



**UNIVERSIDADE ESTADUAL DE CAMPINAS
INSTITUTO DE BIOLOGIA**

EVERTON ALVES MACIEL

**LINKING PATTERNS AND PROCESSES IN TREE PLANT COMMUNITIES TO
CONSERVATION AND MANAGEMENT OF THE SOUTH AMERICAN
SAVANNAS**

**VINCULANDO PADRÕES E PROCESSOS EM COMUNIDADES ARBÓREAS AO
PLANEJAMENTO E MANEJO DA CONSERVAÇÃO DE SAVANAS DA AMÉRICA
DO SUL**

**Campinas
2020**

EVERTON ALVES MACIEL

**LINKING PATTERNS AND PROCESSES IN TREE PLANT COMMUNITIES TO
CONSERVATION AND MANAGEMENT OF THE SOUTH AMERICAN
SAVANNAS**

**VINCULANDO PADRÕES E PROCESSOS EM COMUNIDADES ARBÓREAS AO
PLANEJAMENTO E MANEJO DA CONSERVAÇÃO DE SAVANAS DA AMÉRICA
DO SUL**

Thesis presented to the Institute of Biology of the
University of Campinas in partial fulfilment of
the requirements for the degree of Doctor in Plant
Biology.

Tese apresentada ao Instituto de Biologia da
Universidade Estadual de Campinas como parte
dos requisitos exigidos para a obtenção do Título
de Doutor em Biologia Vegetal.

Orientador: Prof. Dr. Fernando Roberto Martins

ESTE ARQUIVO DIGITAL
CORRESPONDE À VERSÃO FINAL DA
TESE DEFENDIDA PELO ALUNO
EVERTON ALVES MACIEL ORIENTADA
PELO PROF. DR. FERNANDO ROBERTO
MARTINS

**Campinas
2020**

Ficha catalográfica
Universidade Estadual de Campinas
Biblioteca do Instituto de Biologia
Mara Janaina de Oliveira - CRB 8/6972

M187L Maciel, Everton Alves, 1982-
Linking patterns and processes in tree plant communities to conservation and management of the South American savannas / Everton Alves Maciel. – Campinas, SP : [s.n.], 2020.

Orientador: Fernando Roberto Martins.
Tese (doutorado) – Universidade Estadual de Campinas, Instituto de Biologia.

1. Florestas - Conservação. 2. Ecologia das savanas. 3. Áreas protegidas. 4. Levantamento florístico. 5. Plantas raras. 6. Biomassa vegetal. I. Martins, Fernando Roberto, 1949-. II. Universidade Estadual de Campinas. Instituto de Biologia. III. Título.

Informações para Biblioteca Digital

Título em outro idioma: Vinculando padrões e processos em comunidades arbóreas ao planejamento e manejo da conservação de savanas da América do Sul

Palavras-chave em inglês:

Forest conservation

Savanna ecology

Reserves (Protected areas)

Botanical surveys

Rare plants

Plant biomass

Área de concentração: Biologia Vegetal

Titulação: Doutor em Biologia Vegetal

Banca examinadora:

Fernando Roberto Martins [orientador]

André Olmos Simões

László Károly Nagy

Osmar Cavassan

Marcelo Leandro Bueno

Data da defesa: 18-09-2020

Programa de Pós-Graduação: Biologia Vegetal

Identificação e informações acadêmicas do(a) aluno(a)

- ORCID do autor: <https://orcid.org/0000-0002-5204-4457>

- Currículo Lattes do autor: <http://lattes.cnpq.br/8129349542026896>

Campinas, 18 de setembro de 2020

COMISSÃO EXAMINADORA

Prof. Dr. Fernando Roberto Martins

Prof. Dr. André Olmos Simões

Prof. Dr. László Károly Nagy

Prof. Dr. Osmar Cavassan

Prof. Dr. Marcelo Leandro Bueno

Os membros da Comissão Examinadora acima assinaram a Ata de Defesa, que se encontra no processo de vida acadêmica do aluno.

A Ata da defesa com as respectivas assinaturas dos membros encontra-se no SIGA/Sistema de Fluxo de Dissertação/Tese e na Secretaria do Programa Pós Graduação em Biologia Vegetal da Unidade Instituto de Biologia.

AGRADECIMENTOS

Agradeço a Deus, a quem recorro nos momentos de incerteza e, de onde tiro força para continuar quando tudo parece improvável.

Agradeço ao meu orientador, Prof. Fernando Roberto Martins, com quem aprendi muito sobre filosofia e ciência, por abrir as portas do Departamento de Biologia Vegetal da UNICAMP e pela orientação ao longo do meu doutorado. A orientação pelo Professor Fernando é um mergulho nas profundezas do conhecimento.

Agradeço aos professores Andreas Huth e Mateus Dantas de Paula, por terem me aceitado no Helmholtz Centre for Environmental Research (Helmholtz-Zentrum für Umweltforschung GmbH – UFZ), durante um ano de aprendizado, e por terem me orientado no desenvolvimento do capítulo 3 da tese. Agradeço também à professora Valéria Forni Martins, por ter me colocado em contato com a equipe do UFZ e pelas discussões relacionadas ao capítulo 3 da tese.

Agradeço aos meus pais, Maria da Paz e Amerino Maciel, e irmãos, Wellington, Cleber, Tatiane, Ester e Manuel, por me apoiarem em cada passo da minha vida.

Agradeço ao Prof. Fernando Martins e a Profa. Eliana Forni-Martins, pela amizade e carinho que demonstraram por mim. Agradeço-lhes também por terem me emprestado uma chácara para eu morar quando eu estava sem bolsa, onde permaneci mesmo depois de ter sido contemplado com uma. Naquele local, pude desfrutar da mais absoluta paz e tranquilidade.

Agradeço aos professores que contribuíram com dados para esta tese: Ary T. Oliveira-Filho, Antônio Laffayette e Leandro T. A. Vieira. Em especial, gostaria de agradecer ao Prof. Ary T. de Oliveira-Filho que não apenas cedeu os dados das savanas da América do Sul, como também discutiu muitos pontos relacionados aqueles dados.

Agradeço aos amigos e colegas que fiz ao longo do doutorado. Especialmente, agradeço a Frank S. Goessner pelo carinho e amizade, por ter visto e comentado minhas apresentações

prévias, inúmeras vezes. Agradeço também aos amigos Gil Nascimento-Harter, Thaíssa Engel, Fernanda Piccolo, André Giles, Luis C. Quimbayo Guzmán, Diogo Podadera, Eduardo Arlé, Rodrigo Mologni, André Martinez, Vinícius Londe, Anna Abrahão, Cínthia Silva, Laura Hernández, Clovis Tristão, Lucirene Rodrigues e Christian Redlich, seja pela ajuda ou pelos bons momentos que compartilhamos. Agradeço aos demais colegas e amigos não citados aqui, mas por quem tenho apreço e consideração.

Agradeço aos membros das bancas de qualificação e defesa, Maíra Padgurschi, Ingrid Kock David M. Lapola, Osmar Cavassan, André Simões, László K. Nagy, Marcelo M. Bueno e João D. Vital, por terem aceitado compor as bancas e pelas sugestões dadas para a melhoria da tese. Agradeço ao corpo docente que compõe o Programa de Pós-Graduação em Biologia Vegetal da UNICAMP pelo ensino de qualidade. Agradeço também a toda equipe da Coordenadoria de Pós-Graduação, que nos auxiliam na parte burocrática de forma eficiente.

Agradeço ao time FORMIND e a todos os membros do Departamento de Modelagem Ecológica (Departments Ökologische Systemanalyse – ÖSA) do UFZ por me acolherem e por me ajudarem sempre que precisei.

O presente trabalho foi realizado com apoio da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Código de Financiamento 001. Adicionalmente, eu gostaria de reconhecer a importância e agradecer pelo financiamento provido pelo Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) para estudos na Alemanha (Processo número: 290179/2017-3) e no Brasil (Processo número: 157587/2019-3).

*“Tivesse a noite límpida milhões de estrelas, mas
equidistantes e de igual brilho, como se admirariam o
Cruzeiro do Sul, a Estrela d’Alva, as Três Marias?
A diversidade é o encanto da vida”*

Leopoldo Magno Coutinho

RESUMO

As savanas da América do Sul (SAS) estão entre os biomas mais biodiversos do mundo que, apresenta grande lacuna de conhecimento (Déficit Linneano e Wallaceano) e de conservação, além de estar ameaçado por diversos fatores. No presente estudo, abordamos as seguintes questões na SAS: (i) Qual a importância do déficit florístico da SAS? (ii) A rede de Áreas Protegidas (APs) são suficientes para conservar as espécies arbóreas raras e comuns da SAS? (iii) A mudança no clima e na frequência do fogo e a defaunação tem efeito sinérgico na performance de diferentes grupos funcionais de árvores da SAS? Usamos os registros de árvores de levantamentos florísticos e fitossociológicos não identificados até o nível de espécie como um descritor do déficit florístico; as sete formas de raridade de Rabinowitz para avaliar o status de proteção da flora arbórea da SAS; e, três atributos funcionais – fenologia foliar, capacidade de rebrota e dispersão de sementes – para avaliar o efeito sinérgico dos fatores antrópicos na performance de espécies de árvores da SAS. Descobrimos: i) maior déficit florístico em levantamentos fitossociológicos do que em florísticos; ii) famílias muito diversas como Myrtaceae, mas também pouco diversas como Moraceae, apresentaram grande déficit florístico; iii) maior déficit florístico nas regiões periféricas do Cerrado; iv) o déficit florístico foi um preditor fraco da riqueza de espécies; e v) o déficit florístico não mudou ao longo do tempo. Descobrimos que 40,76% de 2.203 espécies de árvores da SAS eram raras. Dessas 2.203 espécies, 37,49% eram estenotópicas (distribuição restrita), 23,97% eram estenoécias (especialistas de ecorregião) e 28,01% tinham população escassa. Algumas ecorregião como Campos Rupestres, apresentaram muitas espécies raras não encontradas em nenhum outro lugar. Nosso estudo, portanto, revela a importância de revisar a lista de ecorregiões prioritárias para conservação (Global200). Existe um efeito sinérgico da mudança climática, do regime do fogo e da defaunação na perda de biomassa vegetal, podendo causar perda de mais de 70% da biomassa acima do solo, sobretudo em espécies decíduas, que não rebrotam após incêndios e são dispersas por animais. Isso mostra que a perda de biomassa vegetal da SAS resulta tanto de efeitos diretos como a incapacidade de lidar com perturbações, e efeitos indiretos como a perda de dispersores de sementes.

Palavras-chave: prioridade da conservação, déficit Linneano, déficit Wallaceano, espécies raras, biomassa acima do solo

ABSTRACT

The South American savannas (SAS) are among the more biodiversity biomes in the world which presents a floristic shortfall (Linnean and Wallace shortfall), a gap of conservation and also face several threats to biodiversity. In this study, we address the following questions in SAS: (i) What is the importance of the floristic deficit of SAS? (ii) Do protected areas enough to conserve rare and common SAS tree species? (iii) How do the synergism of climate change and the frequency of the fire and defaunation affect the performance of different plant functional types of SAS? The records of unidentified tree species were used to quantify the floristic shortfall. The seven forms of rarity were used to analyse the conservation gap in PA. Three traits - leave phenology, resprout capacity, and seed dispersal - was used to assess the synergistic effect of anthropic factors on the performance of SAS tree species. We found: i) greater floristic shortfall in phytosociological than in floristic surveys; ii) huge floristic shortfall in both highly diverse families as Myrtaceae, and low diverse as Moraceae; iii) a floristic shortfall mainly in peripheral regions of the Cerrado; iv) floristic shortfall was a poor predictor of species richness, and v) floristic deficit did not change over time. Of the 2,203 species, 40.76% were rare forms. Of these 2,203 species, 37.49% were stenotopic (restricted distribution in SAS), 23.97% were stenoecius (ecoregion specialists) and 28.01% had a sparse population. Some ecoregion such as Campos Rupestres had many rare species not found anywhere else. Our study, therefore, reveals the importance of reviewing the list of priority ecoregions for conservation (Global200). There is a synergistic effect of the change on climate fire and defaunation on the plant biomass loss. In some cases, the total biomass loss exceeded 70%. Deciduous species, which do not resprout after fires and are dispersed by animals, showed the highest rate of biomass loss. This shows that SAS plant biomass loss results from both direct effects such as an inability to deal with disturbances, and indirect effects such as loss of seed dispersers.

Keywords: priority conservation, Linnean shortfall, Wallacean shortfall, rare species, aboveground biomass

SUMÁRIO

CAPÍTULO 1: Introdução geral	11
1.1 Visão geral	11
1.2 Savanas da América do Sul.....	14
1.3 Escopo da tese.....	17
CAPÍTULO 2: Linnean and Wallacean shortfalls in the South American savanna tree flora: consequences for biodiversity conservation	21
CAPÍTULO 3: Rarity patterns in the tree flora of the South American savannas: are the protected areas enough?	51
CAPÍTULO 4: Defaunation and changes of climate and fire frequency have synergistic effects on biomass loss in South American savannas	84
CONSIDERAÇÕES FINAIS.....	113
REFERÊNCIAS.....	115
APÊNDICES.....	154
Supplementary material chapter 2	155
Supplementary material chapter 3	175
Supplementary material chapter 4	269
Anexo 1 Declaração de Bioética.....	280
Anexo 2 Declaração dos Direitos Autorais.....	281

CAPÍTULO 1: Introdução geral

1.1 Visão geral

A taxa de extinção de espécies no antropoceno já ultrapassa a do registro fóssil (Ceballos et al., 2017). Apenas para angiospermas, cerca de 600 espécies foram registradas como extintas até 2018 (Humphreys et al., 2019). Considerando que a taxa de extinção exata é difícil de precisar (Boucher et al., 2020), é possível que as estimativas atuais estejam subestimadas. Para que essa taxa de extinção seja contida, uma série de estratégias norteadas por princípios da conservação da biodiversidade devem ser desenvolvidas (Lindenmayer et al., 2006; Lindenmayer and Franklin, 2002). Nesse sentido, pesquisadores criaram, durante a décima reunião da Conferência das Partes (COP 10), em Nagoya (Campbell et al., 2014), a estratégia global para a conservação de plantas, com o objetivo geral de conter a perda contínua de espécies que vem ocorrendo (CBD, 2011). Dois objetivos específicos da estratégia global para a conservação de plantas (veja CBD, 2011) incluem: (I) compreender, documentar e reconhecer adequadamente a diversidade de espécies vegetais e, (II) conservar urgente e efetivamente a diversidade de espécies vegetais. Embora a ciência e as práticas de conservação tenham avançado em direção ao alcance desses objetivos (Fonseca and Venticinque, 2018; Zappi et al., 2015), para muitas regiões eles ainda estão longe de serem atingidos (Arruda et al., 2018; Corlett, 2016; Feeley, 2015; Feeley and Silman, 2011; Gomes et al., 2018; A. S. L. Rodrigues et al., 2004).

O conhecimento das espécies e suas distribuições é a base para a conservação da biodiversidade (Mace, 2004; Margules and Pressey, 2000). Não obstante, estima-se que 10-20% das espécies vegetais de angiospermas do mundo ainda não foram descritas (Joppa et al., 2010). Por exemplo, uma análise dos registros de plantas do global biodiversity information facility database (GBIF) depositados até 2013 mostrou que, cerca de 10% da América do Sul

não apresentava registros em coleções biológicas de plantas (Feeley, 2015). Essa falta de dados é observada, inclusive, na flora dos biomas mais estudados daquele continente tais como Amazônia (Ter Steege et al., 2015), Mata Atlântica (de Lima et al., 2015) e o Cerrado (Françoso et al., 2016).

Essa lacuna de conhecimento da flora se reflete na imprecisão taxonômica, ou seja, quando uma ocorrência não é identificada no nível de espécies (Caiafa and Martins, 2007; Troudet et al., 2017) e, passa a ser caracterizada nas amostras de dados como *sp*, *cf* ou *aff*. Essa lacuna de conhecimento afeta nossas conclusões baseadas nos padrões de biodiversidade em diferentes aspectos (Bini et al., 2006; Cardoso et al., 2011; Hortal et al., 2015; Whittaker et al., 2005). Se assumirmos, por exemplo, que os registros não identificados são espécies não descritas (déficit Linneano), isto é, novas espécies (Brown and Lomolino, 1998), então nossas conclusões seriam baseadas em uma fração sub-representativa da biodiversidade existente (Vale and Jenkins, 2012). Por outro lado, se assumirmos que os registros não identificados são parte da distribuição (déficit Wallaceano) de uma espécie já descrita (Brown and Lomolino, 1998), então nossas conclusões seriam baseadas em apenas uma parte da distribuição dessa espécie (Bini et al., 2006; Oliveira et al., 2016). Do ponto de vista pragmático, essa falta de conhecimento da distribuição real de uma espécie pode nos levar a classificar espécies raras como espécies com deficiência de dados (Corlett, 2016).

A riqueza das espécies raras compreende uma parte substancial das assembleias de espécies (Gaston, 2012). Além disso, as espécies raras desempenham um papel funcional na estrutura e função das assembleias, não suportado por espécies comuns (Chapman et al., 2018; Gaston, 2012; Jain et al., 2014; Leitão et al., 2016; Lyons et al., 2005; Mi et al., 2012; Mouillot et al., 2013a; Soliveres et al., 2016). Finalmente, as espécies raras são consideradas espécies focais para a conservação porque serem limitadas por área, processos de dispersão e recursos

(Lambeck, 1999, 1997), além de serem mais susceptíveis as mudanças antrópicas do que espécies comuns (Lambeck, 1997; Sætersdal and Gjerde, 2011; Santoro et al., 2012).

O número de pesquisadores que concordam que espécies raras devam ser consideradas na tomada de decisão tem crescido (Gauthier et al., 2010; Kricsfalussy and Trevisan, 2014; Longton and Hedderson, 2000; Maciel et al., 2016; McIntyre, 1992; Rey Benayas et al., 1999). De acordo com Rabinowitz (Rabinowitz, 1981), raridade é um padrão observado quando a amplitude geográfica, a especificidade ao habitat e o tamanho populacional de uma espécie são combinados. A combinação desses atributos possibilita que as espécies de uma comunidade sejam classificadas em sete formas de raridade e uma forma comum (Rabinowitz, 1981). Na prática da conservação, as espécies raras são usadas numa abordagem espacialmente explícita para avaliar e ampliar a rede de áreas protegidas (Groves et al., 2002; Margules and Pressey, 2000). Em teoria, se os locais e os habitats onde essas espécies ocorrem forem protegidos, então as espécies que lá ocorrem também serão (Arponen, 2012; Kukkala and Moilanen, 2013).

Embora os padrões de raridade em uma comunidade sejam essencialmente importantes para o planejamento da conservação (Groves et al., 2002; Yu and Dobson, 2000), os processos subjacentes que geram tais padrões não devem ser ignorados na tomada de decisão (Marshall et al., 2020). Esses processos subjacentes ou regras de montagem refletem aspectos ecológicos que regulam os padrões emergentes da comunidade (Weiher and Keddy, 2001). Esses padrões emergentes da comunidade podem ser acessados através de estratégias funcionais, por exemplo, usando uma abordagem fisiológica (McGill et al., 2006) como fenologia foliar ou capacidade de rebrota (Nakashizuka, 2001), ou uma abordagem focada na interação como síndrome de dispersão de sementes (Suding et al., 2008; Weiher et al., 1998). No contexto da conservação, essa abordagem pode fornecer uma métrica importante para medir impactos das ações antrópicas na performance dos diferentes grupos funcionais de plantas (McGill et al., 2006; Mouillot et al., 2013b). Enquanto a abordagem baseada em padrões de comunidade

podem nos ajudar no planejamento em escala regional, a abordagem baseada em processos em comunidade pode nos ajudar no manejo da conservação em escala local (Marshall et al., 2020). Assim, padrões e processos em comunidades passam a ser complementares na tomada de decisão (Callicott et al., 1999).

1.2 Savanas da América do Sul

As savanas da América do Sul (SAS) compreendem as seguintes ecoregiões: Cerrado, Llanos, Llanos de Moxos (savana de Beni), Gran Sabana, savanas do Rio Branco-Rupununi, savanas costeiras da Guiana, Llanos del Magdalena (Solbrig, 1996) e Campos rupestres (Alves and Kolbek, 2010; Antar and Sano, 2019), além de encaves de savanas na Amazônia (Barbosa and Fearnside, 2004), Caatinga (Castro and Martins, 1999), Mata Atlântica (Costa-Lima and Chagas, 2019; Moura et al., 2011) e no Chaco (Kunst et al., 2006). Ao longo dessa extensão, a SAS apresenta alta heterogeneidade de habitats (Blydenstein, 1967; Hamilton et al., 2004; Sano et al., 2019; Solbrig, 1996), que proporciona alta diversidade de plantas e elementos florísticos particulares a cada região (Andrade et al., 2018; Bridgewater et al., 2004; Ratter et al., 1996).

No que concerne a fitofisionomia, a savana pode ser caracterizada como um complexo de vegetação composto por dois estratos (Fig. 1): um lenhoso (woody layer), constituído por um componente silvestre esparsa (arbustos e árvores) imerso em um estrato graminoso contínuo (ground layer), onde predominam espécies de via fotossintética C₄ (Ratnam et al., 2011; Solbrig, 1996). Dependendo da razão entre esses estratos e a da altura do estrato lenhoso, a savana pode ser classificada em savana aberta (open savanna), savana arborizada (woody savanna) ou savana florestada (savanna woodland). A savana aberta é uma fisionomia com um estrato lenhoso < 7m de altura, composto por formas arbustivo-arbóreas com cobertura do solo de 10%. A savana arborizada apresenta altura do estrato superior entre 7-14m, as árvores são a forma predominante no estrato lenhoso e a cobertura do solo pode variar entre 40% e 60%. Já

a savana florestada apresenta uma altura superior a 15m, sendo as árvores a forma predominante no estrato lenhoso, com mais de 70% de cobertura do solo (Fig. 1).

O balanço fisionômico entre savana aberta e florestada depende de muitos fatores tais como clima, fogo e solo, o que caracteriza a savana como um piropedobioma (Coutinho, 2006; Langan et al., 2017). O clima predominante nas savana é o sazonal, com seis meses secos e seis meses com precipitação variando entre 400 e 1500 mm/ano, e temperatura média anual é 24°C (Walter, 1986). Na estação seca, o estoque de água no solo é o que mantém a vegetação, sendo que a redução desse estoque limita a formação florestal e favorece a formação de savana (Lehmann et al., 2011; Murphy and Bowman, 2012). Os incêndios naturais são parte integrante da savana (Pivello, 2011), estando o maior número de incêndios relacionado a savana aberta, enquanto a supressão de incêndios favorece a formação savana florestada (Durigan et al., 2007). Solos de savana aberta são menos ricos em nutrientes do que os solos de savana florestada, resultado de uma menor produção de matéria orgânica e dos incêndios mais frequentes (Murphy and Bowman, 2012). Assim, o balanço fisionômico entre savana aberta – arbustivo – arbóreas – florestada depende de uma complexidade de fatores ambientais que atuam para determinar a fisionomia predominante (Felfili and Felfili, 2001; Furley, 1992; Langan et al., 2017; Sarmiento and Monasterio, 1975).

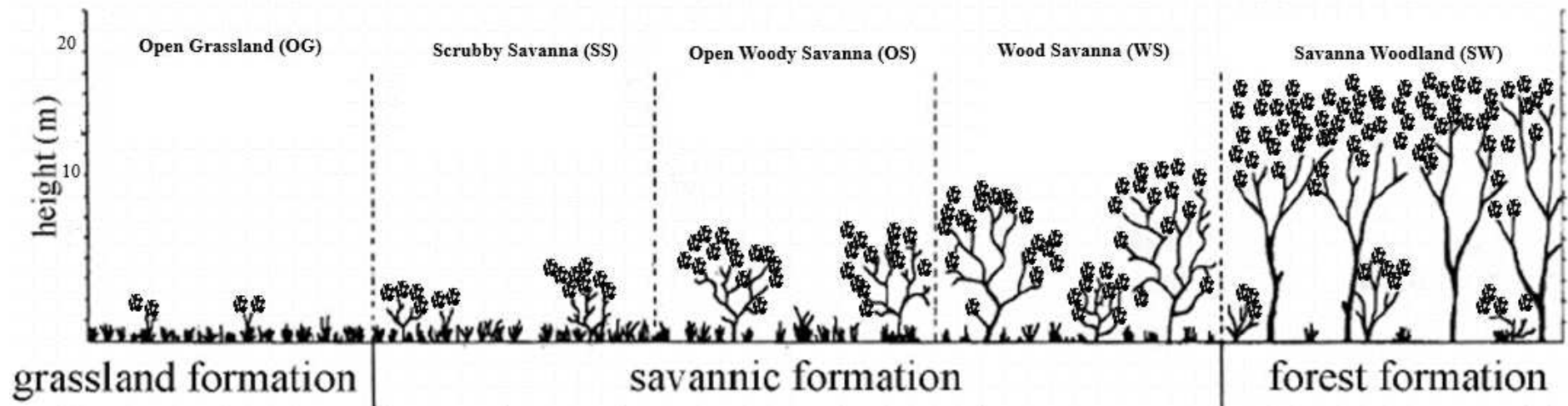


Fig. 1. Esquema de classificação da savana variando de savana aberta para savana florestada. Modificado de Coutinho 1971.

1.3 Escopo da tese

As savanas da América do Sul (SAS) apresentam grande lacuna no conhecimento da flora (Feeley, 2015; Franoso et al., 2016), uma lacuna conservao de esp cies (Oliveira et al., 2017; Rodrigues et al., 2004), ao mesmo tempo em que est  exposta a muitos fatores que desencadeiam a perda de esp cies (Fernandes et al., 2018; Jarvis et al., 2010; Ramirez-Villegas et al., 2012) tais como mudanas clim ticas (Torres and Marengo, 2014), mudana no regime de inc ndios (Pivello, 2011) e defaunao (Galetti et al., 2018). No presente estudo, analisamos a SAS a luz de tr s quest es: (1) onde se concentra a lacuna do conhecimento da flora? (2) qual o status de proteo das esp cies arb reas raras e comuns? (3) como diferentes fatores antr picos podem afetar a performance de diferentes grupos funcionais de plantas?

Para responder as perguntas 1 e 2, usamos uma abordagem baseada em padr es em comunidades. Para isso, os registros taxon micos n o identificadas at  o n vel de esp cie (*spp.* *af.* e *cf.*) foram usados como um descritor da lacuna de conhecimento da flora (d ficit flor stico); e, as sete formas de raridade de Rabinowitz usadas para avaliar as lacunas de proteo na diversidade de  rvores da SAS. Para responder   pergunta 3, usamos os processos de fenologia foliar, capacidade de rebrota e dispers o de sementes para avaliar o efeito das mudanas antr picas na performance da vegetao arb rea da SAS. Especificamente, o efeito da mudana clim tica (aumento de CO₂, e da temperatura m dia anual e diminuio da precipitao), o aumento na frequ ncia de inc ndios e a defaunao foram usados como indicador do efeito antr pico. A perman cia dos grupos funcionais de plantas foram medidas em termos de mudana na taxa de biomassa acima do solo, antes e p s dist rbio.

Aqui, n s aceitamos que o d ficit flor stico pode ser atribu do aos d ficits Linneano e Wallaceano, conceitos propostos para descrever e quantificar as lacunas de conhecimentos na biodiversidade (Brown and Lomolino, 1998). No primeiro cap tulo, fornecemos uma an lise

do déficit florístico na SAS com base em estudos fitossociológicos e florísticos. Explicamos como o déficit florístico pode ofuscar nosso conhecimento da diversidade de plantas e afetar a tomada de decisão, e propomos orientações para reduzir esse déficit florístico. Para realizar essa tarefa, colocamos cinco perguntas como diretrizes: i) Os levantamentos fitossociológicos apresentam maior déficit florístico do que os levantamentos florísticos? Esperávamos que os levantamentos fitossociológicos apresentassem maior déficit florístico porque indivíduos férteis e inférteis são amostrados, enquanto em levantamentos florísticos são coletados apenas indivíduos férteis. Como flores e frutos são a base para a identificação completa da maioria das espécies, sua ausência em indivíduos inférteis pode dificultar a identificação correta. ii) Existem alguns táxons com maior déficit florístico? Esperávamos que houvesse maior déficit florístico em táxons mais diversos, como Myrtaceae e Fabaceae, do que seria encontrado em táxons menos diversos. iii) Quais as ecoregiões da SAS têm o maior déficit florístico? Considerando que, a maioria das pesquisas se concentram na área core das ecoregiões, esperávamos encontrar maior déficit florístico em áreas marginais. iv) O déficit florístico depende do total de espécies amostradas em um levantamento? Como muitas espécies permanecem desconhecidas, esperávamos que o déficit florístico aumentasse à medida que o número de espécies amostradas aumenta. v) O déficit florístico mudou ao longo do tempo? Supondo que o conhecimento da flora de uma ecorregião aumenta com o tempo de estudos realizados, esperávamos uma redução do déficit florístico ao longo do tempo.

O status de conservação de uma espécie requer a análise da representatividade da rede de áreas protegidas (APs) em conservá-la (Margules and Sarkar, 2007). Alguns exemplos demonstram que as APs da SAS é insuficiente para proteger espécies ameaçadas e endêmicas de plantas, vertebrados e invertebrados (Goettsch et al., 2019; Oliveira et al., 2017). A eficiência das APs da SAS em conservar as espécies raras e comuns (Choe et al., 2019), no entanto, permanece desconhecida. No segundo capítulo, usamos o esquema de Rabinowitz

(Rabinowitz et al., 1984) e fornecemos a primeira quantificação de espécies raras e comuns das SAS. Mais especificamente, abordamos as seguintes questões: i) quais as formas de raridade da SAS? Considerando que a SAS apresenta alta riqueza de espécies arbórea, muitas das quais com populações pequenas (Castro et al., 1999), endêmicas (Myers et al., 2000) e com alcance geográfico restrito (Bridgewater et al., 2004), esperávamos que as espécies da SAS tivessem todas as sete formas de raridade. Adicionalmente, perguntamos: 2) como essas formas de raridade são distribuídas na SAS? Esperávamos que diferentes ecorregiões tivessem números diferentes de espécies raras. Finalmente, perguntamos se 3) as espécies raras e comuns estão adequadamente conservadas na rede das áreas protegidas da SAS? Como as áreas protegidas foram criadas em áreas marginais com pouco valor de conservação (Margules and Pressey, 2000), esperávamos que as áreas protegidas não proporcionassem conservação para todas as espécies raras e comuns.

A SAS é um dos biomas mais ameaçados do mundo (Myers et al., 2000). A SAS coincide com os *hotspots* climáticos, regiões esperadas para ocorrer o maior prolongamento da estação seca da América do Sul (Torres and Marengo, 2014). Com esse aumento da seca espera-se que a SAS se tornem mais inflamáveis (Alvarado et al., 2020), o que poderá aumentar a frequência de incêndios em algumas regiões (Pivello, 2011). Adicionalmente, a SAS teve entre 50 a 80% da área nativa convertida (Jepson, 2005) para atividades como a agricultura (Alho and Martins, 1995). Esses fatores podem ter efeito direto na performance de plantas, por exemplo, o aumento na frequência de incêndios e o prolongamento da estação seca podem reduzir as taxas populacionais de espécies não adaptadas as condições extremas (Hoffmann et al., 2011; Hoffmann and Solbrig, 2003; Ojeda et al., 2005). A fragmentação e caça furtiva, por sua vez, podem diminuir as populações de dispersores de sementes (Dirzo et al., 2014), com efeito indireto na performance de espécies dispersas por animais (Herrera et al., 1994; Wright et al., 2000, 2001). Argumenta-se ainda que, esses fatores podem ter um efeito sinérgico na

performance de plantas (Brook et al., 2008), mas para a SAS isso ainda é pouco explorado. Assim, no terceiro capítulo, avaliamos o desempenho de diferentes grupos funcionais de espécies arbóreas da SAS em resposta às mudanças climáticas, mudanças na frequência de incêndio e a defaunação. Testamos as seguintes hipóteses: 1) as espécies decíduas, com capacidade de rebrota pós incêndios e não dispersas por animais são menos suscetíveis a distúrbios do que as espécies sempre-verdes, sem capacidade de rebrota e dispersas por animais; (2) as mudanças climáticas, mudanças na frequência de incêndio e defaunação atuam sinergicamente na perda da biomassa de espécies de árvores de savana.

Na medida em que os táxons e ecorregiões de maior déficit florístico da SAS forem identificados (capítulo 1), os esforços para reduzir esse déficit florístico poderão ser direcionados para táxons e regiões que apresentem maior déficit florístico. O primeiro capítulo, por tanto, contribui para conhecer e documentar a diversidade florística da SAS (objetivo I da CBD, 2011). Se detectarmos uma lacuna na rede de áreas protegidas para conservar espécies raras e comuns, então os padrões de raridade que forem identificados e mapeados aqui (capítulo 2), contribuirá para o planejamento estratégico de novas áreas protegidas. Finalmente, se o efeito da mudança climática, do regime do fogo e a defaunação na mudança da biomassa da vegetação forem conhecidos (capítulo 3), isso contribuirá para as ações de manejo na SAS. Assim, o segundo e o terceiro capítulo contribuirão para desenvolver ações para conservação (objetivo II da CBD, 2011) da diversidade de plantas da SAS.

**CAPÍTULO 2: Linnean and Wallacean shortfalls in the South American savanna tree
flora: consequences for biodiversity conservation¹**

Everton A. Maciel*, Fernando R. Martins

Department of Plant Biology, Institute of Biology, P.O.Box 6109, University of Campinas –
UNICAMP, 13083-970 Campinas, SP, Brazil.

*Corresponding author: everttonmaciel@gmail.com

¹ The paper's format follows Elsevier's formatting

Abstract

To conserve plants, we must close the knowledge gap about species, either unknown species identity (Linnean shortfalls) or unknown species distribution (Wallacean shortfalls). Because unidentified records are supposed to be a new species, we assume they as Linnean shortfall. On the other hand, it can be a species already described and difficult to identify, then this would be a Wallacean shortfall. Here, we call Linnean and Wallacean shortfalls together as flora shortfalls. We analyzed flora shortfalls based on tree phytosociological and floristic surveys to test five assumptions. Flora shortfalls: i) are greater in phytosociological than in floristic surveys; ii) differ between taxa; iii) are concentrated in some regions of the South American savannas; iv) are dependent on species richness and v) decrease over time. To test these expectations, we created a database with 355 surveys of tree species and quantified the number of species confidently identified and those not identified to binomials. An ANOVA test revealed more flora shortfalls in phytosociological than in floristic surveys. Diverse taxa such as Myrtaceae, but also less diverse taxa such as Lythraceae, had more flora shortfall. An interpolation by the inverse of the distance revealed that flora shortfalls are concentrated in the peripheral Cerrado. The greater the number of species surveyed, the higher the number of flora shortfalls. For both floristic and phytosociological surveys, flora shortfalls have not changed over time. To overcome flora shortfalls, we suggest that researchers specialized in different plant groups should engage with generalist researchers performing floristic and phytosociological surveys. Because many species not yet known may lay unidentified in some herbarium collection, the efforts in identifying herbarium exsiccata should be considered a priority.

Keywords: plant conservation, Linnean shortfall, Wallacean shortfall, flora knowledge gap, data void.

1. INTRODUCTION

Because avoiding extinction rates needs appropriate knowledge of taxonomy and species distribution (Mace, 2004; Morais et al., 2013), the knowledge gap in biodiversity became one of the greatest contemporary challenges of the conservation field (Bini et al., 2006; Brito, 2010; Feeley, 2015; Feeley and Silman, 2011; Morais et al., 2013). The knowledge gap is attributed in part to the number of species not yet described, leading to Linnean shortfalls (Lomolino, 2004; Bini et al., 2006; Brown & Lomolino, 2006; Riddle et al., 2011). The Linnean shortfalls were estimated at 10-20% in the world's angiosperms (Joppa et al., 2010). Even confidently identified plant species do not have their geographic distribution completely known (Oliveira et al., 2016; Sousa-Baena et al., 2014), leading to Wallacean shortfalls (Lomolino, 2004; Bini et al., 2006; Brown & Lomolino, 2006; Riddle et al., 2011).

Flora shortfalls affect especially tropical regions (Corlett, 2016; Feeley, 2015; Feeley and Silman, 2011). For instance, 10% of the South America continent do not have information in plant biological collections (Feeley, 2015). Lack of data is also observed in the flora of the most studied biomes of this continent, such as the Amazon (Ter Steege et al., 2015), Atlantic rain forest (de Lima et al., 2015), and the Cerrado (Françoso et al., 2016). This gap in flora knowledge is reflected in taxonomic inaccuracy, which means that when a record is not identified until species level (Caiafa and Martins, 2007; Troudet et al., 2017), then it is characterized as an indeterminated taxon, such as *sp.*, *cf* ou *aff.* This taxonomic inaccuracy has already been documented for both biological collections (Troudet et al., 2017) and phytosociological surveys (Caiafa and Martins, 2007).

A comprehensive analysis of 225 surveys done in the Brazilian Atlantic rainforest revealed that among 2891 records 198 were identified only to family level and 627 to genus level (Caiafa and Martins, 2007). These authors have attributed the non-identified records to limited knowledge of the flora (Caiafa and Martins, 2007). This argument is acceptable if we

consider that the neotropical region has the richest plant biodiversity in the world and also that it is little known (Corlett, 2016; Feeley, 2015). Here, we agree with Caiafa and Martins (2007), but we go beyond them by considering that unidentified records in phytosociological or floristic surveys are Linnean and/or Wallacean shortfalls. A phytosociological survey counts, measures, and collects all individuals fulfilling certain criteria to be included in sampling unities spread across a previously selected vegetation stand, whereas a floristic survey collects reproducing individuals by patrolling a portion of the vegetation. In other words, both reproducing and vegetative individuals are collected in phytosociological surveys, but only reproducing individuals are collected in a floristic survey.

We consider that the complete identification of collected plant material to binomial is a desirable starting point in phytosociological as well as in floristic surveys. In both kinds of surveys, the researchers devote great effort to identify all records, but some remain unidentified to binomials and are included in the floristic list as genus *sp* or even family *sp* (see Caiafa & Martins, 2007). We trust that unidentified records can be Linnean shortfalls because, consequently, new species may remain unknown (Fig. 1). On the other hand, if these unidentified records are considered not new but species already described and difficult to identify, then they would be Wallacean shortfalls because the possible occurrence of the species out of their presently known geographic distribution would not be known (Fig. 1). Hence, if a record is not identified to binomial, it is difficult to distinguish whether it is a Linnean or Wallacean shortfall. Here, we consider these unidentified records as flora shortfalls, a generic designation of Linnean and/or Wallacean shortfall. As it yields an incomplete taxonomic knowledge, the flora shortfalls provide an unrealistic panorama of the spatial distribution of the biodiversity (Schaefer et al., 2011). As a consequence, our understanding of how natural and anthropic pressures influence extinction rates becomes limited (Brito, 2010). Hence, conservation strategies are limited because conservation planning for a sub-representative part

of the biodiversity may not protect that not yet known (Payo-Payo and Lobo, 2016). Then, the complete identification of species plays a key role in conservation and decision-making, since without sufficient taxonomic information, there is less chance of success (Bickford et al., 2007; Mace et al., 2008; Simó-Riudalbas et al., 2017).

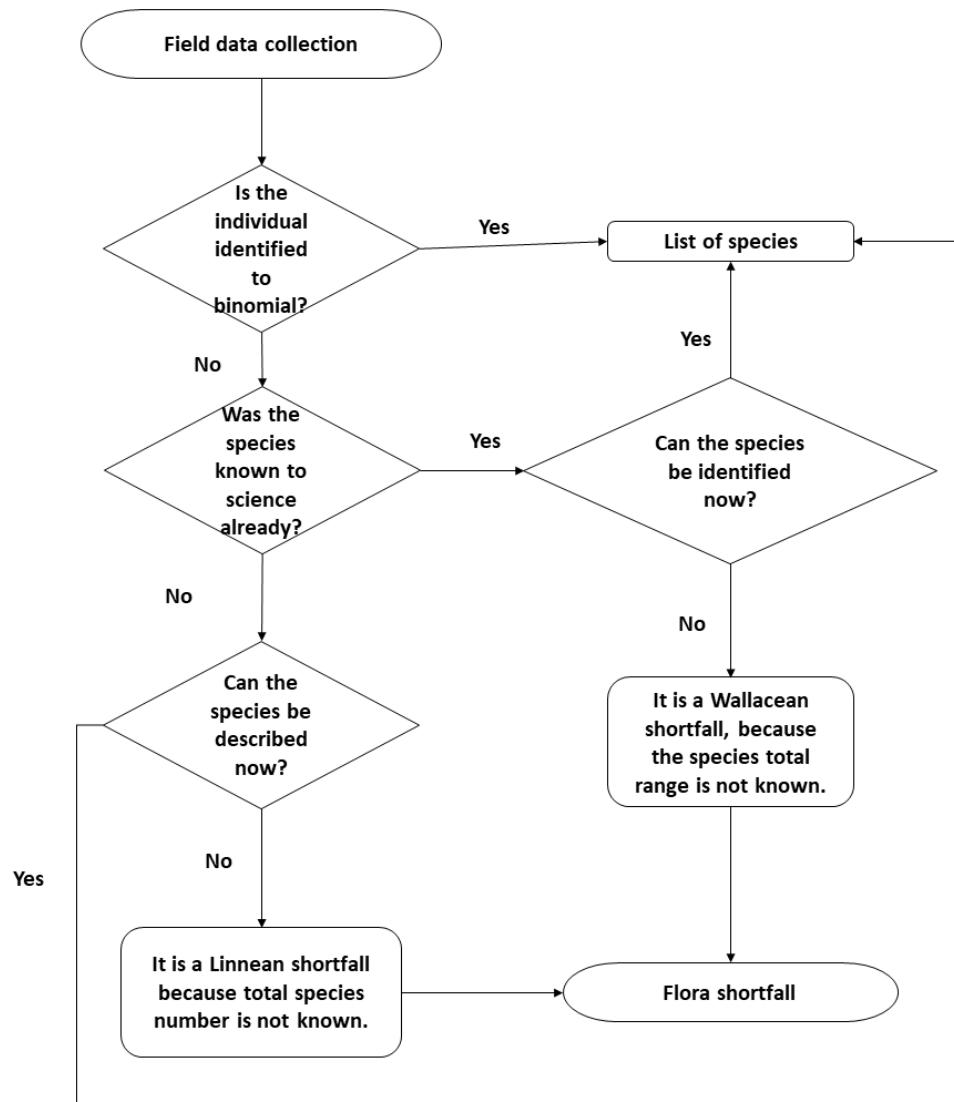


Fig. 1. Flowchart showing steps to Linnean and Wallacean shortfalls, both together called here flora shortfalls.

Here, we provided an analysis of flora shortfalls in the South American savannas based on phytosociological and floristic studies. We explain how flora shortfalls can overshadow what is known about biological diversity, thus affecting decision-making. We also propose directions to reduce flora shortfalls. To accomplish this task, we posed five questions as guidelines (see our scheme for details about our assumptions in Supplementary Fig. 1): i) Do phytosociological surveys have more flora shortfalls than floristic surveys? We expected phytosociological surveys to have more flora shortfalls because both fertile and infertile individuals are sampled and must be identified, whereas in floristic surveys only fertile individuals are collected. Since flowers and fruits are the base for complete identification of most species, their absence in infertile individuals can prevent correct identification. ii) Are there some taxa with a higher incidence of flora shortfalls? We expected more flora shortfalls to occur in more speciose taxa, such as Myrtaceae and Fabaceae. iii) What region of South American savannas has the highest number of flora shortfalls? Considering that the whole extension of the South American savannas is not uniformly sampled, we expected some regions to have more flora shortfalls than others, so that they are worthy of further attention. iv) Are flora shortfalls dependent on the total species sampled in a survey? As many species remain unknown, we expected flora shortfalls to increase as the number of species sampled increases in a survey. v) Have flora shortfalls in phytosociological and floristic surveys changed over time? We expected a reduction of flora shortfalls over time because, supposedly, the knowledge of a flora increases over time. In addressing these issues, we bore in mind that flora shortfalls, the incomplete knowledge of species identity and distribution, can negatively affect what is known about a flora and, hence, the decisions about conservation strategies.

2. METHODS

2.1 Study area

We considered savanna as a vegetation complex that includes three types of physiognomy, namely: open savanna, woody savanna, and savanna woodland (Coutinho, 1978; Furley, 1999, 1992). The open savanna includes open physiognomies with trees <7m in height and a maximum of 10% of shrub and tree crown cover. The woody savanna includes physiognomies with the predominance of trees 7-14m in height and 40% - 60% crown cover. The savanna woodland has forest physiognomies with trees over 15m in height and >70% crown cover. These physiognomies make up a complex mosaic with other vegetation types, especially seasonal forests, all over the South American savanna provinces, whose main ecoregions are the Cerrado, Llanos, Guianan savanna, and Beni savanna (Olson et al., 2001). Although not forming an ecoregion (*sensu* Olson et al., 2001), there are additionally other disjunct, isolated savanna patches scattered in non-savanna vegetation, such as the Amazon forest (northern-northwestern Brazil), Atlantic forest (roughly alongside Brazilian coast) and Caatinga (northeastern Brazil). The inclusion of these disjunct sites widens the savanna occurrence beyond the limits defined by Olson et al. (2001) for the South American Savanna (SAS; Fig. 1).

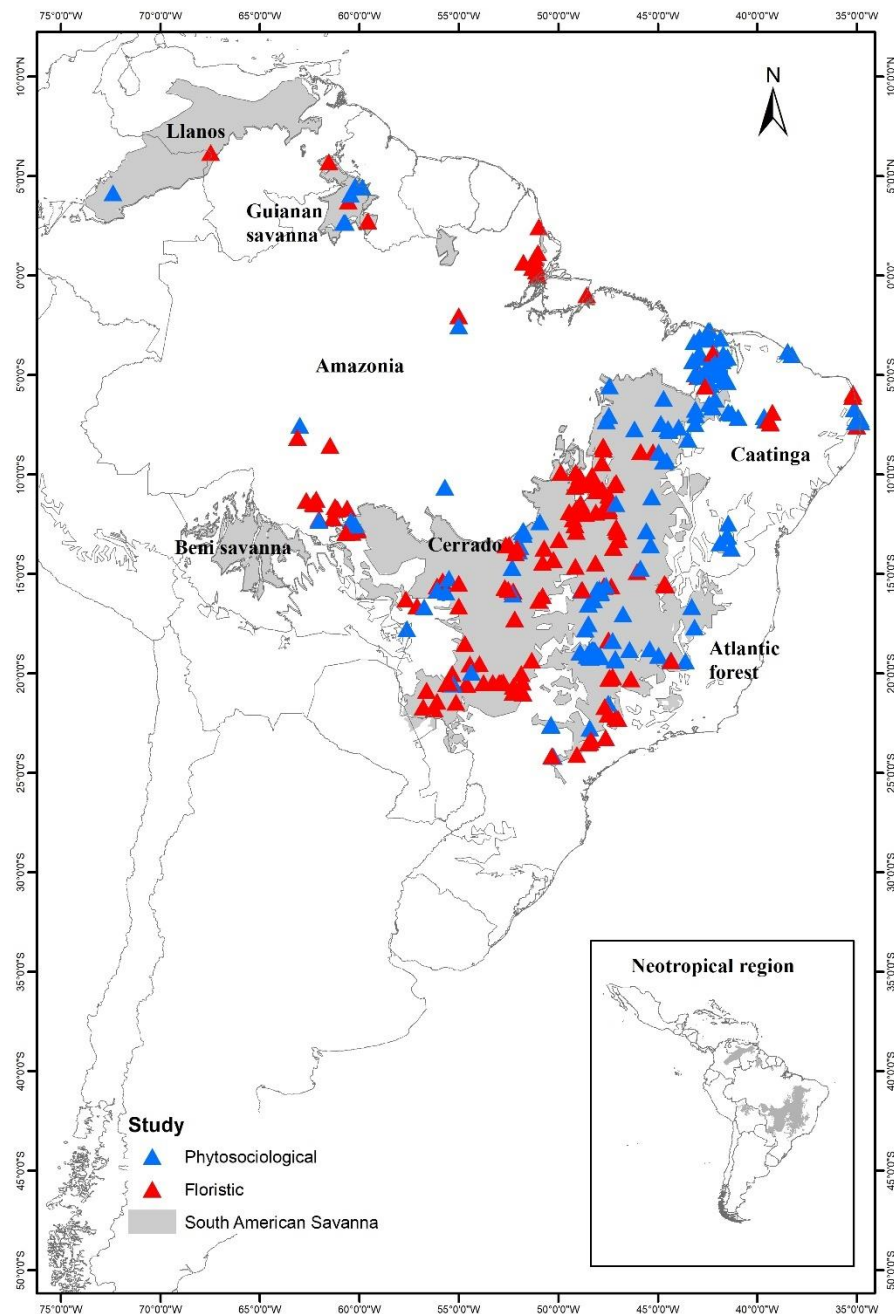


Fig. 1. The South American Savanna (grey) according to Olson et al. (2001). Floristic (red) and phytosociological (blue) surveys with flora shortfalls are scattered in the Llanos, Guianan savanna, Cerrado, and disjunct savanna areas in the Amazonia, Caatinga (northeastern Brazil), and Atlantic forest (alongside Brazilian coast). See Table S3 for literature.

2.2 Database

We searched for papers reporting floristic and phytosociological surveys in the SAS published until February 2016 in *Web of Science*, *Scopus*, *Scielo*, and *Lilacs* using as keywords different combinations of ecoregion + physiognomy + kind of surveys. For example, in searching surveys made in the Cerrado, we used the corresponding keywords ‘Cerrado’, ‘wood savanna’, ‘floristic study’ (see supplementary table 1 for more details about the keywords used). We also considered theses, scientific meeting annals, books, research notes, and unpublished data reported by *Google Scholar*. With the information gathered from this search we created a database containing: 1) the study area (we used the information provided in the papers); 2) the bibliographic reference of each paper; and 3) a list of the taxa sampled/collected in each site. The taxonomic standardization of the names of genera and families followed the *flora* package (Carvalho, 2016) in the R environment (R CoreTeam, 2019). This package directly accesses *flora 2020 online* to generate an output that contains currently accepted taxon names.

2.3 Quantifying the flora shortfalls

We assumed all occurrence of a taxon (whether or not identified to binomial) in floristic and phytosociological survey as a record. Then, we assumed as a flora shortfall any record not identified to binomial, such as unknown, Fabaceae sp., *Andira* sp., spp., aff. (*affinis*), cf. (*conferatum*), and so on (e.g. Caiafa and Martins 2007). We classified data into phytosociological and floristic surveys to allow for comparison between them. For each survey, we quantified the number of records not identified to binomial (absolute shortfalls) and identified to binomial (binomials), and we adopted the same procedure for each family and genus (e.g. Caiafa and Martins 2007). The sum of binomials + absolute shortfalls was considered as the species richness, which was expressed per site or family or genus, according to the case. With these values, we calculated the relative flora shortfall (rfs) as the ratio of the

number of absolute flora shortfalls (afs) to the species richness (S) in each survey or family or genus: $rfs = afs/S$. When analyzing the family or genus with the highest rfs, we pooled floristic and phytosociological surveys together.

2.4 Data analysis

2.4.1 Flora shortfalls in phytosociological and floristic surveys

To analyze differences of relative flora shortfalls (rfs) between the floristic and phytosociological surveys, we performed an analysis of variance (ANOVA). The normality and heterogeneity errors of the variance were tested using the Shapiro and Bartlett test, respectively. Because the rfs did not fulfill the assumptions of normality ($W = 0.725$, $p < 0.00$) and homoscedasticity (Bartlett's K-squared = 45.941, $df = 1$, $p = 0.00$), we applied the Games–Howell test, which is appropriate for unplanned comparisons and nonparametric data (Ruxton & Beauchamp, 2008). The ANOVA with Games–Howell test was applied to compare the number of rfs between floristic and phytosociological surveys (phytosociological $\neq$ floristic), the analyses being carried using the ‘posthocTGH function’ of the ‘userfriendlyscience package’ (Peters et al., 2018) in R version 3.6.1 (R Core Team, 2019). We expected to find a higher number of rfs in phytosociological than in floristic surveys.

2.4.2 Flora shortfalls among the taxa

We considered that a taxon with a high rfs poses a higher difficulty to correct binomial identification and supposed that the relative flora shortfall (rfs) differed among taxa (e.g., Fabaceae $\neq$ Malvaceae $\neq$ Myrtaceae, and so on). To test this assumption, we calculated the rfs of each genus and family. Then, we calculated the median relative flora shortfall (mrfs) for each family and genus in n floristic and phytosociological surveys pooled together. Taxa recorded in less than 5 surveys ($n < 5$) were excluded from the analysis. Additionally, we calculated the semi-amplitude of the 95% confidence interval (SCI) around the mrfs for both families and genera. The overlap of confidence intervals indicates statistically similar medians;

otherwise, the medians differ. The analysis was performed using ‘group.CI function’ of the ‘Rmisc package’ (Hope, 2013) in R version 3.6.1 (R CoreTeam, 2019).

2.4.3 Spatial distribution of the flora shortfalls

To understand how relative flora shortfalls (rfs) are distributed across the SAS, first we built a data matrix with the geographical coordinates of the floristic and phytosociological surveys and the respective rfs. We used this matrix to create a tow data layer in a vector format (floristic and phytosociological layers). Then, we superposed this layer onto a South America map, so as to locate each floristic and phytosociological survey with their respective rfs. Finally, we applied an interpolation technique that uses known point values to estimate values of points not yet known. We compared four different interpolation techniques: idw, spline, natural neighbor, and kriging. To choose the best of them, we adjusted a regression model between the known rfs and the modeled rfs provided by each technique. Hence, we chose the inverse distance weighted (IDW) technique (Watson & Philip, 1985) because it produced the best fit between known data versus modeled data (Table S2). For this procedure, we used the ArcGis (ESRI, 2011) and the World Geodetic System 1984 (WGS 84) as reference systems. As a result of this analysis, we mapped the rfs in the space and identified gaps of knowledge in the SAS tree flora. This helped us to identify the overall pattern of rfs within the SAS.

2.4.4 The relationship between species richness and flora shortfalls

To analyze the relationship between the number of absolute flora shortfalls (afs) and the species richness (S), we quantified them in each phytosociological and floristic survey separately. We used standardized major axis (SMA) regression to evaluate the relationship between the number of afs (y-axis) and the species richness (x-axis). We used the SMA because it is indicated to define a line of best fit for a bivariate relationship (Smith, 2009). To calculate the intercept, slope, 95% confidence interval (CI), and r-square we used *lmodel2* package (Legendre & Oksanen, 2018) in R version 3.6.1 (R CoreTeam, 2019). Because many different

surveys may have the same number of afs, the result is susceptible to recall bias. To correct this bias we calculated the permutation number for repeated elements (Antoch and Hušková, 2001). This procedure helped us to conclude whether or not the observed pattern has arisen by chance even if the dataset was not representative of a statistical population (Legendre and Legendre, 2012). To analyze how rfs varied over time, we used the intercept (β_0) and slope (β_1) of the best line. We first tested if β_1 was different from zero for floristic ($\beta_{1_{\text{flor}}}$) and phytosociological surveys ($\beta_{1_{\text{phyto}}}$). The $\beta_1 = 0$ would indicate that afs did not change with S, while the $\beta_1 \neq 0$ would indicate an increase ($\beta_1 > 0$) or decrease ($\beta_1 < 0$) in it. We expected the number of afs to increase as the number of records increased, hence a positive ($\beta_1 > 0$) relationship between afs and S. We used a t-test to compare the intercepts ($\beta_{0_{\text{flor}}}$ vs. $\beta_{0_{\text{phyto}}}$) and slope ($\beta_{1_{\text{flor}}}$ vs. $\beta_{1_{\text{phyto}}}$) between the two kinds of surveys. This helped us to understand whether afs variation differed between floristic and phytosociological surveys with the increase of species surveyed (S). To analyze how much of the afs variation was explained by S variation, we used the r square value. As our assumption was that the greater the S the higher the number of afs, a high value of r was expected.

2.4.5 Temporal variation in flora shortfalls

To investigate whether relative flora shortfalls (rfs) varied over time, we considered rfs as the dependent variable and the number of years (yr) of study as the independent factor ($\text{rfs} = a + b \text{ yr.}$). We followed Warton's approach to choosing the best goodness of fit model (Warton et al., 2016). As rfs is a proportion, we performed two general linear models (GLM). For the first model, we used rfs without transformation and carried out a GLM with quasi-Poisson distribution and logit link. For the second model, we applied a logit transformation on the rfs (logit rfs) and used logit rfs to adjust a GLM with Gaussian distribution. We took the first model because it produced a better fit model-predicted versus adjusted residuals. In addition, it has the advantage to preserve the data on the same observation scale without transforming

them (St-Pierre et al., 2018)) in R version 3.6.1 (R CoreTeam, 2019). All models were performed by *GLM* function (Wickham, 2009), with $p < 0.05$ as the significant threshold. To analyze how rfs varied over time, we used the intercept (β_0) and slope (β_1) of the best line. We first tested if β_1 was different from zero for floristic ($\beta_{1\text{flor}}$) and phytosociological surveys ($\beta_{1\text{phyto}}$). The $\beta_1 = 0$ would indicate that the rfs has not changed over time while the $\beta_1 \neq 0$ would indicate an increase ($\beta_1 > 0$) or decrease ($\beta_1 < 0$) in it. Because we supposed that a flora becomes better known as it is studied along time, we expected the rfs to decrease over time ($\beta_1 < 0$). We used a t-test to compare the intercepts ($\beta_{0\text{flor}}$ vs. $\beta_{0\text{phyto}}$) and slope ($\beta_{1\text{flor}}$ vs. $\beta_{1\text{phyto}}$) between the two kinds of surveys. This helped us to understand whether rfs variation differed between floristic and phytosociological surveys over time.

3. RESULTS

We found a total of 114 papers with flora shortfalls (Table S3) corresponding to 355 surveys, of which 161 floristic and 194 phytosociological surveys (Table S4). Of these 114 papers, 57.8% were published articles, 15.78% thesis, 13.5% unpublished data, 7.8% technical bulletins, technical reports, or research notes, and 5.3% were books (Table S4). The total number of records in all papers was 20,968, of which 18,671 binomials and 2,297 records not identified to binomials, yielding a relative flora shortfall of 10.9%. Among the 2,297 absolute flora shortfalls, 631 (27.48%) were in floristic surveys, and 1,666 (72.52%) were in phytosociological surveys (supplementary table 3). In the 114 papers, we found 119 families and 637 genera, of which 73 families and 289 genera had flora shortfalls.

