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ECOLOGICAL ASPECTS RELATED TO LIGNEOUS VEGETATION IN THE PERMANENT PRESERVATION AREAS OF MINEIROS, GOIÁS, IN LIGHT OF THE NEW NATIVE VEGETATION PROTECTION POLICY - LAW 12.651/2012[1]

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ABSTRACT – Permanent preservation areas (PPAs) adjacent to drainage channels may include forests, savannahs, or grassland Under a former environmental legislation ("Forest Code"), it was required to maintain a strip of native vegetation (at least 30 m wide) at the margin of any drainage channel, to support environmental functions. Under the current native vegetation protection policy, if a riparian margin was degraded prior to 2008, the landholder is required to regenerate a strip of only 5-20 m, in some cases. The present study evaluated and compared the ligneous vegetation structure in 10 preserved PPAs (following the requirements of the old law) and 10 degraded PPAs (conforming to the current environmental legislation), in Mineiros municipality, southwest Goiás. Sixty plots measuring 15 m × 30 m were delineated, and data for all ligneous individuals with a diameter at breast height (DBH) $\geq$ 5 cm were recorded. A total of 2,662 individuals were documented, distributed among 208 species. Of the total, 1,573 individuals belonging to 167 species were from the preserved PPAs, and 1,089 individuals across 142 species were from the degraded PPAs. According to these results, the preserved PPAs were richer in species composition than in the degraded PPAs (245.5 ± 34.36 and 213.3 ± 34.1, respectively), in addition to being more abundant in terms of individuals. The importance value index (IVI) was well distributed among the species. All the degraded PPAs presented signs of erosion. It was concluded that the reduced width of the PPAs (5-20 m) under the current native vegetation protection policy would result in a loss of the environmental functions sought by the legislation..

Keywords: Phytosociology; Forest Code; Environmental losses.

ASPECTOS ECOLÓGICOS DA VEGETAÇÃO LENHOSA DAS ÁREAS DE PRESERVAÇÃO PERMANENTE, NO MUNICÍPIO DE MINEIROS, GOIÁS, À LUZ DA NOVA POLÍTICA DE PROTEÇÃO DA VEGETAÇÃO NATIVA- A LEI 12.651/2012

RESUMO – As Áreas de Preservação Permanente (APPs) de canais de drenagem podem se apresentar através das formações florestais, savânicas e campestres, sendo que a faixa legal de vegetação para manter suas funções ambientais era de, no mínimo 30 metros marginas (Antigo Código Florestal). Atualmente, a política de proteção da vegetação nativa prevê entre cinco a 20 metros marginais para a recomposição de determinadas áreas degradadas até 2008. Este estudo avaliou e comparou a estrutura da vegetação lenhosa de 10 APPs preservadas (considerando-se o antigo Código) e 10 APPs degradadas (exceções da atual legislação ambiental), no município de Mineiros, sudoeste Goiano. Foram definidas 60 parcelas com dimensão de 15x30 m e todos os indivíduos lenhosos com DAP $\geq$ 5 cm foram amostrados. Foram registrados 2.662 indivíduos distribuídos em 208 espécies, dos quais 1.573 indivíduos pertencentes a 167 espécies são das APPs preservadas e, 1.089 indivíduos distribuídos em 142 espécies são das APPs degradadas. A partir dos resultados, observou-se uma

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maior riqueza estimada de espécies para as APPs preservadas do que para as degradadas (245,5 ± 34,36 e 213,3 ± 34,1, respectivamente), assim como maior abundância de indivíduos. O IVI foi bem distribuído entre as espécies. Todas as APPs degradadas apresentaram processos erosivos. Conclui-se que a redução da metragem da APPs entre cinco e vinte metros marginais previstas na atual política de proteção da vegetação nativa, acarretará em perda das funções ambientais prevista na legislação.

Palavras-chave: Fitossociologia; Código Florestal; Perdas Ambientais.

