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Structure and floristic survey of a forest fragment in the Billings Reservoir, São Paulo

The Atlantic Forest is the largest biome in the State of São Paulo, one of the most biodiverse ecosystems complexes on the planet, considered a conservation hotspot. This work aimed to list the plant species through the classification of the life forms of RAUNKIAER (1905), improved by CABRERA & WILLINK (1973). The survey of the species was carried out by prospecting's in 54 quadratic plots of 36 m², evenly distributed in a forest fragment of 48,010.91 m². There recorded 97 species distributed in 47 families, with predominance Myrtaceae. The survey was carried out in December 2017, of the total number of species collected in the area of the fragment: 63 are trees, 17 are herbaceous, 6 are epiphytic, 4 are lianas, 3 are shrubs, 2 are palm trees, one is arborescent and one scandent. It is worth noting the registration of the vulnerable species Euterpe edulis, all botanical material is in the Herbarium RBR - UFRRJ - Institute of Biological and Health Sciences.

Palabras-chave: Biodiversity; Dense Ombrophilous Forest; Nature Conservation; Billings Reservoir.

Estrutura e levantamento florístico de um fragmento de mata atlântica na Represa Billings, São Paulo

A Mata Atlântica é o maior bioma do Estado de São Paulo, um dos complexos ecossistêmicos mais biodiversos do planeta, considerado um hotspot para conservação. Este trabalho teve como objetivo listar as espécies vegetais através da classificação das formas de vida de RAUNKIAER (1905), aprimorada por CABRERA & WILLINK (1973). O levantamento das espécies foi realizado por prospecções em 54 parcelas quadráticas de 36 m², distribuídas uniformemente num fragmento florestal de 48.010.91 m². Foram registradas 97 espécies, distribuídas em 47 famílias, com predominância de Myrtaceae. O levantamento foi realizado em dezembro de 2017, do total de espécies levantadas na área do fragmento: 63 foram árvores, 17 ervas, 6 epífitas, 4 lianas, 3 arbustos, 2 palmeiras, 1 é arborescente e 1 é árvore escandente. Destaca-se o registro da espécie vulnerável Euterpe edulis, todo material botânico encontra-se Herbário RBR - UFRRJ - Instituto de Ciências Biológicas e da Saúde.

Keywords: Biodiversidade; Floresta Ombrófila Densa; Conservação da Natureza; Represa Billings.

Topic: **Uso de Recursos Naturais**

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INTRODUCTION

Approximately 54.4% of Brazil's territory is occupied by forests (FLORESTAS DO BRASIL, 2015) and from this percentage, approximately 12.5% corresponds to the area of the Atlantic Rainforest Biome (SOS MATA ATLÂNTICA, 2015), stretching for 17 States of the federation, going from the state of Rio Grande do Sul to Rio Grande do Norte, ranging from the coastal regions, such as plateaus and hills of the interior.

In the state of São Paulo, the Atlantic Forest biome offers characteristic phytoecological formations constituted by forest ecosystems: Seasonal Semidecicual Forest and Dense Ombrophilous Forest. The latter features subdivisions in its phytophysiognomy, suffering variations according to the altitude range of relief where it is inserted. The divisions are: The Alluvial Lowlands, Submontane Forest, Montana and Alto-Montana (SOS MATA ATLÂNTICA, 2015).

According to RODRIGUES et al. (2017), in addition to this important set of forest ecosystems, the Atlantic Forest also covers other associated ecosystems such as mangroves, restingas, mixed Araucarias forestry and the altitude fields.

The biome stretched by more than 90% of the total area of the state of São Paulo, according to the annual balance sheet presented by the non-governmental organization SOS Mata Atlântica (2015), until the end of the 1990's, approximately 15% of the area of this territory was still covered by native vegetation. The report of the institution demonstrates that the historical process of anthropic intervention has been happening since the discovery of Brazil and has been expanding over the centuries, due to some activities of economic development, such as exploitation of timber, agricultural and industrial activities. Another factor associated with the loss of vegetation is the unplanned urban growth, which in Brazil occurs mainly in areas that are covered by the biome (SOS MATA ATLÂNTICA, 2015).

According to INPE (2018), of the total Atlantic Forest, 23,548 hectar of vegetation were suppressed of which corresponds to 7% of its forest remains, safeguarded mainly in these areas of more difficult access, how to slopes of the Serra do Mar, considered unsuitable for agricultural practices. This territory has large forest spots adjacent to areas of high fragmentation (ARROMBA et al., 2012). The law n.11.428/2006 determines the area of protection of the biome for the 17 states of the federation, which corresponds to 38% of the Brazilian territory. Studies of the INPE (2018) point out that the whole area of Atlantic Forest had approximately 1,300,000 km² of extension, and now is reduced to 162,666 km², the equivalent to 12.4% of its original forest cover, as today has many uses, some of them being: the remaining forest, planted forests (mainly pinus and eucalyptus), pastures and agricultural crops of annual and perennial plants.

