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eduem@uem.br

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Costella, Eduardo; Garcia, Bruno Alves; Costa, Leonardo Severo da; Corneleo, Nathana
da Silva; Schünemann, Adriano Luis; Stefenon, Valdir Marcos

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Anthropogenic use of gallery forests in the Brazilian Pampa

Eduardo Costella, Bruno Alves Garcia, Leonardo Severo da Costa, Nathana da Silva Corneleo, Adriano Luis Schünemann and Valdir Marcos Stefenon*

Universidade Federal do Pampa, Av. Antonio Trilha, 1847, 97300-000, Campus São Gabriel, São Gabriel, Rio Grande do Sul, Brazil.

*Author for correspondence. E-mail: valdirstefenon@unipampa.edu.br

ABSTRACT. As effect of demographic growth in the last decades, many cities in Southern Brazil experienced a degradation process of conservation areas. In this study, semi-structured interviews and a phytosociological inventory were employed to assess the effect of anthropogenic use of tree species of the gallery forest in the Brazilian Pampa. Eighty-four informants were interviewed and listed a total of 43 tree species, belonging to 23 botanical families. Four categories of use were identified for the referenced species: firewood, medicinal, food and timber. The three most important species were *Blepharocalyx salicifolius*, *Eugenia uniflora* and *Salix humboldtiana*. The phytosociological inventory suggests that the anthropogenic exploitation of the gallery forests is leading some tree species to local threat and/or extinction. Aiming to preserve the gallery forests, we suggest the re-evaluation of the local people attitudes, towards a sustainable use of the gallery forests and the reforestation of the river margins with native species producing palatable fruits, enabling the exploitation of non-wood products, as well as the establishment of animal species in this environment.

Keywords: ethnobotany, sustainability, traditional knowledge.

Uso antropogênico de florestas de galeria do bioma Pampa Brasileiro

RESUMO. Como efeito do crescimento demográfico nas últimas décadas, muitas cidades no Sul do Brasil experimentaram um processo de degradação de áreas de preservação ambiental. Neste estudo, entrevistas semi-estruturadas e um inventário fitossociológico foram empregados para acessar o efeito do uso antropogênico de espécies arbóreas de matas de galeria no Pampa brasileiro. Oitenta e quatro informantes foram entrevistados e listaram um total de 43 espécies, pertencentes a 23 famílias botânicas. Quatro categorias de uso foram identificadas para as espécies citadas: lenha, medicamento, alimento e madeira. As três espécies mais importantes foram *Blepharocalyx salicifolius*, *Eugenia uniflora* e *Salix humboldtiana*. O inventário fitossociológico sugere que a exploração antropogênica da mata de galeria está levando algumas espécies à ameaça e/ou extinção local. Com o objetivo de preservar as matas de galeria, sugere-se a re-avaliação das atitudes das comunidades locais, visando um uso sustentável das matas e o reflorestamento das margens de rios com espécies nativas produtoras de frutos comestíveis, possibilitando a exploração de produtos não-madeireiros, assim como o estabelecimento de animais nestes ambientes.

Palavras-chave: etnobotânica, sustentabilidade, conhecimento tradicional.

Introduction

Biodiversity is one of the essential properties of the environment and a key factor towards the adaptability of living organisms. Such capacity of adaptation is crucial for species and ecosystem survival under a scenario of very fast climate changes, mainly considering the anthropogenic interference in the environments (MÁTYÁS, 2005).

The extreme growth of the worlds' population in the last century has increased the rate of environmental degradation worldwide (GEBUREK, 2005). Due to economical and social weakness, this fact is more accentuate in developing countries in latin America, Asia and Africa, usually resulting in

the over-exploitation of the existing natural resources, including areas of environmental protection, like the gallery forests.