3.1 Phytosociological surveys have more flora shortfalls

The mean relative flora shortfall (rfs) was 0.07 ($SD \pm 0.08$) and 0.16 ($SD \pm 0.13$) in the floristic and phytosociological surveys, respectively. The ANOVA with Games-Howell test

revealed that the mean rfs was significantly higher in phytosociological than floristic surveys ($F = 48.93$, $p < 0.001$).

3.2 Some taxa have more relative flora shortfalls

Of the 119 families, 73 had flora shortfalls and 32 of these were present in 5 or more surveys (5 was considered the minimum sample size based on 355 surveys and 114 papers). The median relative flora shortfall (mrfs) in these 32 families ranged from mrfs=0.12 (SCI $\pm$ 0.01) to 0.50 (SCI $\pm$ 0.07) (Table 1), meaning that these families could present 12% to 50% of records without confident identification to genus or binomials in some surveys. Less frequent families among savanna trees, such as Verbenaceae (mrfs = 0.50 ± 0.07), Asteraceae (0.42 ± 0.05), and Sapindaceae (0.42 ± 0.07), had higher mrfs than the most frequent families, such as Myrtaceae (0.33 ± 0.03), Malpighiaceae (0.25 ± 0.03) and Fabaceae (0.12 ± 0.01).

Table 1. Families with flora shortfalls occurring in five or more surveys. The median relative shortfalls (*mrfs*) and the respective semi-amplitude of the 95% confidence interval (SCI) in the number (*n*) of surveys where they appear are shown. A total of 355 surveys and 114 references were analyzed.

Family	<i>n</i>	<i>mrfs</i>		SIC
Myrtaceae	63	0.33	$\pm$	0.03
Fabaceae	58	0.12	$\pm$	0.01
Malpighiaceae	45	0.25	$\pm$	0.03
Rubiaceae	31	0.23	$\pm$	0.03
Bignoniaceae	26	0.20	$\pm$	0.03
Apocynaceae	24	0.31	$\pm$	0.03
Annonaceae	21	0.33	$\pm$	0.04
Asteraceae	20	0.42	$\pm$	0.05
Melastomataceae	18	0.25	$\pm$	0.05
Sapotaceae	17	0.33	$\pm$	0.06
Malvaceae	16	0.34	$\pm$	0.05
Arecaceae	14	0.38	$\pm$	0.31
Euphorbiaceae	14	0.38	$\pm$	0.05
Ochnaceae	14	0.33	$\pm$	0.06
Chrysobalanaceae	13	0.40	$\pm$	0.06
Erythroxylaceae	13	0.33	$\pm$	0.05

Family	<i>n</i>	<i>mrfs</i>		SIC
Salicaceae	12	0.37	±	0.06
Combretaceae	11	0.16	±	0.06
Lauraceae	11	0.33	±	0.04
Verbenaceae	9	0.50	±	0.07
Vochysiaceae	9	0.27	±	0.06
Anacardiaceae	8	0.29	±	0.1
Calophyllaceae	8	0.31	±	0.09
Celastraceae	8	0.29	±	0.1
Connaraceae	8	0.42	±	0.07
Ebenaceae	8	0.23	±	0.11
Lamiaceae	8	0.25	±	0.1
Sapindaceae	8	0.42	±	0.08
Moraceae	7	0.33	±	0.07
Nyctaginaceae	7	0.25	±	0.05
Polygalaceae	5	0.40	±	0.05
Solanaceae	5	0.33	±	0.07

Of the 637 genera, 289 had flora shortfalls, and 74 of these were present in 5 or more surveys. The *mrfs* in these 74 genera ranged from 0.17 ± 0.36 to 1 ± 0.21 (Table 2). In other words, these genera could present 17% to 100% of their records without confident identification to binomials in some surveys. Only 9 genera had *mrfs* < 1: *Brosimum*, *Byrsonima*, *Campomanesia*, *Hymenaea*, *Machaerium*, *Pseudobombax*, *Psychotria*, *Senna*, and *Symplocos*. All the other genera had a *mrfs* flora shortfall of 1, such as *Casearia*, *Dalbergia*, and *Duguetia*.

Table 2. Genera with flora shortfalls occurring in five or more surveys. The median relative flora shortfalls (*mrfs*) and respective semi-amplitude of the confidence interval (SCI) in the number (*n*) of surveys where they appear are shown. A total of 355 surveys and 114 references were analyzed.

Genera	<i>n</i>	<i>mrfs</i>		SIC
Myrcia	75	1	±	0.07
Eugenia	57	1	±	0.07
Byrsonima	54	0.5	±	0.09
Psidium	50	1	±	0.05
Erythroxylum	47	1	±	0.08
Miconia	46	1	±	0.08
Andira	30	1	±	0.06

Genera	<i>n</i>	<i>mrf</i>s	SIC
Pouteria	29	1 $\pm$	0.06
Bauhinia	26	1 $\pm$	0.05
Kielmeyera	25	1 $\pm$	0.14
Callisthene	22	1 $\pm$	0.05
Ouratea	22	1 $\pm$	0.08
Himatanthus	21	1 $\pm$	0.05
Ocotea	21	1 $\pm$	0.14
Tabebuia	21	1 $\pm$	0.08
Casearia	19	1 $\pm$	0
Hymenaea	19	0.5 $\pm$	0.06
Diospyros	18	1 $\pm$	0.06
Manihot	17	1 $\pm$	0
Aspidosperma	16	1 $\pm$	0.11
Guapira	15	1 $\pm$	0.11
Campomanesia	14	0.75 $\pm$	0.08
Croton	14	1 $\pm$	0.1
Salacia	14	1 $\pm$	0.1
Duguetia	13	1 $\pm$	0
Licania	11	1 $\pm$	0
Vitex	11	1 $\pm$	0
Heteropterys	10	1 $\pm$	0.15
Lippia	10	1 $\pm$	0
Schefflera	10	1 $\pm$	0.15
Syagrus	10	1 $\pm$	0
Vernonia	10	1 $\pm$	0.11
Annona	9	1 $\pm$	0.13
Cordia	9	1 $\pm$	0.13
Dalbergia	9	1 $\pm$	0
Lantana	9	1 $\pm$	0
Vismia	9	1 $\pm$	0.06
Alibertia	8	1 $\pm$	0.15
Eriotheca	8	1 $\pm$	0.2
Jacaranda	8	1 $\pm$	0
Myrsine	8	1 $\pm$	0.15
Cassia	7	1 $\pm$	0
Combretum	7	1 $\pm$	0
Copaifera	7	1 $\pm$	0
Eremanthus	7	1 $\pm$	0.17
Inga	7	1 $\pm$	0
Pseudobombax	7	0.75 $\pm$	0.27
Baccharis	6	1 $\pm$	0.21
Brosimum	6	0.5 $\pm$	0.21
Chrysophyllum	6	1 $\pm$	0
Eupatorium	6	1 $\pm$	0
Guatteria	6	1 $\pm$	0.21

Genera	<i>n</i>	<i>mrfs</i>	SIC
Matayba	6	1 ±	0
Senna	6	0.17 ±	0.36
Solanum	6	1 ±	0
Vochysia	6	1 ±	0.36
Coccoloba	5	1 ±	0.28
Connarus	5	1 ±	0
Davilla	5	1 ±	0
Ficus	5	1 ±	0
Ilex	5	1 ±	0
Machaerium	5	0.67 ±	0.37
Maytenus	5	1 ±	0
Psychotria	5	0.4 ±	0.48
Sapium	5	1 ±	0
Stryphnodendron	5	1 ±	0.28
Symplocos	5	0.5 ±	0.39
Tapirira	5	1 ±	0
Vatairea	5	1 ±	0

3.3 The flora shortfalls concentrated in some ecoregions

Both phytosociological and floristic surveys showed flora shortfalls distributed throughout the SAS but concentrated in some ecoregions. The relative flora shortfall (rfs) ranged from 0.011 to 0.38 in floristic surveys and from 0.009 to 0.541 in phytosociological surveys. The highest rfs (> 0.5) in floristic surveys were found in the Llanos, Cerrado-Caatinga transition, the southeastern sector of the Cerrado, and savanna disjunctions (Amazon and Atlantic forest) (Fig. 3a). In phytosociological surveys, the highest rfs were found in the Cerrado-Amazon and Cerrado-Caatinga transitions, and Beni savanna (Fig. 3b). On the other hand, more than 50% of the total number of surveys have been done in the Cerrado (Table S5), although a great number of surveys have also been done in other ecoregions, such as the Guianan savanna and the disjunct savannas in the Maranhão Babaçu forest, Madeira-Tapajós moist forest, and Caatinga.

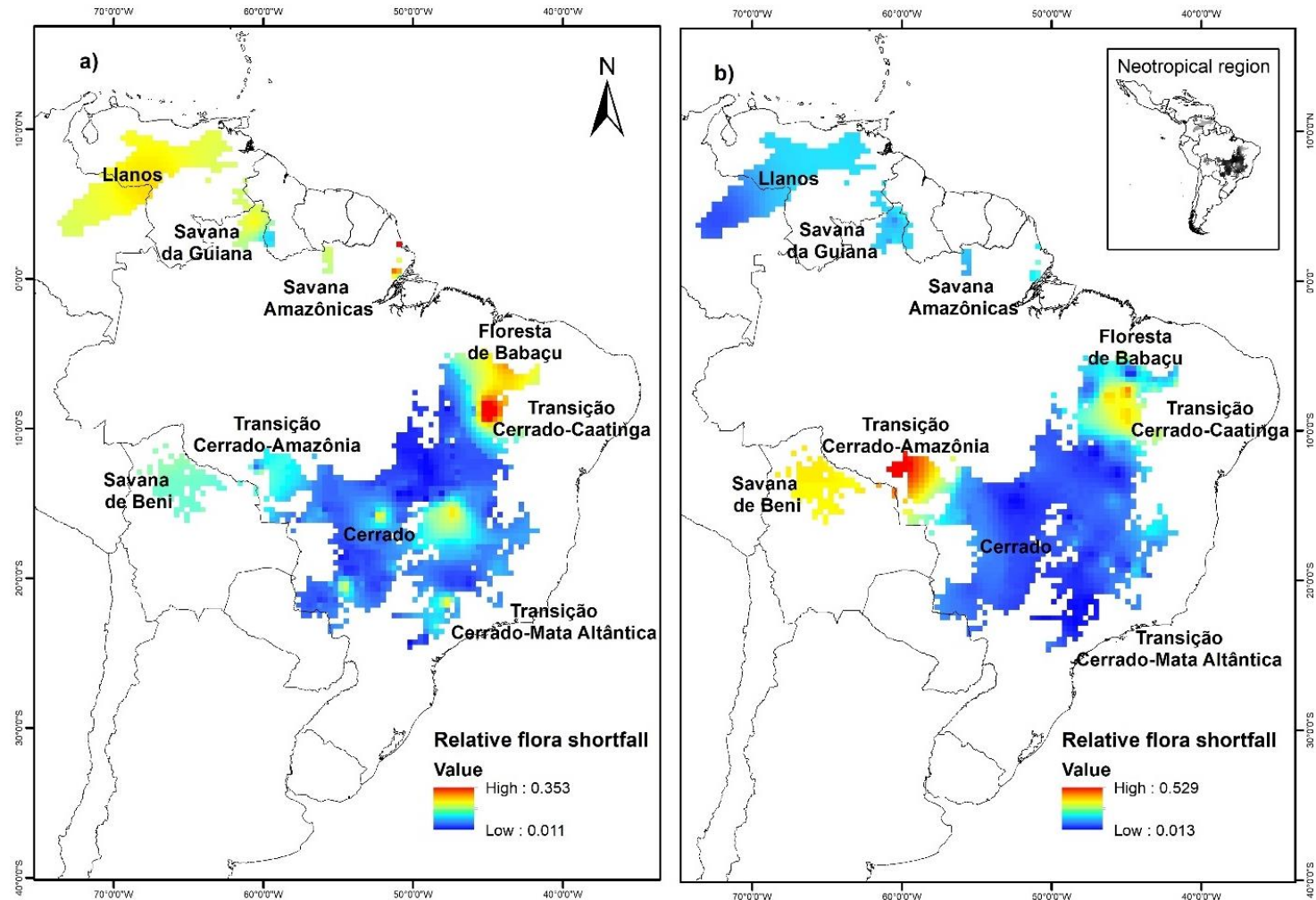


Fig. 3. Interpolation map by the inverse distance weighted (IDW) technique for floristic (a) and phytosociological (b) surveys in the South American savannas (adapted from Olson et al. 2001) including the Llanos, Guianan savanna, Cerrado, and disjunct savanna areas in Amazonia, Caatinga (northeastern Brazil), and Atlantic forest (alongside Brazilian coast). The relative flora shortfall increases from blue to red color (highest relative flora shortfall).

3.4 The number of flora shortfalls is weakly related to the species richness

The SMA slope showed a positive correlation between the number of absolute flora shortfalls (afs) and species richness (S) as can be seen on the β_1 different from zero for both floristic ($\beta_{1\text{flor}} = 0.18$; $p = 0.006$) and phytosociological surveys ($\beta_{1\text{phyto}} = 0.34$; $p = 0.009$). T-tests found no significant differences in the slopes ($t = 3.25$, $df = 1$, $p\text{-value} = 0.19$) or the intercepts ($t = -5.6798$, $df = 1$, $p\text{-value} = 0.1109$) between the floristic and phytosociological surveys. According to the goodness-of-fit test, for both floristic ($R^2=0.04$) and phytosociological ($R^2=0.12$) surveys, the proportion of the variation in afs explained by S was quite small. In the floristic surveys, only 0.5% of the afs could be attributed to the increasing richness, while this number increases to 12% in phytosociological surveys. The results of the regression analysis are set out in figure 4.

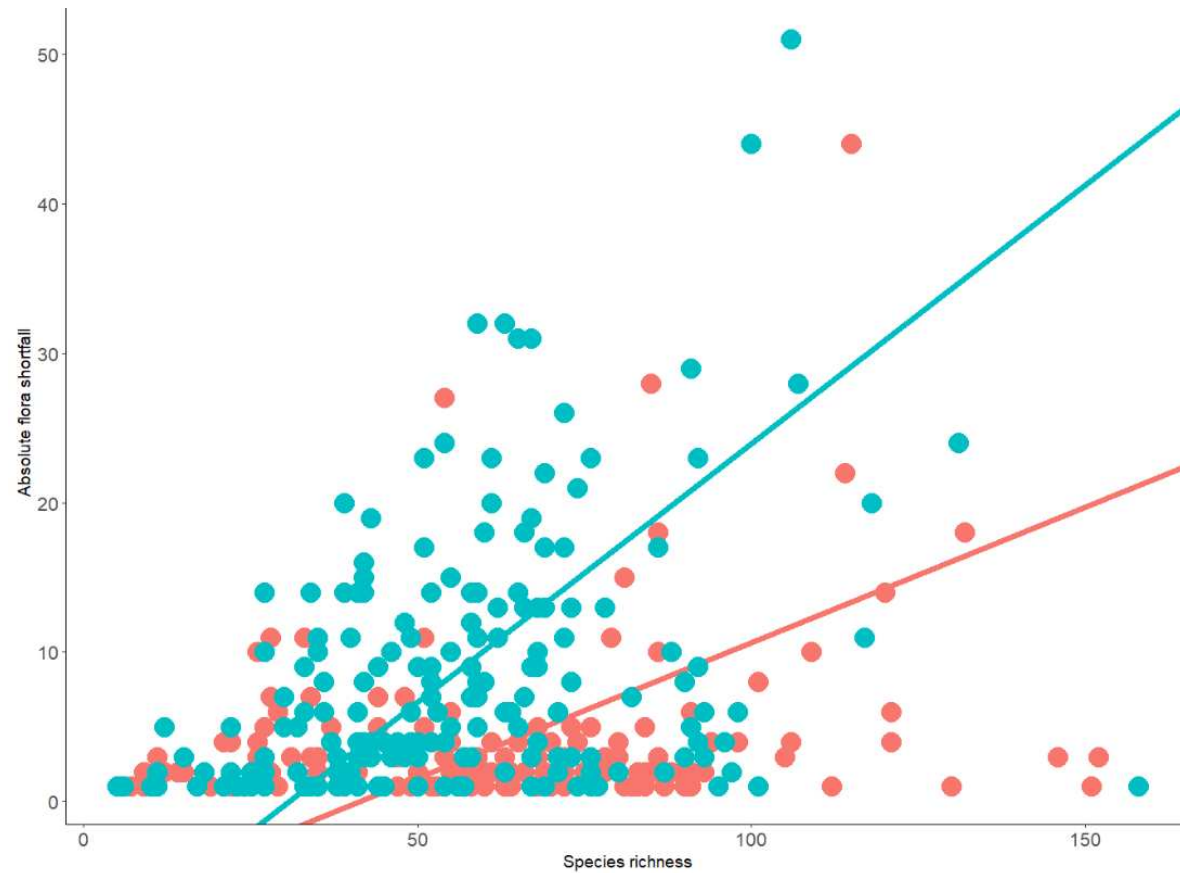


Fig. 4. Relationship between absolute flora shortfall and the species richness of floristic (red) and phytosociological (blue) surveys. The lines represent the best-fit regression from the Standardized Major Axis (SMA) for floristic (red) and phytosociological (blue) surveys.

3.5 Flora shortfall over time

Our data comprised almost 4 decades of surveys between 1980 to 2015, and we expected the flora shortfalls to diminish with time, as the flora became progressively better known. However, the slope (β_1) of the regression line was not different from zero for both floristic ($\beta_{1\text{flor}} = -0.02$; $p = 0.08$) and phytosociological surveys ($\beta_{1\text{phyto}} = 0.01$; $p = 0.3$). This means that there was no relation of the rfs variation with time, whether considering floristic or phytosociological surveys. Also, T-tests found no significant differences in the slopes ($t = 1.73$, $df = 3$, $p = 0.19$) or intercepts ($t = 0.23344$, $df = 1$, $p\text{-value} = 0.854$) of floristic or phytosociological surveys. These results show that the proportion of rfs in both floristic and phytosociological surveys kept a similar magnitude and did not diminish along time. The results of the Generalized Linear Model analysis are set out in figure 5.



Fig. 5. Dispersion model of the relative flora shortfalls over time in floristic (red) and phytosociological (blue) surveys. The lines represent the best-fit regression from the Generalized Linear Model (GLM) with quasi-Poisson logit link for floristic (red) and phytosociological (blue) surveys.

4. DISCUSSION

Several reports have shown that Linnean and Wallacean shortfalls represent a big challenge for conservation biodiversity, but none of them investigated these shortfalls in the South America savanna (SAS). Here, we provide the first analysis using the records unidentified until binomial as a descriptor of the Linnean and Wallacean shortfalls of the SAS tree flora. Of the 20,968 records analyzed, 2,297 were flora shortfalls, which occurred mainly in some taxa and regions of the SAS.

4.1 Phytosociological surveys have more flora shortfalls

We found more flora shortfalls in phytosociological than floristic surveys. In the phytosociological surveys, all individuals fulfilling previously agreed sampling criteria are collected, independently of their phenophase. On the other hand, only individuals with fruits and/or flowers are collected in floristic surveys. Depending on the family or genus, the identification of some species is very difficult, even when they bear flowers and fruits; and when they are in a vegetative phenophase, the identification to binomial is at least harder, if possible. Traditionally, flowers and fruits are the basis for the taxonomic description of species and genera (Rejmánek and Brewer, 2001). In his book *Philosophia botanica*, Linneus (1755) declared that '*habitus occulte consulendus est*', i.e., plant habitus (non-reproductive structures) are surreptitiously analyzed, so that they would not be part of the basis for separating genera and species (Cain, 1995).

Even today, non-reproductive structures are still seldom considered in identification keys of traditional taxonomy, and most identification keys consider only reproductive attributes (Rejmánek and Brewer, 2001). To reduce flora shortfalls, we argue that identification keys and the respective species description should provide more detailed characters and consider both reproductive and vegetative attributes (Costion and Plunkett, 2016; Mantovani et al., 1985; Urbanetz et al., 2010). For example, Costion and Plunkett (2016) proposed an identification

key for the genus *Osmoxylon* (Araliaceae) that uses both vegetative and reproductive characters.

4.2 Some taxa have higher proportions of relative flora shortfall

Some savanna taxa have wide morphological variations. For example, a study comparing individual variations of *Myrcia splendens* (Sw.) DC. (Myrtaceae) from different populations revealed differences in many attributes, such as leaf area, length, thickness, and width (Amorim and de Melo Júnior, 2016). This makes the process of delimiting species very difficult even for specialists (Barroso, 1984; McVaugh, 1968). Due to these morphological variations, there are cases in which a unique species was considered to be various. On the other hand, some taxa are very similar and lack of variation can lead to more than one species being classified as a unique, a well-known problem in savanna flora (e.g. Goodland and Ferri, 1979). Due to morphological similarity, about 10-20% of the species that are identified by traditional taxonomy are supposedly to be two or more (Janzen et al., 2017).

We observed that two kinds of families have higher proportions of flora shortfalls. On one side, the most speciose families in the savanna tree flora, such as Fabaceae, Myrtaceae, Vochysiaceae, Malpigiaceae, Bignoniaceae, Apocynaceae, and Rubiaceae (Castro et al., 1999; Françoso et al., 2016) have many records without confident identification to binomials. On the other side, families with few species in the savanna tree flora also show many shortfalls, as is the case of Chrysobalanaceae, Ebenaceae, and Ochnaceae. There is in the research literature a historic tendency to focus efforts on the more diverse taxa while the less diverse taxa have been neglected (Di Marco et al., 2015). Many authors have focused discussion on the most diverse families such as Fabaceae and Myrtaceae (e.g. Dutra et al., 2015; Zappi et al., 2015; Terra et al., 2017), while other smaller families are seldom discussed. Our results show that both large and small families pose similar problems in identifying species. In both floristic and phytosociological surveys, the most speciose families are sampled with many species, not

all of them known by the researcher, although these large families are the most studied in taxonomic investigations. The consequence is that many records of these families are not confidently identified to binomials because very few specialists know every species of a very large family (Hopkins, 2005). However, there are families with few species in the savanna tree flora, and because the small taxa usually do not attract much taxonomic attention (Di Marco et al., 2015), they are seldom studied and their species are generally not completely known.

The use of vegetative characters as additional information in the plant keys is just one of the necessary actions because diminishing the taxonomic uncertainty will only be possible with the application of modern techniques together with traditional ones (Draper et al., 2020). These modern techniques may include, for example, DNA sequencing and image recognition (Draper et al., 2020). DNA sequencing is a powerful technique for the discrimination of cryptic species (Prata et al., 2018; Vicentini, 2016), i.e., two morphologically similar species. A recent example using Fourier Transformed Near-Infrared Spectroscopy for taxonomic identification from tree branches proved to be efficient in identifying genus and family (Lang et al., 2017).

4.3 Flora shortfalls are concentrated in some regions

The pattern that we observed in the spatial analysis of the flora shortfalls in the SAS showed that the Brazilian Cerrado is the most problematic savanna in South America since it had the greatest number of flora shortfalls. On the one hand, the Brazilian Cerrado is the richest savanna in the world, especially in South America (Pennington and Lavin, 2016), meaning that it can still have many unknown species. On the other hand, the Cerrado has also been the most surveyed savanna, and few surveys have been done in other savanna ecoregions. Hence, the smaller proportions of flora shortfalls in non-Cerrado savannas in South America may be the outcome of a small number of surveys. The small number or lack of surveys in non-Cerrado South American savannas has been reported as a great problem in the Neotropics, leading to knowledge gaps of the flora of entire regions (e.g. Kier et al., 2005). These Neotropical regions

with gaps in the flora knowledge have great potential for the discovery of new species (Bini et al., 2006; Brito, 2010). Then, both Cerrado and non-cerrado savannas still require more surveys and special attention to their flora.

Our results also show that the Cerrado-Amazonia and Cerrado-Caatinga transition zones concentrate many flora shortfalls. The savanna transition zones in South America have been reported as regions representing great gaps of knowledge on the flora (Castro et al., 1999; Françoso et al., 2016), and at the same time they are regions for the potential appearing of new species (Schmida and Wilson, 1985; Castro et al., 1999). The Cerrado transition zones are generally far from the research centers that traditionally make researches on the Cerrado flora, which are located in regions with great population density. A spatially explicit analysis by Diniz-Filho et al. (2005) showed that the number of described anuran species in the Cerrado positively correlates with the size of the regional human population. According to the model proposed by Diniz-Filho et al. (2005), biodiversity knowledge increases in response to the population size and knowledge of a region. In the case of the Cerrado, its occupation has begun in the south heading towards the north (Klink and Moreira, 2002) and may partially explain the spatial pattern we found for the flora shortfalls. We found that most flora shortfalls concentrated in the northern portions of the Cerrado, that is, Cerrado-Amazonia and Cerrado-Caatinga transitions, indicating a delay in the knowledge of the flora in these regions in the relation to the southern portions of the Cerrado. Therefore, intensifying floristic and phytosociological surveys in the South American savanna transition zones is recommended (Haidar et al., 2013; Maciel et al., 2016; Smith et al., 1997).

Nevertheless, the many tree flora shortfalls observed in the savanna transition zones may be a consequence of phenotypic variation in response to the variable environmental conditions. Plant populations may show great variability among individuals in response to multiple, different factors that are frequent in heterogeneous environments, such as transition

zones (Menezes et al., 2017; Slovák et al., 2012; Valladares et al., 2007). Therefore, individuals in transition zones may show great variation in attributes that largely differ from those of individuals of the same species in a core area (Smith et al., 2001). We believe that at least part of the flora shortfalls we observed in transition zones comes out from the peculiar environmental variation among savannas.

4.4 The number of flora shortfalls is weakly related to the species richness

Given the fact that many species are still unknown in the world (Linnean shortfalls), we expected a strong correlation between richness and flora shortfall. We expected that as species richness in a survey increased, the chance for new species to appear also increased. Indeed, we found that the number of flora shortfalls increased as the number of surveyed species increased. However, this correlation was weak, meaning that only a small part of the flora shortfalls could be attributed to an increasing number of records surveyed. Therefore, we conclude that most of the flora shortfalls result from hardly identifiable, widespread species. In consequence, the geographic distribution of many taxa (Wallacean shortfalls) in the South American savannas remains unknown.

Although our results suggest that the flora shortfalls are more likely to be Wallacean than Linnaean, they are still a problem. In fact, if these biodiversity data are a sample of already known species, this suggests a bias in the distribution of existing biodiversity (Oliveira et al., 2016; Sousa-Baena et al., 2014). The main methods for the analysis of the threat status of a species are based on its distribution (Mace et al., 2008). The incomplete knowledge of the spatial distribution of taxa affects the programs of biodiversity monitoring (Pereira and Cooper, 2006). Likewise, the analysis of a species conservation status can only be done through the analysis of its distribution relative to the network of protected areas (Margules and Pressey, 2000; A. S. L. Rodrigues et al., 2004). Thus, the Wallacean shortfalls have serious implications for flora conservation.

4.5 Flora shortfalls over time

We admitted that along time there would be at least some advance in the knowledge of a flora, so we expected a decrease of the flora shortfalls over time. However, our expectation was not confirmed for both floristic and phytosociological surveys. The slopes of the GLM line of both floristic and phytosociological surveys were not significantly different from zero, meaning an absence of a tendency between flora shortfalls and time. Also, the intercepts did not significantly differ between the two regression lines, meaning that in both floristic and phytosociological surveys a similar proportion of non-identified taxa held over time. This means that the non-identified records of already surveyed areas keep on being flora shortfalls, and new shortfalls appear as new areas are sampled. The result is the maintenance of a proportion of non-identified records along time, thus perennating Linnean and Wallacean shortfalls.

Traditionally, the botanical material sampled in floristic and phytosociological surveys becomes part of regional herbarium collections. Eventually, some unidentified material can be identified, and data become available for all people around the world through platforms such as the Global Biodiversity Information Facility (GBIF). These data are the opportunity to answer questions on a large geographical and temporal scale (Troudet et al., 2017). The complete identification of the species list from a region made at a specific time is the opportunity to analyze how species richness changes in response to human actions when compared within a given time interval (Steinbauer et al., 2018). The accurate recording of a species over time underlies the many issues that emerge from the global change scenario. Thus, we believe that researchers will have to strive for this deficit to decrease in the coming decades.

5. CONCLUSION

Our results showed more frequent flora shortfalls in phytosociological than floristic surveys. Both very speciose and poor families showed high numbers of flora shortfalls, confirming that taxonomic difficulties vary among taxa. Cerrado-Amazonia and Cerrado-Caatinga transition zones had the highest numbers of flora shortfalls, demanding greater attention. These results show that the proportion of relative flora shortfalls in both floristic and phytosociological surveys kept a similar magnitude and did not diminish along time. Our findings suggest several courses of action to scale down flora shortfalls. (1) Specialists acquainted with different plant groups should integrate with specialists who carry out phytosociological and floristic surveys. (2) Because many species not yet known may lay unidentified in some collection, concentrating efforts in identifying herbarium exsiccata should be considered a priority. (3) It is do not possible to know all species in the world, but efforts should be made towards identifying as many binomials as possible.

CAPÍTULO 3: Rarity patterns in the tree flora of the South American savannas: are the protected areas enough?

Everton A. Maciel*, Fernando R. Martins

Department of Plant Biology, Institute of Biology, P. O. Box 6109, University of Campinas – UNICAMP, 13083-970 Campinas, SP, Brazil.

*Corresponding author: everttonmaciel@gmail.com

Abstract

The interest in quantifying rare species has been increasing recently, but less attention has been paid to the analysis of their conservation status. Here, we used the Rabinowitz' method, based on geographical range, habitat specificity and population size, to classify the rarity forms of tree species in the South America savanna (SAS) and to analyse their conservation status. We sought to answer the following questions: (1) What forms of rarity does the SAS tree flora have? (2) How are these forms of rarity distributed over the SAS and (3) especially in the protected savanna areas (PAs)? We considered species with narrow (stenotopic) or wide (eurytopic) geographic range occurring respectively in up to 10% or more of the latitudinal belts in the SAS, generalist (euryoecious) or specialist (stenoecious) species occurring in one or more ecoregions, respectively, and locally scarce or abundant populations with respectively low or high numbers of the records within a grid cell of 1° latitude x 1° longitude. These parameters were combined to classify 2,203 SAS species into a common and seven forms of rarity and to analyse these species according to three categories: those occurring only within PAs, within and outside PAs or only outside PAs. Of the 2,203 tree species, 898 were rare, 826 stenotopic, 528 stenoecious and 617 locally scarce. The Cerrado had the highest number of rare species, followed by savannas in the Dry Chaco, Bahia coastal forests, Campos Rupestres, Guianan savanna and Llanos. Of the 2,203 species, 205 species occurred only in PAs, 1,650 within and outside PAs and 348 only outside PAs. Our results reveal a sampling bias on the species records outside PAs relative to those inside PAs. Future studies in PAs could reveal a conservation status of species not yet known.

Keywords: seven forms of rarity, conservation gap, protected areas, ecoregion, priority species.

1. Introduction

The identification of priority species should underly any strategy for biodiversity conservation because it is important to take into account that different species have different vulnerability levels (Groves, 1994; Groves et al., 2002). Consequently, classifying species into different threat levels has become a powerful ally in species conservation (Gärdenfors, 2001; Morais et al., 2012; Possingham et al., 2002). The scheme of the IUCN (International Union for Conservation of Nature) is the most used and accepted system for classifying species in different threat categories (Mace et al., 2008). To classify species according to their extinction risk, the IUCN scheme considers a taxon's spatial and temporal distribution and its life history. However, the IUCN scheme has some biases (Abeli et al., 2009), such as some species with a great risk for extinction being classified as deficient data (Bland et al., 2015), although some researchers have averred that the data-deficient species are more likely to be rare (Corlett, 2016; Roberts et al., 2016).

Rare species in a community can result from a combination of geographic range, population size and habitat affinity (Broennimann et al., 2005; Caiafa and Martins, 2010; Fattorini, 2014; Maciel and Martins, 2019; Manne and Pimm, 2001; Rabinowitz, 1981; Rey Benayas et al., 1999; Yu and Dobson, 2000). Species can have scarce (single or doubleton) or abundant populations, a narrow (stenotopy) or wide (eurytopy) geographic range and low (euryoecy) or high (stenoecy) affinity for a specific habitat (Caiafa and Martins, 2010; Rabinowitz, 1981). The arrangement of these possibilities leads to eight situations where the combination of eurytopic, euryoecious and abundant populations results in common species, whereas the other combinations result in seven forms of rarity (Rabinowitz, 1981).

The interest in rare plant species, classified according to Rabinowitz's scheme, has increased over time (Caiafa and Martins, 2010; Harnik et al., 2012; Reed et al., 2020; Yu and Dobson, 2000), but for some ecoregions, this subject is still poorly explored. In South

America, little is currently known about rare plant species, which has been investigated only in the Amazon (Pitman et al., 1999), the Atlantic forest (Caiafa and Martins, 2010) and the Cerrado (Maciel and Martins, 2019). Nothing is known about the seven forms of rarity in the South American savannas, which comprise the Cerrado, Gran Sabana, Llanos, Beni savanna, Campos Rupestres (topmontane rocky grasslands) and disjunct areas interspersed in the Caatinga (dry forest), the Amazon and the Amazon and Atlantic forest (Olson et al., 2001; Ratter et al., 2003). It is well established that many savanna plant species have small populations (Castro et al., 1999), whereas others are endemic (Alves and Kolbek, 1994; Pennington and Ratter, 2006) or occur within geographically restricted areas (Bridgewater et al., 2004). South American savannas occur in a wide range of environmental conditions of climates (Blydenstein, 1967), soils (Goodland and Pollard, 1973) and fire frequency (Coutinho, 1990; Murphy and Bowman, 2012). As these factors can limit species on different scales, different forms of rarity are expected in the South American savannas.

These different forms of rarity are differently associated with species extinction rates, with the highest extinction rates being expected for stenoecious species with restricted distribution and low abundance (Davies et al., 2004; Purvis et al., 2000). Savannas are among the 60% of the planet's ecosystems most affected by human activities (Grantham et al., 2020). In contrast to the many threats, the area officially protected in the South American savannas is one of the smallest when compared to that in the Amazonia rain forest (Oliveira et al., 2017). In South America, few investigations have been conducted on species rarity, and they considered only species that were previously recognised as endemic or threatened (Monteiro et al., 2018; Oliveira et al., 2017). It has been claimed that rare species are unlikely to be conserved if conservation strategies are made with an exclusive focus on other groups of species (Groves et al., 2002). Despite the importance of the rare species for conservation policies (Chapman et al., 2018; Lyons and Schwartz, 2001; Mouillot et al., 2013a), no

previous study has investigated if and how each species in each form of rarity is conserved in the protected areas (PA) of the South American savanna.

Here, using Rabinowitz's scheme (Rabinowitz et al., 1984), we provide the first quantification of rare and common species in the South American savannas (SAS). More specifically, we addressed the following questions: (1) What forms of rarity does the SAS tree flora have? Considering that the SAS is rich in species and has a high environmental heterogeneity (Sarmiento, 1984) and that a large number of plant species have small populations (Castro et al., 1999), are endemic (Colli-Silva et al., 2019; Pennington and Ratter, 2006) and have a restricted geographic range (Bridgewater et al., 2004), we expected the species to show all the seven forms of rarity. (2) How are these forms of rarity distributed over the SAS? We expected that different ecoregions have different numbers of species in each form of rarity. (3) Are both rare and common species conserved in the network of the SAS protected areas (PAs)? Because the PAs were created in marginal areas with little conservation value (Margules and Pressey, 2000), we expected that the PAs would not provide conservation for all rare species in the SAS.

2. Material and Methods

2.1. Study area

We considered a savanna a vegetation complex that includes three types of physiognomy, namely: open savanna, woody savanna and savanna woodland (Coutinho, 1978; Furley, 1999, 1992). The open savanna includes physiognomies in which the dominant forms are shrubs and trees < 7 m in height and with a crown cover of up to 10%. The woody savanna encloses physiognomies with the predominance of trees with 7-14 m in height and covering 40–60% of the ground. In the savanna woodland, trees are the dominant form and attain 15 m or more in height and > 70% crown cover. The savanna vegetation complex predominates in

the SAS ecoregions such as Llanos and Cerrado (Olson et al., 2001), but as a result of the expansion and retraction of the savanna through the glacial cycles (Berrio et al., 2002; Bueno et al., 2017), areas of savannas vegetation are found in non-savanna ecoregions, such as the Amazon (Barbosa and Fearnside, 2004), the Caatinga (Castro et al., 1999; Vieira et al., 2019), the Chacos (Kunst et al., 2006; Morales et al., 2019), and Atlantic forests (Costa-Lima and Chagas, 2019; Moura et al., 2011).

2.2. Datasets

Our database was built from two datasets. To build the first dataset, we searched for floristic and phytosociological surveys of trees performed in the SAS. To do this, we used different combinations of keywords such as, for example, ‘cerrado’, ‘dense’, ‘floristic study’ (see Table S1 for the complete keyword combinations). We then searched for papers published until December 2016 in *Web of Science*, *Scopus*, *Scielo* and *Lilacs* and built a dataset containing: 1) the localisation of each study site (using the information on latitude and longitude from the surveys) and 2) a list of the species that were sampled in each site. All studies performed in the savanna vegetation complex were included in our dataset. In total, 104 references were recovered (Table S2), namely, annals (n = 3), articles (68), books (6), research note (1), technical bulletins (3), technical report (1), theses (18) and unpublished data (3).

To build the second dataset, we used the NeoTropTree (Oliveira-Filho, 2017), a large database containing the results of a collaboration, to compile data across the tropical region of South America. The NeoTropTree database divides the space into sites with five kilometres in diameter and lists species with their geographic localisation, besides providing physiognomies, domain and environmental variables such as climate and precipitation. We used the savanna physiognomies as filters to pick up the surveys of SAS from the NeoTropTree and to construct our second dataset.

To build our final databank (hereafter referred to as “savanna database”), we merged the two datasets, making up 949 sites surveyed (Fig. S1). For taxonomic standardisation of species and family names, we used the ‘*flora* package’ in the R environment (Carvalho, 2016), which interacts with Flora 2020 online, to generate an output containing the currently accepted taxon names. For species names not standardised by the ‘*flora* package’, we used the Taxonomic Name Resolution Service (Boyle et al., 2013).

2.3. Rabinowitz’s seven forms of rarity

To classify the forms of rarity of the SAS tree species, we followed Rabinowitz’s scheme (Rabinowitz, 1981), who proposed that species rarity can be assessed according to a restricted or wide geographic range, low or high affinity for the habitat and scarce or abundant local population (Fig. 1). Rabinowitz's scheme is a robust method because it provides a scale of species rarity on multiple levels. The combination of the two states of each of these three parameters ($2 \times 2 \times 2$) leads to eight situations, in which one of the eight forms englobes species with a wide geographic range (eurytopic), low affinity for the habitat (euryecious) and abundant local populations, thus being common species. The other seven situations are considered the seven forms of rarity (Fig. 1). Form 1 species are eurytopic and euryoecious, but have scarce local populations, being rare due to scarcity; Form 2 species are eurytopic and have abundant local populations, but occur in a specific habitat, being rare due to the single habitat. Form 3 includes eurytopic, stenoecious species with scarce local populations, which are rare due to the single habitat and scarcity; whereas Form 4 species are stenotopic, euryoecious and have abundant local populations, being rare due to their narrow geographical range. Form 5 species are stenotopic and euryoecious with scarce local populations, being rare due to their narrow geographic range and paucity; Form 6 species are stenotopic and stenoecious, although with abundant local populations, being rare due to their narrow geographic range within a single habitat. Form 7, the most extreme form of rarity, contains stenotopic, stenoecious species with

scarce local populations, which are rare due to their narrow geographic range, single habitat and paucity. An overview of the database construction and the rarity forms classification can be seen in Figure 1.

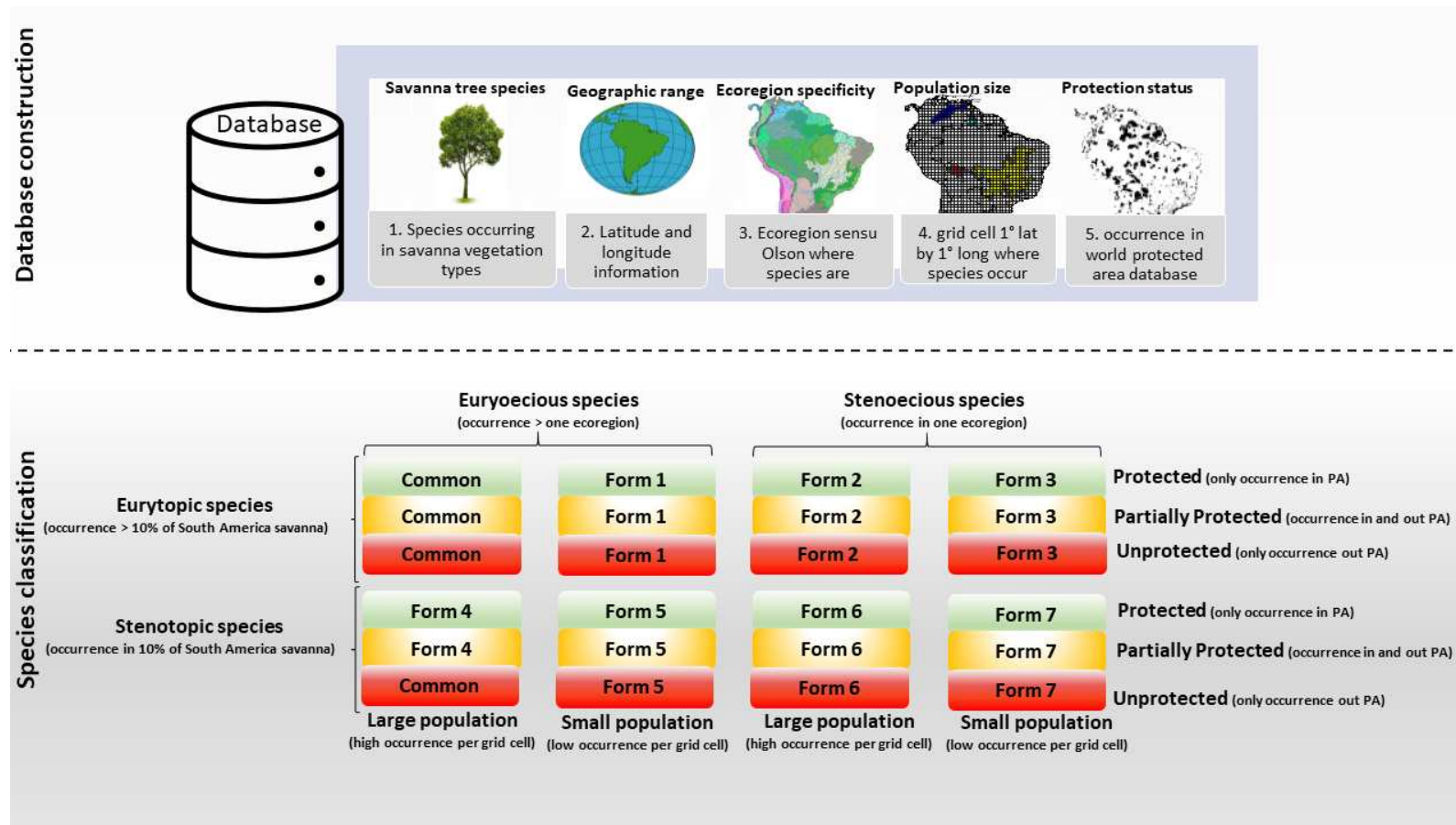


Fig. 1. Database construction including tree species with their geographical coordinates, occurrence in the South American savanna ecoregions, 1 x 1 degree of latitude x longitude cells and protected areas. Species classification according to Rabinowitz's scheme shows the eight combinations that give rise to common species and seven forms of rarity, each of them classified into three protection categories according to their occurrence exclusively in protected areas (protected species), both in protected and non-protected areas (partially protected) as well as only in unprotected areas (unprotected species).

2.3.1. Geographic range

Usually, the geographic range is calculated by considering the number of plots with the species' presence in a geographic region; species occurring in less than 10% of all plots are considered stenotopic (Sætersdal and Birks, 1997). More recently, the geographic range has been calculated from the number of latitudinal belts where the species occur (Caiafa and Martins, 2010). We think that expressing the geographic range of a species as its latitudinal range may better reflect the species distribution limits as a response to the latitudinal gradient. The SAS latitudinal range comprises 35 belts from latitude 9° N to 25° S and is equivalent to a linear distance of around 3,939.82 km (Fig. S1). To attribute the species geographic range, we followed Caiafa and Martins (2010) and considered the number of latitudinal belts within which each species occurs. We considered as stenotopic the species occurring in three or less latitudinal belts, as this corresponds to around 10% of the total belts in the SAS. All species occurring in four or more latitudinal belts were considered eurytopic.

2.3.2. Ecoregion affinity

Although habitats are usually defined on a local scale, they can also be defined at the landscape scale (Tews et al., 2004). It is also accepted that the ecoregion concept provides a different way to classify habitat-specialist species. For example, in Canada, one study has shown that habitat-specific species were exclusive to one ecoregion (Kricsfalussy and Trevisan, 2014). Here, we use the ecoregion concept to classify habitat specificity (from now on, ecoregion specialist). Ecoregions are “relatively large units of land containing a distinct assemblage of natural communities and species, with boundaries that approximate the original extent of natural communities prior to major land-use change”(Olson et al., 2001). An ecoregion is an area where ecological processes strongly interact (Oriens, 1993) and includes different levels of biological complexity for conservation planning (Olson et al., 2001; Smith et al., 2018). Currently, conservation planning is based on the ecoregion concept, not anymore

on phytophysiognomy. Therefore, the ecoregion concept can provide a more coherent base to classify the forms of rarity because it is more congruent with current international conservation strategies (Loyola et al., 2009; Smith et al., 2018). Thus, we considered as stenoecious species those occurring in only one ecoregion, whereas species that occur in two or more ecoregions were considered euryecious. For this classification, we considered all the 38 South American ecoregions where savanna communities occur (Olson et al., 2001).

2.3.3. Population size

We used cells of 1° latitude by 1° longitude to calculate the population size per species (Ratter et al., 2003; Simon and Proença, 2000). Although abundance was originally proposed as a measure of the number of individuals in an area of 1 hectare, we accepted the record of each species per grid cell because it showed a positive correlation with abundance per ha (Spearman test, $n = 225$; $r = 0.7$, $p = < 0.05$; Fig. S2). To avoid that low sampled grid cells resulted in low population sizes due to methodological artifacts, we assessed how each species was relatively “diluted” or “concentrated” in a grid cell. We expressed the species “content” in a grid cell as the ratio between the number of records of a species and the total number of records of all species in a grid cell and considered this ratio to be the response or dependent variable. The “dilution” or “concentration” of this content was estimated considering the ratio between the number of grid cells with the species presence and the total number of grid cells (a constant); we considered this ratio to be the explanatory or independent variable. Then, we adjusted the General Linear Model with the best fit for these two variables in R version 4.0.2 (R CoreTeam, 2019). Finally, we used a piecewise regression (Muggeo, 2008a, 2008b) to detect the breakpoint position in the saturation curve and estimate the parameters of the linear regressions under and above the breakpoint. The breakpoint is an abrupt threshold where there is a sharp change in the relationship between the response and explanatory variables. Species with a population size below the breakpoint were considered to

have a scarce population (Fig. S3). The analysis was performed in the *segment* package (Muggeo, 2008b) in R version 4.0.2 (R CoreTeam, 2019).

2.4. Data analysis

2.4.1. Forms of rarity in the SAS tree flora

To investigate the forms of rarity and the proportions of rare and common tree species in the SAS, we first built a data matrix with the species names (rows) and the following four parameters (columns): latitude, longitude, number of ecoregions where the species occur and population size calculated as described above (Fig. 1). Then, we classified each species in one of the eight categories of Rabinowitz (1981) by applying the package *rare7* (Maciel and Arlé, 2020) in R version 4.0.2 (R CoreTeam, 2019). First, the *raredata* function calculates the total amplitude of all species based on the data input. Then, this same function quantifies, for each species, the number of latitudinal belts and ecoregions where it occurs and the maximum number of individuals as a discrete variable. Since we did not have the number of individuals, one solution we found was to assign the number 1 to the species that stayed below the breakpoint and the number 3 to the species above the breakpoint. This allowed the *rarityseven* function to classify the species below the breakpoint as locally rare. Finally, we obtained a list of species with the following parameters: maximum number of belts, maximum number of ecoregions and population size (Table S3). Using this list as input data, the *rareseven* function was able to operate and classify species as rare or common.

2.4.2. Differences of rarity among SAS ecoregions

To investigate whether the number of species in each Rabinowitz's form differed among ecoregions, we created a matrix with the number of species in each Rabinowitz' category in each ecoregion. According to the Shapiro-Wilk test, the number of species did not fulfil the assumption of normality. Then, to compare the number of rare species in each ecoregion, we performed the Friedman test using the *t* function in R version 4.0.2 (R

CoreTeam, 2019). All statistical analyses were performed at a significance level of 0.05 and a confidence interval of 95%. This procedure helped us to find out how the forms of rarity were distributed among the ecoregions and how much each ecoregion stood out for its contribution to rare and common species.

2.4.3 Species protection status

We considered as protected areas (PAs) those listed in the World Database on Protected Areas (WDPA), which provides information about the number, size, year of creation, among other data, of protected areas (Fig. 1). A full description of WDPA protected areas is available on the International Union for Conservation of Nature (IUCN) site (<https://www.iucn.org>).

The species protection status considered the species occurring within or outside the PAs. We classified the species into three protection status: protected, partially protected and unprotected. Protected species occurred only within Pas, partially protected species occurred both within and outside of the Pas, and unprotected species occurred only outside PAs. To assess the species protection status, we considered each form of rarity in each SAS ecoregion. This procedure allowed us to assess the proportion of the species with any record within PAs relative to all SAS species (Cao et al., 2010).

For the partially protected species, we calculated the proportion of records within PAs relative to all records. For each species partially protected, we carried out the following analysis: $r = opa/to$, where r was the ratio between the number of records within PAs (opa) and the total number of records (to). At the end of this analysis, each partially protected species had an r value between 0 (no record within PAs) and 1 (all records within PAs). Then, we calculated the median of r (rMD) and the semi-amplitude of the 95% confidence interval (SCI) around the MD for all species together (protected, partially protected and unprotected) and for each form of rarity.

2.4.4 Sampling effect on the species protection status

To find out whether the protection status of a species was influenced by the sampling effort within PAs, for each grid cell, we calculated the proportion of harboured (protected + partially protected) species, that is, the ratio between the number of species within PAs and the total number of species. We took the proportion of harboured species in each grid cell as the dependent or response variable. To represent the sampling effort within each PA, we calculated the proportion of records within PAs in relation to all records per grid cell and took this as the explanatory variable. Then, we hypothesised that the proportion of harboured species is directly related to the sampling effort within PAs and tested this hypothesis by applying a general linear model. Because both y and x values were proportions ranging from 0 to 1, we used the *glm* function (Warton et al., 2016) in R version 4.0.2 (R CoreTeam, 2019) to adjust a general linear model with quasibinomial distribution after applying a logit transformation to the data. A positive correlation between y and x would indicate that the proportion of harboured species within PAs was dependent on the sampling effort. This helped us understand whether the species protection status was influenced by the relatively low sampling effort within PAs.

3. Results

3.1. The seven forms of rarity and common species in the SAS

We found all seven forms of rarity and common species as proposed by Rabinowitz et al. (1981) in the SAS (Table 1). Among the total 2,203 species, 40.76% (898) were classified as rare and 59.24% (1,305) as common. Form 7, the most extreme form of rarity, attained the highest proportion (16.98%) among all species. Form 3 (wide geographic range, ecoregion specificity and scarce population) had the least proportion, with only one species. Of all 2,203 species, 37.49% showed a restricted geographic range (stenotopic species), while 62.51% showed a wide geographic range (eurytopic species); 23.97% were stenoecious species, whereas

76.03% were euryoecious species. Further, 71.99% had abundant populations, whereas 28.01% had scarce populations (Table 1).

Table 1 Number and percentage (between parentheses) of forms of rarity found in the South American savannas.

Geographic distribution		Wide		Restricted	
Habitat preference		Various	Single	Various	Single
Abundant population	1,305 (59.2%) common	26 (1.18%) Form 2	128 (5.81%) Form 4	127 (5.76%) Form 6	
Scarce population	45 (2.04%) Form 1	1 (0.05%) Form 3	197 (8.94%) Form 5	374 (17%) Form 7	

3.2. Distribution of the rare and common species among the SAS ecoregions

Our comparisons revealed differences in the numbers of rare and common species among ecoregions ($F_{(37)} = 2.927$, $p < 0.001$). The number of rare species in each ecoregion ranged from 276 (Cerrado) to 2 (Bolivian Yungas and Caatinga), and that of the common species ranged from 1,023 (Cerrado) to 30 (Bolivian montane dry forests). Two ecoregions did not show any rare species (Tocantins-Pindaré moist forests and Serra do Mar coastal forests). All seven forms of rarity were present in the Cerrado. Form 4 was the most frequent one and present in 31 ecoregions, whereas Form 2 had the lowest frequency, occurring in only one ecoregion (Cerrado). The Cerrado had the highest number of rare species (all forms of rarity), followed by the Dry Chaco, Bahia coastal forests, Campos Rupestres montane savanna, Guiana savanna and Llanos (Fig. and Table 2). The ecoregion specialists (species occurring in just one of the 38 ecoregions) ranged from 142 (Cerrado) to 1 (Bolivian Yungas, Monte Alegre várzea, and Tapajós-Xingu moist forests). Seven ecoregions had over 20 stenoecious species: Cerrado (142), Bahia coastal forests (104), Dry Chaco (49), Llanos (42), Maranhão Babassu forests (32), Guianan savanna (31) and Campos Rupestres montane savanna (28), whereas seven other ecoregions did not contain any specialist species (Fig. and Table 2).

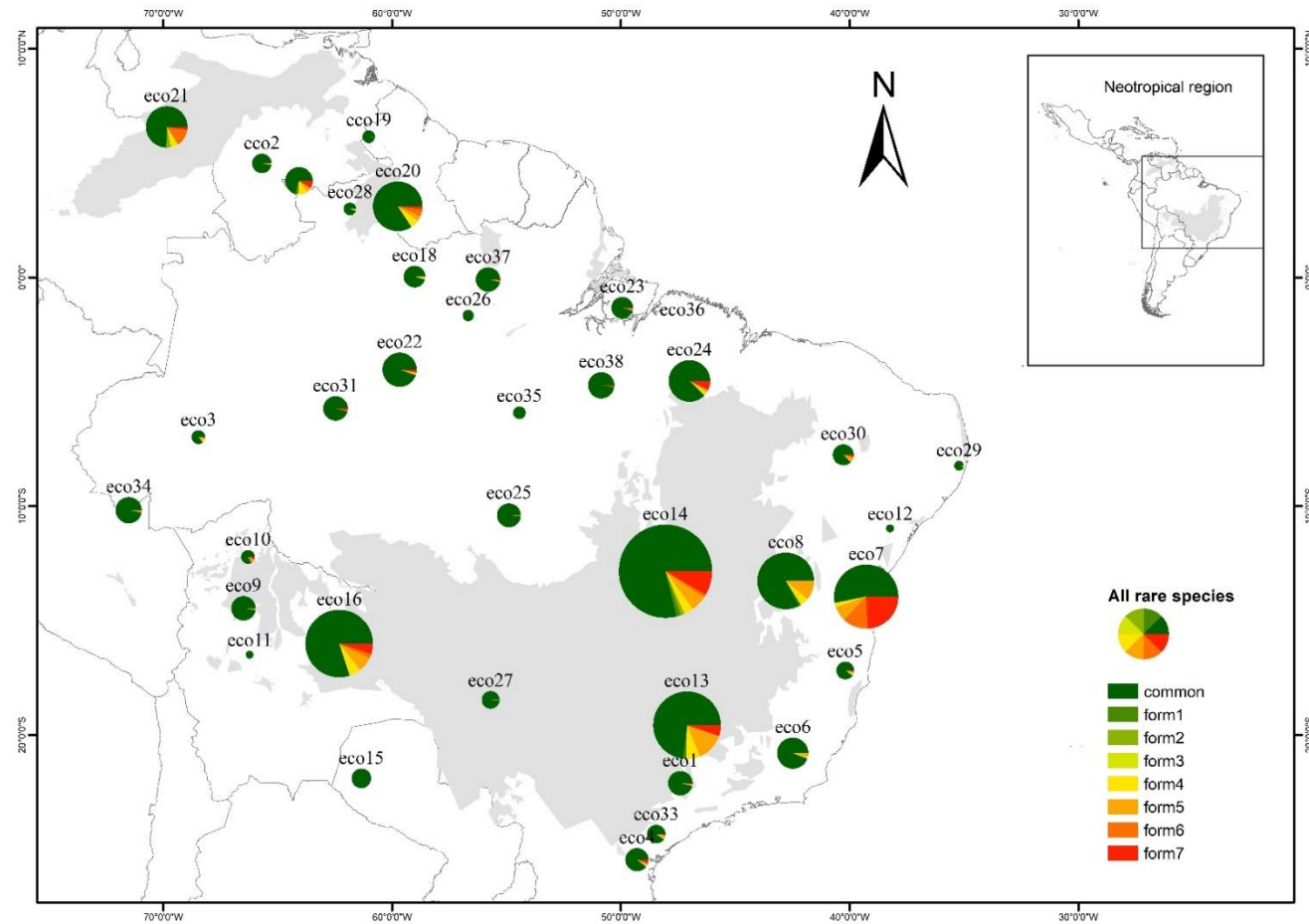


Fig. 2. Pie charts indicating the proportions of common and rare species in the 38 ecoregions (in grey) of the South American savannas. The pie codes are not the same as Olson's and are used here as a linchpin between this figure and Table 2. Pie size is proportional to the total number of rare species. The colours indicate Rabinowitz's forms of rarity.

