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RESEARCH ARTICLE

SPECIES DISTRIBUTION AND CERRADO CONSERVATION

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ABSTRACT

The MaxEnt algorithm was used for study the geographical distribution and species richness for Dilleniaceae family, considered an important plant group of Cerrado. The aims were to analyze the species distributions and richness, comparing the species occurrence with biological reserves and priority areas for Cerrado conservation. The species distribution and richness of Dilleniaceae occurs predominantly in open cerrado that encompasses greater geographical area and larger plant biodiversity of Cerrado. The Dilleniaceae richness indicates that the Cerrado possesses gaps in network of biological reserves, therefore, are not effective in biodiversity protection. The Cerrado priority conservation areas are consistent with the Dilleniaceae richness, therefore, it is necessary new researches for support the creation of new reserves. These measures are necessary due to current rates of environmental degradation such as fire damage in vegetation, fragmentation and habitat loss.

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INTRODUCTION

The tropics have an extraordinary species richness (Raven *et al.,* 2011). This region exhibits different geographic species patterns originating through speciation, extinction and dispersal processes (Gavrilets, 2009; Ricklefs, 2004). In Brazil occurs greats biodiversity of the world (Raven, *et al.,* 2011). However, due the vast territory, combined with scarce studies aimed the biodiversity knowledge, the Brazilian biodiversity still is underestimate (Giulietti *et al.,* 2005). These biodiversity occurs in most important Brazilian biomes (Amazon Forest, Atlantic Forest, Cerrado and Caatinga). The Cerrado and Atlantic Forest are world biodiversity *hotspots* due to higher rates of endemism and degree of anthropogenic threats, therefore, are priorities for biodiversity conservation (Mittermeier *et al.,* 2005; Klink and Machado, 2005). However, the habitat fragmentation and degradations are constant threats to conservation of biodiversity in the Cerrado biome (Carvalho *et al.,* 2009). Many theories have been proposed to explain species distribution patterns and diversity, until 1950s historical factors were considered the most important (Ricklefs, 2004). Later, studies demonstrated that community level interactions, in addition, physical environmental factors, including climate as determinants at larger scales (Ricklefs, 2004; Couvreur and Forest, 2011). Recent reports suggest that high tropical biodiversity levels are due to environmental heterogeneity (Pennington *et al.,* 2009; Wittmann *et al.,* 2013), since in the forests and savannas are primarily controlled by climatic and edaphic factors, and periodic influences, *e.g.* fire (Simon *et al.,* 2009; Hoffmann *et al.,* 2009; Murphy, 2012). Therefore, the diversification rates are dependent upon many interacting factors (Pennington, 2009). In order to identify and explain species distribution patterns in high biodiversity regions arisen several limitations, requiring special methodology to differentiate biodiversity patterns in time and geographic space (Stockwell and Peterson, 2002). Assigned to this function, the ecological species distribution modeling (SDM) becoming powerful tool used to establish species geographic distributions (De Marco Júnior, 2007; Guisan and Thuiller, 2005). SDM quantifies species/environment relationships, representing a central element in predictive modeling, based on environmental, ecological and historical factors that controlling the species distribution due the physiological and ecosystem limitations

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(Austin, 2002; Guisan, 2005). This approach combines occurrence records and digital layers of environmental data which we can choose several algorithms (Pearson *et al.,* 2006; Soberón and Nakamura, 2009). However, as the occurrence species data has incomplete geographic coverage, due the unequal samplings (Schulman *et al.,* 2007; Hopkins, 2007) i.e. this records cannot establish full species distribution and not can be used directly in conservation and biogeography studies. Thus, the SDMs represent an empirical method to draw statistical inferences about the drivers of species' ranges under different conservation, ecological and evolutionary processes (Zimmermann *et al.,* 2010). This method generate extrapolation of geographic distribution for large areas where species distributions are uncertain due to inaccessibility and high costs and time required (Zimmermann, 2010). The modeling exhibits unquestionable applicability, with more accurate algorithms, including methods to locate suitable sites for rare species (Engler *et al.,* 2004), and biodiversity conservation areas (Johnson and Gillingham, 2005; Pearson, 2007, Pereira *et al.,* 2014). Moreover, the modeling is important in monitoring species, in field data collection, including new records based on distribution maps (Urbina-Cardona and Flores-Villela, 2010; Pereira and Groppo, 2012). Finally, modeling facilitates tracking geographic climate change scenarios and impacts on species distributions (Guisan and Thuiller, 2005). The Brazilian Cerrado is global biodiversity hotspot and the world's most species-rich tropical savanna (Wittmann *et al.,* 2013). Since the anthropogenic activity and environmental degradation (Klink and Machado, 2005; Wittmann *et al.,* 2013), the Cerrado is priority in conservation studies. The anthropogenic effect in the Cerrado include: over-exploitation, habitat loss and fragmentation, environmental pollution, and climate change (Klink and Machado, 2005; Durigan and Siqueira, 2007; Carvalho and De Marco Júnior, 2009). These impacts justifies studies to document the geographic distribution and species richness of Cerrado, aimed preserve species and biodiversity over time (Primack, 2006).The aim of study was analyze the geographical distribution and species richness of Dilleniaceae and compare these results with biological reserves and priority areas for Cerrado conservation. These data base serve to generate information for biodiversity conservation of Cerrado biome.

MATERIALS AND METHODS

Study area

The study was performed in Cerrado biome, covering 1.8-2 million km² and 23% of Brazilian territory (Ribeiro and Walter, 1998). The climate in Cerrado is seasonal with dry winter and average precipitation of 800-2000 mm over 90% of the area (Alvares *et al.,* 2013). The vegetation landscapes within the Cerrado biome consist of well-drained interfluves with gallery forests following the watercourses (Ratter *et al.,* 1997). The Cerrado flora is extremely varied, ranging from dense grassland, usually with a sparse covering of shrubs and small trees to an almost closed woodland with a canopy height of 12-15m (Ratter *et al.,* 1997). Eleven vegetation types are described for Cerrado: forest formations - (riparian forest, gallery forest, deciduous forest and cerradao); savanna - (cerrado *stricto sensu*, park cerrado, palms, and "veredas"); and grassland - (fields grubby, fields clean, and rocky fields) (Ribeiro and Walter, 1998).

Study Group

The Dilleniaceae is monophyletic group (Horn, 2009), represented by three genera and approximately 13 species in Cerrado (Table 1) (Kubitzki, 2004). *Curatella* L. is monospecific, comprising only *Curatella americana* L. (lixeira), a typical Cerrado species; *Davilla* Vand., posses 28 species recognized, these seven new species have already been published and three are presented as new by Fraga (2012), nine are endemic to Cerrado; *Doliocarpus* Roland., with approximately 45 neotropical liana species, three in Cerrado, one endemic (Aymard and Muller, 1994). The Dilleniaceae species can be recognized by the presence of exfoliating bark, and secondary parallel ribbed leaves, ending at a scalloped leaf edge. The leaves are sclerophyllous and scabrous in many species. The flowers exhibit a yellow (*Davilla*) or white (*Curatella* and *Doliocarpus*) corolla, which is often deciduous. The androecium has numerous stamens; the gynoecium possesses one to many free carpels; the seeds are arillated and dispersed by ants and birds in neotropical species (Kubitzki, 2004). Table 1 lists the Cerrado Dilleniaceae species.

Occurrence data and Environmental data

Were obtained 570 occurrence records for 13 species compiled from herbaria in Brazil and international Herbaria (Tab. 2). The number of specimens from individual taxa can be seen in tab. 1. Specimens were properly identified by experts or by virtual herbarium analyses. The environmental data are derived from Bioclim 30 arc-seconds resolution (http://www. worldclim.org/current) derive from AMBIDATA INPE http://www.dpi.inpe.br/Ambdata/download.php (Tab. 3). The statistic Jackknife test was performed for all species. The policy boundaries were obtained from the Ministry of the Environment (MMA - http://mapas.mma.gov.br) and the Brazilian Institute of Geography Statistics (IBGE - http://www.ibge.gov.br).