However, even facing an intense and historical process of deforestation, the Atlantic Forest biome has one of the largest biodiversity in the planet, with high concentrations of endemic species (BERGALLO et al., 2016) and a high level of degradation. Thus, it is possible to consider it as a hotspot, being the conservation of its natural resources of utmost importance to mankind.

This high biodiversity has been attributed to climate and geographical characteristics that vary greatly throughout its territory, which account for this biome's vegetation variations followed by a specific fauna and

flora composition. It is estimated that over 1360 species of mammals, birds, reptiles, and amphibian occur in the biome. 567 of those are endemic. Superior plants total 20,000 species, more than half of the endemic mass.

The state of São Paulo is included in the Atlantic Forest domain. The devastation of forests in this state is happening almost since the period of its discovery, drastically reducing their original vegetation coverage. Only 7.26% of the original area remains (TAVARES et al., 2012; FUNDAÇÃO SOS MATA ATLÂNTICA et al., 2011), it is vital that the green areas and woody species that still exist are preserved. Especially considering the various services that the forest ecosystem can provide., such as: maintenance of water resources, conservation and preservation of soils and the concentration of atmospheric carbon in forest fragments.

The city São Bernardo do Campo is located at the top of the Serra do Mar, the Atlantic Plateau, however in almost every area of Atlantic Forest in the region, it is possible to observe influxes of eucalyptus and pine trees, the livestock and agriculture also distort the Atlantic Forest site, in addition to the massive synthesis of real estate ventures.

Billings reservoir is one of the biggest and most important reservoirs of water in the Metropolitan Region of São Paulo. The West borders the watershed of the Guarapiranga reservoir, and South, Serra do mar. Its main rivers and streams are the Rio Grande or Jurubatuba. Located in a fishing region with an emerging spot of strong environmental interest, its area of the original forest is altered, when not completely deleted due to the deployment of real estate ventures or agriculture, in addition to the cultivation of *Pinus sp.*, *Eucalyptus sp.* and *Corymbia sp.* For these reasons, even today, its humid areas of ecotone with rain forests and gallery forests, although quite affected by human activity, stand still as important floristic and faunistic elements of interest to conservationists, especially the flora (SOS MATA ATLÂNTICA, 2015).

Because of importance of the Billings reservoir for the state of São Paulo and the need for the preservation of its ecosystem, the objective of this work was to list the botanical species through the classification of the life forms of RAUNKIAER (1905) improved by CABRERA et al. (1973), through the installation of 54 plots (UA) of 36 m^2 arranged randomly in a forest fragment of 48,010.91 m^2 encompassing a sampling area of 1944 m^2.

MATERIAL AND METHODS

Characterization of the study area

The forest fragment is in the area of influence of the Billings reservoir (Figure 1) in the municipality of São Bernardo do Campo, which is one of the largest and most important reservoirs of water in the Metropolitan Region of São Paulo.

The dam was conceived in the decades of 1930 and 1940 by engineer Billings, one of the employees of the former energy provider Light. Initially, the dam had the objective of storing water to generate electrical power for the hydroelectric plant Henry Borden in Cubatão.

The city São Bernardo do Campo has a warm climate and temperate climate. There is significant rainfall throughout the year, even the driest month there is plenty of rainfall. According to the Köppen Geiger and the climate is classified as CFB (LUCHIARI et al., 2012). In São Bernardo do Campo, the average temperature is 17.8°C, the average annual rainfall is 1524 mm. The difference between the precipitation of the driest month and the rainiest is 190 mm. Throughout the year the average temperatures vary 6.5 °C. The hottest month of the year is February with an average temperature of 20.9°C. July has an average temperature of 14.4°C, this was the lowest mean temperature, precipitation in the month of July is 44 mm, this being the driest month. The wettest month was January, with an average of 234 mm.

The forest fragment located in the Taquacetuba Road, in the Taquacetuba neighborhood, under the inscription 624700708000, in the Alto-Tietê's basin area, specifically in the sub-basin of the Billings reservoir. The main access roads to the location of the project are by the highway of Imigrantes and by Mário Covas Beltway, so it is in an important and privileged geographical position. In accordance with the environmental process N 59.602/2017, the fragment has 3 stages of succession: initial, medium and advanced, the largest portion of the successional stage corresponding to the 'initial' stage.

