller fish, therefore it is considered as an omnivorous species.

Distribution: Antioquia: León river; Cauca: Patía River (middle and lower basin), sheep river, Guaitará River and Obispo.

Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Astyanax sp is considered an ornamental species, it is omnivorous, it is not migratory and it is not reported in any category of threat in accordance with Resolution 0192 of 2014 and Red Book of “Peces Dulceacuícolas de Colombia”.

Ecological indexes and analysis of similarity for the Ichthyofauna

The ecological indexes are tools that allow to study in a quantitative way the interactions within and between the communities, which together with the physicochemical conditions model the diversity and distribution of the organisms in the ecosystems; as its main objective is to determine the diversity of the communities; to calculate them it is necessary to have more than one or two species, that is why for this community it was not possible to calculate the different indexes, since only one species was recorded.

The similarity analysis of Bray Curtis is used to compare the composition of species between two or more sampling sites and with this it is also possible to relate a certain percentage of reliability to the sampling stations with similar biotic and similar abiotic conditions in said composition. In this community, it was not possible to carry out this analysis for the León River, given that only one species was recorded in the two sampling points.

5.2.4 Marine- coastal ecosystems

According to the methodology proposed in the chapter on Generalities, the results obtained for the characterization of the vegetation and wildlife present in the marine-coastal ecosystems (Figure No. 5.61) that are part of the area of influence are shown below.

- *Vegetation*

1. Phytoplankton

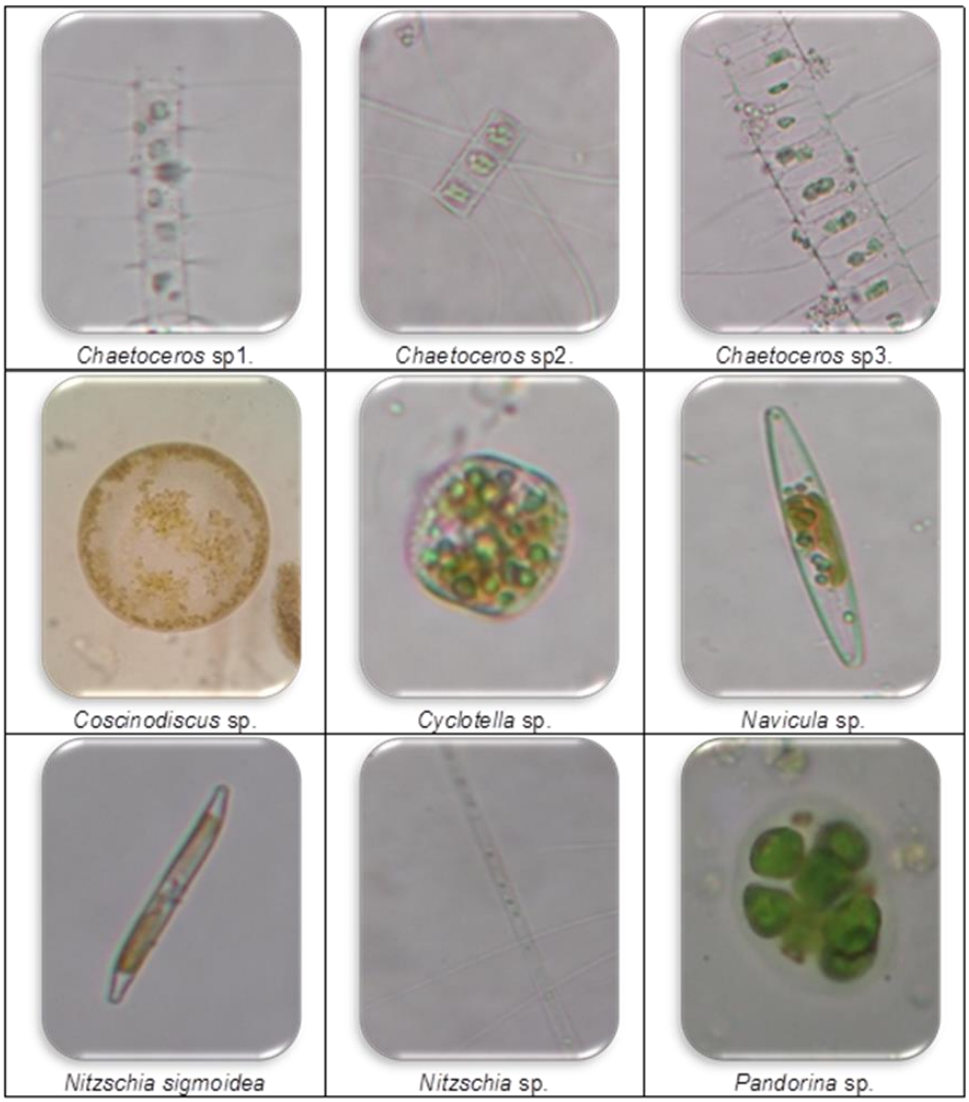
The marine phytoplankton is of special interest, due to its importance within the trophic network to group the largest portion of primary producers of the ocean, so the impacts that this supports, product of physical or biological variations of the environment, impact on the rest of the communities that depend on it. Phytoplankton depends mainly on the supply of light, inorganic nutrients and temperature, since it is responsible for collecting and transforming solar energy

SEMINA H.J. Treatment of an aliquot simple. In: Manual Phytoplankton. SOURNIA A. (ed.) Muséum National d'Histoire Naturelle. Paris. United Nations Educational, Scientific and Cultural Organization - UNESCO. 1978. 335 p. ISBN: 92-3-101572-9

into chemical energy and therefore become a primary source of food expressed in organic matter to subsequently be the maintenance of trophic networks.

Composition and Abundance

For the area of marine biotic influence, the phytoplankton community was represented by 10 organisms of the Bacillariophyta division (diatoms): Chaetoceros sp1, Chaetoceros sp2, Chaetoceros sp3, Coscinodiscus sp., Cyclotella sp., Navicula sp., Nitzschia sigmoidea, Nitzschia sp. ., Skeletonema sp., Surirella sp. and a single taxon of the Chlorophyta division: Pandorina sp. which was recorded only for point HB3 (Photograph No. 5.34).



Photography No. 5.34 Some species of the phytoplankton community found at the sampling points in Bahía Colombia
Source: SGS Environmental Services, 2015

In general, Coscinodiscus was dominant, which was recorded in all sampling points with great representativeness (Table No. 5.51). This gender is usually found in the pelagic water column, occupies the upper layers of water in coastal waters and also in the high seas. The greatest abundance was recorded by the HB3 point when there were seven (7) taxa (Figure No. 5.65), points HB4 and HB7 had five (5) taxa and the other points with four (4) taxa respectively.

Table No. 5.41 Taxonomic composition of phytoplanktonic species identified in the sampling points in the area of influence of the project in Bahía Colombia

Sampling Points	Division	Class	Order	Family	Taxa
HB3	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus* sp.
		Bacillariophyceae	Naviculales	Naviculaceae	*Navicula* sp.
		Coscinodiscophyceae	Thalassiosirales	Stephanodiscaceae	*Cyclotella* sp.
		Bacillariophyceae	Bacillariales	Bacillariaceae	*Nitzschia sigmoidea*
		Bacillariophyceae	Bacillariales	Bacillariaceae	*Nitzschia* sp.
		Bacillariophyceae	Surirellales	Surirellaceae	*Surirella* sp.
	Chlorophyta	Chlorophyceae	Volvocales	Volvocaceae	*Pandorina* sp.
HB4	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus* sp.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp1.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp2.
		Coscinodiscophyceae	Thalassiosirales	Stephanodiscaceae	*Cyclotella* sp.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp3.
HB5	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus* sp.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp1.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp2.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp3.
HB6	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus* sp.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp1.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp2.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp3.
HB7	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus* sp.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp1.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp2.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp3.
		Coscinodiscophyceae	Thalassiosirales	Skeletonemaceae	*Skeletonema* sp.
HB8	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus* sp.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp1.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp2.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp3.
HB9	Bacillariophyta	Coscinodiscophyceae	Coscinodiscales	Coscinodiscaceae	*Coscinodiscus* sp.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp1.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp2.
		Coscinodiscophyceae	Chaetocerotales	Chaetocerotaceae	*Chaetoceros* sp3.

Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

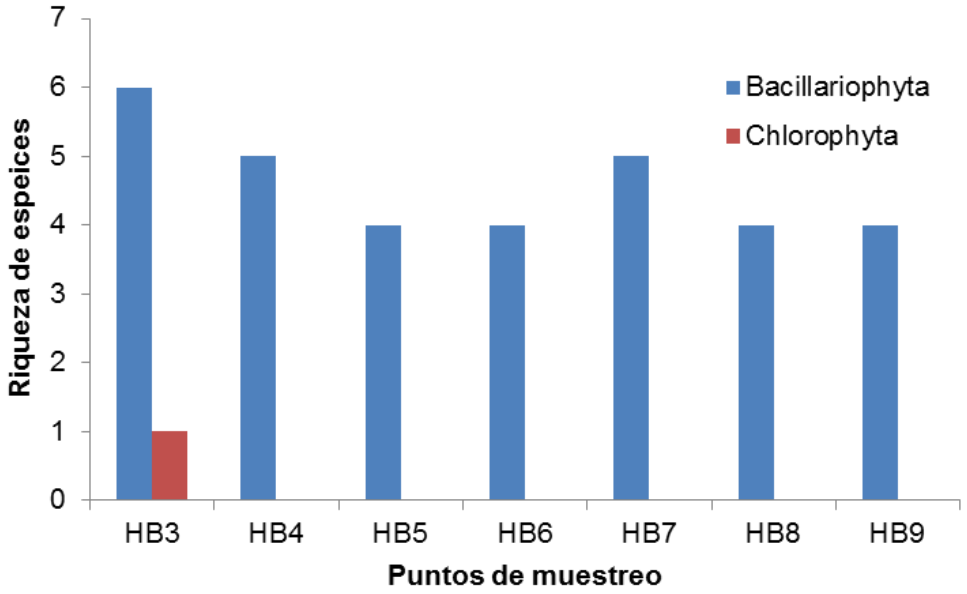


Figure No. 5.65 Abundance of species of the phytoplankton community present in the sampling points in the area of influence of the project in Bahía Colombia

Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Density of the phytoplankton community

In terms of density, the phytoplankton community registered a total of 27,009.65 Ind/L (Table No. 5.52), of which 27,005.4 Ind/L were recorded for diatoms, that is, they contributed 99.98% of the recorded total density, followed by green algae (Chlorophyta) that had 4.21 Ind/L (0.02%) and were recorded only for point HB3 (Figure No. 5.66).

Table No. 5.42 Density (ind / L) of the phytoplanktonic community present in the points sampled in Bahía Colombia

Taxa	Sampling Points							Total
	HB3	HB4	HB5	HB6	HB7	HB8	HB9	
Chaetoceros sp1.	0,00	55,93	76,40	65,78	79,65	110,94	82,75	471,45
Chaetoceros sp2.	0,00	81,71	89,21	74,29	86,29	128,71	108,78	568,98
Chaetoceros sp3.	0,00	6,86	23,79	21,45	22,83	20,07	22,27	117,26
Coscinodiscus sp.	1.410,35	3.112,11	4.077,07	3.287,99	4.462,90	4.667,87	4.590,85	25.609,14
Cyclotella sp.	126,30	1,06	0,00	0,00	0,00	0,00	0,00	127,36
Navicula sp.	42,10	0,00	0,00	0,00	0,00	0,00	0,00	42,10
Nitzschia sigmoidea	54,73	0,00	0,00	0,00	0,00	0,00	0,00	54,73
Nitzschia sp.	4,21	0,00	0,00	0,00	0,00	0,00	0,00	4,21
Pandorina sp.	4,21	0,00	0,00	0,00	0,00	0,00	0,00	4,21
Surirella sp.	8,42	0,00	0,00	0,00	0,00	0,00	0,00	8,42
Skeletonema sp.	0,00	0,00	0,00	0,00	1,78	0,00	0,00	1,78

Total	**1.650,32**	**3.257,67**	**4.266,47**	**3.449,51**	**4.653,44**	**4.927,59**	**4.804,66**	**27.009,65**

Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

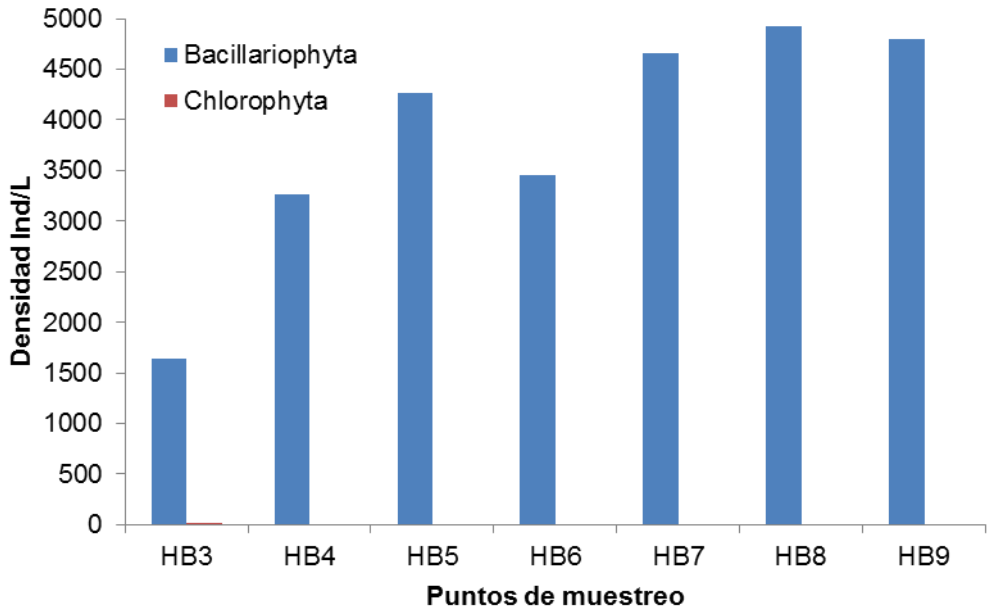


Figure No. 5.66 Density of the phytoplankton community present in the sampling points in the area of influence of the project in Bahía Colombia

Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

The HB8 point was the most abundant when registering 4.927.6 Ind / L, followed by the HB9 point with 4.804.7 Ind/L. These results can be attributed to the fact that these points have the greatest oceanic influence; On the other hand HB7 point had 4,653.4 Ind/L and finally HB5 with 4,266.5 Ind/L, the other points registered densities below 4,000.0 Ind/L, with HB3 being the least abundant when registering only 1,650.3 Ind/L(Figure No. 5.66), in accordance with the above and based on the observations made in the field, this effect may be due to the proximity to the coast and the presence of pollutants of organic origin, as well as of the urban settlements of its coastal areas, which drain its sewage or domestic residual waters in the bay, which is reflected in the presence of organisms belonging to green algae (Chlorophyta).

CORPORATION FOR THE SUSTAINABLE DEVELOPMENT OF URABÁ CORPOURABA. R-PG-01: regional environmental management plan. 2002-2012. Section 2002.

Likewise, this point (HB3) could be influenced by the proximity of the mangrove zone that contributes a large amount of organic material in the water in that area, preventing the incidence of light and therefore the population structure of phytoplankton.

Diatoms were the most representative microalgae. This type of individuals are characterized by forming simple filaments or colonies. They are a very important component of oceanic phytoplankton and are an important source of food for small marine animals. Diatoms also habit continental bodies of water. Some can be found in lagoons and hypersaline ponds and others in less brackish waters. All are photosynthetic, although some need certain organic substances (such as vitamins) for their growth, are ecologically indicative of systems with a neutral pH, low concentrations of calcium and above all a planktonic succession can happen.

The high representativeness of diatoms can be attributed to their capacity to live in a wide variety of habitats, even under extreme conditions, which allows them to be well represented in the marine waters of coastal ecosystems; constituting the most successful group of autotrophs in this type of environment, both for its great diversity of forms and species which are estimated between 1,300-1,700 although there is a calculation of about 5,000 species; as well as for its important contribution to global productivity, since they contribute between 20 and 25% to the world's net primary production and are an essential component of the food webs in aquatic ecosystems.

Ecological indexes and analysis of similarity for the phytoplankton community

Table No. 5.53 describes the values for the analyzes of uniformity, diversity and predominance of the phytoplankton community of the seven (7) sampled points, where values of diversity were found in a very low range (between 0.21 - 0, 59 bits / Ind). These values are low as reported by Margalef (1983), who states that a good indicator of phytoplankton is between the 2.4 and 2.6 bits / Ind intervals. This low composition can be attributed to the availability of nutrients and the entry of light that could affect the presence of a greater number of species in the community, this is due to the dragging effect of contaminants that affect the bottom and the water column.

PINILLA. Op. cit.
ROUND, F. E., CRAWFORD, R. M., & MANN, D. G. The Diatoms. Biology & Morphology of the Genera. Cambridge University Press. 1990. 747 p.
SOURNIA, A. Phytoplankton manual. París.: Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura (Unesco). 1978. 337 p.

KATZ, M. E., FINKEL, Z. V., GRZEBYK, D., KNOLL, A. H., & P. G. FALKOWSKI. Evolutionary trajectories and biogeochemical impacts of marine eukaryotic phytoplankton. En: Annu. Rev. Ecol.Evol. S. 2004. vol. 35, p. 523– 556

KOOISTRA, W.H.C.F., R. GERSONDE, L. K. MEDLIN, & D. G. MANN. The origin and evolution of the diatoms: Their adaptation to a planktonic existence. In: P. G. Falkowski and A. H. Knol [eds.]., Evolution of primary producers in the sea. Elsevier Academic Press, 2007. p. 207-249.

WERNER, D. The biology of diatoms. Botanical Monographs. Berkeley. 1977. 498 p.

TABORDA-MARIN, Alexander. 2013. Deforestation and sedimentation in the mangroves of the Gulf of Urabá. Rev. Gestión y Ambiente. Vol. 11 (3), December 2008, Medellín. ISSN 0124.177X. pp 19-36.

Likewise, dredging activities (to improve the navigability of the Gulf of Urabá) and the contribution of organic matter of continental origin that increases the turbidity of the water and decreases the light incidence, disadvantage the photosynthetic process and therefore the optimal development of this community.

Regarding the values of uniformity, the community did not behave similarly to its diversity, which suggests that the changes in the Shannon index respond to the presence of dominant species, that is, structurally the community presents differences which is reflected in density heterogeneity. This is corroborated by the values shown by the predominance, which are above 0.74.

Table No. 5.43 Ecological indices for the phytoplankton community present at the sampling points in Bahía Colombia

Sampling Points	S	N	d	J'	H'(loge)	λ
HB3	7	392	1,00	0,31	0,59	0,74
HB4	5	27551	0,39	0,14	0,22	0,91
HB5	4	27978	0,29	0,16	0,23	0,91
HB6	4	28788	0,29	0,17	0,24	0,91
HB7	5	28745	0,39	0,13	0,21	0,92
HB8	4	32159	0,29	0,18	0,25	0,90
HB9	4	31933	0,29	0,16	0,22	0,91

S: Abundance of species, N: Total organisms in the sample, d: Abundance of Margalef, J': Uniformity of Pielou, H': Diversity of Shannon-Wiener, λ Predominance of Simpson

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados SAS, 2015

On the other hand, from the values reported for N (total of organisms in the sample) in relation to the sampling points, these were low for Point HB3 and were increasing for the other points (Table No. 5.53), This condition can be attributed to the proximity to the coast and the mouth of the León River, which has a high load of organic matter that generates a greater concentration of sediments that can limit the development of this community.

In the similarity analysis of Bray Curtis, a grouping was observed with a similarity of 97.94%, where three (3) subgroups were registered that were formed by presenting four (4) common species: Cosinodiscus sp., Chaetoceros sp1, Chaetoceros sp2 and Chaetoceros sp3. The grouping between points depended on the similarity in the composition of these taxa, among which the highest percentage was the result between the association of HB8 and HB9 and HB6 and HB7 with 99.44% respectively, followed by HB4 and HB5 with 98.82% of similarity, on the other hand point HB3 did not register similarity with any of the points, since it registered species exclusively for that point associated to the organic matter load due to the proximity to the coast (Figure No. 5.67) .

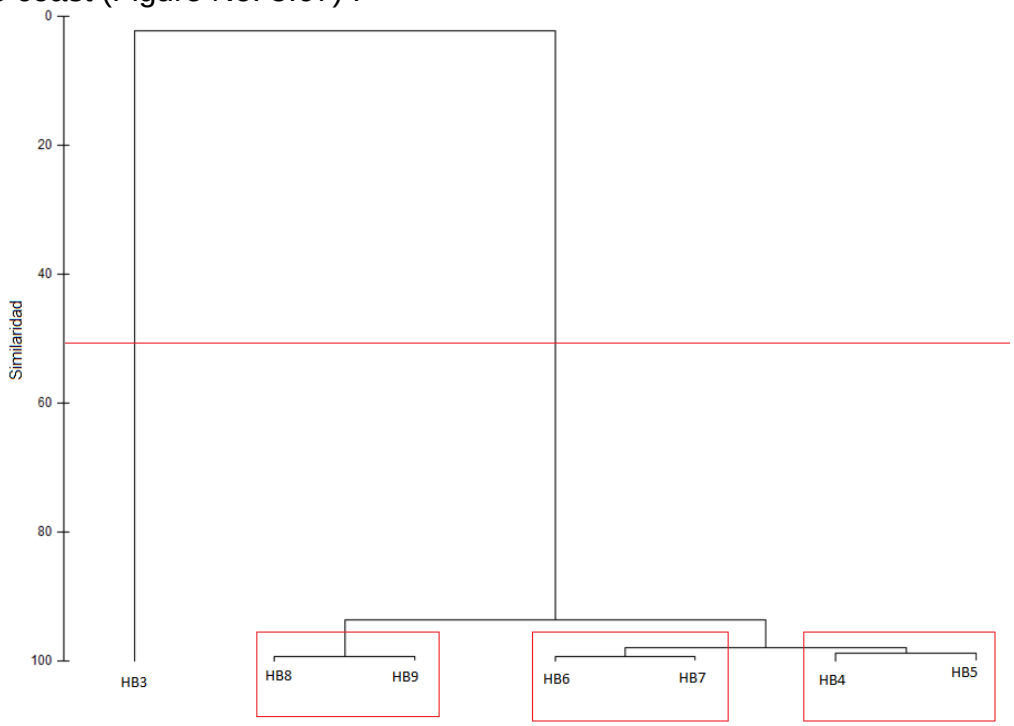


Figure No. 5.67 Bray-Curtis analysis for the phytoplankton community present in the sampling points in the area of influence of the project in Bahía Colombia
Source: Produced by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Correlation with physicochemical parameters

The variation of the phytoplankton community registered in Bahía Colombia was statistically significantly correlated ($p < 0.05$) with the total nitrogen concentration (mg N / L) and turbidity. This relationship was positive with the first parameter, indicating that 70% of the increase in phytoplankton density is explained by the increase in nitrogen concentration, while the relationship with turbidity was negative. In this respect, it is indicated that the decrease in the density of phytoplankton is explained by 60% with the increase in water turbidity (Figure No. 5.68). The phytoplankton

density did not present significant correlations with the other five physicochemical parameters evaluated (Table No. 5.54).

The previous is explained because the parameters of suspended solids, salinity and bacterial outcrop are directly related in estuarine waters (salt water mixture with the sea) where there is the greatest deposit of industrial pollutants or domestic waters, in this sense salinity is an attenuator of bacterial development and therefore of contamination and affectation of the development of primary microbiota, nevertheless when reducing the salinity by the contribution of continental waters, it increases the rate of stabilization of the water in this zone, seeking a greater cycling of nutrients such as nitrogen and carbon, which leads to a high BOD5 and a fixation in the substrate decreasing oxygen, making the optimum environment for organisms such as microalgae that are precursors of stabilization.

VELÁSQUEZ - GÓMEZ, FELIPE., AGUIRRE-RAMÍREZ, NÉSTOR., URBAN, JUDITH., TORO-BOTERO, MAURITIUS. 2008. Distribution of two bacterial indicators of water quality in the Gulf of Urabá. Rev. Gestión y Ambiente. Vol. 16 (2), August 2013, Medellín. p 87-96.