1. INTRODUCTION

Currently, there is a consensus in the scientific community about a biodiversity crisis unfolding due to the conflict between conservation and socioeconomic development involving intensive human use of land with farming potential (MYERS, 1996). With respect to this, the Cerrado deserves to be highlighted, as it is considered a biodiversity hotspot owing to its great diversity of endemic species as well as a high degree of human interference (MYERS et al., 2000). Located primarily in the central part of Brazil, the Cerrado originally covered an area of 25 million km^2 (SILVA; BATES, 2002). It was first colonized by humans at the beginning of the 1930s, but during 1960–1970, it served as a targeted frontier for agricultural expansion, owing to credit concessions and technical modernization that expanded the range of productive areas (TEIXEIRA; HESPANHOL, 2006).

Because of this progression of human occupation, the biodiversity conservation efforts in the Cerrado have been observed (DINIZ-FILHO et al., 2006; RANGEL et al., 2006). Increased habitat fragmentation has led to frightening estimates of biodiversity loss in Cerrado, which are not even fully mapped yet (MACHADO et al., 2004). Less than 4% of the Cerrado's area is protected as federal conservation areas (CABRAL; BRITO, 2013). Moreover, Law 12.651 of December 2012, which replaced the old Forest Code, might further facilitate the expansion of agricultural frontiers into this biome, to the detriment of biodiversity (MARTINELLI et al., 2010).

It is estimated that over the long term, such an environmental policy could significantly harm the environment, as the native vegetation areas would be converted into farmland. Under Law 12.651/2012, the rural properties that have between one and four "fiscal modules," and were deforested prior to 2008, would satisfy the permanent preservation area (PPA) requirement if they have a 5–15 m wide strip of native forest adjacent to the watercourses. Thus, legally protected areas along the margins of drainage channels are considerably reduced in size. Klink and Machado (2005) have emphasized the importance of conserving Cerrado; however, in the light of these recent changes, the task has become more urgent.

Currently, 7.000 species of vascular plants are found in the Cerrado (MENDONÇA et al., 1998). However, despite the high number of species in this biome, forest and phytosociological studies have started only recently, especially in the southeast region of the Goias state (CABACINHA; CASTRO, 2009; CARNEIRO et al., 2011) . Considering the recent changes to the Brazilian Forest Code, studies that document the ecological parameters of plant communities for comparing the scenario under the old forest code (with the minimum requirement of a 30-m strip along the margin) might be useful for exploring the possibilities of conservation in the biome under the current policy (with the minimum requirement of 5–20 m strip for certain areas that are already altered).

PPAs adjacent to water resources present diverse phytophysiognomies. Ribeiro and Walter (2008) describe gallery forests, riparian forests, and wetlands as phytophysiognomies associated with drainage channels. It is worth highlighting the fact that when natural habitats are close to human influence, there might be many physical, biotic, and ecological alterations that adversely affect the biota (MURCIA, 1995). However, there is a scarcity of studies that show the alterations to ligneous vegetation in PPAs, especially ones that are less than 30 m wide, which are described here as degraded.

Cabacinha and Castro (2009) and Cabacinha et al. (2010) carried out spatial and ecological studies of forest vegetation around drainage channels in mid-2007 and 2008 near the sources of the Araguaia River, in the city of Mineiros, Goiás. This was before the new law (12.651/2012) came into existence. The authors observed that a great part of the vegetation was in a good state from a conservation viewpoint, and some fragmented environments could still be restored.

According to the new legislation (Law 12.651/2012), PPAs can be defined as follows: "*protected area covered or not by native vegetation, with the environmental function of preserving water resources, landscape, geological stability, and biodiversity, to facilitate the genetic flux of flora and fauna, protect the soil, and ensure the well-being of human populations*." In this context, the present study had the objective of evaluating whether there are ecological differences between the drainage channel PPAs with different degrees of preservation, in Mineiros, Goiás. Specifically, this study investigated whether the abundance, diversity, and species richness in ligneous vegetation differed between PPAs in which a 30 m margin of native vegetation was in place (in a good state of preservation) and PPAs where human interference was evident within the 30 m vegetation margin (also in a bad state of preservation).