Table 2. Numbers of total species (S), common species (common), rare species (rare), the seven forms of rarity (Form 1 to Form7), ecoregion-specialist species (es), as well as protected (prot), partially protected (part) and unprotected (unp) species in the 38 ecoregions (Olson et al. 2001) of the South American savannas (SAS). The codes in this table are not the same as Olson's codes and are used here as a linchpin between this table and the chart in Figures 3 and 4.3.3. Protection status of species.

codes	eco	S	common	rare	form1	form2	form3	form4	form5	form6	form7	es	prot	part	unp
eco1	Alto Paraná Atlantic forests	491	472	19	2	0	0	5	5	0	7	7	469	2	17
eco2	Amazon-Orinoco-Southern Caribbean mangroves	237	225	12	1	0	0	1	7	1	2	3	230	3	4
eco3	Apure-Villavicencio dry forests	46	40	6	0	0	0	4	0	2	0	2	41	0	9
eco4	Araucaria moist forests	165	148	17	0	0	0	4	3	2	8	10	153	4	8
eco5	Atlantic Coast restingas	106	96	10	0	0	0	4	4	0	2	2	97	1	8
eco6	Atlantic dry forests	496	465	31	3	0	0	11	17	0	0	0	484	0	13
eco7	Bahia coastal forests	280	149	131	0	0	0	6	21	36	68	104	225	31	24
eco8	Bahia interior forests	573	471	102	6	0	0	28	63	0	5	5	542	5	27
eco9	Beni savanna	433	414	19	5	0	0	2	9	1	2	3	423	1	9
eco10	Bolivian montane dry forests	36	30	6	0	0	0	0	4	0	2	2	61	5	0
eco11	Bolivian Yungas	67	65	2	1	0	0	0	0	1	0	1	66	0	1
eco12	Caatinga Enclaves moist forests	112	110	2	0	0	0	2	0	0	0	0	111	0	1
eco13	Campos Rupestres montane savanna	540	395	145	8	0	0	36	73	0	28	28	500	9	32
eco14	Cerrado	1299	1023	276	19	18	1	44	71	14	109	142	1144	31	128
eco15	Chiquitano dry forests	596	584	12	2	0	0	4	4	1	1	2	587	0	9
eco16	Dry Chaco	705	560	145	5	0	0	40	51	14	35	49	621	15	73
eco17	Guianan Highlands moist forests	80	56	24	3	0	0	9	5	0	7	7	67	12	0
eco18	Guianan moist forests	230	215	15	1	0	0	10	2	1	1	2	222	0	8
eco19	Guianan piedmont and lowland moist forests	89	84	5	5	0	0	0	0	0	0	0	88	1	0
eco20	Guianan savanna	473	395	78	4	0	0	27	16	22	9	31	417	43	14
eco21	Llanos	214	159	55	0	8	0	12	1	29	5	42	172	0	42
eco22	Madeira-Tapajos moist forests	569	532	37	7	0	0	8	3	6	13	19	537	16	16
eco23	Marajó varzea	270	255	15	1	0	0	1	7	1	5	6	265	3	2
eco24	Maranhão Babassu forests	432	377	55	1	0	0	12	10	1	31	32	394	5	36
eco25	Mato Grosso seasonal forests	617	599	18	3	0	0	1	7	1	6	7	603	5	10

codes	eco	S	common	rare	form1	form2	form3	form4	form5	form6	form7	es	prot	part	unp
eco26	Monte Alegre várzea	138	134	4	3	0	0	0	0	1	0	1	136	0	2
eco27	Pantanal	359	349	10	2	0	0	4	1	0	3	3	351	0	8
eco28	Pantepui	89	84	5	0	0	0	4	1	0	0	0	88	1	0
eco29	Pernambuco coastal forest	81	78	3	0	0	0	2	1	0	0	0	75	0	6
eco30	Pernambuco interior forests	106	92	14	1	0	0	2	7	0	4	4	94	0	12
eco31	Purus-Madeira moist forests	323	304	19	4	0	0	3	1	4	7	11	309	10	4
eco32	Serra do Mar coastal forests	96	96	0	0	0	0	0	0	0	0	0	96	0	0
eco33	Southern Atlantic mangroves	117	106	11	0	0	0	4	5	0	2	2	104	0	13
eco34	Southwest Amazon moist forests	412	390	22	6	0	0	2	9	1	4	5	400	3	9
eco35	Tapajós-Xingu moist forests	285	280	5	4	0	0	0	0	1	0	1	281	1	3
eco36	Tocantins/Pindare moist forests	40	40	0	0	0	0	0	0	0	0	0	40	0	0
eco37	Uatuma-Trombetas moist forests	399	380	19	4	0	0	3	7	1	4	5	386	5	8
eco38	Xingu-Tocantins-Araguaia moist forests	498	476	22	7	0	0	3	3	1	8	9	480	13	5

3.3. Protection status of species

We found only 9.30% (205) of the total species occurring only within protected areas; 74.89% (1,650) were partially protected, occurring both within and outside PAs, whereas 15.79% (348 species) were unprotected, only occurring outside PAs (Fig. 3A and Table S3 and S4). The number of rare species protected varied from 6 (common and Form 4) to 135 (Form 7). Rarity Forms 2 and 3 had no protected species. The number of partially protected species ranged from 1 (Form 3) to 1,254 (common species). The number of unprotected species ranged from 2 (Form 2) to 165 species (Form 7) (Fig. 3B). The protected species were concentrated in some ecoregions across the SAS, whereas the partially protected species were distributed over almost the entire SAS (Fig. 3B and D). Except for the common species and the rarity Forms 1 and 7, the unprotected species were also found in specific regions of the SAS (Fig. 3E).

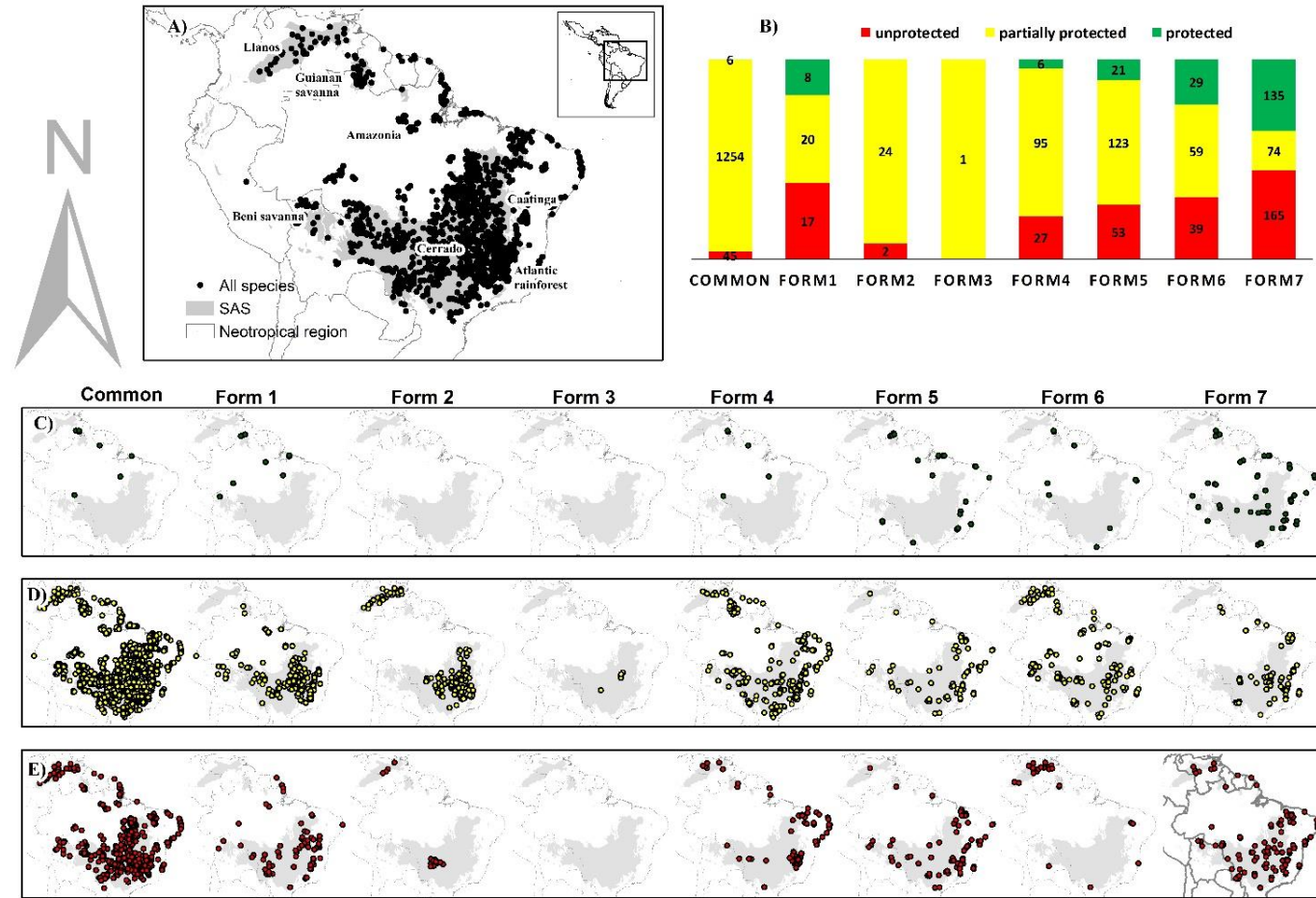


Fig. 3. (A) Tree species protection status (protected in green, partially protected in yellow and unprotected in red) in the network of protected areas in the South American savannas. (B) Number of species in each protection status (C, D, and E) and the geographic distribution of each form of rarity according to the species protection status.

Species in different protection categories were distributed differently among the ecoregions. Just one protected species occurred in the Atlantic Coast restingas, whereas 43 occurred in the Guiana savanna. Partially protected species ranged from 40 in the Tocantins-Pindaré moist forests to 1,144 species in the Cerrado, and unprotected species ranged from 1 in the Bolivian yungas and Caatinga to 128 species in the Cerrado (Fig. 3). The largest number of unprotected species was found in the Cerrado (128 species), followed by the Dry Chaco (73), Llanos (42), Campos Rupestres montane savanna (32) and Bahia interior forests (24).

When all partially protected species were considered (1,650 species), the median ratio (rMD) between the records within PAs and total records was $rMD = 0.14949$ (semi-amplitude of the 95% confidence interval - $SIC \pm 0.0003$), and the minimum (rMin) and maximum (rMax) ratios were 0.02 and 0.88, respectively (Table S5). Of all the 2,203 species, 1,317 species had maximum r above rMD, whereas 333 species had it below rMD. Rarity Form 1 showed the lowest rMD ($rMD = 0.13$, $SCI \pm 0.023$), whereas Form 6 had the highest value ($rMD = 0.6$, $SCI \pm 0$).

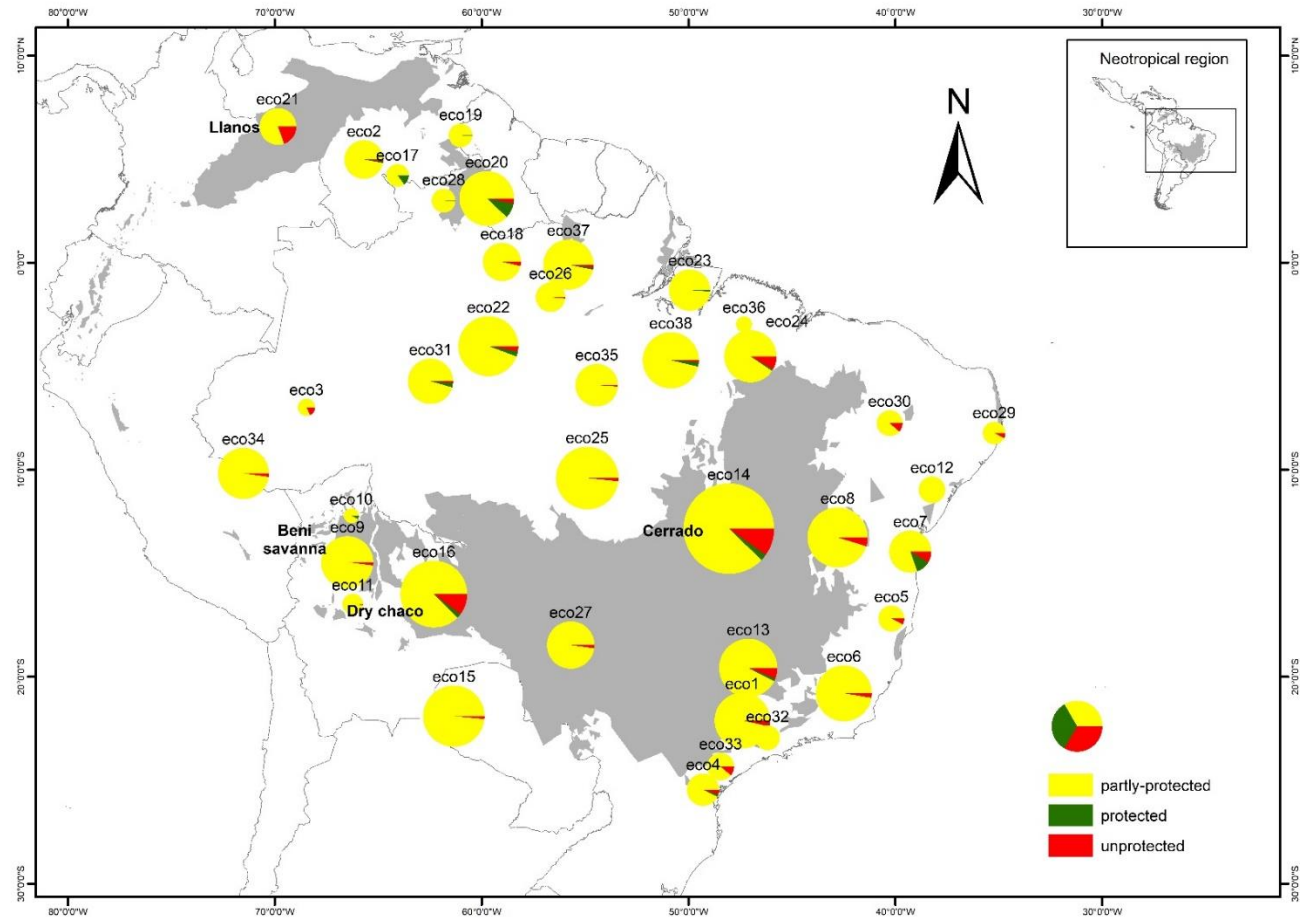


Fig. 4. Pie charts showing the proportions of the protection status (protected in green, partly protected in yellow and unprotected in red) of common and rare species in each of the 38 ecoregions (in grey) of the South American savannas. The pie codes are the same as Olson's (2001) and are used here as a linchpin between this figure and Table 2. Pie size is proportional to the total number of species.

3.4. Species recorded within PAs versus sampling effort

We found a sampling effect on the species protection status. The greater the ratio between the number of species within PAs and the total number of species the higher was the ratio between records within PAs and all records per grid cell (Fig. 5). The mean ratio between the number of species within PAs (harboured species) and the total number of species in a grid cell was 0.23, whereas the mean ratio between species records within PAs and the total number of records in the grid cell was 0.33. Our GLM model showed that the higher the ratio of records within PAs, the higher the proportion of harboured species in each grid cell (Fig. S4). The high value of the R square ($R^2 = 0.86$) revealed a good fit of the model, suggesting that higher numbers of harboured species per grid cell can be attributed to higher sample efforts.

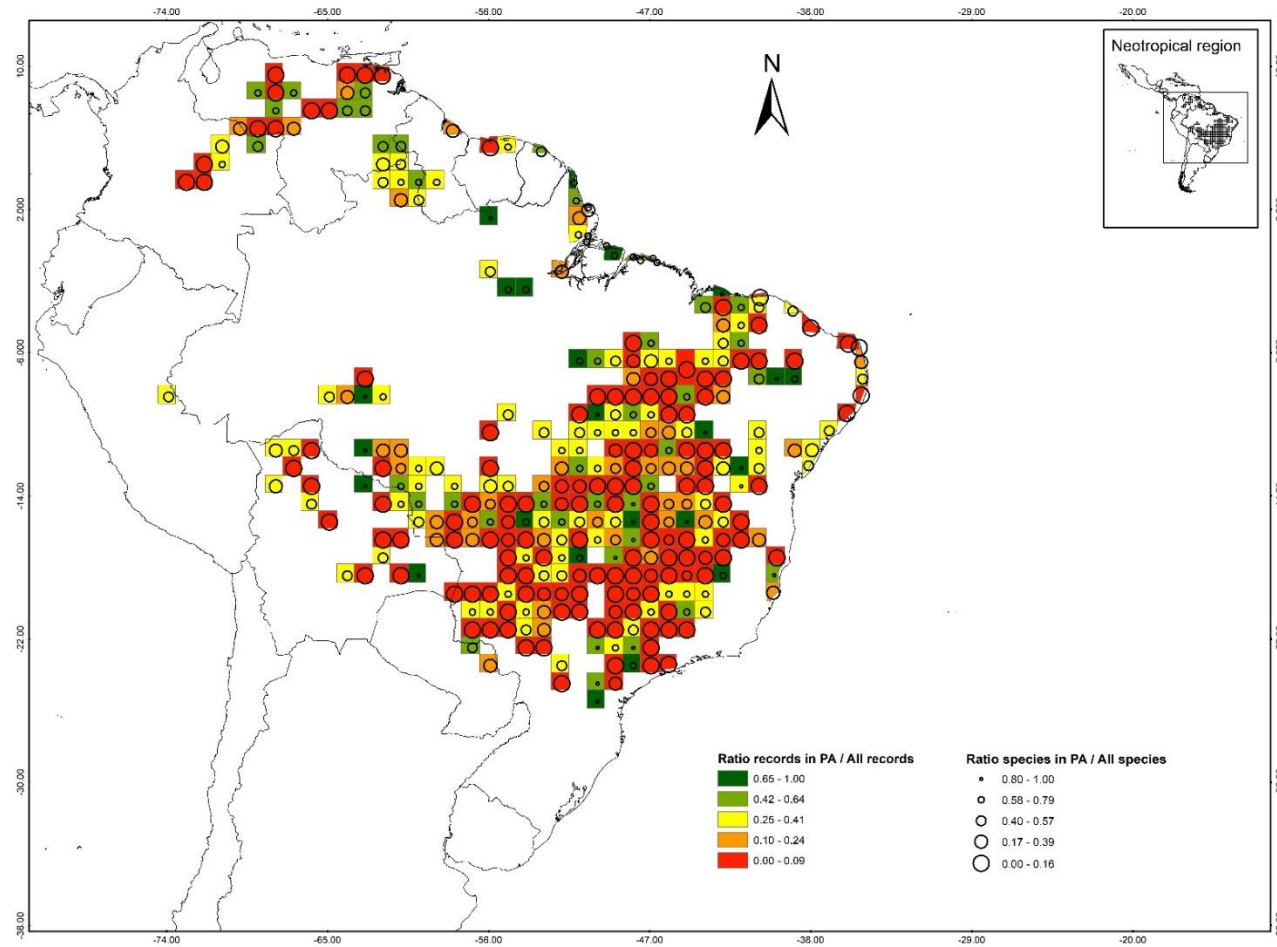


Fig. 5. Ratio between the number of records within the protected areas and all records in each grid cell of 1° of latitude by 1° of longitude. The ratio of records within PAs decreases from green to red colour (larger sampling gap within PAs).

4. Discussion

The importance of rare species is recognising as part of biodiversity conservation strategies (Groves et al., 2002; Le Berre et al., 2019; Longton and Hedderson, 2000; Maciel et al., 2016; Maciel and Arlé, 2020; McIntyre, 1992; Rey Benayas et al., 1999). This is justified because the rare species comprises a huge part of the community (Gaston, 2012), and they play a crucial role in the assemblies' structure and function, not supported by common species (Chapman et al., 2018; Gaston, 2012; Jain et al., 2014; Leitão et al., 2016; Lyons et al., 2005; Mi et al., 2012; Mouillot et al., 2013a; Soliveres et al., 2016). Moreover, because rare species are limited by area, dispersion, resources, or ecological processes (Lambeck, 1999, 1997) this makes them prone to extinction due to atrophic and stochastic processes (Lambeck, 1997; Sætersdal and Gjerde, 2011; Santoro et al., 2012). Here, we found rare species distributed throughout the Cerrado, Llanos, Beni savanna, Dry Chaco, Guiana savanna, and disjunct savannas in the Caatinga and Amazon and Atlantic rain forest. Therefore, our results provide an opportunity for plant biodiversity conservation strategies in South American savanna.

4.1. Forms of rarity among the tree species

Geographic range. The majority of the SAS rare species are geographically restricted (Forms 4, 5, 6 and 7; Table 1), with 37.49% (826) of all species being observed in only 10% or less of the SAS latitudinal range. Therefore, as in the Atlantic rain forest (Caiafa and Martins, 2010), stenotopy is the most important variable determining rarity in the SAS. Many species that are now considered characteristic of the Cerrado experienced their maximum expansion during the Last Interglacial (Bueno et al., 2017). Regions that today have disjunct savannas had suitable climatic conditions for the expansion of the savanna in the past (Bueno et al., 2017; Haffer, 1969). In some regions, the climate conditions such as precipitation and temperature are quite different than it has been in the Quaternary period (Auler and Smart, 2001). As a result, some species that have been able to overcome the climate changes condition are now

wide distribution, while species that were not able to inhabit some current conditions have become restricted over time (Foster, 2001; Hunter Jr et al., 1988; Pearman et al., 2008; Saupe et al., 2015).

Ecoregion preference. We observed 23.97% (528) of all species occurring in only one ecoregion. Each ecoregion has unique features that could have favoured the evolution of different species lineages over time (Liu et al., 2016). Presently, many ecoregions face numerous threats and, therefore, a high risk of habitat loss (Taylor et al., 2016). The distribution of plants is considered to be suited to the range of conditions found in an ecoregion, such as water table and rainfall (Oldfather, 2019). The areas of the SAS are among the richest environments, with high heterogeneity of soil, climate and relief (Coutinho, 1990; Sarmiento and Monasterio, 1975; Solbrig, 1996), thus explaining the high proportion of habitat-specialist species that we found.

Population size. We found that 28.01% (617) of all species have scarce populations (Forms 1, 3, 5 and 7), i.e., species that occur with few individuals in each savanna grid cell. The great proportion of species with scarce populations may be a result of the synergy of different factors. For instance, the high limitation of seed dispersal has been reported as a filter leading to the maintenance of small local populations while also maintaining high diversity (Salazar et al., 2012). Also, in hyperseasonal savannas, waterlogging is the main factor determining the low density of species that do not have the ability to cope with saturated soils (Batalha et al., 2005). In addition, fire is considered an important factor reducing species populations, especially of those that do not have resprout capacity (Ojeda et al., 2005; Salazar and Goldstein, 2014).

4.2. Compositions of rare species differ among ecoregions

Our analyses showed that some ecoregions have exclusive rare species that do not occur anywhere else. The Cerrado and Llanos make up the largest ecoregions of the South American

savannas. They also are part of the Global200 ecoregions (Olson et al., 2001), the priority ecoregions for conservation in the world. In the case of the Cerrado, it has been recurrently emphasised as an important ecoregion in the tropics (Giam et al., 2011; Redo et al., 2013). Nevertheless, other ecoregions, such as the Campos Rupestres, Maranhão Babassu forests and Dry Chaco, also contain large numbers of rare species, but they are not part of the Global200. The Campos Rupestres, for example, has a high floristic diversity that is driven by many factors (Neves et al., 2018) and as considered a conservation priority due to the threatened flora of the mountaintops in Brazil (Monteiro et al., 2018). Since the Global200 ecoregions are considered a priority, they should receive more funding for conservation than non-priority ecoregions. These resources are intended to maintain protected areas or sustain projects in these ecoregions. However, our findings show that more savanna ecoregions should be included in the Global200, as they have many unique species that are probably vulnerable to extinction. Therefore, we strongly suggest an urgent revision of the list of ecoregions included in the Global200.

4.3. The status of protected species of the South America Savanna

Of all analysed species, 15.84% (350) were unprotected species, meaning that these species are not inside any protected area at all. Some of these species, such as *Annona pickelii* (Diels) H. Rainer (Form 7), were classified as ecoregion specialists, geographically restricted, with scarce population, and have previously been classified as vulnerable (IUCN, 2019). Thus, our results agree with those of other authors who found that the South American network of protected areas has a conservation gap that fails to conserve a part of the biodiversity (Forero-Medina and Joppa, 2010; Jenkins and Joppa, 2009; Neves et al., 2018; Ribeiro et al., 2018; A. S. L. Rodrigues et al., 2004; Silva and Bates, 2002). Like the threatened and endemic plant species (Dryflor et al., 2016; Neves et al., 2018; Oliveira et al., 2017), we found that part of SAS rare species is also not protected in the present network of protected areas. However, the

conservation gap concerning rare species has not yet received attention in the South American protection network (Maciel et al., 2016). Efforts for flora conservation in South America have considered only threatened and endemic species (Oliveira et al., 2017; Ribeiro et al., 2018). We do not advocate that well-established groups of species should be replaced for rare species in conservation planning, but we agree with the importance of also considering the rare species in conservation planning (Broennimann et al., 2005; Maciel and Eisenlohr, 2016; Mehlman et al., 2004).

Another issue is the low proportion of species populations occurring within protected areas. Of the species occurring within any protected area, 851 (rare and common species) had less than 10% of their occurrences within PAs. This is quite disturbing for species that have scarce populations, such as, for instance, *Campomanesia xanthocarpa* (Mart.) O. Berg. Of 12 records of *C. xanthocarpa* in the entire databank, only one was within a protected area. In our analysis, *C. xanthocarpa* had, on average, two or fewer individuals per grid cell. Globally, the population size decrease of species is one of the most important triggers for local extinction (Belaid et al., 2018; Khanum, 2017). Therefore, maintaining a viable population size of both common and rare species is one of the great conservation challenges. Although the existing protected areas play a great role in the conservation of species populations, a great deal of commitment from decision-makers and managers is required.

4.4. Species records within PA versus sampling effort

We showed that the protected areas have a good performance in harbouring species, but not in keeping abundant populations. In addition, we showed that the proportion of the number of records within protected areas to the total number of records within a grid cell is low, that is, PAs have been little sampled. We found a strong positive correlation between the proportion of species and records within PAs in each grid cell, meaning that the number of harboured species depends on the sampling effort in the PAs; if more samples are taken within PAs, the

number of harboured species can increase. However, these statements cannot be conclusive because many grid cells do not have any PAs. Protected areas are mainly located in the south of the Llanos and Cerrado core area and completely absent in many other grid cells of the SAS, where many species occur in all forms of rarity. Thus, although the sampling effort within the PAs should be encouraged, the creation of new protected areas is still necessary since there are large conservation gaps in many other savanna areas in South America.

4.5. Implications for conservation

Habitat specialist species with a restricted geographic range and small populations are more likely to become extinct (Purvis et al., 2000; Staude et al., 2020). Drivers such as climate, habitat fragmentation, fire regime (Pivello, 2011; Torres and Marengo, 2014) and others, which may trigger the process of extinction of plant species, are intensifying in the SAS. These changes occur so rapidly that many species may not have time to adapt to them. As a result, the loss of these species is expected. Thus, the high proportion of rare species that we found in the savannas of South America claims the urgent need to include them in conservation planning. Besides, our results reinforce the need to conserve ecoregions (Smith et al., 2018), thus conserving habitats and, as a consequence, the many exclusive rare plant species that only occur therein.

We detected that many rare species are restricted to only one of these Olson's ecoregions. Some of these ecoregions are restricted to the country, such as the Campos Rupestres (Brazil), or embrace more than one country, such as Llanos (Colombia and Venezuela). Collaboration among countries aimed at conservation is not frequent due to different policies, and conservation actions are usually done on a national scale. In consequence, species occurring in more than one country have the chance of being conserved by different governments, while restricted species may not be conserved anywhere. In this sense, cross-boundary collaboration has been encouraged in the conservation field (Kark et al.,

2015). Our results claim for the opportunity of the application of cross-boundary collaboration to the South America savanna. For example, species restricted to Llanos, Dry chaco, Beni savanna, Cerrado and Campos Rupestres can be prioritised by the countries where these ecoregions occur.

Additionally, we observed many rare species occurring also in ecoregions where the savanna is not the predominant vegetation but occurs as enclaves or refuges (disjunction savanna). These ecoregions of disjunction savanna are located in the Amazon, for example, Madeira-Tapajos moist forest and Xingu-Tocantins-Araguaia moist forests, and in the Atlantic rain forest, for example, Bahia coastal forests and Bahia interior forests. These savanna disjunctions are well known and have been reported as a result of the expansion and contraction of large biomes during Pleistocene climate oscillations. We found that many of these species of disjunction savanna were classified in Forms 4 and 5, i.e., occurring in many ecoregions, but are locally scarce or geographically restricted. Conservation approaches are usually focused on core areas and have fewer focuses on disjunctions. However, these disjunction areas keep species that are crucial for our understanding of the evolutionary processes that result from the floristic exchange between core savanna and disjunctions. We have shown that many of these shared species are rare, and we encourage conservation strategies focused on both core savannas and their disjunctions.

Conclusion

We found that 40.76% of the 2,203 tree species in the South America savanna show a form of rarity. Of these 2,203 species, 37.49% were stenotopic (restricted distribution), 23.97% were stenoecious (ecoregion specialists), and 28.01% had a scarce population. Our findings revealed that many ecoregions have not been considered a priority for conservation, such as the Campos Rupestres. These ecoregions contain many rare species found nowhere else, and

our study emphasises the importance of reviewing the list of priority ecoregions for conservation (Global200). The existing protected areas harbour a high number of savanna tree species, but the proportion of records within PAs relative to the total number of records is low, that is, the sampling effort in PAs is relatively small. Enhancing the number of samples done in PAs can provide more accurate information about the conservation status of savanna tree species in South America. In addition, PAs are concentrated in some savanna core areas and completely absent in peripheral and disjunct areas. Considering the evolutive importance and the uniqueness of species occurring in these areas, new protected areas should be created.

CAPÍTULO 4: Defaunation and changes of climate and fire frequency have synergistic effects on biomass loss in South American savannas²

Everton A. Maciel¹, Valeria F. Martins^{1,2}, Mateus D. de Paula^{3,4}, Andreas Huth⁴, Frederico A. G. Guilherme⁵, Rico Fischer⁴, André Giles¹, Reinaldo I. Barbosa⁶, Osmar Cavassan⁷,
Fernando R. Martins¹

1- Department of Plant Biology, Institute of Biology, P.O. Box 6109, University of Campinas – UNICAMP, 13083-970, Campinas, SP, Brazil.

2- Department of Natural Sciences, Maths, and Education, Centre for Agrarian Sciences, Federal University of São Carlos (UFSCar), Rodovia Anhanguera - SP 330, km 174, 13600-970, Araras, SP, Brazil.

3- Department of Ecological Modelling, Helmholtz Centre for Environmental Research – UFZ, Permoserstraße 15, 04318 Leipzig, Germany.

4- SBIK-F – Senckenberg Biodiversity and Climate Research Centre Georg-Voigt-Straße 14-16, D-60325 Frankfurt am Main, Germany.

5- Federal University of Goiás – UFG, Regional Jataí, BR 364, km 192, 75801-615, Jataí, GO, Brazil.

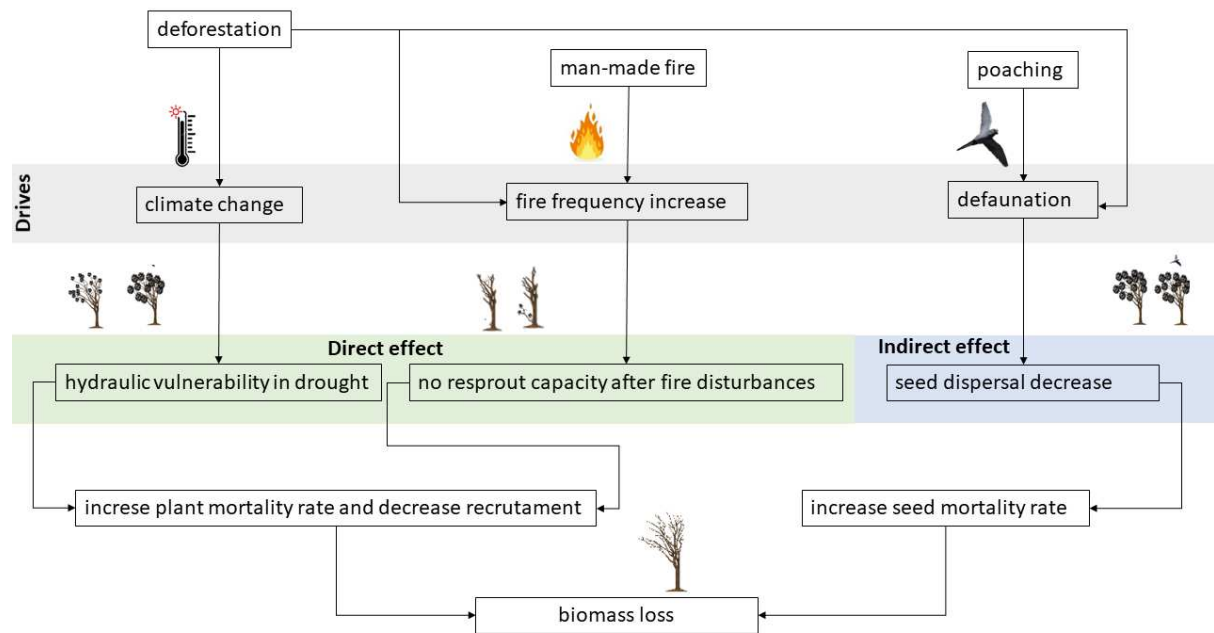
6- Research Center of Roraima, National Institute of Amazonian Research – INPA, 69301-150, Boa Vista, RR, Brazil.

7- Department of Biological Sciences, Faculty of Sciences, São Paulo State University – UNESP, Bauru, SP, Brazil.

*Corresponding author: everttonmaciel@gmail.com

² The paper's format follows Elsevier's formatting

Graphical abstract



Highlights

- We found a synergic effect of climate and fire regime changes and defaunation on the savanna biomass loss.
- In some cases, the total biomass loss exceeded 70%.
- Different physiognomies and plant functional strategies have different responses to global changes.
- Animal-dispersed, deciduous non-resprouting species have the highest biomass loss among functional groups.

Abstract

As a result of anthropogenic pressure, three effects are expected to occur in Brazilian savannas: an increase in the dry season, more frequent fire events, and defaunation. These drivers are a trigger for biodiversity loss, which hinders ecosystem services such as carbon storage. Our goal was to analyze how these drivers can affect the structure and dynamics of savanna tree species and estimated aboveground biomass (AGB). We analyzed eight areas comprising a vegetation gradient from open savanna to savanna woodland in Brazil. The species were classified by their phenological strategies (deciduous or evergreen), fire resistance (resprouting or non-resprouting), and dispersal syndrome (animal or non-animal). We modeled AGB loss in a dry season (austral winter), five fire events by decadal-series, and a defaunation scenario. Although climate, fire, and defaunation effects impact AGB separately, they also have a synergistic effect. This effect was observed in functional groups and also in the community total AGB, which exceeded 70% in some cases. AGB loss was highest in animal-dispersed, deciduous non-resprouting species. These results show that AGB loss is an outcome of both direct (e.g. inability to cope with disturbance) and indirect effects (e.g. loss of animals for seed dispersal). In the long term, these changes can hinder ecosystem services such as carbon balance and groundwater stock. Our results show that responses to environmental changes are different among phytophysiognomies and areas, suggesting that management plans should take into account the savanna heterogeneity.

Keywords: climate change, fire frequency, defaunation, aboveground biomass loss, biodiversity loss, biodiversity management.

1. Introduction

The savanna is a type of vegetation found in Central and South America, Africa, and Australia under tropical climates with a defined dry season when natural fires occur (Coutinho, 1990; Durigan and Ratter, 2016; Solbrig, 1996). The savanna covers poor soils, whose aluminum gradient is the main driver of the different savanna physiognomies (Lopes and Cox, 1977). Although the savanna has a well-defined herbaceous stratum (mainly C4 grasses), it is an important carbon sink and thus a climate regulator (Ratnam et al., 2011). Additionally, the savanna plays a key role in other ecosystem services, such as the provision of food to humans, and the improvement of freshwater and air quality (Batlle-Bayer et al., 2010; Klink and Machado, 2005; Nabout et al., 2011). Nevertheless, ecosystem services provided by the savanna are now at risk of being lost due to anthropic changes in the environment, such as land conversion (Abreu et al., 2017; Cardoso Da Silva and Bates, 2002; Carvalho et al., 2009), the introduction of exotic species, defaunation (Hoffmann and Haridasan, 2008; Mistry, 1998), and climate change with consequent changes in fire frequency (Coutinho, 1990; Kauffman et al., 1994; Klink et al., 1993; Torres and Marengo, 2014), all of which increase plant mortality and lead to changes in the vegetation structure (e.g. Abreu et al., 2017; Rossatto et al., 2012).

Not all savanna woody species are expected to respond similarly to anthropic changes in the environment. For example, the seasonal tropical climate where the savanna occurs has acted as a selective pressure on leaf phenology (Van Schaik et al., 1993). Some species are deciduous and avoid drought by shedding their canopy, either entirely or partially, and hence not transpiring at significant rates during the dry season (Franco et al., 2005). Additionally, deciduous species show a decreased demand for belowground water in the dry season (Eamus, 1999; Franco et al., 2005; Lambers et al., 2008). This functional strategy provides high water use efficiency but comes at the expense of high vulnerability to cavitation due to the high gradient of water potential between the leaves and the soil (Santiago et al., 2016). Another cost

of this strategy is the high investment in leaf nitrogen to maintain high photosynthetic rates during the rainy season (Donovan et al., 2011; Edwards et al., 2014; Rossatto et al., 2013). On the other hand, other species of savanna communities are evergreen, which means they keep their canopy and transpire during the entire dry season (García-Núñez et al., 2019; Goldstein et al., 2008; Rossatto et al., 2013). In face of the climate change resulting in longer dry seasons, evergreens are expected to show higher mortality than deciduous species, leading to deciduous-dominated communities (Engelbrecht and Kursar, 2003; Hasselquist et al., 2010).

Fire is another important selective pressure on savanna tree species (Bueno et al., 2018). Some species reconstitute their aerial parts from the underground system after fire events and are called resprouters (Moreira et al., 2012; Ojeda et al., 2005). In the savannas, the resprouting strategy increases survival in comparison to the non-resprouters (Clarke et al., 2015; de Moraes et al., 2016; Ott et al., 2019; Salazar and Goldstein, 2014) because fire can kill seeds and small individual (de Medeiros and Miranda, 2005a; Hoffmann and Solbrig, 2003) but commonly does not damage underground structures. In a future scenario of increasing fire frequency due to longer and drier periods, resprouters can experience an increase in abundance whereas non-resprouters are likely to become less abundant (Hoffmann, 1998; Ojeda et al., 2005; Salazar and Goldstein, 2014).

While climate and fire have a direct effect on plant performance (Ratnam et al., 2011), defaunation indirectly impacts vegetation structure through changes in plant-animal interactions such as seed dispersal and seed predation. The causes of defaunation are many and complex, including poaching (Ferreira et al., 2015, 2012), modification of natural fire frequency (Abom et al., 2016; Langevelde et al., 2003; Radford et al., 2015), animal trafficking (Souto et al., 2017), and habitat fragmentation (Marine, 2001). These factors have an overall stronger negative effect on large animals that act as effective seed dispersers and as top-down control of seed predators (Wright et al., 2000). As a result, there is a decline in plant recruitment

(Dantas et al., 2018) and consequently in local plant populations (Carvalho et al., 2016; Rumeu et al., 2017; Terborgh et al., 2008; Valiente-Banuet et al., 2015). Similarly to other tropical vegetation, most tree species of the Brazilian savannas rely on animals for seed dispersal (e.g., Batalha et al., 1997; Mantovani and Martins, 1988), meaning that these species are more susceptible to local extinction than those that do not depend on animals as dispersal agents (Dantas et al., 2018).

It has been shown that climate change (Bustamante et al., 2012), changes in fire frequency (Abreu et al., 2017), and defaunation (Dirzo et al., 2014) separately change ecosystem dynamics in the neotropics. However, factors affecting vegetation dynamics are many and do not act in isolation and therefore there is a growing interest in understanding how drivers act synergistically (Brook et al., 2008; Laurance and Useche, 2009; Midgley et al., 2010), i.e. whether the effects of two or more factors combined are stronger than the effect of each factor acting in isolation. For example, drought and deforestation acting together in South American rainforests cause an alternative community state (Staal et al., 2015). Additionally, poaching and fragment size have a synergistic effect on the population decline of large vertebrates (Peres, 2001). Nevertheless, there is still little knowledge of how the main drivers of the savanna dynamics act synergistically.

Here, using a process-based dynamic vegetation model (FORMIND), we evaluated the performance, by estimating aboveground biomass (AGB), of different plant functional types (PFTs) in Brazilian savannas in response to climate change, changes in fire frequency, and defaunation. We tested the following hypotheses: (1) species that are deciduous, resprouters, or not primarily dispersed by animals are less susceptible to disturbance than evergreen, non-resprouting, and animal-dispersed species; (2) the synergistic effects of climate change, changes in fire frequency, and defaunation on AGB are greater than the isolated effects of each disturbance type.

2. Methods

2.1. Study sites

The Brazilian savanna comprises the core area of the Brazilian Cerrado and the Amazonian disjunction savannas (e.g., Huber, 1987; Salazar et al., 2015). Our data included eight sites of open savanna (OS), woody savanna (WS), and savanna woodland (SW) (Coutinho, 1978; Furley, 1999, 1992). The OS is dominated by shrubs and trees <7m in height and up to 10% of crown cover. The physiognomy of WS is dominated by 7-14m tall trees with crown cover between 40% and 60%. In the SW, trees are taller than 15m and cover more than 70% of the ground (Fig. S1).

Open Savanna. We used a site at the northeastern portion of the state of Roraima, northern Brazil. This physiognomy comprises part of the Rio Branco-Rupununi complex of Brazil, Venezuela, and the Republic of Guyana (Barbosa and Fearnside, 2004). In Roraima, the OS is popularly known as '*Campos do Rio Branco*' or '*lavrado*' and occupies an area of ~40,000 km² (Barbosa et al., 2007). The climate is Aw (tropical humid without a cold season) in the Köppen classification system (Barbosa et al., 2007).

Woody Savanna. Our data come from five sites in different savanna regions. Three sites are located in the Cerrado core in Brazil (WS1, WS2, and WS3) and have been surveyed twice, in 2009 and 2013 (Silva et al., 2019). The Aw-tropical seasonal climate is predominant in these sites, with a dry season lasting from April to September. The annual average temperature varies between 19 and 20°C with an annual mean precipitation of 1600-1900 mm (Alvares et al., 2013). The fourth WS site (WS4) is located in the state of Minas Gerais, southeastern Brazil. The climate is highland tropical, Cwb, with an annual average temperature of 23°C, and annual mean precipitation of 700-2000 mm (Alvares et al., 2013). Our fifth WS site (WS5) is located in the municipality of Carolina in the state of Maranhão, northeastern Brazil (de Medeiros et

al., 2008), in the transition between the Cerrado and the Amazon, thus having ecotone characteristics. The predominant climatic regime is Aw.

Savanna Woodland. We used data from two sites in southeastern Brazil, both located at the municipality of Bauru in the state of São Paulo. The Cwag climate subtype, temperate, moderately rainy with a dry winter, is predominant in the region (Cavassan, 2002, 1990). In Brazil, this climate is characterized by an average annual temperature ranging between 17 and 24°C, and average precipitation of 700-2500 mm (Alvares et al., 2013). In Bauru municipality, the minimum temperature can be as low as 13.6°C and the average annual rainfall is 1262.9mm (Cavassan and Weiser, 2015). An overview of the eight study sites is shown in Table 1 and Fig. S1.

Table 1. Location of the sites used in this study with physiognomies of open savanna (OS), wood savanna (WS), and savanna woodland (SW). Details for each site can be found in the respective references.

Site	Locality	Forest type	Domain	Reference
OS1	Água Boa-RR	<i>Grassland + Parkland savanna</i>	Amazonia	Barbosa and Fearnside 2005
WS1	Rio Paraiso-GO	<i>cerrado stricto sensu</i>	Cerrado	Eliseu-Silva et al. 2019
WS2	Batalhão-GO	<i>cerrado stricto sensu</i>	Cerrado	Eliseu-Silva et al. 2019
WS3	Lajeado-GO	<i>cerrado stricto sensu</i>	Cerrado	Eliseu-Silva et al. 2019
WS4	Serra do Cipó –MG	<i>cerrado dense</i>	Cerrado	Sarmiento 2014
WS5	Carolina-MA	<i>cerrado stricto sensu</i>	Transition Cerrado-Amazônia	Medeiros et al. 2008
SW1	Bauru-SP	Cerradao	Cerrado	Unpublished data
SW2	Bauru-SP	Cerradao	Cerrado	Unpublished data

2.2. FORMIND model

To model the dynamics of the vegetation, we used FORMIND (e.g. Fischer et al., 2016), which is a dynamic vegetation model that simulates tree growth based on the carbon balance of individual trees (Köhler and Huth, 1998) resulting from basic processes such as competition for light and water, seed dispersal, recruitment, and mortality (Fischer et al., 2016). To model the community dynamics, the species are classified into plant functional types (PFTs) according to their life histories, based on characteristics such as seed dispersal and resource-use strategies. Simulations are performed for a minimum area of 1 ha, and this area is divided into plots of 20 × 20m, where the trees interact within each plot (Fischer et al., 2016). The survival and growth rates of the trees depend on environmental factors such as soil water table, temperature, and disturbance rates (e.g., Köhler and Huth, 2007). The competitive capacity of each PFT determines its basal area and AGB accumulation rate. Therefore, species with greater capacity to acquire resources provide a greater contribution to the community basal area and AGB (Pagel et al., 1991).

2.3. Plant functional types

We classified the species (trees and shrubs) surveyed in our eight study sites into eight PFTs, which were a combination of leaf phenology (deciduous *vs.* evergreen), resprouting capacity (resprouters *vs.* non-resprouters), and seed dispersal strategy (animal *vs.* non-animal) (Table S1). Because plant species with small, medium, and large seeds that are dispersed by animals of different sizes have been reported to decline progressively and quickly in the savanna (Harrison et al., 2013), we did not discriminate seed size in our models.

2.4. Baseline model (Control scenario – C)

For each of the eight study sites, we built a baseline model assuming political intervention that resulted in the stall of anthropic effects. In this scenario, the CO₂ emission was controlled until 2050 and CO₂ concentration remained around the current 400ppm (Moss

et al., 2010). The other characteristics of the C model were parameterized in the submodels below.

Advanced climate submodel: here we included precipitation and temperature for each site. Data were extracted from the Brazilian National Meteorology Institute (INMET - Instituto Nacional de Meteorologia, 2018) using the geographic position of each study site and for the same years that each site was surveyed. The dry season did not exceed six months, with a monthly average of <10-40mm of rain. The annual precipitation reached up to 1,500mm with a minimum monthly average of 200mm. The annual temperature remained at an average of 25°C.

Soil water submodel: in FORMIND, soil water content is hourly calculated according to the volume of precipitation, interception, and runoff (Kumagai et al., 2004). In order to represent realistic gap/successional dynamics within water-limited environments, we included the effect of rooting in soils as a facilitation process for water availability. Therefore, in our simulations we assumed that water infiltration (I) was facilitated by root mass density, using the relationship developed by Hart (2017):

$$I = 4.8 \cdot B_{root} + 0.6 \quad (1)$$

Where I is in cm/hr and B_{root} is root mass density (kg/mg). This allows for larger soil water availability through the open pore structure of strongly rooted soils (Zhou and Shangguan 2007; Ostonen et al. 2007; Bartens et al. 2009) and a dynamic in which plants with lower hydraulic conductivities and photosynthesis rates (evergreen PFTs in our model) are selected for in uncolonized soils with low infiltration rates and high potential evapotranspiration. Once the volume of water in the soil increases through rooting by evergreen species (San José and Medina 1975), these are substituted by deciduous (Nardoto et al. 1998; Ludwig et al. 2004). In our model, deciduous species have lower water use efficiency but a higher photosynthetic capacity than evergreen species (Jackson et al. 1999; Franco et al. 2004); this provides a

functional advantage to deciduous against evergreen species in less water-limited environments.

Fire submodel: in our models, the fire was parameterized from empirical studies, which have shown that the frequency of natural fire is two or three episodes per 10-yr interval (*e.g.* Pivello and Norton, 1996) and that each episode burns ~40% of Cerrado areas (Pereira Júnior et al., 2014; Ramos-Neto and Pivello, 2000). In our models, the mortality rate after the fire disturbance was assumed as inversely proportional to the stem height (de Medeiros and Miranda, 2005b; Massi and Franco, 2016; Vale and Lopes, 2010). Additionally, fire tolerance of PFTs was defined on a scale of 1 (no tolerance) to 4 (tolerant). We specified non-resprouters as 2 (less fire-tolerant) and resprouters as 3 (more fire-tolerant) in our models, because resprouters are in general more successful than non-resprouters after fire events (Hoffmann, 1998; Ojeda et al., 2005).

Seed production and dispersal of mother trees submodel: seed limitation can be affected by the number of seeds produced (source limitation) and by the spatial dispersal capacity of seeds (dispersal limitation) (Nathan and Muller-Landau, 2000; Turnbull et al., 2000). Thus, more abundant species are likely to produce a larger number of seeds than rare species (Salazar et al., 2012), while taller species would disperse seeds to a greater distance from parent plants than shorter species (Thomson et al., 2011). We parameterized our models using mean species abundance and height per PFT (see de Paula et al. 2018). Additionally, we specified that only 20% of the total seed production was dispersed (see Mariano and Christianini, 2016; Salazar et al., 2012). Because dispersed seeds may not find suitable sites for germination and further plant establishment (Herrera et al., 1994; Nathan and Muller-Landau, 2000), or be destroyed by seed predators (Wright et al., 2000), the mean post-dispersal seed mortality in our models was 10% for all individuals (Salazar et al., 2012).

2.4.2 The model accuracy

In order to parameterise our FORMIND models with the basal area (BA) of each PFT in the communities, we used field data from three savanna sites (Table S2). These three sites were chosen because they were the only ones that had two inventories done in different times. We calculated the percentage BA of the eight PFTs (Table S1) and the range of each PFT's BA for the three sites. Once the FORMIND had been parameterized for three sites, we were able to run the FORMIND for the other ones. We run the FORMIND models for 1,000 years (e.g. Dantas et al. 2018). For all sites, we selected parameter values that resulted in BA within the empirical range, indicating the good performance of our models (Fig. S1). In order to test the accuracy of AGB predicted by FORMIND, we used the AGB value reported in the literature as an AGB reference value (Table S3). Then, for each area, we compared the AGB averages provide by FORMIND and standard deviation with the maximum and minimum AGB reference values.

2.4.3 Disturbance scenarios

We created three individual disturbance scenarios: climate change (CC), changes in fire frequency (CF), and defaunation (DE) (Table S4), in all of which there would be no effective policies to control anthropic actions (e.g. Jarvie and Svenning, 2018). In our CC scenario, the length of the dry season was increased from six to seven months and the average maximum daily temperature was increased from 25°C to 27°C (e.g. Torres and Marengo, 2014). We set out the temperature increase at 2°C because it is expected to cause large fires in the future (Silva et al., 2016; P. S. Silva et al., 2019). In the CF scenario, fire frequency was increased to five episodes per 10-yr interval. In both scenarios, the water table decreased relative to the control scenario (e.g. Gosling and Arnell, 2016). In the DE scenario, seed survival of animal-dispersed species was decreased from 10% to 5% due to the decrease of suitable sites (Herrera et al., 1994; Nathan and Muller-Landau, 2000) and post-dispersal seed predation of both animal

and non-animal dispersed species increased from 10% (before defaunation) to 50% (after defaunation) (Wright et al., 2000).

Because our main interest was to understand how the synergistic effects of climate change, changes in fire frequency, and defaunation lead to AGB change of savanna communities, we ran FORMIND with combinations of disturbances, namely climate change and changes in fire frequency (CC.CF), climate change and defaunation (CC.DE), and climate change, changes in fire frequency, and defaunation (CC.CF.DE). The effect of the different disturbance scenarios on the vegetation was assessed by the percentage in the AGB change relative to the C scenario. The AGB change (*agbc*) was calculated as $agbc = [(b1 - bn) / b1]$, where, *b1* was the AGB in the control scenario (C) and *bn* was the AGB in each disturbance scenario. The *agbc* could range from 1 (100% AGB increase) to -1 (100% AGB loss).

2.5. Statistical analysis

We compared *agbc* among the different disturbance scenarios. The comparisons were done among each area of study (eight areas), phytophysiognomies (open savanna, wood savanna, and savanna woodland), and functional strategies (deciduous vs. evergreen, resprouters vs. non-resprouters, and animal vs. non-animal). In these comparisons, the mean *agbc* was calculated for each disturbance scenario. Because the data did not meet the assumptions of the parametric statistical, we used Games-Howell test, which is recommended when the distribution does not meet the assumption of normality (see Ruxton and Beauchamp, 2008). The 95% confidence interval around the average was calculated by the bootstrap method with 10,000 resamples (Streukens and Leroi-Werelds, 2016).

3. Results

The AGB (ton.ha⁻¹) estimated by FORMIND ranged from 11.74 (open savanna) to 73.27 (savanna woodland) for areas in the baseline scenario (C). Comparisons between the

AGB estimated by FORMIND and AGB reference values reported in studies of the savanna revealed the performance of the FORMIND model was good. Apart from one area, the AGB estimated by FORMIND was within the range (min and max AGB value) of the AGB references (Fig. S2).

3.1 Change in AGB in the areas

Our test revealed a significant change in average AGB for disturbance scenarios in all eight areas (Table 2). However, no significant differences were found in average AGB among all areas in the same disturbance scenario (Table 2). The increase in average AGB between areas ranged from 0.2% to 35%, while the decrease ranged from 21% to 77% (Table 2). In the climate change scenario (CC), there was an average increase in AGB in five areas (Table 2, Fig. 1a, e, f, g, and h) and a decrease in three areas (Table 1, Fig. 1b, c, and d). The CC.FC scenario (climate and fire change combined) produced a decrease in the average AGB in all areas (Table 2, Fig. 1). In the CC.DE scenario (climate change and defaunation-affected), the average AGB increased in half of the areas (Table 2; Fig. 1a, e, g, and h), and decreased in the other half (Table 2; Fig. 1b, c, d, and f). The synergism scenario produced a decrease in average AGB in all areas and it was greater than CC.FC (Table 2; Fig. 1). Overall, the synergistic effects of all types of disturbance (the CC.CF.DE scenario) resulted in the highest decrease (35-77%) in AGB (Table 2).

Table 2. Average rate of AGB (aboveground biomass) change (*agbc*) in four global change scenarios: climate change (CC), climate change and change in fire frequency (CC.CF), climate change, and defaunation (CC.DE), and all factors together (CC.CF.DE). Positive and negative values indicate gain and loss of AGB relative to the baseline scenario, respectively. All models were run for 1000 years. The 95% confidence interval, calculated by the bootstrap re-sampling method with 10000 repetitions, is provided. Significant statistical differences between average AGB are indicated by different letters among disturbance scenarios in the same area (uppercase letters), and among areas in the same disturbance scenario (lowercase letters). The letters in the last column correspond to the boxplot of each area in Figure 1.

scenario		CC		CC.CF		CC.DE		CC.CF.DE		Fig. 1
areas	n	<i>agbc</i>	95% CI	<i>agbc</i>	95% CI	<i>Agbc</i>	95% CI	<i>agbc</i>	95% CI	
OS1	995	0.26 ^{Aa}	0.22, 0.29	-0.29 ^{Ba}	-0.32, -0.27	0.17 ^{Ca}	0.13, 0.2	-0.36 ^{Da}	-0.38, -0.34	a
WS1	995	-0.21 ^{Ab}	-0.23, -0.19	-0.71 ^{Bb}	-0.72, -0.7	-0.41 ^{Cb}	-0.42, -0.4	-0.74 ^{Db}	-0.75, -0.74	b
WS2	995	-0.23 ^{Ab}	-0.25, -0.21	-0.77 ^{Bc}	-0.78, -0.76	-0.45 ^{Cc}	-0.47, -0.43	-0.77 ^{Bc}	-0.77, -0.76	c
WS3	995	-0.27 ^{Ac}	-0.29, -0.26	-0.71 ^{Bb}	-0.72, -0.7	-0.41 ^{Cb}	-0.43, -0.4	-0.74 ^{Db}	-0.75, -0.74	d
WS4	996	0.36 ^{Ad}	0.33, 0.39	-0.53 ^{Bd}	-0.56, -0.51	0.02 ^{Cd}	-0.003, 0.05	-0.56 ^{Dd}	-0.58, -0.54	e
WS5	996	0.21 ^{Aa}	0.18, 0.24	-0.51 ^{Bd}	-0.53, -0.48	0.04 ^{Cd}	0.01, 0.07	-0.58 ^{Dd}	-0.6, -0.56	f
SW1	992	0.23 ^{Aa}	0.21, 0.25	-0.24 ^{Be}	-0.25, -0.22	0.06 ^{Cd}	0.04, 0.07	-0.39 ^{Da}	-0.41, -0.38	g
SW2	989	0.35 ^{Ae}	0.33, 0.37	-0.21 ^{Be}	-0.23, -0.19	0.18 ^{Ca}	0.16, 0.2	-0.35 ^{Da}	-0.38, -0.34	h

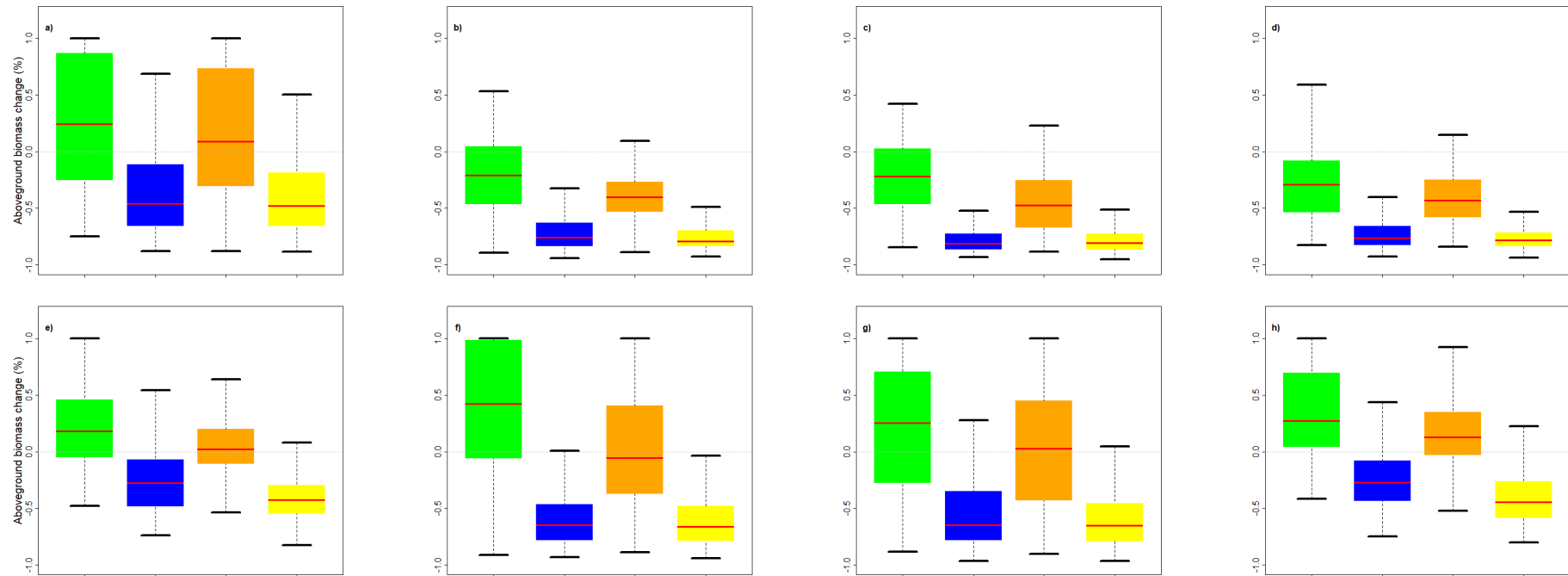


Fig. 1. Changes in aboveground biomass (AGB) in eight study areas (a-h) based on a 1000-year simulation. The colors green (climate change), blue (climate change and change in fire effects), orange (climate change and defaunation), and yellow (all factors together) indicate global change scenarios. Positive and negative values indicate gain and loss of AGB relative to the baseline scenario, respectively. The red lines of each boxplot indicate the average AGB in the global change scenarios.