As effect of the human occupation of the wild and urban environments, many of the existing gallery forests in the Brazilian Pampa are deeply degraded. The Brazilian Pampa is a naturally fragile Biome (see ROESCH et al., 2009 for a discussion about the natural fragility of the Pampa biome), located between latitudes 28°00' and 34°00' S and longitudes 49°30' and 58°00' W, in southern Brazil. The dominant vegetation in this biome is grassland. The occurrence of large forest formations is infrequent in this region, limited mainly to gallery

forests along rivers and some small forest formations surrounded by grassland (ROESCH et al., 2009).

Despite the regulatory intervention of the government, the exploratory pressure over the gallery forests still occurs. The main ground of such exploratory pressure is the need of the low income communities in obtaining food, energy (firewood), building material and profits (obtained with the commercialization of forest wood derived products). Currently, the exploitation of such areas has decreased as effect of environmental education programs and regulatory policy. However, gallery forest degradation is the main cause of many environmental problems such as floods, erosion, river siltation and impoverishment of the soil (ROESCH et al., 2009). Therefore, initiatives towards the recovery of such areas are imperative.

Since local communities usually handle and conserve a significant part of the genetic resources of the ecosystems, assessing the traditional knowledge of these people about the valorization and use of native plants in a particular region may significantly help the planning of conservation strategies (STEFENON et al., 2009). The present study used ethnobotanical surveys to characterize the tree species considered of higher importance for the inhabitants of riverside regions in the municipalities of São Gabriel and Rosário do Sul, within the Pampa biome, in the Rio Grande do Sul State, Southern Brazil. This region is located within the South Temperate Zone and has subtropical and temperate climates with clear differentiation between a warm and a cold season, being therefore classified as Steppe (IBGE, 2004). Discussions about

the appropriated use of the term steppe to the physiographic formations of the Brazilian Pampa (e.g. BREDENKAMP et al., 2002; ROESCH et al., 2009; OVERBECK et al., 2007) reflect the biological uniqueness of the area. This uniqueness may be also reflected in the traditional use of the regional resources.

In this study, we intended to answer the following questions: (1) which tree species are considered the most important for local people? (2) Which is the more frequent use given to these species? (3) How is the current conservation status of the species more frequently cited by local people? Through these questions we aimed to test the hypothesis that valorization of native species as raw material for human needs results in the unsustainable exploitation of the natural resources.

Material and methods

Study area

The ethnobotanical survey was performed with the riverside communities of the Vacacaí river in the municipality of São Gabriel (30°20'S and 54°19'W, 124 m above sea level), and the Santa Maria river, in the municipality of Rosário do Sul, Rio Grande do Sul State (30°17'S and 54°02'W, 151 m above sea level) (Figure 1). The economy of these cities is based mainly on agriculture and cattle production. Both rivers play an important role in the economy of the municipalities, through tourism, sand extraction for building, and irrigation of rice plantations. Despite its economical and social importance, such activities lead to depletion of the gallery forests.