Species distribution modeling and species richness

Several modeling algorithms are available, including MaxEnt (Elith *et al.,* 2011), developed by Phillips *et al.* (Phillips *et al.,* 2004), which models geographical distributions based on maximum entropy. The MaxEnt algorithm was compared with other algorithms and produced more robust results (Araujo *et al.,* 2008). We applied the option to output logistic results with 50% random test, while all other parameters were program standards functions.

The results are images that represent the probability of occurrence in a range of distinctive colors, indicating where conditions are adequate (values close to 1) to inadequate (values close to 0). Species richness was determined using the program DIVA-GIS (http://www.diva-gis.org/). All results were transformed in distribution maps using DIVA-GIS containing environmental conservation areas and policy boundaries.

RESULTS

The Cerrado possesses 12 species of Dilleniaceae, 8 these are endemic*. The species *Curatella americana, Davilla elliptica*, Davilla grandiflora*, Davilla lacunosa*, Davilla nitida, Doliocarpus dentatus,* and *Doliocarpus brevipedicellatus* are widely distributed in the Cerrado (Figs. 1, 3, 4, 5 and 6). The species *Davilla cearensis*, D. minutifolia*, D. villosa*, D. angustifolia**, and *Doliocarpus elegans** are endemic with restricted occurrence areas into the Cerrado (Figs. 1, 2, 4 and 6). E.g. *D. villosa* (Fig. 2 C) are restricted to northern Cerrado biome from Jalapão region. *D. cearensis* (fig. 2 D) occur only in northern edge of the Cerrado biome, especially in Ceará state. *Curatella americana* and *Davilla nitida* are neotropical species distributed in all Cerrado biome and neotropical savannas (Figs 1 and 5). Many species overlap their distributions in many localities, particularly species as *C. americana* and *D. elliptica* (Figs. 1 A and 3 E), which are partially sympatric. Eight species, including *Davilla angustifolia*, *D. villosa, D. cearensis, D. elliptica, D. lacunosa, D. grandiflora*, *D. minutifolia, and Curatella americana* occurs in physiognomy of cerrado *stricto sensu* and cerrado rupestre (Figs. 1 - 4).

The species *Davilla nitida, Doliocarpus brevipedicellatus, Doliocarpus dentatus and Doliocarpus elegans* are lianas that occurs in seasonal forests (Figs. 5 I, J, and 6 K, L). However, *Doliocarpus elegans* are endemic with restricte occurrence areas in riparian forest to altitudes above 1.000m in Cerrado (Fig. 6 L). Moreover, *D. angustifolia* is an species of scandent shrub endemic with restrictive occurrence areas in Cerrado at altitudes above 1.200m (Fig. 1 B). The species richness of Dilleniaceae in Cerrado indicated areas supporting a total of 8 species (Fig. 7 M). These areas belong to the Brazilian plateau, especially the Serra of Pireneus, Chapada of Veadeiros, Espigão Mestre, Serra of Espinhaço and Serra of Caiapó (see Fig. 7 M). These areas have the most important biological natural reserves of the Cerrado, such as: National Parks: Chapada of Veadeiros, Sempre Viva, Serra of Cipó, and Emas (Fig. 7 N). Thus, the results of species richness and species distributions indicate that network biological reserves protect partially the Cerrado biodiversity (Fig. 7 N). Moreover, the Cerrado priority conservation areas indicated by the Brazilian Ministry of Environment (MMA) correspond with many species distribution and richness of Dilleniaceae in the Cerrado, indicated by our study (Fig. 7 N).

Table 1. Dilleniaceae species list of the Cerrado

Species	Habitat	Distribution
1 - *Curatella americana (n=100)*	Cerrado and Savannas	Neotropical
2 - *Davilla angustifolia (n=16)*	Cerrado (endemic)	Brazil (BA, GO and MG)
3 - *Davilla aymardii (n=12)*	Cerrado (endemic)	Brazil (MA, BA, PI and TO)
4 - *Davilla cearensis (n=9)*	Cerrado/restinga (endemic)	Brazil (CE, MA and PI)
5 - *Davilla elliptica (n=161)*	Cerrado (endemic)	Brazil (BA, DF, GO, MT, MG, TO and SP)
6 - *Davilla grandiflora (n=40)*	Cerrado (endemic)	Brazil (BA, GO, MT and TO)
7 - *Davilla lacunosa (n=12)*	Cerrado (endemic)	Brazil (GO and MT)
8 - *Davilla minutifolia (n=7)*	Cerrado (endemic)	Brazil (BA and GO)
9 - *Davilla nitida (n=89)*	Forest and Savanna	Neotropical
10 – *Davilla villosa* Eichler (x)	Cerrado (endemic)	GO, TO, MA, PI and BA
11 - *Doliocarpus brevipedicellatus (n=23)*	Forest and Cerrado	Neotropical
12 - *Doliocarpus dentatus (n=45)*	Forest and Cerrado	Neotropical
13 - *Doliocarpus elegans (n=27)*	Cerrado (endemic)	Brazil (GO, DF, MG e BA)

Legend: Brazilian States - AM – Amazonas; BA – Bahia; CE – Ceará; DF – Distrito Federal; GO – Goiás; MA – Maranhão; MT – Mato Grosso; MG – Minas Gerais; SP – São Paulo; PI – Piauí; TO – Tocantins.

Table 2. Major botanical collections consulted

R - Herbarium, National Botanic Garden of Belgium, Meise, Belgium;
INbio – National Biodiversity Institute, Santo Domingo de Heredia, Costa Rica;
CEN* - Embrapa Genetic Resources and Biotechnology (Cenargen), Brasilia, Brazil;
EAC * - Herbarium Prisco Bezerra, Fortaleza, Ceara, Brazil;
HTO* - Herbarium of the Federal University of Tocantins, Porto Nacional, Tocantins, Brazil
IBGE* - Herbarium Ecological Reserve of IBGE, Brasilia, Brazil;
INPA* - Herbarium of the National Institute of Amazonian Research, Manaus, Amazonas, Brazil;
IAC* - Herbarium of Agronomic Institute of Campinas, Campinas, Sao Paulo, Brazil;
K - Herbarium, Royal Botanic Gardens, Kew, England;
M* - Herbarium Botanische Staatssammlung, Munich, Germany;
MG - Herbarium Emilio Goeldi Paraense Museum, Belem, Brazil;
MO - Missouri Botanical Garden, St. Louis, USA;
NY - Herbarium, New York Botanical Garden, New York, U.S.A;
R* - Herbarium of the National Museum of Rio de Janeiro, Rio de Janeiro, Brazil;
RB* - Herbarium of the Botanical Garden of Rio de Janeiro, Rio de Janeiro, Brazil;
SP* - USP Herbarium, Maria P. Eneyda K. Fidalgo, São Paulo, Brazil;
SPFR* - Herbarium of the Department of Biology, FFCLRP, USP, Brazil;
UB* - Herbarium of the University of Brasilia, Brasilia, Brazil;
UFG* - Herbarium of the Federal University of Goias, Goiania, Brazil;
UNITINS* - Herbarium University of Tocantins, Palmas, Tocantins, Brazil;
UFP - Herbarium of the Federal Universidad of Pernambuco, Recife, Brazil.