2. MATERIALS AND METHODS

The study region is in the city of Mineiros, located in southwest Goiás, Brazil. The region is ecologically important, as it is home to the sources of the Araguaia and Paranaíba rivers, the most important hydrographic basins in the region. The municipality has an approximate area of 900,000 ha and borders the municipalities of Jataí, Santa Rita do Araguaia, Serranópolis, Portelândia, Chapadão do Céu, and Caiapônia in Goiás, the municipalities of Alto Taquari, Alto Araguaia, and Ponte Branca of the state of Mato Grosso, and the municipality of Costa Rica in the state of Mato Grosso do Sul (IBGE, 2010). The Mineiros municipality has a population of approximately 53,000 people (IBGE, 2010). The natural habitats in this region have been transformed for human use, primarily farming (CABACINHA and CASTRO, 2009; CABACINHA et al*.,* 2010; PRADO et al., 2012).

The climate in the study region is rainy tropical, type Aw (hot and humid with a wet summer and dry winter), with temperatures between 18–32 °C and an average annual rainfall of 1700 mm (CARNEIRO et al., 2009). The topography of the region varies from flat to slightly hilly, with extensive areas of Latosol (40.27% of the municipality) and Neosol soils (31.91%) (RADAMBRASIL, 1982), allowing easy use of farm machinery.

The sampling of ligneous vegetation took place in July 2013, and during this period, phytosociological surveys were performed in the PPAs following the random methodology proposed by Felfili et al. (2011). The sampling design took in 20 PPAs in the study area, 10 in a good state of preservation (having 30 m of native vegetation at the margins of streams that are up to 10 m wide) and 10 degraded (having human interference within 10–25 m of streams that are up to 10 m wide). This analysis allows a comparison of the plant community structure within the PPAs that are in accord with the old and the current legislation regarding the protection of native vegetation (Law 4.771/1965 and Law 12.651/2012, respectively).

The current law permits the continuation of human activities within the 30-m margin of watercourses, such as agrosilvopastoral activities, ecotourism, and rural tourism, if already converted for that use by July 22, 2008, and the property has between one and four fiscal modules (or more - see point 4 below). Such areas must restore a strip along the watercourse to the following widths to make up the PPA: 1) if the property is one fiscal module, only 5 m need to be restored, 2) if the property has greater than 1 (one) module and less than 2 (two) modules, 8 m need to be restored, 3) if the property has more than 2 (two) modules and less than 4 (four) modules, 15 m need to be restored, 4) if the property has more than 4 (four) modules, a minimum of 20 m and a maximum of 100 m need to be restored (Law 12.651/2012).

Given that the cited exceptions in relation to PPAs deforested or converted to human use up to 2008 might continue that use, this study considers PPAs as degraded if they currently maintain some agrosilvopastoral, ecotourism, or rural tourism activity within a 30-m margin of a drainage channel that is up to 10 m wide, independent of the year in which the occupation/deforestation first occurred and independent of the area of the property in terms of fiscal modules. PPAs with a maintained 30 m wide margin were considered as preserved. By using this standard, it was possible to test the hypothesis that there may be differences between the PPAs with a preserved 30 m margin and those with some other use of the soil within this margin. For the survey of arboreal vegetation, the method of plots proposed by Felfili et al. (2011) was used - delineating three plots in each preserved PPA and another three in each degraded PPA. Overall, 60 plots were used, 30 in preserved PPAs and 30 in degraded PPAs. The PPAs were chosen randomly within the municipality of Mineiros. Each plot measured 30 m × 15 m, totaling 2.7 ha of sample area.

In each plot, all individual trees with a diameter at breast height (DBH) greater than or equal to 5 cm were assessed in accordance with the recommendations of Scolforo (1998). Characterization of each plot was done, recording the location of the first sample plot in the PPA, the approximate width of the vegetation strip, the matrix where the PPA is situated, as well as the presence or absence of erosive processes (Table 1), given that the other two plots within each PPA were random in relation to the first.

In addition, a comparative study was carried out between the preserved PPAs and those having some type of human interference through phytosociological data, as recommended by Mueller-Dombois and Ellenberg (1974). The parameters considered were absolute density, absolute frequency, absolute dominance expressed in basal area, relative density, relative frequency, relative dominance, and importance value. Also calculated were the Shannon biodiversity index (H2) and the Pielou evenness index (J2), in accordance with Brower and Zar (1984). To verify if there was a difference in the total abundance of individuals and the Shannon diversity index between the two categories of PPA, Student's *t*-test was used with a 5% significance level, following Zar (1996).