Sample Design and Analysis

From 10 December until 23 December 2017, 54 square (6x6 m) sampling units were systematically demarcated in the area of the real state interest, total of 1944 m^2 of sampling area (figure 1) the fragment studied has a total area of 48,010,91 m^2, the field team mapped all the botanic species occurring in the 36 m^2 units, RAUNKIAER's classification of life forms (1905), refined by Cabrera et al. (1973). Within each quadratic plot they were collected arboreal species with CAP greater than or equal to 5 cm and estimated the height and the radius of the canopy of sampled individuals. The quadrats were marked with striped tape. The vertex closest to the access to the sampling unit was georeferenced using a GPS with an accuracy of 3 meters under vegetation cover, as well as the horizontal and vertical structure of the tree community and the basal area of all plots, besides to include all life forms like herbs, vines, palms, trees, arborescens, shrubs, creepers and scandalized trees. The material was studied and duly deposited in Herbarium Herbarium RBR - UFRRJ - Institute of Biological and Health Sciences. The results obtained in this study were paired with Resolution n.01/1994 of the Environment National Council (CONAMA).

The simple random sampling is the fundamental process of selection from which to derive all other sampling procedures, aiming to increase the accuracy of estimates and to reduce the costs of the survey (RIBEIRO et al., 2009).

The simple random sampling is the best method for presentation of the theory of sampling, because it allows estimating the sampling error. The selection of each sampling unit must be free of any choice and totally independent from the selection of the other sample units. The equation for the calculation of the sample sufficiency in simple random sampling is shown below (HUSCH et al.1982) (Equation 1):

$$n=N\times S^2\times t^2/(N\times(E\times x^-)^2+S^2\times t^2 \quad (1)$$

Where:
n = number of parcels to be raised;
N = total number of samples possible in the area;
t = value of probability distribution ($t_{0.10}$, with n-1 GL);
S^2 = variance of the parameter evaluated;
$\bar{x}$ = average
E = Error (10%) and X=Average of the parameter evaluated.

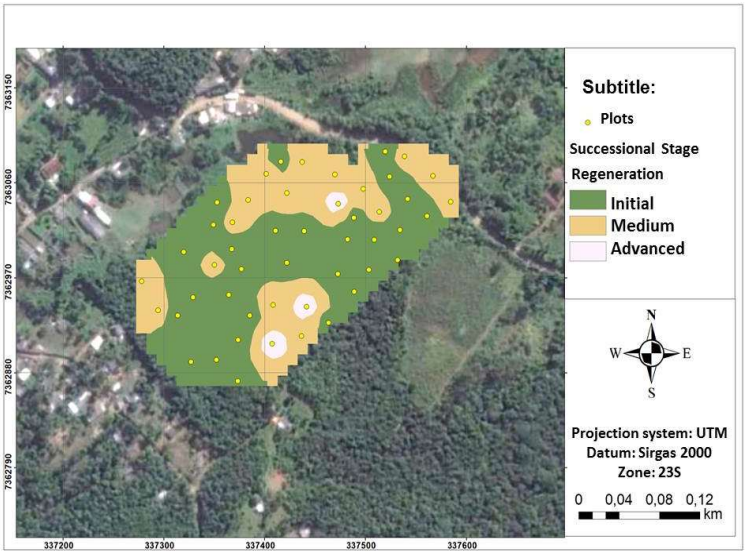

Figure 1: Classification of successional stage of regeneration of the fragment and provision of sample units in the area of studies. Total area: 48,010.91 m^2.

RESULTS AND DISCUSSIONS

For the calculation of the sample sufficiency in simple random sampling, met a n= 45.65 sample units (U.A) for the total area of 48,010.91 m^2 (N=54; S2= 24.40531; S= 4.94 plants; Std. Error= 0.67 plants; CV = 42.89 %; an estimate of the total population= 57.613092; CI= 12±1.12 plants per hectare), so the allocation of 54 plots of 36 m^2 was sampled more than representative for this work, it can be concluded that the sampling was sufficient.

The field team listed 97 species belonging to 47 families (Table 1), where Myrtaceae was the most abundant family with 9 species, all of which were trees, followed by Lauraceae and Rubiaceae families with 6 species, Melastomataceae and Poaceae with 5 species each.

Table 1: List of the floristic composition of Families and Species sample in the prospection, Represa Billings-SP Hab=habit, AR=trees, AB=bushes, HE=herbaceous, PA=palm trees, LI=lianas, ABR=arborescent and ABE=scandent tree. SD= dispersion syndrome: Zoo=zoochorous, Anemo=anemoric, Auto=autochoric; Hidro=hydrochoric. SC=No classification. Suce=Successional Stage P=pioneer; NP=non-pioneer.