3.2 AGB change within phytophysiological communities

Our test revealed a significant change in the average AGB among the disturbance scenarios for all phytophysiological communities (Table 3). Our test revealed significant AGB losses in woody savanna relative to woodland and open savanna resulting from all disturbance scenarios (Table 3). Average AGB losses were also significantly higher in open savanna than in savanna woodland in the climate and fire change scenario (Table 3). The same overall pattern we found for communities was also observed for the phytophysiological communities (Table 3; Fig. 2). The increase in average AGB ranged from 17% to 26% (open savanna) and from 23% to 38% (savanna woodland), while the decrease ranged from 29% to 36% (open savanna), from 0.2% to 35% (woody savanna), and from 23% to 38% (savanna woodland). Two scenarios (climate change and climate change and defaunation effect) produced an increase in the average AGB for two phytophysiological communities, open savanna and savanna woodland, and a decrease in that of woody savanna (Table 3). Climate change and change in fire frequency (CC.CF), as well as the synergy of all factors (CC.CF.DE), produced a decrease in average AGB for all physiological communities (Table 3; Fig. 2). The CC.CF.DE scenario resulted in the greatest decrease (41.93% and 76.06%) of AGB within the phytophysiological communities.

Table 3. Change in aboveground biomass (AGB) in three physiognomies: open savanna (OS), woody savanna (WS), and savanna woodland (SW). The average rate of AGB change (*agbc*) in four global change scenarios: climate change (CC), climate change and change in fire frequency (CC.CF), climate change, and defaunation (CC.DE), and all factors together (CC.CF.DE). Positive and negative values indicate gain and loss of AGB relative to the baseline scenario, respectively. All models were run for 1000 years. The 95% confidence interval, calculated by the bootstrap re-sampling method with 10000 repetitions, is provided. Significant statistical differences between average AGB are indicated by different letters between disturbance scenarios in the same phytophysiology (uppercase letters), and between phytophysiology in the same disturbance scenario (lowercase letters). The letters in the last column correspond to the boxplot of each area in Figure 2.

scenario	CC			CC.CF			CC.DE			CC.CF.DE			Fig. 2
	n	<i>agbc</i>	95% CI	<i>agbc</i>	95% CI	<i>Agbc</i>	95% CI	<i>agbc</i>	95% CI				
OS	995	0.26 ^{Aa}	0.22, 0.29	-0.29 ^{Ba}	-0.38, -0.29	0.17 ^{Ca}	0.13, 0.20	-0.36 ^{Da}	-0.38, -0.34				a
WS	4,975	-0.09 ^{Ab}	-0.13, -0.08	-0.71 ^{Bb}	-0.72, -0.70	-0.32 ^{Cb}	-0.33, -0.32	-0.73 ^{Db}	-0.74, -0.72				b
SW	1,984	0.28 ^{Aa}	0.27, 0.30	-0.23 ^{Bc}	-0.25, -0.22	0.11 ^{Cc}	0.09, 0.12	-0.38 ^{Da}	-0.39, -0.37				c

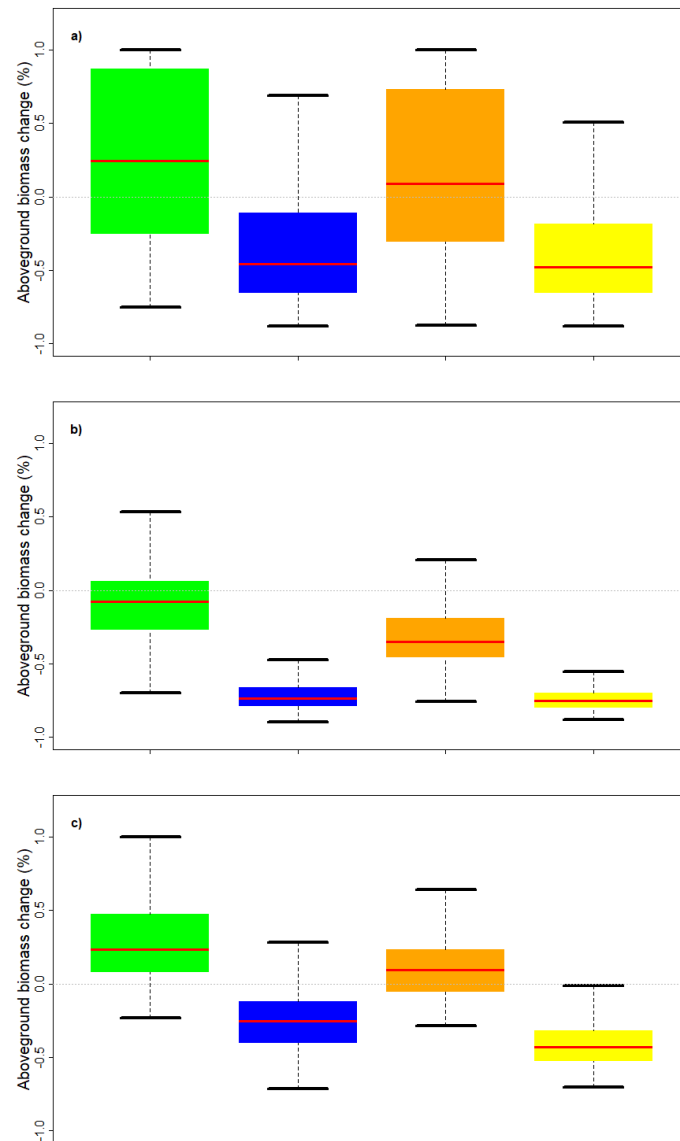


Fig. 2. Changes in aboveground biomass (AGB) in open savanna (a), woody savanna (b), and savanna woodland (c) based on a 1000-year simulation. The colors green (climate change), blue (climate change and change in fire effects), orange (climate change and defaunation), and yellow (all factors together) indicate global change scenarios. Positive and negative values indicate gain and loss of AGB relative to the baseline scenario, respectively. The red lines of each boxplot indicate the average AGB in the global change scenarios.

3.3 AGB change and functional strategies

Changes in AGB differed among functional strategies. CC produced an increase in AGB for all functional strategies (Table 3), which ranged from 1% to 9%. All the other scenarios produced a decrease in average AGB for all the strategies, which ranged from 7% to 70% (Table 4). Comparing all functional strategies, the lowest decrease in average AGB was observed in evergreen species while the greatest decrease was observed in those species dispersed by animals and non-resprouters (Table 4; Fig. 3b and c). Deciduous species showed a lower increase and a greater decrease in average AGB than evergreen species (Table 4, Fig. 3a). Similarly, non-resprouting species exhibited a lower increase and a greater decrease in average AGB than resprouter species (Table 4, Fig. 3b). Finally, animal-dispersed species showed a lower increase and greater decrease in average AGB than species that are not dispersed by animals (Table 4, Fig. 3c).

Table 4. Change in aboveground biomass (AGB) in six plant functional types (PFTs): deciduous (DC), evergreen (EV), resprouters (RESP), non-resprouters (NRESP), animal-dispersed (ZOO), and non-animal dispersed (NZOO). The average rate of AGB change (*agbc*) in four global change scenarios: climate change (CC), climate change and change in fire frequency (CC.CF), climate change, and defaunation (CC.DE), and all factors together (CC.CF.DE). Positive and negative values indicate gain and loss of AGB relative to the baseline scenario, respectively. All models were run for 1000 years. The 95% confidence interval, calculated by the bootstrap re-sampling method with 10000 repetitions, is provided. Significant statistical differences between average AGB are indicated by different letters between disturbance scenarios in the same PFT (uppercase letters), and between PFTs in the same disturbance scenario (lowercase letters). The letters in the last column correspond to the boxplot of each area in Figure 3.

		CC		CC+CF		CC+DE		CC+CF+DE		Fig. 3	
PFT	n	<i>agbc</i>	95% CI	<i>agbc</i>	95% CI	<i>agbc</i>	95% CI	<i>agbc</i>	95% CI		
DC	7,916	0.03 ^{Aa}	0.02, 0.04	-0.48 ^{Ba}	-0.49, -0.47	-0.11 ^{Ca}	-0.12, -0.1	-0.55 ^{Da}	-0.56, -0.55		a
EV	7,916	0.07 ^{Ab}	0.06, 0.08	-0.43 ^{Bb}	-0.44, -0.42	-0.07 ^{Cb}	-0.08, -0.07	-0.5 ^{Db}	-0.51, -0.5		a
NRESP	7,916	0.02 ^{Ac}	0.01, 0.03	-0.56 ^{Bc}	-0.57, -0.55	-0.11 ^{Cc}	-0.12, -0.1	-0.61 ^{Dc}	-0.62, -0.61		b
RESP	7,916	0.08 ^{Ad}	0.07, 0.09	-0.35 ^{Bd}	-0.36, -0.34	-0.07 ^{Cd}	-0.08, -0.07	-0.44 ^{Dd}	-0.45, -0.43		b
ZOO	7,916	0.09 ^{Ae}	0.08, 0.1	-0.51 ^{Be}	-0.52, -0.5	-0.28 ^{Ce}	-0.29, -0.27	-0.7 ^{De}	-0.7, -0.69		c
NZOO	7,916	0.01 ^{Af}	0, 0.02	-0.4 ^{Bf}	-0.43, -0.39	0.09 ^{Cf}	0.08, 0.1	-0.36 ^{Df}	-0.31, -0.3		c

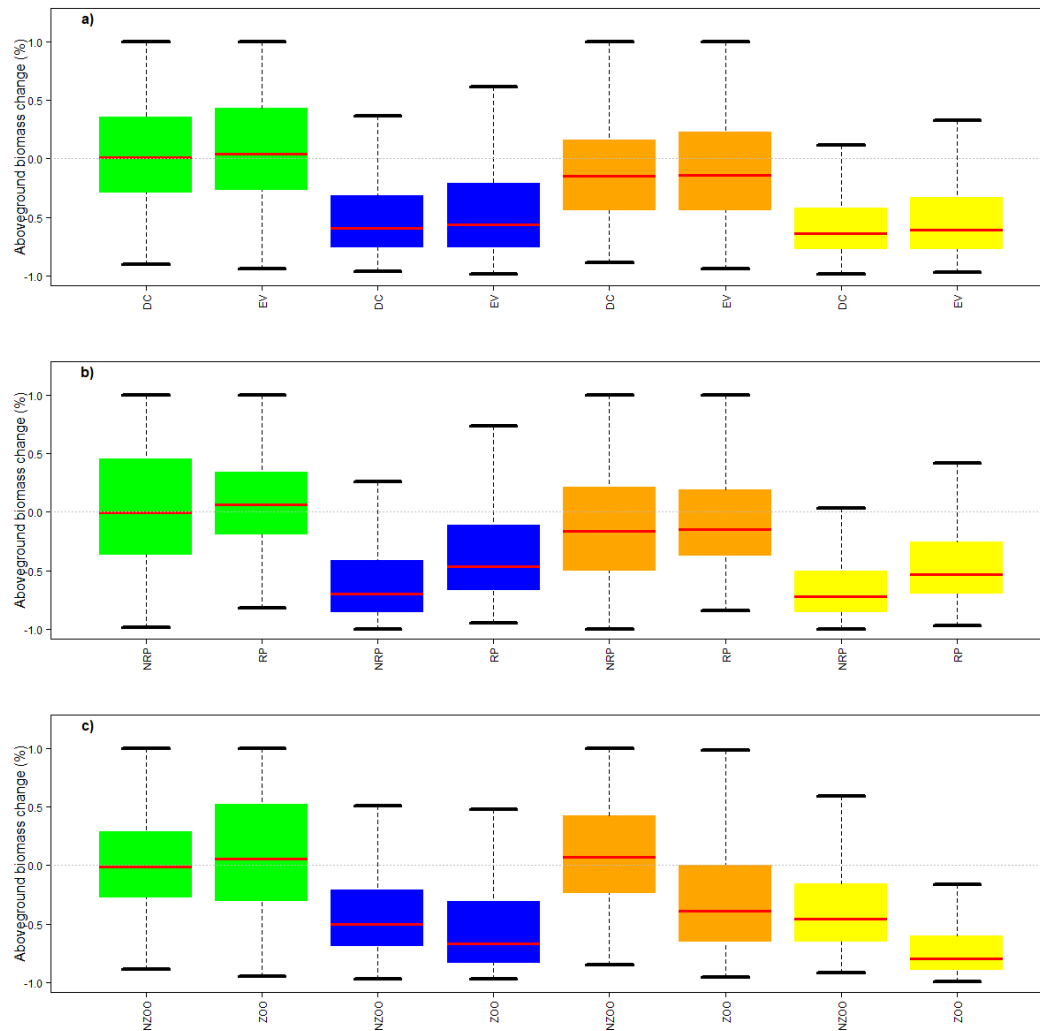


Fig. 3. Change in aboveground biomass (AGB) in six functional groups: deciduous (DC), evergreen (EV), resprouters (RESP), non-resprouters (NRESP), animal dispersed (ZOO), and non-animal dispersed (NZOO), based on a 1000-year simulation. The colors green (climate change), blue (climate change and change in fire effects), orange (climate change and defaunation), and yellow (all factors together) indicate global change scenarios. Positive and negative values indicate gain and loss of AGB relative to the baseline scenario, respectively. The red lines of each boxplot indicate the average AGB in the global change scenarios.

4. Discussion

Our study presents a significantly different trend in AGB over time in response to the synergism of changes in the climate and fire frequency and defaunation compared to the separate effects of these phenomena. When the synergistic effects of these three drivers were considered, AGB fell in all the areas of our study, ranging from 35% to 77%. As has been suggested (Sankaran, 2019), changes in savanna vegetation result not only from the occurrence of the dry season but also from the multiple drivers that work together, such as change in fire intensity and the loss of animal dispersers. To the best of our knowledge, this is the first study to consider the synergistic effects of these drivers on change in AGB on a long-term scale (1000 years) in Brazilian savannas. Our study, therefore, can contribute to closing the knowledge gap regarding longer-term atrophic effects in these savannas (Arruda et al., 2018; Gomes et al., 2018).

Different physiognomies responded differently to disturbance. Woody savanna was the most affected physiognomy, presenting the greatest AGB loss in all scenarios. Climate change and defaunation (CC.DE) decreased the AGB in woody savanna, while AGB increased in open savanna and savanna woodland. Open savanna in CC.DE conditions showed a significant increase relative to savanna woodland. Thus, the loss of seed dispersers appears to have less impact on the open savanna. Unlike open savanna, which has a dominant shrub component, the arboreal component dominates woody savannas and savanna woodland (Coutinho, 1978; Furley, 1992). Animal dispersal is significantly more frequent in the arboreal component than in the shrub component (Batalha and Mantovani, 2000; Mantovani and Martins, 1988; Pirani et al., 2009), so it makes sense that open savanna was the least affected physiognomy when defaunation was added to our model. Conversely, when fire was considered in our model, the greatest loss of AGB was experienced in the following order: woody savanna, open savanna, and woodland savanna. In this case, savanna woodland was the least affected. Savanna

woodland has a denser structure (very much like woods) than the other savanna types. These denser savannas normally lose less moisture than open savannas and woody savannas, consequently, fire disturbance affects them differently (Pereira Júnior et al., 2014).

Evergreens had a larger increase (CC) and a less decrease (other scenarios) in AGB than deciduous species. The difference in AGB loss of deciduous species was 5% more than evergreens. Specific leaf mass (SLM) was one of the contrasting parameters between evergreen (high SLM) and deciduous species (low SLM) in our model. SLM is the main predictor of sclerophylly (Neves et al., 2010), which is an evolutionary strategy for managing resources in habitats with limited water (Lohbeck et al., 2013). Large SLM contributes to the growth rate in favorable seasons (Eamus, 1999; Hartley and Jones, 1997), with a consequent delay in AGB loss in a disturbance scenario. Our studies, therefore, support the hypothesis that sclerophylly is a trait providing savanna species with some adaptation to changing environmental conditions (Fonseca et al., 2018; Guerra and Scremin-Dias, 2018; Lebrija-Trejos et al., 2011, 2010).

Resprouting species had greater AGB than non-resprouting species in both pre- and post-disturbance scenarios. Change in the fire regimen resulted in a loss of AGB that was 20% greater in non-resprouters compared to resprouters. Our results give support to the idea that non-resprouters are more vulnerable than resprouters to change in the fire regime (Salazar and Goldstein, 2014). Studies based on the seed bank have shown that fire plays a key role in the maintenance of the savanna's plant diversity (Abreu et al., 2017; Andrade and Miranda, 2014). However, because many species are fire-sensitive, changes in natural fire regimes are reported to cause changes in plant community structure (Salazar and Goldstein, 2014), which is in agreement with our results. We recommend that fire management should be carefully conducted, keeping fire frequency as close as possible to the natural frequency, at around four-year intervals (Coutinho, 1990; Furley et al., 2008; Pivello, 2011; Pivello and Coutinho, 1992).

The higher AGB demonstrated by animal-dispersed species in the control model was reversed after disturbance. In our study, there were PFTs dispersed by animals that lost 60% of their AGB. This represented a 30% greater AGB loss than the observed in groups that were not dispersed by animals. In our models, when the population of dispersers decreases, the chances that dispersed seeds arrive at safe sites decrease too (Herrera et al., 1994; Nathan and Muller-Landau, 2000). Thus, an extinction vortex is triggered that begins with a reduction in seed dispersers as a result of anthropic processes, leads to a decrease in plant species, and again a further decrease in savanna animals. These results reinforce the need to consider mutual interactions in savanna management as a strategy to maintain savanna ecosystem services. However, our findings must be interpreted with caution because our model did not distinguish between the functional role of vertebrates and invertebrates and, as we know, ants play an important role in the dispersal of the seeds of savannas tree species (Christianini et al., 2012; Christianini and Oliveira, 2010, 2009). In addition, responses to anthropic disturbances may differ between vertebrates and invertebrates. Therefore, further studies with more focus on different animal groups are required.

4.1 Implications of our findings

Our model investigated the response of AGB to a rise in temperature of 2° C. When this effect of climate change was considered in isolation, there was no loss of biomass in any of the areas, phytophysionomies, or PFTs. However, when fires became more frequent, AGB losses were evident in all study areas, phytophysionomies, and PFTs. Recently, a systematic increase in the risk of extreme fire events has been reported if global temperature increases by 2 °C in daily values (Silva et al., 2016). According to these authors, an increase of more than 1.5 °C in global temperature will result in increasingly frequent fires in the savanna. Our results show that these changes can cause huge losses in AGB and consequently in the savannas' carbon storage capacity. Therefore, it is wise that warming should be kept at a maximum of

1.5 °C by the end of the century (Silva et al., 2019) to minimize the effects of fire on the savanna AGB.

Most carbon in the savanna is stored in the belowground biomass (Bustamante et al., 2012). However, the biomass of branches, trunks, and leaves is estimated to be 50% carbon (Batlle-Bayer et al., 2010). Thus, AGB also plays an important role in atmospheric carbon storage in the savanna (Paiva et al., 2011; Roquette, 2018; Scolforo et al., 2015). When the synergism of the three factors was considered in our model, AGB losses in the ecosystems were 38%, 74%, and 39% relative to a baseline scenario, in the open savanna, woody savanna, and savanna woodland, respectively. Such AGB loss would result in higher greenhouse gas emissions. AGB losses and carbon emission in the Cerrado have mainly been attributed to the effects of habitat loss and fire (Bustamante et al., 2012; Carvalho et al., 2014). According to our model, the loss of seed dispersers also plays an important role in the loss of AGB and, consequently, in greenhouse gas emissions. The most important savanna in South America is found in Brazil, which is a signatory to global greenhouse gas reduction targets. The main strategies to achieve greenhouse gas reduction targets are focused on reducing deforestation, which is justified because deforestation is one of the largest sources of greenhouse gas emissions. However, non-deforested areas may be susceptible to fire and hunting. Thus, incorporating the analysis and intervention of different factors should be considered future challenges in the study of savanna dynamics in South America.

5. Conclusions

The most obvious finding to emerge from our study is that climate, fire, and defaunation act synergistically leading to the loss of AGB in savannas. Our study also showed that responses were different between phytophysiognomies and plant functional groups. The response of physiognomies and functional groups depends on the type of disturbance

considered. In general, woody savannas were the most seriously affected among phytophysionomies. Deciduous, non-resprouting, animal-dispersed species were the most susceptible to disturbance. This information can be used to target interventions aimed at the conservation of plants and ecosystem services in the savanna.

CONSIDERAÇÕES FINAIS

Três resultados importantes emergem desta tese. Primeiro, o déficit florístico é maior em alguns gêneros, famílias e ecorregiões das savanas da América do Sul (SAS). Segundo, mais de 40.76% das 2.203 espécies de árvores encontradas na SAS foram classificadas nas sete formas de raridade de Rabinowitz; e 74.89% dessas 2.203 espécies tinham pelo menos uma ocorrência na rede de áreas protegidas (APs). Finalmente, a mudança climática, a mudança no regime do fogo e a defaunação tiveram um efeito sinérgico na performance de grupos funcionais de plantas; em alguns casos levando a uma perda de 70% de biomassa vegetal.

O déficit florístico é maior em alguns táxons e ecorregiões da SAS. Diferente do que era esperado, esse déficit florístico é grande tanto nos gêneros e famílias mais diversos quanto nos gêneros e famílias menos diversos. Dentre os táxons mais diversos da SAS com grande déficit florístico estavam, por exemplo, as famílias Myrtaceae, Fabaceae e Malpighiaceae, e gêneros como *Myrcia*, *Eugenia* e *Psidium*. Dentre os táxons menos diversos da SAS com grande déficit florístico estavam famílias como Verbenaceae, Sapindaceae e Polygalaceae, e gêneros como *Ficus*, *Ilex* e *Tapirira*. Espacialmente, o maior déficit florístico foi observado no sentido Cerrado-Savana de Beni-Llanos e savanas da Amazônia. No Cerrado, o déficit florístico foi principalmente observado nas zonas de transições Cerrado-Amazônia e Cerrado-Caatinga. Nos Llanos e nas Savana da Amazônia, o déficit florístico parece ser localizado principalmente nas regiões mais ao norte. Sugerimos que os táxons e as regiões onde o maior déficit florístico foi observado devem ser foco para pesquisas futuras na SAS.

De modo geral, nossos resultados parecem indicar que a rede de APs da SAS tem um bom desempenho, pois, 74.89% de todas as espécies têm alguma ocorrência dentro daquelas APs. Esse resultado seria bastante otimista se não fosse o fato de que muitas das espécies que ocorrem dentro de APs apresentaram maior proporção de registros fora. De acordo com nossos resultados, 59.7% das espécies verificadas dentro de APs tinham cerca 75% dos seus registros

de ocorrência fora daquelas APs. Esses casos envolviam desde espécies comuns como *Byrsonima clausseniana* A.Juss. (~16% do total de indivíduos dentro de áreas protegidas) até espécies raras como *Campomanesia xanthocarpa* (Mart.) O. Berg. (~8% do total de indivíduos dentro de áreas protegidas). No caso de *C. xanthocarpa*, esse percentual de indivíduos dentro das APs correspondia a um dos 12 registros observados para aquela espécie. Casos como o de *C. xanthocarpa* sugerem que a rede de APs das SAS precisa ser ampliada. Embora pareça contraditório, nossos resultados revelaram que a razão entre o número de registros dentro de APs e o número total de registros por célula de grade é baixo. Também mostramos que quanto maior é a razão entre os registros dentro de APs e os registros totais, maior é a razão entre o número de espécies que ocorrem em APs e o total de espécies por uma célula de grade. Isso sugere que, se nosso esforço amostral dentro das APs aumentar, nosso conhecimento sobre a lacuna de conservação de espécies pode mudar. Assim, nossos resultados sugerem que, mais estudos dentro das APs são necessários para melhor avaliação do status de conservação das espécies da SAS.

De acordo com nossos achados, os três fatores antrópicos analisados aqui (mudança climática e do regime de incêndios e defaunação) têm um efeito sinérgico na diminuição da performance de grupos funcionais de plantas. Atualmente, tanto as estratégias de planejamento de áreas protegidas como as estratégias de manejo dentro das áreas protegidas já existentes estão focadas na ação desses fatores separadamente. Acreditamos que as ações estratégicas de planejamento e manejo dentro do contexto de mudanças globais devem levar em conta o sinergismo de diferentes fatores antrópicos.

REFERÊNCIAS

- Abeli, T., Gentili, R., Rossi, G., Bedini, G., Foggi, B., 2009. Can the IUCN criteria be effectively applied to peripheral isolated plant populations? *Biodivers. Conserv.* 18, 3877.
- Abom, R., Parsons, S.A., Schwarzkopf, L., 2016. Complex mammal species responses to fire in a native tropical savannah invaded by non-native grader grass (*Themeda quadrivalvis*). *Biol. Invasions* 18, 3319–3332. <https://doi.org/10.1007/s10530-016-1224-0>
- Abreu, R.C.R., Hoffmann, W.A., Vasconcelos, H.L., Pilon, N.A., Rossatto, D.R., Durigan, G., 2017. The biodiversity cost of carbon sequestration in tropical savanna. *Sci. Adv.* 3, e1701284.
- Alho, C.J.R., Martins, E. de S., 1995. De grão em grão, o cerrado perde espaço (cerrado-impactos do processo de ocupação). WWF-Fundo Mund. para a Natureza. Brasília.
- Alvarado, S.T., Andela, N., Silva, T.S.F., Archibald, S., 2020. Thresholds of fire response to moisture and fuel load differ between tropical savannas and grasslands across continents. *Glob. Ecol. Biogeogr.* 29, 331–344. <https://doi.org/10.1111/geb.13034>
- Alvares, C.A., Stape, J.L., Sentelhas, P.C., de Moraes, G., Leonardo, J., Sparovek, G., 2013. Köppen's climate classification map for Brazil. *Meteorol. Zeitschrift* 22, 711–728.
- Alves, R.J. V, Kolbek, J., 2010. Can campo rupestre vegetation be floristically delimited based on vascular plant genera? *Plant Ecol.* 207, 67–79.
- Alves, R.J. V, Kolbek, J., 1994. Plant species endemism in savanna vegetation on table mountains (Campo Rupestre) in Brazil. *Vegetatio* 113, 125–139.
- Amorim, M.W., de Melo Júnior, J.C.F., 2016. Plasticidade morfológica de *Myrcia splendens* (Sw) CD.(Myrtaceae) ocorrente em Mata Atlântica e Cerrado. *Iheringia. Série Botânica.* 71, 261–268.

- Andrade, B.O., Marchesi, E., Burkart, S., Setubal, R.B., Lezama, F., Perelman, S., Schneider, A.A., Trevisan, R., Overbeck, G.E., Boldrini, I.I., 2018. Vascular plant species richness and distribution in the Río de la Plata grasslands. *Bot. J. Linn. Soc.* 188, 250–256.
- Andrade, L.A.Z., Miranda, H.S., 2014. The dynamics of the soil seed bank after a fire event in a woody savanna in central Brazil. *Plant Ecol.* 215, 1199–1209.
<https://doi.org/10.1007/s11258-014-0378-z>
- Antar, G.M., Sano, P.T., 2019. Angiosperms of dry grasslands and savannahs of Jalapão, the largest conserved Cerrado area in Brazil. *Rodriguésia* 70.
- Antoch, J., Hušková, M., 2001. Permutation tests in change point analysis. *Stat. Probab. Lett.* 53, 37–46.
- Arponen, A., 2012. Prioritizing species for conservation planning. *Biodivers. Conserv.* 21, 875–893.
- Arruda, F.V. de, Sousa, D.G. de, Teresa, F.B., Prado, V.H.M. do, Cunha, H.F. da, Izzo, T.J., 2018. Trends and gaps of the scientific literature about the effects of fire on Brazilian Cerrado. *Biota Neotrop.* 18, 20170426. <https://doi.org/10.1590/1676-0611-bn-2017-0426>
- Auler, A.S., Smart, P.L., 2001. Late Quaternary paleoclimate in semiarid northeastern Brazil from U-series dating of travertine and water-table speleothems. *Quat. Res.* 55, 159–167.
- Barbosa, R.I., Campos, C., Pinto, F., Fearnside, P.M., 2007. The “Lavrados” of Roraima: biodiversity and conservation of Brazil’s Amazonian Savannas. *Funct. Ecosyst. Communities* 1, 29–41.
- Barbosa, R.I., Fearnside, P.M., 2005. Above-ground biomass and the fate of carbon after burning in the savannas of Roraima, Brazilian Amazonia. *For. Ecol. Manage.* 216, 295–316.
- Barbosa, R.I., Fearnside, P.M., 2004. Wood density of trees in open savannas of the Brazilian

- Amazon. For. Ecol. Manage. 199, 115–123.
- Barroso, G.M., 1984. Sistemática de angiospermas do Brasil. Universidade Federal de Viçosa.
- Batalha, M.A., Aragaki, S., Mantovani, W., 1997. Variações fenológicas das espécies do cerrado em Emas (Pirassununga, SP). Acta Bot. Bras 11, 61–78.
- Batalha, M.A., Cianciaruso, M.V., Silva, I.A., 2005. Seasonal variation of a hyperseasonal cerrado in Emas National Park, central Brazil. Flora 200, 345–353.
- Batalha, M.A., Mantovani, W., 2000. Reproductive phenological patterns of cerrado plant species at the pé-de-gigante reserve (santa rita do passa quatro, sp, brazil): a comparison between the herbaceous and woody floras., Brazilian Journal of Biology.
- Battle-Bayer, L., Batjes, N.H., Bindraban, P.S., 2010. Changes in organic carbon stocks upon land use conversion in the Brazilian Cerrado: a review. Agric. Ecosyst. Environ. 137, 47–58.
- Belaid, A.H., Maurice, S., Freville, H., Carbonell, D., Imbert, E., 2018. Predicting population viability of the narrow endemic Mediterranean plant *Centaurea corymbosa* under climate change. Biol. Conserv. 223, 19–33.
- Berrio, J.C., Hooghiemstra, H., Behling, H., Botero, P., Van der Borg, K., 2002. Late-Quaternary savanna history of the Colombian Llanos Orientales from Lagunas Chenevo and Mozambique: a transect synthesis. The Holocene 12, 35–48.
- Bickford, D., Lohman, D.J., Sodhi, N.S., Ng, P.K.L., Meier, R., Winker, K., Ingram, K.K., Das, I., 2007. Cryptic species as a window on diversity and conservation. Trends Ecol. Evol. 22, 148–155.
- Bini, L.M., Diniz-Filho, J.A.F., Rangel, T.F., Bastos, R.P., Pinto, M.P., 2006. Challenging Wallacean and Linnean shortfalls: knowledge gradients and conservation planning in a biodiversity hotspot. Divers. Distrib. 12, 475–482.

- Bland, L.M., Collen, B., Orme, C.D.L., Bielby, J., 2015. Predicting the conservation status of data-deficient species. *Conserv. Biol.* 29, 250–259. <https://doi.org/10.1111/cobi.12372>
- Blydenstein, J., 1967. Tropical savanna vegetation of the Llanos of Colombia. *Ecology* 48, 1–15.
- Boucher, F.C., Quatela, A.-S., Ellis, A.G., Verboom, G.A., 2020. Diversification rate vs. diversification density: Decoupled consequences of plant height for diversification of Alooideae in time and space. *PLoS One* 15, e0233597.
- Boyle, B., Hopkins, N., Lu, Z., Raygoza Garay, J.A., Mozzherin, D., Rees, T., Matasci, N., Narro, M.L., Piel, W.H., Mckay, S.J., Lowry, S., Freeland, C., Peet, R.K., Enquist, B.J., 2013. The taxonomic name resolution service: an online tool for automated standardization of plant names. *BMC Bioinformatics* 14, 16. <https://doi.org/10.1186/1471-2105-14-16>
- Bridgewater, S., Ratter, J.A., Ribeiro, J.F., 2004. Biogeographic patterns, β -diversity and dominance in the cerrado biome of Brazil. *Biodivers. Conserv.* 13, 2295–2317.
- Brito, D., 2010. Overcoming the Linnean shortfall: data deficiency and biological survey priorities. *Basic Appl. Ecol.* 11, 709–713.
- Broennimann, O., Vittoz, P., Moser, D., Guisan, A., 2005. Rarity types among plant species with high conservation priority in Switzerland. *Bot. Helv.* 115, 95–108.
- Brook, B.W., Sodhi, N.S., Bradshaw, C.J.A., 2008. Synergies among extinction drivers under global change. *Trends Ecol. Evol.* 23, 453–460.
- Brown, J.H., Lomolino, M. V., 1998. *Biogeography*. Sinauer Press, Sunderland, Massachusetts.
- Brown, J.H., Lomolino, M. V., 2006. *Biogeografia, Biogeografia*. FUNPEC, Ribeirão Preto.
- Bueno, M.L., Dexter, K.G., Pennington, R.T., Pontara, V., Neves, D.M., Ratter, J.A., de Oliveira-Filho, A.T., 2018. The environmental triangle of the Cerrado Domain:

- Ecological factors driving shifts in tree species composition between forests and savannas. *J. Ecol.* 106, 2109–2120. <https://doi.org/10.1111/1365-2745.12969>
- Bueno, M.L., Pennington, R.T., Dexter, K.G., Kamino, L.H.Y., Pontara, V., Neves, D.M., Ratter, J.A., de Oliveira-Filho, A.T., 2017. Effects of Quaternary climatic fluctuations on the distribution of Neotropical savanna tree species. *Ecography (Cop.)*. 40, 403–414.
- Bustamante, M.M. da C., Nardoto, G.B., Pinto, A.S., Resende, J.C.F., Takahashi, F.S.C., Vieira, L.C.G., 2012. Potential impacts of climate change on biogeochemical functioning of Cerrado ecosystems. *Brazilian J. Biol.* 72, 655–671.
- Caiafa, A.N., Martins, F.R., 2010. Forms of rarity of tree species in the southern Brazilian Atlantic rainforest. *Biodivers. Conserv.* 19, 2597–2618.
- Caiafa, A.N., Martins, F.R., 2007. Taxonomic identification, sampling methods, and minimum size of the tree sampled: implications and perspectives for studies in the Brazilian Atlantic Rainforest. *Funct. Ecosyst. Communities* 1, 95–104.
- Cain, A.J., 1995. Linnaeus's natural and artificial arrangements of plants. *Bot. J. Linn. Soc.* 117, 73–133.
- Callicott, J.B., Crowder, L.B., Mumford, K., 1999. Current normative concepts in conservation. *Conserv. Biol.* 13, 22–35.
- Campbell, L.M., Corson, C., Gray, N.J., MacDonald, K.I., Brosius, J.P., 2014. Studying global environmental meetings to understand global environmental governance: Collaborative event ethnography at the tenth conference of the parties to the convention on biological diversity. *Glob. Environ. Polit.* 14, 1–20.
- Cao, L., Zhang, Y., Barter, M., Lei, G., 2010. Anatidae in eastern China during the non-breeding season: Geographical distributions and protection status. *Biol. Conserv.* 143, 650–659. <https://doi.org/10.1016/j.biocon.2009.12.001>
- Cardoso Da Silva, J.M., Bates, J.M., 2002. Biogeographic Patterns and Conservation in the

- South American Cerrado: A Tropical Savanna Hotspot The Cerrado, which includes both forest and savanna habitats, is the second largest South American biome, and among the most threatened on the continent. *Bioscience* 52, 225–234. [https://doi.org/10.1641/0006-3568\(2002\)052\[0225:bpacit\]2.0.co;2](https://doi.org/10.1641/0006-3568(2002)052[0225:bpacit]2.0.co;2)
- Cardoso, P., Erwin, T.L., Borges, P.A.V., New, T.R., 2011. The seven impediments in invertebrate conservation and how to overcome them. *Biol. Conserv.* 144, 2647–2655. <https://doi.org/10.1016/j.biocon.2011.07.024>
- Carvalho, C.S., Galetti, M., Colevatti, R.G., Jordano, P., 2016. Defaunation leads to microevolutionary changes in a tropical palm. *Sci. Rep.* 6, 31957.
- Carvalho, F.M.V., De Marco, 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. <https://doi.org/10.1016/J.BIOCON.2009.01.031>
- Carvalho, G., 2016. Flora: Tools for Interacting with the Brazilian Flora 2020 [WWW Document]. R Packag. version 0.2.7.2006. URL <http://www.github.com/gustavobio/flora>
- Carvalho, J.L.N., Raucci, G.S., Frazão, L.A., Cerri, C.E.P., Bernoux, M., Cerri, C.C., 2014. Crop-pasture rotation: A strategy to reduce soil greenhouse gas emissions in the Brazilian Cerrado. *Agric. Ecosyst. Environ.* 183, 167–175. <https://doi.org/10.1016/j.agee.2013.11.014>
- Castro, A., Martins, F.R., 1999. Cerrados do Brasil e do Nordeste: caracterização, área de ocupação e considerações sobre a sua fitodiversidade. *Pesqui. em foco* 7, 147–178.
- Castro, A., Martins, F.R., Tamashiro, J.Y., Shepherd, G.J., 1999. How rich is the flora of Brazilian cerrados? *Ann. Missouri Bot. Gard.* 192–224.
- Cavassan, O., 2002. O cerrado do Estado de São Paulo, in: Klein, A. (Ed.), *Eugen Warming e o Cerrado Brasileiro: Um Século Depois*. Editora UNESP São Paulo, pp. 93–106.

- Cavassan, O., 1990. Florística e fitossociologia da vegetação lenhosa de um hectare de cerrado do Parque Ecológico Municipal de Bauru (SP). 1990. 224f.
- Cavassan, O., Weiser, V. de L., 2015. Vascular flora of the cerrado of Bauru-SP. *Biota Neotrop.* 15.
- CBD, 2011. Global Strategy for Plant Conservation [WWW Document].
- Ceballos, G., Ehrlich, P.R., Dirzo, R., 2017. Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. *Proc. Natl. Acad. Sci. U. S. A.* 114, E6089–E6096. <https://doi.org/10.1073/pnas.1704949114>
- Chapman, A.S.A., Tunnicliffe, V., Bates, A.E., 2018. Both rare and common species make unique contributions to functional diversity in an ecosystem unaffected by human activities. *Divers. Distrib.* 24, 568–578.
- Choe, H., Thorne, J.H., Hijmans, R., Seo, C., 2019. Integrating the Rabinowitz rarity framework with a National Plant Inventory in South Korea. *Ecol. Evol.* 9, 1353–1363. <https://doi.org/10.1002/ece3.4851>
- Christianini, A. V., Mayhé-Nunes, A.J., Oliveira, P.S., 2012. Exploitation of Fallen Diaspores by Ants: Are there Ant-Plant Partner Choices? *Biotropica* 44, 360–367. <https://doi.org/10.1111/j.1744-7429.2011.00822.x>
- Christianini, A. V., Oliveira, P.S., 2010. Birds and ants provide complementary seed dispersal in a neotropical savanna. *J. Ecol.* 98, 573–582. <https://doi.org/10.1111/j.1365-2745.2010.01653.x>
- Christianini, A. V., Oliveira, P.S., 2009. The relevance of ants as seed rescuers of a primarily bird-dispersed tree in the Neotropical cerrado savanna. *Oecologia* 160, 735–745. <https://doi.org/10.1007/s00442-009-1349-2>
- Clarke, P.J., Lawes, M.J., Murphy, B.P., Russell-Smith, J., Nano, C.E.M., Bradstock, R., Enright, N.J., Fontaine, J.B., Gosper, C.R., Radford, I., 2015. A synthesis of postfire

- recovery traits of woody plants in Australian ecosystems. *Sci. Total Environ.* 534, 31–42.
- Colli-Silva, M., Vasconcelos, T.N.C., Pirani, J.R., 2019. Outstanding plant endemism levels strongly support the recognition of campo rupestre provinces in mountaintops of eastern South America. *J. Biogeogr.* 46, 1723–1733.
- Corlett, R.T., 2016. Plant diversity in a changing world: status, trends, and conservation needs. *Plant Divers.* 38, 10–16.
- Costa-Lima, L., Chagas, E., 2019. Two New Species of *Turnera* (Passifloraceae sl, Turneroideae) from Northeastern Brazil and Considerations on the Identity of *T. pernambucensis*. *Syst. Bot.* 44, 838–843.
- Costion, C.M., Plunkett, G.M., 2016. A revision of the genus *Osmoxylon* (Araliaceae) in Palau, including two new species. *PhytoKeys* 49.
- Coutinho, L.M., 2006. O conceito de bioma. *Acta Bot. Brasilica* 20, 13–23.
- Coutinho, L.M., 1990. Fire in the ecology of the Brazilian cerrado, in: *Fire in the Tropical Biota*. Springer, pp. 82–105.
- Coutinho, L.M., 1978. O conceito de Cerrado.(The concept of Cerrado.). *Rev. Bras. Bot* 1, 17–23.
- da Silva Rios, M.N., Sousa-Silva, J.C., 2017. Grupos funcionais em áreas com histórico de queimadas em Cerrado sentido restrito no Distrito Federal. *Pesqui. Florest. Bras.* 37, 285–298.
- Dantas, de P.M., Groeneveld, J., Fischer, R., Taubert, F., Martins, V.F., Huth, A., 2018. Defaunation impacts on seed survival and its effect on the biomass of future tropical forests. *Oikos* 127, 1526–1538.
- Davies, K.F., Margules, C.R., Lawrence, J.F., 2004. A synergistic effect puts rare, specialized species at greater risk of extinction. *Ecology* 85, 265–271.

- de Lima, R.A.F., Mori, D.P., Pitta, G., Melito, M.O., Bello, C., Magnago, L.F., Zwiener, V.P., Saraiva, D.D., Marques, M.C.M., de Oliveira, A.A., 2015. How much do we know about the endangered Atlantic Forest? Reviewing nearly 70 years of information on tree community surveys. *Biodivers. Conserv.* 24, 2135–2148.
- de Medeiros, M.B., Miranda, H.S., 2005. Mortalidade pós-fogo em espécies lenhosas de campo sujo submetido a três queimadas prescritas anuais. *Acta Bot. Brasilica* 19, 493–500. <https://doi.org/10.1590/S0102-33062005000300009>
- de Medeiros, M.B., Walter, B.M.T., Silva, G.P., 2008. Fitossociologia do cerrado stricto sensu no município de Carolina, MA, Brasil. *Cerne* 14, 285–294.
- de Moraes, M.G., de Carvalho, M.A.M., Franco, A.C., Pollock, C.J., Figueiredo-Ribeiro, R. de C.L., 2016. Fire and drought: soluble carbohydrate storage and survival mechanisms in herbaceous plants from the Cerrado. *Bioscience* 66, 107–117.
- Di Marco, M., Collen, B., Rondinini, C., Mace, G.M., 2015. Historical drivers of extinction risk: using past evidence to direct future monitoring. *Proc. R. Soc. B Biol. Sci.* 282, 20150928. <https://doi.org/10.1098/rspb.2015.0928>
- Diniz-Filho, J.A.F., Bastos, R.P., Rangel, T.F., Bini, L.M., Carvalho, P., Silva, R.J., 2005. Macroecological correlates and spatial patterns of anuran description dates in the Brazilian Cerrado. *Glob. Ecol. Biogeogr.* 14, 469–477.
- Dirzo, R., Young, H.S., Galetti, M., Ceballos, G., Isaac, N.J.B., Collen, B., 2014. Defaunation in the Anthropocene. *Science* (80-.). 345, 401–406.
- Donovan, L.A., Maherali, H., Caruso, C.M., Huber, H., de Kroon, H., 2011. The evolution of the worldwide leaf economics spectrum. *Trends Ecol. Evol.* 26, 88–95.
- Draper, F.C., Baker, T.R., Baraloto, C., Chave, J., Costa, F., Martin, R.E., Pennington, R.T., Vicentini, A., Asner, G.P., 2020. Quantifying Tropical Plant Diversity Requires an Integrated Technological Approach. *Trends Ecol. Evol.*

- Dryflor, Banda-R, K., Delgado-Salinas, A., Dexter, K.G., Linares-Palomino, R., Oliveira-Filho, A., Prado, D., Pullan, M., Quintana, C., Riina, R., Rodríguez M, G.M., Weintritt, J., Acevedo-Rodríguez, P., Adarve, J., Álvarez, E., Aranguren B, A., Arteaga, J.C., Aymard, G., Castaño, A., Ceballos-Mago, N., Cogollo, Á., Cuadros, H., Delgado, F., Devia, W., Dueñas, H., Fajardo, L., Fernández, Á., Fernández, M.Á., Franklin, J., Freid, E.H., Galetti, L.A., Gonto, R., González-M, R., Graveson, R., Helmer, E.H., Idárraga, Á., López, R., Marcano-Vega, H., Martínez, O.G., Maturo, H.M., McDonald, M., McLaren, K., Melo, O., Mijares, F., Mogni, V., Molina, D., Moreno, N.D.P., Nassar, J.M., Neves, D.M., Oakley, L.J., Oatham, M., Olvera-Luna, A.R., Pezzini, F.F., Dominguez, O.J.R., Ríos, M.E., Rivera, O., Rodríguez, N., Rojas, A., Särkinen, T., Sánchez, R., Smith, M., Vargas, C., Villanueva, B., Pennington, R.T., 2016. Plant diversity patterns in neotropical dry forests and their conservation implications. *Science* 353, 1383–1387. <https://doi.org/10.1126/science.aaf5080>
- Durigan, G., Ratter, J.A., 2016. The need for a consistent fire policy for Cerrado conservation. *J. Appl. Ecol.* 53, 11–15.
- Durigan, G., Siqueira, M.F. de, Franco, G.A.D.C., 2007. Threats to the Cerrado remnants of the state of São Paulo, Brazil. *Sci. Agric.* 64, 355–363.
- Dutra, V.F., Alves-Araújo, A., Carrijo, T.T., 2015. Angiosperm checklist of Espírito Santo: using electronic tools to improve the knowledge of an Atlantic Forest biodiversity hotspot. *Rodriguésia* 66, 1145–1152.
- Eamus, D., 1999. Ecophysiological traits of deciduous and evergreen woody species in the seasonally dry tropics. *Trends Ecol. Evol.* 14, 11–16.
- Edwards, E.J., Chatelet, D.S., Sack, L., Donoghue, M.J., 2014. Leaf life span and the leaf economic spectrum in the context of whole plant architecture. *J. Ecol.* 102, 328–336.
- Engelbrecht, B.M.J., Kursar, T.A., 2003. Comparative drought-resistance of seedlings of 28

- species of co-occurring tropical woody plants. *Oecologia* 136, 383–393.
- ESRI, R., 2011. ArcGIS desktop: release 10. Environ. Syst. Res. Institute, CA.
- Fattorini, S., 2014. Relations between species rarity, vulnerability, and range contraction for a beetle group in a densely populated region in the Mediterranean biodiversity hotspot. *Conserv. Biol.* 28, 169–176.
- Fearnside, P.M., Righi, C.A., de Alencastro Graça, P.M.L., Keizer, E.W.H., Cerri, C.C., Nogueira, E.M., Barbosa, R.I., 2009. Biomass and greenhouse-gas emissions from land-use change in Brazil's Amazonian “arc of deforestation”: The states of Mato Grosso and Rondônia. *For. Ecol. Manage.* 258, 1968–1978.
- Feeley, K., 2015. Are we filling the data void? An assessment of the amount and extent of plant collection records and census data available for tropical South America. *PLoS One* 10, e0125629.
- Feeley, K.J., Silman, M.R., 2011. The data void in modeling current and future distributions of tropical species. *Glob. Chang. Biol.* 17, 626–630.
- Felfili, J.M., da Silva Júnior, M.C., Sevilha, A.C., Fagg, C.W., Walter, B.M.T., Nogueira, P.E., Rezende, A.V., 2004. Diversity, floristic and structural patterns of cerrado vegetation in Central Brazil. *Plant Ecol.* 175, 37–46.
- Felfili, J.M., Silva, P.E.N. da, Silva Júnior, M.C. da, Marimon, B.S., Delitti, W.B.C., 2002. Composição florística e fitossociologia do cerrado sentido restrito no município de Água Boa–MT.
- Felfili, M.C., Felfili, J.M., 2001. Diversidade alfa e beta no cerrado sensu strictu da Chapada Pratinha, Brasil. *Acta Bot. Brasilica* 15, 243–254.
- Fernandes, G.W., Barbosa, N.P.U., Alberton, B., Barbieri, A., Dirzo, R., Goulart, F., Guerra, T.J., Morellato, L.P.C., Solar, R.R.C., 2018. The deadly route to collapse and the uncertain fate of Brazilian rupestrian grasslands. *Biodivers. Conserv.* 27, 2587–2603.

- Ferreira, S.M., Botha, J.M., Emmett, M.C., 2012. Anthropogenic Influences on Conservation Values of White Rhinoceros. *PLoS One* 7, e45989.
<https://doi.org/10.1371/journal.pone.0045989>
- Ferreira, S.M., Greaver, C., Knight, G.A., Knight, M.H., Smit, I.P.J., Pienaar, D., 2015. Disruption of Rhino Demography by Poachers May Lead to Population Declines in Kruger National Park, South Africa. *PLoS One* 10, e0127783.
<https://doi.org/10.1371/journal.pone.0127783>
- Fischer, R., Bohn, F., de Paula, M.D., Dislich, C., Groeneveld, J., Gutiérrez, A.G., Kazmierczak, M., Knapp, N., Lehmann, S., Paulick, S., 2016. Lessons learned from applying a forest gap model to understand ecosystem and carbon dynamics of complex tropical forests. *Ecol. Modell.* 326, 124–133.
- Fonseca, C.R., Venticinque, E.M., 2018. Biodiversity conservation gaps in Brazil: A role for systematic conservation planning. *Perspect. Ecol. Conserv.* 16, 61–67.
- Fonseca, M.B., Silva, J.O., Falcão, L.A.D., Dupin, M.G.V., Melo, G.A., Espírito-Santo, M.M., 2018. Leaf damage and functional traits along a successional gradient in Brazilian tropical dry forests. *Plant Ecol.* 219, 403–415. <https://doi.org/10.1007/s11258-018-0804-8>
- Forero-Medina, G., Joppa, L., 2010. Representation of Global and National Conservation Priorities by Colombia's Protected Area Network. *PLoS One* 5, e13210.
<https://doi.org/10.1371/journal.pone.0013210>
- Foster, P., 2001. The potential negative impacts of global climate change on tropical montane cloud forests. *Earth-Science Rev.* 55, 73–106.
- Franco, A.C., Bustamante, M., Caldas, L.S., Goldstein, G., Meinzer, F.C., Kozovits, A.R., Rundel, P., Coradin, V.T.R., 2005. Leaf functional traits of Neotropical savanna trees in relation to seasonal water deficit. *Trees* 19, 326–335.

- Françoso, R.D., Haidar, R.F., Machado, R.B., 2016. Tree species of South America central savanna: endemism, marginal areas and the relationship with other biomes. *Acta Bot. Brasilica* 30, 78–86.
- 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.
- Furley, P.A., 1992. Cambios edáficos en la frontera entre bosque y sabana, con énfasis particular a los neotrópicos]. Edaphic changes at the forest-savanna boundary with particular reference to the neotropics.
- Furley, P.A., Rees, R.M., Ryan, C.M., Saiz, G., 2008. Savanna burning and the assessment of long-term fire experiments with particular reference to Zimbabwe. *Prog. Phys. Geogr. Earth Environ.* 32, 611–634. <https://doi.org/10.1177/0309133308101383>
- Galetti, M., Moleón, M., Jordano, P., Pires, M.M., Guimaraes Jr, P.R., Pape, T., Nichols, E., Hansen, D., Olesen, J.M., Munk, M., 2018. Ecological and evolutionary legacy of megafauna extinctions. *Biol. Rev.* 93, 845–862.
- García-Núñez, C., Pirela, M., Fariñas, M., Azócar, A., 2019. Seasonal patterns of gas exchange and water relations in juveniles of two Neotropical savanna tree species differing in leaf phenology. *Acta oecologica* 95, 57–67.
- Gärdenfors, U., 2001. Classifying threatened species at national versus global levels. *Trends Ecol. Evol.* 16, 511–516.
- Gaston, K.J., 2012. The importance of being rare. *Nature* 487, 46–47.
- Gauthier, P., Debussche, M., Thompson, J.D., 2010. Regional priority setting for rare species based on a method combining three criteria. *Biol. Conserv.* 143, 1501–1509.
- Giam, X., Sodhi, N.S., Brook, B.W., Tan, H.T.W., Bradshaw, C.J.A., 2011. Relative need for conservation assessments of vascular plant species among ecoregions. *J. Biogeogr.* 38, 55–68.

- Goettsch, B., Durán, A.P., Gaston, K.J., 2019. Global gap analysis of cactus species and priority sites for their conservation. *Conserv. Biol.* 33, 369–376.
- Goldstein, G., Meinzer, F.C., Bucci, S.J., Scholz, F.G., Franco, A.C., Hoffmann, W.A., 2008. Water economy of Neotropical savanna trees: six paradigms revisited. *Tree Physiol.* 28, 395–404.
- Gomes, L., Miranda, H.S., Bustamante, M.M. da C., 2018. How can we advance the knowledge on the behavior and effects of fire in the Cerrado biome? *For. Ecol. Manage.* <https://doi.org/10.1016/j.foreco.2018.02.032>
- Goodland, R., Pollard, R., 1973. The Brazilian cerrado vegetation: a fertility gradient. *J. Ecol.* 219–224.
- Goodland, R.J.A., Ferri, M.G., 1979. Ecologia do cerrado, in: *Ecologia Do Cerrado*. EDUSP/Itatiaia.
- Gosling, S.N., Arnell, N.W., 2016. A global assessment of the impact of climate change on water scarcity. *Clim. Change* 134, 371–385.
- Grantham, H.S., Duncan, A., Evans, T.D., Jones, K.R., Beyer, H., Schuster, R., Walston, J., Ray, J., Robinson, J., Callow, M., 2020. Only 40% of the world's forests are in good health. *bioRxiv*.
- Groves, C.R., 1994. Candidate and Sensitive Species Programs. *Endanger. Species Recover. Find. Lessons, Improv. Process* 227.
- Groves, C.R., Jensen, D.B., Valutis, L.L., Redford, K.H., Shaffer, M.L., Scott, J.M., Baumgartner, J. V, Higgins, J. V, Beck, M.W., Anderson, M.G., 2002. Planning for Biodiversity Conservation: Putting Conservation Science into Practice: A seven-step framework for developing regional plans to conserve biological diversity, based upon principles of conservation biology and ecology, is being used extensively. *AIBS Bull.* 52, 499–512.

- Guerra, A., Scremin-Dias, E., 2018. Leaf traits, sclerophylly and growth habits in plant species of a semiarid environment. *Brazilian J. Bot.* 41, 131–144.
- Haffer, J., 1969. Speciation in Amazonian forest birds. *Science* (80-.). 165, 131–137.
- Haidar, R.F., Fagg, J.M.F., Pinto, J.R.R., Dias, R.R., Damasco, G., Silva, L. de C.R., Fagg, C.W., 2013. Florestas estacionais e áreas de ecótono no estado do Tocantins, Brasil: parâmetros estruturais, classificação das fitofisionomias florestais e subsídios para conservação. *Acta Amaz.* 43, 261–290.
- Hamilton, S.K., Sippel, S.J., Melack, J.M., 2004. Seasonal inundation patterns in two large savanna floodplains of South America: the Llanos de Moxos (Bolivia) and the Llanos del Orinoco (Venezuela and Colombia). *Hydrol. Process.* 18, 2103–2116.
- Harnik, P.G., Simpson, C., Payne, J.L., 2012. Long-term differences in extinction risk among the seven forms of rarity. *Proc. R. Soc. B Biol. Sci.* 279, 4969–4976.
- Harrison, R.D., Tan, S., Plotkin, J.B., Slik, F., Detto, M., Brenes, T., Itoh, A., Davies, S.J., 2013. Consequences of defaunation for a tropical tree community. *Ecol. Lett.* 16, 687–694.
- Hartley, J.L., Jones, G.E., 1997. Process oriented supplier development: building the capability for change. *Int. J. Purch. Mater. Manag.* 33, 24–29.
- Hasselquist, N.J., Allen, M.F., Santiago, L.S., 2010. Water relations of evergreen and drought-deciduous trees along a seasonally dry tropical forest chronosequence. *Oecologia* 164, 881–890.
- Herrera, C.M., Jordano, P., Lopez-Soria, L., Amat, J.A., 1994. Recruitment of a Mast-Fruiting, Bird-Dispersed Tree: Bridging Frugivore Activity and Seedling Establishment. *Ecol. Monogr.* 64, 315–344. <https://doi.org/10.2307/2937165>
- Hoffmann, W.A., 1998. Post-burn reproduction of woody plants in a neotropical savanna: the relative importance of sexual and vegetative reproduction. *J. Appl. Ecol.* 35, 422–433.

- Hoffmann, W.A., Haridasan, M., 2008. The invasive grass, *Melinis minutiflora*, inhibits tree regeneration in a Neotropical savanna. *Austral Ecol.* 33, 29–36.
- Hoffmann, W.A., Marchin, R.M., Abit, P., Lau, O.L., 2011. Hydraulic failure and tree dieback are associated with high wood density in a temperate forest under extreme drought. *Glob. Chang. Biol.* 17, 2731–2742.
- Hoffmann, W.A., Solbrig, O.T., 2003. The role of topkill in the differential response of savanna woody species to fire. *For. Ecol. Manage.* 180, 273–286.
- Hope, R.M., 2013. Rmisc: Ryan miscellaneous. R package version 1.5.
- Hopkins, M.J.G., 2005. Flora da Reserva Ducke, Amazonas, Brasil. *Rodriguésia* 9–25.
- Hortal, J., de Bello, F., Diniz-Filho, J.A.F., Lewinsohn, T.M., Lobo, J.M., Ladle, R.J., 2015. Seven shortfalls that beset large-scale knowledge of biodiversity. *Annu. Rev. Ecol. Evol. Syst.* 46, 523–549.
- Huber, O., 1987. Neotropical savannas: Their flora and vegetation. *Trends Ecol. Evol.* 2, 67–71. [https://doi.org/10.1016/0169-5347\(87\)90151-0](https://doi.org/10.1016/0169-5347(87)90151-0)
- Hughes, L., Dunlop, M., French, K., Leishman, M.R., Rice, B., Rodgerson, L., Westoby, M., 1994. Predicting dispersal spectra: a minimal set of hypotheses based on plant attributes. *J. Ecol.* 82, 933–950.
- Humphreys, A.M., Govaerts, R., Ficinski, S.Z., Nic Lughadha, E., Vorontsova, M.S., 2019. Global dataset shows geography and life form predict modern plant extinction and rediscovery. *Nat. Ecol. Evol.* 3, 1043–1047. <https://doi.org/10.1038/s41559-019-0906-2>
- Hunter Jr, M.L., Jacobson Jr, G.L., WEBB III, T., 1988. Paleoecology and the coarse-filter approach to maintaining biological diversity. *Conserv. Biol.* 2, 375–385.
- INMET - Instituto Nacional de Meteorologia, 2018. No Title [WWW Document]. URL <http://www.inmet.gov.br>
- IUCN, 2019. The IUCN Red List of Threatened Species, Version 20. ed.