To estimate the species richness in the sampled PPAs, the methodology proposed by Coddington et al. (1991) and Colwell and Coddington (1994) was used, in which the non-parametric first order *Jackknife* estimator was considered, using 100 randomizations. This estimate extrapolates the observed richness through the frequency of rare species ("*unique*") present in the samples, and produces an accurate estimate of the richness of the community (KREBS, 1999). In addition, such a procedure provides a confidence interval, allowing statistical

Table 1 – Characterization of the 20 permanent preservation areas (PPAs) investigated (10 preserved and 10 degraded) in the Mineiros municipality, Goiás, Brazil. (DN: degraded north; DS: degraded south; PN: preserved north; PS: preserved south; MG: mata de galeria (gallery forest); MC: mata ciliar (riparian forest); MGI: mata de galeria inundável (flooded gallery forest); C: cerradão (humid cerrado).

***Tabela 1** – Caracterização das 20 APPs investigadas (10 preservadas e 10 degradadas) no município de Mineiros, Estado de Goiás, Brasil. (DN: degradada norte; DS: degradada sul; PN: preservada norte; PS: preservada sul; MG: mata de galeria; MC: mata ciliar; MGI: mata de galeria inundável; C: cerradão).*

Plot	Zone	Latitude	Longitude	Phytophysiognomy	Matrix	Drainage channel	PPA	Erosion presence
DN1.1	22K	321245	8114675	MG	Pasture	< 10 m	10 - 15 m	Yes
DN2.1	22K	311392	8117405	MG	Pasture	< 10 m	5 - 15 m	Yes
DN3.1	22K	308011	8103451	MG	Pasture	< 10 m	5 - 15 m	Yes
DN4.1	22K	312680	8095522	MG	Pasture; eucalyptus	< 10 m	5 - 10 m	Yes
DN5.1	22K	327267	8117341	MG	Pasture	< 10 m	10 - 15 m	Yes
DS1.1	22K	306899	8050093	MG	Pasture	< 10 m	10 - 15 m	Yes
DS2.1	22K	299900	8052852	MG	Pasture	< 10 m	10 - 15 m	Yes
DS3.1	22K	291493	8079524	MG	Dirt road; Pasture	< 10 m	5 - 15 m	Yes
DS4.1	22K	290225	8080206	MG	Pasture	< 10 m	8 - 15 m	Yes
DS5.1	22K	277981	8078787	MC	Dirt road; Pasture	< 10 m	5 - 15 m	Yes
PN1.1	22K	304926	8116834	MC	Pasture	25 m	> 100 m	No
PN2.1	22K	310171	8118573	MGI	Pasture	< 10 m	> 30 m	No
PN3.1	22K	310389	8096895	MG	Pasture	< 10 m	50 - 70 m	No
PN4.1	22K	316998	8095542	MC	Pasture	15– 20 m	> 100 m	No
PN5.1	22K	304169	8144779	MC	Pasture	50 m	> 100 m	No
PS1.1	22K	299981	8051392	MG	Sugar cane plantation	< 10 m	> 100 m	No
PS2.1	22K	297281	8048963	MG	Pasture	< 10 m	> 50 m	No
PS3.1	22K	279000	8025631	MGI	Corn plantation	< 10 m	> 200 m	No
PS4.1	22K	285856	8076705	MGI	Pasture	< 10 m	> 100 m	No
PS5.1	22K	306014	8050581	MGI + C	Pasture; eucalyptus	< 10 m	> 100 m	No

comparisons between two or more sample locations. Finally, the estimated species richness was tested for the preserved and degraded PPAs, and the difference was calculated using the confidence intervals.

