UNIVERSIDADE FEDERAL DO PAMPA

Campus **São Gabriel**

Diferentes usos da terra determinam a ocorrência de espécies vegetais exóticas em ambientes campestres do Sul do Brasil

NEIL DAMAS DE OLIVEIRA JUNIOR

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Monografia apresentada à Comissão de Trabalho de Conclusão do Curso de Ciências Biológicas, Universidade Federal do Pampa — UNIPAMPA, *Campus* São Gabriel, como parte dos requisitos necessários à obtenção do grau de Bacharel em Ciências Biológicas.

Orientador: Rubem Samuel de Avila Jr

Rio Grande do Sul

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São Gabriel, Julho de 2016

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I dedicate this to my parents and Olivia and Meire (in memoriam), two brave and strong women who were the pillars of my life, my example, endless source of strength, love and inspiration.

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Resumo

As invasões biológicas representam uma ameaça para a biodiversidade e as atividades humanas podem induzir invasões de plantas, o que afeta espécies nativas, comunidades e ecossistemas. No entanto, o bioma pampa brasileiro possui poucos estudos voltados para a investigação da relação entre espécies exóticas e diferentes tipos de uso da terra. Assim, este estudo investigou a relação entre espécies exóticas e distintos usos da terra, com base em diferentes tipos de distúrbios tais como: estradas, agricultura, campo sem manejo e pastagem. Nas quatro distintas áreas, foram realizados transectos de 400 m e a flora foi amostrada pelo método Braun-Blanquet com um metro quadrado dividido em 100 partes iguais a cada 20 m para determinar a cobertura vegetal de cada espécie exótica e nativa. Foram encontradas 13 espécies exóticas em nosso estudo e diferenças significativas na composição florística tanto para espécies exóticas (ANOSIM, $R = 0,56$, $p < 0,0001$) quanto para espécies nativas (ANOSIM, $R = 0,52$, $p < 0,0001$) para as quatro diferentes áreas. O maior número de espécies exóticas foi encontrado nos transectos da estrada, seguido pelos transectos de área agrícola. Estes resultados sugerem que a presença de espécies exóticas é diretamente relacionada com distintos usos do solo e especialmente aqueles com alto impacto. Portanto, recomenda-se um manejo correto do solo e controle sobre as atividades humanas para evitar grandes distúrbios e evitar a propagação de espécies exóticas para novas áreas.

Palavras- chave: distúrbios, invasões biológicas, plantas exóticas, usos da terra, riqueza de espécies exóticas.

Abstract

Biological invasions represents a threat to the biodiversity and human activities may induce plant invasions, which affects native species, communities and ecosystems. Yet, brazilian pampas lack of studies focused on the investigation of the relation between alien species and land use. Thus, this study investigated the relation between alien species and distincts land uses based on different kinds of disturbance such as roads, agriculture, field with no management and grazing. A 400m transect were performed in the four different areas and the flora was sampled using braun-blanquet method with a meter square subdivided in 100 equal parts every 20 meters amounting to 20 samples per area to determine the coverage of each alien and native species. It was found 13 alien species in our study with significant differences in the abundance of each area (Tukey Test $p<0,001$) and significant differences in the floristic composition for both alien (ONE-WAY ANOSIM $R=0,56$, $p<0,0001$) and native species (ONE-WAY ANOSIM $R=0,52$, $p<0,0001$) in the four different areas. The highest number of alien species was found on the road transects followed by agricultural area. These results suggest that the presence of alien species is directly related to land uses, especially the ones with high impact. Therefore, a correct management of the soil and control over human activities is encouraged to avoid high levels of disturbance and prevent the spread of alien species to new areas.

Key words: biological invasion, alien plants, disturbance, land use, non-native richness species

Sumário

1.Introduction

Biological invasions has been reported as a dangerous threat to biodiversity in different ecosystems. Human activities may be responsible for the accidental or intentional spread of alien plant species out of their natural range (Kolar & Lodge, 2001). These alien species (sensu Richardson et.al., 2000) may affect native species, communities and ecosystems negatively or positively (Vilà et al., 2011). One of the most serious negative consequence is the functional diversity of a community modification that can cause functinal homogenization, replacing ecological specialist species by widespread generalist species (Olden et al. 2004).