- Jackson, P.C., Meinzer, F.C., Bustamante, M., Goldstein, G., Franco, A., Rundel, P.W., Caldas, L., Iglar, E., Causin, F., 1999. Partitioning of soil water among tree species in a Brazilian Cerrado ecosystem. *Tree Physiol.* 19, 717–724.
- Jain, M., Flynn, D.F.B., Prager, C.M., Hart, G.M., DeVan, C.M., Ahrestani, F.S., Palmer, M.I., Bunker, D.E., Knops, J.M.H., Jouseau, C.F., 2014. The importance of rare species: A trait-based assessment of rare species contributions to functional diversity and possible ecosystem function in tall-grass prairies. *Ecol. Evol.* 4, 104–112.
- Janzen, D.H., Burns, J.M., Cong, Q., Hallwachs, W., Dapkey, T., Manjunath, R., Hajibabaei, M., Hebert, P.D.N., Grishin, N. V, 2017. Nuclear genomes distinguish cryptic species suggested by their DNA barcodes and ecology. *Proc. Natl. Acad. Sci.* 114, 8313–8318.
- Jarvie, S., Svenning, J.-C., 2018. Using species distribution modelling to determine opportunities for trophic rewilding under future scenarios of climate change. *Philos. Trans. R. Soc. B Biol. Sci.* 373, 20170446.
- Jarvis, A., Touval, J.L., Schmitz, M.C., Sotomayor, L., Hyman, G.G., 2010. Assessment of threats to ecosystems in South America. *J. Nat. Conserv.* 18, 180–188.
- Jenkins, C.N., Joppa, L., 2009. Expansion of the global terrestrial protected area system. *Biol. Conserv.* 142, 2166–2174. <https://doi.org/10.1016/J.BIOCON.2009.04.016>
- Jepson, W., 2005. A disappearing biome? Reconsidering land-cover change in the Brazilian savanna. *Geogr. J.* 171, 99–111. <https://doi.org/10.1111/j.1475-4959.2005.00153.x>
- Joppa, L.N., Roberts, D.L., Pimm, S.L., 2010. How many species of flowering plants are there? *Proc. R. Soc. London B Biol. Sci.* rspb20101004.
- Kark, S., Tulloch, A., Gordon, A., Mazor, T., Bunnefeld, N., Levin, N., 2015. Cross-boundary collaboration: key to the conservation puzzle. *Curr. Opin. Environ. Sustain.* 12, 12–24.
- Kauffman, J.B., Cummings, D.L., Ward, D.E., 1994. Relationships of fire, biomass and

- nutrient dynamics along a vegetation gradient in the Brazilian cerrado. *J. Ecol.* 519–531.
- Khanum, R., 2017. Rarity of Endemic Medicinal Plants and Role of Herbaria for Their Conservation Against Environmental Challenges, in: *Medicinal Plants and Environmental Challenges*. Springer, pp. 49–68.
- Kier, G., Mutke, J., Dinerstein, E., Ricketts, T.H., Küper, W., Kreft, H., Barthlott, W., 2005. Global patterns of plant diversity and floristic knowledge. *J. Biogeogr.* 32, 1107–1116.
- Klink, C.A., Machado, R.B., 2005. Conservation of the Brazilian Cerrado. *Conserv. Biol.* 19, 707–713. <https://doi.org/10.1111/j.1523-1739.2005.00702.x>
- Klink, C.A., Moreira, A.G., 2002. Past and current human occupation, and land use., in: Marquis, R.J. (Ed.), *The Cerrado of Brazil: Ecology and Natural History of a Neotropical Savanna*. Columbia University Press.
- Klink, C.A., Moreira, A.G., Solbrig, O.T., 1993. Ecological impacts of agricultural development in the Brazilian Cerrados. *World's Savannas Econ. Driv. Forces, Ecol. Constraints Policy Options Sustain. L. Use (Man Biosph. Ser. 12 (eds Young MD, Solbrig OT))*, pp. 259–283. Parthenon Publ. London.
- Köhler, P., Huth, A., 2007. Impacts of recruitment limitation and canopy disturbance on tropical tree species richness. *Ecol. Modell.* 203, 511–517.
- Köhler, P., Huth, A., 1998. The effects of tree species grouping in tropical rainforest modelling: simulations with the individual-based model FORMIND. *Ecol. Modell.* 109, 301–321.
- Kricsfalussy, V. V., Trevisan, N., 2014. Prioritizing regionally rare plant species for conservation using herbarium data. *Biodivers. Conserv.* 23, 39–61. <https://doi.org/10.1007/s10531-013-0583-4>
- Kukkala, A.S., Moilanen, A., 2013. Core concepts of spatial prioritisation in systematic conservation planning. *Biol. Rev.* 88, 443–464.

- Kumagai, T., Katul, G.G., Saitoh, T.M., Sato, Y., Manfroi, O.J., Morooka, T., Ichie, T., Kuraji, K., Suzuki, M., Porporato, A., 2004. Water cycling in a Bornean tropical rain forest under current and projected precipitation scenarios. *Water Resour. Res.* 40.
- Kunst, C., Monti, E., Pérez, H., Godoy, J., 2006. Assessment of the rangelands of southwestern Santiago del Estero, Argentina, for grazing management and research. *J. Environ. Manage.* 80, 248–265.
- Lambeck, R.J., 1999. Landscape planning for biodiversity conservation in agricultural regions: a case study from the wheatbelt of Western Australia. Canberra, Environment Australia.
- Lambeck, R.J., 1997. Focal species: a multi-species umbrella for nature conservation. *Conserv. Biol.* 11, 849–856.
- Lambers, H., Chapin III, F.S., Pons, T.L., 2008. Plant physiological ecology. Springer Science & Business Media.
- Lang, C., Almeida, D.R.A., Costa, F.R.C., 2017. Discrimination of taxonomic identity at species, genus and family levels using Fourier Transformed Near-Infrared Spectroscopy (FT-NIR). *For. Ecol. Manage.* 406, 219–227.
- Langan, L., Higgins, S.I., Scheiter, S., 2017. Climate-biomes, pedo-biomes or pyro-biomes: which world view explains the tropical forest–savanna boundary in South America? *J. Biogeogr.* 44, 2319–2330.
- Langevelde, F. Van, Vijver, C.A.D.M. Van De, Kumar, L., Koppel, J. Van De, Ridder, N. De, Andel, J. Van, Skidmore, A.K., Hearne, J.W., Stroosnijder, L., Bond, W.J., Prins, H.H.T., Rietkerk, M., 2003. Effects of fire and herbivory on the stability of savanna ecosystems. *Ecology* 84, 337–350. [https://doi.org/10.1890/0012-9658\(2003\)084\[0337:EOFAHO\]2.0.CO;2](https://doi.org/10.1890/0012-9658(2003)084[0337:EOFAHO]2.0.CO;2)
- Laurance, W.F., Useche, D.C., 2009. Environmental synergisms and extinctions of tropical

- species. *Conserv. Biol.* 23, 1427–1437.
- Le Berre, M., Noble, V., Pires, M., Médail, F., Diadema, K., 2019. How to hierarchise species to determine priorities for conservation action? A critical analysis. *Biodivers. Conserv.* 1–21.
- Lebrija-Trejos, E., Pérez-García, E.A., Meave, J.A., Bongers, F., Poorter, L., 2010. Functional traits and environmental filtering drive community assembly in a species-rich tropical system. *Ecology* 91, 386–398. <https://doi.org/10.1890/08-1449.1>
- Lebrija-Trejos, E., Pérez-García, E.A., Meave, J.A., Poorter, L., Bongers, F., 2011. Environmental changes during secondary succession in a tropical dry forest in Mexico. *J. Trop. Ecol.* 27, 477–489. <https://doi.org/10.1017/S0266467411000253>
- Legendre, P., Legendre, L.F.J., 2012. *Numerical ecology*. Elsevier.
- Lehmann, C.E.R., Archibald, S.A., Hoffmann, W.A., Bond, W.J., 2011. Deciphering the distribution of the savanna biome. *New Phytol.* 191, 197–209. <https://doi.org/10.1111/j.1469-8137.2011.03689.x>
- Leitão, R.P., Zuanon, J., Villéger, S., Williams, S.E., Baraloto, C., Fortunel, C., Mendonça, F.P., Mouillot, D., 2016. Rare species contribute disproportionately to the functional structure of species assemblages. *Proceedings. Biol. Sci.* 283, 20160084. <https://doi.org/10.1098/rspb.2016.0084>
- Lindenmayer, D.B., Franklin, J.F., 2002. *Conserving forest biodiversity: a comprehensive multiscaled approach*. Island press.
- Lindenmayer, D.B., Franklin, J.F., Fischer, J., 2006. General management principles and a checklist of strategies to guide forest biodiversity conservation. *Biol. Conserv.* 131, 433–445. <https://doi.org/10.1016/j.biocon.2006.02.019>
- Liu, Z., Ji, Z., Wang, G., Chao, T., Hou, L., Wang, J., 2016. Genome-wide analysis reveals signatures of selection for important traits in domestic sheep from different ecoregions.

- BMC Genomics 17, 863.
- Lohbeck, M., Poorter, L., Lebrija-Trejos, E., Nez-Ramos, M.M., Meave, J.A., Paz, H., Perez-Garcia, E.A., Romero-Perez, I.E., Tauro, A., Bongers, F., 2013. Successional changes in functional composition contrast for dry and wet tropical forest. *Ecology* 94, 1211–1216. <https://doi.org/10.1890/12-1850.1>
- Lomolino, M. V, 2004. Conservation biogeography. *Front. Biogeogr. new Dir. Geogr. Nat.* 293–296.
- Longton, R.E., Hedderson, T.A., 2000. What are rare species and why conserve them? *Lindbergia* 25, 53–61.
- Lopes, A.S., Cox, F.R., 1977. Cerrado Vegetation in Brazil: An Edaphic Gradient1. *Agron. J.* 69, 828–831.
- Loyola, R.D., Kubota, U., da Fonseca, G.A.B., Lewinsohn, T.M., 2009. Key Neotropical ecoregions for conservation of terrestrial vertebrates. *Biodivers. Conserv.* 18, 2017.
- Lyons, K.G., Brigham, C.A., Traut, B.H., Schwartz, M.W., 2005. Rare species and ecosystem functioning. *Conserv. Biol.* 19, 1019–1024.
- Lyons, K.G., Schwartz, M.W., 2001. Rare species loss alters ecosystem function–invasion resistance. *Ecol. Lett.* 4, 358–365.
- Mace, G.M., 2004. The role of taxonomy in species conservation. *Philos. Trans. R. Soc. London B Biol. Sci.* 359, 711–719.
- Mace, G.M., Collar, N.J., Gaston, K.J., Hilton-Taylor, C., Akçakaya, H.R., Leader-Williams, N., Milner-Gulland, E.J., Stuart, S.N., 2008. Quantification of extinction risk: IUCN's system for classifying threatened species. *Conserv. Biol.* 22, 1424–1442.
- Maciel, E.A., Arlé, E., 2020. Rare7: An R package to assess the forms of rarity in a community. *Ecol. Indic.* 115, 106419. <https://doi.org/10.1016/j.ecolind.2020.106419>
- Maciel, E.A., Eisenlohr, P. V, 2016. On the collective analysis of species: how can Red Lists

- and lists of regional priorities be combined to assist in decision-making? A reply to Lõhmus (2015). *Biodivers. Conserv.* 25, 611–614.
- Maciel, E.A., Martins, F.R., 2019. Rare Tree Species as Surrogates for Biodiversity in Conservation Decision-Making: What Are They and How to Select and Use Them?, in: Eisenlohr, P. V (Ed.), *Forest Conservation: Methods, Management and Challenges*. Nova Science Publishers.
- Maciel, E.A., Oliveira-Filho, A.T., Eisenlohr, P. V, 2016. Prioritizing rare tree species of the Cerrado-Amazon ecotone: warnings and insights emerging from a comprehensive transitional zone of South America. *Nat. Conserv.* 14, 74–82.
- Manne, L.L., Pimm, S.L., 2001. Beyond eight forms of rarity: which species are threatened and which will be next?, in: *Animal Conservation Forum*. Cambridge University Press, pp. 221–229.
- Mantovani, W., Leitao Filho, H. de F., Martins, F.R., 1985. Chave baseada em caracteres vegetativos para identificacao de especies lenhosas do cerrado da reserva de moji guacu, estado de sao paulo. *Hoehnea* 12, 35–56.
- Mantovani, W., Martins, F.R., 1988. Variações fenológicas das espécies do cerrado da Reserva Biológica de Moji Guaçu. *Revta. Bras. Bot* 11, 101–112.
- Margules, C., Sarkar, S., 2007. *Systematic conservation planning*. Cambridge University Press.
- Margules, C.R., Pressey, R.L., 2000. Systematic conservation planning. *Nature* 405, 243–253.
- Mariano, V., Christianini, A. V, 2016. Reproductive phenology, seed removal and early regeneration in relation to distance from parental plants of a native palm in small Atlantic forest fragments. *Acta Bot. Brasilica* 30, 176–182.
- Marine, M.Â., 2001. Effects of forest fragmentation on birds of the cerrado region, Brazil.

- Bird Conserv. Int. 11, 13–25. <https://doi.org/10.1017/S0959270901001034>
- Marshall, E., Wintle, B.A., Southwell, D., Kujala, H., 2020. What are we measuring? A review of metrics used to describe biodiversity in offsets exchanges. *Biol. Conserv.* 241, 108250.
- Massi, K.G., Franco, A.C., 2016. How does resprouting response differ among three species of savanna trees and in relation to plant size? *Acta Bot. Brasilica* 30, 693–699. <https://doi.org/10.1590/0102-33062016abb0264>
- McGill, B.J., Enquist, B.J., Weiher, E., Westoby, M., 2006. Rebuilding community ecology from functional traits. *Trends Ecol. Evol.* 21, 178–185. <https://doi.org/10.1016/j.tree.2006.02.002>
- McIntyre, S., 1992. Risks associated with the setting of conservation priorities from rare plant species lists. *Biol. Conserv.* 60, 31–37.
- McVaugh, R., 1968. The genera of American Myrtaceae: an interim report. *Taxon* 354–418.
- Mehlman, D.W., Rosenberg, K. V, Wells, J. V, Robertson, B., 2004. A comparison of North American avian conservation priority ranking systems. *Biol. Conserv.* 120, 383–390.
- Menezes, T.G.C., Rodal, M.J.N., Lima, A.L.A. de, Lima, L.R., Pinto, M.A.D.S.C., Melo, A.L. de, 2017. Do seedling functional groups reflect ecological strategies of woody plant species in Caatinga? *Acta Bot. Brasilica* 0.
- Mi, X., Swenson, N.G., Valencia, R., Kress, W.J., Erickson, D.L., Pérez, Á.J., Ren, H., Su, S.-H., Gunatilleke, N., Gunatilleke, S., Hao, Z., Ye, W., Cao, M., Suresh, H.S., Dattaraja, H.S., Sukumar, R., Ma, K., 2012. The contribution of rare species to community phylogenetic diversity across a global network of forest plots. *Am. Nat.* 180, E17–30. <https://doi.org/10.1086/665999>
- Midgley, J.J., Lawes, M.J., Chamaillé-Jammes, S., 2010. Savanna woody plant dynamics: the role of fire and herbivory, separately and synergistically. *Aust. J. Bot.* 58, 1–11.

- Mistry, J., 1998. Fire in the cerrado (savannas) of Brazil: an ecological review. *Prog. Phys. Geogr.* 22, 425–448.
- Monteiro, L., Machado, N., Martins, E., Pougy, N., Verdi, M., Martinelli, G., Loyola, R., 2018. Conservation priorities for the threatened flora of mountaintop grasslands in Brazil. *Flora* 238, 234–243.
- Morais, A.R., Braga, R.T., Bastos, R.P., Brito, D., 2012. A comparative analysis of global, national, and state red lists for threatened amphibians in Brazil. *Biodivers. Conserv.* 21, 2633–2640.
- Morais, A.R., Siqueira, M.N., Lemes, P., Maciel, N.M., De Marco Jr, P., Brito, D., 2013. Unraveling the conservation status of Data Deficient species. *Biol. Conserv.* 166, 98–102.
- Morales, M., Oakley, L., Sartori, A.L.B., Mogni, V.Y., Atahuachi, M., Vanni, R.O., Fortunato, R.H., Prado, D.E., 2019. Diversity and conservation of legumes in the Gran Chaco and biogeographical inferences. *PLoS One* 14, e0220151.
- Moreira, B., Tormo, J., Pausas, J.G., 2012. To resprout or not to resprout: factors driving intraspecific variability in resprouting. *Oikos* 121, 1577–1584.
- Moss, R.H., Edmonds, J.A., Hibbard, K.A., Manning, M.R., Rose, S.K., Van Vuuren, D.P., Carter, T.R., Emori, S., Kainuma, M., Kram, T., 2010. The next generation of scenarios for climate change research and assessment. *Nature* 463, 747.
- Mouillot, D., Bellwood, D.R., Baraloto, C., Chave, J., Galzin, R., Harmelin-Vivien, M., Kulbicki, M., Lavergne, S., Lavorel, S., Mouquet, N., 2013a. Rare species support vulnerable functions in high-diversity ecosystems. *PLoS Biol.* 11, e1001569.
- Mouillot, D., Graham, N.A.J., Villéger, S., Mason, N.W.H., Bellwood, D.R., 2013b. A functional approach reveals community responses to disturbances. *Trends Ecol. Evol.* 28, 167–177.

- Moura, F. de B.P., Duarte, J.M.M., de Lyra Lemos, R.P., 2011. Floristic composition and dispersal syndromes at an urban remnant from the Atlantic forest in Brazilian Northeast. *Acta Sci. Biol. Sci.* 33, 471–478.
- Muggeo, V.M.R., 2008a. Modeling temperature effects on mortality: multiple segmented relationships with common break points. *Biostatistics* 9, 613–620.
- Muggeo, V.M.R., 2008b. Segmented: an R package to fit regression models with broken-line relationships. *R news* 8, 20–25.
- Murphy, B.P., Bowman, D.M.J.S., 2012. What controls the distribution of tropical forest and savanna? *Ecol. Lett.* 15, 748–758.
- Myers, N., Mittermeier, R.A., Mittermeier, C.G., Da Fonseca, G.A.B., Kent, J., 2000. Biodiversity hotspots for conservation priorities. *Nature* 403, 853–858.
- Nabout, J.C., Oliveira, G., Magalhães, M.R., Terribile, L.C., Almeida, F.A.S. de, 2011. Global climate change and the production of “Pequi” fruits (*Caryocar brasiliense*) in the Brazilian Cerrado.
- Nakashizuka, T., 2001. Species coexistence in temperate, mixed deciduous forests. *Trends Ecol. Evol.* [https://doi.org/10.1016/S0169-5347\(01\)02117-6](https://doi.org/10.1016/S0169-5347(01)02117-6)
- Nathan, R., Muller-Landau, H.C., 2000. Spatial patterns of seed dispersal, their determinants and consequences for recruitment. *Trends Ecol. Evol.* 15, 278–285. [https://doi.org/10.1016/S0169-5347\(00\)01874-7](https://doi.org/10.1016/S0169-5347(00)01874-7)
- Neves, D.M., Dexter, K.G., Pennington, R.T., Bueno, M.L., de Miranda, P.L.S., Oliveira-Filho, A.T., 2018. Lack of floristic identity in campos rupestres—A hyperdiverse mosaic of rocky montane savannas in South America. *Flora* 238, 24–31. <https://doi.org/10.1016/J.FLORA.2017.03.011>
- Neves, F.S., Araújo, L.S., Espírito-Santo, M.M., Fagundes, M., Fernandes, G.W., Sanchez-Azofeifa, G.A., Quesada, M., 2010. Canopy Herbivory and Insect Herbivore Diversity

- in a Dry Forest-Savanna Transition in Brazil. *Biotropica* 42, 112–118.
- <https://doi.org/10.1111/j.1744-7429.2009.00541.x>
- Ojeda, F., Brun, F.G., Vergara, J.J., 2005. Fire, rain and the selection of seeder and resprouter life-histories in fire-recruiting, woody plants. *New Phytol.* 168, 155–165.
- Oldfather, M.F., 2019. Ecoregion shapes the range response. *Nat. Clim. Chang.* 1–2.
- Oliveira-Filho, A.T. de, 2017. NeoTropTree, Flora arbórea da Região Neotropical: Um banco de dados envolvendo biogeografia, diversidade e conservação [WWW Document]. Univ. Fed. Minas Gerais. URL <http://www.neotropree.info/>
- Oliveira, U., Paglia, A.P., Brescovit, A.D., Carvalho, C.J.B., Silva, D.P., Rezende, D.T., Leite, F.S.F., Batista, J.A.N., Barbosa, J.P.P.P., Stehmann, J.R., 2016. The strong influence of collection bias on biodiversity knowledge shortfalls of Brazilian terrestrial biodiversity. *Divers. Distrib.* 22, 1232–1244.
- Oliveira, U., Soares-Filho, B.S., Paglia, A.P., Brescovit, A.D., Carvalho, C.J.B., Silva, D.P., Rezende, D.T., Leite, F.S.F., Batista, J.A.N., Barbosa, J.P.P.P., 2017. Biodiversity conservation gaps in the Brazilian protected areas. *Sci. Rep.* 7, 9141.
- Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C., D'amico, J.A., Itoua, I., Strand, H.E., Morrison, J.C., Loucks, C.J., Allnutt, T.F., Ricketts, T.H., Kura, Y., Lamoreux, J.F., Wettengel, W.W., Hedao, P., Kassem, K.R., 2001. Terrestrial Ecoregions of the World: A New Map of Life on Earth A new global map of terrestrial ecoregions provides an innovative tool for conserving biodiversity. *Bioscience* 51, 933–938. [https://doi.org/10.1641/0006-3568\(2001\)051\[0933:teotwa\]2.0.co;2](https://doi.org/10.1641/0006-3568(2001)051[0933:teotwa]2.0.co;2)
- Orians, G.H., 1993. Endangered at what level? *Ecol. Appl.* 3, 206–208.
- Ott, J.P., Klimešová, J., Hartnett, D.C., 2019. The ecology and significance of below-ground bud banks in plants. *Ann. Bot.* 123, 1099–1118.

- Pagel, M.D., Harvey, P.H., Godfray, H.C.J., 1991. Species-abundance, biomass, and resource-use distributions. *Am. Nat.* 138, 836–850.
- Paiva, A.O., Rezende, A.V., Pereira, R.S., 2011. Estoque de carbono em cerrado *Sensu stricto* do Distrito Federal. *Rev. Arvore* 35, 527–538. <https://doi.org/10.1590/S0100-67622011000300015>
- Payo-Payo, A., Lobo, J.M., 2016. The unpredictable characteristics of the localities where new Iberian species will be discovered. *Divers. Distrib.* 22, 73–82.
- Pearman, P.B., Guisan, A., Broennimann, O., Randin, C.F., 2008. Niche dynamics in space and time. *Trends Ecol. Evol.* 23, 149–158.
- Pennington, R.T., Lavin, M., 2016. The contrasting nature of woody plant species in different neotropical forest biomes reflects differences in ecological stability. *New Phytol.* 210, 25–37.
- Pennington, R.T., Ratter, J.A., 2006. Neotropical savannas and seasonally dry forests: plant diversity, biogeography, and conservation. CRC press.
- Pereira, H.M., Cooper, H.D., 2006. Towards the global monitoring of biodiversity change. *Trends Ecol. Evol.* 21, 123–129.
- Pereira Júnior, A.C., Oliveira, S.L.J., Pereira, J.M.C., Turkman, M.A.A., 2014. Modelling fire frequency in a Cerrado savanna protected area. *PLoS One* 9.
- Peres, C.A., 2001. Synergistic effects of subsistence hunting and habitat fragmentation on Amazonian forest vertebrates. *Conserv. Biol.* 15, 1490–1505.
- Peters, G.-J., Peters, M.G.-J., XLConnect, S., 2018. Package ‘userfriendlyscience.’ Vienna R Found. Stat. Comput.
- Pirani, F.R., Pedroni, F., 2009. Phenology of a tree community in a cerrado *sensu stricto*, Barra do Garças, Mato Grosso state, Brasil. *Acta Bot. Brasilica* 23, 1096–1110.
- Pirani, F.R., Sanchez, M., Pedroni, F., 2009. Fenologia de uma comunidade arbórea em

- cerrado sentido restrito, Barra do Garças, MT, Brasil. *Acta Bot. Brasilica* 23, 1096–1109.
- Pitman, N.C.A., Terborgh, J., Silman, M.R., Nunez, V., 1999. Tree species distributions in an upper Amazonian forest. *Ecology* 80, 2651–2661.
- Pivello, V.R., 2011. The Use of Fire in the Cerrado and Amazonian Rainforests of Brazil: Past and Present. *Fire Ecol.* 7, 24–39. <https://doi.org/10.4996/fireecology.0701024>
- Pivello, V.R., Coutinho, L.M., 1992. Transfer of macro-nutrients to the atmosphere during experimental burnings in an open cerrado (Brazilian savanna). *J. Trop. Ecol.* 487–497.
- Pivello, V.R., Norton, G.A., 1996. FIRETOOL: an expert system for the use of prescribed fires in Brazilian savannas. *J. Appl. Ecol.* 348–356.
- Possingham, H.P., Andelman, S.J., Burgman, M.A., Medellín, R.A., Master, L.L., Keith, D.A., 2002. Limits to the use of threatened species lists. *Trends Ecol. Evol.* 17, 503–507.
- Prado, C.H.B. de A., De Moraes, J., 1997. Photosynthetic capacity and specific leaf mass in twenty woody species of Cerrado vegetation under field conditions. *Photosynthetica* 33, 103–112.
- Prata, E.M.B., Sass, C., Rodrigues, D.P., Domingos, F.M.C.B., Specht, C.D., Damasco, G., Ribas, C.C., Fine, P.V.A., Vicentini, A., 2018. Towards integrative taxonomy in Neotropical botany: disentangling the *Pagamea guianensis* species complex (Rubiaceae). *Bot. J. Linn. Soc.* 188, 213–231.
- Purvis, A., Gittleman, J.L., Cowlishaw, G., Mace, G.M., 2000. Predicting extinction risk in declining species. *Proc. R. Soc. London. Ser. B Biol. Sci.* 267, 1947–1952. <https://doi.org/10.1098/rspb.2000.1234>
- R CoreTeam, 2019. R: A language and environment for statistical computing.
- Rabinowitz, D., 1981. Seven forms of rarity. In ‘The biological aspects of rare plant

- conservation'. (Ed. H Synge) pp. 205–217.
- Rabinowitz, D., Rapp, J.K., Dixon, P.M., 1984. Competitive abilities of sparse grass species: means of persistence or cause of abundance. *Ecology* 65, 1144–1154.
- Radford, I.J., Gibson, L.A., Corey, B., Carnes, K., Fairman, R., 2015. Influence of Fire Mosaics, Habitat Characteristics and Cattle Disturbance on Mammals in Fire-Prone Savanna Landscapes of the Northern Kimberley. *PLoS One* 10, e0130721.
<https://doi.org/10.1371/journal.pone.0130721>
- Ramirez-Villegas, J., Jarvis, A., Touval, J., 2012. Analysis of threats to South American flora and its implications for conservation. *J. Nat. Conserv.* 20, 337–348.
- Ramos-Neto, M.B., Pivello, V.R., 2000. Lightning fires in a Brazilian savanna National Park: rethinking management strategies. *Environ. Manage.* 26, 675–684.
- Ratnam, J., Bond, W.J., Fensham, R.J., Hoffmann, W.A., Archibald, S., Lehmann, C.E.R., Anderson, M.T., Higgins, S.I., Sankaran, M., 2011. When is a 'forest' a savanna, and why does it matter? *Glob. Ecol. Biogeogr.* 20, 653–660.
- Ratter, J.A., Bridgewater, S., Atkinson, R., Ribeiro, J.F., 1996. Analysis of the floristic composition of the Brazilian cerrado vegetation II: comparison of the woody vegetation of 98 areas. *Edinburgh J. Bot.* 53, 153–180.
- Ratter, J.A., Bridgewater, S., Ribeiro, J.F., 2003. Analysis of the floristic composition of the Brazilian cerrado vegetation III: comparison of the woody vegetation of 376 areas. *Edinburgh J. Bot.* 60, 57–109.
- Redo, D., Aide, T.M., Clark, M.L., 2013. Vegetation change in Brazil's dryland ecoregions and the relationship to crop production and environmental factors: Cerrado, Caatinga, and Mato Grosso, 2001–2009. *J. Land Use Sci.* 8, 123–153.
- Reed, J.M., Nguyen, A., Owens, A.C.S., Lewis, S.M., 2020. Linking the seven forms of rarity to extinction threats and risk factors: an assessment of North American fireflies.

- Biodivers. Conserv. 29, 57–75. <https://doi.org/10.1007/s10531-019-01869-7>
- Rejmánek, M., Brewer, S.W., 2001. Vegetative Identification of Tropical Woody Plants: State of the Art and Annotated Bibliography 1. *Biotropica* 33, 214–228.
- Rey Benayas, J.M., Scheiner, S., García Sánchez-Colomer, M., Levassor, C., 1999. Commonness and rarity: theory and application of a new model to Mediterranean montane grasslands. *Conserv. Ecol.* 3.
- Ribeiro, B.R., Martins, E., Martinelli, G., Loyola, R., Ribeiro, B.R., Martins, E., Martinelli, G., Loyola, R., 2018. The effectiveness of protected areas and indigenous lands in representing threatened plant species in Brazil. *Rodriguésia* 69, 1539–1546. <https://doi.org/10.1590/2175-7860201869404>
- Riddle, B.R., Ladle, R.J., Lourie, S.A., Whittaker, R.J., 2011. Basic biogeography: estimating biodiversity and mapping nature. *Conserv. Biogeogr.* 45–92.
- Roberts, D.L., Taylor, L., Joppa, L.N., 2016. Threatened or Data Deficient: assessing the conservation status of poorly known species. *Divers. Distrib.* 22, 558–565.
- Rodrigues, A.S.L., Andelman, S.J., Bakarr, M.I., Boitani, L., Brooks, T.M., Cowling, R.M., Fishpool, L.D.C., da Fonseca, G.A.B., Gaston, K.J., Hoffmann, M., Long, J.S., Marquet, P.A., Pilgrim, J.D., Pressey, R.L., Schipper, J., Sechrest, W., Stuart, S.N., Underhill, L.G., Waller, R.W., Watts, M.E.J., Yan, X., 2004. Effectiveness of the global protected area network in representing species diversity. *Nature* 428, 640–643. <https://doi.org/10.1038/nature02422>
- Rodrigues, A.S.L., Akcakaya, H.R., Andelman, S.J., Bakarr, M.I., Boitani, L., Brooks, T.M., Chanson, J.S., Fishpool, L.D.C., Da Fonseca, G.A.B., Gaston, K.J., 2004. Global gap analysis: priority regions for expanding the global protected-area network. *AIBS Bull.* 54, 1092–1100.
- Roquette, J.G., 2018. Distribution of biomass in cerrado and its importance for carbon

- storage. *Cienc. Florest.* 28, 1350–1363. <https://doi.org/10.5902/1980509833354>
- Rossatto, D.R., Hoffmann, W.A., Silva, L. de C.R., Haridasan, M., Sternberg, L.S.L., Franco, A.C., 2013. Seasonal variation in leaf traits between congeneric savanna and forest trees in Central Brazil: implications for forest expansion into savanna. *Trees* 27, 1139–1150.
- Rossatto, D.R., Silva, L. de C.R., Villalobos-Vega, R., Sternberg, L. da S.L., Franco, A.C., 2012. Depth of water uptake in woody plants relates to groundwater level and vegetation structure along a topographic gradient in a neotropical savanna. *Environ. Exp. Bot.* 77, 259–266.
- Rumeu, B., Devoto, M., Traveset, A., Olesen, J.M., Vargas, P., Nogales, M., Heleno, R., 2017. Predicting the consequences of disperser extinction: richness matters the most when abundance is low. *Funct. Ecol.* 31, 1910–1920.
- Ruxton, G.D., Beauchamp, G., 2008. Time for some a priori thinking about post hoc testing. *Behav. Ecol.* 19, 690–693.
- Sætersdal, M., Birks, H.J.B., 1997. A comparative ecological study of Norwegian mountain plants in relation to possible future climatic change. *J. Biogeogr.* 24, 127–152.
- Sætersdal, M., Gjerde, I., 2011. Prioritising conservation areas using species surrogate measures: consistent with ecological theory? *J. Appl. Ecol.* 48, 1236–1240.
- Salazar, A., Baldi, G., Hirota, M., Syktus, J., McAlpine, C., 2015. Land use and land cover change impacts on the regional climate of non-Amazonian South America: A review. *Glob. Planet. Change* 128, 103–119.
<https://doi.org/10.1016/J.GLOPLACHA.2015.02.009>
- Salazar, A., Goldstein, G., 2014. Effects of fire on seedling diversity and plant reproduction (sexual vs. vegetative) in neotropical savannas differing in tree density. *Biotropica* 46, 139–147.
- Salazar, A., Goldstein, G., Franco, A.C., Miralles-Wilhelm, F., 2012. Seed limitation of

- woody plants in Neotropical savannas. *Plant Ecol.* 213, 273–287.
<https://doi.org/10.1007/s11258-011-9973-4>
- Sankaran, M., 2019. Droughts and the ecological future of tropical savanna vegetation. *J. Ecol.* 107, 1531–1549.
- Sano, E.E., Rodrigues, A.A., Martins, E.S., Bettiol, G.M., Bustamante, M.M.C., Bezerra, A.S., Couto Jr, A.F., Vasconcelos, V., Schüler, J., Bolfe, E.L., 2019. Cerrado ecoregions: A spatial framework to assess and prioritize Brazilian savanna environmental diversity for conservation. *J. Environ. Manage.* 232, 818–828.
- Santiago, L.S., Bonal, D., De Guzman, M.E., Ávila-Lovera, E., 2016. Drought survival strategies of tropical trees, in: *Tropical Tree Physiology*. Springer, pp. 243–258.
- Santoro, R., Carboni, M., Carranza, M.L., Acosta, A.T.R., 2012. Focal species diversity patterns can provide diagnostic information on plant invasions. *J. Nat. Conserv.* 20, 85–91.
- Sarmiento, G., 1984. *The ecology of neotropical savannas*. Harvard University Press.
- Sarmiento, G., Monasterio, M., 1975. A critical consideration of the environmental conditions associated with the occurrence of savanna ecosystems in tropical America, in: *Tropical Ecological Systems*. Springer, pp. 223–250.
- Saupe, E.E., Qiao, H., Hendricks, J.R., Portell, R.W., Hunter, S.J., Soberón, J., Lieberman, B.S., 2015. Niche breadth and geographic range size as determinants of species survival on geological time scales. *Glob. Ecol. Biogeogr.* 24, 1159–1169.
<https://doi.org/10.1111/geb.12333>
- Schaefer, H., Moura, M., Belo Maciel, M.G., Silva, L., Rumsey, F.J., Carine, M.A., 2011. The Linnean shortfall in oceanic island biogeography: a case study in the Azores. *J. Biogeogr.* 38, 1345–1355.
- Scolforo, H.F., Scolforo, J.R.S., Mello, C.R., Mello, J.M., Ferraz Filho, A.C., 2015. Spatial

- Distribution of Aboveground Carbon Stock of the Arboreal Vegetation in Brazilian Biomes of Savanna, Atlantic Forest and Semi-Arid Woodland. *PLoS One* 10, e0128781. <https://doi.org/10.1371/journal.pone.0128781>
- Silva, E.G., Guilherme, G., Augusto, F., Silva Carneiro, S.E., Ongaro Pinheiro, M.H., Carniello Ferreira, W., 2019. Heterogeneidade ambiental e estrutura da vegetação arbustivo-arbórea em três áreas de Cerrado sentido restrito no Sudoeste goiano. *Ciência Florest.* 29.
- Silva, J.M.C., Bates, J.M., 2002. Biogeographic Patterns and Conservation in the South American Cerrado: A Tropical Savanna Hotspot: The Cerrado, which includes both forest and savanna habitats, is the second largest South American biome, and among the most threatened on the continent. *AIBS Bull.* 52, 225–234.
- Silva, P., Bastos, A., DaCamara, C.C., Libonati, R., 2016. Future projections of fire occurrence in Brazil using EC-Earth climate model. *Rev. Bras. Meteorol.* 31, 288–297.
- Silva, P.S., Bastos, A., Libonati, R., Rodrigues, J.A., DaCamara, C.C., 2019. Impacts of the 1.5 °C global warming target on future burned area in the Brazilian Cerrado. *For. Ecol. Manage.* 446, 193–203. <https://doi.org/10.1016/j.foreco.2019.05.047>
- Simó-Riudalbas, M., Metallinou, M., de Pous, P., Els, J., Jayasinghe, S., Péntek-Zakar, E., Wilms, T., Al-Saadi, S., Carranza, S., 2017. Cryptic diversity in *Ptyodactylus* (Reptilia: Gekkonidae) from the northern Hajar Mountains of Oman and the United Arab Emirates uncovered by an integrative taxonomic approach. *PLoS One* 12, e0180397.
- Simon, M.F., Proença, C., 2000. Phytogeographic patterns of *Mimosa* (Mimosoideae, Leguminosae) in the Cerrado biome of Brazil: an indicator genus of high-altitude centers of endemism? *Biol. Conserv.* 96, 279–296.
- Slovák, M., Kučera, J., Marhold, K., Zozomová-Lihová, J., 2012. The morphological and genetic variation in the polymorphic species *Picris hieracioides* (Compositae, Lactuceae)

- in Europe strongly contrasts with traditional taxonomical concepts. *Syst. Bot.* 37, 258–278.
- Smith, J.R., Letten, A.D., Ke, P.-J., Anderson, C.B., Hendershot, J.N., Dhimi, M.K., Dlott, G.A., Grainger, T.N., Howard, M.E., Morrison, B.M.L., Routh, D., San Juan, P.A., Mooney, H.A., Mordecai, E.A., Crowther, T.W., Daily, G.C., 2018. A global test of ecoregions. *Nat. Ecol. Evol.* 2, 1889–1896. <https://doi.org/10.1038/s41559-018-0709-x>
- Smith, R.J., 2009. Use and misuse of the reduced major axis for line-fitting. *Am. J. Phys. Anthropol. Off. Publ. Am. Assoc. Phys. Anthropol.* 140, 476–486.
- Smith, T.B., Kark, S., Schneider, C.J., Wayne, R.K., Moritz, C., 2001. Biodiversity hotspots and beyond: the need for preserving environmental transitions. *Trends Ecol. Evol.* 16, 431.
- Smith, T.B., Wayne, R.K., Girman, D.J., Bruford, M.W., 1997. A role for ecotones in generating rainforest biodiversity. *Science* (80-.). 276, 1855–1857.
- Solbrig, O.T., 1996. The diversity of the savanna ecosystem, in: *Biodiversity and Savanna Ecosystem Processes*. Springer, pp. 1–27.
- Soliveres, S., Manning, P., Prati, D., Gossner, M.M., Alt, F., Arndt, H., Baumgartner, V., Binkenstein, J., Birkhofer, K., Blaser, S., Blüthgen, N., Boch, S., Böhm, S., Börschig, C., Buscot, F., Diekötter, T., Heinze, J., Hölzel, N., Jung, K., Klaus, V.H., Klein, A.-M., Kleinebecker, T., Klemmer, S., Krauss, J., Lange, M., Morris, E.K., Müller, J., Oelmann, Y., Overmann, J., Pašalić, E., Renner, S.C., Rillig, M.C., Schaefer, H.M., Schlöter, M., Schmitt, B., Schöning, I., Schrumpf, M., Sikorski, J., Socher, S.A., Solly, E.F., Sonnemann, I., Sorkau, E., Steckel, J., Steffan-Dewenter, I., Stempfhuber, B., Tschapka, M., Türke, M., Venter, P., Weiner, C.N., Weisser, W.W., Werner, M., Westphal, C., Wilcke, W., Wolters, V., Wubet, T., Wurst, S., Fischer, M., Allan, E., 2016. Locally rare species influence grassland ecosystem multifunctionality. *Philos.*

- Trans. R. Soc. Lond. B. Biol. Sci. 371, 20150269.
<https://doi.org/10.1098/rstb.2015.0269>
- Sousa-Baena, M.S., Garcia, L.C., Peterson, A.T., 2014. Completeness of digital accessible knowledge of the plants of Brazil and priorities for survey and inventory. *Divers. Distrib.* 20, 369–381. <https://doi.org/10.1111/ddi.12136>
- Souto, W.M.S., Torres, M.A.R., Sousa, B.F.C.F., Lima, K.G.G.C., Vieira, L.T.S., Pereira, G.A., Guzzi, A., Silva, M.V., Pralon, B.G.N., 2017. Singing for Cages: the use and trade of Passeriformes as wild pets in an economic center of the Amazon—NE Brazil route. *Trop. Conserv. Sci.* 10, 194008291768989. <https://doi.org/10.1177/1940082917689898>
- St-Pierre, A.P., Shikon, V., Schneider, D.C., 2018. Count data in biology—Data transformation or model reformation? *Ecol. Evol.* 8, 3077–3085.
- Staal, A., Dekker, S.C., Hirota, M., van Nes, E.H., 2015. Synergistic effects of drought and deforestation on the resilience of the south-eastern Amazon rainforest. *Ecol. Complex.* 22, 65–75.
- Staude, I.R., Navarro, L.M., Pereira, H.M., 2020. Range size predicts the risk of local extinction from habitat loss. *Glob. Ecol. Biogeogr.* 29, 16–25.
- Steinbauer, M.J., Grytnes, J.-A., Jurasinski, G., Kulonen, A., Lenoir, J., Pauli, H., Rixen, C., Winkler, M., Bardy-Durchhalter, M., Barni, E., 2018. Accelerated increase in plant species richness on mountain summits is linked to warming. *Nature* 556, 231–234.
- Streukens, S., Leroi-Werelds, S., 2016. Bootstrapping and PLS-SEM: A step-by-step guide to get more out of your bootstrap results. *Eur. Manag. J.* 34, 618–632.
<https://doi.org/10.1016/j.emj.2016.06.003>
- Suding, K.N., Lavorel, S., Chapin, F.S., Cornelissen, J.H.C., Díaz, S., Garnier, E., Goldberg, D., Hooper, D.U., Jackson, S.T., Navas, M.L., 2008. Scaling environmental change through the community-level: A trait-based response-and-effect framework for plants.

- Glob. Chang. Biol. 14, 1125–1140. <https://doi.org/10.1111/j.1365-2486.2008.01557.x>
- Taylor, K.T., Maxwell, B.D., Pauchard, A., Nuñez, M.A., Peltzer, D.A., Terwei, A., Rew, L.J., 2016. Drivers of plant invasion vary globally: evidence from pine invasions within six ecoregions. *Glob. Ecol. Biogeogr.* 25, 96–106.
- Teodoro, D.A.A., 2014. Biomassa, estoque de carbono e nutrientes no Cerrado, *Disertação de Mestrado*. Universidade de Brasília.
- Ter Steege, H., Pitman, N.C.A., Killeen, T.J., Laurance, W.F., Peres, C.A., Guevara, J.E., Salomão, R.P., Castilho, C. V, Amaral, I.L., de Almeida Matos, F.D., 2015. Estimating the global conservation status of more than 15,000 Amazonian tree species. *Sci. Adv.* 1, e1500936.
- Terborgh, J., Nuñez-Iturri, G., Pitman, N.C.A., Valverde, F.H.C., Alvarez, P., Swamy, V., Pringle, E.G., Paine, C.E.T., 2008. Tree recruitment in an empty forest. *Ecology* 89, 1757–1768.
- Terra, M. de C.N.S., dos Santos, R.M., Fontes, M.A.L., de Mello, J.M., Scolforo, J.R.S., Gomide, L.R., do Prado Júnior, J.A., Schiavini, I., ter Steege, H., 2017. Tree dominance and diversity in Minas Gerais, Brazil. *Biodivers. Conserv.* 26, 2133–2153.
- Tews, J., Brose, U., Grimm, V., Tielbörger, K., Wichmann, M.C., Schwager, M., Jeltsch, F., 2004. Animal species diversity driven by habitat heterogeneity/diversity: the importance of keystone structures. *J. Biogeogr.* 31, 79–92. <https://doi.org/10.1046/j.0305-0270.2003.00994.x>
- Thomson, F.J., Moles, A.T., Auld, T.D., Kingsford, R.T., 2011. Seed dispersal distance is more strongly correlated with plant height than with seed mass. *J. Ecol.* 99, 1299–1307.
- Torello-Raventos, M., Feldpausch, T.R., Veenendaal, E., Schrod, F., Saiz, G., Domingues, T.F., Djagbletey, G., Ford, A., Kemp, J., Marimon, B.S., Hur Marimon Junior, B., Lenza, E., Ratter, J.A., Maracahipes, L., Sasaki, D., Sonké, B., Zapfack, L., Taedoumg,

- H., Villarroel, D., Schwarz, M., Quesada, C.A., Yoko Ishida, F., Nardoto, G.B., Affum-Baffoe, K., Arroyo, L., M.J.S. Bowman, D., Compaore, H., Davies, K., Diallo, A., Fyllas, N.M., Gilpin, M., Hien, F., Johnson, M., Killeen, T.J., Metcalfe, D., Miranda, H.S., Steininger, M., Thomson, J., Sykora, K., Mougin, E., Hiernaux, P., Bird, M.I., Grace, J., Lewis, S.L., Phillips, O.L., Lloyd, J., 2013. On the delineation of tropical vegetation types with an emphasis on forest/savanna transitions. *Plant Ecol. Divers.* 6, 101–137. <https://doi.org/10.1080/17550874.2012.762812>
- Torres, R.R., Marengo, J.A., 2014. Climate change hotspots over South America: from CMIP3 to CMIP5 multi-model datasets. *Theor. Appl. Climatol.* 117, 579–587.
- TrouDET, J., Grandcolas, P., Blin, A., Vignes-Lebbe, R., Legendre, F., 2017. Taxonomic bias in biodiversity data and societal preferences. *Sci. Rep.* 7, 1–14.
- Turnbull, L.A., Crawley, M.J., Rees, M., 2000. Are plant populations seed-limited? A review of seed sowing experiments. *Oikos* 88, 225–238.
- UNEP-WCMC, IUCN, 2019. Protected Planet [WWW Document]. URL www.protectedplanet.net
- Urbanetz, C., Tamashiro, J.Y., Kinoshita, L.S., 2010. Identification key for woody species of an Atlantic Rain Forest remnant, in the Southeast of Brazil, based on vegetative characters. *Biota Neotrop.* 10, 349–398.
- Vale, M.M., Jenkins, C.N., 2012. Across-taxa incongruence in patterns of collecting bias. *J. Biogeogr.* 39, 1744–1748.
- Vale, V.S., Lopes, S.F., 2010. Efeitos do fogo na estrutura populacional de quatro espécies de plantas do cerrado. *Rev. Nord. Biol.* 19.
- Valiente-Banuet, A., Aizen, M.A., Alcántara, J.M., Arroyo, J., Cocucci, A., Galetti, M., García, M.B., García, D., Gómez, J.M., Jordano, P., Medel, R., Navarro, L., Obeso, J.R., Oviedo, R., Ramírez, N., Rey, P.J., Traveset, A., Verdú, M., Zamora, R., 2015. Beyond

- species loss: the extinction of ecological interactions in a changing world. *Funct. Ecol.* 29, 299–307. <https://doi.org/10.1111/1365-2435.12356>
- Valladares, F., Gianoli, E., Gómez, J.M., 2007. Ecological limits to plant phenotypic plasticity. *New Phytol.* 176, 749–763.
- Van Schaik, C.P., Terborgh, J.W., Wright, S.J., 1993. The phenology of tropical forests: adaptive significance and consequences for primary consumers. *Annu. Rev. Ecol. Syst.* 24, 353–377.
- Vicentini, A., 2016. The evolutionary history of *Pagamea* (Rubiaceae), a white-sand specialist lineage in tropical South America. *Biotropica* 48, 58–69.
- Vieira, L.T.A., Castro, A.A.J.F., Coutinho, J.M.C.P., de Sousa, S.R., de Farias, R.R.S., Castro, N.M.C.F., Martins, F.R., 2019. A biogeographic and evolutionary analysis of the flora of the North-eastern cerrado, Brazil. *Plant Ecol. Divers.* 1–14.
- Walter, H., 1986. *Vegetação e zonas climáticas: tratado de ecologia global*, in: *Vegetação e Zonas Climáticas: Tratado de Ecologia Global*. EPU.
- Warton, D.I., Lyons, M., Stoklosa, J., Ives, A.R., 2016. Three points to consider when choosing a LM or GLM test for count data. *Methods Ecol. Evol.* 7, 882–890.
- Weiher, E., Clarke, G.D.P., Keddy, P.A., 1998. Community Assembly Rules, Morphological Dispersion, and the Coexistence of Plant Species. *Oikos* 81, 309. <https://doi.org/10.2307/3547051>
- Weiher, E., Keddy, P., 2001. *Ecological assembly rules: perspectives, advances, retreats*. Cambridge University Press.
- Whittaker, R.J., Araújo, M.B., Jepson, P., Ladle, R.J., Watson, J.E.M., Willis, K.J., 2005. Conservation biogeography: Assessment and prospect. *Divers. Distrib.* <https://doi.org/10.1111/j.1366-9516.2005.00143.x>
- Wickham, H., 2009. *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New

York.

Wright, S.J., Zeballos, H., Domínguez, I., Gallardo, M.M., Moreno, M.C., Ibáñez, R., 2000.

Poachers alter mammal abundance, seed dispersal, and seed predation in a Neotropical forest. *Conserv. Biol.* 14, 227–239.

Wright, T.F., Toft, C.A., Enkerlin-Hoeflich, E., Gonzalez-Elizondo, J., Albornoz, M.,

Rodríguez-Ferraro, A., Rojas-Suárez, F., Sanz, V., Trujillo, A., Beissinger, S.R., 2001.

Nest poaching in Neotropical parrots. *Conserv. Biol.* 15, 710–720.

Yu, J., Dobson, F.S., 2000. Seven forms of rarity in mammals. *J. Biogeogr.* 27, 131–139.

Zappi, D.C., Filardi, F.L.R., Leitman, P., Souza, V.C., Walter, B.M.T., Pirani, J.R., Morim,

M.P., Queiroz, L.P., Cavalcanti, T.B., Mansano, V.F., 2015. Growing knowledge: an overview of Seed Plant diversity in Brazil. *Rodriguésia* 66, 1085–1113.

APÊNDICES

Supplementary material chapter 2

Table 1. Keywords used to search for papers published. Different combinations were done with the words in each column.

Keywords 1	Keywords 2	Keywords 3
‘cerrado’ ‘cerradão’	‘Stricto sensu’ ‘rupestre’	‘vegetation’
‘savanna’ ‘Guiana	‘dense’ ‘grassland’	‘phytosociological’
savanna’ ‘Llanos’ Llanos	‘forested’ ‘tree’ ‘arboreal’	‘floristic’ ‘structure’
of moxos’ ‘amazonia	‘hyper seasonal’ ‘steppe’	‘community’
savanna’ ‘caatinga	‘woodland’ ‘parkland’	
savanna’	‘eutrophic’	

Table 2. Results of the regression analysis between relative flora shortfall (rfs) and estimated relative flora shortfall by different interpolation techniques (it) for floristic and phytosociological surveys.

surveys	it	R-squared	Estimate	Std. Error	t value	Pr(> t)
floristic	Idw	0.9113	1.045649	0.027563	37.937	<2e-16***
	Spline	0.8201	0.955156	0.037804	25.266	<2e-16 ***
	Natural Neighbor	0.8585	1.0231136	0.0351091	29.141	<2e-16 ***
	Kriging	0.5927	1.201880	0.084213	14.272	<2e-16 ***
phytosociological	Idw	0.9113	1.045649	0.027563	37.937	<2e-16 ***
	Spline	0.875	0.9608528	0.0269187	35.695	<2e-16 ***
	Natural Neighbor	0.8875	1.054924	0.027845	37.886	<2e-16 ***
	Kriging	0.6771	1.16106	0.05943	19.538	<2e-16 ***

Table 3. Papers reporting phytosociological or floristic surveys in the Neotropical savanna and they respective references.

Literature	Reference
Annals	Ribeiro, J. F., & Haridasan, M. (1984). Comparação fitossociológica de um cerrado denso e um cerradão em solos distróficos no Distrito Federal. In Congresso nacional de botânica (Vol. 35, pp. 342-347). Manaus: Sociedade de Botânica do Brasil.
Annals	Fonseca, E. M., Ferreira, M.A., Nunes, J.R.S., Pinho, N.G.C.; Ferraz, L., Macedo, M., Guarim Neto, G. (2004). Aspectos fitossociológicos de uma comunidade de Carvoal (<i>Callisthene fasciculata</i>) no pantanal de Mato Grosso, Brasil. Simpósio sobre Recursos Naturais e Socioeconômicos do Pantanal, 229-243.
Annals	Rodrigues, W. A. (1971). Plantas dos Campos do Rio Branco (Território de Roraima). In III (Ie Terceiro) Simposio sobre o Cerrado.
Annals	Castro, A. A. J. F. (1984) Vegetação e flora da Estação Ecológica de Uruçuí-Una (resultados preliminares). In: Annals of 34° National Congress of Botany, Porto Alegre, 2, 251-261.
Article	Ribeiro-Silva, S., Medeiros, M. D., Gomes, B. M., Seixas, E. N. C., & Silva, M. A. P. (2012). Angiosperms from the Araripe national forest, Ceará, Brazil. Check List, 8(4), 744-751.
Article	Ratter, J. A., Bridgewater, S., & Ribeiro, J. F. (2001). Espécies lenhosas da fitofisionomia cerrado sentido amplo em 170 localidades do bioma cerrado. Boletim do Herbário Ezechias Paulo Heringer, 7(1), 5-112.
Article	Sinimbu, G. (2008). Fitossociologia em Cerrado Sentido Restrito na Floresta Nacional de Brasília-DF. Revista Brasileira de Biociências, 5(S2), pg-1183.
Article	Felfili, J.M., et al. (1993). Análise Comparativa da Florística e Fitossociologia da Vegetação Arbórea do Cerrado sensu stricto na Chapada Pratinha, DF, Brasil. Acta Botanica Brasilica, 6(2): 27-46.
Article	Andrade, L. A., Felfili, J. M., & Violatti, L. (2002). Phytosociology of an area of "cerrado denso" at the RECOR-IBGE, Brasília-DF, Brazil. Acta Botanica Brasilica, 16(2), 225-240.
Article	Ribeiro, J. F., Silva, J. C. S., & Batmanian, G. J. (1985). Fitossociologia de tipos fisionômicos de cerrado em Planaltina-DF. Revista Brasileira de Botânica, 8(2), 131-142.
Article	Araujo Neto, M. D., Furley, P. A., Haridasan, M., & Johnson, C. E. (1986). The murundus of the cerrado region of Central Brazil. Journal of Tropical Ecology, 2(01), 17-35.
Article	Moura, I. I. O., Klein, V. L. G., Felfili, J. M., & Ferreira, H. D. (2007). Fitossociologia da comunidade lenhosa de uma área de cerrado rupestre no Parque Estadual dos Pireneus, Pirenópolis, Goiás. Revista de Biologia Neotropical, 4(2), 18.
Article	Borges, H. B. N., & Shepherd, G. J. (2005). Flora e estrutura do estrato lenhoso numa comunidade de Cerrado em Santo Antônio do Leverger, MT, Brasil. Revista Brasileira de Botânica, 28(1), 61-74.
Article	Felfili, J. M., Nogueira, P.E., Silva, Silva Júnior, M. C. D., Marimon, B. S., & Delitti, W. B. C. (2002). Composição florística e fitossociologia do cerrado sentido restrito no município de Água Boa-MT. Acta Botanica Brasilica, 16(1), 103-112.
Article	Marimon, B.S., Lima, E.D.S., Duarte, T.G., Chierogatto, L.C., & Ratter, J. (2006). Observations on the vegetation of Northeastern Mato Grosso, Brazil. IV. Na analysis of the Cerrado–Amazonian forest ecotone. Edinburgh Journal of Botany, 63(2-3), 323-341.
Article	Nascimento, M. T., & Saddi, N. (1992). Structure and floristic composition in an area of cerrado in Cuiabá-MT, Brazil. Revista Brasileira Botânica, 15(1), 47-55.