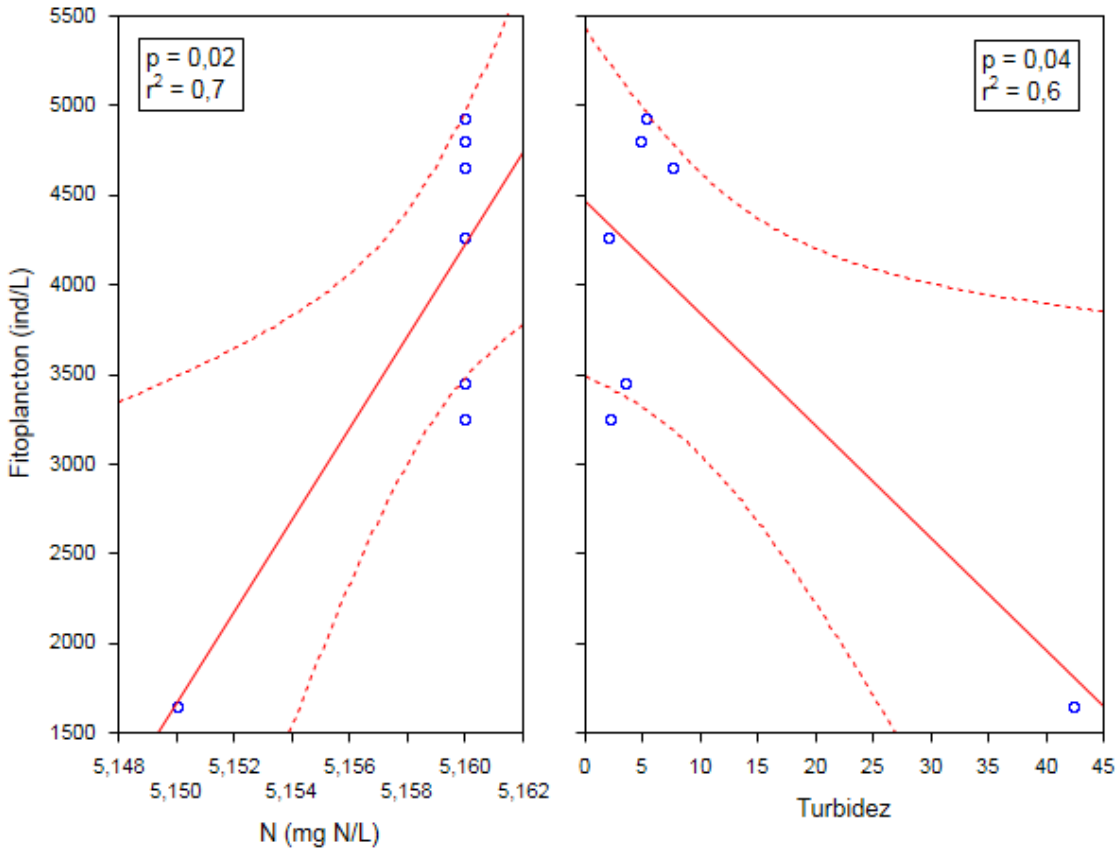


Figure No. 5.68 Correlation between phytoplankton density and nitrogen concentration (left) and turbidity (right) in the area of marine influence of the project
Source: Produced by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.44 Correlation of phytoplankton density and physical-chemical parameters in the area of marine influence of the project

Parameter	P	r^2
Temperature (°C)	0,61	0,06
pH	0,12	0,41
Biochemical Demand For Oxygen	0,48	0,11
Chemical Demand For Oxygen	0,34	0,19
Dissolved Oxygen	0,14	0,61

Source: Produced by Aqua & Terra Consultores Asociados S.A.S., 2015

2. Mangrove

The mangrove forest present in the area of influence of the project is a lowland forest, which usually does not exceed 11 m in height, although in some areas, which coincide with the mouth of the León River, it reaches up to 15 meters. It is constituted by straight and slender trunks trees that present fulcrum roots (epigeous or aerial

roots that support the plant) that can surpass 2 m above the base (Photograph No. 5.35).

Photography No. 5.35 Mangrove vegetation present in the area of influence.
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The floristic composition corresponding to the mangrove ecosystem was made by grouping the high dense mangrove covers and the secondary high vegetation corresponding to the natural regeneration of the mangrove. A floristic composition was found represented in three (3) families, three (3) species in a total of 119 individuals, being the family Avicenniaceae the most abundant within the sample with the species *Avicennia Germinans* (Annex 5.2.11).

This coverage is protected by the protective forest reserve of the Suriquí and León river wetlands, even though it has been affected by the colonization of lands and the expansion of the agricultural frontier, which has been deforested (Photo No. 5.36) these areas for the planting of grasslands for livestock use.

Photography No. 5.36 Affectation observed in the mangrove cover
Source Aqua & Terra Consultores Asociados S.A.S., 2015

Two (2) parcels of 50m x 50m were established (Figure No. 5.69) as a sample unit, to achieve a reliability of 95% and a sampling error of no more than 15%, taking an average volume of 61.24 m3 / ha, a standard deviation of 9.14 m3 / ha and a coefficient of variation of 15%.

In this sampling, 119 individuals were identified in 0.5 ha, that is, approximately 238 individuals per hectare could be found in the mangrove cover.

Table No. 5.45 Floristic composition for Mangrove coverage

Family	Scientific Name	Vulgar Name
Avicenniaceae	*Avicennia germinans*	Black mangrove
Combretaceae	*Laguncularia racemosa*	Black mangrove
Rhizophoraceae	*Rhizophora mangle*	Black mangrove

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

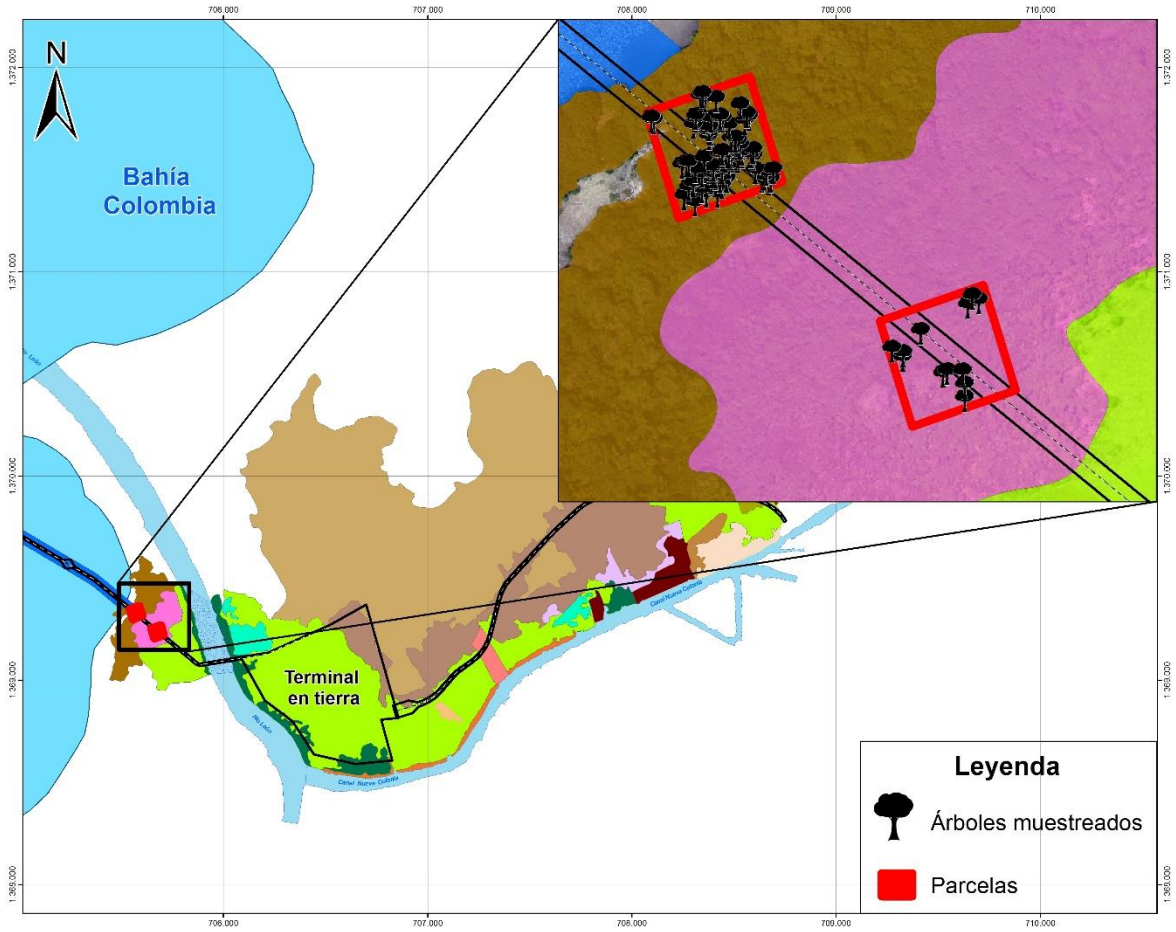


Figure No. 5.69 Spatial location of the sampling plots
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Table 5.56 shows the structural analysis for mangrove coverage. There, the Value of Importance Index (I.V.I) was determined.

The high values of abundance and frequency are characteristic of a low abundance and high frequency combined with high dominance, are typical characteristics of large isolated trees; In general, they are not numerous but they are uniformly distributed over large areas. Finally, the low values of abundance, frequency and dominance are associated with the 'companion' species, which do not have major ecological or economic importance.

MATTEUCCI, D. S. AND A. COLMA. Methodology for the study of vegetation. General Secretariat of the Organization of American States, Washington, D.C. 1982. 168p.

A low abundance and high frequency combined with high dominance are typical characteristics of large isolated trees; In general, they are not numerous but they are uniformly distributed over large areas. Finally, the low values of abundance, frequency and dominance are associated with the 'companion' species, which do not have major ecological or economic importance.

Table No. 5.46 Structural analysis for mangrove coverage

Species	Plot	Abundance		Frequency		Dominance		I.V.I
		A.a	A.r	F.a	F.r	D.a	D.r	
Avicennia germinans	P1,P2	89	74,8	100	40	0,5	42,8	157,5
Rhizophora mangrove	P1,P2	29	24,4	100	40	0,7	56,3	120,7
Laguncularia racemosa	P1	1	0,8	50	20	0,0	0,9	21,8
Grand Total		119	100,0	250	100	1,2	100,0	300,0

A.a: Absolute abundance; A.r%: Relative abundance; F.a: Absolute frequency; F.r%: Relative frequency; D.a: Absolute dominance; D.r%: Relative Dominance; I.V.I: Importance value index.
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The values recorded in Table No. 5.56 indicate that the mangrove cover present in the area of influence of the project has dominant species, because the importance value index shows differences between the values.

This indicates that this ecosystem has a tendency towards homogeneity, where the species *Avicennia germinans* (Black Mangrove) predominates, followed by Rhizophora mangrove (Red Mangrove).

A. germinans (Black Mangrove) is the species with the highest abundance represented by 89 individuals corresponding to 74.8% of the total sample. This species has adapted to the areas of more stable substrates such as the tidal planes that form the study area; This species is recognized as having no branching roots in the form of stilts, but shallow radial roots with abundant pneumatophores, which emerge perpendicularly from the ground as can be seen in Photograph No. 5.37.

Photography No. 5.37 Avicennia germinans (Black mangrove) in the area of influence of the project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The highest representativeness in terms of frequency corresponds to the species of A. germinans followed by Rhizophora Mangrove (Red Mangrove). These two species were found in the two plots established for the floristic characterization of this cover.

For the species Laguncularia racemosa, only one individual was recorded within the sampling area, being in the densest area of the mangrove. This type of vegetation is classified as a riparian mangrove due to its floristic composition, where the dominant genera are Avicennia (Black Mangrove), Rhizophora (Red Mangrove) and Laguncularia (White Mangrove).

The species with the greatest domain space was R. mangrove with 56.3% (0.7 m2) of coverage in the basal area. R. manglrove is characterized by having roots in the shape of stilts (Photo No. 5.38) and embryos of elongated shape.

Photography No. 5.38 Rhizophora mangrove (Red Mangrove) in the area of influence of the project
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The distribution of the species according to their abundance, frequency and relative dominance for mangrove cover is shown in Figure No. 5.70.

In this it is observed that the highest percentage in abundance was obtained by A. germinans, followed by Rhizophora Mangrove (Red Mangrove). Regarding the frequency, the species A. germinans and Rhizophora Mangrove (Red Mangrove), have existence in the same number of plots. The species Rhizophora Mangrove(Red Mangrove) was the most dominant, since it was the one of greater degree of coverage in comparison with the other species.

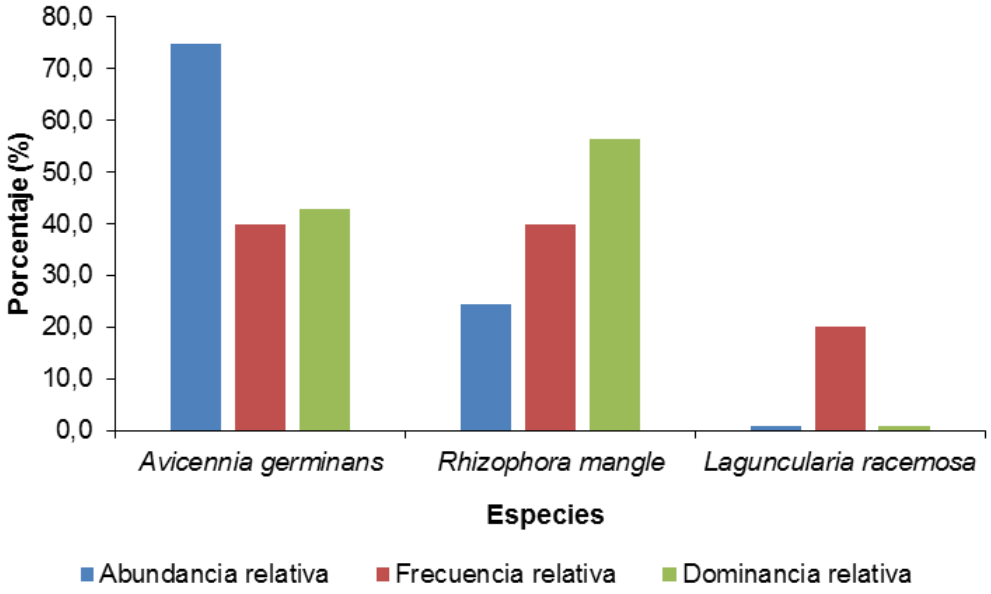


Figure No. 5.70 Structural analysis for mangrove coverage
Source Aqua & Terra Consultores Asociados S.A.S., 2015

In Figure No. 5.71 species of A. germinans are observed with 157.5%, followed by R. mangrove with 102.7%. These two species are those that have the greatest ecological weight within the mangrove ecosystem due to their abundance, frequency and dominance in the sampling plots. The species L. racemose was classified as a rare species due to its low value index with 21.8% importance compared to the other values.

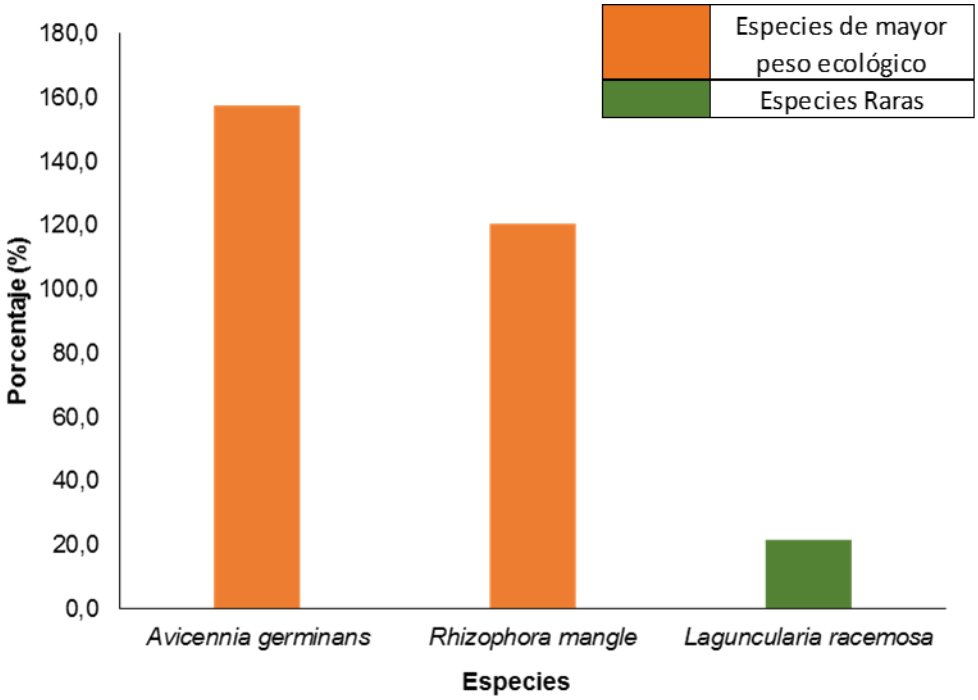


Figure No. 5.71 Value index of importance for mangrove coverage
Source Aqua & Terra Consultores Asociados S.A.S., 2015

On the other hand, according to the mixing ratio (CM), the floristic composition that gives the mangrove coverage within the area of influence of the project, is characterized by presenting an arboreal community with a low mixing intensity (homogeneous in species) in which it can be observed that its mixing ratio was 1:40, which indicates that on average each species is represented by 40 individuals.

The density of this mangrove is considered average, since the average of individuals per hectare with a diameter greater than or equal to 10 centimeters is approximately 238, with a tendency to decrease due to anthropic intervention that occurs in the area.

Distribution by diametric and altimetric classes of the mangrove

The total structure is the extension of tree species. In tropical forests this phenomenon is reflected in the distribution of individuals by diametric classes. The distribution of the diameter classes for most of the species in the tropical forests is that of 'J inverted', that is, the number of trees decreases as the DAP (Diameter to the Breast Height) increases.

Table 5.57 shows the frequency distribution for the normal diameter variable. This has a decreasing tendency, in which as the diameter increases the number of individuals decreases.

Figure No. 5.72 shows the trend of the diameter distribution for the trees present in the mangrove cover.

It is observed that the distribution of the individuals is mainly represented by the diametric classes 1 and 2, with class 1 (Normal diameters between 9 cm and 14 cm) being the most abundant with a total of 59 individuals (49.6%) followed for class 2 (Normal diameters between 14.1 cm to 19 cm) with 51 individuals (42.9).

Table No. 5.47 Frequency distribution for the variable normal diameter for mangrove trees

Diameter Class	Interval Class	Mark Class	Frequency		
			F.a	F.ac	F.r
1	9 - 14 cm	11,5	59	59	49,6
2	14,1 - 19 cm	16,5	51	110	42,9
3	19,1 - 24 cm	21,5	4	114	3,4
4	24,1 - 29 cm	26,5	1	115	0,8
5	29,1 - 34 cm	31,5	2	117	1,7
6	34,1 - 39 cm	36,5	2	119	1,7
Total			**119**		**100,0**

F.a: Absolute frequency; F.ac Cumulative frequency; F.r: Relative frequency.
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

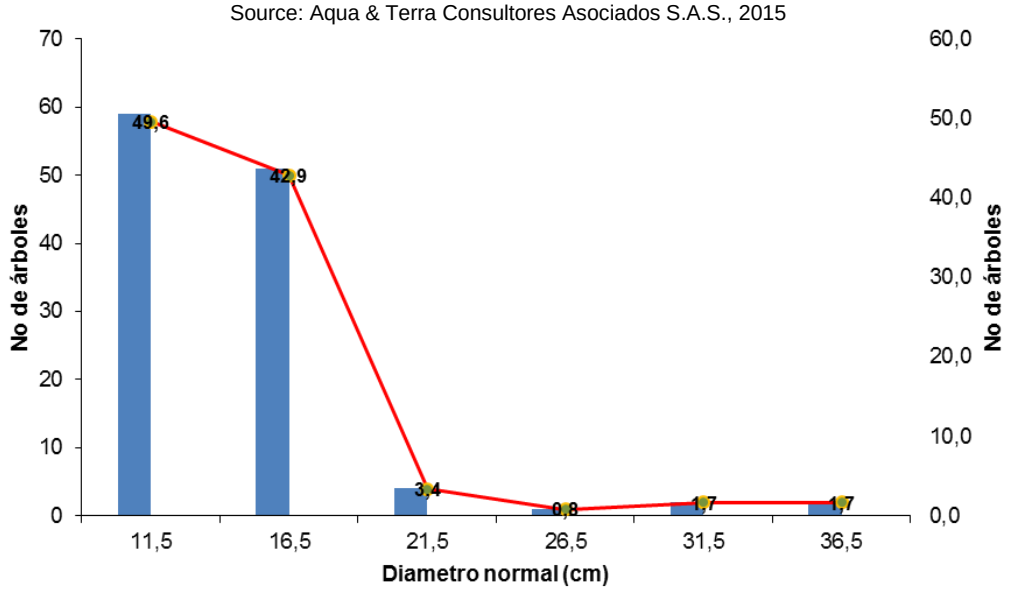


Figure No. 5.72 Diameter distribution in absolute and accumulated form, for mangrove trees
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Figure No. 5.73 shows the tree dispersion diagram for the arboreal individuals identified in the mangrove cover, where only a generalized dispersion of points appears, without gaps or clusters. The above is evidence of the lack of layers in the forest.

Likewise, the figure allows the visualization of the emergent trees, which appear as isolated points in the upper-right part of the graph, without constituting a proper stratum.

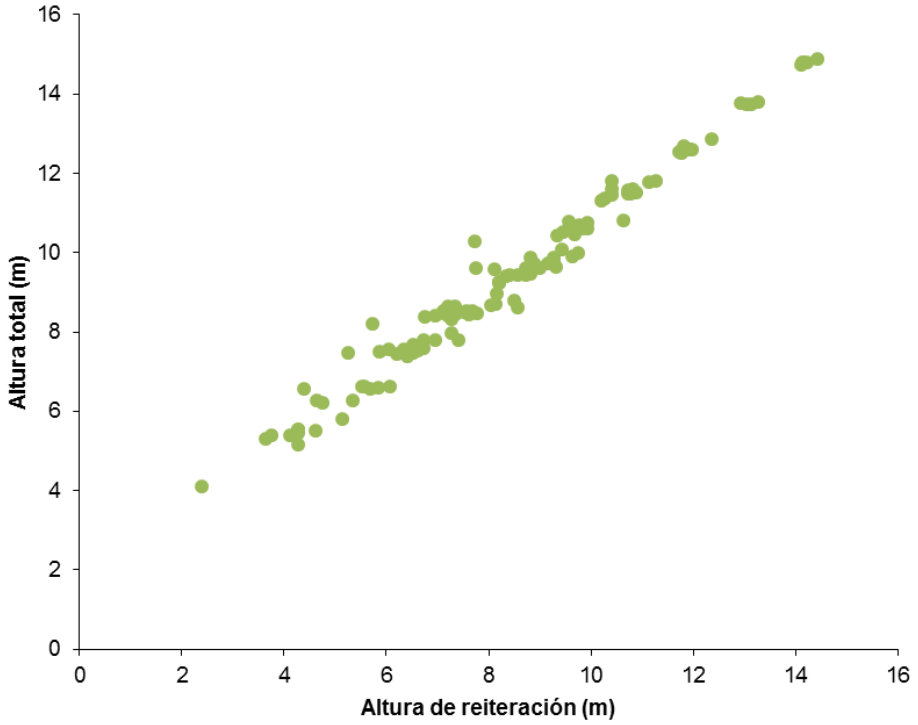


Figure No. 5.73 Stratification trends for the cup dispersion diagram for mangrove coverage
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Table 5.58 shows the altimetric position for the species identified in the mangrove cover. There the grouping of these species by forest stratum is observed, from their respective intervals of total height.

Table No. 5.58 Distribution of the number of species and their abundances (Number of trees) in each stratum (Sociological position), for the trees inventoried in the mangrove cover

Stratum	Interval	Number of Trees	Number of Species	Species
Stratum I	1,5 m - 5 m	12	2	*Avicennia germinans*
				Laguncularia racemosa
Stratum II	5,1 m - 10 m	77	2	*Avicennia germinans*
				Rhizophora mangrove
Stratum III	10,1 m - 15 m	30	2	*Avicennia germinans*
				Rhizophora mangle

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Ecological indexes of the mangrove

Table No. 5.59 shows the values for the indices of species abundance and diversity found in the area of direct involvement of the project, for the mangrove vegetation.

The Margalef and Menhinick index indicates that this ecosystem has a low richness, corresponding to only three (3) species (Avicennia germinans (Black Mangrove), Rhizophora mangrove (Red Mangrove) and Laguncularia mangrove (White Mangrove), characteristics of the mangrove vegetation.

For diversity measures, the Shannon index is 0.60, Simpson reciprocal (1 / D) is 0.38 and reciprocal of Berger-Parker (1 / d) is 0.74; indicating that there is and low diversity and that the dominance of the species identified in this coverage is high.

These indices define a homogeneous community with low diversity and high dominance of the species that characterize the mangrove cover.

Table No. 5.48 Abundance and Diversity indices for mangrove vegetation

Abundance	Margalef	0,41
	Menhinick	0,27
Diversity	Shannon	0,60
	Simpson	0,38
	Berger-Parker	0,74

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Analysis of the natural regeneration of the mangrove

Dense high mangrove pole stage of very humid warm climate

The floristic composition for the classification of pole stages, which corresponds to the high dense mangrove coverage of very humid warm climate within the area of influence of the project, presents in total 290 individuals belonging to 7 species, 7

families and 7 orders; as shown in Table No. 5.60, being the Avicenniaceae family the one that presented the highest number of individuals in the forest with the species A. germinans.

Table No. 5.49 Floristic composition, latizales of dense mangrove

Order	Family	Species	Common Name	Number of Individuals
Lamiales	Avicenniaceae	Avicennia germinans	Black Mangrove	197
Rhizophorales	Rhizophoraceae	Rhizophora mangrove	Red Mangrove	73
Myrtales	Combretaceae	Laguncularia racemosa	White Mangrove	11
Malvales	Bombacaceae	Pachira aquatica	Salero	6
Alismatales	Araceae	Monster sp.	Bejuquillo	1
Magnoliales	Annonaceae	Annona cherimola	Chirimoya	1
Fabales	Fabaceae	Apuleia leiocarpa	Combita	1
Total				290

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Figure No. 5.74 shows the number of individuals per family present in the high dense mangrove latitudes corresponding to the area of influence of the project.

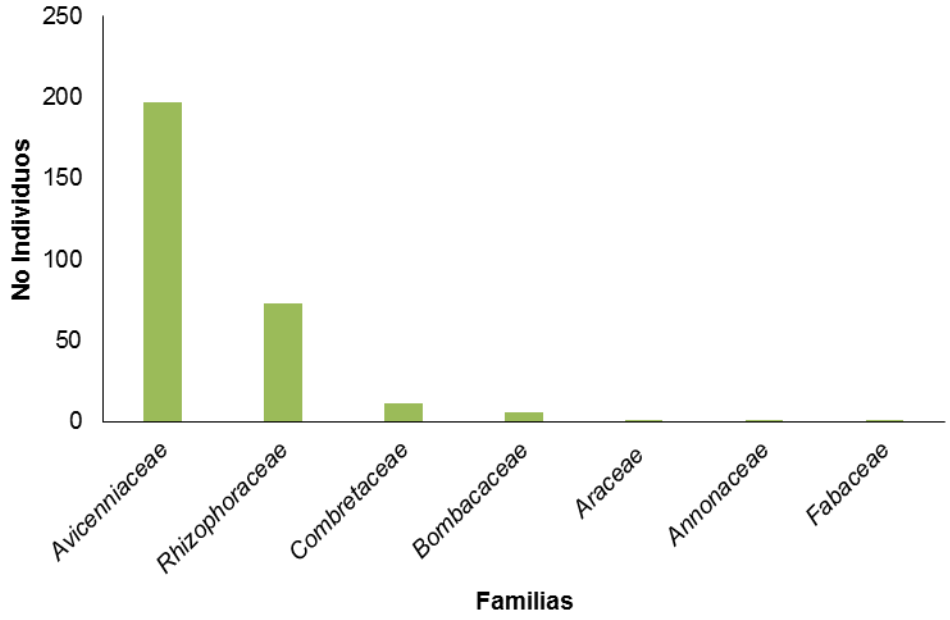


Figure No. 5.74 Representation by families, pole stages of dense high mangrove
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The structural analysis for high dense mangrove cover is shown in Table No. 5.61. There, the Value of Importance Index (I.V.I.) was determined

The values recorded in Table No. 5.61 indicate that the species A. germinans is the species with the greatest ecological importance in the vegetation belonging to the

latitudes of the mangrove population; This is because, its index of importance value is the highest compared to the indexes of the other species.