Most alien species are not very efficient competitors in their natural range as they become when introduced to new areas (Callaway & Aschehoug, 2000). Gordon (1998) found that about 50% of alien species he found in his study can change ecosystem processes, causing shifts in the availability of resources and provoking changes in the selective pressures, frequently leading to changes in natural communities. Allelopathy is one of the mechanisms that makes some plants more competitive in a new environment and it has been related to invasion of alien species into grasslands (Gibson, 2009) Moreover, herbs that exclusively reproduce by seeds and has no specific mechanism of dispersal are more likely to become naturalized in southern Brazil (Rolim et al., 2014). In contrast, in other crucial stages of plant life cycle, some alien plants may act positively on native plant species co-ocurrents. Lopezaraiza-Mikel et al. (2007) observed an increasing in pollinator visitation rates in native plant in the presence of alien plants . Also, Gibson (2009) observed that native plants enhances the seedlings establishment in the presence of alien plants. Both examples could be associated with facilitaton interactions between alien and native plants. However, most alien plants studies highlight negative consequences in some level (e.g. Stinson et al., 2006; Ghazoul, 2004).

Pampean grasslands occupies a great extension of area in Southern Brazil (and in Argentina and Uruguay) and its regional singularities may be useful to understand regional issues with biological invasions. Historical and currently land use of pampean grasslands changes significatively the disturbance regimes and hence the environmental conditions affecting the process of invasion (Pauchard & Alabak, 2004). Spatial patterns and specific use of land results from ecological and historical factors, which in turn, may determine differences in the invasibility or the probability that a specific area has been occupied by alien plants (Fonseca et al., 2013).

Different uses of land promote differential stress in habitat (Alpert et al., 2000) and may interfere differently on the occurrence of alien plant species. Southern Brazil is recognized by an intensity agriculture and pastoril activities. These practices promote a significant soil disturbance that favors the establishment of ruderal and weedy plants (Hobbs & Huenneke, 1992). For examp,le areas of mixed-hardwood forest that were once used for agriculture, presented high abundance of alien species. Also, the abundance of non native plants were higher in the vicinity of roads but not neccessarily absent when not in the adjacences of the road (Kuhman et al., 2011). In fact, roads may induce dispersal of exotic species by creating new habitats due to habitat alteration, facilitating invasion by stress or removal of the natives (Trombulack & Frissell, 2000).

Finally, grazing activities are very commom in grasslands. Depending on the management of the area, species community may change its composition. For instance, areas with rotational grazing has more influence in species composition whereas the area with intensive grazing had no change in composition (Brum et al., 2007). Besides, grazing has a remarkable influence on the composition, apperance and productivity in grasslands, playing an important role maintaining the diversity and physionomy of the landscape (Hobbs & Huenneke, 1992). However, not all plants tolerate grazing, thus, the exclusion of invading trees in grasslands, for example, is a direct effect of grazing (Hobbs & Huenneke, 1992).

All these activities are associated with disturbances regimes that differ in intensity but contribute significatively for habitat invasibility. Thus, the composition of plant species will be changed spatial-temporaly with the amount of alien species occurring (Hobbs & Huenecke, 1992). So far, not many studies has been done in the brazilian pampas relating land use and hence differents disturbances regimes and plant invasions. In point of fact, most of the studies performed in this cointext are either related to forests (e.g. Pauchard & Alabak, 2004) or related to roads (Christen & Matlack, 2009; Meunier & Lavoie, 2012) and some related to grazing (Ditomaso 2010; Lisboa et al. 2009; Lunt, 1990).

Southern Brazil is known by its tradition of livestock production and intensive agriculture. Such activities may facilitate biological invasions if there is no appropriate management. Fonseca et al. (2013) found 356 species of invasive plants occuring in the pampean grasslands (including Argentina, Brazil and Uruguay). A total amount of 153 species occuring in Brazilian pampas and 35 occurring exclusively in the brazilian pampas. Nonetheless, Brazilian pampas lacks of studies about invasive plants, especially related to the human activities that may lead to an invasion. In this way, to better understand the high occurrence of alien plants in Southern Brazil grasslands, the main of our study was to evaluate the association of different typical land use in the presence and abundance of non native plant species in four distinct uses of land in the Brazilian pampean grasslands. We predicted that activities that promote stronger habitat structural modification such as roads and agricultural practices could be more susceptible to alien plants than habitats with light disturbance. This could be associated with practices that creates strong gaps in the original vegetation.