Literature	Reference
Article	Guarim, V. L. M. S., Moraes, E. C. C., Prance, G. T., & Ratter, J. A. (2000). Inventory of a mesotrophic Callisthene cerradão in the Pantanal of Mato Grosso, Brazil. <i>Edinburgh Journal of Botany</i> , 57(03), 429-436.
Article	Marimon-Junior, B., & Haridasan, M. (2005). Comparação da vegetação arbórea e características edáficas de um cerradão e um cerrado sensu stricto em áreas adjacentes sobre solo distrófico no leste de Mato Grosso, Brasil. <i>Acta Botanica Brasilica</i> , 19(4), 913-926.
Article	Prance, G. T., & Schaller, G. B. (1982). Preliminary study of some vegetation types of the Pantanal, Mato Grosso, Brazil. <i>Brittonia</i> , 34(2), 228-251.
Article	Oliveira-Filho, A. T., Martins, F.R. (1986). Distribuicao, caracterizacao e composicao floristica das formacoes vegetais da regio da Salgadeira, na Chapada dos Guimaraes (MT). <i>Revista Brasileira de Botânica</i> , 9(2), 2007-223.
Article	Costa, I. R. D., & Araújo, F. S. D. (2007). Organização comunitária de um enclave de cerrado sensu stricto no bioma Caatinga, chapada do Araripe, Barbalha, Ceará. <i>Acta Botanica Brasilica</i> , 21(2), 281-291.
Article	Medeiros, M. B., Walter, B. M. T., & Silva, G. P. (2008). Fitossociologia do cerrado stricto sensu no município de Carolina, MA, Brasil. <i>Cerne</i> , 14(4), 285-294.
Article	Imaña-Encinas, J., & Paula, J. E. D. (2003). Análise da vegetação de cerrado no município de Santa Quitéria-Maranhão. <i>Brasil Florestal</i> , 78,33-42.
Article	Ribeiro, L. F., & Tabarelli, M. (2002). A structural gradient in cerrado vegetation of Brazil: changes in woody plant density, species richness, life history and plant composition. <i>Journal of tropical ecology</i> , 18(05), 775-794.
Article	Vidotto, E., Pessenda, L.C.R., Ribeiro, A.S., Freitas, H.A., Bendassolli, J.A. (2007). Dinâmica do ecótono floresta-campo no sul do estado do Amazonas no Holoceno, através de estudos isotópicos e fitossociológicos. <i>Acta Amazônica</i> , 37(3), 385-400.
Article	Sanaiotti, T. M., Bridgewater, S., & Ratter, J. A. (1997). A floristic study of the savanna vegetation of the state of Amapá, Brazil, and suggestions for its conservation. <i>Boletim do Museu Paraense Emilio Goeldi, Série Botânica</i> , 13(1), 3-29.
Article	Miranda, I. S. (1993). Estrutura do estrato arbóreo do cerrado amazônico em Alter-do-Chão, Pará, Brasil. <i>Revista Brasileira de Botânica</i> , 16(2), 143-150.
Article	Bastos, M. D. N. D. C. (1984). Levantamento florístico dos campos do Estado do Pará. I. Campo de Joanes (Ilha de Marajó). <i>Boletim Museu Paraense Emilio Goeldi, Série Botânica</i> , 1(1/2),67-86.
Article	Miranda, I. S., Almeida, S. S., & Dantas, P. J. (2006). Florística e estrutura de comunidades arbóreas em cerrados de Rondônia, Brasil. <i>Acta Amazônica</i> , 36(4), 419-430.
Article	Saporetti Jr, A. W., Meira Neto, J. A. A., & Almado, R. D. P. (2003). Fitossociologia de cerrado sensu stricto no município de Abaeté-MG. <i>Revista Árvore</i> , 27(3), 413-419.
Article	Campos, E. P. D., Duarte, T. G., Neri, A. V., Silva, A. F. D., Meira-Neto, J. A. A., & Valente, G. E. (2006). Composição florística de um trecho de cerradão e cerrado sensu stricto e sua relação com o solo na Floresta Nacional (FLONA) de Paraopeba, MG, Brasil. <i>Revista Árvore</i> , 30(3),471-479.
Article	Meira-Neto, J. A.A., & Saporetti-Júnior, A. W. (2002). Parâmetros fitossociológicos de um cerrado no Parque Nacional Da Serra Do Cipó, MG. <i>Revista Árvore</i> , 26(5)645-648.

Literature	Reference
Article	Cardoso, E., Moreno, M. I. C., & Guimarães, A. J. M. (2002). Estudo fitossociológico em área de cerrado sensu stricto na Estação de Pesquisa e Desenvolvimento Ambiental Galheiro-Perdizes, MG. <i>Caminhos de Geografia</i> , 3(5).
Article	Brandao, M., Gavilanes, M. L., & Araujo, M. G. (1996). Cobertura vegetal do município de Prudente de Moraes, MG. <i>Daphne</i> , 6(2), 40-58.
Article	Brandão, M., Laca Buendia, J. P., Araujo, M. G., & Ferreira, F. B. D. (1995). Município de Uberaba, MG: cobertura vegetal e composição florística. <i>Daphne</i> , 5(1), 19-39.
Article	Costa, A. A., & Araújo, G. M. D. (2001). Comparação da vegetação arbórea de cerradão e de cerrado na Reserva do Panga, Uberlândia, Minas Gerais. <i>Acta botanica brasílica</i> .
Article	Araujo, G. M., Nunes, J.J., Rosa, A.G., Resende, E.J. (1997). Estrutura comunitaria de vinte areas de cerrado residuais no municipio de Uberlandia, MG. <i>Daphne</i> , 7(2)7-14
Article	Ratter, J. A., Leitao Filho, H., Argent, G., Gibbs, P. E., Semir, J., Shepherd, G., & Tamashiro, J. (1988). Floristic composition and community structure of a southern cerrado area in Brazil. Notes from the Royal Botanic Garden, Edinburgh.
Article	Durigan, G., Bacic, M. C., Franco, G. A. D. C., & Siqueira, M. D. (1999). Inventario florístico de Cerrado na Estacao Ecologica de Assis, SP. Inventory of cerrado in the Assis Ecological Station.) <i>Hoehnea</i> , 26(2), 149-172.
Article	Brando, P. M., & Durigan, G. (2005). Changes in cerrado vegetation after disturbance by frost (São Paulo State, Brazil). <i>Plant Ecology</i> , 175(2), 205-215.
Article	Cesar, O., Pagano, S. N., Leitao Filho, H. D. F., Monteiro, R., da Silva, O. A., Marinis, G. D., & Shepherd, G. J. (1988). Estrutura fitossociologica do estrato arboreo de uma area de vegetacao de cerrado no municipio de Corumbatal. <i>Naturalia</i> , 13, 91-101.
Article	Pereira-Silva, E.F.L., Santos, J.E., Kageyama, P.Y., Hardt, E. (2004). Florística e fitossociologia dos estratos arbustivo e arbóreo de um remanescente de cerradão em uma Unidade de Conservação do Estado de São Paulo. <i>Revista Brasileira de Botânica</i> , 27(3), 533-544.
Article	Gibbs, P. E., Leitão Filho, H. D. F., & Shepherd, G. (1983). Floristic composition and community structure in an area of cerrado in SE Brazil. <i>Flora (Germany)</i> , 173(5-6), 433-449.
Article	Sasaki, D., & Mello-Silva, R. D. (2008). Levantamento florístico no cerrado de Pedregulho, SP, Brasil. <i>Acta Botanica Brasilica</i> , 22(1), 187-202.
Article	Batalha, M. A., Aragaki, S., & Mantovani, W. (1997). Florística do cerrado em Emas (Pirassununga, SP). <i>Boletim de Botânica da Universidade de São Paulo</i> , 49-64.
Article	Silberbauer-Gottsberger, I., & Eiten, G. (1983). Fitossociologia de um hectare de cerrado. (Phytosociology of a hectare of cerrado.). <i>Brasil Florest</i> , 13(54), 55-70.
Article	Uhlmann, A., Galvão, F., & Silva, S. M. (1998). Análise da estrutura de duas unidades fitofisionômicas de savana (cerrado) no Sul do Brasil. <i>Acta Botanica Brasilica</i> , 12(3), 231-247.
Article	von Linsingen, L., de Souza Sonehara, J., Uhlmann, A., & Cervi, A. (2006). Composição florística do parque estadual do Cerrado de Jaguariaíva, Paraná, Brasil. <i>Acta Biológica Paranaense</i> , 35.
Article	Silva, L. O., Costa, D. A. U., Santo Filho, E., Ferreira, H. D., & Brandão, D. (2002). Levantamento florístico e fitossociológico em duas áreas de cerrado sensu stricto no Parque Estadual da Serra de Caldas Novas, Goiás. <i>Acta Botanica Brasilica</i> .

Literature	Reference
Article	Camilotti, D. C., Pagotto, T. C. S., & Araujo, A. C. (2011). Análise da vegetação arbórea de um remanescente de Cerradão em Bandeirantes, Mato Grosso do Sul, Brasil. <i>Iheringia, Série Botânica</i> , Porto Alegre, 66(1), 31-46.
Article	Figueiredo, M. A. & Fernandes, A. (1987) Encraves de cerrado no interior do Ceará. <i>Ciência Agronômica</i> , 18, 1-4.
Article	Sousa, J. T., Silva, M. A. M., Mendes, P. G. A., Sousa, J. R., Lima, A. S.; Mendonça, F. G. T., Sousa, M. M. A. (2007) Caracterização de uma vegetação de cerrado em uma área no município de Nova Olinda-CE. <i>Cadernos de Cultura e Ciência</i> , 2, 2-12.
Article	Silva, H. G., Figueiredo, N. & Andrade, G. V. (2008) - Estrutura da Vegetação de um Cerradão e a Heterogeneidade Regional do Cerrado do Maranhão, Brasil. <i>Árvore</i> , 32, 921-930.
Article	Barroso, G. M. & Guimarães, E. F. (1980) Excursão botânica ao Parque Nacional de Sete Cidades, Piauí. <i>Rodriguésia</i> , 32, 241-268.
Article	Oliveira, A. P. D., Schiavini, I., Vale, V. S. D., Lopes, S. D. F., Arantes, C. D. S., Gusson, A. E., ... & Dias-Neto, O. C. (2014). Mortality, recruitment and growth of the tree communities in three forest formations at the Panga Ecological Station over ten years (1997-2007). <i>Acta Botanica Brasilica</i> , 28(2), 234-248.
Article	Otoni, T. J. O., Pereira, I. M., Oliveira, M. L. R., Machado, E. L. M., Farnezi, M. M., & Mota, S. D. L. L. (2013). Componente arbóreo, estrutura fitossociológica e relações ambientais em um remanescente de cerradão em Curvelo-MG. <i>Cerne</i> , 19, 201-11.
Article	Solórzano, A., Pinto, J. R. R., Felfili, J. M., & Hay, J. D. V. (2012). Perfil florístico e estrutural do componente lenhoso em seis áreas de cerradão ao longo do bioma Cerrado.
Article	Ramos, W. M., & Sartori, A. L. B. (2013). Floristic analysis and dispersal syndromes of woody species of the Serra de Maracaju, Mato Grosso do Sul, Brazil. <i>Brazilian Journal of Biology</i> , 73(1), 67-78.
Article	Pinheiro, E. D. S., & Durigan, G. (2012). Floristic and structural differences among cerrado phytophysognomies in Assis, SP, Brazil. <i>Revista Árvore</i> , 36(1), 181-193.
Article	Santos, L. M., Lenza, E., dos Santos, J. O., Marimon, B. S., Eisenlohr, P. V., Junior, B. H. M., & Feldpausch, T. R. (2015). Diversity, floristic composition, and structure of the woody vegetation of the Cerrado in the Cerrado–Amazon transition zone in Mato Grosso, Brazil. <i>Brazilian Journal of Botany</i> , 38(4), 877-887.
Article	Neri, A. V., Meira Neto, J. A. A., SILVA, A. D., Martins, S. V., & Batista, M. L. (2007). Análise da estrutura de uma comunidade lenhosa em área de cerrado sensu stricto no município de Senador Modestino Gonçalves, norte de Minas Gerais, Brasil. <i>Revista Árvore</i> , 31(1), 123-134.
Article	Parra-O, C. 2006. Estudio general de la vegetación nativa de Puerto Carreño (Vichada), Colombia). <i>Caldasia</i> 28(2): 165-177
Article	Ramírez, N., Dezzio, N., & Chacón, N. (2007). Floristic composition, plant species abundance, and soil properties of montane savannas in the Gran Sabana, Venezuela. <i>Flora-Morphology, Distribution, Functional Ecology of Plants</i> , 202(4), 316-327.
Article	Lima, R. A. F. D., Rando, J. G., & Barreto, K. D. (2015). Composition and Diversity in the Cerrado of Eastern Mato Grosso do Sul, Brazil. <i>Revista Árvore</i> , 39(1), 9-24.
Article	Medeiros, M. B. D., & Walter, B. M. T. (2012). Composition and structure of the woody cerrado stricto sensu in northern Tocantins and southern Maranhão. <i>Revista Árvore</i> , 36(4), 673-683.

Literature	Reference
Article	Giácomo, R. G., De Carvalho, D. C., Pereira, M. G., De Souza, A. B., & Gai, T. D. (2013). Florística e fitossociologia em áreas de campo sujo e cerrado sensu stricto na estação ecológica de Pirapitinga–MG. <i>Ciência Florestal</i> , 23(1), 29-43.
Article	Oliveira, C. P. D., Francelino, M. R., Cysneiros, V. C., Andrade, F. C. D., & Booth, M. C. (2015). Structure and Floristic of the Cerrado Sensu Stricto in West of Bahia. <i>CERNE</i> , 21(4), 545-552.
Article	Costa, F. V., Oliveira, K. N., Nunes, Y. R. F., de Oliveira Menino, G. C., Brandão, D. O., de Araújo, L. S., ... & Santos, D. (2015). Floristic composition and wood community structure of two stricto sensu areas on North of Minas Gerais. <i>Cerne</i> , 16(3), 267-281.
Article	Ribeiro, M. N., Sanchez, M., Pedroni, F., & Peixoto, K. S. (2012). Fogo e dinâmica da comunidade lenhosa em cerrado sentido restrito, Barra do Garças, Mato Grosso. <i>Acta Botanica Brasilica</i> , 26(1), 203-217.
Article	Araújo, G. M., Nascimento, A. R. T., Lopes, S. F., Rodrigues, R. F., & Ratter, J. A. (2011). Structure and floristics of the arboreal component of a dystrophic Cerradão and comparison with other Cerradões in Central Brazil. <i>Edinburgh Journal of Botany</i> , 68(3), 401-418.
Article	Vieira, L. T., Castro, A. A., Coutinho, J. M., de Sousa, S. R., de Farias, R. R., Castro, N. M., & Martins, F. R. (2019). A biogeographic and evolutionary analysis of the flora of the North-eastern cerrado, Brazil. <i>Plant Ecology & Diversity</i> , 12(5), 475-488.
Books	Figueiredo, N. & Andrade, G. V. (2007) Informações sobre a estrutura e composição florística da vegetação de um Cerradão na Chapada do Gado Bravo município de Balsas - MA. In: Barreto, L. (Org.). <i>Cerrado Norte do Brasil</i> (2007). Pelotas, RG: USEB, 2007. p. 141-155.
Books	Felfili, J. M. & Silva Júnior, M. C. (2001) Biogeografia do bioma cerrado: estudo fitofisionômico na Chapada do Espigão Mestre do São Francisco. University of Brasília.
Books	Harley, R. M., Giulietti, A., Grilo, A. S., Silva, T. R. S., Funch, L., Funch, R. R., ... & Nascimento, F. D. (2005). <i>Cerrado. Biodiversidade e conservação da Chapada Diamantina</i> (FA Junca, L. Funch & R. Rocha, orgs.). Ministério do Meio Ambiente, Série Biodiversidade 13.
Books	Moro, M. F., Castro, A. S. F., & de Araújo, F. S. (2011). Composição florística e estrutura de um fragmento de vegetação savânica sobre os tabuleiros pré-litorâneos na zona urbana de Fortaleza, Ceará. <i>Rodriguésia-Instituto de Pesquisas Jardim Botânico do</i>
Books	Serna-Isaza R.A., Rippstein G., Grollier C., Mesa E. (2001) Biodiversidad de la vegetacion de sabana en la Atillanura plana y la serrania de los Llano Orientales. In : Rippstein Georges (ed.), Escobar German (ed.), Motta Francisco (ed.). <i>Agroecologia y biodiversidad de las sabanas en los Llanos Orientales de Colombia</i> . Cali : CIAT, p. 46-63.
Books	Jansen-Jacobs, M. & ter Steege, H.. (2000) Plant Diversity in Guyana. 147-157 in: ter Steege, H. (ed.) <i>Plant diversity in Guyana. With recommendations for a National Protected Area Strategy</i> . Tropenbos Series 18. Tropenbos Foundation, Wageningen.
Database	Bioten Program (2001)
Research note	Alves, F. M., Noguchi, D. K., Lescano, L. E. A. M., Ramos, W. M., & Sartori, Â. L. B. (2007). Levantamento Florístico do Componente Arbóreo de duas Áreas de Cerradão em Campo Grande-MS, Brasil. <i>Revista Brasileira de Biociências</i> , 5(S2), pg-564.

Literature	Reference
Technical bulletin	Medeiros, M. B., Guarino, E., & da Silva, G. P. (2005). Fitossociologia de um trecho de Cerrado sensu stricto na Bacia do Rio Corumbá-área de influência direta do aproveitamento hidrelétrico Corumbá IV (GO). Embrapa Recursos Genéticos e Biotecnologia-Boletim de Pesquisa e Desenvolvimento (INFOTECA-E).
Technical bulletin	Lisboa, P. L. B. (1990). Rondônia: colonização e floresta. Programa Polonoroeste, Programa do Trópico Umido. POLONOROESTE, Relatório de Pesquisa no. 9. CNPq, AED, Brasília.
Technical bulletin	Tavares, S. (1964) Inventário da vegetação dos tabuleiros do Nordeste. Boletim de Recursos Naturais da SUDENE, 2, 9-10.
Technical report	Granjeiro, C. M. M. (1983) Contribuição ao estudo integrado da paisagem e dos ecossistemas da área do município de Aquiraz, Ceará. NUGA/UECE/GTZ Final Report, volume 1, Fortaleza, 644p.
Thesis	Bosquetti, L.B. (2008). Análise da estrutura da paisagem e fitofisionomias do Parque Estadual dos Pirineus, Goiás, Brasil. Universidade de São Paulo.
Thesis	Barbosa, M. M. (2006). Florística e fitossociologia de Cerrado sentido restrito no Parque Estadual da Serra Azul, Barra do Garças, MT. Universidade Federal do Mato Grosso.
Thesis	Finger, Z. (2008). Fitossociologia de Comunidades Arbóreas em Savanas do Brasil Central. Universidade Federal de Santa Maria.
Thesis	Silveira, A.L.P. (2002). Estrutura do componente arbustivo-arbóreo de um cerrado em Alta Floresta do Oeste, Rondônia. Universidade Federal do Mato Grosso.
Thesis	Miranda, I.S. (1998). Flora, fisionomia e estrutura das savanas de Roraima, Brasil. Instituto Nacional de Pesquisa da Amazônia.
Thesis	Neri, A. V. (2007). Gradiente pedológico-vegetacional de Cerrado em Paraopeba, MG. Universidade Federal de Viçosa.
Thesis	Albuquerque, V. M. (1987) Desmatamento da chapada do Araripe: causas e consequências. Monography, Federal University of Ceará.
Thesis	Pessoa, M.J. (2014) Composição florística e estrutura da vegetação lenhosa de savanas sobre afloramentos rochosos na transição Cerrado - Amazônia, MT. Universidade do Estado de Mato Grosso.
Thesis	Ferreira, K. B. (1997) Estudo fitossociológico em uma área de cerrado marginal no município de Afonso Cunha, MA. Federal University of Maranhão.
Thesis	Soares, Z. T. (1996) Fitossociologia do estrato arbóreo em uma área de Cerrado na Amazônia Oriental, Maranhão. State University of Maranhão.
Thesis	Torquato, T. G. M. (2006) Potencial da vegetação melitófila e abelhas associadas da área Olho D'água dos Pires, Esperantina, Piauí, Brasil. Thesis. Federal University of Piauí.
Thesis	Franco, E. Á. P. (2005) A diversidade etnobotânica no quilombo Olho D'água dos Pires, Esperantina, Piauí, Brasil. Federal University of Piauí.
Thesis	Castro, A. A. J. F. (1994) Comparação Florístico-Geográfico (Brasil) e Fitossociológica (Piauí-São Paulo) de amostras de Cerrado. State University of Campinas.
Thesis	Moura, I. O. (2007) Relações florístico-estruturais e ecológicas do cerrado sensu stricto sobre afloramentos rochosos. University of Brasília.
Thesis	Lindoso, G. S. (2008) Cerrado sensu stricto sobre neossolo quartzarênico: fitogeografia e conservação. University of Brasília.
Thesis	Ribeiro, L. F. (2000) Riqueza de plantas lenhosas e distribuição de grupos ecológicos em uma área de cerrado no Piauí, Brasil. Federal University of Pernambuco.

Literature	Reference
Thesis	Santos, L. G. P. (2008) Florística e conhecimento botânico tradicional em áreas de cerrado no município de Monsenhor Gil, Piauí, Brasil. Federal University of Piauí.
Thesis	Sanaiotti, T. M. (1996). The woody flora and soils of seven Brazilian Amazonian dry savanna areas. University of Stirling.
Unpublished data	Bioten Program (2002)
Unpublished data	Bioten Program (2008)
Unpublished data	Bioten Program (2006)
Unpublished data	Bioten Program (2004)
Unpublished data	Bioten Program (2005)
Unpublished data	Bioten Program (2003)
Unpublished data	Bioten Program (2000)
Unpublished data	Bioten Program (2009)
Unpublished data	Bioten Program (1995)
Unpublished data	Bioten Program (2011)
Unpublished data	Paulo, P. Dados não publicados
Unpublished data	Silveira, A.L.P., Dados não publicados
Unpublished data	Gribel, R. Dados não publicados

Table 4. Number of absolut flora shortfall (afs), binomials, total records (N) and relative shortfall (rfs = afs/N) found in each paper. The tables are sorted by year in a decrescent way. Each row in the table represents a survey for floristic and phytosociological studies separately.

Years	Study	afs	N	rfs	Years	Study	afs	N	rfs
1970	Floristic	10	26	0.384615	1982	Phytosociology	5	22	0.227273
1971	Floristic	4	26	0.153846	1983	Phytosociology	9	33	0.272727
1980	Floristic	14	120	0.116667	1983	Phytosociology	1	54	0.018519
1983	Floristic	4	106	0.037736	1986	Phytosociology	14	41	0.341463
1984	Floristic	2	14	0.142857	1986	Phytosociology	2	27	0.074074
1984	Floristic	44	115	0.382609	1987	Phytosociology	8	36	0.222222
1985	Floristic	6	55	0.109091	1993	Phytosociology	7	66	0.106061
1985	Floristic	3	35	0.085714	1993	Phytosociology	6	71	0.084507
1985	Floristic	15	81	0.185185	1993	Phytosociology	3	57	0.052632
1986	Floristic	3	146	0.020548	1993	Phytosociology	4	68	0.058824
1986	Floristic	2	93	0.021505	1993	Phytosociology	3	58	0.051724
1986	Floristic	4	121	0.033058	1993	Phytosociology	9	68	0.132353
1986	Floristic	1	112	0.008929	1994	Phytosociology	1	23	0.043478
1987	Floristic	3	31	0.096774	1994	Phytosociology	5	30	0.166667
1988	Floristic	5	51	0.098039	1994	Phytosociology	1	21	0.047619
1988	Floristic	11	79	0.139241	1994	Phytosociology	2	25	0.08
1988	Floristic	1	54	0.018519	1994	Phytosociology	1	24	0.041667
1988	Floristic	8	101	0.079208	1994	Phytosociology	17	69	0.246377
1989	Floristic	7	34	0.205882	1994	Phytosociology	6	36	0.166667
1989	Floristic	1	21	0.047619	1994	Phytosociology	4	37	0.108108
1989	Floristic	9	67	0.134328	1994	Phytosociology	2	26	0.076923
1989	Floristic	5	27	0.185185	1994	Phytosociology	3	27	0.111111
1989	Floristic	6	121	0.049587	1994	Phytosociology	10	68	0.147059
1990	Floristic	11	51	0.215686	1995	Phytosociology	9	58	0.155172
1990	Floristic	1	50	0.02	1996	Phytosociology	6	41	0.146341
1992	Floristic	2	27	0.074074	1997	Phytosociology	14	41	0.341463

Years	Study	afs	N	rfs	Years	Study	afs	N	rfs
1992	Floristic	3	34	0.088235	1997	Phytosociology	3	41	0.073171
1993	Floristic	1	19	0.052632	1997	Phytosociology	3	46	0.065217
1995	Floristic	4	61	0.065574	1997	Phytosociology	1	33	0.030303
1996	Floristic	1	151	0.006623	1997	Phytosociology	2	40	0.05
1997	Floristic	1	29	0.034483	1997	Phytosociology	1	34	0.029412
1997	Floristic	2	15	0.133333	1997	Phytosociology	1	41	0.02439
1997	Floristic	7	28	0.25	1997	Phytosociology	4	42	0.095238
1997	Floristic	4	22	0.181818	1997	Phytosociology	1	39	0.025641
1997	Floristic	2	9	0.222222	1997	Phytosociology	2	39	0.051282
1997	Floristic	1	22	0.045455	1997	Phytosociology	1	38	0.026316
1997	Floristic	2	18	0.111111	1997	Phytosociology	4	43	0.093023
1997	Floristic	1	7	0.142857	1997	Phytosociology	2	40	0.05
1997	Floristic	3	11	0.272727	1997	Phytosociology	1	35	0.028571
1997	Floristic	3	152	0.019737	1997	Phytosociology	4	45	0.088889
2000	Floristic	2	28	0.071429	1997	Phytosociology	3	43	0.069767
2001	Floristic	1	90	0.011111	1997	Phytosociology	1	45	0.022222
2001	Floristic	3	73	0.041096	1997	Phytosociology	1	25	0.04
2001	Floristic	1	90	0.011111	1997	Phytosociology	1	11	0.090909
2001	Floristic	2	85	0.023529	1997	Phytosociology	1	5	0.2
2001	Floristic	5	73	0.068493	1997	Phytosociology	1	10	0.1
2001	Floristic	1	77	0.012987	1997	Phytosociology	2	11	0.181818
2001	Floristic	4	94	0.042553	1997	Phytosociology	1	6	0.166667
2001	Floristic	3	86	0.034884	1998	Phytosociology	2	18	0.111111
2001	Floristic	2	88	0.022727	1998	Phytosociology	2	32	0.0625
2001	Floristic	1	87	0.011494	2000	Phytosociology	1	158	0.006329
2001	Floristic	1	74	0.013514	2000	Phytosociology	6	33	0.181818
2001	Floristic	3	43	0.069767	2000	Phytosociology	23	92	0.25
2001	Floristic	2	63	0.031746	2000	Phytosociology	21	74	0.283784
2001	Floristic	1	47	0.021277	2000	Phytosociology	14	65	0.215385

Years	Study	afs	N	rfs	Years	Study	afs	N	rfs
2001	Floristic	1	44	0.022727	2000	Phytosociology	8	52	0.153846
2001	Floristic	1	57	0.017544	2000	Phytosociology	5	22	0.227273
2001	Floristic	1	53	0.018868	2001	Phytosociology	6	64	0.09375
2001	Floristic	4	65	0.061538	2001	Phytosociology	1	67	0.014925
2001	Floristic	2	61	0.032787	2001	Phytosociology	3	67	0.044776
2001	Floristic	1	67	0.014925	2001	Phytosociology	1	17	0.058824
2001	Floristic	1	44	0.022727	2001	Phytosociology	11	40	0.275
2001	Floristic	2	57	0.035088	2001	Phytosociology	16	42	0.380952
2001	Floristic	1	64	0.015625	2001	Phytosociology	3	93	0.032258
2001	Floristic	1	52	0.019231	2001	Phytosociology	3	76	0.039474
2001	Floristic	1	68	0.014706	2002	Phytosociology	2	63	0.031746
2001	Floristic	2	63	0.031746	2002	Phytosociology	8	59	0.135593
2001	Floristic	3	72	0.041667	2002	Phytosociology	9	58	0.155172
2001	Floristic	5	68	0.073529	2002	Phytosociology	11	72	0.152778
2001	Floristic	1	29	0.034483	2002	Phytosociology	13	69	0.188406
2001	Floristic	2	75	0.026667	2002	Phytosociology	1	44	0.022727
2001	Floristic	1	58	0.017241	2002	Phytosociology	3	38	0.078947
2001	Floristic	1	70	0.014286	2002	Phytosociology	3	42	0.071429
2001	Floristic	2	66	0.030303	2002	Phytosociology	3	73	0.041096
2001	Floristic	2	69	0.028986	2002	Phytosociology	23	61	0.377049
2001	Floristic	3	59	0.050847	2002	Phytosociology	10	27	0.37037
2001	Floristic	1	58	0.017241	2002	Phytosociology	7	59	0.118644
2001	Floristic	4	98	0.040816	2002	Phytosociology	7	52	0.134615
2001	Floristic	3	59	0.050847	2002	Phytosociology	17	86	0.197674
2001	Floristic	3	47	0.06383	2002	Phytosociology	17	72	0.236111
2001	Floristic	4	55	0.072727	2002	Phytosociology	9	67	0.134328
2001	Floristic	3	26	0.115385	2003	Phytosociology	4	41	0.097561
2001	Floristic	2	35	0.057143	2003	Phytosociology	17	51	0.333333
2001	Floristic	2	26	0.076923	2003	Phytosociology	18	60	0.3

Years	Study	afs	N	rfs	Years	Study	afs	N	rfs
2001	Floristic	2	41	0.04878	2003	Phytosociology	44	100	0.44
2001	Floristic	2	63	0.031746	2003	Phytosociology	14	58	0.241379
2001	Floristic	1	49	0.020408	2003	Phytosociology	2	87	0.022989
2001	Floristic	5	76	0.065789	2003	Phytosociology	10	88	0.113636
2001	Floristic	1	77	0.012987	2003	Phytosociology	6	63	0.095238
2001	Floristic	3	54	0.055556	2003	Phytosociology	5	65	0.076923
2001	Floristic	1	24	0.041667	2003	Phytosociology	12	48	0.25
2001	Floristic	1	81	0.012346	2003	Phytosociology	23	76	0.302632
2001	Floristic	1	74	0.013514	2003	Phytosociology	11	59	0.186441
2001	Floristic	1	54	0.018519	2003	Phytosociology	24	54	0.444444
2001	Floristic	3	68	0.044118	2003	Phytosociology	15	42	0.357143
2001	Floristic	2	84	0.02381	2003	Phytosociology	1	74	0.013514
2001	Floristic	4	74	0.054054	2004	Phytosociology	2	18	0.111111
2001	Floristic	1	54	0.018519	2004	Phytosociology	23	92	0.25
2001	Floristic	1	74	0.013514	2004	Phytosociology	28	107	0.261682
2001	Floristic	1	84	0.011905	2004	Phytosociology	14	42	0.333333
2001	Floristic	3	80	0.0375	2004	Phytosociology	32	63	0.507937
2001	Floristic	1	76	0.013158	2004	Phytosociology	31	65	0.476923
2001	Floristic	2	83	0.024096	2004	Phytosociology	1	57	0.017544
2001	Floristic	2	90	0.022222	2005	Phytosociology	5	12	0.416667
2001	Floristic	1	72	0.013889	2005	Phytosociology	12	58	0.206897
2001	Floristic	1	83	0.012048	2005	Phytosociology	4	50	0.08
2001	Floristic	2	80	0.025	2005	Phytosociology	20	118	0.169492
2001	Floristic	1	82	0.012195	2005	Phytosociology	10	46	0.217391
2001	Floristic	2	90	0.022222	2005	Phytosociology	8	60	0.133333
2001	Floristic	1	91	0.010989	2005	Phytosociology	8	73	0.109589
2001	Floristic	2	55	0.036364	2005	Phytosociology	24	131	0.183206
2001	Floristic	1	82	0.012195	2005	Phytosociology	1	77	0.012987
2001	Floristic	2	72	0.027778	2005	Phytosociology	1	77	0.012987

Years	Study	afs	N	rfs	Years	Study	afs	N	rfs
2001	Floristic	1	60	0.016667	2005	Phytosociology	3	15	0.2
2001	Floristic	3	80	0.0375	2005	Phytosociology	10	55	0.181818
2001	Floristic	3	67	0.044776	2005	Phytosociology	13	78	0.166667
2001	Floristic	2	91	0.021978	2005	Phytosociology	13	62	0.209677
2001	Floristic	3	78	0.038462	2005	Phytosociology	5	55	0.090909
2002	Floristic	28	85	0.329412	2005	Phytosociology	13	66	0.19697
2004	Floristic	22	114	0.192982	2005	Phytosociology	9	52	0.173077
2005	Floristic	3	38	0.078947	2005	Phytosociology	11	49	0.22449
2006	Floristic	2	12	0.166667	2005	Phytosociology	18	66	0.272727
2006	Floristic	6	91	0.065934	2005	Phytosociology	7	30	0.233333
2006	Floristic	18	86	0.209302	2005	Phytosociology	1	27	0.037037
2006	Floristic	3	63	0.047619	2005	Phytosociology	3	71	0.042254
2006	Floristic	1	130	0.007692	2006	Phytosociology	1	56	0.017857
2007	Floristic	27	54	0.5	2006	Phytosociology	3	50	0.06
2007	Floristic	11	28	0.392857	2006	Phytosociology	4	49	0.081633
2007	Floristic	5	37	0.135135	2006	Phytosociology	22	69	0.318841
2007	Floristic	5	30	0.166667	2006	Phytosociology	51	106	0.481132
2007	Floristic	3	26	0.115385	2006	Phytosociology	14	27	0.518519
2007	Floristic	6	29	0.206897	2006	Phytosociology	32	59	0.542373
2007	Floristic	7	44	0.159091	2006	Phytosociology	20	39	0.512821
2007	Floristic	2	15	0.133333	2006	Phytosociology	19	43	0.44186
2008	Floristic	10	86	0.116279	2007	Phytosociology	3	42	0.071429
2008	Floristic	18	132	0.136364	2007	Phytosociology	14	34	0.411765
2008	Floristic	4	21	0.190476	2007	Phytosociology	2	38	0.052632
2008	Floristic	11	33	0.333333	2007	Phytosociology	1	56	0.017857
2008	Floristic	2	83	0.024096	2007	Phytosociology	14	39	0.358974
2008	Floristic	2	83	0.024096	2007	Phytosociology	11	35	0.314286
2008	Floristic	1	44	0.022727	2007	Phytosociology	26	72	0.361111
2008	Floristic	2	50	0.04	2007	Phytosociology	9	92	0.097826

Years	Study	afs	N	rfs	Years	Study	afs	N	rfs
2009	Floristic	5	44	0.113636	2007	Phytosociology	2	63	0.031746
2009	Floristic	7	48	0.145833	2007	Phytosociology	2	22	0.090909
2012	Floristic	2	35	0.057143	2007	Phytosociology	9	44	0.204545
2012	Floristic	1	9	0.111111	2007	Phytosociology	5	32	0.15625
2012	Floristic	1	63	0.015873	2007	Phytosociology	8	42	0.190476
2013	Floristic	10	109	0.091743	2007	Phytosociology	4	47	0.085106
2015	Floristic	4	70	0.057143	2007	Phytosociology	4	50	0.08
2015	Floristic	2	50	0.04	2007	Phytosociology	10	35	0.285714
2015	Floristic	2	41	0.04878	2007	Phytosociology	11	62	0.177419
NA	Floristic	2	59	0.033898	2008	Phytosociology	31	67	0.462687
NA	Floristic	5	84	0.059524	2008	Phytosociology	4	52	0.076923
NA	Floristic	2	61	0.032787	2008	Phytosociology	1	95	0.010526
NA	Floristic	2	64	0.03125	2008	Phytosociology	1	69	0.014493
NA	Floristic	3	105	0.028571	2008	Phytosociology	1	101	0.009901
NA	Floristic	2	78	0.025641	2008	Phytosociology	8	90	0.088889
NA	Floristic	2	85	0.023529	2008	Phytosociology	6	93	0.064516
NA	Floristic	2	58	0.034483	2008	Phytosociology	17	69	0.246377
NA	Floristic	2	60	0.033333	2008	Phytosociology	13	68	0.191176
NA	Floristic	4	80	0.05	2008	Phytosociology	10	35	0.285714
					2008	Phytosociology	23	51	0.45098
					2008	Phytosociology	14	59	0.237288
					2008	Phytosociology	6	49	0.122449
					2008	Phytosociology	15	55	0.272727
					2008	Phytosociology	20	61	0.327869
					2009	Phytosociology	6	53	0.113208
					2009	Phytosociology	9	44	0.204545
					2009	Phytosociology	14	58	0.241379
					2009	Phytosociology	3	43	0.069767
					2009	Phytosociology	19	67	0.283582

Years	Study	afs	N	rfs	Years	Study	afs	N	rfs
					2011	Phytosociology	5	59	0.084746
					2011	Phytosociology	6	98	0.061224
					2011	Phytosociology	7	82	0.085366
					2011	Phytosociology	14	52	0.269231
					2012	Phytosociology	3	48	0.0625
					2012	Phytosociology	11	117	0.094017
					2012	Phytosociology	4	96	0.041667
					2012	Phytosociology	29	91	0.318681
					2012	Phytosociology	1	50	0.02
					2012	Phytosociology	1	54	0.018519
					2012	Phytosociology	2	71	0.028169
					2012	Phytosociology	1	76	0.013158
					2012	Phytosociology	4	54	0.074074
					2013	Phytosociology	4	92	0.043478
					2013	Phytosociology	2	80	0.025
					2014	Phytosociology	2	97	0.020619
					2014	Phytosociology	9	50	0.18
					2014	Phytosociology	11	35	0.314286
					2015	Phytosociology	7	58	0.12069
					2015	Phytosociology	13	73	0.178082
					2015	Phytosociology	5	91	0.054945
					2015	Phytosociology	3	90	0.033333
					2015	Phytosociology	2	76	0.026316

Table 5. The number of surveys (surveys) across ecoregions according to *Olson et al. (2001)* for floristic (flora) and phytosociological (phyto).

Study	Ecoregion Olson et al. 2001	surveys
Flora	Alto Paraná Atlantic forests	3
Flora	Araucaria moist forests	1
Flora	Atlantic Coast restingas	2
Flora	Atlantic dry forests	1
Flora	Caatinga	4
Flora	Cerrado	104
Flora	Guiana savanna	10
Flora	Gurupa varzeá	1
Flora	Llanos	2
Flora	Madeira-Tapajós moist forests	11
Flora	Maranhao Babacu forests	4
Flora	Mato Grosso seasonal forests	9
Flora	Pantanal	2
Flora	Pernambuco interior forests	1
Flora	Purus madeira	1
Flora	Uatuma-Trombetas moist forests	5
Phyto	Amazonas-Orinoco	2
Phyto	Araucaria moist forest	2
Phyto	Atlantic dry forest	2
Phyto	Caatinga	26
Phyto	Cerrado	97
Phyto	Chiquitano Dry-forest	1
Phyto	Guiana savanna	5
Phyto	Llanos	2
Phyto	Madeira Tapajos moist forest	3
Phyto	Maranhao Babacu	48
Phyto	Mato Grosso seasonal forest	1
Phyto	Pantanal	1
Phyto	Pernambuco interior forest	3
Phyto	Purus madeira	1

Table 6. Parameter estimates of the radon intercept and slope SMA model applied to the description of the relative flora shortfall as a function of the species richness of floristic (n=161) and phytosociological (n=194) surveys. The confidence interval (CI) and the p-value at a 5% level of significance are presented.

model	y Intercept β_0		Slope β_1		p-value	R^2
	Estimate	CI (2.5 $\pm$ 97.5%)	Estimate	CI (2.5 $\pm$ 97.5%)		
floristic	-7.52	-9.40 $\pm$ -5.90	0.18	0.15 $\pm$ 0.21	0.006	0.04
phytosociological	-10.68	-13.43 $\pm$ -8.28	0.34	-8.28 $\pm$ 0.30	0.009	0.12

Table 7. Parameter estimates of the radon intercept and slope GLM model (*quasi-Poisson* distribution and logit link) applied to the description of the relative flora shortfall as a function of the time (years) of the floristic (n=161) and phytosociological (n=194) surveys. The confidence interval (CI) and the p-value at a 5% level of significance are presented. The standard error (SE) and the $\text{Pr}(> |t|)$ at a 5% level of significance.

y Intercept β_0				Slope β_1		
model	Estimate	SE	$\text{Pr}(> t)$	Estimate	SE	$\text{Pr}(> t)$
floristic	39.14716	24.13353	0.1069	-0.02082	0.01208	0.0867
phytosociological	-24.32945	21.93874	0.269	0.01131	0.01095	0.303

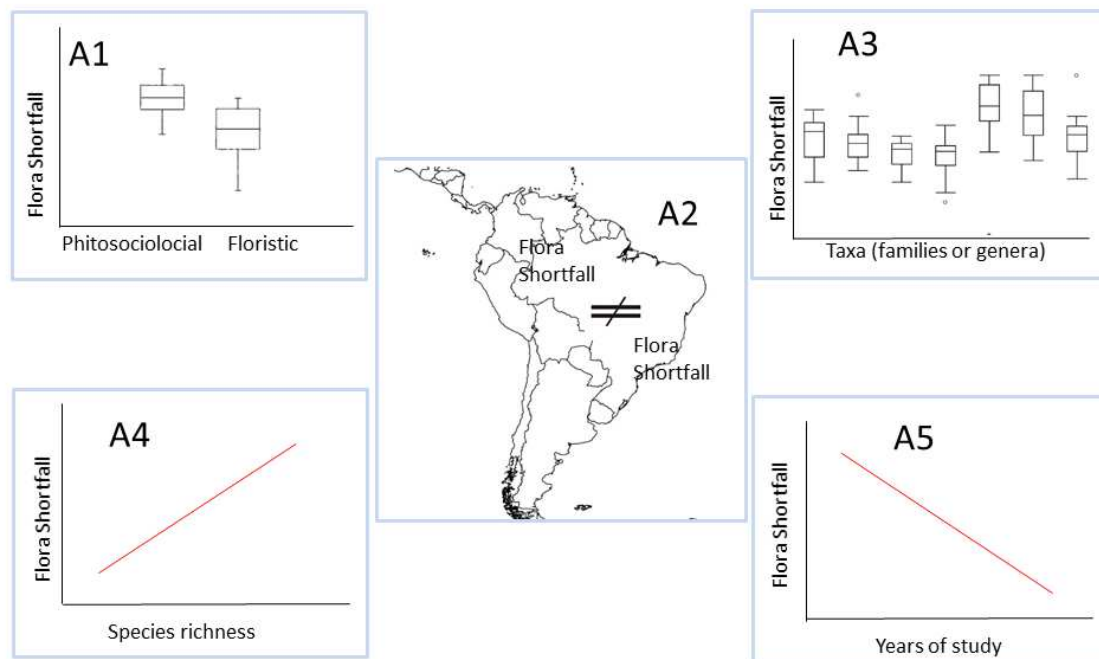


Fig. 1. Scheme assumed to classify flora shortfall. The number in each box corresponds to the question number in the introduction (for example question 1 in the introduction is equal to A1 in the box).

Supplementary material chapter 3

Additional information.

To quantify the forms of rarity in the ESAS, we used the NeoTropSavanna database, as we were interested in verifying farther geographic range intervals, the ecoregion number, and the number of grid cells that species occupy.

Geographic range - To quantify the geographic range, we created a matrix with the points of occurrence of all species. We then used the function *frequency* of the *MASS* package in R (R CoreTeam, 2019) to create a matrix of species occurrence and latitudinal belts.

Ecoregion number - To quantify the species affinity for the habitat, we used a layer of the ecoregions in matrix form (Olson et al., 2001). We used the *raster dataset* tool of the Data Management toolbox in ArcGIS to convert the polygonal ecoregions (Olson et al., 2001) to a raster form with a 0.005 cell size. We created a vector layer of the savanna's rare species and used the extraction tool of the spatial analyst (ESRI, 2011) to extract information about the ecoregions where each species occurred. Then, to extract information on where species occur, we used the *extraction* function in ArcGIS (ESRI, 2011) and generated one matrix with all species and ecoregions. Then, we quantified the number of ecoregions in which species occurred.

Population size - We used Hawth's Analysis Tools (ESRI, 2011) to create a grid of cells in the ESAS polygon. We used the function *Create Mosaic Dataset* on Arcgis to create a vector grid of the SAS and recorded species occurrence in 331 of the total grid cells. Species with one or two individuals sampled per grid cell were considered rare or as having a scarce population. We used the *union* function of the Overlay tool to combine species occurrence and grid cells and generated a data matrix of species and the number of grid cells they occurred in. Then, the number of occurrences that each species has in each grid was considered the local population.

Network protected area - To check the protection level of SAS species, we consulted the World Database on Protected Areas (WDPA), an up-to-date database of protected areas in the world (UNEP-WCMC and IUCN, 2019). We created a vector layer with all SAS species (rare and common) and their geographical location, then used the extraction tool function to extract the values of the cells into two matrix layers (ESRI, 2011).

Table 1. Keywords used to search for papers published. Different combinations were done with the words in each column.

Keywords 1	Keywords 2	Keywords 3
‘cerrado’ ‘cerradão’	‘Stricto sensu’ ‘rupestre’	‘vegetation’
‘savanna’ ‘Guiana	‘dense’ ‘grassland’	‘phytosociological’
savanna’ ‘Llanos’ Llanos	‘forested’ ‘tree’ ‘arboreal’	‘floristic’ ‘structure’
of moxos’ ‘amazonia	‘hyper seasonal’ ‘steppe’	‘community’
savanna’ ‘caatinga	‘woodland’ ‘parkland’	
savanna’	‘eutrophic’	

Table 2. Literature reporting phytosociological or floristic surveys (n=104) in the Neotropical savanna and they respective references.

Literature	Reference
Annals	Ribeiro, J. F., & Haridasan, M. (1984). Comparação fitossociológica de um cerrado denso e um cerradão em solos distróficos no Distrito Federal. In Congresso nacional de botanica (Vol. 35, pp. 342-347). Manaus: Sociedade de Botânica do Brasil.
Annals	Fonseca, E. M., Ferreira, M.A., Nunes, J.R.S., Pinho, N.G.C.; Ferraz, L., Macedo, M., Guarim Neto, G. (2004). Aspectos fitossociológicos de uma comunidade de Carvoal (<i>Callisthene fasciculata</i>) no pantanal de Mato Grosso, Brasil. Simpósio sobre Recursos Naturais e Socioeconômicos do Pantanal, 229-243.
Annals	Rodrigues, W. A. (1971). Plantas dos Campos do Rio Branco (Território de Roraima). In III (Ie Terceiro) Simposio sobre o Cerrado.
Annals	Castro, A. A. J. F. (1984) Vegetação e flora da Estação Ecológica de Uruçuí-Una (resultados preliminares). In: Annals of 34° National Congress of Botany, Porto Alegre, 2, 251-261.
Article	Ribeiro-Silva, S., Medeiros, M. D., Gomes, B. M., Seixas, E. N. C., & Silva, M. A. P. (2012). Angiosperms from the Araripe national forest, Ceará, brazil. Check List, 8(4), 744-751.
Article	Ratter, J. A., Bridgewater, S., & Ribeiro, J. F. (2001). Espécies lenhosas da fitofisionomia cerrado sentido amplo em 170 localidades do bioma cerrado. Boletim do Herbário Ezechias Paulo Heringer, 7(1), 5-112.
Article	Sinimbu, G. (2008). Fitossociologia em Cerrado Sentido Restrito na Floresta Nacional de Brasília–DF. Revista Brasileira de Biociências, 5(S2), pg-1183.
Article	Felfili, J.M., et al. (1993). Análise Comparativa da Florística e Fitossociologia da Vegetação Arbórea do Cerrado sensu stricto na Chapada Pratinha, DF, Brasil. Acta Botanica Brasilica, 6(2): 27-46.
Article	Andrade, L. A., Felfili, J. M., & Violatti, L. (2002). Phytosociology of an area of" cerrado denso" at the RECOR-IBGE, Brasília-DF, Brazil. Acta Botanica Brasilica, 16(2), 225-240.
Article	Ribeiro, J. F., Silva, J. C. S., & Batmanian, G. J. (1985). Fitossociologia de tipos fisionômicos de cerrado em Planaltina-DF. Revista Brasileira de Botânica, 8(2),131-142.
Article	Araujo Neto, M. D., Furley, P. A., Haridasan, M., & Johnson, C. E. (1986). The murundus of the cerrado region of Central Brazil. Journal of Tropical Ecology, 2(01), 17-35.
Article	Moura, I. I. O., Klein, V. L. G., Felfili, J. M., & Ferreira, H. D. (2007). Fitossociologia da comunidade lenhosa de uma área de cerrado rupestre no Parque Estadual dos Pireneus, Pirenópolis, Goiás. Revista de Biologia Neotropical, 4(2), 18.
Article	Borges, H. B. N., & Shepherd, G. J. (2005). Flora e estrutura do estrato lenhoso numa comunidade de Cerrado em Santo Antônio do Leverger, MT, Brasil. Revista Brasileira de Botânica, 28(1), 61-74.

Literature	Reference
Article	Felfili, J. M., Nogueira, P.E., Silva, Silva Júnior, M. C. D., Marimon, B. S., & Delitti, W. B. C. (2002). Composição florística e fitossociologia do cerrado sentido restrito no município de Água Boa–MT. <i>Acta Botanica Brasilica</i> , 16(1), 103-112.
Article	Marimon, B.S., Lima, E.D.S., Duarte, T.G., Chieregatto, L.C., & Ratter, J. (2006). Observations on the vegetation of Northeastern Mato Grosso, Brazil. IV. Na analysis of the Cerrado–Amazonian forest ecotone. <i>Edinburgh Journal of Botany</i> , 63(2-3), 323-341.
Article	Nascimento, M. T., & Saddi, N. (1992). Structure and floristic composition in an area of cerrado in Cuiabá-MT, Brazil. <i>Revista Brasileira Botânica</i> , 15(1), 47-55.
Article	Guarim, V. L. M. S., Moraes, E. C. C., Prance, G. T., & Ratter, J. A. (2000). Inventory of a mesotrophic Callisthene cerradão in the Pantanal of Mato Grosso, Brazil. <i>Edinburgh Journal of Botany</i> , 57(03), 429-436.
Article	Marimon-Junior, B., & Haridasan, M. (2005). Comparação da vegetação arbórea e características edáficas de um cerradão e um cerrado sensu stricto em áreas adjacentes sobre solo distrófico no leste de Mato Grosso, Brasil. <i>Acta Botanica Brasilica</i> , 19(4), 913-926.
Article	Prance, G. T., & Schaller, G. B. (1982). Preliminary study of some vegetation types of the Pantanal, Mato Grosso, Brazil. <i>Brittonia</i> , 34(2), 228-251.
Article	Oliveira-Filho, A. T., Martins, F.R. (1986). Distribuicao, caracterizacao e composicao floristica das formacoes vegetais da regio da Salgadeira, na Chapada dos Guimaraes (MT). <i>Revista Brasileira de Botânica</i> , 9(2), 2007-223.
Article	Costa, I. R. D., & Araújo, F. S. D. (2007). Organização comunitária de um enclave de cerrado sensu stricto no bioma Caatinga, chapada do Araripe, Barbalha, Ceará. <i>Acta Botanica Brasilica</i> , 21(2), 281-291.
Article	Medeiros, M. B., Walter, B. M. T., & Silva, G. P. (2008). Fitossociologia do cerrado stricto sensu no município de Carolina, MA, Brasil. <i>Cerne</i> , 14(4), 285-294.
Article	Imaña-Encinas, J., & Paula, J. E. D. (2003). Análise da vegetação de cerrado no município de Santa Quitéria-Maranhão. <i>Brasil Florestal</i> , 78, 33-42.
Article	Ribeiro, L. F., & Tabarelli, M. (2002). A structural gradient in cerrado vegetation of Brazil: changes in woody plant density, species richness, life history and plant composition. <i>Journal of tropical ecology</i> , 18(05), 775-794.
Article	Vidotto, E., Pessenda, L.C.R., Ribeiro, A.S., Freitas, H.A., Bendassolli, J.A. (2007). Dinâmica do ecótono floresta-campo no sul do estado do Amazonas no Holoceno, através de estudos isotópicos e fitossociológicos. <i>Acta Amazônica</i> , 37(3), 385-400.
Article	Sanaïotti, T. M., Bridgewater, S., & Ratter, J. A. (1997). A floristic study of the savanna vegetation of the state of Amapá, Brazil, and suggestions for its conservation. <i>Boletim do Museu Paraense Emilio Goeldi, Série Botânica</i> , 13(1), 3-29.

Literature	Reference
Article	Miranda, I. S. (1993). Estrutura do estrato arbóreo do cerrado amazônico em Alter-do-Chão, Pará, Brasil. <i>Revista Brasileira de Botânica</i> , 16(2), 143-150.
Article	Bastos, M. D. N. D. C. (1984). Levantamento florístico dos campos do Estado do Pará. I. Campo de Joanes (Ilha de Marajó). <i>Boletim Museu Paraense Emílio Goeldi, Série Botânica</i> , 1(1/2), 67-86.
Article	Miranda, I. S., Almeida, S. S., & Dantas, P. J. (2006). Florística e estrutura de comunidades arbóreas em cerrados de Rondônia, Brasil. <i>Acta Amazônica</i> , 36(4), 419-430.
Article	Saporetti Jr, A. W., Meira Neto, J. A. A., & Almado, R. D. P. (2003). Fitossociologia de cerrado sensu stricto no município de Abaeté-MG. <i>Revista Árvore</i> , 27(3), 413-419.
Article	Campos, E. P. D., Duarte, T. G., Neri, A. V., Silva, A. F. D., Meira-Neto, J. A. A., & Valente, G. E. (2006). Composição florística de um trecho de cerradão e cerrado sensu stricto e sua relação com o solo na Floresta Nacional (FLONA) de Paraopeba, MG, Brasil. <i>Revista Árvore</i> , 30(3), 471-479.
Article	Meira-Neto, J. A. A., & Saporetti-Júnior, A. W. (2002). Parâmetros fitossociológicos de um cerrado no Parque Nacional Da Serra Do Cipó, MG. <i>Revista Árvore</i> , 26(5), 645-648.
Article	Cardoso, E., Moreno, M. I. C., & Guimarães, A. J. M. (2002). Estudo fitossociológico em área de cerrado sensu stricto na Estação de Pesquisa e Desenvolvimento Ambiental Galheiro-Perdizes, MG. <i>Caminhos de Geografia</i> , 3(5).
Article	Brandao, M., Gavilanes, M. L., & Araujo, M. G. (1996). Cobertura vegetal do município de Prudente de Moraes, MG. <i>Daphne</i> , 6(2), 40-58.
Article	Brandão, M., Laca Buendia, J. P., Araujo, M. G., & Ferreira, F. B. D. (1995). Município de Uberaba, MG: cobertura vegetal e composição florística. <i>Daphne</i> , 5(1), 19-39.
Article	Costa, A. A., & Araújo, G. M. D. (2001). Comparação da vegetação arbórea de cerradão e de cerrado na Reserva do Panga, Uberlândia, Minas Gerais. <i>Acta botanica brasílica</i> .
Article	Araujo, G. M., Nunes, J. J., Rosa, A. G., Resende, E. J. (1997). Estrutura comunitária de vinte áreas de cerrado residuais no município de Uberlândia, MG. <i>Daphne</i> , 7(2), 7-14.
Article	Ratter, J. A., Leitao Filho, H., Argent, G., Gibbs, P. E., Semir, J., Shepherd, G., & Tamashiro, J. (1988). Floristic composition and community structure of a southern cerrado area in Brazil. Notes from the Royal Botanic Garden, Edinburgh.
Article	Durigan, G., Bacic, M. C., Franco, G. A. D. C., & Siqueira, M. D. (1999). Inventário florístico de Cerrado na Estação Ecológica de Assis, SP. Inventory of cerrado in the Assis Ecological Station. <i>Hoehnea</i> , 26(2), 149-172.
Article	Brando, P. M., & Durigan, G. (2005). Changes in cerrado vegetation after disturbance by frost (São Paulo State, Brazil). <i>Plant Ecology</i> , 175(2), 205-215.

Literature	Reference
Article	Cesar, O., Pagano, S. N., Leitao Filho, H. D. F., Monteiro, R., da Silva, O. A., Marinis, G. D., & Shepherd, G. J. (1988). Estrutura fitossociologica do estrato arboreo de uma area de vegetacao de cerrado no municipio de Corumbatal. <i>Naturalia</i> , 13, 91-101.
Article	Pereira-Silva, E.F.L., Santos, J.E., Kageyama, P.Y., Hardt, E. (2004). Florística e fitossociologia dos estratos arbustivo e arbóreo de um remanescente de cerradão em uma Unidade de Conservação do Estado de São Paulo. <i>Revista Brasileira de Botânica</i> , 27(3), 533-544.
Article	Gibbs, P. E., Leitão Filho, H. D. F., & Shepherd, G. (1983). Floristic composition and community structure in an area of cerrado in SE Brazil. <i>Flora (Germany)</i> , 173(5-6), 433-449.
Article	Sasaki, D., & Mello-Silva, R. D. (2008). Levantamento florístico no cerrado de Pedregulho, SP, Brasil. <i>Acta Botanica Brasilica</i> , 22(1), 187-202.
Article	Batalha, M. A., Aragaki, S., & Mantovani, W. (1997). Florística do cerrado em Emas (Pirassununga, SP). <i>Boletim de Botânica da Universidade de São Paulo</i> , 49-64.
Article	Silberbauer-Gottsberger, I., & Eiten, G. (1983). Fitossociologia de um hectare de cerrado.(Phytosociology of a hectare of cerrado.). <i>Brasil Florest</i> , 13(54), 55-70.
Article	Uhlmann, A., Galvão, F., & Silva, S. M. (1998). Análise da estrutura de duas unidades fitofisionômicas de savana (cerrado) no Sul do Brasil. <i>Acta Botanica Brasilica</i> , 12(3), 231-247.
Article	von Linsingen, L., de Souza Sonehara, J., Uhlmann, A., & Cervi, A. (2006). Composição florística do parque estadual do Cerrado de Jaguariaíva, Paraná, Brasil. <i>Acta Biológica Paranaense</i> , 35.
Article	Silva, L. O., Costa, D. A. U., Santo Filho, E., Ferreira, H. D., & Brandão, D. (2002). Levantamento florístico e fitossociológico em duas áreas de cerrado sensu stricto no Parque Estadual da Serra de Caldas Novas, Goiás. <i>Acta Botanica Brasilica</i> .
Article	Camilotti, D. C., Pagotto, T. C. S., & Araujo, A. C. (2011). Análise da vegetação arbórea de um remanescente de Cerradão em Bandeirantes, Mato Grosso do Sul, Brasil. <i>Iheringia, Série Botânica</i> , Porto Alegre, 66(1), 31-46.
Article	Figueiredo, M. A. & Fernandes, A. (1987) Encraves de cerrado no interior do Ceará. <i>Ciência Agrônômica</i> , 18, 1-4.
Article	Sousa, J. T., Silva, M. A. M., Mendes, P. G. A., Sousa, J. R., Lima, A. S.; Mendonça, F. G. T., Sousa, M. M. A. (2007) Caracterização de uma vegetação de cerrado em uma área no município de Nova Olinda-CE. <i>Cadernos de Cultura e Ciência</i> , 2, 2-12.
Article	Silva, H. G., Figueiredo, N. & Andrade, G. V. (2008) - Estrutura da Vegetação de um Cerradão e a Heterogeneidade Regional do Cerrado do Maranhão, Brasil. <i>Árvore</i> , 32, 921-930.
Article	Barroso, G. M. & Guimarães, E. F. (1980) Excursão botânica ao Parque Nacional de Sete Cidades, Piauí. <i>Rodriguésia</i> , 32, 241-268.