Table No. 5.50 Structural analysis for mangrove pole stages

Species	Abundance		Frequency		Dominance		I.V.I
	A.a	A.r	F.a	F.r	D.a	D.r	
Avicennia germinans	197	67,9	88,9	37,2	0,318	74,6	179,7
Rhizophora mangrove	73	25,2	88,9	37,2	0,083	19,4	81,8
Laguncularia mangrove	11	3,8	27,8	11,6	0,011	2,5	17,9
Pachira aquatica	6	2,1	16,7	7,0	0,010	2,3	11,4
Monster sp.	1	0,3	5,6	2,3	0,000	0,0	2,7
Annona cherimola	1	0,3	5,6	2,3	0,001	0,2	2,9
Apuleia leiocarpa	1	0,3	5,6	2,3	0,004	1,0	3,7
	290	100,0	238,9	100,0	0,426	100,0	300,0

A.a: Absolute abundance; A.r%: Relative abundance; F.a: Absolute frequency; F.r%: Relative frequency; D.a: Absolute dominance; D.r%: Relative Dominance; I.V.I: Importance value index.
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Of the total number of species found in the forest, the most abundant is A. germinans with 197 individuals corresponding to 67.9%, followed by R. mangrove with 73 individuals corresponding to 25.2%.

The highest representativeness in terms of frequency, corresponds equally to the species of A. germinans and R. mangrove, these species were found in 37.2% of the sampling quadrants established for the characterization of this vegetation. Given its high basal area value compared to the other species, the species with the largest domain space was A. germinans with 74.6%.

The distribution of the species, according to their abundance, frequency and relative dominance is represented in Figure No. 5.75.

Figure No. 5.76 shows the species with the highest ecological weight with the rest of the species classified as rare species, due to their low importance value index.

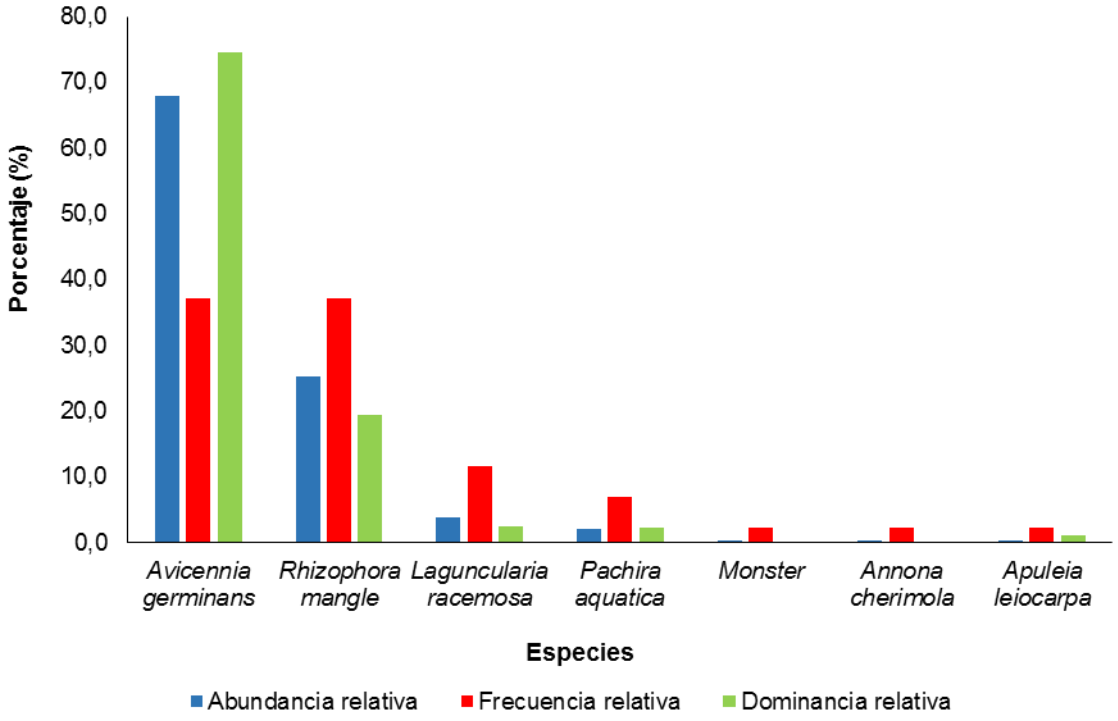


Figure No. 5.75 Structural analysis for mangrove pole stages
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

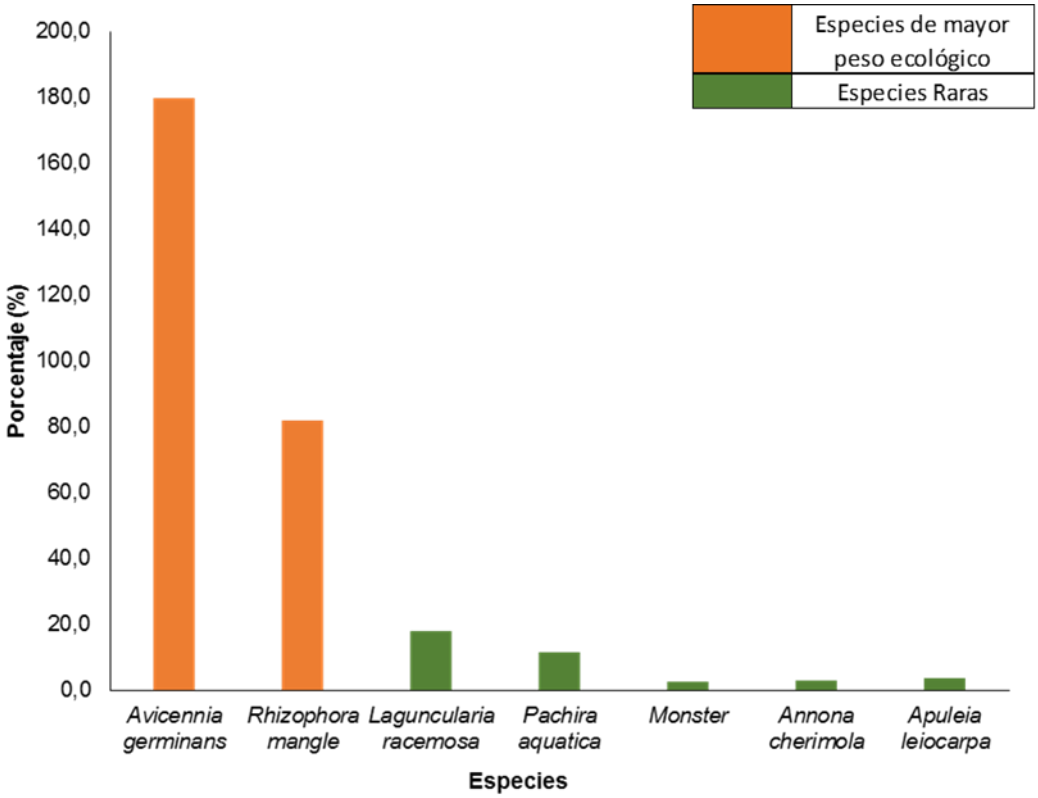


Figure No. 5.76 Value index of importance for mangrove pole stages
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

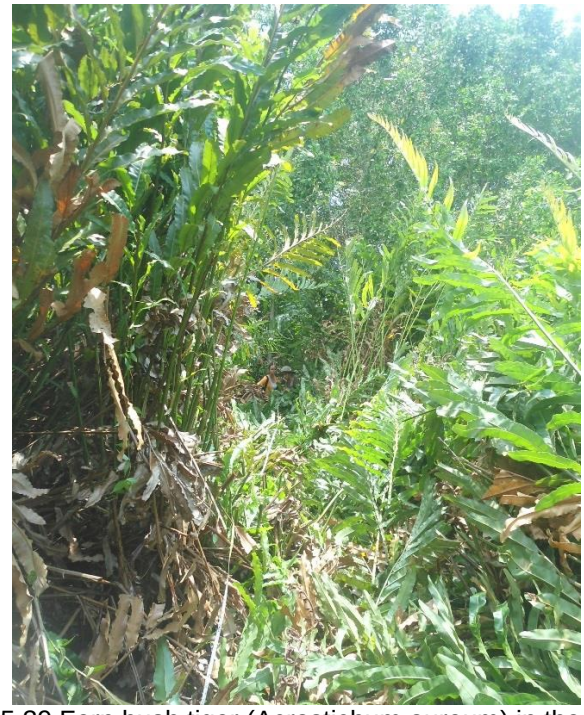
The most important ecological species is A. germinans (Black Mangrove) with 179.7% importance value index, followed by R. mangrove (Red Mangle) with 81.8%, because these were the species with the highest number of individuals and with greater dominance in floristic sampling units.

On the other hand and according to the mixture ratio (CM) that gives a value of 1:41, it indicates that for each species found there are 41 individuals in the vegetation under study. A forest with a certain proportion of mixture is observed without much heterogeneity. The density of this forest is considered average, since on average there are 1812.5 individuals per hectare with CAP between 1.5 and 3 cm.

Saplings of dense high mangrove of very humid warm climate

The saplings make up the vegetation also called natural regeneration, which is a group of individuals that settle down after a process of dispersion, grow, compete and survive until they become physiologically functional trees. In the saplings that

make up the dense high mangroves of the study area, there are dense cumulative associations of the tiger bush fern (Acrostichum aureum), especially in some humid and shaded places or in those where the main vegetation of the mangrove has been eliminated (Photo No. 5.39). The tiger bush fern is considered as an aggressor of the mangrove because it inhibits the natural regeneration of the mangrove.



Photograph No. 5.39 Fern bush tiger (Acrostichum aureum) in the area of influence
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

In the sampling carried out for 12 subplots in the category of saplings belonging to dense high mangrove cover, a total of 527 individuals belonging to eight (8) species and seven (7) families in natural regeneration were recorded (Table No. 5.62).

Table No. 5.51 Floristic composition of the tall dense mangrove saplings.

Family	Species	Common Name	Abundance		Frequency	
			A.a	A.r	F.a	F.r
Rhizophoraceae	Rhizophora mangrove	Black mangrove	339	64,3	100,0	34,3
Avicenniaceae	Avicennia germinans	Black mangrove	83	15,7	91,7	31,4
Phyllantha ceae	Phyllanthus niruri	Balsilla	60	11,4	25,0	8,6
Fabaceae	Apuleia leiocarpa	Combita	28	5,3	16,7	5,7
Araceae	Montricha rdia arborescens Schott	Arracacho	7	1,3	25,0	8,6
Bombacaceae	Pachira aquatica	Salero	5	0,9	16,7	5,7
Combretáceas	Laguncularia racemosa	White mangrove	4	0,8	8,3	2,9

Family	Species	Common Name	Abundance		Frequency	
			A.a	A.r	F.a	F.r
Combretáceas	Terminalia Catappa L	Almond	1	0,2	8,3	2,9
Grand total			527	100,0	291,7	100,0

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The species R. mangrove (Red Mangrove) is the most abundant with a total of 339 individuals corresponding to 64.3% of the sample; followed by A. germinans with a total of 83 individuals corresponding to 15.7% of the sample, as indicated in Figure No. 5.77.

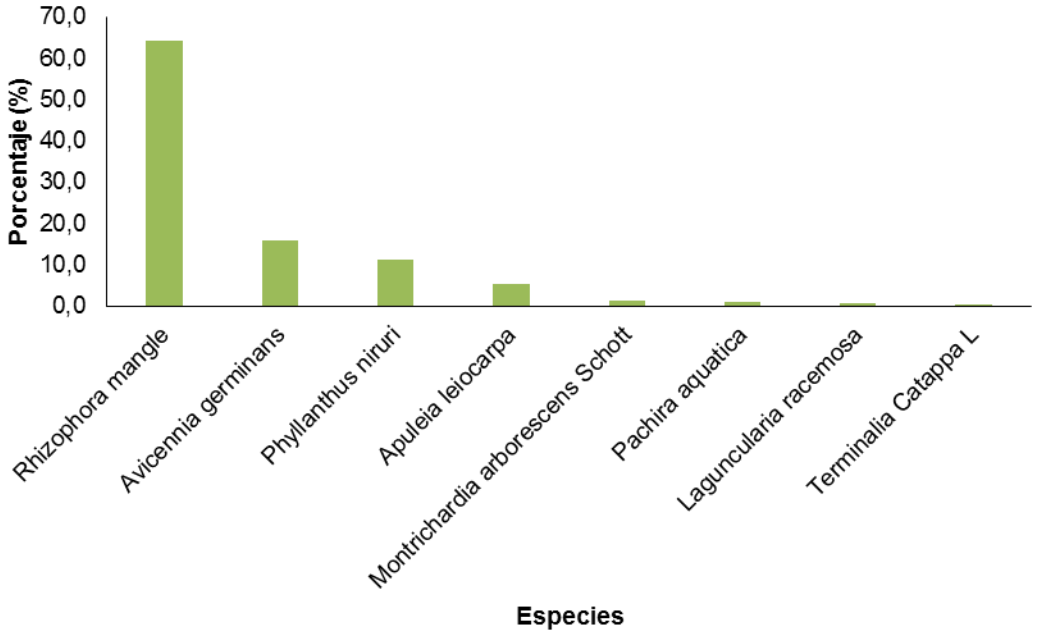


Figure No. 5.77 Abundance of tall dense mangrove saplings
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The highest representativeness in terms of frequency corresponds to the R. mangrove species, which was identified in 100% of the sampling subplots, followed by the A. germinans species, which was found in 91.7% of the sampling area, as shown in Figure No. 5.78.

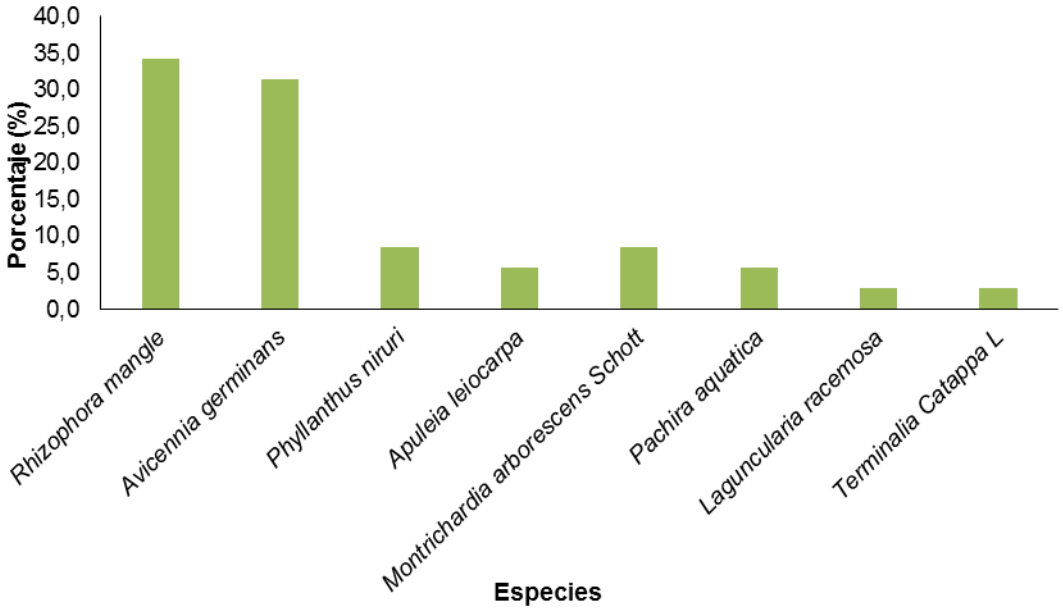


Figure No. 5.78 Frequency of tall dense mangrove saplings
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

In the case of floristic sampling of the saplings belonging to the high dense mangrove cover, the mixing ratio was calculated in equivalence of 1:66, which indicates that for each species found there are 66 individuals.

A forest with a tendency towards homogeneity is observed, the proportion for this coverage is 17,567 individuals per hectare, which indicates that it is an ecosystem with a high capacity for natural regeneration, which ensures the permanence and competition of the species reported in this sampling.

Pole stage of high secondary vegetation of very humid warm climate

The coverage of high secondary vegetation corresponds to the natural regeneration of the mangrove, where the low stratum of this forest is dominated by fern tiger bush (Acrostichum aureum), which prevents the growth of low vegetation such as saplings or shoots.

Within the area of influence this vegetation has a floristic composition corresponding to six (6) species, six (6) families and six (6) orders; as shown in Table No. 5.63, Rhizophoraceae being the family with the highest number of individuals in the forest with the R. mangrove species.

Table No. 5.52 Floristic composition, pole stages of high secondary vegetation

Order	Family	Species	Common Name	Number of Individuals
Rhizophorales	Rhizophoraceae	Rhizophora mangrove	Red mangrove	2230
Lamiales	Avicenniaceae	Avicennia germinans	Black mangrove	996
Fabales	Fabaceae	Apuleia leiocarpa	Combita	44
Malvales	Bombacaceae	Pachira aquatica	Salero	28
Rosales	Cecropiaceae	Cecropia telenitida	Yarumo	8
Myrtales	Combretaceae	Laguncularia racemosa	White mangrove	10
Total				3316

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Figure No. 5.79 shows the number of individuals per family present in the pole stages of high secondary vegetation corresponding to the natural regeneration of the mangrove within the area of influence of the project.

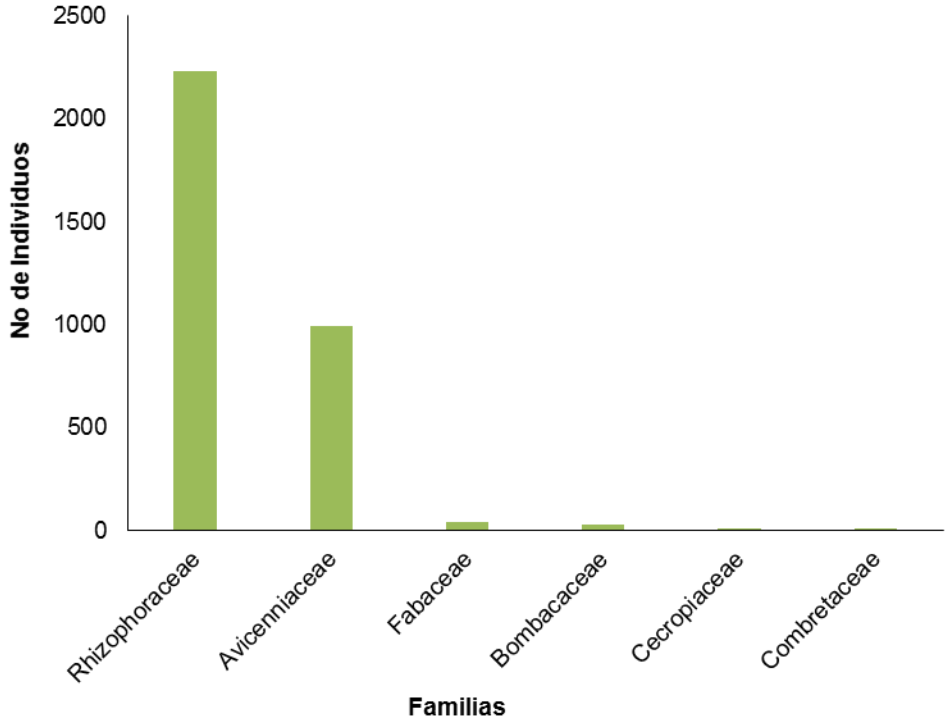


Figure No. 5.79 Representation by families of pole stages of high secondary vegetation
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Table 5.64 shows the structural analysis for the pole stages of the secondary high vegetation of the mangrove; there, the Value of Importance Index (I.V.I) was determined.

The values recorded in Table No. 5.64 indicate that the R. mangrove species is the species with the greatest ecological importance in the vegetation belonging to the pole stages of the mangrove population. That is, because its importance value index is the highest compared to the indexes of the other species.

Table No. 5.53 Structural analysis for pole stages of high secondary vegetation.

Species	Abundance		Frequence		Dominance		I.V.I
	A.a	A.r	F.a	F.r	D.a	D.r	
Rhizophora mangrove	2230	67,2	100,0	30,9	2,642	57,6	155,7
Avicennia germinans	996	30,0	80,0	24,7	1,767	38,5	93,3
Apuleia leiocarpa	44	1,3	80,0	24,7	0,087	1,9	27,9
Pachira aquatica	28	0,8	40,0	12,3	0,056	1,2	14,4
Cecropia telenitida	8	0,2	16,0	4,9	0,011	0,2	5,4
Laguncularia racemosa	10	0,3	8,0	2,5	0,021	0,5	3,2
	3316	100,0	324,0	100,0	4,585	100,0	300

A.a: Absolute abundance; A.r%: Relative abundance; F.a: Absolute frequency; F.r%: Relative frequency; D.a: Absolute dominance; D.r%: Relative Dominance; I.V.I: Importance value index.
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

Of the total species found in the forest, the most abundant is R. mangrove with 2,230 individuals corresponding to 67.2%, followed by A. germinans with 996 individuals corresponding to 30%.

The greatest representativeness in terms of frequency corresponds to the R. Mangrove species. This species was found in 100% of the sampling quadrants, followed by the species A. germinans and Apuleia leiocarpa, which were found in 80% of the sampling quadrants established for the characterization of this vegetation. Given its high value of basal area in comparison with the other species, the species with the greatest domain space was R. mangrove with 57.6% coverage corresponding to 2.64 m².

The distribution of the pole stages species corresponding to the secondary vegetation of the mangrove, according to its abundance, frequency and relative dominance, is shown in Figure No. 5.80.

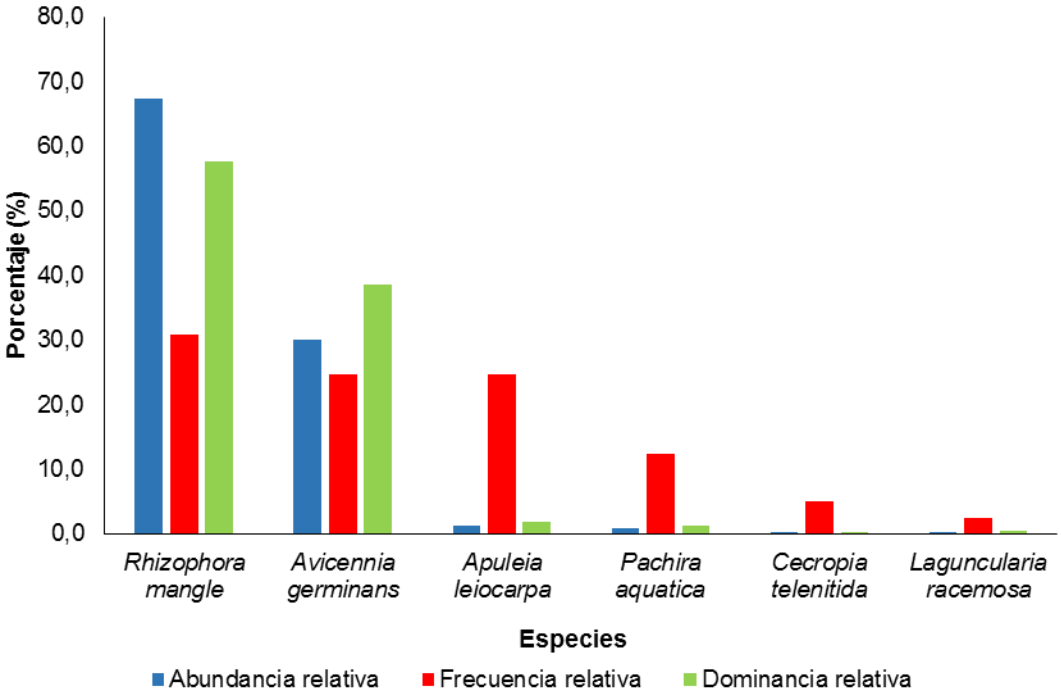


Figure No. 5.80 Structural analysis for pole stages of secondary mangrove vegetation
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

In Figure No. 5.81 the distribution of ecological weight is graphically observed, being the species of R. mangrove (Red Mangrove) with 155.7% and A. germinans (Black Mangrove) with 93.3%, the most significant in comparison with the rest of species classified as rare species due to their low importance value index.