2.Material and Methods

2.1 Study sites

The experiment was conducted in four different areas within the pampa biome that differ in uses of land: 1) an area with agriculture activity (soybean cultivation mainly) (AGR) (30°22'15.74"S 54°19'47.32"O), area with no management of grazing or agriculture (NOM) (30°20'4.19"S 54°21'33.76"O), a third area along the road Br 290 (ROAD) (30°19'48.94"S 54°21'36.52"O) in the municipality of São Gabriel, and a low grazing level area with cattle and sheeps (GRZ) (30º04’80.88"S 55°55'42.94"O) in the municipality of Alegrete, both cities in the Rio Grande do Sul state, Brazil.

In Brazil, the Pampa Biome occupies 2,07% of the total Brazilian territory and 63% of the state of the Rio Grande do Sul (IBGE 2004), the only state of Brazil covered by this Biome. Southern Brazil lies between temperate and tropical climates (Overbeck et al., 2007) and it is characterized by a warm summer and cool winter with no dry season (Mack 1989; Overbeck et al., 2007, Pillar et al., 2009). The predominant vegetation of pampa biome is grasslands, a high number of herbaceous species, some shurbs and small trees (Pillar et al., 2009).

2.1.1 Sample design

To perform the experiment, transects were made along four different areas. In order to sample the exotic species in each area it was used Braun-Blanquet method using a meter square subdivided in 10 x 10cm squares to sample the percentage of cover for each species. Twenty replications in each area were made with about 20 meters distance between each one of them . All the plants were identified either on field or in the laboratory.

The transects along the road were 200 meters long on each side, parallel to the road. For grazing and field with few human interference areas, the transects were 400 meters long across the area. For agriculture, the same 400 meters along the edge of soybean cultivation.

2.1.2 Statistical analysis

To compare the abundance of exotic species found on each site it was performed ANOVA ONE-WAY followed by Tukey test (P<0,005). In order to compare the community of alien species in our four areas, comparative analyses to quantify potential differences in alien species richness was made throught ANOVA (one-way) with a critical p-value at 0.05 using STATISTICA 8.0 (StatSoft, 2006) To evaluate the similarity between alien plant assemblages we used a ANOSIM (one-way) using a Bray-curtis distance metric. The permutation value chosen was 10,000. We also performed a analysis to determine which plant species contributed for the difference between areas and in which area they were related using SIMPER (Hammer et al., 2001). It was also performed NMDS in order to display the communities of exotic and native species. These analysis were made using the PAST software (Hammer et al., 2001).

3. Results

It was found 109 species in the four land uses, of which 12 are alien species of nine different families (Table 1). ANOVA ONE WAY test has shown that the higher abundance of alien plant species were found on road, followed by agricultural area (Fig 1), Tukey test has shown significant differences among the four areas studied ($P < 0.001$). Asteraceae and Poaceae were the most representative alien plant families (Table1). One way ANOSIM has shown that there were significant differences among the vegetative component (composition and abundance) in the four distinctive land uses ($R = 0.56$, $p < 0.0001$) to alien plant species. Simper analysis showed that *Eragrostis plana* Nees (Poaceae) were strongly related to both road and agriculture area representing about 24.45% of the difference between the uses of land. *Echium plantagineum* L. (Boraginaceae) explains about 15.83% of the difference among the areas and it is related to road areas, *Coleostephus myconis* L. (Asteraceae) represents 11.31% of the difference among different areas and it is more common in agriculture. *Anagallis arvensis* L. (Primulaceae) explains 9.35% is more related to road area, *Briza minor* L. (Poaceae) is common in field with no management explained 9,22%, *Ammi majus* L. (Apiaceae) explained 8.76% and it is more related to roads and finally, *Hypochaeris glabra* L. (Asteraceae) explaining 8.03% of the difference between areas and more related to grazing field, the only place it was found.

For natives, it was also found a significant difference between the four areas (ANOSIM $p < 0.001$) strongly related to the uses of land (ANOSIM $R = 0.52$). *Paspalum notatum* Flüggé contributed 18%, *Paspalum plicatulum* Michx. 8%, *Piptochaetium* *montevidense* (Spreng.) Parodi. 7.9% and finally, *Dichondra sericea* Sw. contributed 4% for this result. *P.notatum* is more related to field with no management and grazing field. *P. plicatulum* is more related to field with no management; *P. montevidense* has higher abundance in three areas: field with no management, grazing field and agriculture area; finally, *D. sericea* is more related to grazing field.