Table 3. Environmental dada

bio1	Averege annual temperature
bio2	Average annual temperature
bio3	Isotermality ((bio2/bio7) (* 100))
bio4	Temperature seasonality (standard deviation * 100)
bio5	Maximum temperature of the warmest month
bio6	Minimum temperature of the coldest month
bio7	Annual temperature range (BIO5-bio6)
bio8	Average temperature of the wettest quarter
bio9	Average temperature of the driest quarter
bio10	Average temperature of the hottest quarter
bio11	Average temperature of the coldest quarter
bio12	Annual rainfall
bio13	Rainiest month precipitation
bio14	Driest month of precipitation
bio15	Seasonality of rainfall (coefficient of variation)
bio16	Precipitation of the wettest quarter
bio17	Driest quarter of precipitation
bio18	Hottest quarter of precipitation
bio19	Coldest quarter of precipitation
land cover	land cover
Tree cover	MODIS (Percent Tree Cover)
soil	soil cover maps
altitude	altitude
slope	Slope or gradient
orient.	Exposure or relief Orientation
hand	HAND (Height Above the Nearest Drainage - * hand_100
des.drain.	Density of Drenagem

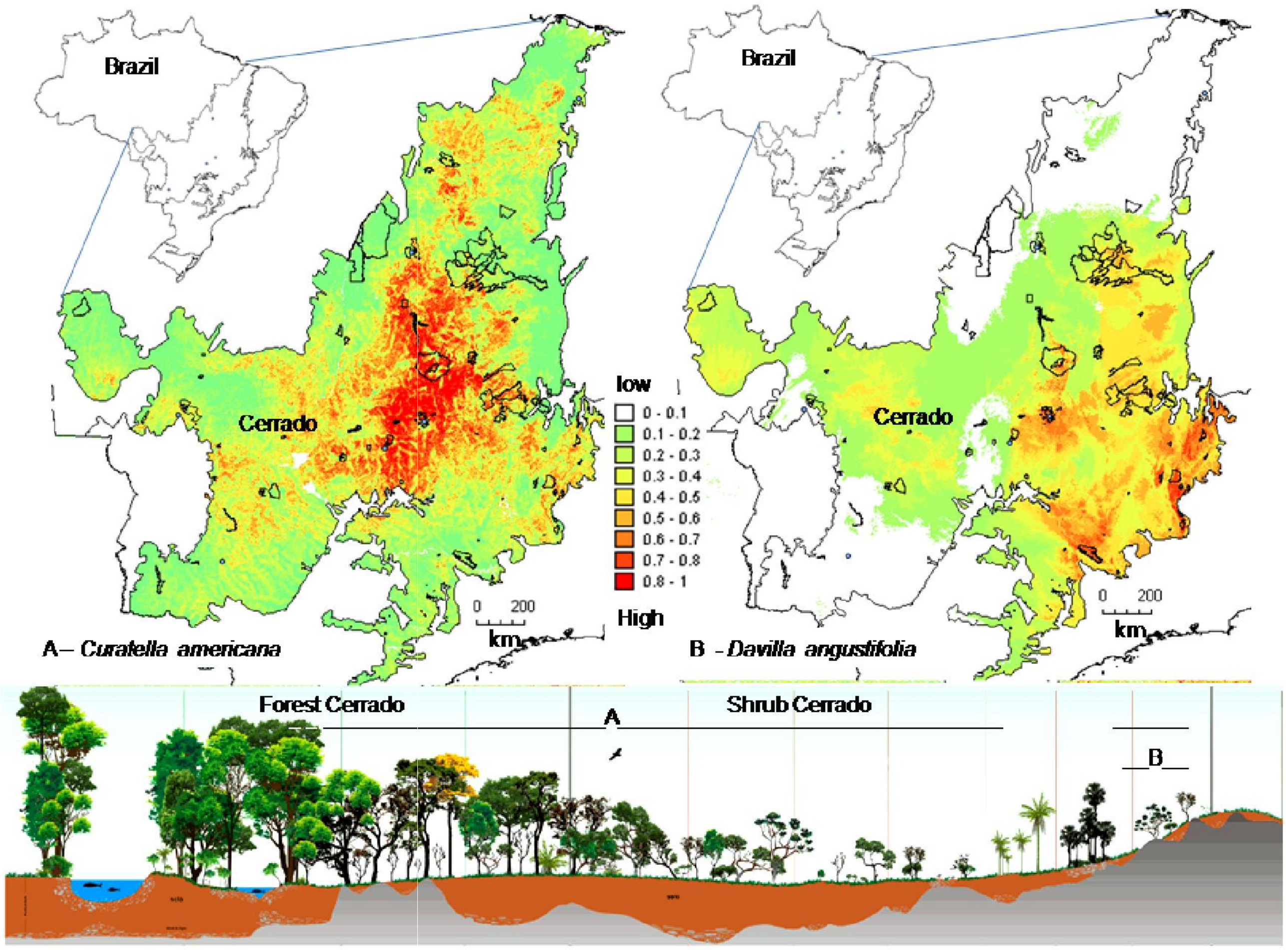

Figure 1. Distributional range of *Curatella americana* (A) and *Davilla angustifolia* (B) in Cerrado. High probability of occurrence close to 1. Line shows the type of vegetation for the species. Illustration. José Filipe Ribeiro. AUC = 0.910, 0.949, respectively

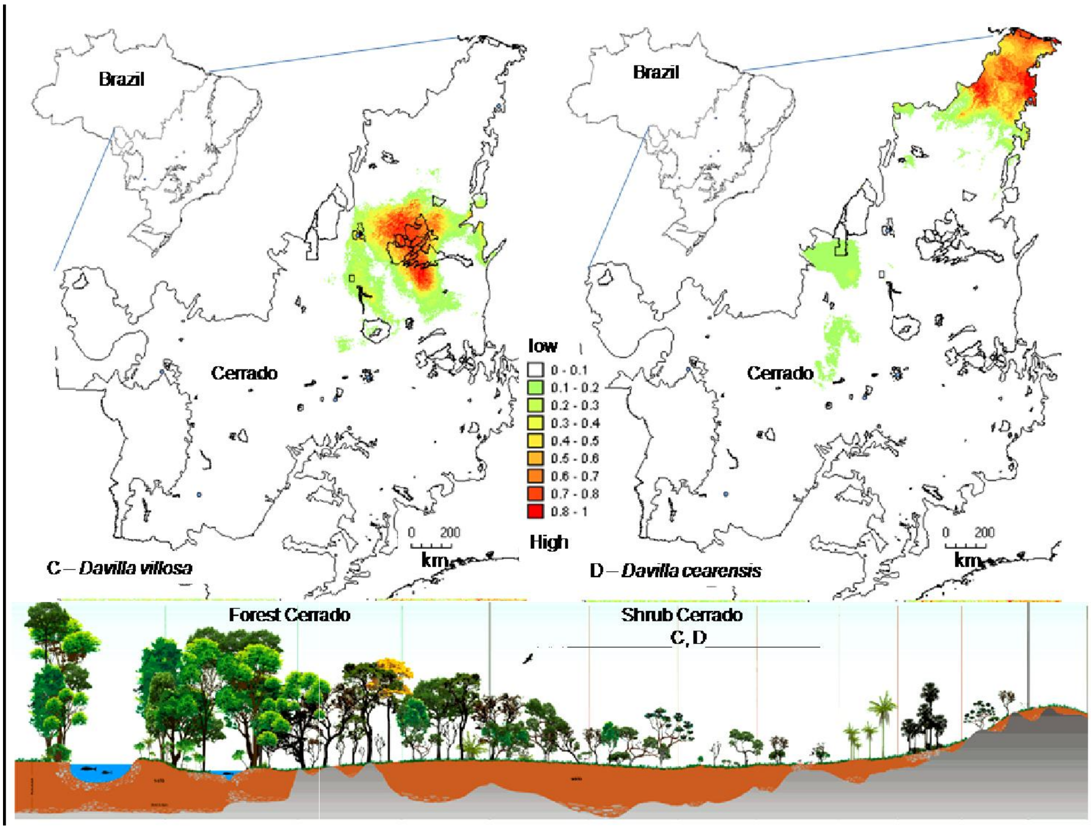

Figure 2. Distributional range of *Davilla villosa* (C) and *Davilla cearensis* (D) in Cerrado. High probability of occurrence close to 1. Line shows the type of vegetation for the species. Illustration. José Filipe Ribeiro. AUC = 0.995, 0.830, respectively