Literature	Reference
Article	Oliveira, A. P. D., Schiavini, I., Vale, V. S. D., Lopes, S. D. F., Arantes, C. D. S., Gusson, A. E., ... & Dias-Neto, O. C. (2014). Mortality, recruitment and growth of the tree communities in three forest formations at the Panga Ecological Station over ten years (1997-2007). <i>Acta Botanica Brasilica</i> , 28(2), 234-248.
Article	Otoni, T. J. O., Pereira, I. M., Oliveira, M. L. R., Machado, E. L. M., Farnezi, M. M., & Mota, S. D. L. L. (2013). Componente arbóreo, estrutura fitossociológica e relações ambientais em um remanescente de cerradão em Curvelo-MG. <i>Cerne</i> , 19, 201-11.
Article	Solórzano, A., Pinto, J. R. R., Felfili, J. M., & Hay, J. D. V. (2012). Perfil florístico e estrutural do componente lenhoso em seis áreas de cerradão ao longo do bioma Cerrado.
Article	Ramos, W. M., & Sartori, A. L. B. (2013). Floristic analysis and dispersal syndromes of woody species of the Serra de Maracaju, Mato Grosso do Sul, Brazil. <i>Brazilian Journal of Biology</i> , 73(1), 67-78.
Article	Pinheiro, E. D. S., & Durigan, G. (2012). Floristic and structural differences among cerrado phytophysiognomies in Assis, SP, Brazil. <i>Revista Árvore</i> , 36(1), 181-193.
Article	Santos, L. M., Lenza, E., dos Santos, J. O., Marimon, B. S., Eisenlohr, P. V., Junior, B. H. M., & Feldpausch, T. R. (2015). Diversity, floristic composition, and structure of the woody vegetation of the Cerrado in the Cerrado–Amazon transition zone in Mato Grosso, Brazil. <i>Brazilian Journal of Botany</i> , 38(4), 877-887.
Article	Neri, A. V., Meira Neto, J. A. A., SILVA, A. D., Martins, S. V., & Batista, M. L. (2007). Análise da estrutura de uma comunidade lenhosa em área de cerrado sensu stricto no município de Senador Modestino Gonçalves, norte de Minas Gerais, Brasil. <i>Revista Árvore</i> , 31(1), 123-134.
Article	Parra-O, C. 2006. Estudio general de la vegetación nativa de Puerto Carreño (Vichada), Colombia). <i>Caldasia</i> 28(2): 165-177
Article	Ramírez, N., Dezzee, N., & Chacón, N. (2007). Floristic composition, plant species abundance, and soil properties of montane savannas in the Gran Sabana, Venezuela. <i>Flora-Morphology, Distribution, Functional Ecology of Plants</i> , 202(4), 316-327.
Article	Lima, R. A. F. D., Rando, J. G., & Barreto, K. D. (2015). Composition and Diversity in the Cerrado of Eastern Mato Grosso do Sul, Brazil. <i>Revista Árvore</i> , 39(1), 9-24.
Article	Medeiros, M. B. D., & Walter, B. M. T. (2012). Composition and structure of the woody cerrado stricto sensu in northern Tocantins and southern Maranhão. <i>Revista Árvore</i> , 36(4), 673-683.
Article	Giácomo, R. G., De Carvalho, D. C., Pereira, M. G., De Souza, A. B., & Gaui, T. D. (2013). Florística e fitossociologia em áreas de campo sujo e cerrado sensu stricto na estação ecológica de Pirapitinga–MG. <i>Ciência Florestal</i> , 23(1), 29-43.
Article	Oliveira, C. P. D., Francelino, M. R., Cysneiros, V. C., Andrade, F. C. D., & Booth, M. C. (2015). Structure and Floristic of the Cerrado Sensu Stricto in West of Bahia. <i>CERNE</i> , 21(4), 545-552.

Literature	Reference
Article	Costa, F. V., Oliveira, K. N., Nunes, Y. R. F., de Oliveira Menino, G. C., Brandão, D. O., de Araújo, L. S., ... & Santos, D. (2015). Floristic composition and wood community structure of two stricto sensu areas on North of Minas Gerais. <i>Cerne</i> , 16(3), 267-281.
Article	Ribeiro, M. N., Sanchez, M., Pedroni, F., & Peixoto, K. S. (2012). Fogo e dinâmica da comunidade lenhosa em cerrado sentido restrito, Barra do Garças, Mato Grosso. <i>Acta Botanica Brasilica</i> , 26(1), 203-217.
Article	Araújo, G. M., Nascimento, A. R. T., Lopes, S. F., Rodrigues, R. F., & Ratter, J. A. (2011). Structure and floristics of the arboreal component of a dystrophic Cerradão and comparison with other Cerradões in Central Brazil. <i>Edinburgh Journal of Botany</i> , 68(3), 401-418.
Article	Vieira, L. T., Castro, A. A., Coutinho, J. M., de Sousa, S. R., de Farias, R. R., Castro, N. M., & Martins, F. R. (2019). A biogeographic and evolutionary analysis of the flora of the North-eastern cerrado, Brazil. <i>Plant Ecology & Diversity</i> , 12(5), 475-488.
Article	Vieira, L. T., Castro, A. A., Coutinho, J. M., de Sousa, S. R., de Farias, R. R., Castro, N. M., & Martins, F. R. (2019). A biogeographic and evolutionary analysis of the flora of the North-eastern cerrado, Brazil. <i>Plant Ecology & Diversity</i> , 12(5), 475-488.
Books	Figueiredo, N. & Andrade, G. V. (2007) Informações sobre a estrutura e composição florística da vegetação de um Cerradão na Chapada do Gado Bravo município de Balsas - MA. In: Barreto, L. (Org.). <i>Cerrado Norte do Brasil</i> (2007). Pelotas, RG: USEB, 2007. p. 141-155.
Books	Felfili, J. M. & Silva Júnior, M. C. (2001) Biogeografia do bioma cerrado: estudo fitofisionômico na Chapada do Espigão Mestre do São Francisco. University of Brasília.
Books	Harley, R. M., Giulietti, A., Grilo, A. S., Silva, T. R. S., Funch, L., Funch, R. R., ... & Nascimento, F. D. (2005). <i>Cerrado. Biodiversidade e conservação da Chapada Diamantina</i> (FA Junca, L. Funch & R. Rocha, orgs.). Ministério do Meio Ambiente, Série Biodiversidade 13.
Books	Moro, M. F., Castro, A. S. F., & de Araújo, F. S. (2011). Composição florística e estrutura de um fragmento de vegetação savânica sobre os tabuleiros pré-litorâneos na zona urbana de Fortaleza, Ceará. Rodriguésia-Instituto de Pesquisas Jardim Botânico do
Books	Serna-Isaza R.A., Rippstein G., Grollier C., Mesa E. (2001) Biodiversidad de la vegetacion de sabana en la Atillanura plana y la serrania de los Llano Orientales. In : Rippstein Georges (ed.), Escobar German (ed.), Motta Francisco (ed.). <i>Agroecologia y biodiversidad de las sabanas en los Llanos Orientales de Colombia</i> . Cali : CIAT, p. 46-63.
Books	Jansen-Jacobs, M. & ter Steege, H.. (2000) Plant Diversity in Guyana. 147-157 in: ter Steege, H. (ed.) <i>Plant diversity in Guyana. With recommendations for a National Protected Area Strategy</i> . Tropenbos Series 18. Tropenbos Foundation, Wageningen.

Literature	Reference
Research note	Alves, F. M., Noguchi, D. K., Lescano, L. E. A. M., Ramos, W. M., & Sartori, Â. L. B. (2007). Levantamento Florístico do Componente Arbóreo de duas Áreas de Cerradão em Campo Grande-MS, Brasil. <i>Revista Brasileira de Biociências</i> , 5(S2), pg-564.
Technical bulletin	Medeiros, M. B., Guarino, E., & da Silva, G. P. (2005). Fitossociologia de um trecho de Cerrado sensu stricto na Bacia do Rio Corumbá-área de influência direta do aproveitamento hidrelétrico Corumbá IV (GO). <i>Embrapa Recursos Genéticos e Biotecnologia-Boletim de Pesquisa e Desenvolvimento (INFOTECA-E)</i> .
Technical bulletin	Lisboa, P. L. B. (1990). Rondônia: colonização e floresta. Programa Polonoroeste, Programa do Trópico Umido. POLONOROESTE, Relatório de Pesquisa no. 9. CNPq, AED, Brasília.
Technical bulletin	Tavares, S. (1964) Inventário da vegetação dos tabuleiros do Nordeste. <i>Boletim de Recursos Naturais da SUDENE</i> , 2, 9-10.
Technical report	Granjeiro, C. M. M. (1983) Contribuição ao estudo integrado da paisagem e dos ecossistemas da área do município de Aquiraz, Ceará. NUGA/UECE/GTZ Final Report, volume 1, Fortaleza, 644p.
Thesis	Bosquetti, L.B. (2008). Análise da estrutura da paisagem e fitofisionomias do Parque Estadual dos Pirineus, Goiás, Brasil. Universidade de São Paulo.
Thesis	Barbosa, M. M. (2006). Florística e fitossociologia de Cerrado sentido restrito no Parque Estadual da Serra Azul, Barra do Garças, MT. Universidade Federal do Mato Grosso.
Thesis	Finger, Z. (2008). Fitossociologia de Comunidades Arbóreas em Savanas do Brasil Central. Universidade Federal de Santa Maria.
Thesis	Silveira, A.L.P. (2002). Estrutura do componente arbustivo-arbóreo de um cerrado em Alta Floresta do Oeste, Rondônia. Universidade Federal do Mato Grosso.
Thesis	Miranda, I.S. (1998). Flora, fisionomia e estrutura das savanas de Roraima, Brasil. Instituto Nacional de Pesquisa da Amazônia.
Thesis	Neri, A. V. (2007). Gradiente pedológico-vegetacional de Cerrado em Paraopeba, MG. Universidade Federal de Viçosa.
Thesis	Albuquerque, V. M. (1987) Desmatamento da chapada do Araripe: causas e consequências. Monography, Federal University of Ceará.
Thesis	Pessoa, M.J. (2014) Composição florística e estrutura da vegetação lenhosa de savanas sobre afloramentos rochosos na transição Cerrado - Amazônia, MT. Universidade do Estado de Mato Grosso.
Thesis	Ferreira, K. B. (1997) Estudo fitossociológico em uma área de cerrado marginal no município de Afonso Cunha, MA. Federal University of Maranhão.
Thesis	Soares, Z. T. (1996) Fitossociologia do estrato arbóreo em uma área de Cerrado na Amazônia Oriental, Maranhão. State University of Maranhão.

Literature	Reference
Thesis	Torquato, T. G. M. (2006) Potencial da vegetação melitófila e abelhas associadas da área Olho D'água dos Pires, Esperantina, Piauí, Brasil. Thesis. Federal University of Piauí.
Thesis	Franco, E. Á. P. (2005) A diversidade etnobotânica no quilombo Olho D'água dos Pires, Esperantina, Piauí, Brasil. Federal University of Piauí.
Thesis	Castro, A. A. J. F. (1994) Comparação Florístico-Geográfico (Brasil) e Fitossociológica (Piauí-São Paulo) de amostras de Cerrado. State University of Campinas.
Thesis	Moura, I. O. (2007) Relações florístico-estruturais e ecológicas do cerrado sensu stricto sobre afloramentos rochosos. University of Brasília.
Thesis	Lindoso, G. S. (2008) Cerrado sensu stricto sobre neossolo quartzarênico: fitogeografia e conservação. University of Brasília.
Thesis	Ribeiro, L. F. (2000) Riqueza de plantas lenhosas e distribuição de grupos ecológicos em uma área de cerrado no Piauí, Brasil. Federal University of Pernambuco.
Thesis	Santos, L. G. P. (2008) Florística e conhecimento botânico tradicional em áreas de cerrado no município de Monsenhor Gil, Piauí, Brasil. Federal University of Piauí.
Thesis	Sanaiotti, T. M. (1996). The woody flora and soils of seven Brazilian Amazonian dry savanna areas. University of Stirling.
Unpublished data	Paulo, P. Dados não publicados
Unpublished data	Silveira, A.L.P., Dados não publicados
Unpublished data	Gribel, R. Dados não publicados

Table 3. For each species the table has a total number of latitudes belt that a species has occurred in our database (lat), the species that were below (1) and after breaking point (3), and the total number of ecoregions where species were found (ecoregion). Tree species (s) of the South American savanna (n=2,203). Rabinowitz's forms (form), the value of protection ratio (r) and the status of protection (status) for each species are presented. The values of r range from 0 (no species occurrence within protected areas) to 1 (all species occurrence inside protected area).