3. RESULTS

Data for 2,662 ligneous individuals belonging to 208 plant species were recorded. In the preserved PPAs, 1,573 individuals from 167 species were documented, while in the degraded PPAs, 1,089 individuals from 142 species were documented. A total of 150 dead individuals were also surveyed, 77 of which were in preserved PPAs (4.66% of the total) and 73 were in degraded PPAs (6.28% of the total). According to the *Jackknife* 1 estimator, species richness for the preserved and degraded PPAs was 245.5 ± 34.36 and 213.3 ± 34.1, respectively (Figure 1).

Twenty species from the preserved and degraded environments, which had the highest values of importance, are listed in Table 02. In the preserved PPAs, the 10 species with the highest values of importance were *Protium spruceanum* (19.33), *Tapirira guianensis* (15.88), *Attalea phalerata* (15.69), *Mauritia flexuosa* (7.71), *Xylopia emarginata* (7.63), *Hieronyma alchorneoides* (6.94), *Copaifera langsdorffii* (6.26), *Ilex affinis* (6.62), *Hirtella gracilipes* (6.03), and *Ormosia paraensis* (5.23); these make up 32.29% of the importance value of these PPAs. On the other hand, in the degraded PPAs, the 10 species with the greatest values of importance constituted 33.34% of the total value, namely, *Tapirira guianensis* (20.40), *Hirtella gracilipes* (16.64), *Tachigali vulgaris* (16.56), *Copaifera langsdorffii* (10.59), *Simarouba amara* (8.18), *Calophyllum brasiliensis* (7.13), *Protium spruceanum* (6.89), *Coussarea hydrangeifolia* (6.74), *Licania* sp. (6.49), and *Vochysia pyramidalis* (6.38) (Table 02).

The preserved PPAs had a Shannon diversity index and Pielou evenness index equal to 4.29 nats. ind^{-1} and 0.839, respectively. On the other hand, the Shannon diversity index and Pielou evenness index in the degraded PPAs were 4.24 nats. ind^{-1} and 0.857, respectively. It was observed that the diversity index ($t = 0.093$; df = 58; $p = 0.926$) did not differ between the preserved and the degraded PPAs. The average number of individuals encountered in the preserved PPAs was greater than that recorded in the degraded PPAs ($t = -3.06$; df = 58; $p < 0.001$) (Figure 02), as in the preserved PPAs, there were an average of 50 individuals more than in the degraded PPAs.

4. DISCUSSION

In the present study, both the number of individuals and the estimated species richness were greater in the PPAs with a 30 m margin of vegetation strip than in

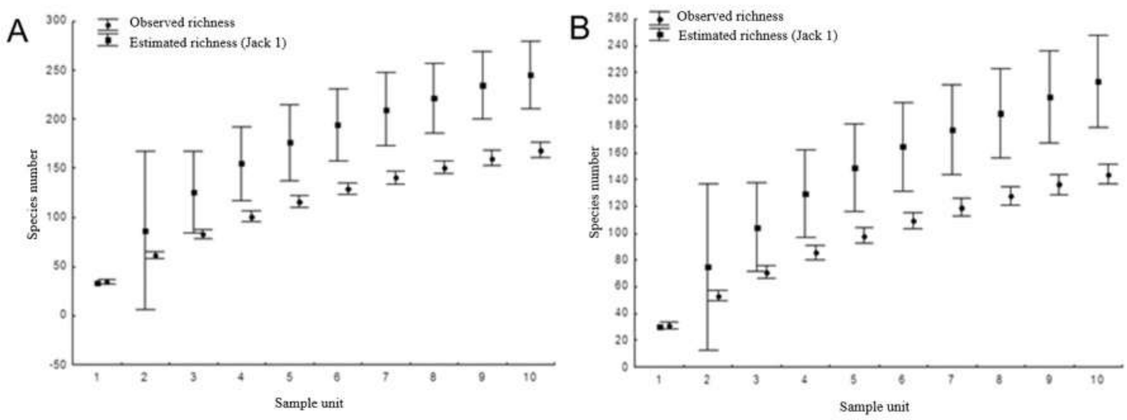

Figure 1 – A) Species accumulation curve (observed and estimated richness—*Jackknife* 1) of ligneous plants in the preserved permanent preservation areas (PPAs), Mineiros municipality, Goiás, Brazil. B) Species accumulation curve (observed and estimated richness—*Jackknife* 1) of ligneous plants in the degraded PPAs, Mineiros municipality, Goiás, Brazil.