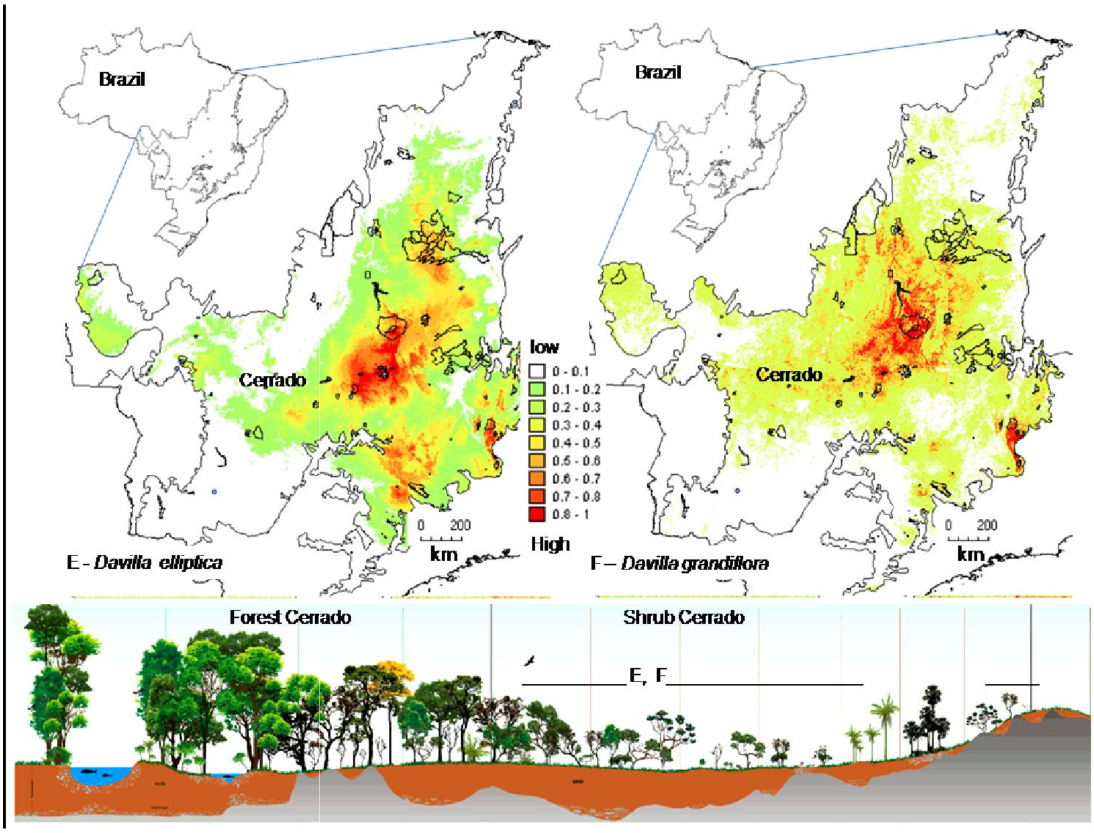

Figure 3. Distributional range of *Davilla elliptica* (E) and *Davilla grandiflora* (F) in Cerrado. High probability of occurrence close to 1. Line shows the type of vegetation for the species. Illustration. José Filipe Ribeiro. AUC = 0.952, 0.928, respectively

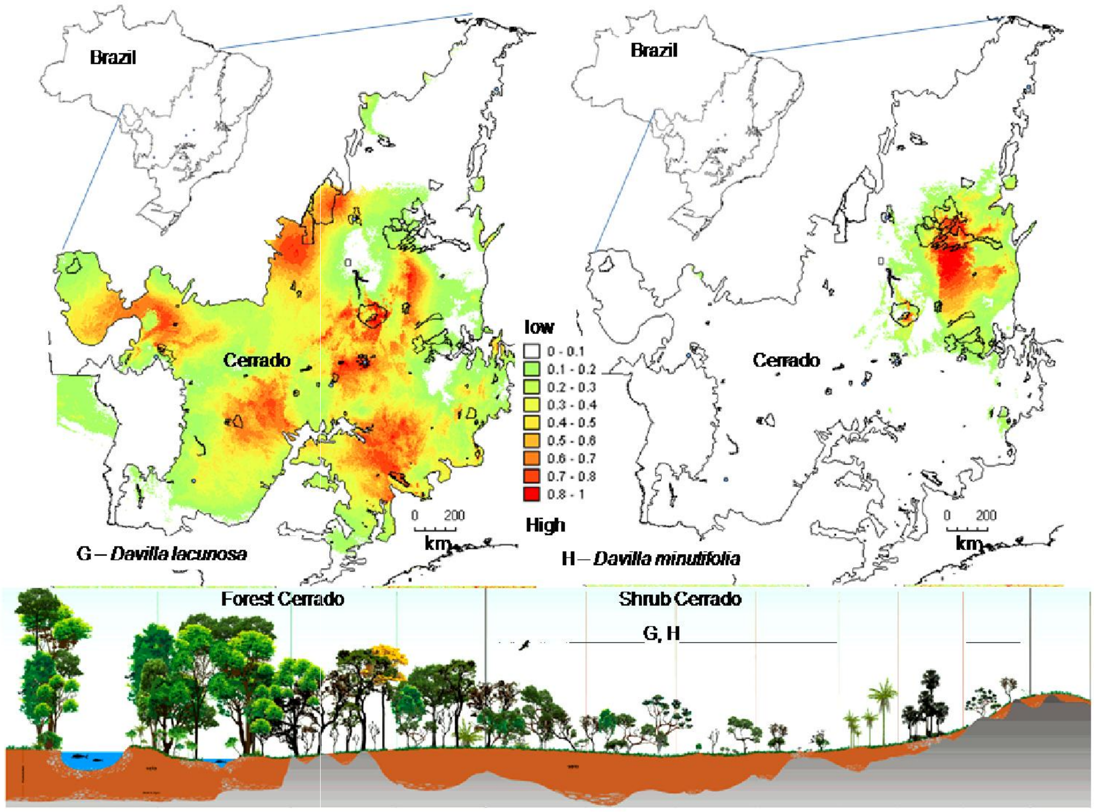

Figure 4. Distributional range of *Davilla lacunosa* (G) and *Davilla minutifolia* (H) in Cerrado. High probability of occurrence close to 1. Line shows the type of vegetation for the species. Illustration. José Filipe Ribeiro. AUC = 0.964, 0.995, respectively