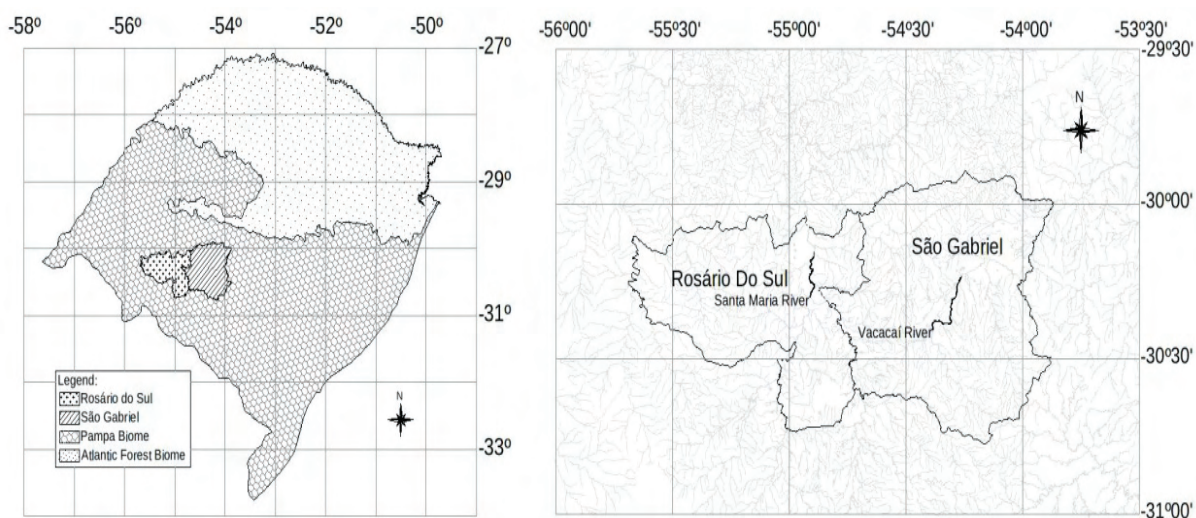


Figure 1. Localization of the study sites in the Brazilian Pampa, southern Brazil.

Collection and analysis of ethnobotanical data

The research was performed through semi-structured interviews, applied to all inhabitants living in the region longer than ten years. The informants were requested to list the tree species of the gallery forest, considered of higher importance. To each species, informants cited its use and occurrence in the forest (abundant, common, rare or extinct). Species considered harmful by the informants were also listed. All informants were initially informed about the aims of the research. Only the informants who agreed in cooperating with the study and that signed a participatory term were interviewed. The interviews were achieved from August to December 2009. Identification of the species was performed with the help of local people used to handle native species of the region. Scientific names were determined through dendrological evaluation of the cited species. The actual occurrence of the three most cited species was determined through a phytosociological survey, performed in December 2009. To this survey, one plot of 250 m² (5 x 50 meters) was delimited in the gallery forests near each interviewed community, totalizing eight plots. In each plot, the number of individuals of each target-species (*Blepharocalyx salicifolius*, *Eugenia uniflora* and *Salix humboldtiana*; see results) was determined.

The ethnobotanical data were analyzed using qualitative and quantitative criteria. To the qualitative analysis, the data were tabulated and sorted according to the uses determined by the informants to each species, including multiple use categories.

Quantitative analyses in ethnobotany are mainly based on indexes of relative importance of the cited species, considering, for instance, the number of citations or uses given by the informants for each species. The most widespread index employed in ethnobotany is the Use Value (PHILLIPS; GENTRY, 1993a and b). However, this index just considers the number of uses cited to a plant and cannot be related to use pressure and species conservation. In order to correlate the valorization of a species by the local people with the conservation status of this species, the data were analyzed considering the importance of each particular species and the diversity of species in each city.

Assuming that the species judged by the local people as the most important are cited more frequently, the quoted importance of each species (i.e. the importance given to a particular species by the informants, by referencing it) was computed for each site based on the number of citations by the informants, using the importance value (BYG; BALSLEV, 2001) of each category as $IV_{cat} = cat/tot$ and the importance value of each species within each category as $IV_{sp/cat} = sp/cat$, where:

IV_{cat} = importance value of the category,

$IV_{sp/cat}$ = importance value of the species within the category,

tot = total of citations,

cat = number of times the category was cited,

sp = number of times the species was cited within the category.

The diversity of species listed in each site and overall was computed using the Shannon index of diversity as $H' = -\sum p_i \cdot \log_{10} p_i$, where p_i is the relative frequency of each species within the studied site and $\log_{10} p_i$ is the base 10 logarithm of p_i . Similarity of species between cities was determined using the Jaccard's index of similarity $J = a/(a+b+c)$, where a is the number of plants cited in both cities, b is the number of plants cited in São Gabriel but not in Rosário do Sul and c is the number of plants cited in Rosário do Sul but not in São Gabriel.