N	Family	Vernacular	Taxon	Origin	SD	Suce	Hábit
1	Amaranthaceae	carrapicho	*Achyranthes aspera*	Native	Zoo	SC	HE
2	Anacardiaceae	aroeira	*Schinus terebinthifolia*	Native	Zoo	P	AV
3	Annonaceae	Araticum-de-tolo	*Annona* sp.	Native	Zoo	P	AV
4	Annonaceae	envira	*Guatteria australis*	Native	Zoo	NP	AV
5	Apiaceae	erva-doce	*Foeniculum* sp.	Exotic	Ane		HE
6	Areceaceae	Juçara	*Euterpe edulis*	Native	Zoo	NP	PA
7	Areceaceae	Jerivá	*Syagrus romanzoffiana*	Native	Zoo	NP	PA
8	Aspleniaceae	erva-epífita	*Asplenium* sp.	Native	Ane	SC	EP
9	Asteraceae	assa peixe	*Baccharis oreophila*	Native	Ane	P	AB
10	Asteraceae	cambara	*Gochnatia polymorpha*	Native	Ane	P	AV
11	Asteraceae	vassourão	*Piptocarpha axillaris*	Native	Ane	P	AV

12	Asteraceae	vassourão branco	*Piptocarpha sp.*	Native	Ane	P	AV
13	Bignoniaceae	caroba	*Jacaranda puberula*	Native	Ane	NP	AV
14	Bignoniaceae	ipê-cinco-chagas	*Sparattosperma leucanthum*	Native	Ane	P	EP
15	Blechnaceae	Samambaia	*Telmatoblechnum* sp.	Native	Hidro	SC	HE
16	Blechnaceae	erva-terrícola	*Blechnum* sp.	Native	Ane	SC	HE
17	Bromeliaceae	Quesnelia	*Quesnelia quesneliana*	Native	Zoo	SC	HE
18	Bromeliaceae	caraguatá-do-campo	*Bromelia antiacantha*	Native	Zoo	SC	HE
19	Bromeliaceae	Tillandsia	*Tillandsia* sp.	Native	Zoo	SC	EP
20	Bromeliaceae	Bromélia	*Vriesea* sp.	Native	Ane	NP	EP
21	Cannabaceae	Crandiúva	*Trema micrantha*	Native	Zoo	P	AV
22	Celastraceae	Maytenus	*Maytenus* sp.	Native	Zoo	NP	AV
23	Clethraceae	Aleixo	*Clethra scabra Pers.*	Native	Zoo	P	AV
24	Clusiaceae	Clusia	*Clusia criuva*	Native	Zoo	P	AV
25	Cucurbitaceae	Melão-de-São-Caetano	*Cucumis argyi*	Native	Zoo	SC	LI
26	Cyatheaceae	Samambaia açu	*Cyathea cf. corcovadensis*	Native	Hidro	NP	ABR
27	Euphorbiaceae	Tapia	*Alchornea sp.*	Native	Zoo	P	AV
28	Euphorbiaceae	tapiazinho	*Alchornea triplinervia*	Native	Zoo	P	AV
29	Euphorbiaceae	Leiteira vermelha	*Sapium glandulosum*	Native	Zoo	P	AV
30	Euphorbiaceae	Mandioca	*Manihot esculenta*	Native	Zoo	P	AB
31	Fabaceae	Angico Branco	*Pseudopiptadenia* sp.	Native	Auto	NP	AV
32	Fabaceae	jequitiri	*Abrus precatorius*	Native	Zoo	NP	LI
33	Heliconiaceae	heliconia	*Heliconia* sp.	Native	Auto	NP	HE
34	Lauraceae	Canela sem cheiro	*Endlicheria* sp.	Native	Zoo	NP	AV
35	Lauraceae	canela amarela	*Nectandra grandiflora*	Native	Zoo	NP	AV
36	Lauraceae	Canela comida	*Nectandra* sp.	Native	Zoo	NP	AV
37	Lauraceae	canela piper	*Nectandra* sp2.	Native	Zoo	NP	AV
38	Lauraceae	canela fedorenta	*Ocotea aff. nitida*	Native	Zoo	NP	AV
39	Lauraceae	canela de cheiro	*Ocotea odorifera*	Native	Zoo	NP	AV
40	Marantaceae	Maranta	*Ctenanthe* sp.	Native	Auto	SC	HE
41	Melastomataceae	pixirico amarelo	*Miconia cinnamomifolia*	Native	Zoo	P	AV
42	Melastomataceae	miconia	*Miconia cubatanensis*	Native	Zoo	P	AV
43	Melastomataceae	pixirico	*Miconia fasciculata*	Native	Zoo	NP	AV
44	Melastomataceae	pixirico rajado	*Miconia* sp.	Native	Zoo	P	AV
45	Melastomataceae	manaca da serra	*Tibouchina mutabilis*	Native	Auto	P	AV
46	Meliaceae	canjerana	*Cabralea canjerana*	Native	Zoo	NP	AV
47	Meliaceae	carrapeta	*Guarea macrophylla*	Native	Zoo	NP	AV
48	Moraceae	ficus elastica	*ficus elastica*	Exotic	Zoo	SC	AV
49	Myrsinaceae	capororoca grande	*Myrsine aff. balansae*	Native	Zoo	P	AV
50	Myrsinaceae	capororoca	*Myrsine coriacea*	Native	Zoo	P	AV
51	Myrsinaceae	capororoca-vermelha	*Myrsine gardneriana*	Native	Zoo	P	AV
52	Myrsinaceae	capororoca-vermelha	*Myrsine umbellata*	Native	Zoo	P	AV
53	Myrtaceae	Eucalipto	*Eucaliptus* sp	Exotic	Auto	NP	AV
54	Myrtaceae	Goiabeira do mato	*Eugenia cf glazioviana*	Native	Zoo	NP	AV
55	Myrtaceae	Cambuci s/ cheiro	*Eugenia pruniformis*	Native	Zoo	NP	AV
56	Myrtaceae	Pitanga	*Eugenia uniflora*	Native	Zoo	NP	AV
57	Myrtaceae	myrcia	*Myrcia multiflora*	Native	Zoo	NP	AV
58	Myrtaceae	myrcia	*Myrcia* sp.	Native	Zoo	NP	AV
59	Myrtaceae	myrcia murici	*Myrcia* sp2.	Native	Zoo	NP	AV
60	Myrtaceae	Myrcia splendens	*Myrcia splendens*	Native	Zoo	NP	AV
61	Myrtaceae	Araça vermelho	*Psidium cattleianum*	Native	Zoo	NP	AV
62	Nyctaginaceae	joao mole	*Guapira opposita*	Native	Zoo	NP	AV
63	Olacaceae	ameixa-amarela	*Ximenia americana*	Native	Zoo	P	AV
64	Orchidaceae	orquídea-amarela	*Alatiglossum longipes*	Native	Ane	NP	EP
65	Orchidaceae	micro-orquídea	*Capanemia micromera*	Native	Ane	NP	EP
66	Pandanaceae	palmerinha-terrícola	*Freycinetia* sp.	Native	Auto	NP	HE
67	Passifloraceae	maracujá-de-paca	*Passiflora* sp.	Native	Zoo	NP	Li
68	Peraceae	Pera	*Pera glabrata*	Native	Zoo	SC	AV
69	Pinaceae	Pinus	*Pinus* sp.	Exotic	Ane	SC	AV
70	Piperaceae	piper	*Piper aduncum*	Native	Zoo	P	AB
71	Poaceae	colonião	*Panicum maximum*	Exotic	Ane	SC	HE
72	Poaceae	capim	*Eragrostis* sp.	Exotic	Ane	SC	HE
73	Poaceae	braquiária	*Brachiaria decumbens*	Exotic	Ane	SC	HE
74	Poaceae	grama-batatais	*Paspalum notatum*	Native	Ane	P	HE
75	Poaceae	bambu	*Bambusa vulgaris*	Exotic	Ane	P	ABE
76	Polygonaceae	cocoloba	*Coccoloba glaziovii*	Native	Zoo	NP	AV
77	Polypodiaceae	cipó cabeludo	*Polypodium* sp.	Native	Hidro	SC	LI
78	Rosacae	Morango-silvestre	*Fragaria vesca*	Exotic	Zoo	SC	HE