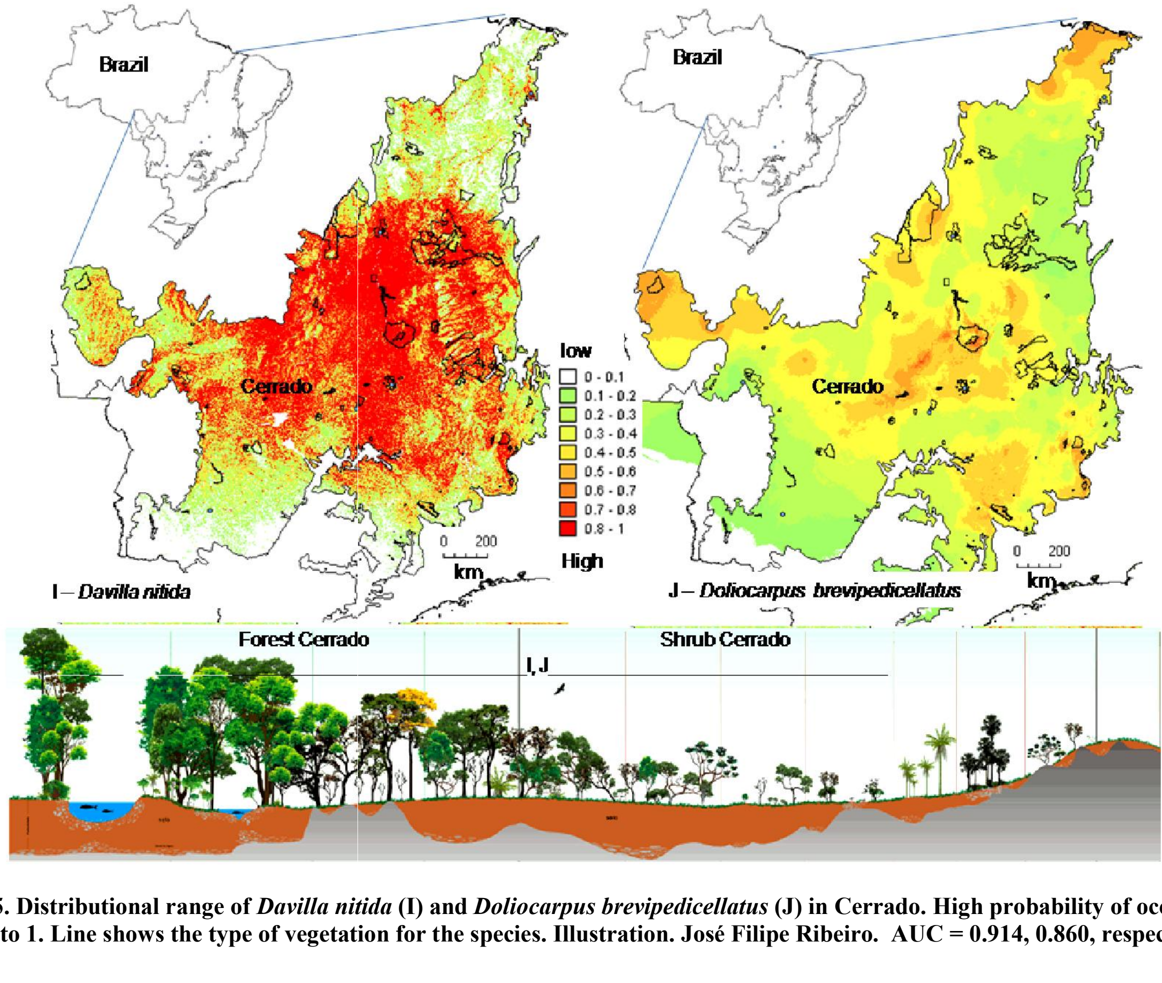

Figure 5. Distributional range of *Davilla nitida* (I) and *Doliocarpus brevipedicellatus* (J) in Cerrado. High probability of occurrence close to 1. Line shows the type of vegetation for the species. Illustration. José Filipe Ribeiro. AUC = 0.914, 0.860, respectively

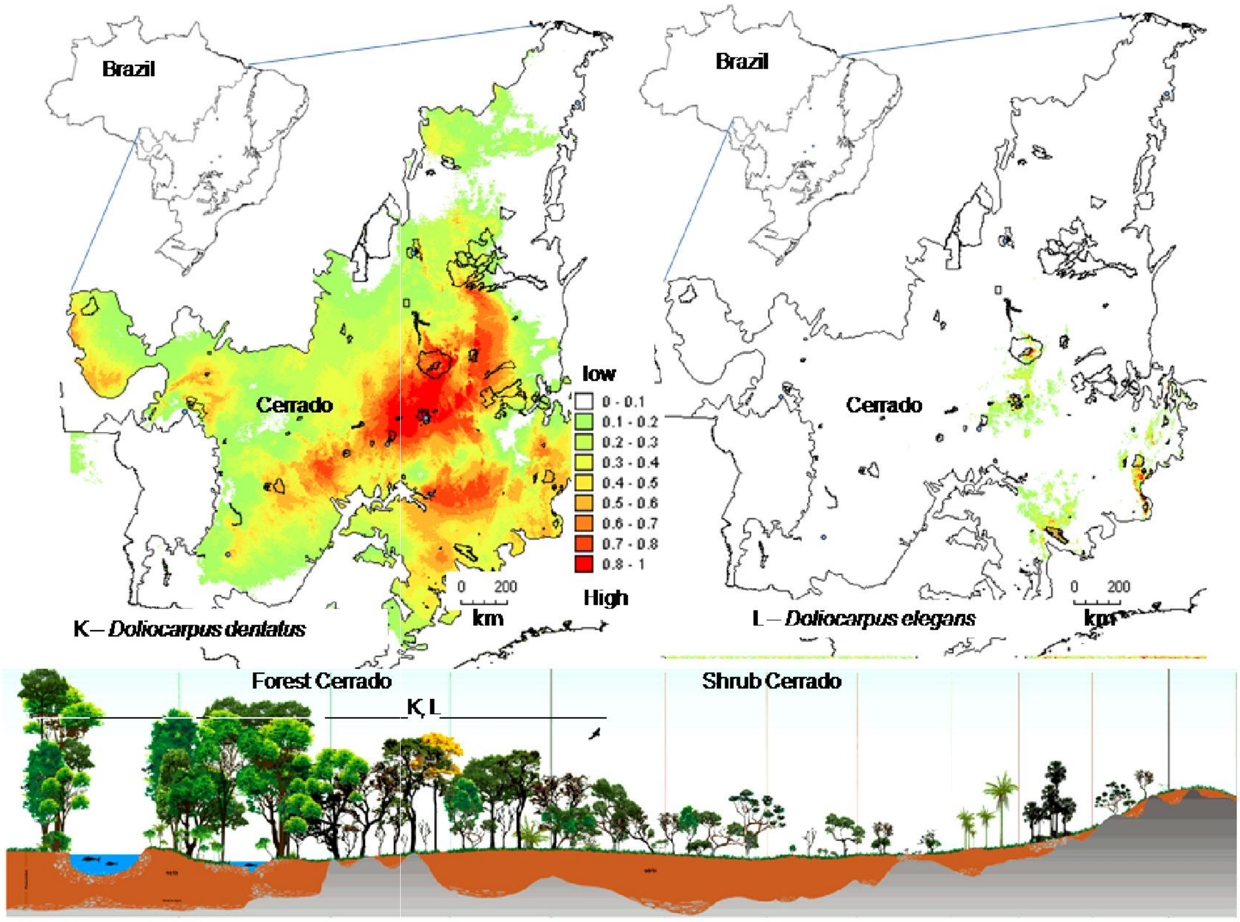

Figure 6. Distributional range of *Doliocarpus dentatus* (K) and *Doliocarpus elegans* (L) in Cerrado. High probability of occurrence close to 1. Line shows the type of vegetation for the species. Illustration. José Filipe Ribeiro. AUC = 0.962, 0.995, respectively

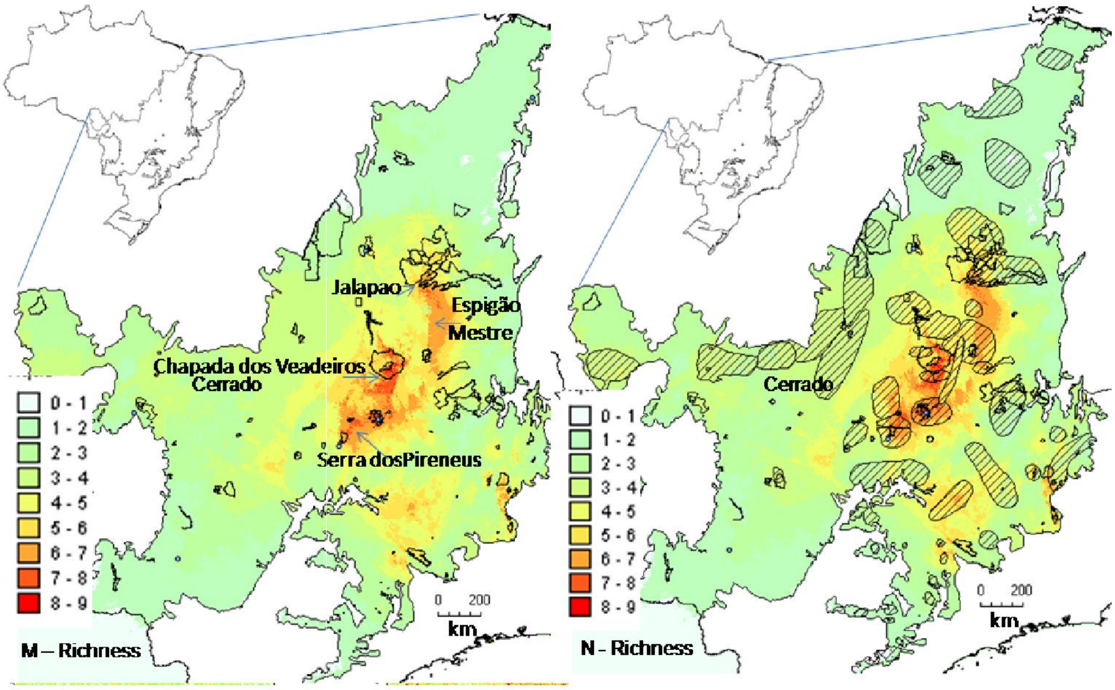

Figure 7. Species richness Compared with the reserves (M) and priority areas for conservation (N) in the Cerrado. Colors represent species richness (9 red and green species only one)