Results

In the present survey, 48 informants were interviewed in São Gabriel and 36 informants in Rosário do Sul. These 84 informants listed a total of 43 tree species, belonging to 23 botanical families (Table 1). Twenty-nine species were cited in São Gabriel and 34 in Rosário do Sul. Nine species were cited only in São Gabriel and 14 just in Rosário do Sul (Table 1). Family Myrtaceae – one of the most important in the forests of the steppic region of the Brazilian Pampa (UFSM/SEMA-RS, 2007) – was the most significant considering the number of species as well as the number of citations. The Shannon index of diversity (H') was $H' = 1.29$ in São Gabriel, $H' = 1.48$ in Rosário do Sul and $H' = 1.38$ overall. The Jaccard's index of similarity revealed 37% of correspondence among the species cited in each city.

Table 1. Tree species listed by the informants as important in the gallery forest of the Vacacaí river in São Gabriel and Santa Maria river in Rosário do Sul, Rio Grande do Sul State, Brazil.

Family/Species	São Gabriel		Rosário do Sul	
	Number of references	Uses*	Number of references	Uses*
ANACARDIACEAE				
<i>Schinus molle</i> L.	13	Med/Fw	5	Fw
<i>Astronium balansae</i> Engl.	-	-	3	Fw/Ti
BIGNONIACEAE				
<i>Tabebuia heptaphylla</i> (Vell.) Toledo	-	-	1	Fw
BORAGINACEAE				
<i>Cordia americana</i> (L.) Gottschling & L. E. Mill.	12	Fw	1	Fw
CANELLACEAE				
<i>Capsicodendron dinisii</i> (Schwake) Occhioni	-	-	1	Fw
CELASTRACEAE				
<i>Maytenus aquifolia</i> Mart.	1		1	Fw
COMBRETACEAE				
<i>Terminalia australis</i> Cambess.	16	Fw/Med	6	Fw
EUPHORBIACEAE				
<i>Sapium glandulosum</i> (L.) Morong	-	-	1	Fw
<i>Sebastiania commersoniana</i> (Baill.) L. B. Sm. & Downs	19	Fw	8	Fw
FABACEAE				
<i>Acacia bonariensis</i> Gill.	4	Med	-	-
<i>Acacia caven</i> (Molina) Molina	1	Fw	2	Fw
<i>Bauhinia forficata</i> Link	1	Med	2	Fw
<i>Caesalpinia ferrea</i> Mart.	1	Fw	3	Fw/Ti
<i>Enterolobium contortisiliquum</i> (Vell.) Morong	-	-	2	Fw
<i>Erythrina speciosa</i> Andrews	-	-	3	Fw
<i>Inga vera</i> Willd.	1	Fo	-	-
<i>Parapiptadenia rigida</i> (Benth.) Brenan	16	Ti	-	-
LAMIACEAE				
<i>Vitex megapotamica</i> (Spreng.) Moldenke	9	Ti	5	Ti
LAURACEAE				
<i>Nectandra</i> sp.	1	Fw	1	Fw
MALVACEAE				
<i>Luehea divaricata</i> Mart. & Zucc.	10	Fw	4	Med/Fw
MYRTACEAE				
<i>Blepharocalyx salicifolius</i> (Kunth) O. Berg	29	Med/Fw	18	Med/Fw/Fo
<i>Campomanesia rhombea</i> O. Berg	15	Med	-	-
<i>Eucalyptus</i> sp.	6	Med/Fw	7	Med/Fw
<i>Eugenia moraviana</i> O.	18	Fw	3	Fw
<i>Eugenia uniflora</i> L.	32	Med/Fw/Fo	12	Med/Fw/Fo
<i>Myrcianthes pungens</i> (O. Berg) D. Legrand	-	-	1	Fo/Ti
<i>Psidium cattleianum</i> Sabine	-	-	3	Med/Fw
MELIACEAE				
<i>Cedrela fissilis</i> Vell.	1	Med	-	-
<i>Cephalanthus glabratus</i> (Spr.) K. Schum.	17	Fw	6	Fw
<i>Melia azedarach</i> L.	2	Fw	3	Fw
MORACEAE				
<i>Ficus</i> sp.	-	-	1	Med
<i>Morus</i> sp.	1	Med/Fw/Fo	-	-
ARECACEAE				
<i>Syagrus romanzoffiana</i> (Cham.) Glassman	-	-	2	Med
POLYGONACEAE				
<i>Ruprechtia laxiflora</i> Meisn.	16	Med/Fw	-	-
PUNICACEAE				
<i>Punica granatum</i> L.	-	-	1	Med
RHAMNACEAE				
<i>Scutia buxifolia</i> Reissek	18	Med/Fw	10	Med/Fw
ROSACEAE				
<i>Eriobotrya japonica</i> (Thunb.) Lindl.	-	-	3	Fw/Fo
RUBIACEAE				
<i>Guettarda uruguensis</i> Cham. & Schltdl.	2	Med/Fw/Fo	-	-
RUTACEAE				
<i>Zanthoxylum caribaeum</i> Lam.	17	Med/Fw	2	Med
SALICACEAE				
<i>Casearia decandra</i> Jacq.	-	-	1	Med
<i>Casearia silvestris</i> Sw.	-	-	2	Med
<i>Salix humboldtiana</i> Willd.	22	Fw	12	Fw/Ti
SAPINDACEAE				
<i>Matayba guianensis</i> cf. Aubl.	3	Fw	-	-