NMDS analysis for alien plants (Fig.2) showed that the communites of exotic species from road and agriculture area are grouped as well as field with no management and grazing field. For natives (Fig.3) it is still possible to observe proximity of the community of exotic from roads and agriculture and field with no management with grazing field but not as clear as for exotic species. The graphic shows a gradient from agriculture to field with no management.

4. Discussion

It was found significant differences among the community of alien species in each sampled area.. The best represented families of alien plants found in this study were Poaceae (23%) and Asteraceae (23%). This result corroborates with other studies that has been found the same pattern for families of alien species (Pysek 1998, Schneider 2007, Schneider & Irgang, 2005). It is known that some plants may present traits that makes them more invasive such as a short juvenile period, short period between large seed crops and small seed mass (Rejmánek & Richardson 1996). Some of the attributes of the family Poaceae such as an inflorescence shape strongly evolved, and its ability to fix nitrogen combined with a very well succeded pollination system (Pysek 1998) may also explain why many species of this family are succesful invaders.

One of the most important species found in our study and the most representative one in our analysis is *Eragrostis plana (*Poaceae), and it was more related to agriculture area although a relative high abundance of this specie was also found in the road. In a study performed by Daehler (1998), the family Poaceae were well represented in both agriculture area and in natural areas, being considered serious invaders and widespread weeds. It is worth to highlight that *E.plana* was introduced as a forrager specie in southern Brazil in mid 1950, and currently there are about 2 million hectares of Brazilian pampas invaded by *E.plana* (Boldrini et al., 2010). Thus, the widespread of this specie is directly related to human activity. Lisboa et al. (2009) found intact seeds of *Eragrostis plana* in bovine feces after seven days of collection, although the number of viable seeds decreases as number of days after ingestion decreases. Nevertheless, the study points out that cattle can be a crucial dispersor for this specie contributing to the expansion of the range of occurence of *E. plana*. Therefore, for this plant, grazing has an important effect for dispersion and this activity may potencialize their invasiveness.

There is evidence that roads may favor the establishment of alien species as it was stated before in this study. Indeed, roadsides act as corridors for dispersal of invasive plants as obseved by Meunier & Lavoie (2012), and this may explain the higher abundance of alien plants found on the road. The most representative specie found on the road was *Echium plantagineum* (Boraginaceae) representing 15.8% of the difference between areas and it seems to be affected by land use. Piggin (1978) showed that in grazed pasture *Echium plantagineum* L. (Boraginaceae) produced over 6.000 seeds per m² whereas in ungrazed areas it produced 10 000 seeds m². This amount of seeds is enough to endure their persitence and possibly their dominance over another species (Piggin, 1978). This could explain why *E. plantagineum* is one of the most abundant specie found in this study on the road, although the reason why it has not been found in grazing field might not be directly related to grazing but with the introduction of this specie instead.

The third specie in our analysis is *Coleostephus myconis* (Asteraceae) which represented 11.31% of the difference among the four areas, is more related to agricultural areas. *C. myconis* is a weed of crops, fairly common in agricultural areas and pastures according to Weed Science Society of America (WSSA). Due to its abundance in agricultural area, this specie of weed might be considered as a potential invasive specie when the area become obsolete for planting. Studies that investigates influence of past land use in current community of alien plants such as the one performed by Kuhman et al. (2011), are encouraged in the pampa biome to gather information about changes in community species after use of land and restoration in order to predict future invasions or naturalization of current exotic species.

Field with no management were the second area with fewer alien species. *Briza minor* was the specie that presented higher abundance for this area and explained 9,22% of the difference between areas. According to Morgan (1998), *B. minor* is part of a group of species with low biomass, low cover and high frequency. Also, Morgan points out that this species does not present specific requirements of habitat and nutrients for its establishment, and it germinates through the grasslands without disturbance. These traits by itself can explain the abundance of this species in this study.