Figura 1 – *A) Curva de acumulação de espécies (riqueza observada e estimada –* ***Jackknife*** *1) de plantas lenhosas nas APPs preservadas, Município de Mineiros, estado de Goiás, Brasil. B) Curva de acumulação de espécies (riqueza observada e estimada –* ***Jackknife*** *1) de plantas lenhosas nas APPs degradadas, Município de Mineiros, estado de Goiás, Brasil.*

Table 2 – Phytosociological values of 20 species with the greatest importance values in the preserved and the degraded permanent preservation areas (PPAs), in decreasing order of IVI (N.I.: number of individuals; N.P.: number of plots; DR: relative density (%); DoR: dominância relative (relative dominance) (%); and IVI: importance value index).

Tabela 2 – *Valores fitossociológicos das 20 espécies que apresentaram maior valor de importância nas APPs preservadas em ordem decrescente de IVI e nas APPs degradadas (N.I.: número de indivíduos; N.P.: número de parcelas; DR: densidade relativa (%); DoR: dominância relativa (%) e IVI: índice de valor de importância).*

Preserved permanent preservation (PPAs)							
Family	Species	N. I.	N. P.	DR	DoR	FR	IVI
Burseraceae	*Protium sprunceanum*(Bent.) Engl.	154	18	9.790	6.286	3.255	19.332
Anacardiaceae	*TapiriraguianensisAubl.*	119	18	7.565	5.062	3.255	15.882
Arecaceae	*Attalea phalerata* Mart. ExSpreng.	60	3	3.814	10.338	0.542	14.695
Arecaceae	*Mauritia flexuosa* L. f.	22	5	1.399	5.413	0.904	7.716
Annonaceae	*Xylopia emarginata* Mart.	68	10	4.323	1.501	1.808	7.633
Phyllanthaceae	*Hieronyma alchorneoides* Allemão	20	7	1.271	4.403	1.266	6.940
Fabaceae	*Copaifera langsdorffii* Desf.	20	9	1.271	3.728	1.627	6.626
Aquifoliaceae	*Ilex affinis* Gardner	40	13	2.543	1.351	2.351	6.245
Chrysobalanaceae	*Hirtella gracilipes* (Hook. f.) Prance	47	11	2.988	1.060	1.989	6.037
Fabaceae	*Ormosia paraenses* Ducke	18	3	1.144	4.084	0.542	5.771
Chrysobalanaceae	*Licania gardneri* (Hook. f.) Fritsch	30	6	1.907	2.757	1.085	5.750
Guttiferae	*Calophyllum brasiliensis* Camb.	32	11	2.034	1.437	1.989	5.461
Fabaceae	*Anadenanthera peregrina* (L.) Speg.	33	5	2.098	2.267	0.904	5.269
Arecaceae	*Attalea speciosa* Mart. ex Spreng.	15	2	0.954	3.553	0.362	4.868
Fabaceae	*Tachigali vulgaris* L.G. Silva & H.C. Lima	32	6	2.034	1.400	1.085	4.519
Moraceae	*Pseudolmedia laevigata* Trécul	35	6	2.225	1.157	1.085	4.467
Lauraceae	*Cryptocarya moschata* Nees & Mart.	13	3	0.826	2.890	0.542	4.259
Anacardiaceae	*Myracrodruon urundeuva* Allemao	17	5	1.081	2.032	0.904	4.017
Rubiaceae	*Coussarea hydrangeifolia* (Benth.) Müll.Arg.	37	6	2.352	0.529	1.085	3.967
Sapotaceae	*Pouteria guianenses* Aubl.	12	5	0.763	2.262	0.904	3.929
Degraded permanente preservation (PPAs)							
Family	Species	N. I.	N. P.	DR	DoR	FR	IVI
Anacardiaceae	*Tapirira guianensis* Aubl.	74	15	6.795	10.403	3.205	20.403
Chrysobalanaceae	*Hirtella gracilipes* (Hook. f.) Prance	66	17	6.061	6.949	3.632	16.642
Fabaceae	*Tachigali vulgaris* L.G. Silva & H.C. Lima	75	17	6.887	6.040	3.632	16.560
Fabaceae	*Copaifera langsdorffii* Desf.	27	14	2.479	5.120	2.991	10.591
Simaroubaceae	*Simarouba amara* Aubl.	23	7	2.112	4.573	1.496	8.180
Guttiferae	*Calophyllum brasiliensis* Camb.	23	11	2.112	2.670	2.350	7.133
Burseraceae	*Protium sprunceanum* (Bent.) Engl.	30	12	2.755	1.577	2.564	6.896
Rubiaceae	*Coussarea hydrangeifolia* (Benth.) Müll.Arg.	40	10	3.673	0.939	2.137	6.749
Chrysobalanaceae	*Licania sp.*	14	4	1.286	4.354	0.855	6.494
Vochysiaceae	*Vochysia pyramidalis* Mart.	13	7	1.194	3.691	1.496	6.381
Anacardiaceae	*Myracrodruon urundeuva* Allemao	25	5	2.296	2.241	1.068	5.605
Araliaceae	*Dendropanax cuneatus* (DC.) Decne. & Planch.	24	9	2.204	1.224	1.923	5.351
Polygonaceae	*Coccoloba mollis* Casar.	28	10	2.571	0.625	2.137	5.333
Lauraceae	*Nectandra lanceolata* Nees	30	3	2.755	1.663	0.641	5.059
Fabaceae	*Hymenaea courbaril* L.	4	4	0.367	3.836	0.855	5.058
Chrysobalanaceae	*Licania gardneri* (Hook. f.) Fritsch	17	8	1.561	1.721	1.709	4.991
Anacardiaceae	*Tapirira obtusa* (Benth.) J.D. Mitch.	13	3	1.194	2.894	0.641	4.729
Annonaceae	*Xylopia aromatica* (Lam.) Mart.	19	10	1.745	0.640	2.137	4.521
Icacinaceae	*Emmotum nitens* (Benth.) Miers	17	8	1.561	0.946	1.709	4.216
Primulaceae	*Myrsine guianensis* (Aubl.) Kuntze	17	8	1.561	0.847	1.709	4.117