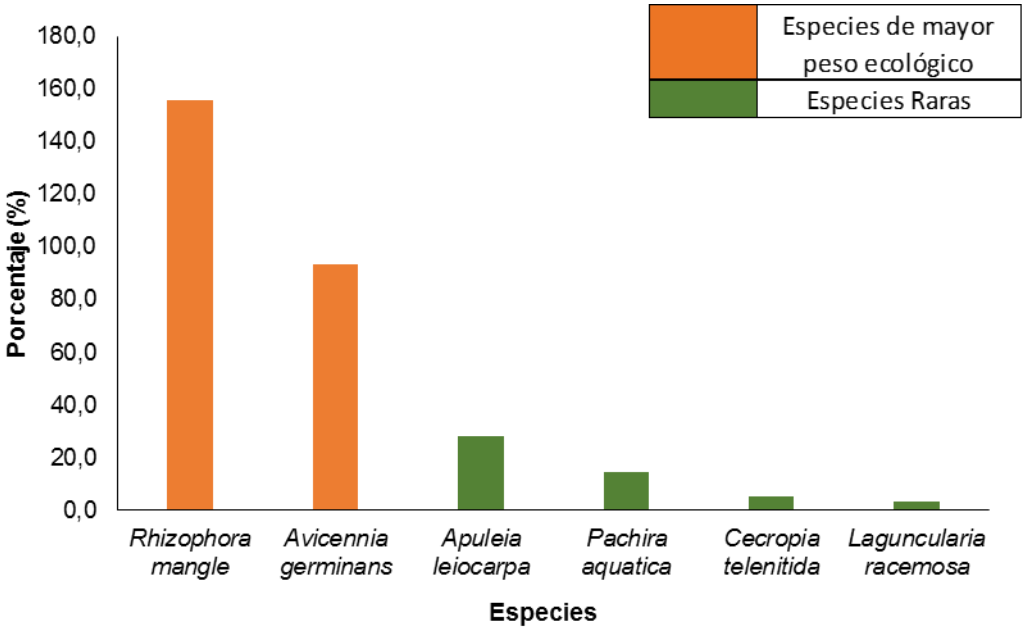


Figure No. 5.81 Value index of importance for mangrove pole stages
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The mixing ratio indicates that the species found in the pole stages of the secondary vegetation of the mangrove, are represented on average by 553 individuals, we observe a vegetation that tends towards homogeneity where the most predominant species is R. Mangrove

The density of this forest is on average 13,264 individuals per hectare, which means that this coverage has a high potential for natural regeneration, ensuring the permanence and competence of the species reported in this sample to be an established tree in adulthood.

Endangered Species

After reviewing the CITES databases and the IUCN red list, it was found that the three identified mangrove species, Avicennia germinans (Black Mangrove), Rhizophora mangrove (Red Mangrove) and Laguncularia racemosa (White Mangrove), are not within the CITES appendices, however they are listed as minor concern species on the IUCN red list.

http://www.cites.org/eng/resources/species.htm
http://www.iucnredlist.org/search/search-basic

Additionally, the species Avicennia germinans (Black Mangrove), Rhizophora mangrove (Red Mangrove) and Laguncularia racemosa (White Mangrove) are within the Resolution of closure number 076395 B of August 4, 1995 of CORPOURABA. But that through the agreement No 100-02-02-01-0004-2011 the ban was lifted by CORPOURABÁ.

Species of ecological, economic, and cultural importance

Rhizophora mangrove (Red Mangrove)

The species Rhizophora mangrove (Red Mangrove) is the one with the greatest distribution and until 1918 it was considered the only species in America. The red mangrove is usually, but not exclusively, the species found on the outside of the fringes of the mangrove and on the edges of the channels.

The most striking feature of this species is its complex system of aerial roots. These roots start from the same trunk or side branches and fall to the ground. The root network provides support to the tree in addition to carrying out vital nutrition and aeration functions (Photograph No. 5.40). In general, Rhizophora mangrove trees are 4 to 10 m tall. The leaves are simple, opposite and petiolate, usually 8 to 10 cm long and 4 to 5 cm wide. The flowers are small, 2.5 cm in diameter, with four lanced pedals, thick and coriaceous. The flower has four yellowish white petals. It has two to four flowers per stem or peduncle.

Photography No. 5.39 Red mangrove (*Rhizophora mangrove)*
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The red or scarlet mangrove, Rhizophora mangrove is the species that is best adapted to the development in unstable soils by having roots in the form of stilts, which allows it to stabilize on muddy planes, it is common to see it on the banks of swamps, estuaries or spouts always trying to increase its root area to develop and colonize new spaces.

It is a species that has been used as an adhesive in the manufacture of triplex, bowling or polo balls and handicrafts in general. Turned items. Likewise, the bark and root are important source of tannins (10 to 40%) that are used in tanning skins, string stains, nets and lines.

GEOGRAPHIC SOCIETY OF COLOMBIA. Academy of Geographical Sciences. The Mangroves in the world and in Colombia. Basic Descriptive Study. 2006

The harvest of the bark is carried out in a primitive way using only a machete, causing great damage to the tree when the vascular cambium is affected, due to the

wound they produce. It is also used as a source of combustion for firewood and charcoal. On the other hand the fermented juice produces an intoxicating drink. It is used for rural and marine construction. A widespread use is the extraction of juvenile trees of R. mangrove, for their resistance to be used as crossbeams in houses or for the construction of shrimp traps. The leaves are used in rural roofs.

The hardness and resistance of poles and piles to sea water is widely recognized by fishermen. Wood is in great demand in light constructions, also for making bridges, piles, house poles, beams, wood slats, sleepers, furniture, dykes, ribs for boats, manufacture of boats and flats, oars and instruments used in fishing gear.

Almost all parts of the tree are medicinal, bark: febrifuge, hemostatic, antidiarrheal, for asthma, hemoptysis, bites or stings of poisonous marine animals, various wounds, tuberculosis, leprosy, hemorrhages, dysentery, elephantiasis. Leaf: scurvy, toothache, leprosy ulcers. Root: the scraping of the roots is used by fishermen against fish bites and poisonous insect bites.

The embryos are rich in tannins and are used as cooked and astringent. The plant has anti-hyperglycemic effect and could be used clinically in the control of diabetes mellitus.

Avicennia germinans (Black mangrove)

The genre Avicennia is distinguished by the pronounced development of pneumatophores. These organs originate from the root system that is very superficial and is arranged radially around the trunk. The pneumatophores sprout from these roots and reach heights of 20 cm or more above the ground (Photograph No. 5.41).

As in Laguncularia, the function of pneumophores is to ventilate the root system. The trees of Avicennia germinans are of variable size reaching up to 15 m in height and diameter of 30 to 50 cm or more. However, in highly salty soils or in marginal and rigorous environments, they grow as short shrubs.

The species has a dark gray or black outer bark with a yellowish interior. The leaves are opposite, elliptical-lanceolate and full-edge with a sharp apex. They usually reach 8 cm long by 3 cm wide. The flowers are sessile, they are arranged in terminal groups and are small, 5 mm long and 2.5 mm in diameter. The fruit is an oval and flattened capsule, the embryo develops before the fall of the fruit. Avicennia germinans is the most tolerant species to climatic and edaphic conditions.

For this reason, it is frequently the dominant or exclusive species of marginal environments in the latitudinal limits or in the areas where the soils contain high

concentrations of salt. It has subsurface roots in the form of a star that give it stability, however, it is located in more consolidated soils.

Photography No. 5.40 Black mangrove (Avicennia germinans)
Source: Aqua & Terra Consultores Asociados S.A.S., 2015

The black mangrove, Iguanero, salty or smoky, belongs to the group of mangroves known as secretors. They let the salt dissolved in the water through their roots through a selective filtration process and eliminate the excesses through the glands that they possess in their leaves. The other strategy is to let the water enter with much smaller amounts of salt through membranes located in the roots, filtering, this is achieved by maintaining negative pressure differences inside the tissue through a physical process.

Laguncularia racemosa (White mangrove)

Laguncularia is a monotype genus that only includes the species Laguncularia racemosa (White Mangrove). The white mangrove trees reach up to 20 m high,

although it usually occurs as a medium height tree (4 to 6 meters high). Its trunk has a fissured bark, a characteristic that distinguishes it from the black mangrove, which has an integral bark. The leaves are opposite, simple, integral, leathery and succulent texture, oblong with a rounded apex (Photograph No. 5.42). The flowers are small and numerous; the petals are whitish, tubular, with five prominent ribs.

The fruit is 1.5 to 2.5 cm long, somewhat crushed and finely tomentose. In this species the fruit is detached from the plant with great ease. It can germinate quickly once it falls or floats for 20 to 30 days. Laguncularia racemosa has a shallow root system with roots that split radially from the trunk and produce geotropically negative projections (pneumatophores) that protrude from the ground. These pneumatophores are not as developed and aggregates tend to occur near the trunk. The pneumatophores leave intact from the root, but then bifurcate near the surface.

Photography No. 5.41 White mangrove (Laguncularia racemosa)
Source: Araujo Ibarra & Asociados s.a, ,2010

- *Fauna*

1. Zooplankton

The zooplankton plays an important role in water bodies, since its knowledge implies the establishment of its condition, its environmental quality and its trophic ecology. The knowledge of the biodiversity of the marine ecosystems is very important

regarding the understanding of the ecological processes that derive from it, such as the production and functioning of the natural cycles that serve as sustenance for many organisms; that is why zooplankton by acting as a transporter of energy from the primary level to higher levels, becomes a very important community in the marine environment, so any impact on it generates an imbalance in other communities[123].

Composition and richness

In the area of influence, the presence of several taxonomic groups (Photo No. 5.42) distributed in the different areas was identified, highlighting the classes Maxillopoda, Lobosa, Gastropoda, Bivalvia and Malacostraca. The Maxillopoda class was represented in all the monitored areas (Table No. 5.54), being dominant at area HB4 reaching a total of three (3) species within which their representatives are the Calanoida and Cyclopoida orders. This behavior is consistent with other coastal and estuarine areas of the Colombian Caribbean, finding a greater percentage in terms of abundance represented in the Maxillopoda class.[124]

[123] VANEGAS, T. Abundance of orders and dynamics of marine mesozooplankton in coastal environments of the Gulf of Salamanca and Tayrona Park, Colombian Caribbean. Thesis for the title of Marine Biologist. Santa Marta.: Jorge Tadeo Lozano University. 2002. 109 p.

[124] PUERTO BAHÍA COLOMBIA DE URABA S.A. and ARAÚJO IBARRA & ASOCIADOS S.A. Op. Cit.

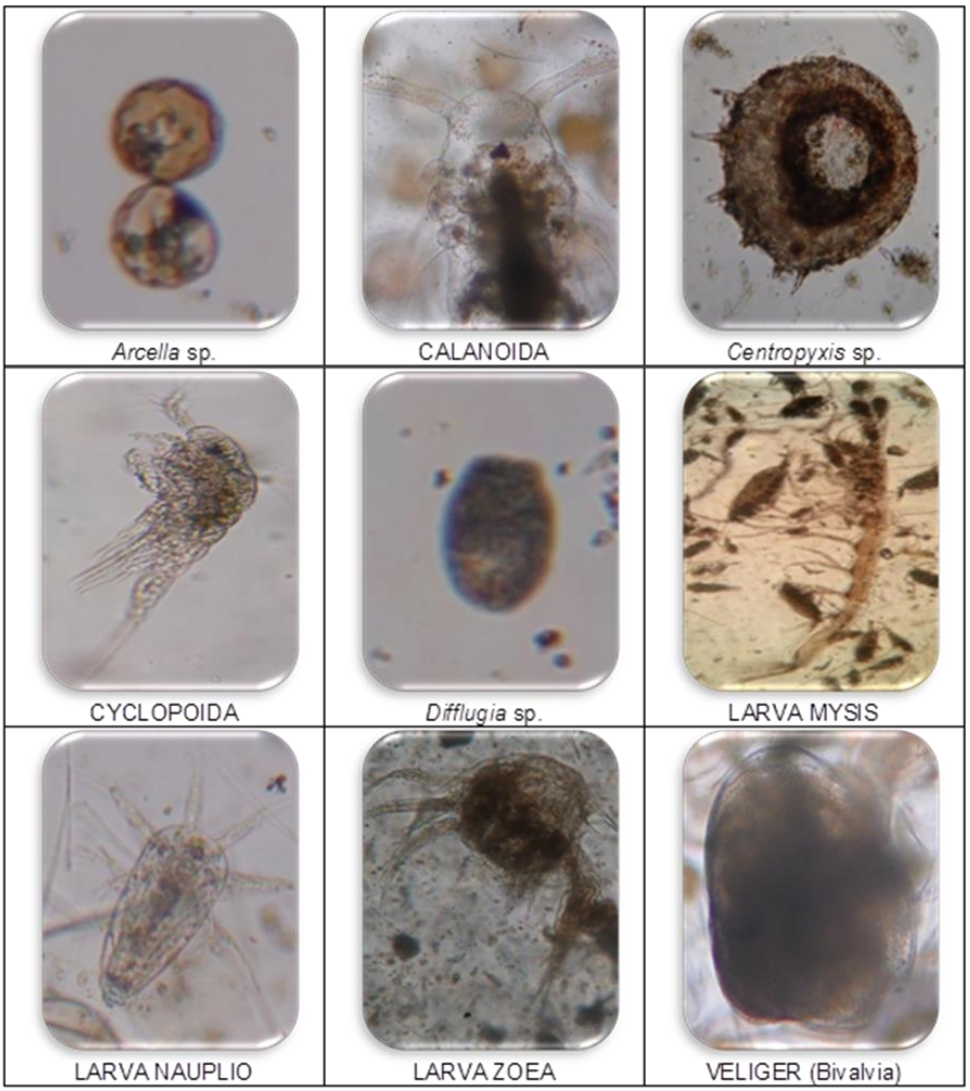


Photo No. 5.42 Some species of the zooplankton community found at the sampling points in Bahía Colombia
Source: SGS Environmental Services, 2015

Table No. 5.54 Taxonomic composition of zooplankton species identified in the sampling points in the project's area of influence in Bahía Colombia

Sampling points	Phylum	Class	Order	Family	Taxa
HB3	Arthropoda	Maxillopoda	------	------	Morph 17
	Protozoa	Lobosa	Arcellinida	Arcellidae	*Arcella* sp.
	Arthropoda	Maxillopoda	Cyclopoida (Podoplea)	Cyclopidae	Morph 7
	Protozoa	Lobosa	Arcellinida	Centropyxidae	*Centropyxis* sp.
	Protozoa	Lobosa	Arcellinida	Difflugiidae	*Difflugia* sp.
HB4	Arthropoda	Maxillopoda	------	------	Morph 17
	Arthropoda	Maxillopoda	Calanoida (Gymnoplea)	Calanidae	Morph 3
	Arthropoda	Maxillopoda	Cyclopoida (Podoplea)	Cyclopidae	Morph 7

Sampling points	Phylum	Class	Order	Family	Taxa
HB5	Arthropoda	Maxillopoda	Cyclopoida (Podoplea)	Cyclopidae	Morph 7
	Arthropoda	Maxillopoda	Calanoida (Gymnoplea)	Calanidae	Morph 3
	Arthropoda	Maxillopoda	------	------	Morph 17
	Mollusca	Gastropoda	---	---	Morph 11
HB6	Arthropoda	Maxillopoda	Calanoida (Gymnoplea)	Calanidae	Morph 3
	Arthropoda	Maxillopoda	Cyclopoida (Podoplea)	Cyclopidae	Morph 7
	Mollusca	Bivalvia	---	---	Morph 10
HB7	Arthropoda	Maxillopoda	Cyclopoida (Podoplea)	Cyclopidae	Morph 7
	Arthropoda	Maxillopoda	Calanoida (Gymnoplea)	Calanidae	Morph 3
	Arthropoda	Malacostraca	Decapoda	-------	Morph 22
	Arthropoda	Malacostraca	Decapoda	------	Morph 20
HB8	Arthropoda	Maxillopoda	Calanoida (Gymnoplea)	Calanidae	Morph 3
	Arthropoda	Malacostraca	Decapoda	-------	Morph 22
	Arthropoda	Maxillopoda	Cyclopoida (Podoplea)	Cyclopidae	Morph 7
HB9	Arthropoda	Maxillopoda	Calanoida (Gymnoplea)	Calanidae	Morph 3
	Mollusca	Bivalvia	---	---	Morph 10
	Arthropoda	Malacostraca	Decapoda	-------	Morph 22
	Arthropoda	Maxillopoda	Cyclopoida (Podoplea)	Cyclopidae	Morph 7
	Mollusca	Gastropoda	---	---	Morph 11

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

At point HB9, it was possible to identify the largest class composition, including Maxillopoda, Gastropoda, Bivalvia and Malacostraca, with the first one achieving greater abundance. The points HB3, HB5 and HB9 recorded the highest resources by having five (5) taxa respectively (Figure No. 5.82). At point HB3 the presence of the Maxillopoda and Lobosa classes was highlighted, the latter being the most representative with the presence of species *Arcella* sp. *Centropyxis* sp. and *Difflugia* sp. (Table No. 5.54). These organisms have the capacity to resist increasing salinity in the water, however they are from freshwater.

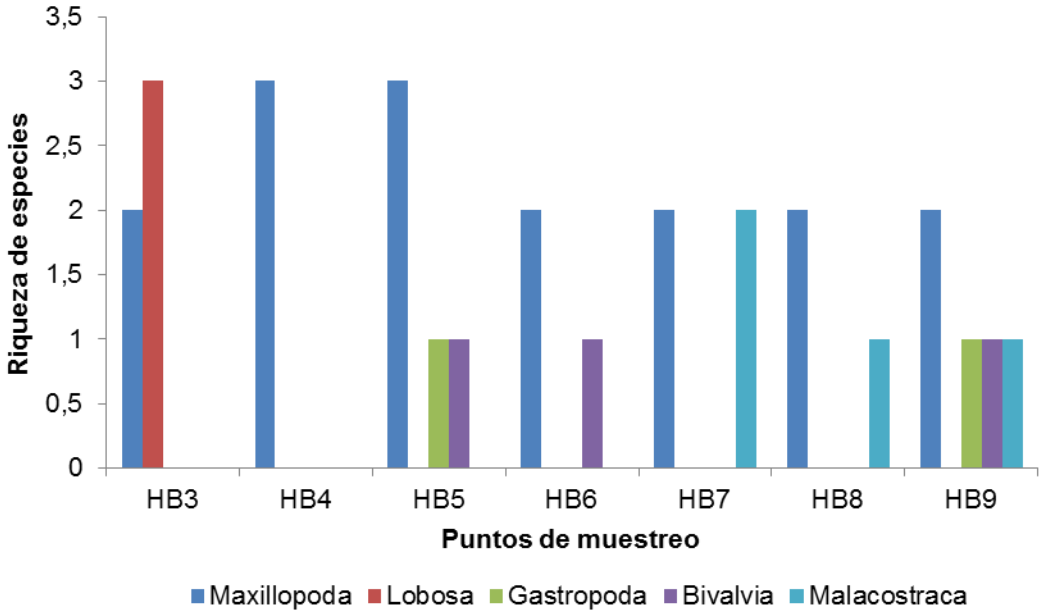


Figure No. 5.82 Abundance of species of the zooplankton community present in the sampling points in the project's area of influence in Bahía Colombia
Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

These inland water organisms are associated with places with high loads of organic material that comes from organic discharges brought by the continental system, since it is one of its main sources of food[125]. In this case, its presence is attributed to the continental contributions by the León River.

The HB5 point was characterized by the presence of the Maxillopoda, Gastropoda and Bivalvia classes, the first class being represented with greater abundance, where two orders of copepods are described: Calanoida and Cyclopoida, and a larval stage named Nauplio is also shown.

In the case of the other two classes, it was possible to identify the larval stages described as veliger, which are usually associated in the water column where in its early phase it feeds on microalgae and afterwards it will be fixed in the substrate being part of the benthic community where it plays another important role.

[125] GUILLÉN, G. Protozoological diversity of the Pantanos de Villa, Chorrillos, Lima-Peru. Undergraduate thesis to apply for the Biologist degree. Lima-Perú.: Universidad Nacional Mayor de San Marcos. 2002. 143 p.

The HB6 point had the presence of the Maxillopoda and Bivalvia classes, with the Maxillopoda class having greater abundance with two (2) organisms that essentially play the role of microalgae grazers, exercising control over the phytoplankton community.

For the HB7 point the presence of the Maxillopoda and Malacostraca classes was described, which presented an abundance of two (2) species each (Figure No. 5.82), so no dominant group was identified. The Malacostraca class, on the other hand, was represented by the presence of two larvae: Mysis and Zoea, which are present in the water column during their juvenile phases and serve as food for other taxonomic groups specialized in consuming plankton, as is the case of fish, which transfer energy to higher levels in this way. In the case of the Maxillopoda class, the presence of the Calanoida and Cyclopoida orders was described, which have been present throughout most of the monitored points, suggesting that these organisms are cosmopolitan and that they usually dominate in coastal marine waters[126].

Density of the zooplankton community

In terms of density (Table No. 5.55), it is highlighted that the Maxillopoda class had a dominance in the vast majority of the systems evaluated with superiority, being more abundant in the HB5 point with a density of 30,656 Ind/L where the Cyclopoide order was the most important, which suggests that this point has a high load of nutrients[127], product of the organic discharge from the continental waters that brings the proximity to the León River.

In this area of influence, fresh water is mixed with seawater, which converts the place into an estuarine zone, where some species can tolerate changes in salinity, turbidity, pH, etc., that are affected by the mixture[128].

In general, the high representativeness of Maxillopoda is influenced by the constant contribution of nutrients and by the availability of food in the form of microalgae that is favored by the constant continental contribution that brings with it a large amount of organic matter that, when decomposed, releases the nutrients that are fundamental for the development of primary producers.

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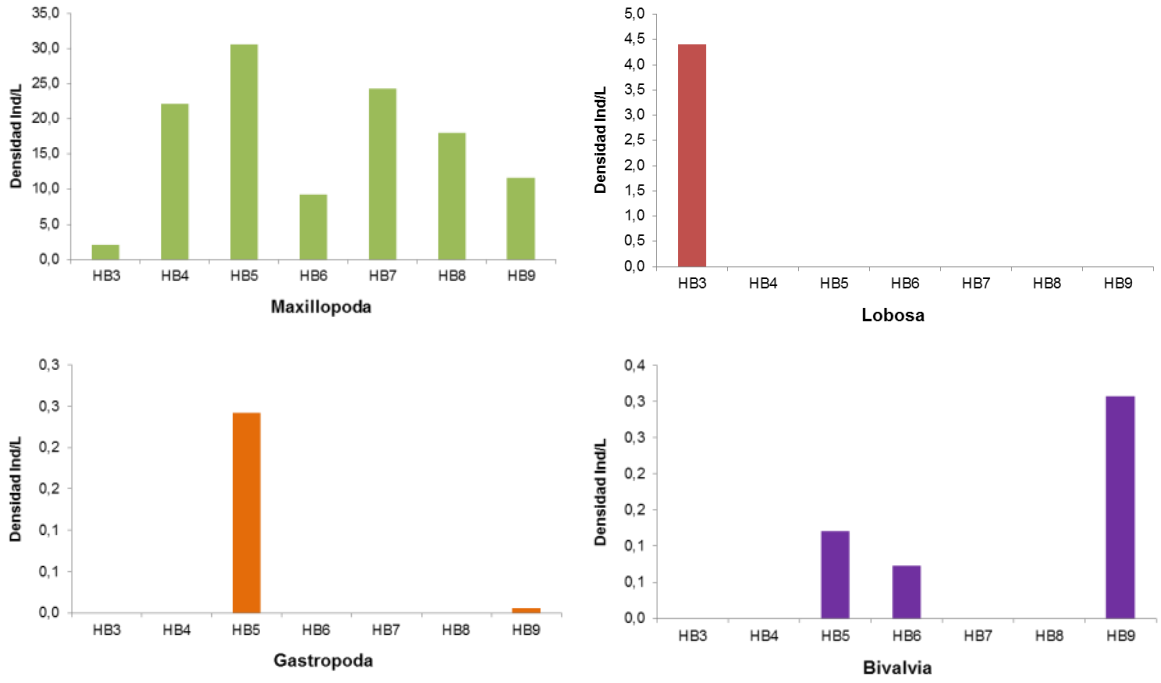
[126] LÓPEZ, D. Structural aspects of the zooplankton community during upwelling pulses / no coastal upwelling in the region of Santa Marta, Colombian Caribbean. Degree thesis (Marine Biologist). Santa Marta.: Jorge Tadeo Lozano University. Faculty of Marine Biology. 2009. 175 p.
[127] PINILLA. Op. cit.
[128] BURGOS., GARCÍA., & GARCÍA. Op. cit.

On the other hand, the Malacostraca were present for points HB7, HB8 and HB9 and were represented by Morph 20 and 22 (Table No. 5.55 and Figure No. 5.83). The decapods have an essential role within the trophic chain for aquatic systems, as they are a source of food for other organisms, however the pressure on the ecosystems causes risks on the permanence of these organisms, which is why they registered low composition.

The Bivalvia and Gastropoda classes had the lowest density (Figure No. 5.83), however, it is relevant to bear in mind that these organisms are important, because when presented in larval stages within the zooplankton, they fulfill the same functions as the primary consumer link of the trophic network in the oceans. Its importance lies in the fact that they are organisms that will be part of the benthos that temporarily benefit from the system allochthonous nutrients deposited on the surface of the water column[129].



[129] CIFUENTES, J., TORRES-GARCIA, P. & FRIAS, M. The Ocean and its resources. Chap. IV: The sciences of the sea: Biological Oceanography, Chap. V: Plankton, Cap. VI: Benthos and Nekton. 2nd edition. La ciencia para todos Editorial. 1997.