DISCUSSION

The species distribution maps can been used with relative success to investigate a variety of scientific issues (Guisan and Thuiller, 2005), with reliable results. The reliability of the results can be analyzed by the AUC statistic test (area-under-the-curve), representing the probability that the model correctly predicts the observed presences and absences. The AUC value from 0.5 are random assignments, tending to 1 indicate accurate predictions (Araújo, 2005). Thus, the high values of AUC obtained in this study between of 0.860 to 0.995, representing good performance of the results. The Dilleniaceae is important in abundance and frequency in Cerrado biome. Species such *Curatella americana* and *Davilla elliptica* possess major frequency and abundance in shrubs cerrado (*stricto sensu*) (Felfili *et al.,* 2002). These species have some studies due to occurrence throughout the Cerrado biome, cited in many papers (Felfili and Fagg, 2007). Unlike these, *Davilla angustifolia* and *Doliocarpus elegans* are rare and infrequently studied species, with only few samples data in herbaria (Pereira and Gomes-Klein, 2007), make it difficult, therefore, to definition of degree of threat for these species (IUCN, 2001). Thus, given the fragmented knowledge of biodiversity, the choice of surrogates of biodiversity is important aspect in conservation biology (Pinto *et al.,* 2008). Moreover, the urgency to conserve habitats and species, the time to conduct surveys of entire region is not available (Costa *et al.,* 2010). In this sense, we have made efforts in this respect, using the ecological modeling previously to predict species distribution in Cerrado to conservation (Pereira and Groppo, 2012). Moreover, we develop studies indicating priority areas for the conservation of species of this family for Atlantic forest (Pereira *et al.,* 2014). The results of Dilleniaceae species distribution indicated that many species overlapping their distributions i.e. are sympatric. *E.g. Curatella americana* can be considered niche generalist species (Peers and Thornton, 2012) or a top competitor with adaptations to fire (Pennington, 2009). The Dilleniaceae, especially species of *Curatella* and *Davilla* genera that are frequent in the Cerrado, are adapted to fires due to the presence of thick bark and exfoliating (Simon *et al.,* 2009). Furthermore, the Dilleniaceae have their seeds dispersed by birds (Stefanello, 2009), providing an advantage in colonizing habitats. The observed patterns for Dilleniaceae occurrence are due to large phytophysiognomical heterogeneity encountered in Cerrado, even at small scales (Ribeiro and Walter, 1998). The Cerrado vegetations occurs as mosaic of similar patches in disjunct sites this biome (Felfili, 2007). *E.g.* in higher altitude in Brazilian Cerrado plateau predominate small shrubs or grasses, while in altitude under 1.000m predominate shrubs and tree like *Davilla* and *Curatella,* respectively (Felfili, 1993). Evidence reveal spatial changing in biodiversity patterns ranging from tree, to shrub, and herbaceous species, due to local environmental changes as soils, water availability and topograph (Furley, 1999). The greatest biodiversity of Dilleniaceae species occurs in the cerrado *stricto sensu* (35%), in riparian forests occurs (30%) of species, resembling to pattern found in Cerrado (Mendonça *et al.,* 1998). The largest cerrado *stricto sensu* biodiversity is due to its increased geographical area. However, the seazonal forest and riparian forest despite occupying just 5% of Cerrado, support approximately 30% of total Cerrado species, emphasizing its conservation value (Martinelli *et al.,* 2014). Unfortunately, the seasonal forests are the most degraded and fragmented vegetation in this biome (Silva Pereira and Venturoli, 2011). The Cerrado supporting approximately 5% of the planet's life and an endemism index about 44% in 10.000 plant species (Machado *et al.,* 2004). The red book of Cerrado Flora indicates at least 578 rare species (Martinelli *et al.,* 2014). Many Dilleniaceae species are endemic, some of them endangered, for example, *Davilla angustifolia*, due to its restricted distribution and the reduction and loss of habitat quality, it is suggested that this species will be included in the category Endangered (Fraga, 2012). This region has global importance and was designated as biodiversity hotspot, but this area is currently vulnerable (Klink and Machado, 2005). Although the number of angiosperms have potential to increase of 10 - 20% due to discovery of rare species in hotspots, the current threats in this regions are leading to rapid extinction rates, as well as cryptic extinction, *i.e.* species loss prior to discovery/description by science (Pimm, 2000). The expansion of cropland in tropical countries is the principal cause of biodiversity loss (Phalan *et al.,* 2013). Currently, only 20% to 45% of original Cerrado vegetation remains unchanged (Tabor *et al.,* 2004), with only 35% non-anthropogenic and only 5% in protected areas (Ibama, 2010). At current rates of anthropogenic impact, the Cerrado biome may be completely lost by 2030 (Machado, 2004). The Cerrado "is in peaces" (Carvalho and De Marco Júnior, P., Ferreira, 2009), due to unfortunate circumstances like inadequate protected areas, combined with continued expansion of agriculture in Cerrado, such pastures, extensive soybeans crops and sugar cane, and recently introduction of *Eucalyptus* and *Pinus* forests in Cerrado.

Although crops such soybeans and sugarcane are gradually surpassing pastures (Ratter and Bridgewater, 2004), the cattle are touted as negative in maintaining the native areas, since they enter these areas looking for food or shelter, bringing invasive species and destroying the vegetation (Durigan and Siqueira, 2007). Soybean crops, create a dilemma of economic development versus environmental damage (Carvalho *et al.,* 2009; Richards *et al.,* 2012). Soybean plantations occupy great areas in Cerrado, *e.g.* the plateau of Espigão Mestre - Serra Geral Range and southern area of Chapada of Veadeiros, which is currently indicated as life refuge (Werneck *et al.,* 2012), with a high biodiversity of Dilleniaceae and other groups (Neto, 2013). However, this area has scarce environmental reserves (Fig. 7 N). The expansion of sugar cane cropping represents an environmental threat. It may increase deforestation pressure in the Amazon region (Martinelli, 2008; Neto, 2013). In Cerrado, this cropping sugar cane resulted in degradation in remnants. e.g. São Paulo State the Cerrado are degraded by fire and addition of pesticides. Although the fire is a natural factor in the Cerrado flora (Simon *et al*, 2009), the higher frequency (Brito and Ferreira, 2015), combined with invasive grasses has increased its effect (Araújo and Ferreira, 2012). This process leading to community changes (Hoffmann *et al.,* 2009) *e.g.* excessive homogenization of flora (Tabarelli *et al.,* 2012). Moreover, the conversion of Cerrado remnants in sugar cane cropland leads to a "cane sea, green desert" effect (Gonçalves, 2005). Thus, stimulated by biofuels policy, sugar cane croplands spreaded throughout the Brazilian Cerrado (Gonçalves, 2009), caused environmental impacts, threats to biodiversity, food price increases, and competition for water resources, etc. (Koh and Ghazoul, 2008). *Eucalyptus cultivation* is recent phenomenon and needs to be studied carefully. The Cerrado remnants near major cities, *e.g.* Goiânia, Anápolis, and Brasília, are replaced by Eucalyptus cropping, even in poor soils and rugged terrain that were unsuitable for other crops. The neglect for Cerrado conservation by governmental policy it is evident in the new Brazilian forest code legislation made controversial changes, e.g. the reduction of permanent preservation areas at gallery forest, in some cases from 30m to just 20m wide, contrary evidence that indicate at least 60 m in central Brazil are necessary for mammals species (Faleiro *et al.,* 2013). Thus, we need to definite conservation priorities on land-use as an alternative to balance the economic activities with environmental sustainable development. We need implement the measures proposed by Brazilian Ministry of the Environment (MMA) for priority conservation areas in Cerrado (see fig. 8 P). These measures include: biological inventories; creation of new reserves and ecological corridors. Together, constitute excellent alternatives to increase and improve the protection of Cerrado and its biodiversity. We might ask "how much biodiversity is worth", the response is that biodiversity has infinite value because human life is not possible without it (Toman, 1998).