79	Rubiaceae	café-preto	*Faramea tetragona*	Native	Zoo	NP	AV
80	Rubiaceae	goiaba-do-mato	*Psidium* sp.	Native	Zoo	NP	AV
81	Rubiaceae	Café-taturana	*Psychotria* sp.	Native	Zoo	NP	AV
82	Rubiaceae	roxinho	*Psychotria suterella*	Native	Zoo	NP	AV
83	Rubiaceae	Café liso	*Psychotria vellosiana*	Native	Zoo	NP	AV
84	Rubiaceae	cafézinho-do-mato	*Bathysa gymnocarpa*	Native	Zoo	NP	AV
85	Rutaceae	falsa-aroeira	*Zanthoxylum fagara*	Native	Zoo	NP	AV
86	Rutaceae	mamica-de-porca	*Zanthoxylum rhoifolium*	Native	Zoo	NP	AV
87	Salicaceae	Pau-lagarto	*Casearia sylvestris*	Native	Zoo	P	AV
88	Sapindaceae	Camboata	*Cupania oblongifolia*	Native	Zoo	NP	AV
89	Sapindaceae	Miguel-pintado	*Matayba intermedia*	Native	Zoo	NP	AV
90	Sapindaceae	Cheiro-de-barata	*Toulicia laevigata*	Native	Ane	NP	AV
91	Sapindaceae	Correiro	*Diatenopteryx* sp.	Native	Ane	P	AV
92	Sapotaceae	abiu-do-mato	*Pouteria* sp.	Native	Zoo	P	AV
93	Solanaceae	arrebenta-cavalo	*Solanum palinacanthum*	Native	Zoo	SC	HE
94	Solanaceae	Tomate-do-mato	*Solanum* sp.	Native	Zoo	SC	HE
95	Styracaceae	Benjoeiro	*Styrax lancifolius*	Native	Zoo	NP	AV
96	Urticaceae	Embaúba vermelha	*Cecropia glaziovii*	Native	Zoo	P	AV
97	Verbenaceae	Camará	*Lantana camara*	Native	Zoo	P	HE