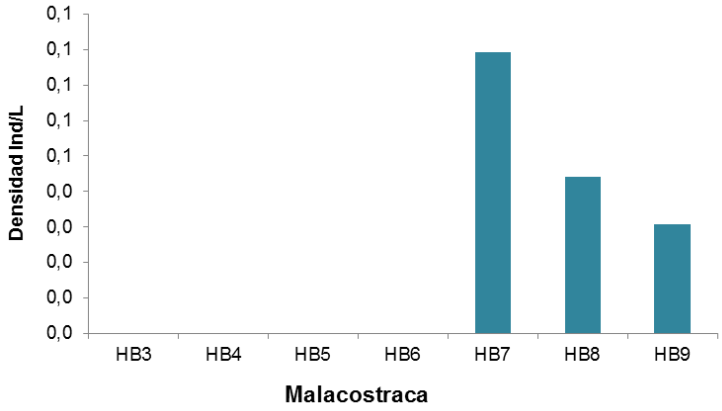


Figure No. 5.83 Density of the zooplanktonic community present in the sampling points in the project's area of influence in Bahía Colombia
Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.55 Density (ind/L) of the zooplankton community present in the sampling points in Bahía Colombia

Taxa	Sampling points							Total
	HB3	HB4	HB5	HB6	HB7	HB8	HB9	
Arcella sp.	2,73	0,00	0,00	0,00	0,00	0,00	0,00	2,73
Centropyxis sp.	0,42	0,00	0,00	0,00	0,00	0,00	0,00	0,42
Difflugia sp.	1,26	0,00	0,00	0,00	0,00	0,00	0,00	1,26
Morph 3	0,00	7,06	9,68	6,99	18,09	17,24	10,77	69,82
Morph 7	0,63	13,15	19,25	2,21	6,20	0,78	0,90	43,13
Morph 10	0,00	0,00	0,12	0,07	0,00	0,00	0,31	0,50
Morph 11	0,00	0,00	0,24	0,00	0,00	0,00	0,01	0,25
Morph 17	1,47	1,90	1,72	0,00	0,00	0,00	0,00	5,09
Morph 20	0,00	0,00	0,00	0,00	0,05	0,00	0,00	0,05
Morph 22	0,00	0,00	0,00	0,00	0,03	0,04	0,03	0,11
Total	**6,51**	**22,11**	**31,02**	**9,27**	**24,38**	**18,06**	**12,01**	**123,35**

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

The high representativeness of this community, in relation to the phytoplanktonic community, lies in the contribution of continental waters that favored the presence of organisms belonging to the Malacostraca and Lobosa order even though they registered low composition. Additionally, organisms of the Maxillopoda class were the most common, particularly those belonging to the Calanoida order (Table No.

5.54), omnivorous organisms that were possibly present due to the great food supply generated by the continental contributions and coastal outcrops[130].

This was reflected with the low composition of the phytoplankton community, additionally there was great contribution of detritus or carnivorous consuming organisms that are not affected by the presence of the phytoplankton community, which is why the composition of phytoplankton and zooplankton was not directly proportional.

Ecological indices and similarity analysis for the zooplankton community

The analysis of the ecological indices (Table No. 5.56) for the zooplankton community reflects a low diversity for all the points, obtaining values below 1.5 bits/Ind, which is attributed to the low number of species found, being the point HB3 where the highest value of wealth (S = 5) and diversity (H'= 1.42 bits/Ind) will be reached, very close to the limit value, which was probably determined by the proximity to the mouth of the León River, where there is more concentration of nutrients, which generates a greater supply of food.

Table No. 5.56 Ecological indices for the zooplankton community at the sampling points in Bahía Colombia

Sampling points	S	N	d	J'	H'(loge)	λ
HB3	5	31	1,16	0,88	1,42	0,28
HB4	3	3837	0,24	0,80	0,88	0,46
HB5	5	4366	0,48	0,55	0,88	0,49
HB6	3	1779	0,27	0,54	0,59	0,63
HB7	4	3076	0,37	0,43	0,59	0,62
HB8	3	2458	0,26	0,18	0,20	0,91
HB9	5	1955	0,53	0,25	0,40	0,81

S: Species Richness, N: Total organisms of the sample, d: Margalef, J´ Richness: Pielou, H´ evenness: Shannon-Wiener diversity, λ Simpson Predominance

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

At this point the Lobosa class was the one that reached the maximum representation with three (3) species, which is especially due to the proximity to the tributary of fresh water. At this point a low dominance index is reflected (λ=0,28), which describes that the species present there have a low level of competence.

[130] BERNAL, A. Y ZEA, S. Structure of the zooplankton community under conditions of continental discharge and coastal outcrop in Santa Marta, Colombian Caribbean. In: Boletín Instituto de Investigaciones marinas y costeras. 2000. (29): p. 3-26.

Starting in point HB4 and up to point HB9 a quite high level of dominance was evidenced, with values up to 91% as was the case of point HB9 where the Calanoida order had a much higher density than the other groups identified.

From the composition registered in each of the analyzed points, the similarity analysis of Bray Curtis was performed for the sampled points, in Figure No. 5.84 the formation of two groups with 51.71% similarity can be observed, the first group conformed the one of greater similarity (91.43%) between points HB4 and HB5 that Morph 3, Morph 7 and Morph 17 had in common, presenting very similar composition.

The second group with 75.4% similarity was formed by two subgroups, the first between points HB6 and HB9 that registered 80.4% similarity for which Morph 10 had a similar composition. And finally, the second subgroup between points HB7 and HB8 that had 86.66% similarity, where it shared very similar composition between Morph 22.

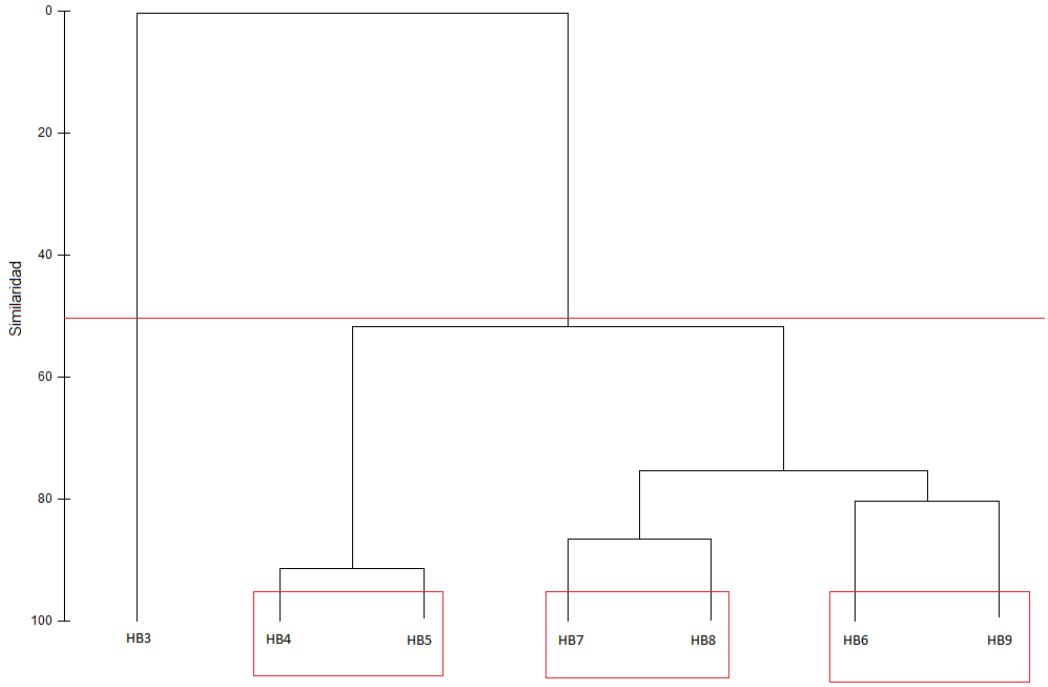


Figure No. 5.84 Bray-Curtis analysis for the zooplankton community present in the sampling points in the project's area of influence in Bahía Colombia
Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Correlation with physicochemical parameters

The variation of the zooplankton community registered in Bahía Colombia was significantly correlated, in statistical terms ($p < 0.05$), with the concentration of

dissolved oxygen (mg/L). This relationship was positive, indicating that 60% of the increase in the density of zooplankton is explained by the increase in the concentration of said parameter (Figure No. 5.85). The density of zooplankton did not present significant correlations with the remaining six physical-chemical parameters evaluated (Table No. 5.57).

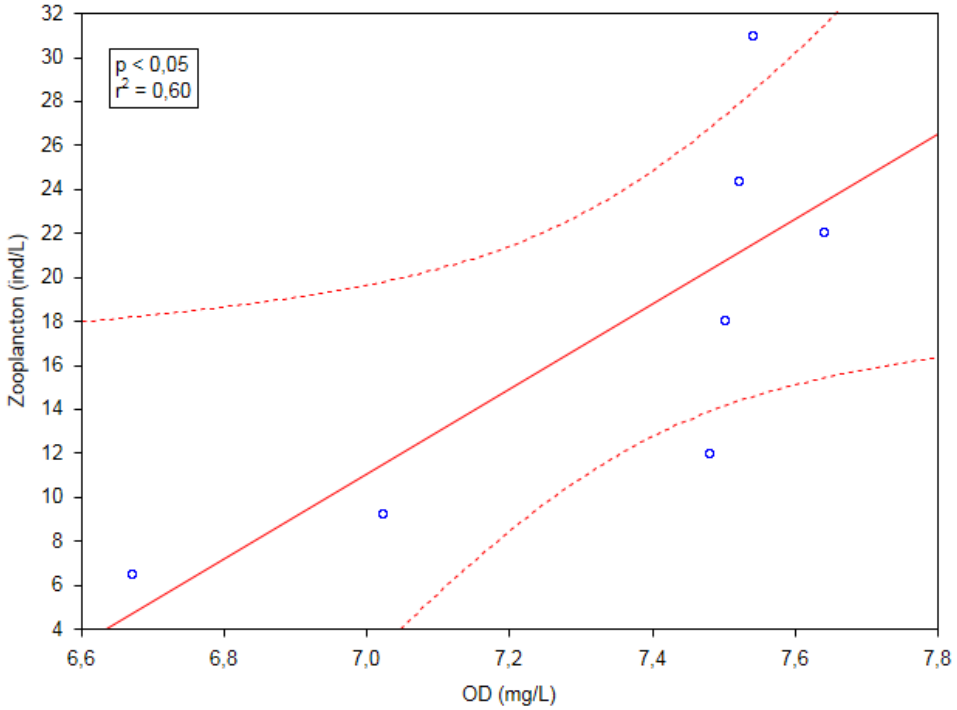


Figure No. 5.85 Correlation between the density of zooplankton and the concentration of dissolved oxygen in the area of marine influence of the project
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.57 Correlation of zooplankton density and physicochemical parameters in the area of marine influence of the project

Parameter	p	r^2
Temperature (°C)	0,48	0,10
pH	0,59	0,06
Biochemical Oxygen Demand	0,72	0,03
Chemical Oxygen demand	0,68	0,04
Total Nitrogen (mg N/L)	0,20	0,31
Turbidity (NTU)	0,19	0,32

Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

2. Benthos

The marine benthic organisms are of great importance, since they constitute one of the most diverse marine communities and likewise promote the establishment and growth of new species that in one way or another are beneficial for the populations and / or human settlements[131].

Composition and richness

Points HB3 and HB7 did not register organisms of this community, which can be attributed to local factors, generated by tides, waves and flow velocity that influence the recovery of benthic communities after long periods of sedimentation[132]; thus the density in each one of the points could be responding to the temporal variability imposed by the influence of variables that tend to be determinant; pH, oxygen and temperature, which can present significant temporal differences and can be explained by the difference in the contributions of fresh water that reach each of the points across the León River and that vary with respect to the proximity of its mouth. In addition, the composition also depends on the types of substrates, given that in hard substrates, and consolidated sands, the richness and density of infaunal organisms is limited.

In general, the marine benthic community (Photo No. 5.43) recorded a total of five (5) organisms: Morph 6 and Morph 180 belonging to the Sedentary class and *Acteocina sp., Atys sp.* and Morph 102 corresponded to the Gastropoda class (Table No. 5.58 and Figure No. 5.86).

[131] CIFUENTES., TORRES-GARCÍA., & FRIAS. Op. cit.
[132] THRUSH SF, HEWITT JE, CUMMINGS VJ, ELLIS JI, HA TTON C, LOHRER A, NORKKO A. Muddy waters: elevating sediment input to coastal and estuarine habitats. In: Frontier Ecology Enviromental. 2004, 2 (6): p. 299-306.

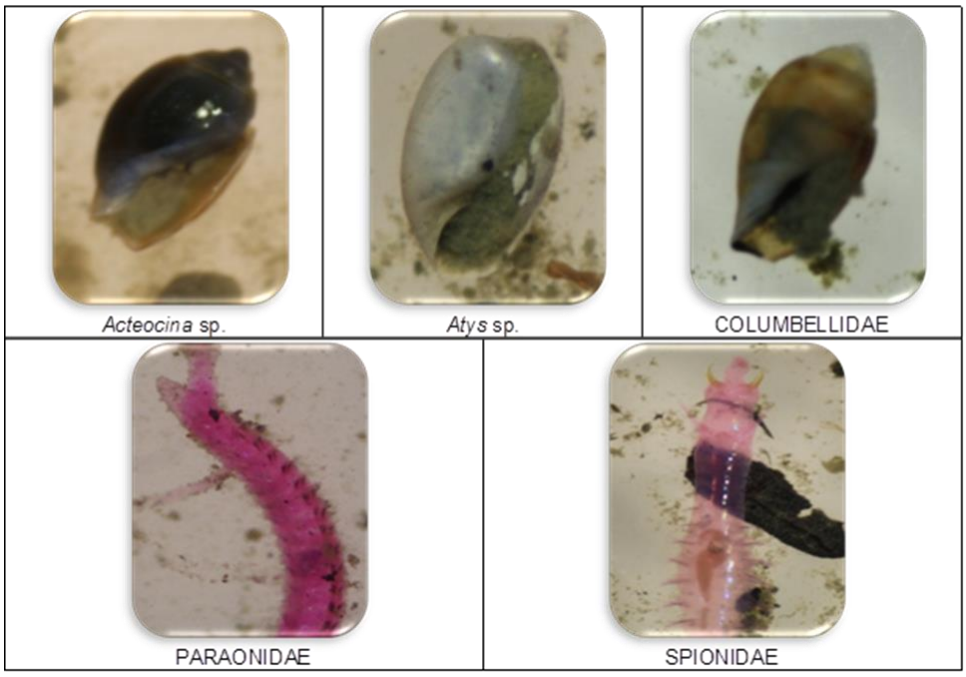


Photo No. 5.43 Some species of the marine benthic community found at the sampling points in Bahía Colombia
Source: SGS Environmental Services, 2015

Table No. 5.58 Taxonomic composition of benthic species identified in the sampling points in the project's area of influence in Bahía Colombia

Sampling points	Phylum	Class	Order	Family	Taxa
HB3	No organisms were found				
HB4	Mollusca	Gastropoda	Cephalaspidea	Haminoeidae	*Atys* sp.
	Annelida	Sedentaria	Scolecida	Spionidae	Morph 180
	Mollusca	Gastropoda	Cephalaspidea	Cylichnidae	*Acteocina* sp.
	Mollusca	Gastropoda	Neogastropoda	Columbellidae	Morph 102
HB5	Annelida	Sedentaria	Scolecida	Spionidae	Morph 180
	Annelida	Sedentaria	Scolecida	Paraonidae	Morph 6
HB6	Annelida	Sedentaria	Scolecida	Paraonidae	Morph 6
HB7	No organisms were found				
HB8	Annelida	Sedentaria	Scolecida	Spionidae	Morph 180
	Annelida	Sedentaria	Scolecida	Paraonidae	Morph 6
	Mollusca	Gastropoda	Cephalaspidea	Cylichnidae	*Acteocina* sp.
	Mollusca	Gastropoda	Cephalaspidea	Haminoeidae	*Atys* sp.
HB9	Annelida	Sedentaria	Scolecida	Paraonidae	Morph 6

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

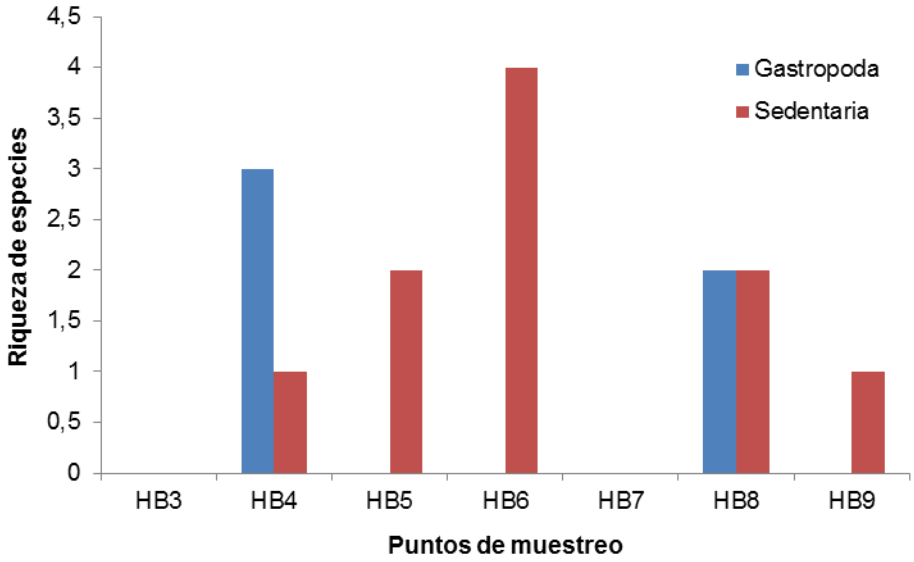


Figure No. 5.86 Species richness of the benthic community present in the sampling points in the project's area of influence in Bahía Colombia
Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Density of the marine benthic community

The marine benthic community registered a total density of 250 Ind / m2 (Table No. 5.59), represented by organisms of the Gastropoda and Sedentaria classes, the latter being the most abundant with 150 Ind/m^2. Within this group, Morph 180 of the Spionidae family and Morph 6 of Paraonidae were identified, which Raz-Guzmán (2000)[133] has designated as indicators of contamination by organic matter.

Table No. 5.59 Density of the benthic community present in the sampling points in Bahía Colombia

Taxa	Sampling points							Total
	HB3	HB4	HB5	HB6	HB7	HB8	HB9	
Acteocina sp.	0	10	0	0	0	10	0	**20**
Atys sp.	0	50	0	0	0	10	0	**60**
Morph 6	0	0	20	20		30	50	**120**
Morph 102	0	20	0	0	0	0	0	**20**
Morph 180	0	10	10	0	0	10	0	**30**
Total	**0**	**90**	**30**	**20**	**0**	**60**	**50**	**250**

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

[133] RAZ-GUZMÁN, A. Crustaceans and Polychaetes. In: LANZA ESPINO, G., HERNÁNDEZPULIDO, S. Y CARBAJAL-PÉREZ, L (eds); Organisms that indicate water quality and pollution: (Bioindicators). Plaza y Valdés Editorial. Mexico, 2000. p. 265-308.

In general, the ecological characteristics of the Sedentaria allow that when in permanent contact with different types of pollutants, bioaccumulative respond decreasing or increasing its density, depending on the species, this fact positions this type of organisms as potential indicators of marine pollution.

Its density, species richness, forms of feeding and great permanence in the benthos make them excellent indicators of environmental disturbance, as the sediment traps and stores pollutants temporarily; in this way, the benthic organisms present in this substrate, must resist environmental disturbances (for example, increase in suspended organic matter, or decrease in dissolved oxygen)[134]. These species, being resistant or tolerant, proliferate rapidly in the niche that other species have left due to environmental pressure[135].

This class was the most representative for all the points where organisms of this community were registered, with the exception of point HB4, for which the Gastropoda class was the most abundant, providing 89% of the total density recorded for the point (Figure No. 5.87). In this case, the high representativeness of Gastropoda can be attributed to the wide variety of diets of these organisms, being considered ecologically as important links in the food chain.

[134] SALAZAR-VALLEJO, S. I. Marine Pollution: Methods of Biological Evaluation. Quintana Roo Research Center. Chetumal, Mexico: Fondo de Publicaciones y Ediciones Gobierno de Quintana Roo. 2000.
[135] SOLÍS-WEISS, V. Marine worms help detect pollution of the seas. 2010. [Online]. Agencia Ciudadana de Ciencia e Innovación para Iberoamérica. [Retrieved on July 29, 2015]. Available online: <. http://www.dicyt.com/ noticias/los-gusanos-marinos-ayudan-a-detectar-la-contaminacion-de-los-mares>.

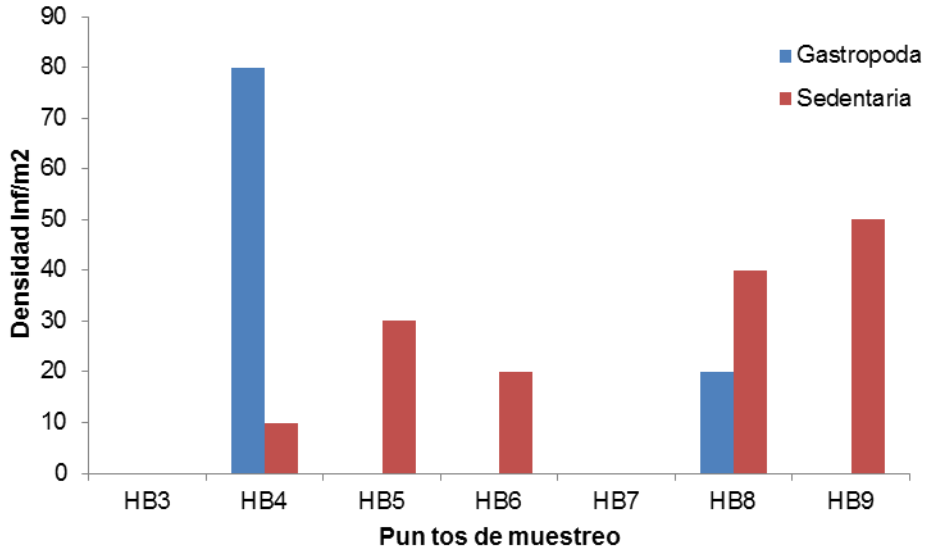


Figure No. 5.87 Density of the benthic community present in the sampling points in the project's area of influence in Bahía Colombia
Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Most of the latter are of commercial importance for man, some are predators of higher levels, in addition, the structures they generate for their growth (shells), provide habitats for other species, which is why their presence is important[136].
The variability in the structural composition of benthic macroinvertebrates between the points, may be due to the rapid response of these organisms to disturbances, because of the low mobility and its close relation with the sediment, since it recycles organic matter, pollutants and / or toxics. Based on the above, it can be said that the places with the highest concentration of taxa (HB4) are offering variability of available niches, as a response to environmental changes. Additionally, the Gastropoda have been the most significant and able to adapt to the granulometric conditions and organic composition of the sediments of this area, which explains their representativeness. Mollusks can easily exploit this type of semi-enclosed marine systems thanks to the amount of organic and inorganic material that is being deposited by the currents effects[137]. The Gastropoda class describes the presence

[136] SUMICH, J. L & MORRISEY, J. F. Introduction to the Biology of Marine Life. Illustrated Edition. Editorial: Jones & Barlett Learning. 2004. 449 p. ISBN 076373313X, 9780763733131.
[137] DÍAZ, Juan Manuel. & PUYANA, Mónica. Mollusks of the Caribbean Colombia. Colciencias-Natura-Invemar Foundation. 1994. 291 p.

of a favorable substrate for the settlement of these organisms counting on soft material and sufficient decomposing organic matter from which they tend to feed.

Ecological indices and similarity analysis for the marine benthic community

The main objective of the ecological indices is to determine the diversity of the communities and according to Barnes and Massarini[138], to calculate them, it is necessary to have more than two species, which is why this analysis was only carried out for HB4 and HB8 (Table No. 5.60), which recorded diversity values of 1,15 bits/Ind and 1,24 bits/Ind respectively, indicating a high degree of contamination, possibly due to the high accumulation of organic matter from the continent.

Table No. 5.60 Ecological indices for the benthic community at the sampling points in Bahía Colombia

Sampling points	S	N	d	J'	H'(loge)	λ
HB3	No organisms were registered					
HB4	4	9	1,37	0,83	1,15	0,38
HB5	2	3	0,91	0,92	0,64	0,56
HB6	1	2	0,00	-	0,00	1,00
HB7	No organisms were registered					
HB8	4	6	1,67	0,90	1,24	0,33
HB9	1	5	0,00	-	0,00	1,00

S: Species Richness, N: Total organisms of the sample, d: Margalef Richness, J´: Pielou evenness, H´: Shannon-Wiener diversity, λ: Simpson Predominance

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Regarding evenness indices, values are reported above 0.90, indicating that there is a comparability in the community. This, in general terms, determines that there is no dominance on the part of any of the species, which is corroborated with the values expressed by the Simpson index, which was below 0.40 (Table No. 5.60).

For the analysis of similarity of Bray Curtis, based on the composition recorded in each of the monitored points, the formation of a group with 53.9% similarity can be observed; the points HB5 and HB6 formed the one of greater similarity (80%) that presented Morph 6 in common registering the same composition. Likewise, to this is added the HB8 with 58.33%, attributed to the same Morph 6 but with similar composition (Figure No. 5.88). The similarity in this community is attributed mainly to the presence of morph 6 belonging to the Paraonidae family of the Sedentary class, organisms that, as mentioned above, are indicators of contamination by organic matter and contributions of allochthonous sediments, characteristics observed in the sampling points.

[138] CURTIS & SCHNEK. Op. cit.