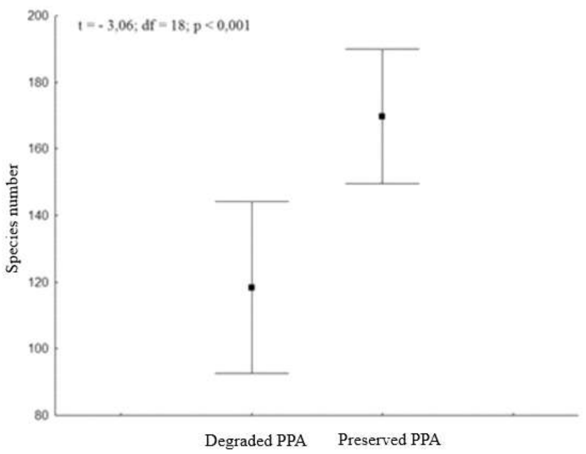

Figure 2 – Result of Student's t-test comparing the abundance of individuals in the PPAs preserved and degraded.
Figura 2– *Resultado do teste t de Student comparando a abundância de indivíduos das APPs preservadas e degradadas.*

the PPAs with a strip width of 5–20 m. Therefore, the results are evidence that the reduction in vegetation cover in PPAs correlates negatively with the ecological aspects of the ligneous vegetation in such environments. According to Law 12.651/2012, PPAs are important areas for species maintenance and consequently, various ecosystem services. However, this law may bring alterations in the structure and functioning of the existing PPAs in Brazil, as demonstrated above.

Apart from the environmental losses related to flora, in all the PPAs that had human intrusion into the 30-m margin, there were erosive processes. According to Galindo et al. (2008), there is a negative relationship between vegetation and erosion, thus, greater the index of vegetation cover, lesser would be the occurrence of erosive processes. In addition, Klink and Machado (2005) highlight the fact that erosion is one of the greatest environmental problems caused by changes in the Cerrado, and is one of the major threats to biodiversity. The presence of erosion in the degraded PPAs of the Mineiros municipality reinforces the importance of protecting these soils and in general, the water resources.