Conclusion

The species distribution for Dilleniaceae resulted in data for discussion of Cerrado conservation. The Dilleniaceae shrubs species distributed in open savanna vegetation, which has high biodiversity, or endemic lianas that occur in riparian forest. Despite the small area of riparian forests within the Cerrado, data showed high biodiversity in these communities, indicating the enormous conservation value. Unfortunately the current reserves do not effectively address any species richness or rare species distribution in the Cerrado. We presented some of problems concerning the destruction of the Cerrado and indicated measures for its protection. Many Cerrado remnants inappropriate for agricultural activities are currently being deforested or impacted by various activities. In this case, the Cerrado priority conservation areas and reserves need be urgently implemented and expanded.

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REFERENCES

Alvares, C.A.S, Sentelhas, J.L., Gonçalves, P.C.M, Sparovek, J.L., 2013. Köppen's climate classification map for Brazil. Meteorol. Zeitschrift 22, 711–728.

Araújo MB, Thuiller W, Williams PH, R.I., 2005. Downscaling European species atlas distributions to a finer resolution : implications for conservation planning. *Glob. Ecol. Biogeogr*., 14, 17–30.

Araújo, F.M., Ferreira, L.G., Arantes, A.E., 2012. Distribution Patterns of Burned Areas in the Brazilian Biomes: An Analysis Based on Satellite Data for the 2002–2010 Period. *Remote Sens*. 4, 1929–1946.

Araújo, M.B. & Willians, P.H., 2000. Selecting areas for species persistence using occurrence data. *Biol. Conserv*., 96, 331–345.

Araujo, M.B., Ortega-Huerta, M.A., Peterson, T., 2008. Modeling Ecological niches and predicting geographyc distributions: a test of six presence-only methods. *Rev. Mex. Biodivers*., 79, 205–216.

Austin, M.P., 2002. Spatial prediction of species distribution: an interface between ecological theory and statistical modelling. *Ecol Model*., 157, 101–118.

Aymard, G., 1998. Dilleniaceae novae neotropicae VIII. Two new species of Davilla from Brazil. Brittonia 50, 51–55.

Aymard, G., Muller, J., 1994. Dilleniaceae Novae Neotropicae III. Sinopsis y adiciones a la Dilleniaceae del Peru. Candollea 49, 169–182.

Bojorquez-Tapia, L.A., Azuara, I., Ezcurra, E., and Flores-Vilela, O.A., 1995. Identifying conservation priorities in Mexico through geographic information systems and modeling. *Ecol. Appl*., 5, 215–231.

Brito, G.H.M., Ferreira, A.A., 2015. Identification of Susceptibility Fire Occurrence Forest for the State of Goiás in 2011 Year. *Nucleus*, 12, 135–144.

Carvalho, F.M.V., De Marco Júnior, P., Ferreira, L.G., 2009. The Cerrado into-pieces: Habitat fragmentation as a function of landscape use in the savannas of central Brazil. *Biol. Conserv*., 142, 1392–1403.

Costa, G.C., Nogueira, C, Machado, R.B., Colli, G.R., 2010. Sampling bias and the use of ecological niche modeling in conservation planning: a field evaluation in a biodiversity hotspot. *Biodivers Conserv*, 19, 883–899.

Couvreur, T.L.P, Forest, F.B., Baker, W., 2011. Origin and global diversification patterns of tropical rain forests: inferences from a complete genus-level phylogeny of palms. *BMC Biol*., 9, 44.

De Marco Júnior, P., 2007. Uso de modelos aditivos generalizados na estimativa de distribuição potencial de espécies. *Megadiversidade*, 12, 1–12.

Durigan, G., Siqueira, M.F., Franco, G.A.D., 2007. Threats to the Cerrado remnants of the state of Sao Paulo, Brazil. *Sci. Agric*., 64, 355–363.

Elith, J., Phillips, S.J., Hastie, T., Dudík, M., Chee, Y.E., Yates, C.J., 2011. A statistical explanation of MaxEnt for ecologists. *Divers. Distrib*., 17, 43–57.

Engler, R., Guisan, A., Rechsteiner, L., 2004. An improved approach for predicting the distribution of rare and endangered species from occurrence and pseudo-absence data. *J. Appl. Ecol*., 41, 263–274.

Faleiro, F.V., Machado, R.B., Loyola, R.D., 2013. Defining spatial conservation priorities in the face of land-use and climate change. *Biol. Conserv*., 158, 248–257.

Felfili, J.M., Fagg, C.W., 2007. Floristic composition , diversity and structure of the " cerrado " sensu stricto on rocky soils in northern Goiás and southern Tocantins, Brazil. *Rev. Bras. Bot*., 30, 375–385.

Felfili, J.M., Nogueira, P.E., Silva Júnior, M.C., Marimon, B.S., Delitti, E.B.C., 2002. Composição florística e fitossociologia do cerrado 103. *Acta bot. bras*., 16, 103–112.

Felfili, J.M., Silva Júnior, M.C., 1993. A comparative study of cerrado (sensu stricto) vegetation in Central Brazil. *J. Trop. Ecol*., 9, 277–289.

Fraga, C, N., 2012. Filogenia e revisão taxonômica de Davilla. Universidade Federal de Minas Gerais (UFMG).

Furley, P.A., 1999. The nature and diversity of neotropical savanna vegetation with particular reference to the Brazilian cerrados. *Glob. Ecol. Biogeogr*., 8, 223–241.

Gavrilets, S., 2009. Adaptive Radiation : Contrasting Theory with Data. *Science*, (80). 323, 732–737.

Gentry, A.H., 1992. Tropical forest biodiversity: distributional patterns and their conservational significance. *Oikos*, 63, 19–28.

Giullietti, A.M., Harley, R.M., Queiroz, L.P., Wanderley, M.G.L., Berg, C.V., 2005. Biodiversidade e conservação das plantas no Brasil. Megadiversidade 1.

Gonçalves, D.B., 2005. Cane Sea, Green Desert?. Dilemmas of sustainable development in sugarcane production in São Paulo, BR. Department of Production Engineering of Universidade Federal de Sao Carlos: Sao Carlos.

Gonçalves, D.B. 2009. Considerations about the recent expansion of sugarcane production in Brazil.

Guisan, A., Thuiller, W., 2005. Predicting species distribution: offering more than simple habitat models. *Ecol. Lett*., 8, 993–1009.

Hoffamann, W.A., Adasme, R., Haridasan, M., de Carvalho, M.T., Geiger, E.L., Pereira, M.B., Gotsch, S.G., Franco, A.C., 2009. Tree topkill, not mortality, governs the dynamics of savanna-forest boundaries under frequent fire in central Brazil. *Ecology*, 90, 1326–37.

Hopkins, M.J.G., 2007. Modelling the known and unknown plant biodiversity of the Amazon Basin. *J. Biogeogr*., 34, 1400–1411.

Horn, J.W., 2009. Phylogenetics of Dilleniaceae using sequence data from four plastid loci (rbcL, infA, rps4, rpl16 INTRON). *Int J Plant Sc*., 170, 794–798.

Hunter, M.L., Gibbis, J.P., 2006. Fundamentals of conservation biology, in: Wiley-Blackwell (Ed.), Malden, MA, pp. 252–276.

Ibama, 2010. Unidades de Conservação Federais. Brasil: Brasília.

IUCN Red List Categories and Criteria: Version 3.1., 2001.

Johnson, C.J., Gillingham, M.P., 2005. An evaluation of mapped species distribution models used for conservation planning. *Environ. Conserv*, 32, 117–128.

Joppa, L.N., Roberts, D.L., Pimm, S.L., 2011. How many species of flowering plants are there? *Proc. R. Soc B* 278, 554–9.

Klink, C.A. and, Machado, R.B., 2005. A conservação do Cerrado brasileiro. *Megadiversidade*, 1, 143–155.

Koh, L.P., Ghazoul, J., 2008. Biofuels, biodiversity, and people: Understanding the conflicts and finding opportunities. *Biol. Conserv*., 141, 2450–2460.

Kubitziki, K. 1971. Doliocarpus, Davilla und verwandte gattungen (Dilleniaceae), 9th ed. Staatssamml, München.