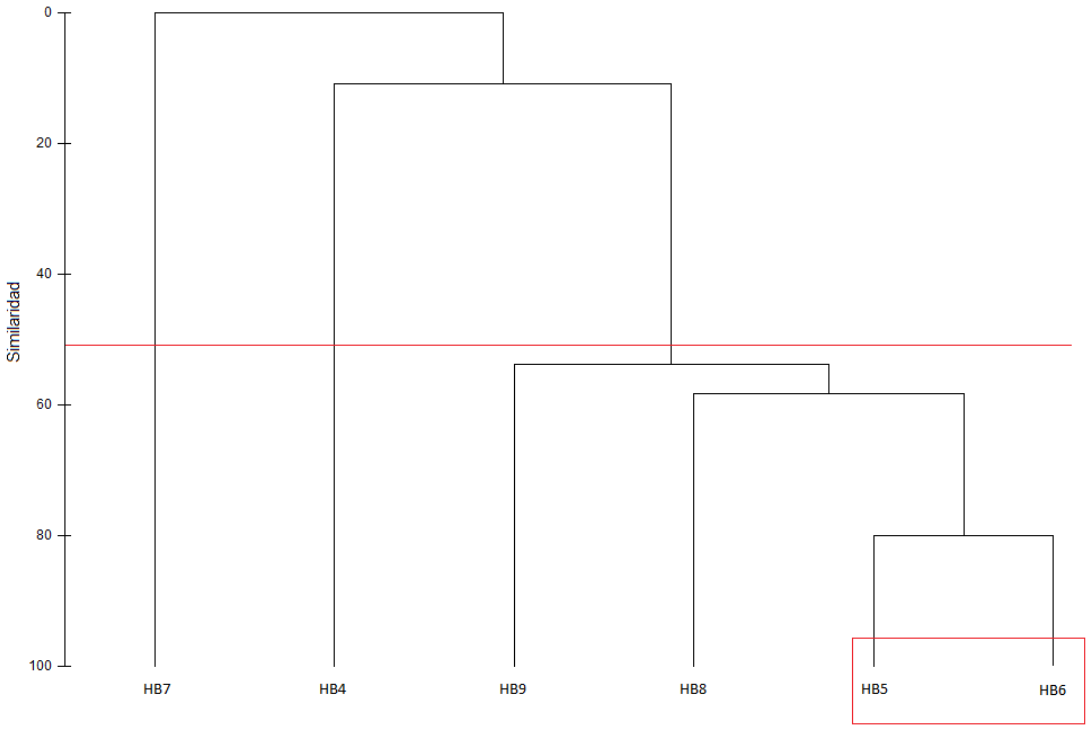


Figure No. 5.88 Bray-Curtis analysis for the benthic community present in the sampling points in the project's area of influence in Bahía Colombia
Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Correlation with parameters measured in the sediments

The variation of the marine benthic community registered in Bahía Colombia did not present a significant correlation in statistical terms ($p > 0,05$) with the three parameters measured in the bottom sediments that were evaluated (Table No. 5.61).

Table No. 5.61 Correlation of fish abundance and physical-chemical parameters in the area of marine influence of the project

Parameter	p	r^2
Organic carbon (mg C/kg)	0,73	0,03
Fats and oils (GyA/kg)	0,38	0,16
Total hydrocarbons (mg/kg)	0,89	0,004

Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

3. Ichthyofauna

Composition, richness and abundance

In the fish community corresponding to the marine ecosystem, 18 species were reported, of which seven (7) were identified at the species level, eight (8) were identified at the gender level and three (3) were identified at the family level. These species were grouped into 11 families and five (5) orders of which Perciformes was the dominant with six (6) families and ten (10) species (Table No. 5.62).

Table No. 5.62 Taxonomic composition of the Ichthyofauna present in the marine ecosystem

Sampling point	Division	Class	Order	Family	Species	Common name
HB3	Chordata	Actinopterygii	Clupeiformes	Engraulidae	*Anchovia clupeoides*	Sardine
					Anchovia sp.	Sardine
				Clupeidae	*Harengula sp.*	Sardine
			Perciformes	Carangidae	*Caranx hippos*	Horse mackerel
					Oligoplites saurus	Meona
					Selene vomer	Pompano
				Centropomidae	*Centropomus sp.*	Snook
				Lobotidae	*Lobotes sp.*	Tripletail
				Polynemidae	*Polydactylus virginicus*	Barbu
				Sciaenidae	*Larimus sp.*	Corvina
					Pachyurus sp.	Corvina
					Umbrina coroides	Corvina
				Trichiuridae	*Trichiurus lepturus*	Sable
			Pleuronectiformes	Paralichthyidae	*Etropus sp.*	Sole
			Siluriformes	Ariidae	Morph 7	Bearded catfish
					Morph 8	Catfish
					Morph 9	Charry catfish
		Chondrichthyes	Myliobatiformes	Dasyatidae	*Dasyatis sp.*	Whiptail stingrays
HB4	Chordata	Actinopterygii	Clupeiformes	Engraulidae	*Anchovia clupeoides*	Sardine
					Anchovia sp.	Sardine
				Clupeidae	*Harengula sp.*	Sardine
			Perciformes	Carangidae	*Caranx hippos*	Horse mackerel
					Oligoplites saurus	Meona
					Selene vomer	Pompano
				Centropomidae	*Centropomus sp.*	Snook
				Lobotidae	*Lobotes sp.*	Tripletail
				Polynemidae	*Polydatylus virginicus*	Barbu
				Sciaenidae	*Larimus sp.*	Corvina
					Pachyurus sp.	Corvina
					Umbrina coroides	Corvina
				Trichiuridae	*Trichiurus lepturus*	Sable
			Pleuronectiformes	Paralichthyidae	*Etropus sp.*	Sole
			Siluriformes	Ariidae	Morph 7	Bearded catfish
					Morph 8	Catfish
					Morph 9	Charry catfish

Sampling point	Division	Class	Order	Family	Species	Common name
		Chondrichthyes	Myliobatiformes	Dasyatidae	*Dasyatis sp.*	Whiptail stingrays
HB5	Chordata	Actinopterygii	Clupeiformes	Engraulidae	*Anchovia clupeoides*	Sardine
					Anchovia sp.	Sardine
				Clupeidae	*Harengula sp.*	Sardine
			Perciformes	Carangidae	*Caranx hippos*	Horse mackerel
					Oligoplites saurus	Meona
					Selene vomer	Pompano
				Centropomidae	*Centropomus sp.*	Snook
				Lobotidae	*Lobotes sp.*	Tripletail
				Polynemidae	*Polydatylus virginicus*	Barbu
				Sciaenidae	*Larimus sp.*	Corvina
					Pachyurus sp.	Corvina
					Umbrina coroides	Corvina
				Trichiuridae	*Trichiurus lepturus*	Sable
			Pleuronectiformes	Paralichthyidae	*Etropus sp.*	Sole
			Siluriformes	Ariidae	Morph 7	Bearded catfish
					Morph 8	Catfish
					Morph 9	Charry catfish
		Chondrichthyes	Myliobatiformes	Dasyatidae	*Dasyatis sp.*	Whiptail stingrays
HB6	Chordata	Actinopterygii	Clupeiformes	Engraulidae	*Anchovia clupeoides*	Sardine
					Anchovia sp.	Sardine
				Clupeidae	*Harengula sp.*	Sardine
			Perciformes	Carangidae	*Caranx hippos*	Horse mackerel
					Oligoplites saurus	Meona
					Selene vomer	Pompano
				Centropomidae	*Centropomus sp.*	Snook
				Lobotidae	*Lobotes sp.*	Tripletail
				Polynemidae	*Polydatylus virginicus*	Barbu
				Sciaenidae	*Larimus sp.*	Corvina
					Pachyurus sp.	Corvina
					Umbrina coroides	Corvina
				Trichiuridae	*Trichiurus lepturus*	Sable
			Pleuronectiformes	Paralichthyidae	*Etropus sp.*	Sole
			Siluriformes	Ariidae	Morph 7	Bearded catfish
					Morph 8	Catfish
					Morph 9	Charry catfish
		Chondrichthyes	Myliobatiformes	Dasyatidae	*Dasyatis sp.*	Whiptail stingrays
HB7	Chordata	Actinopterygii	Clupeiformes	Engraulidae	*Anchovia clupeoides*	Sardine
					Anchovia sp.	Sardine
				Clupeidae	*Harengula sp.*	Sardine
			Perciformes	Carangidae	*Caranx hippos*	Horse mackerel
					Oligoplites saurus	Meona
					Selene vomer	Pompano
				Centropomidae	*Centropomus sp.*	Snook
				Lobotidae	*Lobotes sp.*	Tripletail
				Polynemidae	*Polydatylus virginicus*	Barbu
				Sciaenidae	*Larimus sp.*	Corvina

Sampling point	Division	Class	Order	Family	Species	Common name
					Pachyurus sp.	Corvina
					Umbrina coroides	Corvina
				Trichiuridae	*Trichiurus lepturus*	Sable
			Pleuronectiformes	Paralichthyidae	*Etropus sp.*	Sole
			Siluriformes	Ariidae	Morph 7	Bearded catfish
					Morph 8	Catfish
					Morph 9	Charry catfish
		Chondrichthyes	Myliobatiformes	Dasyatidae	*Dasyatis sp.*	Whiptail stingrays
HB8	Chordata	Actinopterygii	Clupeiformes	Engraulidae	*Anchovia clupeoides*	Sardine
					Anchovia sp.	Sardine
				Clupeidae	*Harengula sp.*	Sardine
			Perciformes	Carangidae	*Caranx hippos*	Horse mackerel
					Oligoplites saurus	Meona
					Selene vomer	Pompano
				Centropomidae	*Centropomus sp.*	Snook
				Lobotidae	*Lobotes sp.*	Tripletail
				Polynemidae	*Polydatylus virginicus*	Barbu
				Sciaenidae	*Larimus sp.*	Corvina
					Pachyurus sp.	Corvina
					Umbrina coroides	Corvina
				Trichiuridae	*Trichiurus lepturus*	Sable
			Pleuronectiformes	Paralichthyidae	*Etropus sp.*	Sole
			Siluriformes	Ariidae	Morph 7	Bearded catfish
					Morph 8	Catfish
					Morph 9	Charry catfish
		Chondrichthyes	Myliobatiformes	Dasyatidae	*Dasyatis sp.*	Whiptail stingrays
HB9	Chordata	Actinopterygii	Clupeiformes	Engraulidae	*Anchovia clupeoides*	Sardine
					Anchovia sp.	Sardine
				Clupeidae	*Harengula sp.*	Sardine
			Perciformes	Carangidae	*Caranx hippos*	Horse mackerel
					Oligoplites saurus	Meona
					Selene vomer	Pompano
				Centropomidae	*Centropomus sp.*	Snook
				Lobotidae	*Lobotes sp.*	Tripletail
				Polynemidae	*Polydatylus virginicus*	Barbu
				Sciaenidae	*Larimus sp.*	Corvina
					Pachyurus sp.	Corvina
					Umbrina coroides	Corvina
				Trichiuridae	*Trichiurus lepturus*	Sable
			Pleuronectiformes	Paralichthyidae	*Etropus sp.*	Sole
			Siluriformes	Ariidae	Morph 7	Bearded catfish
					Morph 8	Catfish
					Morph 9	Charry catfish
		Chondrichthyes	Myliobatiformes	Dasyatidae	*Dasyatis sp.*	Whiptail stingrays

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Regarding abundance, a total of 257 individuals were recorded, being the species *Harengula sp*. and *Anchovia clupeoides* the most representative with 9.34% and 8.17% of registered individuals (Table No. 5.63). At the sampling point level, the most abundant were HB6, HB3 and HB7 (Table No. 5.63 and Figure No. 5.89).

Table No. 5.63 Abundance of the Ichthyofauna present in the marine ecosystem of the area of influence

Species	Stations							Total
	HB3	HB4	HB5	HB6	HB7	HB8	HB9	
Anchovia clupeoides	5	1	3	5	5	1	1	21
Anchovia sp.	2	1	2	3	1	2	2	13
Caranx hippos	2	1	2	1	2	2	2	12
Centropomus sp.	2	1	1	3	2	1	2	12
Dasyatis sp.	2	1	1	2	1	3	1	11
Etropus sp.	2	2	1	2	1	2	1	11
Harengula sp.	3	4	4	3	4	5	1	24
Larimus sp.	1	2	1	1	1	1	1	8
Lobotes sp.	2	1	2	1	1	2	2	11
Morph 7	2	4	1	3	4	2	2	18
Morph 8	1	2	2	2	4	2	3	16
Morph 9	1	2	1	2	2	1	2	11
Oligoplites saurus	5	1	2	3	2	3	2	18
Pachyurus sp.	2	3	2	3	1	1	1	13
Polydatylus virginicus	4	4	2	3	2	1	1	17
Selene vomer	1	1	2	2	3	1	1	11
Trichiurus lepturus	3	3	3	2	3	1	1	16
Umbrina coroides	2	2	2	2	3	2	1	14
Total	**42**	**36**	**34**	**43**	**42**	**33**	**27**	**257**

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

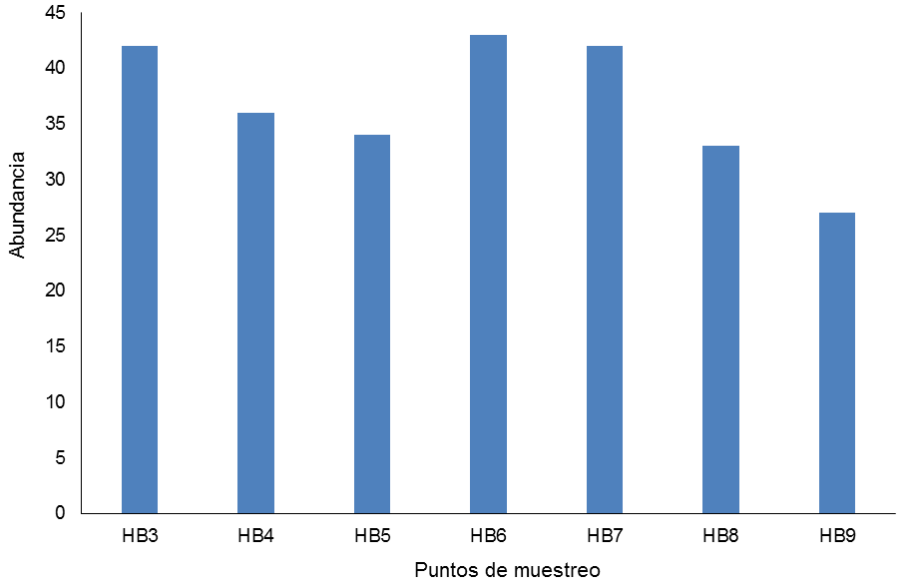


Figure No. 5.89 Abundance of the Ichthyofauna by sampling point present in the marine ecosystem of the area of influence
Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

The representativeness of the Perciformes order is mainly because the vast majority of species are associated with the coastal zone, where it finds a great supply of food, mainly in its juvenile stages. Additionally, these species also find refuge in rocky structures and mangrove roots where they can hide from their predators.

Within the perciformes, the genus *Centropomus* is of great importance. It is one of the most frequent and abundant species in the soft shallow bottoms of the continental shelf and its juveniles abound in mangrove lagoons with muddy bottoms and turbid waters[139].

The carangids (eg *Caranx hippos*) were also well represented, being of great importance at the time of the fishing practice carried out by the inhabitants of the area. Similarly, these species prefer areas of soft substrate [140] which is very common throughout the study area, which is why it was possible to find it in all the points.

[139] CUARTAS, Álvaro, ROSAS, Jesús, VELÁSQUEZ, Aidé & CABRERA, Tomás. Induction to spawning, embryonic and larval development of the corocoro rayao *Ha emulon bonariense* Cuvier, 1830 (Pisces: Ha emulidae). In: Revista de Biología Marina y Oceanografía. 2013. vol. 38. no. 1. p. 27-37.
[140] Ibíd.

The order Siluriformes was represented by three (3) morphs. These species are mainly found in the bottom of the system, where they can capture crustaceans more easily. The great majority of individuals of the Siluriformes group of marine and continental waters have the capacity to tolerate changes in the salinity of the waters, so they can be easily found in estuaries and river mouths[141].

In general, the fish described for this bay are typical of brackish waters or estuarine conditions, which is represented not only with the Ichthyofauna but with the other species of other communities.

On the other hand, the trophic habits identified for the fish were Omnivores (Om) and Carnivores (Ca), the former being found for six (6) species and the latter for eight (8). The barbu *Polydactylus virginicus* feeds additionally on vegetable matter and the sardine *Anchovia* sp., despite being omnivore, specifically consumes plankton organisms[142].

Additionally, most of the species identified have no particular use, however many of these are captured during fishing times. Only four (4) of the species are for consumption and only the horse mackerel *Caranx hippos* and the Sardine *Harengula* sp are for ornamental use. Regarding the type of migration, only two species (*Centropomus* sp. and *Etropus* sp.) show short migration (SM), that means in small distances, since they are typical of estuarine environments that have influence of marine waters.

Also, none of them is endemic, since the distribution of most of these species, particularly marine species, is located from the northern United States to Brazil through the Caribbean Sea region (Table No. 5.64). It is noteworthy that none of the species present in the area of influence was found in Resolution 0192 of 2014[143] or in the Red Book of Marine Fishes of Colombia[144]. Internationally only two species, *Caranx hippos* and *Umbrina coroides*, are in a state of minor concern in the IUCN

[141] OLAYA-NIETO, Charles, ARELLANO-PADILLA, John y MARTÍNEZ-GONZÁLEZ, Angel. Food habits of stone barbu (Ariopsis sp.) n the Sinú River, Colombia. In: Colombian Biological Act. 2012. vol. 17 no. 1. p. 117-128

[142] LASSO, Carlos & SÁNCHEZ-DUARTE, Paula. The fish of the Orinoco delta. Diversity, bioecology, use and conservation. La Salle Foundation of Natural Sciences and Chevron C. A. Venezuela. 2011. 498 p. ISBN 978-980-7090-11-7

[143] COLOMBIA. MINISTRY OF ENVIRONMENT AND SUSTAINABLE DEVELOPMENT. Resolution 0192 (February 10, 2014). Op. cit.

[144] MEJÍA, Luz Stella & ACERO, Arturo Red Book of Marine Fishes of Colombia. INVEMAR, Institute of Natural Sciences-National University of Colombia. Ministry of the Environment. Red Books series of threatened species of Colombia. Bogotá. 2002.p. 37. ISBN 96972-4-0.

red list[145], which indicates that they do not meet the evaluation criteria to classify them in any category of threat and none is reported in the CITES appendices[146].

Table No. 5.64 Uses, endemism, migration type and trophic guild of the ichthyofauna identified in the area of marine influence

Species	Common name	Uses	Endemism	Migration Type	Trophic Guild
Anchovia clupeoides	Sardine	SU	No	None	Om
Anchovia sp.	Sardine	SU	No	None	Om
Caranx hippos	Horse mackerel	OR	No	None	Om
Centropomus sp.	Snook	CON	No	SM	Ca
Dasyatis sp.	Whiptail stingrays	CON	No	None	Ca
Etropus sp.	Sole	SU	No	SM	Ca
Harengula sp.	Sardine	OR	No	None	Om
Larimus sp.	Corbina	SU	No	None	Ca
Lobotes sp.	Tripletail	SU	No	None	Ca - Ichthyophagous
Morph 7	Catfish	CON	No	None	Om - Ca
Morph 8	Catfish	CON	No	None	Om - Ca
Morph 9	Catfish	CON	No	None	Om - Ca
Oligoplites saurus	Meona	SU	No	None	---
Pachyurus sp.	Corbina	SU	No	None	Om
Polydactylus virginicus	Barbu	SU	No	None	Om
Selene vomer	Pompano	CON	No	None	Ca
Trichiurus lepturus	Zable	CON	No	None	Ca
Umbrina coroides	Corbina	SU	No	None	Ca

Conventions: Trophic Guild: Ca (carnivore) and Om (Omnivore). Uses: CON (consumption), OR (ornamental) and SU (without use), Migratory: SM (short migration)
Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

From Table No. 5.65 to Table No. 5.80 is the biological and ecological information of the fish species found in the area of marine influence of the project.

Table No. 5.65 Biological and ecological information of *Anchovia clupeoides*

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Cupleiformes **Family:** Engraulidae **Species:** *Anchovia clupeoides* **Common name:** Sardine	

[145] UICN [online]. <http://www.iucnredlist.org> [Retrieved on August 27, 2015]
[146] CITES [online]. http://www.speciesplus.net/ [Retrieved on August 27, 2015]

CLASSIFICATION	PHOTOGRAPHIC RECORD
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	
GENERAL CHARACTERISTICS	
Characteristics: Reaches a length of about 30 cm[147]. Elongated and compressed body with a silver side band with a greenish tint on the dorsal region; prominent and slightly pointed face, long jaw where the sharp posterior end surpasses the mouth commissure; long caudal fin with 28-35 branched rays [148]. **Biology:** Relatively common in estuaries and polyhaline lagoons, such as along the coast. It is used as bait and sometimes as a human food [149]. It feeds on plankton generally in large shoals. Coastal pelagic on muddy-sandy bottoms in neritic waters, very common in brackish waters or near estuarine areas[150]. **Distribution:** From Panama and some islands of the Greater Antilles to Rio de Janeiro, Brazil [151].	

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.66 Biological and ecological information of *Anchovia sp.*

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Clupeiformes **Family:** Engraulidae **Species:** *Anchovia* sp. **Common name:** Sardine	

147 Ibíd.
148 Ibíd.
149 Ibíd.
150 Ibíd.
151 Ibíd.

CLASSIFICATION	PHOTOGRAPHIC RECORD
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	
GENERAL CHARACTERISTICS	
Characteristics: Elongated and compressed body, body sides with a silver side band. Moderate and pointed face, short maxilla with blunt posterior end and does not reach the mouth commissure. Anal fin with 20-25 branched rays [152]. **Biology:** Planktophagous Inhabits mainly in freshwater [153]. **Distribution:** Rivers of the northeast of South America from Trinidad and Venezuela to the south of Pará, Brazil [154].	

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.67 Biological and ecological information of *Caranx hippos*

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Characiformes **Family:** Carangidae **Species:** *Caranx hippos* **Common name:** Horse mackerel	
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7	

[152] Ibíd.
[153] Ibíd.
[154] Ibíd.

CLASSIFICATION	PHOTOGRAPHIC RECORD
✓ HB8 ✓ HB9	

GENERAL CHARACTERISTICS

Characteristics: Elongated, deep and moderately compressed body; greenish color, yellowish green or golden towards the dorsal and silver part in the ventral part. A black spot on the posterior margin of the operculum and another in the anterior part of the pectoral; small specimens with dark side stripes on the sides of the body. The eye fits 3.8 - 4.2 times the length of the head and has a strong adipose eyelid. Mouth terminal, the upper jaw has an irregular external row composed of small canine teeth and flanked by an inner band and a single row of teeth. With 6-9 gill rakers on the upper branch and 16-19 on the lower branch of the first branchial arch. Two dorsal fins well separated, the first composed of eight spines and the second one by a spine followed by 19-21 soft rays. Anal fin with two anterior spines individualized and with 16-17 soft rays preceded by a spine. Long pectoral fins and caudal fin markedly forked. Lateral line with a strong anterior arch and moderately long, straight part with 23-25 bone escutcheons. Reaches a size greater than 1 m LT and up to 25 kg[155].

Biology: It mainly consumes fish, shrimp and other invertebrates. Large specimens are pelagic and generally live near the coast. The small specimens are found in very shallow sandy or muddy bottoms and can be very abundant in estuarine brackish waters; they are also found in hypersaline waters[156].

Distribution: From the northeast of the United States to Uruguay, in Venezuela it is very abundant along all the continental and insular coasts[157].

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.68 Biological and ecological information of *Centropomus* sp

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Perciformes **Family:** Centropomidae **Species:** *Centropomus* sp. **Common name:** Snook	
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6	

[155] Ibíd.
[156] Ibíd.
[157] Ibíd.

CLASSIFICATION	PHOTOGRAPHIC RECORD
✓ HB7 ✓ HB8 ✓ HB9	

GENERAL CHARACTERISTICS

Characteristics: Compressed body of uniform silver coloration, with gray or green tones without spots, stripes or striae except along the lateral line in some species. Depressed face with protractile mouth and prominent lower jaw. Granular teeth very close together, present in the premaxillary teeth, vomer and platinum. Preopercular serrated edge with one to five major points in the angular region. Ctenoid scales, lateral line prolonged to the end of the central rays of the caudal. Second spine of the anal fin very developed and thicker than the first and third. With two dorsal fins separated from each other. Six rays in the anal fin 14-17 radius in the pectoral that is the same size or longer than the pelvic fins[158].

Biology: Of carnivorous habits that feed mainly on fish, shrimp and other crustaceans; they are of bottom or demersal that are mainly in brackish and even sweet waters of the Delta and estuaries, as well as in coastal and hypersaline marine waters of coastal lagoons[159].

Distribution: From the Gulf of Mexico, the Atlantic coast of Florida to Rio de Janeiro, Brazil. Characteristic group of the western Atlantic Ocean; In Venezuela they are distributed in the Gulf of Paria, in front of the coastal delta of the Orinoco in the Lagoons of Unare, Tacarigua and Patanemo[160].

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.69 Biological and ecological information of *Dasyatis* sp

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Chondrichthyes **Order:** Myliobatiformes **Family:** Dasyatidae **Species:** *Dasyatis* sp. **Common name:** Whiptail stingrays	
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7	

[158] Ibíd.
[159] Ibíd.
[160] Ibíd.

CLASSIFICATION	PHOTOGRAPHIC RECORD
✓ HB8 ✓ HB9	
GENERAL CHARACTERISTICS	
Characteristics: Lateral margin of the pectoral fins more or less angular but never in the form of a broad arc rounded uniformly; end of the face clearly projected in front of the disc with a more or less wide band of small tubercles easily tactile from 30 cm of disc. Lower part of the tail, behind the insertion point of the venous sting, with a fold or longitudinal dermal ridge. Pelvic fins without angular posterior extensions. Uniform dark brown back with lighter pectoral edge, whitish belly, ventral dermal fold and black dorsal crest of tail[161]. **Biology:** It feeds on small crustaceans; are viviparous reproduction. They are found in muddy and shallow sandy bottoms in marine and brackish waters but not in very low salinity [162]. **Distribution:** From the southern Gulf of Mexico to Santos in Brazil, including the coastal areas of the continental and insular Caribbean Sea. In Venezuela it is common in the neritic waters of the northeastern continental shelf and on the Atlantic shelf in front of the Orinoco Delta[163].	

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.70 Biological and ecological information of *Etropus* sp.

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Pleuronectiformes **Family:** Paralichthyidae **Species:** *Etropus* sp. **Common name:** Sole	
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	
GENERAL CHARACTERISTICS	

[161] Ibíd.
[162] Ibíd.
[163] Ibíd.