Of the total number of species mapped in the area of the project 63 are trees, 17 are herbaceous, 6 are epiphytic, 4 are lianas, 3 are shrubs, 2 are palm trees, one is arborescent and one scandent.

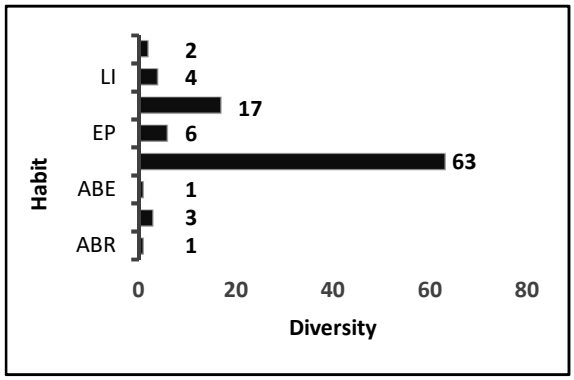

Figure 2: Habit of species mapped by Raunkiaer's Classification of Life Forms. Hab=habit: AR= trees, AB= bushes, HE= herbaceous, PA= palm tree, LI= lianas; ABR= arborescent and ABE=scadent trees. Source: by the author himself.

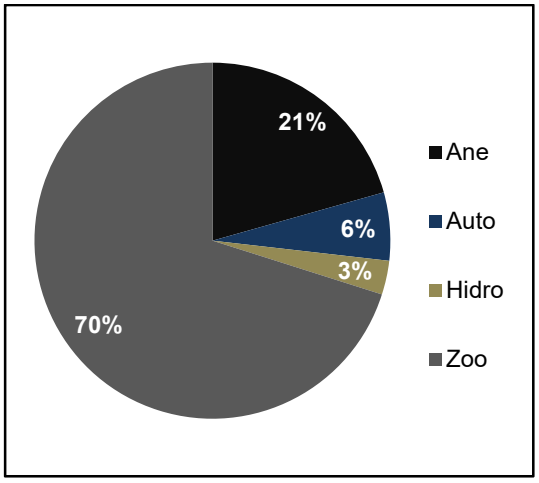

Figure 3: The dispersive syndrome of the forest ecosystem. Source: by the author himself.

From the 97 species mapped, 70% present zoochoric dispersive syndrome, 21 % anemochoric, 6% autochoric, and 3% hydrochoric. As for the Atlantic Forest These are paralel data from Silva, 2016 & Silva, 2013 (Figure 2). Thus, demonstrating a strong association that the sampled ecosystem has the fauna, particularly the birds, and bats, two groups with the highest dispersive potential among the forestry species. The families Myrtaceae, Fabaceae, Rubiaceae and Sapotaceae, are examples of families that have strong relation with the animals from Atlantic Forest biome (SILVA, 2017).

Of the 97 species, 42% are classified as non pioneer, 31% are pioneers and 27% do not have successional classification (Figure 4), demonstrating is an area that has already been decharacterized in the past, now the fragment is in the process of ecological succession , with in different successional stages, as seen in Figure 4.

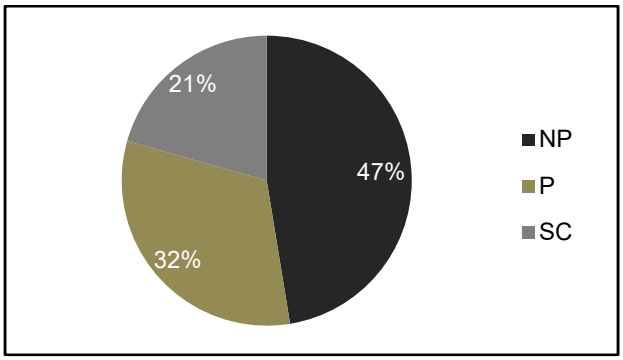

Figure 4: Successional Stage of the species mapped. Suce=Successional Stage P= pioneer; NP= non-pioneer and SC= no classification. Source: by the author himself.