Finally, grazing field were the area with fewer alien species. The only alien specie found was *Hypochaeris glabra* representing about and its presence does not seem to be harmful or potentially invasive in grazing pastures since it has low abundance in the field. Nevertheless, monitoring the area is the most effective method of predicting problems and maintain control of the spread of undesirable weeds (Ditomaso 2000). According to Lunt (1990) the seed bank in long grazed grasslands was dominated by exotic species, therefore, disturbances such burning that maintain the diversity of this area, may also privilege alien species over native ones. This information corroborates with the idea that grazing is both important and potentially harmful for grasslands. Such activity might be important to maintain the phytophisionomy of southern Brazil grasslands like it was said before, nonetheless, it is a harmful activity because it may also induce invasions. Therefore, it reinforces the need of monitoring and managing the grazing in a sustainable perspective, focusing on the conservation of biodiversity and maintaining the ecological processes responsible for the integrity of these areas.

The native species *Paspalum plicatulum*, *Paspalum notatum* e *Piptochaetium montevidense* were mainly found in areas with moderate to low human interference. Nonetheless, *P. plicatulum* is commonly found along road edges as well (Pillar et al., 2009). On the other hand, *P. notatum* is a common native specie of the fields of the center of Rio Grande do Sul state occupying the understory in well managed areas of native field (Boldrini, et al. 2010). Thus, it was expected to find this specie on areas with low human interference. Because *Piptochaetium montevidense* was also found in high abundance in the agricultural area it is possible to infer that this species is resistant to such impacts but further studies are required to elucidate that.

McIntyre & Lavorel (1994) identified three groups of plant species based on the tolerance of disturbance: 1) Intolerant species, composed by native species that do not tolerate disturbance; 2) Tolerant species, with native and alien plants occurring in disturbed and undisturbed areas; and finally 3) Disturbed specialists, with predominance of alien species directly related to disturbed areas. In this context, alien species that was found in areas with high human interference such as roads and agricultural area fits in disturbed specialists species, whereas alien species found in field with no management and grazing pastures fits better in tolerant species group since that there are not many potentially invasive alien species.

It is known that recruitment and dispersal affects species composition, abundance and diversity in grasslands. Also, the more diversity an area has initially the harder will be to other plants to invade. Processes that disrupt natural systems of dispersal are expected to cause changes in species abundance and composition (Tilman, 1997). Thus, the relation found between land use and presence of exotic species indicates that the species composition found in our study is a result of changes in processes due to management of the areas, which in turn led to the establishment of the alien species we found and favoured their dispersion. Therefore, the level of disturbance determines the diversity of species found (Catford et al., 2011).

According to the results, it is possible to suggest that roads and agriculture area communities of exotic species are more closely related than these ones with field with no management and grazing field. Even for natives, it is still possible to see this pattern of group following a gradient from grazing field to agriculture. It possibly indicates that agriculture and roads has a stronger impact on natural communities too, which may be explained by the higher number of alien species found in these areas. Truly, alien species propagules are high in human-disturbed environments and the level of disturbance that increases native species diversity is not the for alien plants species perhaps because of the evolutionary story of alien species often is intrinsically related to human activity. Moreover, the success on establishment is related to novel evolutionary histories of each plant which enable them to overcome competition for example. (Catford et al., 2011).

There are some considerations about roads and field with no management that might be worth to indicate in this study. *E. plantagineum* and *A. arvensis* are very abundant on the road verges but they have not been found inside the field with no management in our sampling. However E.plantagineum can be found in the adjacences of the area as well as *A. arvensis*. Also, there are records for *A. arvensis* and *E. plana* in the field with no management area, but in the areas that has been suffered some kind of impact such as paved trails. Therefore, the sampling method used did not covered these species, probably because they are strictly related to human-disturbed areas and we sampled areas with no management.

5. Conclusion

There is significant difference between the land uses and the abundance of alien plants and our study showed that areas with high human influence such as roads and agriculture might favor the establishment of alien species more than grazing for example. The results indicates the need of a correct management of the human activities in the brazilian pampean grasslands in order to avoid the establishment of invasive species that could potentially threat the local biodiversity. Studies that correlates alien species with past and current land uses, development of techniques for better management of the soil and the vegetation and mainly monitoring the spread of the current alien species are encouraged to mitigate the expansion of the range of alien species in the pampa Biome, therefore protecting the natural biodiversity of this species-rich biome.

6. Figures and Tables

Table 1. Alien plant species found in this study with relevant traits and their respective area of occurence during October to November, 2015.