CLASSIFICATION	PHOTOGRAPHIC RECORD
Characteristics: The base of the pelvic fin of the blind side is anterior to that of the occult side, the urinary papilla is located towards the blind side, the caudal fin has 17 rays and none of them is supported by neural spines, hemal or pleural and have the hypural 5 fused with the epural[164]. **Biology:** It is found in surface water over a variety of different kinds of sediment. In general juveniles are found in estuarine areas and adults in adjacent marine waters. These organisms are usually found in turbid estuarine waters and marine areas of influence. They feed mainly on zooplankton and epibenthic organisms [165]. **Distribution:** Chesapeake Bay, the entire Gulf of Mexico and the Caribbean Sea including the Antilles through Brazil[166].	

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.71 Biological and ecological information of *Harengula sp.*

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Clupeiformes **Family:** Clupeidae **Species:** *Harengula sp*. **Common name:** Sardine	
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	
GENERAL CHARACTERISTICS	

[164] SIELFELD, Walter, VARGAS, Mauricio & KONG, Ismael. First record of Etropus ectenes Jordan, 1889, Bothud constellatus Jordan & Goss, 1889, Achirus Klunzingeri (Steindachner, 1880) and Symphurus elongatus (Günther, 1868) (Pisces, Pleuronectiformes) in Chile, with comments on the distribution of Chilean flounders. In: Investigaciones Marinas. 2003. vol. 31. no. 1. p. 51-65

[165] SÁNCHEZ-GIL, Patricia, YAÑEZ-ARANCIBIA, Alejandro, TAPIA. Margarito, DAY, John, WILSON, Cha rles & COWAN, James. Ecological and biological strategies of Etropus crossotus and Citha richthys spilopterus (Pleuronectifomes: Paralichthyidae) realted to the estarine plume, Southern Gulf of Mexico. In: Journal of Sea Research. 2008. vol. 58. no. 3. p. 173-185

[166] Ibíd.

CLASSIFICATION	PHOTOGRAPHIC RECORD
Characteristics: Fusiform, moderately deep compressed body, greater than the length of the head, ventral region with 28 to 31 scales forming a distinctive keel, teeth present, open branchial posterior edge with two growths, fine gill spines, 30 - 40 in the lower part of the first branchial arch, plates of wide and distinct teeth that extend behind the tongue. The dorsal fin slightly anterior to the point of the central body, short anal fin located behind the base of the posterior dorsal fin, long pectoral fin (22 - 24 LE), branched pelvic fin with 7 rays, origin of the pelvic fin between the insertion of the pectoral fin and the anal fin. Dorsal and laterally blue - black, with clear lateral stripes, ventral region of silver color, presents a dark posterior spot to the operculum, hyaline fins, although the tip of the caudal fin is often dark[167]. **Biology:** They are pelagic and demersal in coastal waters on sand and mud substrates, often near estuaries and sometimes in hypersaline lagoons. They are usually abundant in estuaries near the coast and bays during spring and autumn[168]. **Distribution:** Gulf of Mexico, Orinoco Delta. Apparently from northern New Jersey to southern Brazil[169]	

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.72 Biological and ecological information of *Larimus* sp

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Perciformes **Family:** Sciaenidae **Species:** *Larimus* sp. **Common name:** Corvina	

[167] CARPENTER, KENT. In: The living Marine Resources of the Western Central Atlantic. Volumen 2: Bony fishes part 1 (Acipenseridae to Grammatidae). FAO Species identification guide for fishery purposes and American Society of Ichthyologists and Herpetologists. Special Publication No. 5. p. 601-1374

[168] Ibíd.

[169] Ibíd.

CLASSIFICATION	PHOTOGRAPHIC RECORD
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	

GENERAL CHARACTERISTICS

Characteristics: Body moderately short and not very deep, long and oblique mouth, posterior end of the upper jaw extends beyond the center of the eye, snout with three dorsal pores, the first branchial arch with 20-21 gill spines, pectoral fins with 16-17 rays, ctenoid scales on the body. Sides with very different lateral stripes along the rows of scales, pale gray fins[170].

Biology: Inhabits coastal waters. Feeds mainly on planktonic crustaceans.

Distribution: Mexico to Peru.

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

[170] FROESE, R. & PAULY, D. FishBase. [online]. http://www.fishbase.org/search.php [Retrieved on August 27, 2015]

Table No. 5.73 Biological and ecological information of *Lobotes* sp.

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Perciformes **Family:** Lobotidae **Species:** *Lobotes* sp. **Common name:** Tripletail	
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	

GENERAL CHARACTERISTICS
Characteristics: Compressed body with raised back and concave anterior profile, rounded caudal fin. Soft dorsal and anal fins with a rounded posterior lobe, so that when joined with the tail it seems that the fish has three tails; basal half of the dorsal and anal fins covered with scales. Very large and oblique mouth with large and somewhat crushed teeth. Vomer and palatine without teeth; preopercle very serrated. Pelvic fins larger than the pectorals. **Biology:** Carnivore - ichthyophagous although it also feeds on macroinvertebrates[171], of marine and estuarine habits, it is usually found in oceanic waters floating sideways on the surface with other floating objects such as algae and occasionally it is dragged into shallow waters. The juveniles have the appearance of leaves and can appear in the drift floating in lagoons and mangrove channels[172]. **Distribution:** In the western Atlantic from New England in the United States, to Argentina. Cosmopolitan in all the warm seas.

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

[171] LASSO & SÁNCHEZ-DUARTE. Op. cit
[172] Ibíd

Table No. 5.74 Biological and ecological information of Morphs 7, 8 and 9

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Siluriformes **Family:** Ariidae **Species:** *Morphs 7, 8 and 9* **Common name:** Catfish	
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	

GENERAL CHARACTERISTICS

Characteristics: Fishes of medium size, long and depressed head covered with a rough bony shield, sometimes easily visible through the skin, the supraoccipital process or anterior region of this shield extends backwards to the dorsal plate. Medium to small eyes. Two pairs of nostrils approximately sow on each side, the posterior is covered by a part of skin. Lower terminal mouth, fine or granular teeth, even barbs in the jaws (4 to 6), fused gill membranes attached to the isthmus. Gill spines present in the anterior region of each arch, between 7 - 42 in the first arch. Short dorsal fin with a more or less separated long serrated spine preceded by a shorter one followed by another 7 soft rays. The adipose fin always present opposite to the anal fin, anal fin with 14 to 37 soft rays. Deep bifurcated caudal fin with 13 branched rays (6 in the upper lobe and 7 in the lower lobe). Pectoral fins with serrated spines and 8 to 13 soft rays. The pelvic fins with 6 soft rays, absent scales, full lateral line that branches off at the back and caudal lobes of the caudal fin. Usually of gray color - blue, dark gray, yellow or brown sometimes with black spots, in some species with a silver lateral line[173].

Biology: They are found mainly in marine, continental and warm brackish waters in tropical regions. Most of the marine representatives are confined to continental and insular coastal zones. They can be abundant in turbid waters of specific environments such as estuaries of large rivers, lagoons surrounded by mangroves, some species can reach depths of 100m or more. The nutritional range of marine catfish varies from omnivores (including detritus) to strongly carnivorous, also bony fish and crustaceans[174].

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

[173] CARPENTER. Op. cit.
[174] Ibíd.

Table No. 5.75 Biological and ecological information of *Oligoplites saurus*

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Perciformes **Family:** Carangidae **Species:** *Oligoplites saurus* **Common name:** Meona	
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	

GENERAL CHARACTERISTICS

Characteristics: Elongated slightly deep and very compressed body, dark green on the back and white or ventrally white-silver; not protractile large mouth, premaxillary with two rows of teeth, sometimes a third towards the front; small eyes, content 44.5 times in the length of the head; with 5-8 gill rakers on the upper branch and 13-16 on the lower branch of the first branchial arch; two dorsal fins well separated, the first composed of five spines and the second by a spine followed by 19-21 soft rays. Anal fin with two individualized anterior spines and 19-22 soft rays preceded by a spine. 11-15 soft rays of the back of the dorsal and anal like pinnae partially joined together. Elongated scales, needle-like, largely embedded in the skin, lateral line without bony escutcheons[175].

Biology: Consume fish and crustaceans. Juveniles feed on ectoparasites scales of other fish[176]; in general, they are on shallow bottoms and it is common in bays and protected areas where it generally occupies the whole water column, although they also have pelagic habits. It is usually related to estuarine areas, positive or negative[177].
Distribution: From the Northeast of the United States to Recife in Brazil including the entire Caribbean Sea and the Gulf of Mexico. In Venezuela it is a common species along almost all the continental coasts and on the islands of the shelf[178].

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

[175] LASSO & SÁNCHEZ-DUARTE. Op. cit
[176] Ibíd.
[177] Ibíd.
[178] Ibíd.

Table No. 5.76 Biological and ecological information of *Pachyurus* sp.

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Perciformes **Family:** Sciaenidae **Species:** *Pachyurus* sp. **Common name:** Corvina	
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	
GENERAL CHARACTERISTICS	
Characteristics: Small up to 23 cm. **Biology:** It is found in tropical and temperate waters due to its good adaptation to different temperatures, such as marine, brackish and continental waters. It is found in islander watercourses in the middle Paraná area. Herbivorous food habit but also insects, crustaceans, oligochaetes and eggs [179]. It is associated with lentic systems, it is a bentho-pelagic species [180]. **Distribution:** Hydrographic system of South America, Brazil, Argentina. Orinoco Delta, Paraná, Paraguay, Uruguay, São Fransisco, rivers of the east coast of Brazil, rivers Guyana [181].	

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.77 Biological and ecological information of *Polydactylus virginicus*

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Perciformes **Family:** Polynemidae **Species:** *Polydactylus virginicus* **Common name:** Barbu	

[179] LIMA, D & BEHR, E. Feeding ecology of *Pachyurus bonariensis* Steindachner, 1879 (Sciaenidae: Perciformes) in the Ibicuí River, Southern Brazil: ontogenetic, seasonal and spatial variations. In: Brazilian Journal of Biology. 2010. vol. 70. no. 3. p. 503-509

[180] YOKOTA, Cyntia, VARELA, Antonio, BURNS, Marcelo & VIEIRA, Joao. Establishing evidence of a non-native species *Pachyurus bonariensis* Steindachner, 1879 (Perciformes, Sciaenidae) in Mirim Lagoon, Rio Grande do Sul (Brazil). In: BioInvasions Records. 2014. vol. 3. no. 2. p. 103-110

[181] Ibíd.

CLASSIFICATION	PHOTOGRAPHIC RECORD
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	

GENERAL CHARACTERISTICS

Characteristics: Yellowish gray body, lighter ventrally and with silvery reflections; dorsal and anal fins densely pigmented, blackish pectoral and pelvic fins, and gray caudal fin; conical snout projected above and in front of the mouth, which is located horizontally and inferiorly. Teeth in viliform bands in the jaws. Head and bodies covered with scales as well as the dorsal and anal fins. Seven free rays not joined together by a membrane below the pectoral fin; lateral line with 56-59 scales, bifurcated at the origin of the caudal fin and prolonged on both sides of the central rays. Two dorsal fins well separated. Reaches a maximum length of 460 mm LT[182].

Biology: It feeds mainly on crustaceans and consumes to a lesser extent polychaetas, fish and vegetable matter. It is found in very shallow bottom of soft, muddy or sandy substratum; It is common and abundant in brackish water although it is also found in hypersaline water lagoons[183184].

Distribution: From the northeast of the United States and Bermuda to Uruguay[185].

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.78 Biological and ecological information of *Selene vomer*

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Perciformes **Family:** Carangidae **Species:** *Selene vomer* **Common name:** Pompano	

[182] LASSO & SÁNCHEZ-DUARTE. Op. cit
[183] CARPENTER. Op. cit.
[184] LASSO & SÁNCHEZ-DUARTE. Op. cit.
[185] Ibíd

CLASSIFICATION	PHOTOGRAPHIC RECORD
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	

GENERAL CHARACTERISTICS

Characteristics: Short, very deep and compressed body with very steep or almost vertical frontal profile; bluish gray to the dorsal side and ventrally white-silver. Basal terminal mouth with lower jaw protruding to upper jaw, both with tiny conical teeth arranged in a band. Small eyes, content 5-6 times in the length of the head. With 6-9 gill rakers on the upper branch and 23-27 on the lower branch of the first branchial arch. Two dorsal fins well separated, the first composed of eight spines and the second by a spine followed by 20-23 soft rays. Anal fin with two individualized anterior spines and with 17-20 soft rays preceded by a spine. Very reduced pelvic fins in adults Body covered by small, embedded scales except the head and the area anterior to the second dorsal fin below the curved part of the lateral line; The lateral line escutcheons are reduced to a few (7-12) located in the caudal peduncle. Reaches up to 483 mm LT [186].

Biology: It feeds on small fish, crustaceans and worms. They are found in neritic waters of the continental shelf, generally on soft and semi-hard substrates. The small specimens are found in very shallow bottoms and are common in very brackish estuarine waters, those that are larger are found at depths of up to 50 m [187] [188]

Distribution: From the northeast of the United States to Uruguay, including Bermuda and the Gulf of Mexico. Venezuela and the Lower Delta of the Orinoco [189].

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.79 Biological and ecological information of *Trichiurus lepturus*

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Perciformes **Family:** Trichiuridae **Species:** *Trichiurus lepturus* **Common name:** Sable	

[186] Ibíd
[187] CARPENTER. Op. cit.
[188] LASSO & SÁNCHEZ-DUARTE. Op. cit
[189] Ibíd.

CLASSIFICATION	PHOTOGRAPHIC RECORD
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5 ✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	
GENERAL CHARACTERISTICS	
Characteristics: Very elongated and compressed in ribbon form body, uniform silver color with metallic reflections in live or fresh. Large mouth with strong anterior canine teeth; a single dorsal fin, which is as long as the body composed of three spines and 130-135 rays; anal fin preceded by two free spines located behind the anus; pelvic fins absent as well as caudal. The body ends in a filament. Reaches a maximum size of 1.2 m LT[190]. **Biology:** young and immature individuals feed on crustaceans and small fish, while adults consume fish and invertebrates. It is found in shallow bottoms of soft substrate up to about 100 m deep; adults are also pelagic and can be found near the surface, although they are common in estuarine brackish waters [191] [192] [193]. **Distribution:** From the Northeast of the United States to Argentina, including the Gulf of Mexico and the Caribbean Sea [194].	

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Table No. 5.80 Biological and ecological information of *Umbrina coroides*

CLASSIFICATION	PHOTOGRAPHIC RECORD
Class: Actinopterygii **Order:** Perciformes **Family:** Sciaenidae **Species:** *Umbrina coroides* **Common name:** Corvina	
Sampling points: ✓ HB3 ✓ HB4 ✓ HB5	

[190] Ibíd.
[191] Ibíd.
[192] CARPENTER. Op. cit.
[193] LASSO & SÁNCHEZ-DUARTE. Op. cit
[194] Ibíd.

CLASSIFICATION	PHOTOGRAPHIC RECORD
✓ HB6 ✓ HB7 ✓ HB8 ✓ HB9	

GENERAL CHARACTERISTICS

Characteristics: Small lower mouth, the maxilla surpasses the line drawn from the middle of the eye. It has villiform teeth arranged in bands on both jaws. Chin with a single short stiff barbel with a pore at its tip and a pair of lateral pores; snout with 10 - 12 pores (5-7 in the face and 5 in the margin). Serrated preopercular margin. Ctenoid scales on the body and head. The two spines of the anal fin are strong and sharp. It has transverse stripes along the body[195].

Biology: It is a bipedal species mainly of Amphipoda and Mysidacea [196], it is associated with very shallow, generally sandy bottoms; It is common in clear waters and with soft waves[197].

Distribution: From North Carolina to Recife in northeastern Brazil, including the western and southern Gulf of Mexico, the Antilles and the southern Caribbean Sea, from Panama to Trinidad. Common in Venezuela[198].

Source: Prepared by SGS Environmental Services, 2015, adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

Ecological indices and similarity analysis for the Ichthyofauna

The ecological indices for the fish community indicate that, in the area of influence, there was an average richness (d: 3.06) and diversity (H: 2.85), being dominated by several species, which presented a homogeneous distribution in terms of their abundance.

At the sampling point level, the greatest richness and diversity of species was found in HB9, where the fish community was dominated by several species that presented a homogeneous distribution in relation to their abundance. The lowest diversity of species, although with a mean value of richness was observed in point HB4 (Table No. 5.81).

Table No. 5.81 Ecological indices for the fish community at the sampling points in Bahía Colombia

Sampling points	S	N	d	J'	H'(loge)	λ
HB3	18	42	4,55	0,96	2,77	0,93
HB4	18	36	4,74	0,95	2,75	0,93
HB5	18	34	4,82	0,97	2,80	0,93

[195] Ibíd
[196] Ibíd
[197] Ibíd
[198] Ibíd

Sampling points	S	N	d	J'	H'(loge)	λ
HB6	18	43	4,52	0,97	2,81	0,94
HB7	18	42	4,55	0,95	2,75	0,93
HB8	18	33	4,86	0,95	2,76	0,93
HB9	18	27	5,16	0,97	2,81	0,94

S: Species Richness, N: Total organisms of the sample, d: Margalef Richness, J´: Pielou evenness, H´: Shannon-Wiener diversity, λ: Simpson Predominance
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

For the Bray Curtis similarity analysis, three groups were observed, where the grouped sampling points showed a similarity higher than 70%. The first group was made up of points HB8 and HB9, with approximately 80% similarity. The second group was between points HB7 and HB5, with similarity of 82%. Finally, the points HB3 and HB6 were found with 85% similarity (Figure No. 5.90).

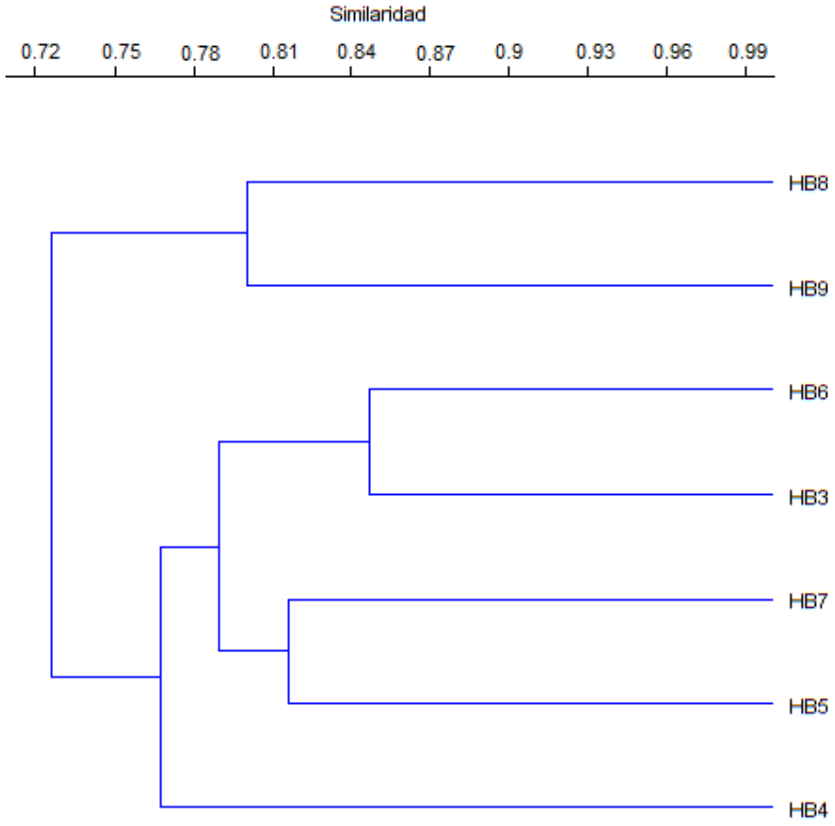


Figure No. 5.90 Bray-Curtis analysis for the fish community present in the sampling points in the project's area of influence in Bahía Colombia
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

Correlation with physicochemical parameters

The variation of the fish community registered in Bahía Colombia did not present any significant correlation, in statistical terms (p> 0.05), with the seven physicochemical parameters evaluated (Table No. 5.82).

Table No. 5.82 Correlation of fish abundance and physicochemical parameters in the area of marine influence of the project

Parameter	P	r^2
Temperature (°C)	0,33	0,18
pH	0,48	0,11
Biochemical Oxygen Demand	0,19	0,31
Chemical Oxygen Demand	0,15	0,36
Total Nitrogen (mg N/L)	0,39	0,15
Turbidity (NTU)	0,36	0,17
Dissolved oxygen	> 0,05	0,33

Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

5.2.5 Strategic, sensitive ecosystems and / or protected areas

The following is a description of the strategic ecosystems and / or protected areas identified in the area of influence of the project. Among them, the protective forest reserve of the wetlands between León and Suriquí rivers and a brief description of the sites of ecological importance that are not part of the project's influence, but that due to their proximity are named (map MOD_LA_PTO_ANT_39_AreasProteg).

- Protective Forest Reserve of the wetlands between León and Suriquí rivers

Through Agreement number 019 of December 17, 2009, the Corporation for the Sustainable Development of Urabá - CORPOURABÁ declared the Protected Reserve Zone of the wetlands between the León and Suriquí rivers, located in the Gulf of Urabá, to the northwest of the department of Antioquia, comprising the middle area of the coastal municipality of Turbo, as can be seen in Figure No. 5.91.

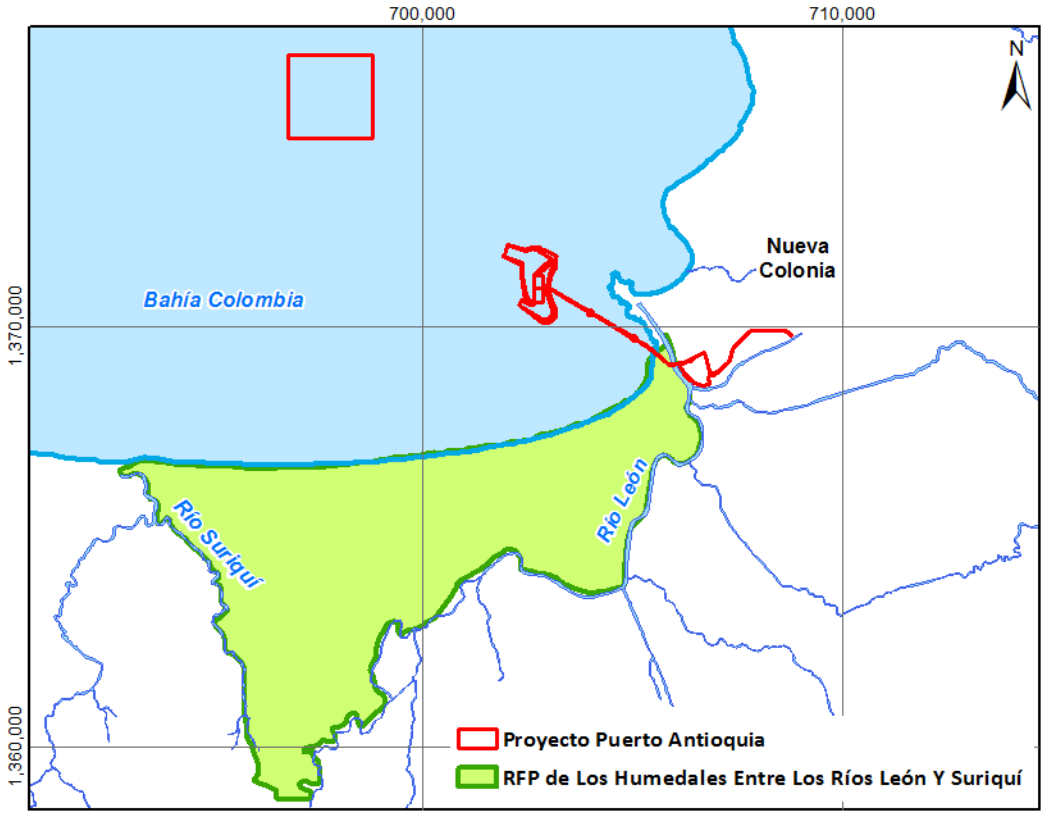


Figure No. 5.91 Protective Forest Reserve of the wetlands between the León and Suriquí rivers
Source: Prepared by Aqua & Terra Consultores Asociados S.A.S., 2015

In general, the area is made up of wetlands or marshes, where the vegetation known as naidizales, Arracachales stands out in association with species commonly found in the area, such as the salero, yarumo, cativo, among others, and a strip of mangrove located in the shore between the left bank of the Leon River and the right bank of the Suriquí River.

At the confluence of the floodplains of León and Suriquí rivers, communicated by channels of different specifications, there is a mixed forest structure with species such as the Prioria *copaifera* “Cativo”, *Pachira aquatica* “Salero”, *Cynometra* sp. “Mangle duro”, *Carapa guianensis* “Güino”, *Inga* sp., “Guamo” and *Pterocarpus officinalis* “Bambudo” among other species. It also has several palm species, configuring a facet of mixed flooded forest, because despite the presence of the cativo, it is not possible to catalog it as a typical cattival of the region and also for its high wood productivity, but of great biological value and of singular importance for

the regional fauna, since this mixed forest is practically the last refuge of communication, on the eastern side, between the wooded areas of the region [199].

According to the map of land cover, CORINE Land Cover methodology adapted for Colombia. Scale 1: 100,000, the area included as wetland of the León-Suriquí River is identified as dense, low-flood forest, which makes the zone an area with serious limitations for the establishment of any type of traditional agrarian production system.

In relation to the life zones according to the Holdridge classification, the León-Suriquí river wetland belongs to the formation called Tropical Humid Forest, with the following climatic characteristics: average temperature higher than 24 degrees Celsius and an average annual rainfall between 2,000 and 4,000 millimeters. The relative humidity varies from 90% in the rainy season to 85% in the dry season.

Currently the León-Suriquí river wetland presents a high vulnerability, due to the pressure originated from the process of colonization in the region, which has involved the occupation or allocation of wastelands, which in turn translates into activities that seek to dry large areas to convert the use of land to livestock activities and to a lesser degree (medium-low vulnerability) alterations due to aperiodic burning, hunting and extraction of firewood[200].