The species *Nectandra grandiflora*, *Ocotea aff. nitida*, *Ocotea odorifera*, are Lauraceae associated with well-preserved forests (KROPF, 2006), and *Euterpe edulis* is a perennial, of shadow, mesophilic or slightly hydrophilic species (LORENZI, 2014). Among the pteridophytes, is the *Cyathea cf. corcovadensis*, which visually constitutes one of the major floristic components of the forest formations of Billings reservoir. The epiphytes *Capanemia micromera* and *Alatiglossum longipes* are indicative of ombrophilous environments with high humidity, zones characteristic of climactic forests (BUZATTO et al., 2010). The species*: Myrsine aff. balansae*, *Myersine gardneriana*, *Myrsine coriacea* and *Myrsine umbellate*, are considered habitat generalists by MARQUES et al. (2003), but are still widely found in surveys made for flooded forests of the Atlantic Forest and are widely distributed in the flooded areas sampled in this study, well as *Pera glabrata*, which is also generalist but widely found in surveys made for flooded forests.

One of the most striking elements of the landscape for the arboreal stratum was the abundance of the species of the genus Miconia and the species *Tibouchina mutabilis*, these taxa of the family Melastomataceae are pioneer species and characteristic of the wet slopes of the Serra do Mar. They tolerate very sunny locations and are more frequently found in the secondary vegetation of the Atlantic forest of the ABC region of São Paulo.

Most of the survey species can still be described as of ethnobotanical importance, both for medicinal and ritualistic use of traditional communities, stand out the species for medical use, *Cecropia glaziovii*, *Passiflora sp.* and *Schinus terebinthifolia*, or for human consumption such as Myrtaceae of the genus Eugenia and Psidium and for Sapotaceae, *Pouteria sp.*, corroborating with the floristic surveys in the Atlantic Forest for ethnobotanical purposes (JESUS, 1997).

For areas of advanced regeneration stage, were found important seedling banks and seeds of the species: *Eugenia cf glazioviana*, *Eugenia pruniformis*, *Eugenia uniflora*, *Euterpe edulis*, *Quesnelia sp.*, *Bromelia antiacantha*, *Tillandsia sp.*, *Vriesea sp.*, *Alatiglossum longipes* e *Capanemia micromera*, due to its relation with the fauna in the establishment of a homeostasis.

The estimates of botanical diversity were similar to other botanical inventory studies in the Atlantic Forest, SILVA et al. (2012) found a diversity of 90 species belonging to 45 families in Mata Santa Genoveva in Presidente Prudente-SP and TAVARES et al. (2013) in one a survey synthesized in Ilha Grande-RJ, also raised the families Myrtaceae, Fabaceae and Rubiaceae as the most representative of the study.

The heights of the trees measured in the inventory were distributed in three (3) classes with amplitude of stratum: lower, middle and upper. Distributed in accordance with Resolution Nº 01/1994 of the Environment National Council (CONAMA), in which the lower strata concentrated trees with up to 5.2 m, the middle stratum of trees that had the height exceeding 5.2 m until the height of 14.5 m and the upper stratum of trees with height greater than 14.5 m. According to Martins, 1991, estimates of the heights of individuals shrubs and trees can provide important information for both the interpretation of vertical structure of the forest as an aid in understanding the dynamics of populations that compose it. According to the analysis of estimated heights of 553 trees (Figure 5), 202 are in the lower strata (<5.2 m), 393 are in the middle stratum (>5.2 and <14.5 m) and 27 are located on the upper stratum (> 14.5 m), indicating an environment of regeneration and with recruitment of new individuals in each stratum of the forest ecosystem.

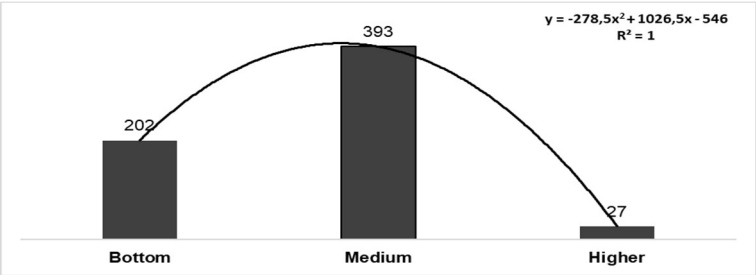

Figure 5: The vertical structure of the forest ecosystem. Source: by the author himself.

From the diametric structure drafted, it was found that the community forestry (Figure 6) showed a tendency to a J-inverted, that is, the higher number of individuals found in the smallest diameter classes, which is a typical behavior of multianeforests (SILVA et al., 2017).

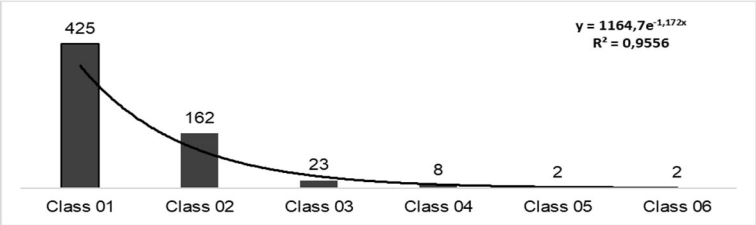

Figure 6: Distribution of frequency per class of Dbh of trees measured.
Source: by the author himself.