In the literature, there is a great deal of discussion with respect to the recent changes in the Brazilian Forest Code (AB'SÁBER, 2010; BRANCALION; RODRIGUES, 2010; CASATTI, 2010; DEVELEY; PONGILUPPI, 2010; TOLEDO et al., 2010; TUNDISI; MATSUMURA-TUNDISI, 2010), in which a false dichotomy is apparent between the conservation of native vegetation and farming, which according to Martinelli et al. (2010), affects various ecological communities. With respect to the ligneous vegetation in PPAs, there are few studies discussing the possible alterations resulting from the changes in legislation (PINHEIRO et al., 2015). The present study promotes such a discussion, given that the results show differences in the ecological parameters between the preserved and degraded PPAs; the observed and estimated species richness and abundance of individuals is greater in the preserved PPAs.

The efficacy of the old Forest Code in protecting arboreal vegetation in gallery forests in the Federal District was evaluated by Silva Júnior (2001), who concluded that it was inefficient in protecting the diversity of arboreal species in gallery forests. This author showed that the soil humidity is an important factor in defining degrees of clustering of certain species in a gallery forest. Therefore, he found forest communities peculiar to sites with humid, intermediate, and dry soils. Species grouped in the intermediate and dry sites advanced beyond the 30 m margin of the PPA in many cases. In light of this, the data of the Mineiros study support the notion that the new law for native vegetation protection may result in losses of species that are exclusive to areas further from the water course, when using narrower margins based on the fiscal modules of the property.

As discussed above, the estimated species richness (from *Jackknife* 1 estimator) in the preserved and degraded PPAs was greater than the observed species richness. Therefore, only 68.02% and 66.57% of the possible species present in such PPAs were recorded. Silva et al. (2009), while studying the structure of arboreal communities in alluvial, human-influenced forests in São Sebastião da Bela Vista (MG), found that 82.4% of the richness was estimated. In the State Park of Araguaia (*Parque Estadual do Araguaia*) (MT), Barbosa et al. (2011) did a comparative analysis of the structure of ligneous vegetation in two fragments of forests subject to flooding (*impucas*), which were PPAs as well, one preserved and the other one degraded. In keeping with the results of the present study, Barbosa et al. (2011) found differences during the ecological analyses between the preserved and the degraded fragments, with greater species richness and individual density in the preserved PPAs, and greater evenness of individual distribution by species in the degraded PPAs. Martins et al. (2008)

also analyzed the structure of forest composition in two forests subject to flooding (*impucas*), one preserved and one degraded, in the lower reaches of the Araguaia River, in Tocantins. They also showed a greater individual density of individuals, numbers of species, as well as Shannon diversity index in the preserved PPAs than in the degraded ones.

With respect to the number of dead individuals in the preserved PPAs (4.66% of the total) and degraded PPAs (6.28% of the total), it is interesting to note that Toniato et al. (1998) compiled the results of five forest surveys, in which the rate of dead individuals varied between 5–8% of the total of individuals sampled. Murcia (2005) emphasized that high arboreal mortality may point to a process of exclusion, characteristic of fragmented forests, owing to physical and biological alterations created by border effects.

5. CONCLUSIONS

Conserving the water resources, landscape, geological stability, and biodiversity, facilitating the genetic flux within fauna and flora, protecting the soil, and ensuring the well-being of human populations are interdependent functions; compromising any one creates a disequilibrium in others. In this context, the ecological parameters evaluated indicate that the establishment of PPAs in accordance with the current law for protection of native vegetation (Law 12.651/2012) might result in significant losses of species and individuals, as well as facilitate the erosive processes. This suggests that, in the long term, such PPAs will not fulfill the environmental functions foreseen in the legislation. Thus, in the long term, environmental losses with respect to forest diversity, density of individuals, and erosive processes might occur in the PPAs that have human intervention within the 30 m margin.

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