In 2008, CORPOURABÁ and the Administrative Department of the Environment, carried out the Management Plan for the Protective Forest Reserve of the Wetlands between the León and Suriquí rivers; The final product was the zoning of the León-Suriquí river wetland, which was defined from the ecosystem analysis, seeking to identify areas that can be interpreted as relatively homogeneous units based on the similarity of their physical-biotic components (Figure No. 5.92 and Table No. 5.83).

[199] CORPORATION FOR THE SUSTAINABLE DEVELOPMENT OF URABÁ- CORPOURABÁ, ADMINISTRATIVE DEPARTMENT OF ENVIRONMENT-DAMA. Management Plan for the Protective Forest Reserve of the Wetlands between the León and Suriquí Rivers, Municipality of Turbo, Department of Antioquia. PUBLIC CALL No. 047 OF 2007. MEDELLÍN, March 31, 2008
[200] Ibíd

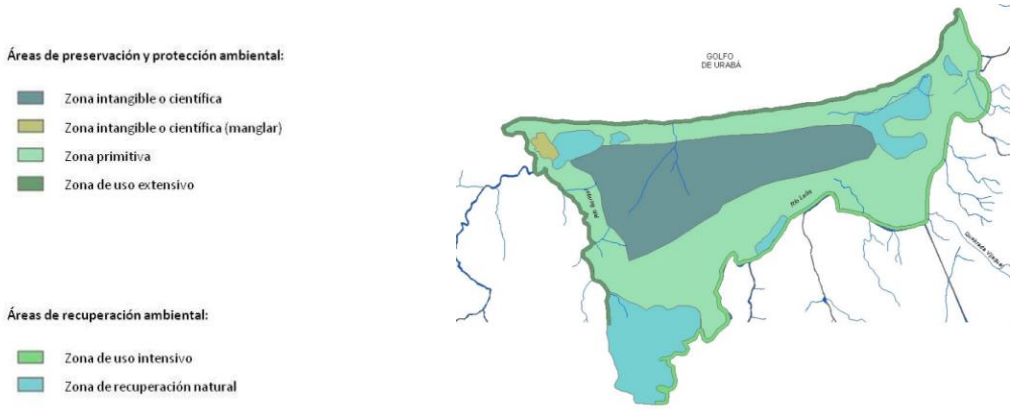


Figure No. 5.92 Zoning of the Protective Forest Reserve of the wetlands between the León and Suriquí rivers
Source: Management Plan for the Protective Forest Reserve of the Wetlands between the León and Suriquí Rivers [201]

Table No. 5.83 Areas and zones established in the zoning of the Protective Forest Reserve of the wetlands between the León and Suriquí rivers

Areas and zones	Definition	Area (ha)
Areas of preservation and environmental protection	"Spaces that have been subjected by man to intensive or inadequate processes of appropriation and use, totally or partially transforming the original vegetation, modifying the water regime and generating erosive and sedimentation processes".	

[201] Ibíd

Areas and zones	Definition	Area (ha)
Intangible or scientific zone	"Those that have suffered low alteration due to human impact and that include portions or elements of unique or fragile ecosystems with the intention of protecting in the same way the species of associated flora and fauna. The mangrove areas (35,545 ha.) located at the mouth of the Suriquí river and mixed forest belong to this area, in both cases defined within the wetland area, that is, the riparian zones are not included in this category, nor are the contiguous to these, but those that are more isolated from the possibility of human intervention or impact".	1.601,743 Incl. mangrove 35,545
Primitive zone	"Natural areas of low human impact, with plant associations that maintains the characteristics of functionality, as well as its original flora and fauna species that although of scientific interest are resistant enough to tolerate a moderate public use".	3.213,546
Extensive use zone	"Zone that contains examples of the most significant landscapes and natural features present in the wetland, even with some minor alterations of the anthropic type and in which educational and recreational activities such as observation of fauna and flora and sport fishing can be developed. It is considered as a zone of transition or buffering of primitive and intangible areas, to the extent that it can support a greater concentration of visitors but always under the consideration of a minimal impact".	226,690

Areas and zones	Definition	Area (ha)
Areas of environmental recovery	"Spaces that have been subjected by man to intensive or inadequate processes of appropriation and use, totally or partially transforming the original vegetation, modifying the water regime and generating erosion and sedimentation processes".	
Intensive use zone	"Zone that consists of natural areas or impacted by man, with individual environments of scenic beauty, resources used for relatively dense leisure activities and for the provision of support services. The environment is kept as natural as possible, but the presence and influence of visitors and to the extent of future possibilities for the case of the wetland, administration facilities, taking advantage of the presence of villages on the right bank of the river, are accepted, as it is the case of Puerto Girón that advances in the search to work on the topic of ecotourism".	225,362
Natural recovery zone	"Provisional class defined in the places where natural vegetation, fauna and soil characteristics are strongly altered, especially by human influence, which must be gradually incorporated into one of the categories described above. In the case of the León-Suriquí River wetland, these areas are associated with the lands affected by the construction of dams to dry the wetland and the introduction of pastures, places where the vegetation was also cut, seeking to introduce pastures and areas affected by slash-and-burn".	915,548

Source: Management Plan for the Protective Forest Reserve of the Wetlands between the León and Suriquí Rivers [202], adapted by Araújo Ibarra[203]

[202] Ibíd
[203] PUERTO BAHÍA COLOMBIA DE URABA S.A. and ARAÚJO IBARRA & ASOCIADOS S.A. Environmental impact study for the construction and operation of a solid bulk port terminal. Turbo. 2010. 428 p.

Within the categories of environmental zoning, two classes called "Extensive use zone and intensive use zone" were considered, defining them as "Wetland sites that can be used for the development of productive activities, involving the concept of sustainability in the use of natural resources and therefore must be subject to regulations aimed at preventing and controlling the environmental impacts generated by its use or exploitation".

These categories are bordering the forest reserve to the mouth of the León River in Bahía Colombia, in order to initially allow the development of an ecotourism project and activities related to artisanal fishing. Clarifying that the development of the viaduct necessary for the port project can be totally compatible with this concept, as long as the environmental determinants to be adopted are agreed with CORPOURABÁ for the control of the processes in charge, especially if recognized, within a focused balance, the benefits that the project generate for the sustainability of the region and necessarily for its areas of interest[204].

Finally, according to the decision support system - SSD SAMP[205] of INVEMAR, the area of influence of the project does not have the presence of reef ecosystems or seagrasses.

5.2.6 Areas of ecological importance and conservation

For Colombia, biodiversity conservation strategies have been defined within the exercise of "Ecoregional Planning for in situ Conservation of Marine and Coastal Biodiversity of the Caribbean and the Colombian Continental Pacific"[206], and the "Ecoregional Planning for the conservation of biodiversity in the Colombian continental Caribbean"[207] where conservation objects, priority conservation sites, threats to biodiversity and conservation goals are identified.

In order to locate the priority conservation sites and their components, the coastline is divided into coastal systems for the Pacific and the Colombian Caribbean, with

[204] Ibíd
[205] INVEMAR. Decision Support System - Subsystem of Marine Protected Areas [Sistema de Soporte de Decisiones – Subsistema de Áreas Marinas Protegidas – SSD SAMP]. [online] http://gis.invemar.org.co/ssdsamp/ [retrieved on October 5, 2015]
[206] INSTITUTO DE INVESTIGACIONES MARINAS Y COSTERAS JOSÉ BENITO VIVES DE ANDREIS – INVEMAR. Technical report: Ecoregional Planning for In situ Conservation of Marine and Coastal Biodiversity of the Caribbean and the Colombian Continental Pacific. Series of General Documents No. 41. Santa Marta. 2009. 106 p + Annexes. ISBN 978-958-8448-23-7.
[207] GALINDO, Gustavo., MARCELO, Darwin., BERNAL, Néstor Ricardo., VERGARA Lina Katerine., & BETANCOURTH, Juan Carlos. Ecoregional Planning for the conservation of biodiversity in the Colombian continental Caribbean. Bogotá D.C. Colombia.: Research Institute of Biological Resources Alexander von Humboldt, National Hydrocarbons Agency, The Nature Conservancy and Institute of Hydrology, Meteorology and Environmental Studies.2009. 24 p. (Ecoregional Planning Series for the Conservation of Biodiversity, No.1). ISBN 978-958-8343-29-7.

respect to the latter, seven coastal systems are established: Guajira (GUA), Palomino (PAL), Tayrona (TAY), Magdalena (MAG), Morrosquillo (MOR), Coral Archipelagos (ARCO) and Darién (DAR).

For the area of influence, the Darién Caribbean coastal system (DAR) is identified and it is described below[208] (Figure No. 5.93):

- ✓ **Darién (DAR):** This system is divided into three different areas, Arboletes, Atrato and Capurganá. The project is in the area called Atrato, which is located between Punta Arenas and Acandí, and to the 50 m isobath. The waters are characterized for being turbid, of low salinity and surrounded by mangroves, composing estuarine zones.

Within the environmental system of Colombia, this coastal system is part of the Regional System of Protected Areas called "SIRAP DARIÉN - URABÁ", which includes the Katios National Natural Parks and the Atrato wetlands forest system.

It is characterized by high rainfall, important and abundant water resources and the presence of three types of ecosystems (low and medium Atrato and León River wetlands, mangroves and cativales).

The León River is part of a strategic ecosystem within the Urabá– Darién region; it is characterized by collecting the waters from the Serrania del Abibe, its main tributaries are on the right bank, being the most important: Villarteaga, Juradó, Cuapá, Chigorodó, Carepa, Zungo and the streams Polines, el Venado, Israel and los Cedros.

Likewise, the present wetlands are of great importance for the different ecological functions they perform, such as: flood control, aquifer recharge and discharge, erosion control, sediment and nutrient retention, biomass export, microclimate stabilization, water transport, among others. Mangroves are also important because they contribute to the protection and stability of the coast and are considered the most productive ecosystems in the world[209].

On the other hand, within the exercise to establish the guidelines and integrated management strategies of the Darien coastal environmental unit, the area of

[208] INVEMAR, (2009). Op. cit.
[209] NATIONAL DEPARTMENT OF PLANNING, ADMINISTRATIVE DEPARTMENT OF PLANNING OF ANTIOQUIA & JUNTA EFEMÉRIDES URABÁ. Strategic plan for the region of Urabá - Darién First phase: Construction of inputs for the process of the region. Medellín. 2006. 154 p.

influence is within seven management categories according to the environmental zoning proposed[210], grouped as follows (Figure No. 5.94):

Protection zone: It refers to areas belonging to or susceptible to belong to the National System of Protected Areas of Colombia, require special management measures to conserve biological diversity and guarantee the supply of environmental goods and services, in the context of regional and local development and dynamics.

These zones allow their ecological self-regulation, they have ecosystems that in general have not been altered, and all their biotic and abiotic components have great importance at social, scientific, educational, landscape, recreational, etc. level[211].

Zone of recovery of strategic ecosystems: it refers to the areas with strategic ecosystems (beaches, mangrove, natural forest, wetlands, coastal lagoons, among others), whose characteristic areas allow the degradation processes to be reversible, these processes occur due to problems of land use conflict, deforestation processes, fluvial and coastal erosion and fluvio-maritime pollution[212].

Zone of sustainable use: the areas of sustainable use present a high supply of natural resources, which allow a rational use through the implementation of traditional techniques, for the case two exploitation areas are presented (*transport and artisanal and sustainable fishing for transport*); these zones correspond to the fluvial-marine area where fishing activities and transit of small and large vessels take place, transporting different goods (agricultural products, wood, etc.)[213].

Zone of sustainable agricultural production: The areas of sustainable production are those that, due to their usability and potential, are suitable for the development of economic activities of production. For the agricultural case, it includes areas with mixed agricultural crops and permanent monocultures (banana, cassava, corn) that has the potential to be part of the agro-industrial system, as well as to produce products and by-products that generate added value[214].

Zone of Port development, transport, mines, energy and interconnections: correspond to areas where current and potential usability is related to the

[210] INVEMAR – GOVERNMENT OF ANTIOQUIA – CORPOURABA – CODECHOCÓ. 2008. Formulation of guidelines and strategies for integrated management of the Coastal Environmental Unit of Darién. Edited by A.P. Zamora, A. López & P.C. Sierra Correa. Santa Marta. 208 p + Cartographic annexes + 5 digital annexes. (Series of general documents INVEMAR No. 22).
[211] Ibíd
[212] Ibíd
[213] Ibíd
[214] Ibíd

infrastructure and provision of services necessary for the development of the agro-industry and the port system, including marine areas of greater depth for the transit and anchoring of vessels, mining-energy exploration and interconnections[215].

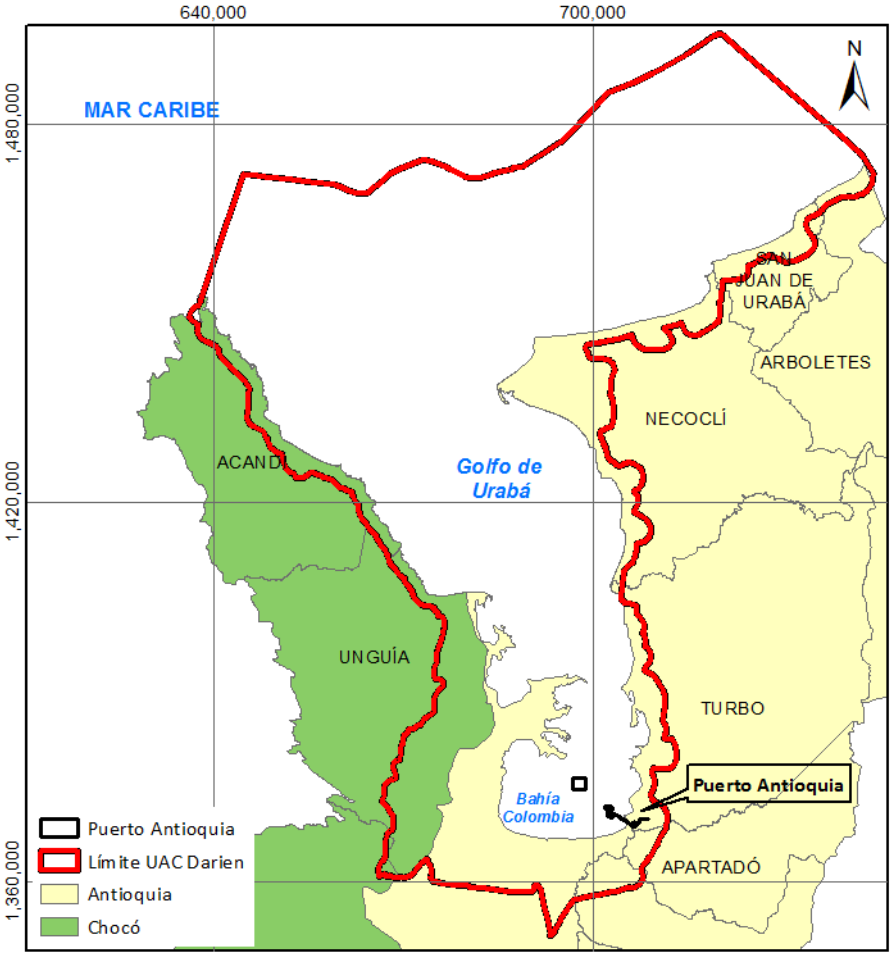


Figure No. 5.93 Location of the Darién Coastal Environmental Unit
Source: Ibíd., Adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

[215] Ibíd

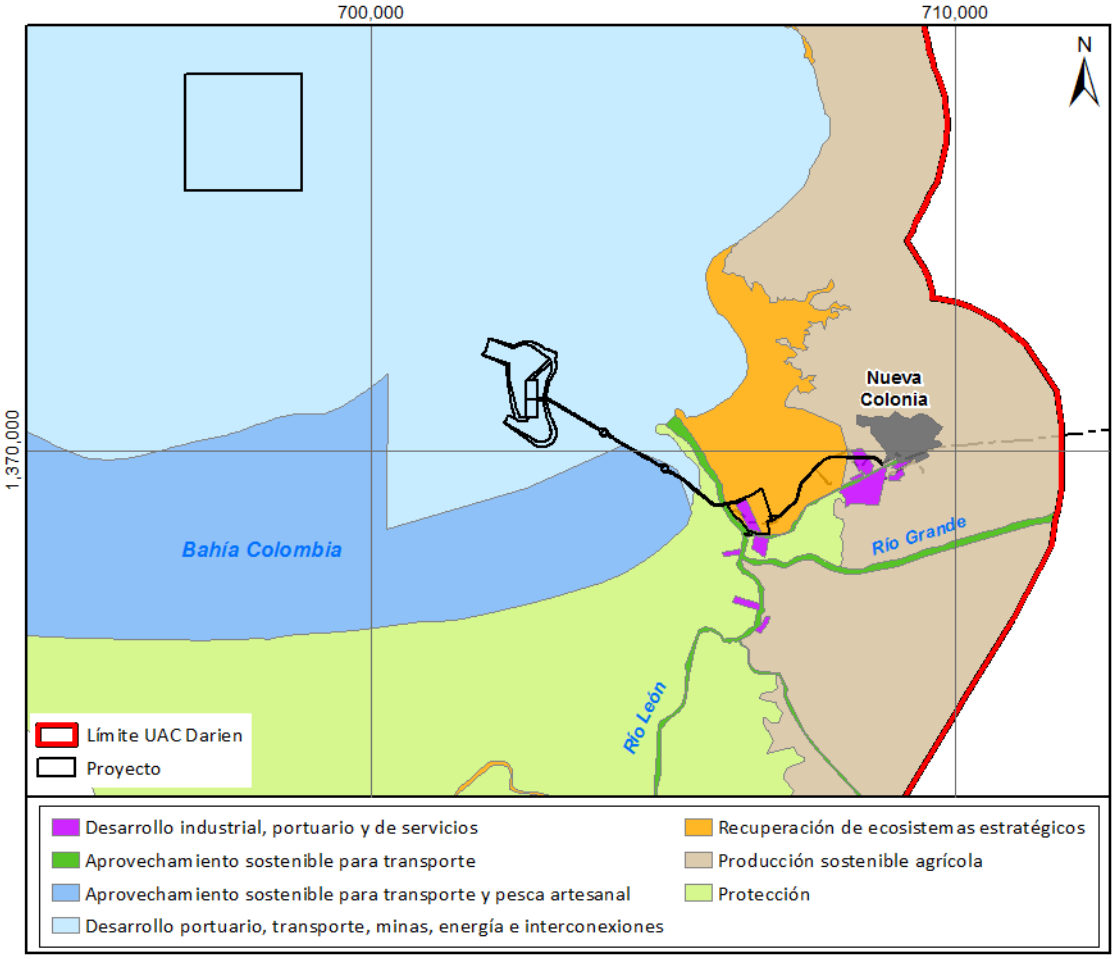


Figure No. 5.94 Coastal-Darien Environmental Unit Zoning
Source: Ibíd., Adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

After reviewing the INVEMAR and ANLA geo-viewers and analyzing the Ecoregional planning documents for the Caribbean area, 100 priority conservation sites were defined, covering approximately 821,260 ha, representing 22.4% of the Colombian continental Caribbean.

The criteria followed for the establishment of these areas of importance and conservation were their biological and ecosystemic representativeness, presence

and dynamics of intertidal ecological systems, as well as the relevant biological communities[216].

For the coastal system -DAR- 28 Conservation Objects were identified, of which seven are in the area of influence or near (Figure No. 5.95 and Table No. 5.84). In connection to the above, within the portfolio of priority conservation sites, the area occupied by the project is classified as a conserved area. On the other hand, in the ANLA geo-viewer[217] the area of influence of wetlands in 2012 is registered as a site of ecological importance.

Table No. 5.84 Conservation objects identified near the area of influence

Conservation objects	Distance to the area of influence (m)
Seabird congregation areas	350
Coastal lagoons and estuaries	0
Panganales	0
Mangrove Forest of Mixohaline Waters	350
Non-carbonated coarse-grained mobile funds from the sublittoral	0
Carbonated coarse-grained mobile funds from the sublittoral	0
Sea turtle nesting areas	25000
Other important sites	**Distance to the area of influence (m)**
Wetlands of 2012	350
Preservation area	350

Source: Aqua & Terra Consultores Asociados S.A.S., 2015

[216] INVEMAR, (2009). Op. cit.
[217] AUTORIDAD NACIONAL DE LICENCIAS AMBIENTALES – ANLA. Sistema de Información Ambiental de Colombia – SIAC. Available in: http://sig.anla.gov.co:8083/

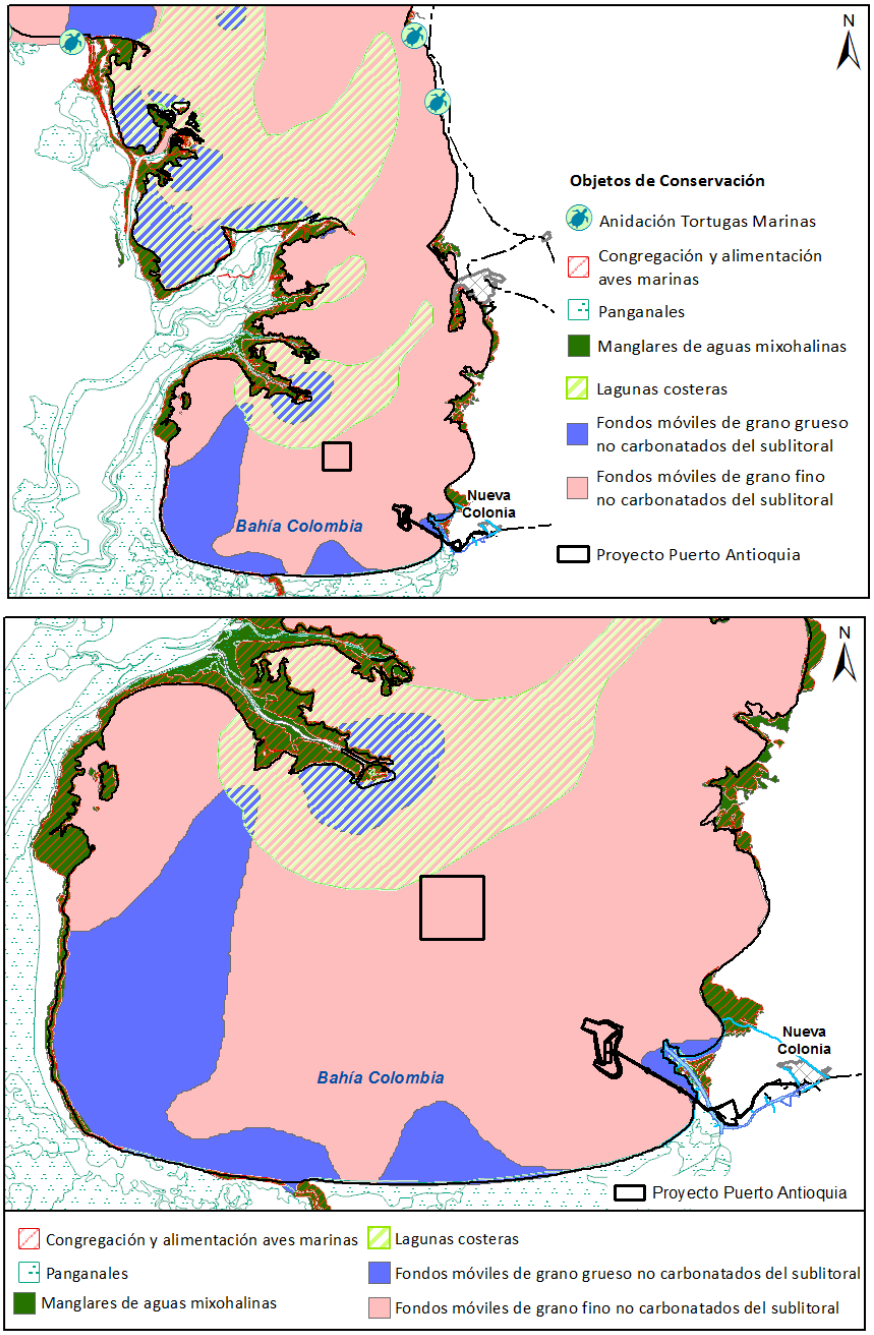


Figure No. 5.95 Conservation objects identified in the area of influence and its surroundings
Source: Geo-viewers INVEMAR, ANLA, Adapted by Aqua & Terra Consultores Asociados S.A.S., 2015

In the portfolio of important sites for the conservation of biodiversity in the Colombian continental Caribbean and geo-viewers of INVEMAR, the mangroves of Punta

Coquito[218] are recorded as priority conservation sites, and as mangrove preservation areas[219] [220], the mangroves located near the area of influence.

The priority conservation sites that were identified are areas that due to their ecological, biological and ecosystem importance, are considered as strategies to implement in situ conservation programs.

These sites are not yet legalized nor are they recognized by the current environmental regulations. However, they are taken into account by different entities to focus their resources, conduct research, implement conservation programs, as buffer zones and as candidates to expand already established protection areas.

Finally, according to the Early Warning Information System - TREMARCTOS[221] for the terrestrial influence area of the mentioned project, two reptile species classified as minor and vulnerable concern were identified, in the first classification the caiman *Caiman crocodilus* was found and in the second the crocodile *Crocodylus acutus*. In the marine portion of the area of influence including the area designated as a dump, this system did not provide alerts on species or areas under conservation.

[218] GALINDO, Gustavo., et al. Op. cit
[219] INSTITUTO DE INVESTIGACIONES MARINAS Y COSTERAS JOSÉ BENITO VIVES DE ANDREIS – INVEMAR. Information System for the management of mangroves in Colombia. Available in: http://gis.invemar.org.co/sigma_geo/
[220] INSTITUTO DE INVESTIGACIONES MARINAS Y COSTERAS JOSÉ BENITO VIVES DE ANDREIS – INVEMAR. Ecoregional Planning - Caribbean. Available in: http://gis.invemar.org.co/PERCaribe/
[221] RODRÍGUEZ-MAHECHA et al. [online] http://www.tremarctoscolombia.org/reportes.html [retrieved on July 29, 2015]