*Med: medicament; Fw: firewood; Fo: food; Ti: Timber for the building of fences or houses.

Based on the interviews, four categories of use were identified: firewood, medicinal (tea, infusions), food (fruits) and timber (for the building of fences, houses,

etc). The most frequently use referred by the communities was firewood, with importance value $IV_{\text{firewood}} = 0.620$ in São Gabriel and $IV_{\text{firewood}} = 0.583$ in

Rosário do Sul, followed by the medicinal use with $IV_{\text{medicinal}} = 0.284$ in São Gabriel and $IV_{\text{medicinal}} = 0.320$ in Rosário do Sul (Table 2). Several species were identified as having multiple uses. The three most cited species in both cities were *B. salicifolius*, *E. uniflora* and *S. humboldtiana*, concerning together, more than one-fourth of the citations in both cities (27.5% in São Gabriel and 31.6% in Rosário do Sul). In contrast, the majority of the species (41.4% in São Gabriel and 66.7% in Rosário do Sul) were referred less than five times. In São Gabriel, the species with higher importance as firewood was *S. humboldtiana* ($IV_{\text{Shu/firewood}} = 0.089$). In the category medicinal, the most cited species was *B. salicifolius* ($VI_{\text{Bsa/medicinal}} = 0.281$), while *E. uniflora* was the most cited as food ($IV_{\text{Eun/food}} = 0.75$) and *Parapiptadenia rigida* was the most referred species of domestic use ($IV_{\text{Pri/timber}} = 0.434$) (Table 2). In Rosário do Sul, *S. humboldtiana* was considered the species with higher importance as firewood ($IV_{\text{Shu/firewood}} = 0.120$), *B. salicifolius* was the most cited species in the medicinal category ($IV_{\text{Bsa/medicinal}} = 0.360$) and as food ($IV_{\text{Bsa/food}} = 0.500$), while *Vitex megapotamica* was the most cited as species of domestic use ($IV_{\text{Vme/timber}} = 0.333$) (Table 2).

Based on the response of the informants, the target-species for the phytosociological inventory were *E. uniflora*, *S. humboldtiana* and *B. salicifolius*, in both cities. The phytosociological inventory demonstrated that the distribution of the target-species is very heterogeneous when comparing all the inventoried sites. In São Gabriel, *E. uniflora* was the species with higher occurrence in three out of four inventoried sites. *B. salicifolius* was the second species in distribution in two sites, but it was the species of lowest occurrence in one site and absent

in another one. *S. humboldtiana* was the most frequent species in one site and was relatively common in the other three sites (Figure 2). In Rosário do Sul, *B. salicifolius* was found in all inventoried sites, while *S. humboldtiana*, although cited by many informants, was not found in none of the sites and *E. uniflora* was found in high abundance in two points and was absent in another two points (Figure 2).