Plant species	Family	Occurence	Status	Life form	Life Cycle	Pollination	Dispersion
Ammi majus L.	Apiaceae	ROAD	Naturalized	Herbaceous	Annual	Entomophily	Barochory
Anagallis arvensis L.	Primulaceae	AGR/ROAD	Naturalized	Herbaceous	Annual	Entomophily	Barochory
Briza minor L.	Poaceae	NOM	Naturalized	Herbaceous	Annual	Anemophily	Anemochory
Centaurium puchellum (Sw.) Druce	Gentianaceae	ROAD	Naturalized	Herbaceous	Annual	Entomophily	Barochory
Cirsium vulgare (Savi) Ten.	Asteraceae	ROAD	Naturalized	Herbaceous	Annual or Biannual	Entomophily	Anemochory
Coleostephus myconis Rchb. f.	Asteraceae	AGR	Naturalized	Herbaceous	Annual	Entomophily	Anemochory
Echium plantagineum L.	Boraginaceae	AGR/ROAD	Invasive	Herbaceous	Biannual	Entomophily	Epizoochory
Eleusine tristachya (Lam.) Lam	Poaceae	AGR	Naturalized	Herbaceous	Perennial	Anemophily	Anemochory
Eragostris plana Nees.	Poaceae	AGR/ROAD	Invasive	Herbaceous	Perennial	Anemophily	Anemochory
Hypochaeris glabra L.	Asteraceae	GRZ	Naturalized	Herbaceous	Annual	Entomophily	Anemochory
Polycarpon tetraphilum (L.) L.	Caryophyllaceae	NOM	Naturalized	Herbaceous	Annual/Perennial	Autogamy	Anemochory
Rumex obtusifolius L.	Polygonaceae	AGR	Naturalized	Herbaceous	Perennial	Anemophily	Barochory

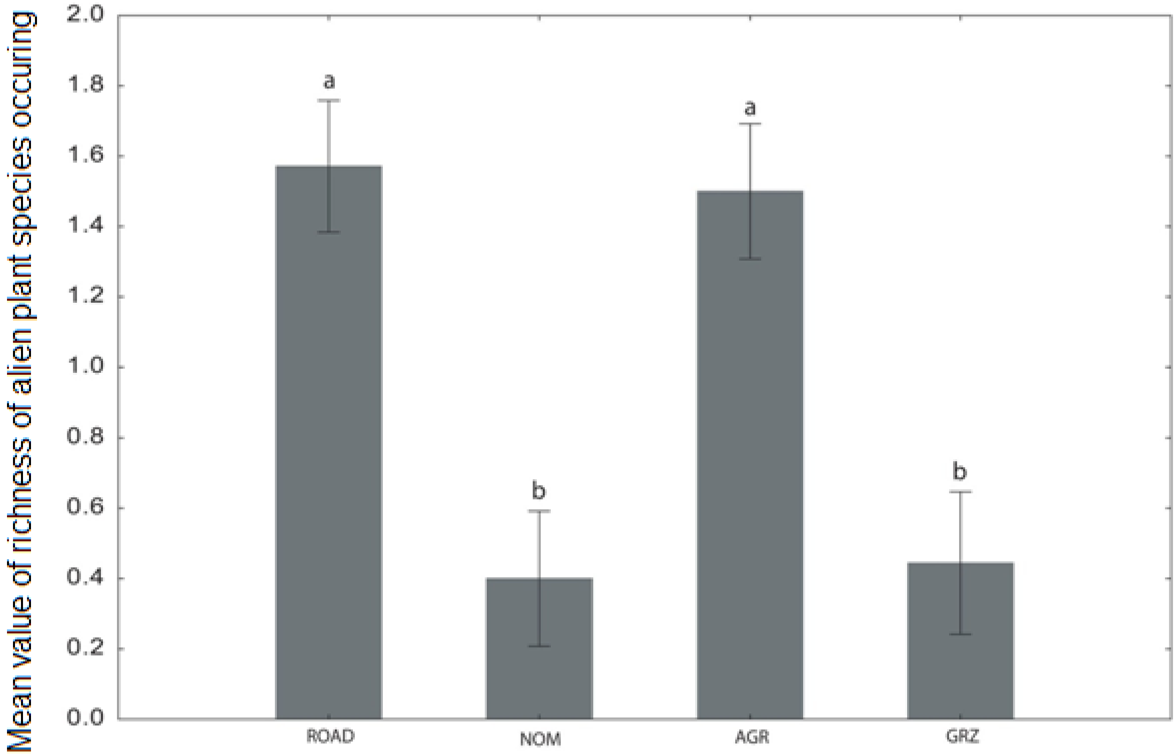

FIG. 1: Mean number of occurence of species in all samples for each one of the four areas. The letter over the bars indicates the difference found on Tukey test.