The population parameters of mature forest (Table 3), in turn, are in accordance with the submitted in Resolution Nº 01/1994 of the Environment National Council (CONAMA), for forests in the initial stages and medium.

Table 2: Mean values (X) of the variables measured by plot and successional stage of each plot analyzed. Legend: G (m2) - basal area; DAP (cm) diameter of breast height; R.C (m) -radius of cup.

Parcels	G(m^2)	DAP(cm)	stature(m)	R.C (m)	Phase
1	0.006094	8.57	5.56	2.13	Page
3	0.007514	9	6.74	1.35	Page
4	0.015629	11.33	6.4	1.75	Average
5	0.013122	11.46	3.5	0.83	Average
6	0.014691	12.46	7.91	1.75	Average
7	0.0057	8.07	5.5	1.09	Page
8	0.007127	8.84	4.89	1.07	Page
9	0.048863	19.91	9.5	2.41	Average

10	0.025425	17.19	10	2.33	Average
11	0.003673	6.57	4.3	0.83	Page
12	0.005511	8.11	4.5	1.65	Page
13	0.009618	10.4	8.16	2.41	Average
14	0.02677	18.46	8.5	2.6	Average
15	0.006019	8.28	6.28	1.46	Page
16	0.005109	7.76	5.38	1.66	Page
17	0.003288	6.37	4.69	1.64	Page
18	0.003858	6.71	9.15	2.02	Page
19	0.038141	21.64	10.5	2.25	Advanced
20	0.006118	8.09	5.87	1.97	Page
21	0.019908	15.6	9.5	3.33	Average
22	0.041097	17.26	11.58	2.44	Average
23	0.008535	9.55	6.4	1.84	Page
24	0.02981	18.67	10	2.84	Average
25	0.00473	7.38	5.17	1.32	Page
26	0.004635	7.48	10	1.25	Page
27	0.004652	7.4	6.92	1.8	Page
28	0.018239	8.7	2.4	0	Page
29	0.008387	9.99	7.43	1.58	Page
30	0.014019	12.73	6.35	2.37	Average
32	0.012758	11.94	11.06	2.75	Average
33	0.004584	7.63	6.5	1.8	Page
34	0.006828	8.91	4	0.76	Page
36	0.055993	23.44	9.16	4.5	Advanced
37	0.022707	12.89	7.75	1.54	Average
38	0.010021	10.42	9.75	2.13	Average
40	0.007009	9	4.5	0.94	Page
41	0.01204	8.75	7.25	1.5	Page
42	0.031143	15.69	8.79	2.53	Average
43	0.000897	9.44	5.87	2.26	Page
44	0.007993	8.36	6.84	2.25	Page
45	0.008666	9.16	6.89	1.99	Page
46	0.003858	6.74	5.81	1.3	Page
47	0.00391	6.96	6.38	1.67	Page
48	0.006005	8.3	5.32	1.21	Page
49	0.003716	6.61	3.78	0.86	Page
50	0.053702	20.9	8.4	2.3	Advanced
51	0.006878	9.03	6.08	1	Page
60	0.007095	9.23	4.92	1.35	Page
61	0.009028	9.07	7.35	1.9	Page
71	0.009691	10.66	7.5	1.67	Average
72	0.000322	10.9	6.78	1.7	Average
77	0.005231	7.98	3.67	1.3	Page

Only the species *Euterpe edulis* is vulnerable according to the red book of the Brazilian flora, the species has been suffering from its illegal extraction in the areas of Atlantic Forest, where it is endemic, is a slow-growing palm that is unable to regrow (MARTINELLI et al., 2013).

CONCLUSIONS

The results presented are important contributions in the knowledge of the plant species richness of the Billings Reservoir sub-basin, providing secondary data for subsequent environmental studies aiming at this same region.

The Dense Ombrophylous Forest fragment studied, despite suffering the consequences of the anthropomorphism of the landscape, presents at present a high number of species and a good diversity when compared to other forest fragments of the Atlantic Forest Biome.

The Atlantic Forest is a biodiversity hotspot, forest restoration actions must be carried out in their ecosystems, because it is a priority biome for conservation and environmental preservation. The recovery of their areas is essential for the quality of life of the communities, considering the amount of environmental services that the ecologically balanced environment can offer. Environmental education actions must be taken by the public authority with the purpose of alleviating the current dumping of waste in the fragments of the Billings reservoir, that is, with the purpose of promoting actions for the conservation of biodiversity.

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