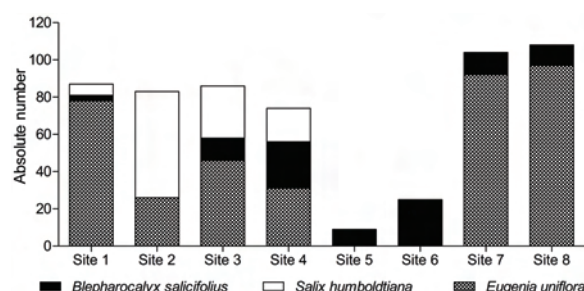


Figure 2. Absolute number of occurrences of the three most cited species (*Blepharocalyx salicifolius*, *Eugenia uniflora* and *Salix humboldtiana*) in eight sites of the gallery forest of the rivers Vacacaí, in São Gabriel (sites 1 to 4) and Santa Maria, in Rosário do Sul (sites 5 to 8).

Discussion

According to the Shannon index, the diversity of species used by local people was similar in both cities and overall, while the three species judged as the most important were the same. These indexes of diversity are slightly lower than estimated to the steppic forests of the Rio Grande do Sul State ($H' = 1.76$; UFSM/SEMA-RS, 2007) showing that local people uses a wide range of species occurring within the ecosystem.

Despite the similarity regarding species diversity, the correspondence of used species is small (37%), as revealed by the Jaccard's index of similarity.

Table 2. Importance value (IV) of each use category and of the three main species within each category in São Gabriel and Rosário do Sul, Rio Grande do Sul State, Brazil. Total number of species listed in each category is given.

São Gabriel			
Firewood (24 species) $IV_{\text{firewood}} = 0.620$ <i>Salix humboldtiana</i> $IV_{\text{Shu/firewood}} = 0.089$ <i>Sebastiania comersoniana</i> $IV_{\text{Sco/firewood}} = 0.084$ <i>Eugenia moraviana</i> $IV_{\text{Emo/firewood}} = 0.080$	Medicinal (12 species) $IV_{\text{medicinal}} = 0.284$ <i>Blepharocalyx salicifolius</i> $IV_{\text{Bsa/medicinal}} = 0.281$ <i>Campomanesia rhombica</i> $IV_{\text{Cch/medicinal}} = 0.145$ <i>Zanthoxylum caribaeum</i> $IV_{\text{Zca/medicinal}} = 0.126$	Timber (5 species) $IV_{\text{timber}} = 0.063$ <i>Paraptadenia rigida</i> $IV_{\text{Pri/timber}} = 0.434$ <i>Eugenia moraviana</i> $IV_{\text{Emo/timber}} = 0.260$ <i>Eugenia uniflora</i> $IV_{\text{Eun/timber}} = 0.173$	Food (4 species) $IV_{\text{food}} = 0.033$ <i>Eugenia uniflora</i> $IV_{\text{Eun/food}} = 0.750$ <i>Guettarda uruguensis</i> $IV_{\text{Gur/food}} = 0.083$ <i>Morus</i> $IV_{\text{Mor/food}} = 0.083$
Rosário do Sul			
Firewood (28 species) $IV_{\text{firewood}} = 0.583$ <i>Salix humboldtiana</i> $IV_{\text{Shu/firewood}} = 0.120$ <i>Sebastiania comersoniana</i> $IV_{\text{Sco/firewood}} = 0.087$ <i>Eugenia uniflora</i> $IV_{\text{Eun/firewood}} = 0.076$	Medicinal (10 species) $IV_{\text{medicinal}} = 0.320$ <i>Blepharocalyx salicifolius</i> $IV_{\text{Bsa/medicinal}} = 0.360$ <i>Eugenia uniflora</i> $IV_{\text{Eun/medicinal}} = 0.180$ <i>Casearia silvestris</i> $IV_{\text{Cas/medicinal}} = 0.081$	Timber (6 species) $IV_{\text{timber}} = 0.058$ <i>Vitex megapotamica</i> $IV_{\text{Vme/timber}} = 0.333$ <i>Salix humboldtiana</i> $IV_{\text{Shu/timber}} = 0.130$ <i>Cordia americana</i> $IV_{\text{Cam/timber}} = 0.130$	Food (4 species) $IV_{\text{food}} = 0.038$ <i>Blepharocalyx salicifolius</i> $IV_{\text{Bsa/food}} = 0.500$ <i>Eriobotrya japonica</i> $IV_{\text{Eja/food}} = 0.166$ <i>Myrcianthes pungens</i> $IV_{\text{Mpu/food}} = 0.166$