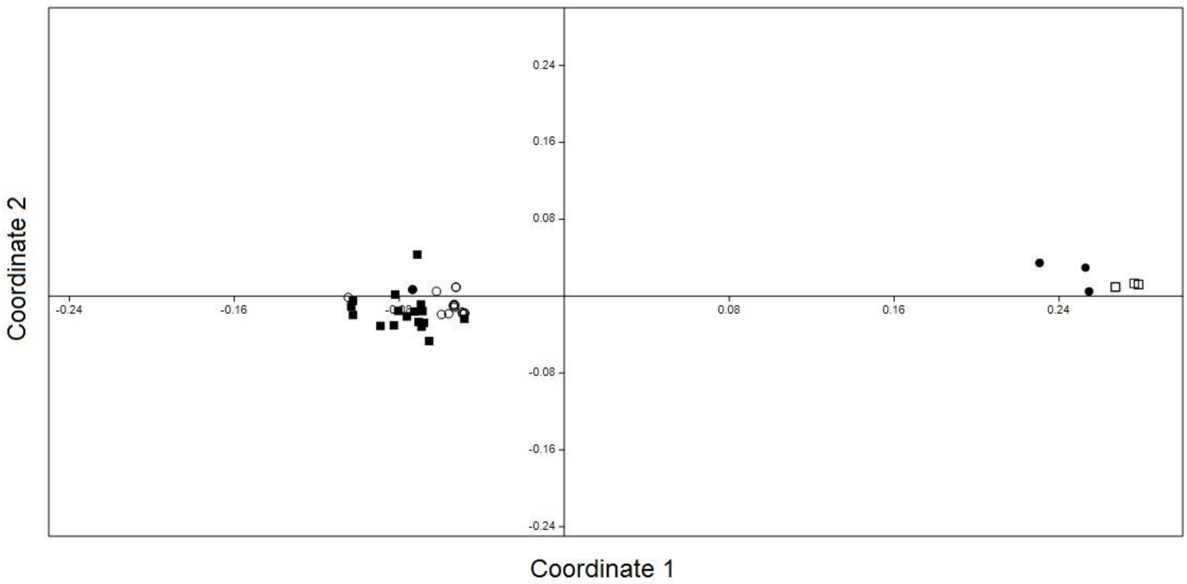

FIG. 2: NMDS graph for alien plant species assemblage found in the four areas: Roads (fill square), field with no management (empty square), agricultural area (empty circle) and Field with grazing (filled circle).

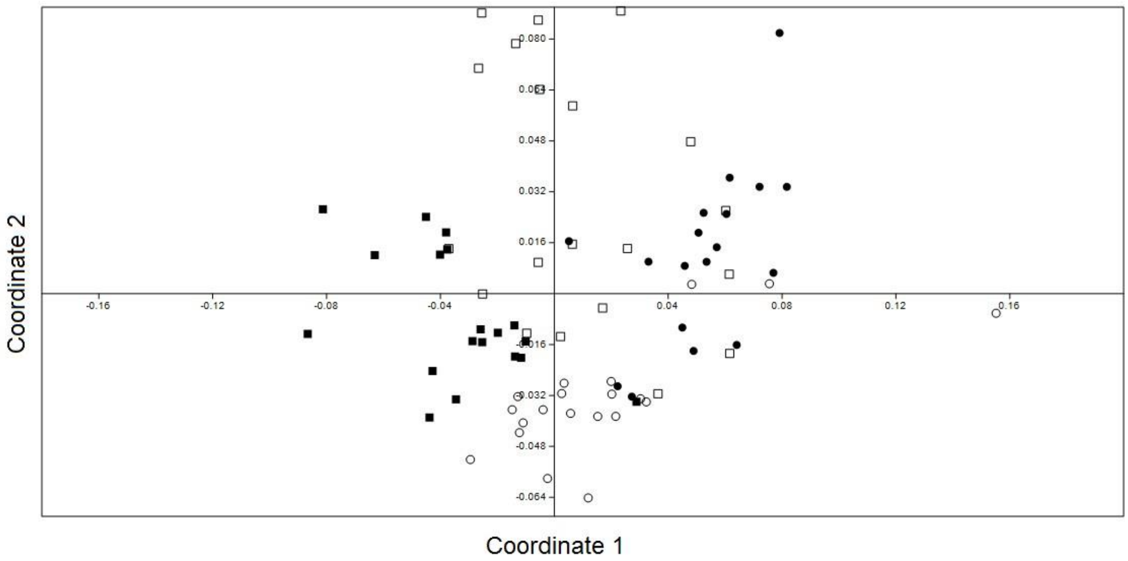

FIG. 3: NMDS graph for native plant species community found in the four areas: Roads (fill square), field with no management (empty square), agricultural area (empty circle) and Field with grazing (filled circle).