Kubitzki, K., 2004. Dilleniaceae In: Flouring Plants of the Neotropics. Princeton University Press, Princenton, New Jersey., pp. 128 – 130.

Machado, R.B., Neto, N.B.R., Pereira, P.G.P., Caldas, E.F., Gonçalves, N.S., *et al*., 2004. Estimativas de perda da área do Cerrado brasileiro. C. Int. 23.

Martinelli, G., Messina, T., Filho, T.M.L.S., 2014. Livro vermelho da flora do Brasil - Plantas raras do Cerrado.

Martinelli, L.A., Filoso, S., 2008. Expansion of sugarcane ethanol production in Brazil: Environmental and social challenges. *Ecol. Appl*., 18, 885–889.

Mendonça, R.C., Felfili, J.M., Walter, B.M.T., Silva Júnior, M.C., Rezende, A.V. *et al*., 1998. Flora vascular do Cerrado., Cerrado, Ambiente e flora. Sano SM, *et al*., Planaltina, DF.

Murphy, B.P., Bowman, D.M., 2012. What controls the distribution of tropical forest and savanna? *Ecol Lett*., 15, 748–758.

Myers, N., 2003. Biodiversity Hotspots Revisited. Bioscience 53, 916.

Neto, L.M., Forzza, R.C., 2013. Biogeography and conservation status assessment of Pseudolaelia (Orchidaceae). *Bot. J. Linn. Soc*., 171, 191–200.

Pearson, R.G., 2007. Species ’ Distribution Modeling for Conservation Educators and Practitioners. Am. Museum Nat. Hist. 1–50.

Pearson, R.G., Raxworthy, C.J., Nakamura, M., Townsend, P.A., 2006. Predicting species distributions from small numbers of occurrence records: a test case using cryptic geckos in Madagascar. *J. Biogeogr*., 34, 102–117.

Peers, M.J.L., Thornton, D.H., Murray, D.L., 2012. Reconsidering the specialist-generalist paradigm in niche breadth dynamics: resource gradient selection by Canada lynx and bobcat. PLoS One 7, e51488.

Pennington, R.T., Lavin, M., Oliveira-filho, A., 2009. Woody Plant Diversity , Evolution , and Ecology in the Tropics : Perspectives from Seasonally Dry Tropical Forests. *Annu. Rev. Ecol. Evol Syst*., 40, 437–457.

Pereira, I.M. and Groppo, M., 2012. Ecological Niche Modeling: Using Satellite Imagery and New Field Data to Support Ecological Theory and its Applicability in the Brazilian Cerrado. *J. Ecosyst. Ecography,* 02, 2–4.

Pereira, I.M., and Gomes-Klein, V.L., 2007. Taxonomia e Ecologia da Família Dilleniaceae nos Estados de Goiás e Tocantins. *Rev. Bras. Biociências*, 5, 975–977.

Pereira, I.M., Gomes-klein, V.L., Groppo, M., 2014. Distribution and Conservation of Davilla (Dilleniaceae) in Brazilian Atlantic Forest Using Ecological Niche Modeling. *Int. J. Ecol*., 2014, 11.

Peterjohn, B.G., 2001. Some considerations on the use of ecological models to predict species’ geographic distributions. *Condor*, 103, 661–663.

Phalan, B., Bertzky, M., Butchart, S.H.M., Donald, P.F., Scharlemann, J.P.W., Stattersfield, A.J., Balmford, A., 2013. Crop expansion and conservation priorities in tropical countries. PLoS One 8, e51759.

Phillips, S.J., Dudík, M., Schapire, R.E., 2004. A maximum entropy approach to species distribution modeling. Twentyfirst Int. Conf. Mach. Learn. ICML, 04 69, 83.

Pimm, S.L., Raven, P., 2000. Extinction by numbers. Nature 403, 843–845.

Pinto, M.P., Diniz-filho, J.A.F., Bini, L.M., Blamires, D., Fernando, T., Rangel, L.V.B., 2008. Biodiversity surrogate groups and conservation priority areas : birds of the Brazilian Cerrado. Divers. Distr. 14, 78–86.

Primack, R.B., 2006. Essentials of conservations biology. Sunderland, MA.

Ratter, J.A., Bridgewate, R.S. Ribeiro, J.F., 2004. Estrutura do cerradão e da transição entre cerradão e floresta paludícola num fragmento da International Paper do Brasil Ltda., em Brotas, SP. Rev. Bras. Botânica 27.

Ratter, J.A., Ribeiro, J.F., Bridgewater, S., 1997. The Brazilian Cerrado Vegetation and Threats to its Biodiversity. Ann. Bot. 80, 223–230.

Raven, P.H., Jonathan, M.C., Chris, J., 2011. Introduction to special issue on biodiversity. Am. J. Bot 98, 333–335.

Ribeiro, J.F. and Walter, B.M.T., 1998. Fitofisionomias do bioma cerrado, in: Embrapa CPAC (Ed.), Cerrado: Ambiente E Flora. Sano SM, *et al*., Planaltina, pp. 89–166.

Richards, P.D., Myers, R.J., Swinton, S.M., Walker, R.T., 2012. Exchange rates, soybean supply response, and deforestation in South America. Globa Environ. Chang. Policy Dimens. 22, 454–462.

Ricklefs, R.E., 2004. A comprehensive framework for global patterns in biodiversity. Ecol Lett 7, 1–15.

Schulman, L., Toivonen, T., Ruokolainen, K., 2007. Analysing botanical collecting effort in Amazonia and correcting for it in species range estimation. *J. Biogeogr*., 34, 1388–1399.

Silva Pereira, B.A., Venturoli, F., Carvalho, A.F., 2011. Florestas Estacionais no Cerrado: Uma visão Geral. *Pesq. Agropec. Trop*., 41, 446–455.

Simon, M.F., Grether, R., Queiroz, L.P., Skema, C., Pennington, R.T., Hughes, C.E., 2009. Recent assembly of the Cerrado , a neotropical plant diversity hotspot , by in situ evolution of adaptations to fire. PNAS 106, 20359–20364.

Soberón, J., Nakamura, M., 2009. Niches and distributional areas: concepts, methods, and assumptions. PNAS 106 Suppl, 19644–19650.

Stefanello, D., 2009. Síndromes de dispersão de sementes em três trechos de vegetação ciliar (nascente, meio e foz) ao longo do rio Pindaíba, MT. Rev. Árvore 33, 1051–1061.

Stockwell, D.R.B., Peterson, A.T., 2002. Effects of sample size on accuracy of species distribution models. *Ecol Model*., 148, 1–13.

Tabarelli, M. Peres, C.A. Melo, F.P.L., 2012. The “few winners and many losers” paradigm revisited: Emerging prospects for tropical forest biodiversity. *Biol. Conserv*., 155, 136–140.

Tabor, K.; Steininger, M.; Machado, R.B. *et al*., 2004. Estimativas de perda da área do Cerrado brasileiro. C. Int. 23.

Toman, M., 1998. Why not to calculate the value of the world’s ecosystem services and natural capital. *Ecol. Econ*., 25, 57–60.

Urbina-Cardona, J.N., Flores-Villela, O., 2010. Ecological-niche modeling and prioritization of conservation-area networks for Mexican herpetofauna. *Conserv. Biol*., 24, 1031–41.

Werneck, F.P., Nogueira, C., Colli, G.R., Sites, J.W., Costa, G.C., 2012. Climatic stability in the Brazilian Cerrado: implications for biogeographical connections of South American savannas, species richness and conservation in a biodiversity hotspot. *J. Biogeogr*., 39, 1695–1706.

Wittmann, F., Householder, E., Piedade, M.T.F., de Assis, R.L., Schöngart, J., Parolin, P., Junk, W.J., 2013. Habitat specifity, endemism and the neotropical distribution of Amazonian white-water floodplain trees. *Ecography (Cop.).* 36, 690–707.

Zimmermann, N.E., Edwards jr., T.C., Graham, C.H., Pearman, P.B., Svenning, J.C., 2010. New trends in species distribution modelling. *Ecography (Cop.).* 33, 985–989.

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