Such low similarity between the cities is effect of the variability of species refereed by less than three informants, since about 31% of the species listed in São Gabriel and 26.5% of the species listed in Rosário do Sul were cited just once (see Table 1). Concerning plants and animals with medicinal use in Northeastern Brazil, Almeida and Albuquerque (2002) identified low agreement for some categories of use, as well as some species which were referred just by a single informant. These facts reveal the idiosyncrasy of the popular knowledge about the use of natural resources.

None of the species cited by the informants in this survey are referenced in the Official List of Endangered Species of the Brazilian Flora (BRASIL, 2008), meaning that also the most used native species, *B. salicifolius*, *E. uniflora* and *S. humboldtiana*, are not threatened at country level. However, they can be locally endangered. In an ethnobotanical study performed in the Northeastern Brazil, Almeida and Albuquerque (2002) emphasized that the species of higher medicinal importance are threatened as effect of their systematic exploitation. The occurrence status of *B. salicifolius* and *E. uniflora*, which are frequent in some of the inventoried sites and absent or found in very low frequency in other ones, suggests that the exploitation of at least some tree species in the Brazilian Pampa followed the same threatening way. Similarly, the species *S. humboldtiana* was not found in the inventoried sites in Rosário do Sul, suggesting intensive exploitation in the recent past.

Ethnobotanical surveys achieved in Brazil in the last two decades have been focused mainly on medicinal species with more than 60% of the investigations in this topic (OLIVEIRA et al., 2009). This is justified by the high importance of medicinal plants for local people, as effective and cost-efficient medicaments. The rise of firewood as the most important use for the tree species of the gallery forest in the Brazilian Pampa is directly correlated with the regional tradition of using fireplaces during the winter. Thus, firewood is an important source of income for local people who commercialize this product. However, aiming to preserve the gallery forests, the use of non-wood products should be the preferred alternative. Moreover, species with recognized importance as food and medicinal purposes have been cited as source of firewood, revealing an urgent need of re-evaluation of the local people attitudes, towards a sustainable use of the gallery forests.

The reforestation of the margins of rivers using native species which produce palatable fruits is an attractive alternative for the recovery of the gallery forests since it can promote the recuperation of the vegetation and stimulate the establishment of animal species. Planting such kind of species can also promote the forest conservation by local people. For instance, considering that *E. uniflora* is listed as important source of food to the local communities in the studied region, they should not be target of logging, but mainly used for fruit harvesting. At the same time, this species may serve as attractive to the local fauna, promoting the seed dispersion of different native species occurring in the region. *B. salicifolius*, another native species, should also be planted in the gallery forests, since it can be locally threatened, as effect of the long time exploitation.

Finally, in order to provide a source of raw material needed by the local people (mainly firewood), exotic tree species may be planted in association with native ones, supplying firewood, medicaments, food and timber. However, considering that gallery forests are areas of permanent preservation and must not be exploited, such plantations should be planned as agroforestry systems and established in areas assessable for the local communities and external to the river margins.

Conclusion

Due to the regional needs and culture, firewood is the main use give to the tree species of the riparian forests in the studied area, resulting in the logging and threatening of native species. Thus the conservation of native trees in Pampean gallery forests depends on a re-evaluation of the use given to each species and planning conservation and recuperation of such environments. It demands programs of environmental education and forest recovery. Moreover, the knowledge of the local communities should be recovered and systematized, towards a more rational use of the non-wood products.

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