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8. Appendix

List of all native species found in this study. Family names corresponds to species that couldn't be identified on gender/species level.

Adesmia tristis Vogel

Alternanthera sp Forssk

Andropogon incanus Hack

Andropogom lateralis Nees

Andropogon bicornis L.

Andropogon sp. L.

Arachis burkartii Handro

Aspilia montevidensis (Spreng.)Kuntze

Austroeupatorium inulaefolium (Kunth) R.M.King Et H. Rob

Axonopus affinis Chase

Axonopus sp.

Baccharis caprariifolia DC.

Baccharis dracunculifolia DC

Baccharis trimera DC

Begonia cucullata Will

Bothriochloa laguroides (DC.) Herter

Bromelia balansae Mez

Campuloclinium macrocephalum (Less.) DC

Canna glauca L.

Carex sororia Kunth

Acanthostyles buniifolius (Hook et Arn) R.M. King et H.Rob

Ciclospermum leptophilum (Pers.) Sprague ex Britton & P. Wilson

Ciperaceae

Cliococca selaginoides (Lam.) C.M. Rogers & Mildner

Coelorachis selloana (Hack.) A. Camus

Comelinaceae

Conyza bonariensis (L.) Cronquist

Cuphea sp P. Browne

Desmodium incanum (Sw.) DC.

Desmodium adscendens (Sw.) DC.

Dichanthelium sabulorum (Lam.) Gould & C.A. Clark

Dichondra sericea Sw.

Eryngium horridum Malme

Eryngium nudicaule Lam

Scutellaria racemosa Pers

Euphorbia papillosa A.ST.-Hill

Euphorbiaceae Juss.

Evolvulus sericeus Sw.

Facelis retusa (Lam.) Sch. Bip.

Galium sp. L.

Gamochaeta americana (Mill.) Wedd.

Gamochaeta coarctata (Willd.) Kerguélen.

Glanduraria marrubioides (Cham.) Tronc.

Hebertia lahue (Molina) Goldblatt

Helianthemum brasiliense (Lam.) Pers.

Hyptis mutabilis Briq.

Hordeum polystichum D.Asch. et Graebn.

Kylinga sp.

Lamiaceae

Lamiaceae sp 2

Lathyris Trew

Malvaceae

Mikania cordifolia (L. f.) Willd.

Monnina resedoides A. St.-Hil.

Oenothera parodiana Munz

Onagraceae

Oxalis sp.

Oxalis eriocarpa DC.

Paspalum notatum Flüggé

Paspalum plicatulum Michx.

Pfaffia tuberosa (Spreng.) Hicken

Piptochaetium montevidense (Spreng.) Parodi

Plantago myosuros Lam.

Plantago ovata Forssk.

Plantago sp

Plantago tomentosa Lam.

Poaceae

Poaceae sp

Polycarpon sp Loefl.

Polygala sp. L.

Polygonum L.

Pterocaulon polystachyum DC.

Richardia brasiliensis Gomes

Rubiaceae

Rubiaceae sp2

Schyzachyrium microstachyum (Desv. ex Ham.) Roseng.

Senecio brasiliensis Less.

Senecio heterotrichius DC.

Senecio oxyphylus DC.

Setaria P. Beauv.

Sida rhombifolia L.

Sisyrinchium micranthum Cav.

Sisyrinchium sp L.

Solanum americanum Mill.

Solidago chilensis Meyen.

Soliva sessilis Ruiz. & Pav.

Soliva sp Ruiz. & Pav.

Stemodia verticillata (Mill.) Hassl.

Trifolium polymorphum Poir.

Turnera sidoides L.

Turneraceae

Vernonanthura nudiflora (Less.) H. Hob

Wahlenbergia linarioides (Lam.) A. DC.