S	author	lat	population	ecoregion	Form	r	status
<i>Abarema barbouriana</i>	(Standl.)Barneby & J.W.Grimes	4	3	3	common	0.25	partially protected
<i>Abarema barnebyana</i>	Iganci & M.P.Morim	1	1	1	form7	1	protected
<i>Abarema campestris</i>	(Benth.)Barneby & J.W.Grimes	1	1	1	form7	1	protected
<i>Abarema cochleata</i>	(Willd.)Barneby & J.W.Grimes	1	1	1	form7	1	protected
<i>Abarema ferruginea</i>	(Benth.)Pittier	1	1	1	form7	1	protected
<i>Abarema filamentosa</i>	(Benth.)Pittier	9	3	5	common	0.3	partially protected
<i>Abarema jupunba</i>	(Willd.)Britton & Killip	7	3	6	common	0.444444	partially protected
<i>Abatia americana</i>	(Gardner) Eichler	2	1	2	form5	0.4	partially protected
<i>Abuta grandifolia</i>	(Mart.) Sandwith	24	3	25	common	0.284553	partially protected
<i>Acalypha stenoloba</i>	MÃfÂ¼ll.Arg.	2	1	1	form7	1	protected
<i>Acosmium bijugum</i>	(Vogel)Yakovlev	2	1	1	form7	0.5	partially protected
<i>Acosmium cardenasii</i>	H.S.Irwin & Arroyo	8	3	5	common	0.272727	partially protected
<i>Acosmium dasycarpum</i>	(Vogel)Yakovlev	23	3	16	common	0.126285	partially protected
<i>Acosmium nitens</i>	(Vogel)Yakovlev	15	3	12	common	0.255814	partially protected
<i>Acritopappus catolesensis</i>	D.J.N.Hind & Bautista	5	3	3	common	0.222222	partially protected
<i>Acritopappus confertus</i>	(Gardner) R.M.King & H.Rob.	9	3	7	common	0.358974	partially protected
<i>Acritopappus connatifolius</i>	(Soar.Nunes) R.M.King & H.Rob.	2	1	1	form7	0.666667	partially protected
<i>Acritopappus harleyi</i>	R.M.King & H.Rob.	3	3	3	form4	0.3	partially protected
<i>Acritopappus heterolepis</i>	(Baker) R.M.King & H.Rob.	3	3	3	form4	0.333333	partially protected
<i>Acritopappus irwinii</i>	R.M.King & H.Rob.	3	1	2	form5	0.25	partially protected
<i>Acritopappus pereirae</i>	Bautista, S.Ortiz & Rodr.Oubi	3	1	2	form5	0	unprotected
<i>Acritopappus pintoii</i>	Bautista & D.J.N.Hind	2	1	1	form7	0.5	partially protected
<i>Acritopappus subtomentosus</i>	R.M.King & H.Rob.	1	1	2	form5	0.5	partially protected
<i>Acritopappus teixeirae</i>	R.M.King & H.Rob.	2	1	2	form5	0	unprotected
<i>Acrocomia aculeata</i>	(Jacq.) Lodd. ex Mart.	29	3	20	common	0.128134	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Acrocomia glaucescens</i>	Lorenzi	4	3	1	form2	0	unprotected
<i>Actinostemon schomburgkii</i>	(Klotzsch) Hochr.	7	3	6	common	0.5	partially protected
<i>Adelia membranifolia</i>	(MÃfÂ¼ll.Arg.) Chodat & Hassl.	2	1	1	form7	0.2	partially protected
<i>Adenaria floribunda</i>	Kunth	15	3	9	common	0.111111	partially protected
<i>Aegiphila bracteolosa</i>	Moldenke	9	1	9	form1	0.5	partially protected
<i>Aegiphila integrifolia</i>	(Jacq.) B.D.Jacks.	32	3	22	common	0.199029	partially protected
<i>Aegiphila laxiflora</i>	Benth.	1	1	1	form7	0	unprotected
<i>Aegiphila luschnathii</i>	Schauer	2	3	2	form4	0	unprotected
<i>Aegiphila mollis</i>	Kunth	7	3	8	common	0.111111	partially protected
<i>Aegiphila pernambucensis</i>	Moldenke	2	1	2	form5	0.666667	partially protected
<i>Aegiphila verticillata</i>	Vell.	28	3	27	common	0.167176	partially protected
<i>Agarista boliviensis</i>	(Sleumer) Judd	1	1	1	form7	1	protected
<i>Agarista chapadensis</i>	(Kin.-Gouv.) Judd	4	3	3	common	0.5	partially protected
<i>Agarista coriifolia</i>	(Thunb.) Hook. ex Nied.	8	3	6	common	0.25	partially protected
<i>Agarista duckei</i>	(Huber) Judd	5	3	4	common	0.5	partially protected
<i>Agarista glaberrima</i>	(Sleumer) Judd	5	3	3	common	0.227273	partially protected
<i>Agarista oleifolia</i>	(Cham.) G.Don	8	3	4	common	0.190476	partially protected
<i>Agarista pulchra</i>	G.Don	4	3	5	common	0.357143	partially protected
<i>Agarista revoluta</i>	(Spreng.) Hook. ex Nied.	5	3	4	common	0.333333	partially protected
<i>Agonandra brasiliensis</i>	Miers ex Benth.	29	3	25	common	0.125616	partially protected
<i>Aiouea macedoana</i>	Vattimo	5	3	3	common	0	unprotected
<i>Aiouea piauihyensis</i>	(Meisn.) Mez	15	3	7	common	0.2	partially protected
<i>Aiouea saligna</i>	Meisn.	15	3	7	common	0.2	partially protected
<i>Aiouea trinervis</i>	Meisn.	16	3	12	common	0.2	partially protected
<i>Albizia guachapele</i>	(Kunth)Dugand	6	3	2	common	0.045455	partially protected
<i>Albizia inundata</i>	(Mart.)Barneby & J.W.Grimes	3	3	2	form4	0	unprotected
<i>Albizia niopoides</i>	(Benth.)Burkart	15	3	11	common	0.074074	partially protected
<i>Albizia pedicellaris</i>	(Dc.)L.Rico	2	1	1	form7	0.5	partially protected
<i>Albizia saman</i>	(Jacq.)Merr.	2	3	2	form4	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Albizia subdimidiata</i>	(Splitg.) Barneby & J.W.Grimes	15	3	17	common	0.571429	partially protected
<i>Alchornea castaneifolia</i>	(Humb. & Bonpl. ex Willd.) A.Juss.	18	3	15	common	0.210526	partially protected
<i>Alchornea discolor</i>	Poepp.	19	3	10	common	0.21875	partially protected
<i>Alchornea glandulosa</i>	Poepp.	1	1	1	form7	0	unprotected
<i>Alchornea latifolia</i>	Sw.	5	1	3	form1	0.333333	partially protected
<i>Alchornea triplinervia</i>	(Spreng.) MÃfÂ¼ll.Arg.	5	3	4	common	0.3	partially protected
<i>Algernonia kuhlmannii</i>	(Emmerich) G.L.Webster	1	1	1	form7	1	protected
<i>Alibertia bertierifolia</i>	K.Schum.	16	3	15	common	0.173913	partially protected
<i>Alibertia duckei</i>	Standl.	5	1	5	form1	1	protected
<i>Alibertia edulis</i>	(Rich.) A.Rich. ex DC.	34	3	30	common	0.167986	partially protected
<i>Alibertia latifolia</i>	(Benth.) K.Schum.	13	3	14	common	0.272727	partially protected
<i>Alibertia pilosa</i>	K.Krause	5	1	6	form1	0	unprotected
<i>Alibertia rotunda</i>	(Cham.) K.Schum.	6	3	3	common	0.345455	partially protected
<i>Allagoptera caudescens</i>	(Mart.) Kuntze	2	3	1	form6	0.5	partially protected
<i>Allamanda blanchetii</i>	A.DC.	1	1	1	form7	0	unprotected
<i>Allophylus edulis</i>	(A.St.-Hil., A.Juss. & Cambess.) Radlk.	4	3	3	common	0	unprotected
<i>Allophylus quercifolius</i>	(Mart.) Radlk.	4	3	3	common	0.25	partially protected
<i>Allophylus racemosus</i>	Sw.	13	3	9	common	0.458333	partially protected
<i>Aloysia virgata</i>	(Ruiz & Pav.) Juss.	7	3	6	common	0.133333	partially protected
<i>Amaioua guianensis</i>	Aubl.	27	3	26	common	0.214286	partially protected
<i>Amaioua intermedia</i>	Mart. ex Schult. & Schult.f.	10	3	3	common	0.357143	partially protected
<i>Amanoa glaucophylla</i>	MÃfÂ¼ll.Arg.	1	1	1	form7	0	unprotected
<i>Amasonia campestris</i>	(Aubl.) Moldenke	3	1	2	form5	0.2	partially protected
<i>Amburana cearensis</i>	(Allemao)A.C.Sm.	5	3	5	common	0.055556	partially protected
<i>Ampelocera edentula</i>	Kuhlm.	20	3	19	common	0.473684	partially protected
<i>Anacardium occidentale</i>	L.	30	3	25	common	0.180328	partially protected
<i>Anadenanthera colubrina</i>	(Vell.)Brenan	19	3	13	common	0.068376	partially protected
<i>Anadenanthera peregrina</i>	(L.)Speg.	30	3	21	common	0.120301	partially protected
<i>Andira anthelmia</i>	(Vell.) Benth.	2	1	2	form5	0.375	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Andira cordata</i>	R.T.Penn. & H.C.Lima	13	3	5	common	0.15942	partially protected
<i>Andira cujabensis</i>	Benth.	19	3	11	common	0.149329	partially protected
<i>Andira fraxinifolia</i>	Benth.	18	3	11	common	0.184783	partially protected
<i>Andira humilis</i>	Mart. ex Benth.	1	1	1	form7	0	unprotected
<i>Andira inermis</i>	(Wright)DC.	17	3	10	common	0.238095	partially protected
<i>Andira legalis</i>	(Vell.) Toledo	3	1	2	form5	0.714286	partially protected
<i>Andira nitida</i>	Benth.	2	1	1	form7	0.333333	partially protected
<i>Andira vermifuga</i>	Benth.	21	3	14	common	0.127764	partially protected
<i>Anemopaegma velutinum</i>	Mart. ex DC.	2	3	2	form4	0	unprotected
<i>Aniba firmula</i>	(Nees & Mart.) Mez	2	1	2	form5	0.8	partially protected
<i>Aniba heringeri</i>	Vattimo	3	1	1	form7	0.333333	partially protected
<i>Anisacanthus trilobus</i>	Lindau	1	3	1	form6	0	unprotected
<i>Annona acutiflora</i>	Mart.	2	3	1	form6	0.5	partially protected
<i>Annona aurantiaca</i>	Barb.Rodr.	10	3	3	common	0.215686	partially protected
<i>Annona cacans</i>	Warm.	4	3	2	common	0.153846	partially protected
<i>Annona coriacea</i>	Mart.	23	3	17	common	0.135327	partially protected
<i>Annona crassiflora</i>	Mart.	24	3	15	common	0.132196	partially protected
<i>Annona cuspidata</i>	(Mart.) H.Rainer	16	3	11	common	0.142857	partially protected
<i>Annona dioica</i>	A.St.-Hil.	1	1	1	form7	0	unprotected
<i>Annona emarginata</i>	(Schltdl.) H.Rainer	14	3	9	common	0.16129	partially protected
<i>Annona exsucca</i>	DC.	1	1	1	form7	0.333333	partially protected
<i>Annona glabra</i>	L.	11	3	6	common	0.448276	partially protected
<i>Annona hypoglauca</i>	Mart.	19	3	22	common	0.111111	partially protected
<i>Annona jahnii</i>	Saff.	10	3	9	common	0.072727	partially protected
<i>Annona leptopetala</i>	(R.E.Fr.) H.Rainer	11	3	6	common	0.178571	partially protected
<i>Annona montana</i>	Macfad.	24	3	19	common	0.163636	partially protected
<i>Annona nutans</i>	(R.E.Fr.) R.E.Fr.	8	3	5	common	0.277778	partially protected
<i>Annona paludosa</i>	Aubl.	20	3	13	common	0.298246	partially protected
<i>Annona pickelii</i>	(Diels) H.Rainer	1	1	1	form7	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Annona sylvatica</i>	A.St.-Hil.	10	3	4	common	0.125	partially protected
<i>Anteremanthus hatschbachii</i>	H.Rob.	2	1	1	form7	0.5	partially protected
<i>Antonia ovata</i>	Pohl	26	3	21	common	0.185015	partially protected
<i>Aparisthium cordatum</i>	(A.Juss.) Baill.	23	3	25	common	0.396226	partially protected
<i>Apeiba tibourbou</i>	Aubl.	25	3	28	common	0.136364	partially protected
<i>Apterokarpos gardneri</i>	(Engl.) Rizzini	2	3	2	form4	0.333333	partially protected
<i>Apuleia leiocarpa</i>	(Vogel) J.F.Macbr.	28	3	29	common	0.192513	partially protected
<i>Archytaea triflora</i>	Mart.	5	3	4	common	0.555556	partially protected
<i>Arrojadoa rhodantha</i>	(GÃfÂ¼rke) Britton & Rose	1	3	1	form6	0	unprotected
<i>Arthrocereus melanurus</i>	(K.Schum.) Diers, P.Br. & Esteves	8	1	9	form1	0	unprotected
<i>Aspidosperma cuspa</i>	(Kunth) S.F.Blake ex Pittier	20	3	13	common	0.116751	partially protected
<i>Aspidosperma cylindrocarpon</i>	MÃfÂ¼ll.Arg.	16	3	10	common	0.103448	partially protected
<i>Aspidosperma discolor</i>	A.DC.	21	3	15	common	0.224719	partially protected
<i>Aspidosperma dispernum</i>	MÃfÂ¼ll.Arg.	4	3	3	common	0.454545	partially protected
<i>Aspidosperma macrocarpon</i>	Mart.	26	3	26	common	0.142427	partially protected
<i>Aspidosperma multiflorum</i>	A.DC.	16	3	10	common	0.183333	partially protected
<i>Aspidosperma nobile</i>	MÃfÂ¼ll.Arg.	16	3	10	common	0.154362	partially protected
<i>Aspidosperma polyneuron</i>	MÃfÂ¼ll.Arg.	1	1	1	form7	0	unprotected
<i>Aspidosperma pyrifolium</i>	Mart.	18	3	11	common	0.088496	partially protected
<i>Aspidosperma spruceanum</i>	Benth. ex MÃfÂ¼ll.Arg.	1	1	1	form7	0.5	partially protected
<i>Aspidosperma subincanum</i>	Mart. ex A.DC.	22	3	15	common	0.161348	partially protected
<i>Aspidosperma tomentosum</i>	Mart.	22	3	16	common	0.1141	partially protected
<i>Astrocaryum campestre</i>	Mart.	1	1	1	form7	0	unprotected
<i>Astrocaryum echinatum</i>	Barb.Rodr.	8	3	3	common	0.21875	partially protected
<i>Astrocaryum ulei</i>	Burret	10	3	7	common	0.428571	partially protected
<i>Astrocaryum vulgare</i>	Mart.	22	3	16	common	0.322917	partially protected
<i>Astronium fraxinifolium</i>	Schott	25	3	18	common	0.136895	partially protected
<i>Astronium graveolens</i>	Jacq.	21	3	14	common	0.432432	partially protected
<i>Attalea brasiliensis</i>	Glassman	4	3	2	common	0.3	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Attalea butyracea</i>	(Mutis ex L.f.) Wess.Boer	10	3	8	common	0.333333	partially protected
<i>Attalea compta</i>	Mart.	3	3	2	form4	0.083333	partially protected
<i>Attalea funifera</i>	Mart.	4	3	4	common	0.2	partially protected
<i>Attalea maripa</i>	(Aubl.) Mart.	19	3	21	common	0.44898	partially protected
<i>Attalea phalerata</i>	Mart. ex Spreng.	26	3	21	common	0.194245	partially protected
<i>Attalea speciosa</i>	Mart. ex Spreng.	21	3	20	common	0.292135	partially protected
<i>Aureliana fasciculata</i>	(Vell.) Sendtn.	3	1	2	form5	1	protected
<i>Austrocritonia angulicaulis</i>	(Sch.Bip. ex Baker) R.M.King & H.Rob.	1	1	2	form5	0.5	partially protected
<i>Austroeupatorium inulaefolium</i>	(Kunth) R.M.King & H.Rob.	7	3	4	common	0.4375	partially protected
<i>Averrhoidium gardnerianum</i>	Baill.	5	3	2	common	0.4	partially protected
<i>Baccharis calvescens</i>	DC.	6	3	4	common	0.25	partially protected
<i>Baccharis dracunculifolia</i>	DC.	12	3	8	common	0.150442	partially protected
<i>Baccharis intermixta</i>	Gardner	7	3	5	common	0.272727	partially protected
<i>Baccharis lychnophora</i>	Gardner	3	3	3	form4	0.384615	partially protected
<i>Baccharis microdonta</i>	DC.	2	1	1	form7	0	unprotected
<i>Baccharis oblongifolia</i>	(Ruiz & Pav.) Pers.	9	3	6	common	0.365385	partially protected
<i>Baccharis retusa</i>	DC.	11	3	5	common	0.278481	partially protected
<i>Baccharis rufidula</i>	(Spreng.) Joch.MÃ¶fÂ¼ll.	3	3	2	form4	0.4	partially protected
<i>Baccharis singularis</i>	(Vell.) G.M.Barroso	4	3	3	common	0.4	partially protected
<i>Baccharis vulneraria</i>	Baker	9	3	5	common	0.346154	partially protected
<i>Bactris campestris</i>	Poepp.	3	1	4	form5	0.5	partially protected
<i>Bactris concinna</i>	Mart.	12	3	8	common	0	unprotected
<i>Bactris ferruginea</i>	Burret	6	3	5	common	0	unprotected
<i>Bactris glaucescens</i>	Drude	8	3	5	common	0.1	partially protected
<i>Bactris horridispatha</i>	Noblick ex A.J.Hend.	2	1	2	form5	0	unprotected
<i>Bactris major</i>	Jacq.	22	3	26	common	0.409091	partially protected
<i>Bactris riparia</i>	Mart.	14	3	12	common	0.411765	partially protected
<i>Bactris vulgaris</i>	Barb.Rodr.	2	3	1	form6	0.333333	partially protected
<i>Balfourodendron molle</i>	(Miq.) Pirani	3	3	2	form4	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Banara arguta</i>	Briq.	16	3	14	common	0.125	partially protected
<i>Banara guianensis</i>	Aubl.	18	3	17	common	0.5625	partially protected
<i>Banara nitida</i>	Spruce ex Benth.	8	1	9	form1	0	unprotected
<i>Banisteriopsis arborea</i>	B.Gates	2	1	3	form5	0.2	partially protected
<i>Banisteriopsis latifolia</i>	(A.Juss.) B.Gates	14	3	5	common	0.230088	partially protected
<i>Barnebya harleyi</i>	W.R.Anderson & B.Gates	1	1	1	form7	0	unprotected
<i>Bastardiopsis densiflora</i>	(Hook. & Arn.) Hassl.	8	3	3	common	0.142857	partially protected
<i>Bauhinia aculeata</i>	L.	4	3	4	common	0	unprotected
<i>Bauhinia acuruana</i>	Moric.	13	3	5	common	0.142857	partially protected
<i>Bauhinia bauhinioides</i>	(Mart.)J.F.Macbr.	2	1	1	form7	0	unprotected
<i>Bauhinia bombaciflora</i>	Ducke	13	3	7	common	0.038462	partially protected
<i>Bauhinia cheilantha</i>	(Bong.)Steud.	5	3	3	common	0.090909	partially protected
<i>Bauhinia corniculata</i>	Benth.	10	3	11	common	0.272727	partially protected
<i>Bauhinia cupulata</i>	Benth.	16	3	8	common	0.148515	partially protected
<i>Bauhinia dubia</i>	G.Don	10	3	9	common	0.162162	partially protected
<i>Bauhinia forficata</i>	Link	12	3	9	common	0.096154	partially protected
<i>Bauhinia longicuspis</i>	Benth.	3	3	2	form4	0.5	partially protected
<i>Bauhinia longifolia</i>	(Bong.)Steud.	6	3	5	common	0.058824	partially protected
<i>Bauhinia longipedicellata</i>	Ducke	3	3	3	form4	1	protected
<i>Bauhinia membranacea</i>	Benth.	8	3	4	common	0.142857	partially protected
<i>Bauhinia mollis</i>	(Bong.) D.Dietr.	15	3	9	common	0.133333	partially protected
<i>Bauhinia pentandra</i>	(Bong.)Steud.	2	1	2	form5	0	unprotected
<i>Bauhinia platypetala</i>	Benth.	1	1	1	form7	1	protected
<i>Bauhinia pulchella</i>	Benth.	20	3	10	common	0.179641	partially protected
<i>Bauhinia rufa</i>	(Bong.)Steud.	20	3	15	common	0.137157	partially protected
<i>Bauhinia subclavata</i>	Benth.	1	3	1	form6	0	unprotected
<i>Bauhinia unguolata</i>	L.	34	3	24	common	0.155216	partially protected
<i>Bejaria sprucei</i>	Meisn.	5	3	4	common	0.6	partially protected
<i>Bellucia acutata</i>	Pilg.	19	3	14	common	0.230769	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Bellucia grossularioides</i>	(L.) Triana	22	3	24	common	0.191489	partially protected
<i>Berberis laurina</i>	Billb.	1	1	2	form5	0.8	partially protected
<i>Bixa arborea</i>	Huber	19	3	14	common	0.333333	partially protected
<i>Blepharandra hypoleuca</i>	(Benth.) Griseb.	2	3	2	form4	0.555556	partially protected
<i>Blepharocalyx salicifolius</i>	(Kunth) O.Berg	19	3	12	common	0.182819	partially protected
<i>Bocageopsis mattogrossensis</i>	(R.E.Fr.) R.E.Fr.	15	3	8	common	0.2	partially protected
<i>Bocageopsis multiflora</i>	(Mart.) R.E.Fr.	18	3	18	common	0.285714	partially protected
<i>Bocoa ratterii</i>	H.E. Ireland	1	1	1	form7	0	unprotected
<i>Bonnetia paniculata</i>	Spruce ex Benth.	13	3	13	common	0.7	partially protected
<i>Bonnetia sessilis</i>	Benth.	7	3	9	common	0.5	partially protected
<i>Bonnetia stricta</i>	(Nees) Nees & Mart.	7	3	6	common	0.3125	partially protected
<i>Bonyunia antoniifolia</i>	Progel	13	3	9	common	0.692308	partially protected
<i>Bonyunia minor</i>	N.E.Br.	1	3	1	form6	1	protected
<i>Bonyunia superba</i>	R.H.Schomb. ex Progel	2	1	2	form5	1	protected
<i>Bougainvillea glabra</i>	Choisy	8	3	2	common	0.272727	partially protected
<i>Bourreria bolivarensis</i>	Gottschling & J.S.Mill.	1	3	1	form6	0	unprotected
<i>Bowdichia virgilioides</i>	Kunth	34	3	37	common	0.154523	partially protected
<i>Brasiliopuntia brasiliensis</i>	(Willd.) A.Berger	8	3	5	common	0.166667	partially protected
<i>Bredemeyera floribunda</i>	Willd.	26	3	23	common	0.174033	partially protected
<i>Bredemeyera hebeclada</i>	(DC.) J.F.B. Pastore	3	1	4	form5	0.333333	partially protected
<i>Bredemeyera laurifolia</i>	Klotzsch ex A.W.Benn.	1	1	1	form7	0	unprotected
<i>Bredemeyera myrtifolia</i>	A.W.Benn.	1	1	1	form7	0	unprotected
<i>Brosimum alicastrum</i>	Sw.	16	3	14	common	0.227273	partially protected
<i>Brosimum gaudichaudii</i>	TrÃ©cul	24	3	22	common	0.136126	partially protected
<i>Brosimum glaucum</i>	Taub.	2	1	2	form5	0.8	partially protected
<i>Buchenavia oxycarpa</i>	(Mart.) Eichler	19	3	21	common	0.181818	partially protected
<i>Buchenavia tetraphylla</i>	(Aubl.) R.A.Howard	26	3	31	common	0.300971	partially protected
<i>Buchenavia tomentosa</i>	Eichler	25	3	25	common	0.115714	partially protected
<i>Buddleja stachyoides</i>	Cham. & Schltdl.	4	3	4	common	0.416667	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Bunchosia argentea</i>	(Jacq.) DC.	6	3	3	common	0.666667	partially protected
<i>Bunchosia mollis</i>	Benth.	5	3	2	common	0.086957	partially protected
<i>Bunchosia odorata</i>	(Jacq.) Juss.	1	1	1	form7	0	unprotected
<i>Bunchosia paraguariensis</i>	Nied.	7	3	4	common	0.416667	partially protected
<i>Butia capitata</i>	(Mart.) Becc.	9	3	4	common	0.119718	partially protected
<i>Butia paraguayensis</i>	(Barb.Rodr.) L.H.Bailey	8	3	4	common	0.107527	partially protected
<i>Butia purpurascens</i>	Glassman	4	3	2	common	0.096774	partially protected
<i>Byrsonima affinis</i>	W.R.Anderson	11	3	5	common	0.081818	partially protected
<i>Byrsonima arthropoda</i>	A.Juss.	16	3	10	common	0.37037	partially protected
<i>Byrsonima basiloba</i>	A.Juss.	1	1	2	form5	0	unprotected
<i>Byrsonima christianeae</i>	W.R.Anderson	3	1	3	form5	1	protected
<i>Byrsonima clauseniana</i>	A.Juss.	9	3	5	common	0.166667	partially protected
<i>Byrsonima coccolobifolia</i>	Kunth	33	3	27	common	0.138009	partially protected
<i>Byrsonima concinna</i>	Benth.	10	3	9	common	0.636364	partially protected
<i>Byrsonima coniophylla</i>	A.Juss.	10	1	6	form1	1	protected
<i>Byrsonima correifolia</i>	A.Juss.	15	3	7	common	0.178404	partially protected
<i>Byrsonima crassifolia</i>	(L.) Kunth	34	3	34	common	0.220447	partially protected
<i>Byrsonima crispa</i>	A.Juss.	20	3	21	common	0.315789	partially protected
<i>Byrsonima cydoniifolia</i>	A.Juss.	19	3	17	common	0.203931	partially protected
<i>Byrsonima fanshawei</i>	W.R.Anderson	2	1	1	form7	0.5	partially protected
<i>Byrsonima fonscae</i>	W.R.Anderson	2	1	2	form5	0	unprotected
<i>Byrsonima gardneriana</i>	A.Juss.	14	3	11	common	0.396226	partially protected
<i>Byrsonima hypoleuca</i>	Turcz.	1	1	1	form7	1	protected
<i>Byrsonima incarnata</i>	Sandwith	7	3	9	common	1	protected
<i>Byrsonima intermedia</i>	A.Juss.	20	3	13	common	0.11617	partially protected
<i>Byrsonima lancifolia</i>	A.Juss.	13	3	7	common	0.24	partially protected
<i>Byrsonima laxiflora</i>	Griseb.	10	3	3	common	0.413043	partially protected
<i>Byrsonima linguifera</i>	Cuatrec.	10	3	6	common	0.046512	partially protected
<i>Byrsonima martiana</i>	A.Juss.	2	1	1	form7	0.5	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Byrsonima nitidissima</i>	Kunth	3	3	1	form6	0.25	partially protected
<i>Byrsonima pachyphylla</i>	A.Juss.	20	3	13	common	0.138288	partially protected
<i>Byrsonima punctulata</i>	A.Juss.	17	3	11	common	0.4	partially protected
<i>Byrsonima rotunda</i>	Griseb.	12	3	4	common	0.2	partially protected
<i>Byrsonima salzmänniana</i>	A.Juss.	4	3	3	common	0.2	partially protected
<i>Byrsonima schomburgkiana</i>	Benth.	9	3	8	common	0.392857	partially protected
<i>Byrsonima sericea</i>	DC.	20	3	21	common	0.253333	partially protected
<i>Byrsonima spicata</i>	(Cav.) Rich. ex Kunth	13	3	10	common	0.470588	partially protected
<i>Byrsonima spinensis</i>	W.R.Anderson	5	3	2	common	0.428571	partially protected
<i>Byrsonima stannardii</i>	W.R.Anderson	4	3	3	common	0.3	partially protected
<i>Byrsonima stipulacea</i>	A.Juss.	16	3	16	common	0.526316	partially protected
<i>Byrsonima umbellata</i>	Mart. ex A.Juss.	2	1	2	form5	0.5	partially protected
<i>Byrsonima vacciniifolia</i>	A.Juss.	12	3	6	common	0.160714	partially protected
<i>Byrsonima variabilis</i>	A.Juss.	18	3	8	common	0.214286	partially protected
<i>Byrsonima verbascifolia</i>	(L.) DC.	34	3	27	common	0.154808	partially protected
<i>Cabralea canjerana</i>	(Vell.) Mart.	20	3	12	common	0.19403	partially protected
<i>Caesalpinia coriaria</i>	(Jacq.) Willd.	4	3	2	common	0.055556	partially protected
<i>Calliandra asplenioides</i>	(Nees) Renvoize	10	3	5	common	0.268293	partially protected
<i>Calliandra bella</i>	(Spreng.) Benth.	3	3	3	form4	0.375	partially protected
<i>Calliandra brevipes</i>	Benth.	5	3	5	common	0.454545	partially protected
<i>Calliandra calycina</i>	Benth.	4	3	3	common	0.444444	partially protected
<i>Calliandra carrascana</i>	Barneby	1	1	1	form7	0	unprotected
<i>Calliandra elegans</i>	Renvoize	3	3	3	form4	0.285714	partially protected
<i>Calliandra erubescens</i>	Renvoize	4	3	3	common	0.285714	partially protected
<i>Calliandra fernandesii</i>	Barneby	3	1	1	form7	0.4	partially protected
<i>Calliandra foliolosa</i>	Benth.	10	3	6	common	0.23913	partially protected
<i>Calliandra glomerulata</i>	H.Karst.	3	3	1	form6	0.125	partially protected
<i>Calliandra harrisii</i>	(Lindl.) Benth.	3	3	3	form4	0.4	partially protected
<i>Calliandra laxa</i>	(Willd.) Benth.	16	3	18	common	0.485714	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Calliandra lintea</i>	Barneby	2	3	2	form4	0.5	partially protected
<i>Calliandra macrocalyx</i>	Harms	3	3	4	form4	0	unprotected
<i>Calliandra parviflora</i>	Benth.	1	1	1	form7	0	unprotected
<i>Calliandra renvoizeana</i>	Barneby	3	3	2	form4	0.4	partially protected
<i>Calliandra surinamensis</i>	Benth.	12	3	16	common	0.428571	partially protected
<i>Calliandra trinervia</i>	Benth.	12	3	9	common	0.2	partially protected
<i>Calliandra umbellifera</i>	Benth.	1	3	1	form6	0	unprotected
<i>Callianthe rufinerva</i>	(A. St.-Hil.) Donnell	1	1	3	form5	0.545455	partially protected
<i>Callisthene fasciculata</i>	Mart.	20	3	13	common	0.110656	partially protected
<i>Callisthene major</i>	Mart.	18	3	11	common	0.186335	partially protected
<i>Callisthene microphylla</i>	Warm.	14	3	8	common	0.265487	partially protected
<i>Callisthene minor</i>	Mart.	11	3	4	common	0.105263	partially protected
<i>Callisthene mollissima</i>	Warm.	10	3	2	common	0.105263	partially protected
<i>Calophyllum brasiliense</i>	Cambess.	28	3	29	common	0.276042	partially protected
<i>Calycolpus goetheanus</i>	(Mart. ex DC.) O.Berg	11	3	12	common	0.657143	partially protected
<i>Calycolpus legrandii</i>	Mattos	1	1	1	form7	0	unprotected
<i>Calycolpus revolutus</i>	(Schauer) O.Berg	9	3	7	common	0.571429	partially protected
<i>Calycophyllum multiflorum</i>	Griseb.	9	3	7	common	0.153846	partially protected
<i>Calyptranthes brasiliensis</i>	Spreng.	5	3	4	common	0.384615	partially protected
<i>Calyptranthes concinna</i>	DC.	2	1	3	form5	0	unprotected
<i>Calyptranthes fasciculata</i>	O.Berg	18	3	14	common	0.444444	partially protected
<i>Calyptranthes lucida</i>	Mart. ex DC.	22	3	16	common	0.258065	partially protected
<i>Calyptranthes ovalifolia</i>	Cambess.	2	1	1	form7	0.5	partially protected
<i>Calyptranthes pulchella</i>	DC.	12	3	11	common	0.272727	partially protected
<i>Camarea affinis</i>	A.St.-Hil.	1	1	1	form7	0	unprotected
<i>Campomanesia aromatica</i>	(Aubl.) Griseb.	13	3	13	common	0.30303	partially protected
<i>Campomanesia dichotoma</i>	(O.Berg) Mattos	9	3	7	common	0.225806	partially protected
<i>Campomanesia eugenioides</i>	(Cambess.) D.Legrand ex Landrum	9	3	4	common	0.175439	partially protected
<i>Campomanesia guaviroba</i>	(DC.) Kiaersk.	2	1	1	form7	0.666667	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Campomanesia ilhoensis</i>	Mattos	1	1	1	form7	0	unprotected
<i>Campomanesia pubescens</i>	(Mart. ex DC.) O.Berg	8	3	5	common	0.222222	partially protected
<i>Campomanesia rufa</i>	(O.Berg) Nied.	1	1	1	form7	1	protected
<i>Campomanesia sessiliflora</i>	(O.Berg) Mattos	14	3	9	common	0.091483	partially protected
<i>Campomanesia velutina</i>	(Cambess.) O.Berg	21	3	8	common	0.136126	partially protected
<i>Campomanesia xanthocarpa</i>	(Mart.) O.Berg	8	3	3	common	0.083333	partially protected
<i>Capirona decorticans</i>	Spruce	21	3	17	common	0.434783	partially protected
<i>Capparidastrum frondosum</i>	(Jacq.) Cornejo & Iltis	13	3	15	common	0.411765	partially protected
<i>Caraipa densifolia</i>	Mart.	23	3	27	common	0.306122	partially protected
<i>Caraipa llanorum</i>	Cuatrec.	11	3	9	common	0.114286	partially protected
<i>Caraipa savannarum</i>	Kubitzki	21	3	19	common	0.235294	partially protected
<i>Caraipa tereticaulis</i>	Tul.	4	1	5	form1	1	protected
<i>Cardiopetalum calophyllum</i>	Schltld.	21	3	19	common	0.208791	partially protected
<i>Cariniana domestica</i>	(Mart.) Miers	15	3	13	common	0.4	partially protected
<i>Caryocar brasiliense</i>	A.St.-Hil.	18	3	14	common	0.112782	partially protected
<i>Caryocar coriaceum</i>	Wittm.	13	3	6	common	0.156134	partially protected
<i>Casearia aculeata</i>	Jacq.	25	3	23	common	0.220779	partially protected
<i>Casearia arborea</i>	(Rich.) Urb.	27	3	25	common	0.283951	partially protected
<i>Casearia arguta</i>	Kunth	2	3	1	form6	0	unprotected
<i>Casearia commersoniana</i>	Cambess.	27	3	40	common	0.297674	partially protected
<i>Casearia decandra</i>	Jacq.	25	3	22	common	0.207547	partially protected
<i>Casearia eichleriana</i>	Sleumer	9	3	5	common	0.4	partially protected
<i>Casearia gossypiosperma</i>	Briq.	19	3	16	common	0.15894	partially protected
<i>Casearia grandiflora</i>	Cambess.	32	3	34	common	0.237643	partially protected
<i>Casearia guianensis</i>	(Aubl.) Urb.	15	3	11	common	0.5	partially protected
<i>Casearia lasiophylla</i>	Eichler	8	3	3	common	0.1875	partially protected
<i>Casearia mestrensis</i>	Sleumer	2	1	3	form5	0.666667	partially protected
<i>Casearia mollis</i>	Kunth	4	3	2	common	0	unprotected
<i>Casearia praecox</i>	Griseb.	2	3	1	form6	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Casearia rufescens</i>	Cambess.	3	3	3	form4	0.193548	partially protected
<i>Casearia rupestris</i>	Eichler	14	3	9	common	0.155405	partially protected
<i>Casearia selloana</i>	Eichler	1	1	1	form7	1	protected
<i>Casearia spinescens</i>	(Sw.) Griseb.	10	3	10	common	0.235294	partially protected
<i>Casearia sylvestris</i>	Sw.	34	3	46	common	0.148885	partially protected
<i>Casearia tenuipilosa</i>	Sleumer	8	1	6	form1	1	protected
<i>Casearia ulmifolia</i>	Vahl ex Vent.	20	3	16	common	0.138889	partially protected
<i>Casearia zizyphoides</i>	Kunth	2	3	2	form4	0.142857	partially protected
<i>Cassia fastuosa</i>	Willd. ex Benth.	1	1	1	form7	1	protected
<i>Cassipourea guianensis</i>	Aubl.	19	3	18	common	0.393939	partially protected
<i>Cathedra rubricaulis</i>	Miers	2	1	1	form7	0.666667	partially protected
<i>Catostemma lemense</i>	Sanoja	1	3	1	form6	1	protected
<i>Cecropia concolor</i>	Willd.	21	3	18	common	0.230769	partially protected
<i>Cecropia distachya</i>	Huber	17	3	20	common	0.368421	partially protected
<i>Cecropia latiloba</i>	Miq.	19	3	20	common	0.258065	partially protected
<i>Cecropia obtusa</i>	TrÃ¶fÃ©cul	1	1	1	form7	0	unprotected
<i>Cecropia pachystachya</i>	TrÃ¶fÃ©cul	14	3	10	common	0.172414	partially protected
<i>Cecropia saxatilis</i>	Snethl.	10	3	6	common	0.25	partially protected
<i>Cedrela fissilis</i>	Vell.	23	3	17	common	0.192308	partially protected
<i>Ceiba glaziovii</i>	(Kuntze) K.Schum.	1	1	1	form7	0	unprotected
<i>Ceiba pubiflora</i>	(A.St.-Hil.) K.Schum.	14	3	6	common	0.157895	partially protected
<i>Celtis iguanaea</i>	(Jacq.) Sarg.	32	3	27	common	0.186508	partially protected
<i>Cenostigma macrophyllum</i>	Tul.	16	3	11	common	0.149798	partially protected
<i>Cereus albicaulis</i>	(Britton & Rose) Luetzelb.	1	3	1	form6	0	unprotected
<i>Cereus fernambucensis</i>	Lem.	1	1	1	form7	1	protected
<i>Cereus hexagonus</i>	(L.) Mill.	4	3	3	common	0.833333	partially protected
<i>Cereus hildmannianus</i>	K.Schum.	7	3	4	common	0.277778	partially protected
<i>Cereus jamacaru</i>	DC.	15	3	10	common	0.164384	partially protected
<i>Cestrum alternifolium</i>	(Jacq.) O.E.Schulz	1	3	1	form6	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Cestrum laevigatum</i>	Schltld.	2	1	3	form5	0	unprotected
<i>Cestrum mariquitense</i>	Kunth	17	3	11	common	0.296296	partially protected
<i>Cestrum obovatum</i>	Sendtn.	8	3	4	common	0.458333	partially protected
<i>Cestrum pedicellatum</i>	Sendtn.	8	3	4	common	0.285714	partially protected
<i>Cestrum reflexum</i>	Sendtn.	12	3	7	common	0.25	partially protected
<i>Cestrum retrofractum</i>	Dunal	5	3	5	common	0.285714	partially protected
<i>Cestrum strigilatum</i>	Ruiz & Pav.	14	3	9	common	0.225806	partially protected
<i>Chaetocarpus echinocarpus</i>	(Baill.) Ducke	29	3	20	common	0.341176	partially protected
<i>Chaetocarpus myrsinites</i>	Baill.	5	3	4	common	0.307692	partially protected
<i>Chaetocarpus schomburgkianus</i>	(Kuntze) Pax & K.Hoffm.	13	3	13	common	0.5	partially protected
<i>Chamaecrista adenophylla</i>	(Taub.)H.S.Irwin & Barneby	1	1	2	form5	0.333333	partially protected
<i>Chamaecrista bahiae</i>	(H.S.Irwin)H.S.Irwin & Barneby	2	1	2	form5	0.5	partially protected
<i>Chamaecrista blanchetii</i>	(Benth.) Conc. et al.	6	3	4	common	0.428571	partially protected
<i>Chamaecrista brachystachya</i>	Conc., L.P. Queiroz & G.P. Lewis	6	3	5	common	0	unprotected
<i>Chamaecrista bracteolata</i>	(Vogel)H.S.Irwin & Barneby	1	1	2	form5	0.5	partially protected
<i>Chamaecrista celiae</i>	(H.S.Irwin & Barneby) H.S.Irwin & Barneby	3	1	2	form5	0.333333	partially protected
<i>Chamaecrista chaetostegia</i>	(H.S.Irwin & Barneby) H.S.Irwin & Barneby	4	1	2	form1	0.75	partially protected
<i>Chamaecrista confertifomis</i>	(H.S. Irwin & Barneby) Conc., L.P. Queiroz & G.P.	4	1	2	form1	0	unprotected
<i>Chamaecrista cytisoides</i>	(Collad.)H.S.Irwin & Barneby	11	3	6	common	0.2	partially protected
<i>Chamaecrista decora</i>	(H.S. Irwin & Barneby) Conc., L.P. Queiroz & G.P.	7	1	3	form5	0	unprotected
<i>Chamaecrista dentata</i>	(Vogel)H.S.Irwin & Barneby	3	3	4	form4	0.333333	partially protected
<i>Chamaecrista dumalis</i>	(Hoehne)H.S.Irwin & Barneby	7	3	3	common	0.2	partially protected
<i>Chamaecrista eitenorum</i>	(H.S.Irwin & Barneby) H.S.Irwin & Barneby	12	3	6	common	0.166667	partially protected
<i>Chamaecrista ensiformis</i>	(Vell.)H.S.Irwin & Barneby	9	3	6	common	0.368421	partially protected
<i>Chamaecrista flexuosa</i>	(L.)Greene	2	1	2	form5	0.5	partially protected
<i>Chamaecrista fulgida</i>	Barneby	1	1	1	form7	1	protected
<i>Chamaecrista glaziovii</i>	(Harms)H.S.Irwin & Barneby	1	1	1	form7	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Chamaecrista glischrodes</i>	H.S.Irwin & Barneby	2	1	3	form5	0.666667	partially protected
<i>Chamaecrista hedysaroides</i>	(Vogel)H.S.Irwin & Barneby	3	3	3	form4	0.272727	partially protected
<i>Chamaecrista machaeriifolia</i>	(Benth.)H.S.Irwin & Barneby	1	3	1	common	0.352941	partially protected
<i>Chamaecrista multiseta</i>	(Benth.)H.S.Irwin & Barneby	8	1	3	form1	0.121212	partially protected
<i>Chamaecrista nuda</i>	(H.S.Irwin & Barneby) H.S.Irwin & Barneby	9	3	6	form6	1	protected
<i>Chamaecrista orbiculata</i>	(Benth.)H.S.Irwin & Barneby	1	1	1	form1	0.130081	partially protected
<i>Chamaecrista pachyclada</i>	(Harms)H.S.Irwin & Barneby	1	1	1	form1	0.4	partially protected
<i>Chamaecrista phyllostachya</i>	(Benth.)H.S.Irwin & Barneby	13	1	7	form1	0.285714	partially protected
<i>Chamaecrista pilicarpa</i>	(Harms)H.S.Irwin & Barneby	4	1	2	form7	1	protected
<i>Chamaecrista roraimae</i>	(Benth.)Gleason	8	3	6	common	0.25	partially protected
<i>Chamaecrista sincorana</i>	(Harms)H.S.Irwin & Barneby	2	3	2	form4	0.428571	partially protected
<i>Chamaecrista spinulosa</i>	(H.S.Irwin & Barneby) H.S.Irwin & Barneby	2	1	2	form5	0.666667	partially protected
<i>Chamaecrista ulmea</i>	H.S.Irwin & Barneby	2	1	2	form5	0.666667	partially protected
<i>Chamaecrista zygomphylloides</i>	(Taub.) H.S.Irwin & Barneby	8	3	5	common	0.266667	partially protected
<i>Chaunochiton angustifolium</i>	Sleumer	13	3	14	common	0.086957	partially protected
<i>Chaunochiton kappleri</i>	(Sagot ex Engl.) Ducke	8	3	6	common	0.1	partially protected
<i>Cheiloclinium cognatum</i>	(Miers) A.C.Sm.	25	3	25	common	0.243421	partially protected
<i>Chelyocarpus chuco</i>	(Mart.) H.E.Moore	5	3	4	common	0.181818	partially protected
<i>Chiococca nitida</i>	Benth.	8	3	10	common	0.5	partially protected
<i>Chionanthus crassifolius</i>	(Mart.) P.S.Green	6	3	4	common	0.230769	partially protected
<i>Chionanthus filiformis</i>	(Vell.) P.S.Green	1	1	1	form7	0	unprotected
<i>Chloroleucon acacioides</i>	(Ducke)Barneby & J.W.Grimes	9	3	9	common	0.470588	partially protected
<i>Chloroleucon foliolosum</i>	(Benth.)G.P.Lewis	2	1	1	form7	1	protected
<i>Chloroleucon mangense</i>	(Jacq.)Britton & Rose	3	3	1	form6	0.111111	partially protected
<i>Chloroleucon tenuiflorum</i>	(Benth.)Barneby & J.W.Grimes	2	1	1	form7	0	unprotected
<i>Chomelia anisomeris</i>	MÃfÂ¼ll.Arg.	1	1	1	form7	1	protected
<i>Chomelia obtusa</i>	Cham. & Schltdl.	23	3	18	common	0.179641	partially protected
<i>Chomelia paniculata</i>	(Bartl. ex DC.) Steyerl.	1	1	1	form7	0	unprotected
<i>Chomelia parviflora</i>	(MÃfÂ¼ll.Arg.) MÃfÂ¼ll.Arg.	11	3	5	common	0.2	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Chomelia pohliana</i>	MÃfÂ¼ll.Arg.	11	3	3	common	0	unprotected
<i>Chomelia pubescens</i>	Cham. & Schltdl.	1	1	1	form7	0	unprotected
<i>Chomelia spinosa</i>	Jacq.	5	3	6	common	0.25	partially protected
<i>Chomelia tenuiflora</i>	Benth.	14	3	15	common	0.5	partially protected
<i>Christiana africana</i>	DC.	13	3	13	common	0.2	partially protected
<i>Christiana mennegae</i>	(Jans.-Jac. & Westra) Kubitzki	1	3	1	form6	1	protected
<i>Chromolaena odorata</i>	(L.) R.M.King & H.Rob.	1	1	1	form7	0	unprotected
<i>Chronopappus bifrons</i>	(DC. ex Pers.) DC.	3	3	3	form4	0.333333	partially protected
<i>Chrysobalanus icaco</i>	L.	12	3	9	common	0.333333	partially protected
<i>Chrysolaena platensis</i>	(Spreng.) H.Rob.	1	1	1	form7	1	protected
<i>Chrysophyllum arenarium</i>	AllemÃfÂ£o	4	3	3	common	0.375	partially protected
<i>Chrysophyllum gonocarpum</i>	(Mart. & Eichler ex Miq.) Engl.	4	3	4	common	0	unprotected
<i>Chrysophyllum januariense</i>	Eichler	2	3	1	form6	0.5	partially protected
<i>Chrysophyllum marginatum</i>	(Hook. & Arn.) Radlk.	15	3	12	common	0.148148	partially protected
<i>Chrysophyllum rufum</i>	Mart.	2	1	3	form5	0	unprotected
<i>Cinnamomum erythropus</i>	(Nees & Mart.) Kosterm.	4	3	3	common	0.44	partially protected
<i>Cinnamomum haussknechtii</i>	(Mez) Kosterm.	8	3	3	common	0.26087	partially protected
<i>Cinnamomum sellowianum</i>	(Nees & Mart.) Kosterm.	1	1	1	form7	0	unprotected
<i>Cinnamomum tomentulosum</i>	Kosterm.	1	1	1	form7	0	unprotected
<i>Cinnamomum triplinerve</i>	(Ruiz & Pav.) Kosterm.	11	3	9	common	0.75	partially protected
<i>Clethra scabra</i>	Pers.	9	3	7	common	0.346939	partially protected
<i>Clusia amabilis</i>	Maguire	2	3	1	form6	0.666667	partially protected
<i>Clusia brachystyla</i>	Maguire	4	3	3	common	0.571429	partially protected
<i>Clusia burchellii</i>	Engl.	4	3	1	form2	0.3	partially protected
<i>Clusia columnaris</i>	Engl.	22	3	25	common	0.421053	partially protected
<i>Clusia crassifolia</i>	Planch. & Triana	3	3	3	form4	1	protected
<i>Clusia criuva</i>	Cambess.	11	3	7	common	0.293333	partially protected
<i>Clusia dardanoi</i>	G.Mariz & Maguire	1	1	1	form7	0	unprotected
<i>Clusia diamantina</i>	Bittrich	1	1	2	form5	0.333333	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Clusia fockeana</i>	Miq.	8	3	8	common	0.714286	partially protected
<i>Clusia fragrans</i>	Gardner	6	3	4	common	0.2	partially protected
<i>Clusia gardneri</i>	Planch. & Triana	4	3	1	form2	0.6	partially protected
<i>Clusia grandiflora</i>	Splitg.	5	3	4	common	0.5	partially protected
<i>Clusia hilariana</i>	Schltld.	2	1	2	form5	0.5	partially protected
<i>Clusia hoffmannseggiana</i>	Schltld.	2	1	2	form5	0.333333	partially protected
<i>Clusia huberi</i>	Pipoly	2	3	1	form6	0.5	partially protected
<i>Clusia melchiori</i>	Gleason	4	3	3	common	0.3	partially protected
<i>Clusia nemorosa</i>	G.Mey.	23	3	25	common	0.293333	partially protected
<i>Clusia obdeltifolia</i>	Bittrich	3	3	2	form4	0.5	partially protected
<i>Clusia obovata</i>	(Spruce ex Planch. & Triana) Pipoly	1	1	1	form7	0	unprotected
<i>Clusia panapanari</i>	(Aubl.) Choisy	15	3	16	common	0.352941	partially protected
<i>Clusia paralicola</i>	G.Mariz	5	3	4	common	0.2	partially protected
<i>Clusia pernambucensis</i>	G.Mariz	1	1	1	form7	1	protected
<i>Clusia polysepala</i>	Engl.	6	1	5	form1	0.5	partially protected
<i>Clusia pusilla</i>	Steyerm.	5	3	4	common	0.636364	partially protected
<i>Clusia riedeliana</i>	Engl.	1	1	1	form7	0	unprotected
<i>Clusia savannarum</i>	Maguire	2	3	2	form4	1	protected
<i>Clusia schomburgkiana</i>	(Planch. & Triana) Benth. ex Engl.	5	3	7	common	0.5	partially protected
<i>Clusia sellowiana</i>	Schltld.	2	1	2	form5	0.666667	partially protected
<i>Clusia tabulamontana</i>	Maguire	3	3	2	form4	0.666667	partially protected
<i>Clusia weddelliana</i>	Planch. & Triana	16	3	8	common	0.333333	partially protected
<i>Cnidoscolus bahianus</i>	(Ule) Pax & K.Hoffm.	1	1	1	form7	0.333333	partially protected
<i>Cnidoscolus vitifolius</i>	(Mill.) Pohl	15	3	6	common	0.183099	partially protected
<i>Coccoloba alnifolia</i>	Casar.	10	3	8	common	0.148148	partially protected
<i>Coccoloba caracasana</i>	Meisn.	5	3	2	common	0.05	partially protected
<i>Coccoloba cujabensis</i>	Wedd.	8	3	4	common	0.173913	partially protected
<i>Coccoloba declinata</i>	(Vell.) Mart.	1	3	1	form6	1	protected
<i>Coccoloba densifrons</i>	Mart. ex Meisn.	3	3	3	form4	0.25	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Coccoloba excelsa</i>	Benth.	19	3	20	common	0.5	partially protected
<i>Coccoloba laevis</i>	Casar.	1	1	2	form5	0.5	partially protected
<i>Coccoloba latifolia</i>	Poir.	9	3	8	common	0.307692	partially protected
<i>Coccoloba llewelynii</i>	R.A.Howard	1	3	1	form6	0	unprotected
<i>Coccoloba lucidula</i>	Benth.	15	3	11	common	0.35	partially protected
<i>Coccoloba marginata</i>	Benth.	20	3	18	common	0.148148	partially protected
<i>Coccoloba mollis</i>	Casar.	29	3	23	common	0.127563	partially protected
<i>Coccoloba obtusifolia</i>	Jacq.	7	3	7	common	0.125	partially protected
<i>Coccoloba orinocana</i>	R.A.Howard	4	3	1	form2	0.142857	partially protected
<i>Coccoloba paraguariensis</i>	Lindau	3	3	4	form4	0.25	partially protected
<i>Coccoloba ramosissima</i>	Wedd.	12	3	10	common	0.297297	partially protected
<i>Coccoloba salicifolia</i>	Wedd.	3	3	3	form4	0.214286	partially protected
<i>Coccoloba savannarum</i>	Standl.	3	3	3	form4	0.2	partially protected
<i>Cochlospermum orinocense</i>	(Kunth) Steud.	21	3	22	common	0.227273	partially protected
<i>Cochlospermum regium</i>	(Schrank) Pilg.	2	3	2	form4	0	unprotected
<i>Cochlospermum vitifolium</i>	(Willd.) Spreng.	28	3	33	common	0.227723	partially protected
<i>Colubrina glandulosa</i>	G.Perkins	1	3	1	form6	0	unprotected
<i>Combretum duarteanum</i>	Cambess.	22	3	10	common	0.141304	partially protected
<i>Combretum lanceolatum</i>	Pohl ex Eichler	25	3	21	common	0.238636	partially protected
<i>Combretum leprosum</i>	Mart.	22	3	17	common	0.14717	partially protected
<i>Combretum mellifluum</i>	Eichler	18	3	10	common	0.190789	partially protected
<i>Combretum monetaria</i>	Mart.	12	3	4	common	0.266667	partially protected
<i>Combretum rotundifolium</i>	Rich.	21	3	26	common	0.133333	partially protected
<i>Commiphora leptophloeos</i>	(Mart.) J.B.Gillett	9	3	9	common	0.263158	partially protected
<i>Compsoeura ulei</i>	Warb. ex Pilg.	1	1	1	form7	1	protected
<i>Conchocarpus longifolius</i>	(A.St.-Hil.) Kallunki & Pirani	1	1	1	form7	1	protected
<i>Connarus deterrentus</i>	Planch.	2	3	2	form4	0.571429	partially protected
<i>Connarus incomptus</i>	Planch.	1	1	1	form7	1	protected
<i>Connarus perrottetii</i>	(DC.) Planch.	23	3	19	common	0.390625	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Connarus suberosus</i>	Planch.	22	3	14	common	0.120165	partially protected
<i>Connarus venezuelanus</i>	Baill.	5	3	4	common	0	unprotected
<i>Conostegia speciosa</i>	Naudin	1	3	2	form4	0	unprotected
<i>Copaifera arenicola</i>	(Ducke) J.Costa & L.P.Queiroz	2	3	2	form4	0	unprotected
<i>Copaifera coriacea</i>	Mart.	7	3	4	common	0.555556	partially protected
<i>Copaifera duckei</i>	Dwyer	15	3	12	common	0.310345	partially protected
<i>Copaifera elliptica</i>	Mart.	5	3	5	common	0.155556	partially protected
<i>Copaifera langsdorffii</i>	Desf.	23	3	19	common	0.11733	partially protected
<i>Copaifera luetzelburgii</i>	Harms	12	3	6	common	0.10625	partially protected
<i>Copaifera magnifolia</i>	Dwyer	8	3	1	form2	0.225806	partially protected
<i>Copaifera malmei</i>	Harms	13	3	5	common	0.090323	partially protected
<i>Copaifera martii</i>	Hayne	15	3	11	common	0.34375	partially protected
<i>Copaifera oblongifolia</i>	Mart. ex Hayne	20	3	11	common	0.167059	partially protected
<i>Copaifera pubiflora</i>	Benth.	7	3	3	common	0.104167	partially protected
<i>Copaifera sabulicola</i>	J.A.S.Costa & L.P. Queiroz	8	3	4	common	0.15625	partially protected
<i>Copernicia alba</i>	Morong	4	3	4	common	0.2	partially protected
<i>Copernicia prunifera</i>	(Mill.) H.E.Moore	9	3	5	common	0.222222	partially protected
<i>Cordia bicolor</i>	A.DC.	18	3	23	common	0.305556	partially protected
<i>Cordia curassavica</i>	(Jacq.) Roem. & Schult.	1	3	1	form6	1	protected
<i>Cordia exaltata</i>	Lam.	16	3	18	common	0.454545	partially protected
<i>Cordia glabrata</i>	(Mart.) A.DC.	19	3	14	common	0.165049	partially protected
<i>Cordia insignis</i>	Cham.	8	3	6	common	0.156627	partially protected
<i>Cordia leucocephala</i>	Moric.	1	1	1	form7	0	unprotected
<i>Cordia nodosa</i>	Lam.	21	3	27	common	0.307692	partially protected
<i>Cordia polycephala</i>	(Lam.) I.M.Johnst.	1	1	1	form7	0	unprotected
<i>Cordia rufescens</i>	A.DC.	13	3	6	common	0.09	partially protected
<i>Cordia scabrifolia</i>	A.DC.	16	3	17	common	0.357143	partially protected
<i>Cordia sellowiana</i>	Cham.	27	3	20	common	0.181818	partially protected
<i>Cordia superba</i>	Cham.	16	3	9	common	0.078431	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Cordia trichotoma</i>	(Vell.) ArrÃb. ex Steud.	20	3	10	common	0.073529	partially protected
<i>Cordia concolor</i>	(Cham.) Kuntze	18	3	12	common	0.102941	partially protected
<i>Cordia elliptica</i>	(Cham.) Kuntze	21	3	10	common	0.174168	partially protected
<i>Cordia macrophylla</i>	(K.Schum.) Kuntze	15	3	8	common	0.174419	partially protected
<i>Cordia myrciifolia</i>	(K.Schum.) Perss. & Delprete	18	3	10	common	0.275	partially protected
<i>Cordia rigida</i>	(K.Schum.) Kuntze	18	3	7	common	0.134503	partially protected
<i>Cordia sessilis</i>	(Vell.) Kuntze	22	3	17	common	0.134111	partially protected
<i>Couepia belemii</i>	Prance	1	1	1	form7	1	protected
<i>Couepia grandiflora</i>	(Mart. & Zucc.) Benth. ex Hook.f.	22	3	13	common	0.145	partially protected
<i>Couepia multiflora</i>	Benth.	3	3	3	form4	0.153846	partially protected
<i>Couepia ovalifolia</i>	(Schott) Benth. ex Hook.f.	1	1	1	form7	1	protected
<i>Couepia schottii</i>	Fritsch	2	1	1	form7	0.5	partially protected
<i>Couepia uiti</i>	(Mart. & Zucc.) Benth. ex Hook.f.	14	3	7	common	0.212121	partially protected
<i>Couepia venosa</i>	Prance	1	1	1	form7	0.5	partially protected
<i>Couma rigida</i>	MÃfÃ¼ll.Arg.	1	1	1	form7	1	protected
<i>Coursetia ferruginea</i>	(Kunth)Lavin	6	3	2	common	0.055556	partially protected
<i>Coussarea hydrangeifolia</i>	(Benth.) Benth. & Hook.f. ex MÃfÃ¼ll.Arg.	23	3	15	common	0.135231	partially protected
<i>Coussarea obscura</i>	MÃfÃ¼ll.Arg.	3	1	2	form5	0	unprotected
<i>Coussarea paniculata</i>	(Vahl) Standl.	14	3	13	common	0.363636	partially protected
<i>Coussarea platyphylla</i>	MÃfÃ¼ll.Arg.	8	3	4	common	0.375	partially protected
<i>Coussarea violacea</i>	Aubl.	3	1	2	form5	1	protected
<i>Coutarea hexandra</i>	(Jacq.) K.Schum.	33	3	25	common	0.193277	partially protected
<i>Crateva tapia</i>	L.	23	3	27	common	0.173077	partially protected
<i>Cratylia argentea</i>	(Desv.)Kuntze	1	1	1	form7	0	unprotected
<i>Cratylia mollis</i>	Benth.	1	3	1	form6	0	unprotected
<i>Crescentia amazonica</i>	Ducke	4	1	5	form1	0	unprotected
<i>Crotalaria holosericea</i>	Nees & Mart.	1	1	1	form7	0	unprotected
<i>Croton argyrophyllus</i>	Kunth	9	3	8	common	0.181818	partially protected
<i>Croton blanchetianus</i>	Baill.	6	3	3	common	0.263158	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Croton campestris</i>	A.St.-Hil.	1	1	1	form7	0	unprotected
<i>Croton celtidifolius</i>	Baill.	3	3	3	form4	0.25	partially protected
<i>Croton draconoides</i>	MÃfÂ¼ll.Arg.	3	1	2	form5	0.333333	partially protected
<i>Croton essequiboensis</i>	Klotzsch	1	1	1	form7	1	protected
<i>Croton floribundus</i>	Spreng.	13	3	4	common	0.172414	partially protected
<i>Croton gossypifolius</i>	Vahl	11	3	11	common	0.225	partially protected
<i>Croton heliotropiifolius</i>	Kunth	8	3	6	common	0.133333	partially protected
<i>Croton matourensis</i>	Aubl.	20	3	24	common	0.384615	partially protected
<i>Croton nepetifolius</i>	Baill.	1	1	1	form7	1	protected
<i>Croton orinocensis</i>	MÃfÂ¼ll.Arg.	1	1	1	form7	1	protected
<i>Croton palanostigma</i>	Klotzsch	15	3	12	common	0.181818	partially protected
<i>Croton pedicellatus</i>	Kunth	1	1	1	form7	0	unprotected
<i>Croton sonderianus</i>	MÃfÂ¼ll.Arg.	1	1	1	form7	1	protected
<i>Croton tricolor</i>	Klotzsch ex Baill.	2	3	2	form4	0	unprotected
<i>Croton urticifolius</i>	Lam.	1	1	1	form7	1	protected
<i>Croton yavitensis</i>	Croizat	7	3	4	common	0	unprotected
<i>Cupania bracteosa</i>	Radlk.	2	1	2	form5	0	unprotected
<i>Cupania emarginata</i>	Cambess.	2	3	1	form6	0.5	partially protected
<i>Cupania impressinervia</i>	Acev.-Rodr.	9	3	7	common	0.318182	partially protected
<i>Cupania ludowigii</i>	Somner & Ferrucci	1	1	2	form5	0	unprotected
<i>Cupania paniculata</i>	Cambess.	9	3	5	common	0.207792	partially protected
<i>Cupania platycarpa</i>	Radlk.	7	3	5	common	0.166667	partially protected
<i>Cupania racemosa</i>	(Vell.) Radlk.	5	3	5	common	0.090909	partially protected
<i>Cupania rubiginosa</i>	(Poir.) Radlk.	1	1	1	form7	1	protected
<i>Cupania rugosa</i>	Radlk.	2	1	2	form5	0	unprotected
<i>Cupania vernalis</i>	Cambess.	19	3	12	common	0.169014	partially protected
<i>Cuphea antisiphilitica</i>	Kunth	1	1	1	form7	0	unprotected
<i>Cuphea campestris</i>	Mart. ex Koehne	1	1	1	form7	0	unprotected
<i>Cuphea ericoides</i>	Cham. & Schltdl.	1	1	1	form7	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Curatella americana</i>	L.	33	3	33	common	0.144351	partially protected
<i>Cyathea microdonta</i>	(Desv.) Domin	28	3	21	common	0.313725	partially protected
<i>Cyathea villosa</i>	Humb. & Bonpl. ex Willd.	8	3	6	common	0.363636	partially protected
<i>Cybianthus detergens</i>	Mart.	1	1	2	form5	0	unprotected
<i>Cybianthus fulvopulverulentus</i>	(Mez) G.Agostini	11	3	13	common	0.428571	partially protected
<i>Cybianthus gardneri</i>	(A.DC.) G.Agostini	13	3	4	common	0.283019	partially protected
<i>Cybianthus goyazensis</i>	Mez	3	3	1	form6	0.25	partially protected
<i>Cybianthus minutiflorus</i>	Mez	3	1	2	form5	0.333333	partially protected
<i>Cybianthus quelchii</i>	(N.E.Br.) G.Agostini	3	3	3	form4	1	protected
<i>Cybianthus resinosus</i>	Mez	7	3	6	common	0.666667	partially protected
<i>Cybianthus venezuelanus</i>	Mez	13	3	8	common	0.333333	partially protected
<i>Cybistax antisiphilitica</i>	(Mart.) Mart.	25	3	21	common	0.136119	partially protected
<i>Cynometra bauhiniifolia</i>	Benth.	19	3	17	common	0.178571	partially protected
<i>Cynophalla flexuosa</i>	(L.) J.Presl	23	3	20	common	0.211268	partially protected
<i>Cynophalla hastata</i>	(Jacq.) J.Presl	12	3	8	common	0.285714	partially protected
<i>Cynophalla retusa</i>	(Griseb.) Cornejo & Iltis	10	3	7	common	0.294118	partially protected
<i>Cyrilla racemiflora</i>	L.	11	3	12	common	0.6	partially protected
<i>Cyrtocarpa velutinifolia</i>	(R.S.Cowan) J.D.Mitch. & Daly	4	3	2	common	0.083333	partially protected
<i>Cyrtocymura scorpioides</i>	(Lam.) H.Rob.	1	1	1	form7	0	unprotected
<i>Dacryodes glabra</i>	(Steyerm.) Cuatrec.	5	3	4	common	0.25	partially protected
<i>Dacryodes microcarpa</i>	Cuatrec.	16	3	16	common	0.25	partially protected
<i>Dacryodes roraimensis</i>	Cuatrec.	3	1	2	form5	0.75	partially protected
<i>Dahlstedtia araripensis</i>	(Benth.) M.J. Silva & A.M.G. Azevedo	5	3	5	common	0.333333	partially protected
<i>Dalbergia acuta</i>	Benth.	8	3	3	common	0.185185	partially protected
<i>Dalbergia brasiliensis</i>	Vogel	2	3	1	form6	0.5	partially protected
<i>Dalbergia cearensis</i>	Ducke	6	3	5	common	0.4	partially protected
<i>Dalbergia densiflora</i>	(Benth.)Benth.	1	1	1	form7	1	protected
<i>Dalbergia glaucescens</i>	(Benth.)Benth.	1	1	1	form7	1	protected
<i>Dalbergia miscolobium</i>	Benth.	23	3	14	common	0.119093	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Dalbergia spruceana</i>	(Benth.)Benth.	1	1	1	form7	1	protected
<i>Daphnopsis fasciculata</i>	(Meisn.) Nevling	12	3	6	common	0.175926	partially protected
<i>Daphnopsis filipedunculata</i>	Nevling & Barringer	2	1	2	form5	1	protected
<i>Daphnopsis longipedunculata</i>	Gilg ex Domke	1	3	1	form6	1	protected
<i>Davilla elliptica</i>	A.St.-Hil.	23	3	17	common	0.133501	partially protected
<i>Davilla grandiflora</i>	A.St.-Hil. & Tul.	20	3	13	common	0.146341	partially protected
<i>Davilla nitida</i>	(Vahl) Kubitzki	2	3	2	form4	0.5	partially protected
<i>Dendropanax cuneatus</i>	(DC.) Decne. & Planch.	19	3	10	common	0.214286	partially protected
<i>Dialium guianense</i>	(Aubl.)Sandwith	2	1	1	form7	0.666667	partially protected
<i>Dialypetalanthus fuscescens</i>	Kuhlm.	13	3	10	common	0.5	partially protected
<i>Dilodendron bipinnatum</i>	Radlk.	15	3	13	common	0.127701	partially protected
<i>Dimorphandra gardneriana</i>	Tul.	16	3	13	common	0.17126	partially protected
<i>Dimorphandra mollis</i>	Benth.	20	3	13	common	0.124038	partially protected
<i>Diodella apiculata</i>	(Willd. ex Roem. & Schult.) Delprete	1	1	1	form7	0	unprotected
<i>Diospyros coccolobifolia</i>	Mart. ex Miq.	15	3	6	common	0.156379	partially protected
<i>Diospyros guianensis</i>	(Aubl.) GÃfÂ¼rke	1	1	1	form7	0	unprotected
<i>Diospyros hispida</i>	A.DC.	23	3	17	common	0.141579	partially protected
<i>Diospyros inconstans</i>	Jacq.	19	3	15	common	0.149533	partially protected
<i>Diospyros sericea</i>	A.DC.	18	3	14	common	0.174129	partially protected
<i>Diospyros tetrandra</i>	Hiern	6	1	8	form1	0	unprotected
<i>Diplotropis brasiliensis</i>	(Tul.)Benth.	1	1	1	form7	1	protected
<i>Dipteryx alata</i>	Vogel	22	3	15	common	0.1261	partially protected
<i>Dipteryx lacunifera</i>	Ducke	5	1	3	form1	0	unprotected
<i>Diptychandra aurantiaca</i>	Tul.	20	3	17	common	0.119835	partially protected
<i>Dodonaea viscosa</i>	(L.) Jacq.	10	3	10	common	0.3	partially protected
<i>Drimys brasiliensis</i>	Miers	9	3	5	common	0.363636	partially protected
<i>Duguetia furfuracea</i>	(A.St.-Hil.) Saff.	3	1	2	form5	0.333333	partially protected
<i>Duguetia gardneriana</i>	Mart.	6	3	5	common	0.375	partially protected
<i>Duguetia lanceolata</i>	A.St.-Hil.	9	3	5	common	0.108108	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Duguetia spixiana</i>	Mart.	17	3	12	common	0.4375	partially protected
<i>Duguetia stelechantha</i>	(Diels) R.E.Fr.	16	3	12	common	0	unprotected
<i>Duguetia yeshidan</i>	Sandwith	9	3	8	common	0.6	partially protected
<i>Duroia duckei</i>	Huber	16	3	17	common	0.25	partially protected
<i>Duroia micrantha</i>	(Ladbr.) Zarucchi & J.H.Kirkbr.	1	1	1	form7	1	protected
<i>Ecclinusa dumetorum</i>	(Baehni) T.D.Penn.	1	1	1	form7	0	unprotected
<i>Ecclinusa ramiflora</i>	Mart.	21	3	20	common	0.433333	partially protected
<i>Elaeoluma schomburgkiana</i>	(Miq.) Baill.	14	1	13	form1	0.5	partially protected
<i>Emmotum acuminatum</i>	(Benth.) Miers	1	1	1	form7	1	protected
<i>Emmotum affine</i>	Miers	2	3	1	form6	0.5	partially protected
<i>Emmotum fagifolium</i>	Desv. ex Ham.	3	1	3	form5	0.6	partially protected
<i>Emmotum harleyi</i>	R.Duno	3	3	3	form4	0.333333	partially protected
<i>Emmotum nitens</i>	(Benth.) Miers	23	3	19	common	0.15738	partially protected
<i>Endlicheria paniculata</i>	(Spreng.) J.F.Macbr.	20	3	12	common	0.277778	partially protected
<i>Enterolobium contortisiliquum</i>	(Vell.)Morong	22	3	19	common	0.102273	partially protected
<i>Enterolobium gummiferum</i>	(Mart.)J.F.Macbr.	22	3	13	common	0.118902	partially protected
<i>Eperua bijuga</i>	Mart. ex Benth.	8	3	7	common	0.833333	partially protected
<i>Ephedranthus parviflorus</i>	S.Moore	16	3	10	common	0.404762	partially protected
<i>Ephedranthus pisocarpus</i>	R.E.Fr.	4	3	3	common	0.235294	partially protected
<i>Eremanthus arboreus</i>	(Gardner) MacLeish	1	3	1	form6	1	protected
<i>Eremanthus argenteus</i>	MacLeish & Schumacher	3	1	1	form7	0.666667	partially protected
<i>Eremanthus brasiliensis</i>	(Gardner) MacLeish	3	3	1	form6	0.125	partially protected
<i>Eremanthus capitatus</i>	(Spreng.) MacLeish	11	3	9	common	0.1875	partially protected
<i>Eremanthus cinctus</i>	Baker	8	3	3	common	0.069767	partially protected
<i>Eremanthus crotonoides</i>	(DC.) Sch.Bip.	3	3	3	form4	0.387097	partially protected
<i>Eremanthus elaeagnus</i>	(Mart. ex DC.) Sch.Bip.	8	3	4	common	0.103448	partially protected
<i>Eremanthus erythropappus</i>	(DC.) MacLeish	8	3	4	common	0.146552	partially protected
<i>Eremanthus glomerulatus</i>	Less.	12	3	6	common	0.165266	partially protected
<i>Eremanthus goyazensis</i>	(Gardner) Sch.Bip.	12	3	4	common	0.288288	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Eremanthus incanus</i>	(Less.) Less.	12	3	6	common	0.135802	partially protected
<i>Eremanthus leucodendron</i>	Mattf.	2	1	3	form5	0.333333	partially protected
<i>Eremanthus mattogrossensis</i>	Kuntze	15	3	6	common	0.166667	partially protected
<i>Eremanthus pohlii</i>	(Baker) MacLeish	3	3	2	form4	0.466667	partially protected
<i>Eremanthus polycephalus</i>	(DC.) MacLeish	7	3	4	common	0.157895	partially protected
<i>Eremanthus rondoniensis</i>	MacLeish & H.Schumach.	2	3	3	form4	0.428571	partially protected
<i>Eremanthus uniflorus</i>	MacLeish & H.Schumach.	4	3	3	common	0.25	partially protected
<i>Eremanthus veadeiroensis</i>	H.Rob.	1	1	1	form7	0.5	partially protected
<i>Eriope exaltata</i>	Harley	3	3	2	form4	0.571429	partially protected
<i>Eriope latifolia</i>	(Mart. ex Benth.) Harley	7	3	4	common	0.25	partially protected
<i>Eriotheca gracilipes</i>	(K.Schum.) A.Robyns	20	3	11	common	0.109785	partially protected
<i>Eriotheca macrophylla</i>	(K.Schum.) A.Robyns	7	1	4	form1	0	unprotected
<i>Eriotheca parvifolia</i>	(Mart. & Zucc.) A.Robyns	10	3	2	common	0.2	partially protected
<i>Eriotheca pubescens</i>	(Mart. & Zucc.) Schott & Endl.	14	3	9	common	0.131635	partially protected
<i>Eriotheca roseorum</i>	(Cuatrec.) A.Robyns	7	3	4	common	0.066667	partially protected
<i>Erythrina dominguezii</i>	Hassl.	11	3	6	common	0.321429	partially protected
<i>Erythrina fusca</i>	Lour.	8	3	6	common	0.230769	partially protected
<i>Erythrochiton fallax</i>	Kallunki	6	1	5	form1	0.166667	partially protected
<i>Erythroxylum affine</i>	A.St.-Hil.	1	3	1	form6	0	unprotected
<i>Erythroxylum ambiguum</i>	Peyr.	2	1	1	form7	0	unprotected
<i>Erythroxylum andrei</i>	Plowman	3	3	4	form4	0	unprotected
<i>Erythroxylum anguifugum</i>	Mart.	22	3	14	common	0.205882	partially protected
<i>Erythroxylum arrojadoi</i>	O.E.Schulz	5	3	2	common	0.142857	partially protected
<i>Erythroxylum ayertonianum</i>	Loiola & M.F.Sales	4	3	2	common	0	unprotected
<i>Erythroxylum barbatum</i>	O.E.Schulz	9	3	7	common	0.5625	partially protected
<i>Erythroxylum bezerrae</i>	Plowman	1	1	1	form7	0	unprotected
<i>Erythroxylum buxus</i>	Peyr.	3	1	1	form7	0.5	partially protected
<i>Erythroxylum citrifolium</i>	A.St.-Hil.	27	3	29	common	0.185185	partially protected
<i>Erythroxylum columbinum</i>	Mart.	2	3	1	form6	0.333333	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Erythroxylum cuneifolium</i>	(Mart.) O.E.Schulz	14	3	13	common	0.181818	partially protected
<i>Erythroxylum daphnites</i>	Mart.	19	3	17	common	0.189055	partially protected
<i>Erythroxylum deciduum</i>	A.St.-Hil.	23	3	16	common	0.1703	partially protected
<i>Erythroxylum engleri</i>	O.E.Schulz	15	3	5	common	0.144509	partially protected
<i>Erythroxylum foetidum</i>	Plowman	2	3	1	form6	0	unprotected
<i>Erythroxylum hamigerum</i>	O.E.Schulz	2	1	2	form5	1	protected
<i>Erythroxylum havanense</i>	Jacq.	2	3	2	form4	0	unprotected
<i>Erythroxylum impressum</i>	O.E.Schulz	4	3	1	form2	0.090909	partially protected
<i>Erythroxylum laetevirens</i>	O.E.Schulz	6	3	3	common	0.25	partially protected
<i>Erythroxylum ligustrinum</i>	DC.	8	3	7	common	0.578947	partially protected
<i>Erythroxylum maracasense</i>	Plowman	3	1	2	form5	0.4	partially protected
<i>Erythroxylum mucronatum</i>	Benth.	20	3	19	common	0.444444	partially protected
<i>Erythroxylum oreophilum</i>	(O.E.Schulz ex Pilg.) Steyerl. & Maguire	2	3	2	form4	0.25	partially protected
<i>Erythroxylum orinocense</i>	Kunth	5	3	4	common	0.090909	partially protected
<i>Erythroxylum passerinum</i>	Mart.	10	3	8	common	0.230769	partially protected
<i>Erythroxylum pelleterianum</i>	A.St.-Hil.	11	3	3	common	0.104167	partially protected
<i>Erythroxylum revolutum</i>	Mart.	5	3	2	common	0.166667	partially protected
<i>Erythroxylum rimosum</i>	O.E.Schulz	1	1	1	form7	1	protected
<i>Erythroxylum roraimae</i>	Klotzsch ex O.E.Schulz	1	3	1	form6	1	protected
<i>Erythroxylum rufum</i>	Cav.	29	3	23	common	0.169231	partially protected
<i>Erythroxylum santosii</i>	Plowman	1	1	1	form7	0	unprotected
<i>Erythroxylum schomburgkii</i>	Peyr.	3	3	2	form4	0.727273	partially protected
<i>Erythroxylum squamatum</i>	Sw.	23	3	19	common	0.347826	partially protected
<i>Erythroxylum steyermarkii</i>	Plowman	3	3	1	form6	0.125	partially protected
<i>Erythroxylum suberosum</i>	A.St.-Hil.	33	3	33	common	0.163711	partially protected
<i>Erythroxylum subracemosum</i>	Turcz.	23	3	13	common	0.210526	partially protected
<i>Erythroxylum subrotundum</i>	A.St.-Hil.	9	3	5	common	0.35	partially protected
<i>Erythroxylum tortuosum</i>	Mart.	19	3	12	common	0.139503	partially protected
<i>Erythroxylum ulei</i>	O.E.Schulz	7	3	5	common	0.5	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Erythroxylum vaccinifolium</i>	Mart.	13	3	6	common	0.26	partially protected
<i>Erythroxylum vernicosum</i>	O.E.Schulz	9	3	8	common	0.333333	partially protected
<i>Escallonia chlorophylla</i>	Cham. & Schltdl.	1	1	2	form5	1	protected
<i>Escallonia hispida</i>	(Vell.) Sleumer	1	1	2	form5	0.666667	partially protected
<i>Escallonia reticulata</i>	Sleumer	2	1	2	form5	1	protected
<i>Eschweilera nana</i>	(O.Berg) Miers	20	3	8	common	0.11583	partially protected
<i>Eschweilera ovata</i>	(Cambess.) Mart. ex Miers	19	3	19	common	0.4375	partially protected
<i>Eschweilera subcordata</i>	S.A.Mori	1	1	1	form7	1	protected
<i>Eschweilera wachenheimii</i>	(Benoist) Sandwith	7	3	7	common	1	protected
<i>Esenbeckia febrifuga</i>	(A.St.-Hil.) A.Juss. ex Mart.	13	3	2	common	0.2	partially protected
<i>Esenbeckia grandiflora</i>	Mart.	17	3	13	common	0.213115	partially protected
<i>Esenbeckia irwiniana</i>	Kaastra	3	1	3	form5	0.5	partially protected
<i>Esenbeckia oligantha</i>	Kaastra	8	3	3	common	0.5	partially protected
<i>Euceraea nitida</i>	Mart.	5	3	8	common	1	protected
<i>Eugenia astringens</i>	Cambess.	8	3	6	common	0.416667	partially protected
<i>Eugenia aurata</i>	O.Berg	20	3	15	common	0.151002	partially protected
<i>Eugenia azeda</i>	Sobral	1	3	2	form4	0	unprotected
<i>Eugenia azurensis</i>	O.Berg	1	1	1	form7	0	unprotected
<i>Eugenia bahiensis</i>	DC.	2	3	1	form6	0.25	partially protected
<i>Eugenia biflora</i>	(L.) DC.	26	3	23	common	0.253846	partially protected
<i>Eugenia bimarginata</i>	DC.	1	1	1	form7	0	unprotected
<i>Eugenia brejoensis</i>	Mazine	1	1	1	form7	0	unprotected
<i>Eugenia candolleana</i>	DC.	2	1	1	form7	0.666667	partially protected
<i>Eugenia capparidifolia</i>	DC.	3	3	2	form4	0	unprotected
<i>Eugenia chlorocarpa</i>	O.Berg	1	1	1	form7	1	protected
<i>Eugenia chrysophyllum</i>	Poir.	6	3	3	common	0.090909	partially protected
<i>Eugenia citrifolia</i>	Poir.	1	1	1	form7	1	protected
<i>Eugenia complicata</i>	O.Berg	10	3	5	common	0.151515	partially protected
<i>Eugenia crassa</i>	Sobral	2	1	2	form5	0.5	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Eugenia cribrata</i>	McVaugh	6	3	2	common	0.047619	partially protected
<i>Eugenia dichroma</i>	O.Berg	2	3	1	form6	0.5	partially protected
<i>Eugenia dictyophleba</i>	O.Berg	2	1	2	form5	0.5	partially protected
<i>Eugenia dysenterica</i>	DC.	21	3	13	common	0.139773	partially protected
<i>Eugenia egensis</i>	DC.	26	3	24	common	0.217391	partially protected
<i>Eugenia excelsa</i>	O.Berg	12	3	7	common	0.333333	partially protected
<i>Eugenia ferreiraeana</i>	O.Berg	9	1	11	form1	0.333333	partially protected
<i>Eugenia flavescens</i>	DC.	22	3	20	common	0.226667	partially protected
<i>Eugenia florida</i>	DC.	29	3	30	common	0.160804	partially protected
<i>Eugenia gemmiflora</i>	O.Berg	1	1	2	form5	0	unprotected
<i>Eugenia hartmanniae</i>	Mattos	1	1	1	form7	0	unprotected
<i>Eugenia hiemalis</i>	Cambess.	10	3	3	common	0.235294	partially protected
<i>Eugenia hirta</i>	O.Berg	1	1	1	form7	1	protected
<i>Eugenia incanescens</i>	Benth.	2	3	2	form4	0	unprotected
<i>Eugenia inundata</i>	DC.	18	3	16	common	0.185185	partially protected
<i>Eugenia involucrata</i>	DC.	6	3	3	common	0.190476	partially protected
<i>Eugenia itapemirimensis</i>	Cambess.	1	1	1	form7	0	unprotected
<i>Eugenia klotzschiana</i>	O.Berg	10	3	4	common	0.171717	partially protected
<i>Eugenia lambertiana</i>	DC.	20	3	16	common	0.466667	partially protected
<i>Eugenia laruotteana</i>	Cambess.	4	1	3	form1	0.166667	partially protected
<i>Eugenia ligustrina</i>	(Sw.) Willd.	21	3	15	common	0.359551	partially protected
<i>Eugenia livida</i>	O.Berg	11	3	6	common	0.089109	partially protected
<i>Eugenia macrantha</i>	O.Berg	1	1	1	form7	1	protected
<i>Eugenia mansoi</i>	O.Berg	5	3	2	common	0.142857	partially protected
<i>Eugenia matogrossensis</i>	Sobral	3	3	3	form4	0.153846	partially protected
<i>Eugenia minuscula</i>	McVaugh	1	3	1	form6	1	protected
<i>Eugenia monosperma</i>	Vell.	1	1	1	form7	1	protected
<i>Eugenia myrcianthes</i>	Nied.	10	3	5	common	0.173913	partially protected
<i>Eugenia neoformosa</i>	Sobral	1	1	1	form7	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Eugenia patrisii</i>	Vahl	19	3	20	common	0.333333	partially protected
<i>Eugenia piloensis</i>	Cambess.	7	3	2	common	0.25	partially protected
<i>Eugenia pluriflora</i>	DC.	4	1	3	form1	0	unprotected
<i>Eugenia pohliana</i>	DC.	2	1	3	form5	0.25	partially protected
<i>Eugenia protenta</i>	McVaugh	11	3	14	common	0.625	partially protected
<i>Eugenia puniceifolia</i>	(Kunth) DC.	35	3	39	common	0.173228	partially protected
<i>Eugenia pyrifera</i>	Faria & Proen?Ã,Â°a	3	1	1	form7	0	unprotected
<i>Eugenia sonderiana</i>	O.Berg	9	3	5	common	0.22449	partially protected
<i>Eugenia sparsa</i>	S.Moore	14	3	4	common	0.1	partially protected
<i>Eugenia stictopetala</i>	DC.	30	3	33	common	0.214286	partially protected
<i>Eugenia suberosa</i>	Cambess.	19	3	8	common	0.161074	partially protected
<i>Eugenia sulcata</i>	Spring ex Mart.	2	3	1	form6	0.333333	partially protected
<i>Eugenia ternatifolia</i>	Cambess.	2	3	2	form4	0.375	partially protected
<i>Eugenia uniflora</i>	L.	17	3	12	common	0.234043	partially protected
<i>Eugenia vernicosa</i>	O.Berg	2	3	3	form4	0.076923	partially protected
<i>Eugenia vetula</i>	DC.	10	3	4	common	0.222222	partially protected
<i>Eugenia warmingiana</i>	Kiaersk.	1	1	1	form7	0	unprotected
<i>Euphorbia cotinifolia</i>	L.	1	3	1	form6	0	unprotected
<i>Euphronia acuminatissima</i>	Steyerm.	1	3	1	form6	1	protected
<i>Euphronia guianensis</i>	(R.H.Schomb.) Hallier f.	7	3	8	common	0.555556	partially protected
<i>Euplassa bahiensis</i>	(Meisn.) I.M.Johnst.	2	1	2	form5	0.333333	partially protected
<i>Euplassa inaequalis</i>	(Pohl) Engl.	23	3	19	common	0.147059	partially protected
<i>Euplassa semicostata</i>	Plana	2	1	3	form5	0.5	partially protected
<i>Exellodendron cordatum</i>	(Hook.f.) Prance	12	3	5	common	0.092308	partially protected
<i>Exellodendron gardneri</i>	(Hook.f.) Prance	10	3	6	common	0.196429	partially protected
<i>Exostyles amazonica</i>	Yakovlev	1	3	1	form6	1	protected
<i>Faramea bracteata</i>	Benth.	14	3	7	common	0.166667	partially protected
<i>Faramea capillipes</i>	MÃfÂ¼ll.Arg.	2	3	2	form4	0.5	partially protected
<i>Faramea corymbosa</i>	Aubl.	16	3	12	common	0.147059	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Faramea crassifolia</i>	Benth.	7	3	8	common	0.6	partially protected
<i>Faramea latifolia</i>	(Cham. & Schltdl.) DC.	10	3	2	common	0.145455	partially protected
<i>Faramea multiflora</i>	A.Rich.	1	1	1	form7	0	unprotected
<i>Faramea nitida</i>	Benth.	11	3	7	common	0.25	partially protected
<i>Faramea paniculata</i>	(Aubl.) Benth.	4	1	3	form1	0	unprotected
<i>Faramea stipulacea</i>	(Cham. & Schltdl.) DC.	3	1	2	form5	0.25	partially protected
<i>Ferdinandusa chlorantha</i>	(Wedd.) Standl.	14	3	12	common	0.416667	partially protected
<i>Ferdinandusa elliptica</i>	(Pohl) Pohl	15	3	8	common	0.147727	partially protected
<i>Ferdinandusa nitida</i>	Ducke	1	1	1	form7	0.666667	partially protected
<i>Ferdinandusa speciosa</i>	(Pohl) Pohl	7	3	5	common	0.111111	partially protected
<i>Ficus adhatodifolia</i>	Schott	1	1	1	form7	1	protected
<i>Ficus americana</i>	Aubl.	27	3	33	common	0.297101	partially protected
<i>Ficus bahiensis</i>	C.C.Berg & Carauta	3	1	2	form5	0	unprotected
<i>Ficus catappifolia</i>	Kunth & C.D.Bouché	4	3	4	common	0.4	partially protected
<i>Ficus citrifolia</i>	Mill.	28	3	25	common	0.200855	partially protected
<i>Ficus enormis</i>	(Miq.) Miq.	2	1	1	form7	0	unprotected
<i>Ficus gomelleira</i>	Kunth & C.D.Bouché	5	3	4	common	0	unprotected
<i>Ficus insipida</i>	Willd.	21	3	20	common	0.216216	partially protected
<i>Ficus laureola</i>	Warb. ex C.C.Berg & Carauta	2	1	2	form5	0.4	partially protected
<i>Ficus mathewsii</i>	(Miq.) Miq.	1	1	1	form7	0	unprotected
<i>Ficus maxima</i>	Mill.	21	3	20	common	0.195652	partially protected
<i>Ficus nymphaeifolia</i>	Mill.	20	3	17	common	0.392857	partially protected
<i>Ficus obtusifolia</i>	Kunth	1	1	1	form7	1	protected
<i>Ficus pertusa</i>	L.f.	25	3	25	common	0.237624	partially protected
<i>Ficus trigona</i>	L.f.	24	3	23	common	0.140845	partially protected
<i>Fridericia bahiensis</i>	(Schauer) L.G.Lohmann	3	1	1	form7	0.666667	partially protected
<i>Fridericia dispar</i>	(Bureau ex K.Schum.) L.G.Lohmann	4	3	4	common	0.071429	partially protected
<i>Fridericia platyphylla</i>	(Cham.) L.G.Lohmann	2	3	1	form6	0.181818	partially protected
<i>Galipea ciliata</i>	Taub.	7	3	4	common	0.157895	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Galipea trifoliata</i>	Aubl.	16	3	17	common	0.230769	partially protected
<i>Garcinia brasiliensis</i>	Mart.	2	1	2	form5	0	unprotected
<i>Gaultheria eriophylla</i>	(Pers.) Sleumer ex Burt	1	1	3	form5	0.5	partially protected
<i>Gaylussacia brasiliensis</i>	(Spreng.) Meisn.	16	3	9	common	0.237668	partially protected
<i>Gaylussacia montana</i>	(Pohl) Sleumer	5	3	5	common	0.297297	partially protected
<i>Gaylussacia pseudogaultheria</i>	Cham. & Schltdl.	7	3	4	common	0.285714	partially protected
<i>Gaylussacia salicifolia</i>	Cham. & Schltdl.	4	3	4	common	0.214286	partially protected
<i>Genipa americana</i>	L.	30	3	30	common	0.253807	partially protected
<i>Geonoma deversa</i>	(Poit.) Kunth	21	3	21	common	0.217391	partially protected
<i>Geonoma stricta</i>	(Poit.) Kunth	1	1	1	form7	1	protected
<i>Gliricidia sepium</i>	(Jacq.)Walp.	2	3	2	form4	0.25	partially protected
<i>Godmania aesculifolia</i>	(Kunth) Standl.	13	3	8	common	0.217391	partially protected
<i>Godmania dardanoi</i>	(J.C.Gomes) A.H.Gentry	3	3	2	form4	0	unprotected
<i>Gongylolepis benthamiana</i>	R.H.Schomb.	5	3	3	common	0.6	partially protected
<i>Gongylolepis martiana</i>	(Baker) Steyerl. & Cuatrec.	10	3	10	common	0.285714	partially protected
<i>Gorceixia decurrens</i>	Baker	3	1	3	form5	0.25	partially protected
<i>Gordonia fruticosa</i>	(Schrad.) H.Keng	6	3	6	common	0.263158	partially protected
<i>Goupia glabra</i>	Aubl.	21	3	21	common	0.176471	partially protected
<i>Graffenrieda weddellii</i>	Naudin	12	3	9	common	0.35	partially protected
<i>Guaiacum officinale</i>	L.	1	3	1	form6	0	unprotected
<i>Guapira areolata</i>	(Heimerl) Lundell	13	3	7	common	0.165468	partially protected
<i>Guapira campestris</i>	(Netto) Lundell	12	3	5	common	0.1	partially protected
<i>Guapira graciliflora</i>	(Mart. ex J.A.Schmidt) Lundell	21	3	11	common	0.151815	partially protected
<i>Guapira microphylla</i>	(Heimerl) Lundell	4	3	1	form2	0	unprotected
<i>Guapira noxia</i>	(Netto) Lundell	18	3	10	common	0.120797	partially protected
<i>Guapira obtusata</i>	(Jacq.) Little	13	3	9	common	0.181818	partially protected
<i>Guapira opposita</i>	(Vell.) Reitz	29	3	28	common	0.22	partially protected
<i>Guapira pacurero</i>	(Kunth) Little	2	3	1	form6	0.2	partially protected
<i>Guapira pernambucensis</i>	(Casar.) Lundell	8	3	4	common	0.352941	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Guapira tomentosa</i>	(Casar.) Lundell	3	3	3	form4	0.608696	partially protected
<i>Guarea guidonia</i>	(L.) Sleumer	30	3	29	common	0.265823	partially protected
<i>Guarea kunthiana</i>	A.Juss.	27	3	28	common	0.244898	partially protected
<i>Guatteria australis</i>	A.St.-Hil.	6	3	3	common	0.25	partially protected
<i>Guatteria discolor</i>	R.E.Fr.	16	3	15	common	0.2	partially protected
<i>Guatteria dura</i>	R.E.Fr.	4	1	4	form1	0	unprotected
<i>Guatteria inundata</i>	Mart.	11	3	8	common	0.125	partially protected
<i>Guatteria maypurensis</i>	Kunth	24	3	17	common	0.121951	partially protected
<i>Guatteria rigida</i>	R.E.Fr.	16	3	9	common	0.340909	partially protected
<i>Guatteria rupestris</i>	Mello-Silva & Pirani	4	3	3	common	0.25	partially protected
<i>Guatteria schomburgkiana</i>	Mart.	24	3	28	common	0.166667	partially protected
<i>Guatteria sellowiana</i>	Schltl.	11	3	9	common	0.272059	partially protected
<i>Guazuma ulmifolia</i>	Lam.	29	3	26	common	0.131222	partially protected
<i>Guettarda macrantha</i>	Benth.	19	3	10	common	0.1	partially protected
<i>Guettarda malacophylla</i>	Standl.	1	3	1	form6	0	unprotected
<i>Guettarda platypoda</i>	DC.	12	3	11	common	0.3125	partially protected
<i>Guettarda pohliana</i>	MÃfÂ¼ll.Arg.	8	3	4	common	0.307692	partially protected
<i>Guettarda viburnoides</i>	Cham. & Schltl.	27	3	24	common	0.142574	partially protected
<i>Guibourtia hymenaefolia</i>	(Moric.)J.Leonard	1	1	1	form7	0	unprotected
<i>Gymnanthes glabrata</i>	(Mart.) Govaerts	2	1	1	form7	0.5	partially protected
<i>Hancornia speciosa</i>	Gomes	26	3	24	common	0.156275	partially protected
<i>Handroanthus heptaphyllus</i>	(Vell.) Mattos	3	1	1	form7	0	unprotected
<i>Handroanthus impetiginosus</i>	(Mart. ex DC.) Mattos	23	3	14	common	0.137615	partially protected
<i>Handroanthus ochraceus</i>	(Cham.) Mattos	33	3	26	common	0.149488	partially protected
<i>Handroanthus pulcherrimus</i>	(Sandwith) S.O.Grose	1	1	1	form7	1	protected
<i>Handroanthus serratifolius</i>	(Vahl) S.O.Grose	28	3	30	common	0.215223	partially protected
<i>Haydenoxylon urbanianum</i>	(Loes.) M.P. Simmons	2	1	2	form5	0	unprotected
<i>Hecatostemon completus</i>	(Jacq.) Sleumer	8	3	5	common	0.122449	partially protected
<i>Hedyosmum brasiliense</i>	Mart.	5	3	5	common	0.181818	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Heisteria citrifolia</i>	Engl.	11	3	7	common	0.196262	partially protected
<i>Heisteria ovata</i>	Benth.	24	3	25	common	0.202899	partially protected
<i>Helicteres aspera</i>	A. St.-Hil. & Naudin	1	1	1	form7	0	unprotected
<i>Helicteres baruensis</i>	Jacq.	12	3	8	common	0.210526	partially protected
<i>Helicteres brevispira</i>	A.Juss.	21	3	16	common	0.139344	partially protected
<i>Helicteres corylifolia</i>	Nees & Mart.	19	3	11	common	0.145161	partially protected
<i>Helicteres eichleri</i>	K. Schum.	5	3	2	common	0.375	partially protected
<i>Helicteres guazumifolia</i>	Kunth	17	3	12	common	0.190476	partially protected
<i>Helicteres heptandra</i>	L.B.Sm.	9	3	8	common	0.195122	partially protected
<i>Helicteres lhotzkyana</i>	K.Schum.	11	3	5	common	0.157895	partially protected
<i>Helicteres macropetala</i>	A. St.-Hil.	2	1	2	form5	0	unprotected
<i>Helicteres muscosa</i>	Mart.	7	3	6	common	0.315789	partially protected
<i>Helicteres ovata</i>	Lam.	5	3	4	common	0.111111	partially protected
<i>Helicteres pentandra</i>	L.	18	3	14	common	0.333333	partially protected
<i>Helietta apiculata</i>	Benth.	3	3	1	form6	0.1	partially protected
<i>Helietta glaziovii</i>	(Engl.) Pirani (Vell.) Penneys, F.A. Michelangeli, Judd &	3	1	1	form7	0.2	partially protected
<i>Henriettea glabra</i>	Almeda	3	1	1	form7	0	unprotected
<i>Henriettea granulata</i>	O. Berg & Triana	1	1	1	form7	1	protected
<i>Henriettea maroniensis</i>	Sagot (Cogn.) Penneys, F.A. Michelangeli, Judd &	8	3	7	common	0.636364	partially protected
<i>Henriettea ovata</i>	Almeda	8	3	7	common	0	unprotected
<i>Henriettea saldanhaei</i>	Cogn.	1	1	1	form7	0.666667	partially protected
<i>Henriettea succosa</i>	(Aubl.) DC.	6	3	8	common	0	unprotected
<i>Heterocoma ekmaniana</i>	(Philipson) B. Loeuille, J.N. Nakaj. & Semir	4	1	4	form1	0	unprotected
<i>Heterocoma lanuginosa</i>	(Glaz. ex Oliv.) B. Loeuille, J.N. Nakaj. & Semir	2	1	2	form5	0	unprotected
<i>Heteropterys sincorensis</i>	W.R.Anderson	5	3	3	common	0.333333	partially protected
<i>Heterostemon mimosoides</i>	Desf.	12	3	14	common	0	unprotected
<i>Hieronyma oblonga</i>	(Tul.) MÃfÂ¼ll.Arg.	2	1	1	form7	0.5	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Himatanthus articulatus</i>	(Vahl) Woodson	24	3	26	common	0.273504	partially protected
<i>Himatanthus bracteatus</i>	(A.DC.) Woodson	16	3	16	common	0.285714	partially protected
<i>Himatanthus drasticus</i>	(Mart.) Plumel	25	3	20	common	0.177898	partially protected
<i>Himatanthus obovatus</i>	(MÃfÂ¼ll.Arg.) Woodson	23	3	20	common	0.122661	partially protected
<i>Himatanthus phagedaenicus</i>	(Mart.) Woodson	20	3	17	common	0.177778	partially protected
<i>Himatanthus sucuuba</i>	(Spruce ex MÃfÂ¼ll.Arg.) Woodson	1	1	1	form7	0	unprotected
<i>Himatanthus tarapotensis</i>	(K.Schum. ex Markgr.) Plumel	13	3	9	common	0.25	partially protected
<i>Hirtella bicornis</i>	Mart. & Zucc.	19	3	18	common	0.266667	partially protected
<i>Hirtella burchellii</i>	Britton	21	3	18	common	0.315789	partially protected
<i>Hirtella ciliata</i>	Mart. & Zucc.	24	3	17	common	0.154734	partially protected
<i>Hirtella glandulosa</i>	Spreng.	27	3	21	common	0.244147	partially protected
<i>Hirtella gracilipes</i>	(Hook.f.) Prance	24	3	16	common	0.155361	partially protected
<i>Hirtella paniculata</i>	Sw.	14	3	14	common	0.197368	partially protected
<i>Hirtella punctillata</i>	Ducke	11	3	11	common	0	unprotected
<i>Hirtella racemosa</i>	Lam.	28	3	37	common	0.29064	partially protected
<i>Hirtella scabra</i>	Benth.	8	3	9	common	0.642857	partially protected
<i>Hirtella sprucei</i>	Benth. ex Hook.f.	5	1	2	form1	0	unprotected
<i>Hirtella triandra</i>	Sw.	18	3	18	common	0.478261	partially protected
<i>Hololepis pedunculata</i>	(DC. ex Pers.) DC.	5	3	4	common	0.285714	partially protected
<i>Hornschuchia bryotrophe</i>	Nees	2	1	1	form7	0.666667	partially protected
<i>Hortia oreadica</i>	Gropp, Kallunki & Pirani	5	3	4	common	0	unprotected
<i>Humiria balsamifera</i>	Aubl.	28	3	36	common	0.293532	partially protected
<i>Humiria crassifolia</i>	Mart. ex Urb.	11	3	13	common	0.833333	partially protected
<i>Humirastrum mussungense</i>	Cuatrec.	2	1	1	form7	0.5	partially protected
<i>Hura crepitans</i>	L.	20	3	19	common	0.264706	partially protected
<i>Hyeronima alchorneoides</i>	AllemÃfÆ’Ã,Ã£o	1	1	1	form7	0	unprotected
<i>Hymenaea courbaril</i>	L.	27	3	31	common	0.217391	partially protected
<i>Hymenaea eriogyne</i>	Benth.	10	3	4	common	0.217391	partially protected
<i>Hymenaea longifolia</i>	(Benth.) I.M. Souza, Funch & L.P. Queiroz	5	1	2	form1	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Hymenaea maranhensis</i>	Lee & Lang.	6	3	3	common	0	unprotected
<i>Hymenaea martiana</i>	Hayne	18	3	11	common	0.2	partially protected
<i>Hymenaea rubriflora</i>	Ducke	5	3	4	common	0	unprotected
<i>Hymenaea stigonocarpa</i>	Hayne	22	3	14	common	0.118674	partially protected
<i>Hymenaea velutina</i>	Ducke	6	3	3	common	0.4	partially protected
<i>Hymenolobium heringeranum</i>	Rizzini	1	1	1	form7	1	protected
<i>Hymenolobium petraeum</i>	Ducke	9	3	10	common	0.2	partially protected
<i>Hyptenia salzmännii</i>	(Benth.) Harley	1	1	1	form7	0	unprotected
<i>Hyptidendron arboreum</i>	(Benth.) Harley	3	3	3	form4	0.714286	partially protected
<i>Hyptidendron canum</i>	(Pohl ex Benth.) Harley	13	3	8	common	0.100649	partially protected
<i>Hyptidendron clausenii</i>	(Benth.) Harley	2	1	1	form7	0.5	partially protected
<i>Hyptidendron conspersum</i>	(Benth.) Harley	5	3	1	form2	0.125	partially protected
<i>Hyptidendron glutinosum</i>	(Benth.) Harley	9	3	3	common	0.2	partially protected
<i>Hyptis pachyphylla</i>	Epling	4	1	1	form3	0.6	partially protected
<i>Ilex affinis</i>	Gardner	18	3	13	common	0.22973	partially protected
<i>Ilex asperula</i>	Mart.	4	3	4	common	0.25	partially protected
<i>Ilex brasiliensis</i>	(Spreng.) Loes.	8	3	4	common	0.25641	partially protected
<i>Ilex cerasifolia</i>	Reissek	9	3	4	common	0.185185	partially protected
<i>Ilex conocarpa</i>	Reissek	7	3	4	common	0.309091	partially protected
<i>Ilex dumosa</i>	Reissek	9	3	4	common	0.326531	partially protected
<i>Ilex floribunda</i>	Reissek ex Maxim.	6	3	3	common	0.285714	partially protected
<i>Ilex inundata</i>	Poepp. ex Reissek	16	3	18	common	0.25	partially protected
<i>Ilex jenmanii</i>	Loes.	1	3	1	form6	0	unprotected
<i>Ilex lundii</i>	Warm.	8	3	5	common	0.189189	partially protected
<i>Ilex martiniana</i>	D.Don	3	3	2	form4	0.25	partially protected
<i>Ilex microdonta</i>	Reissek	1	1	1	form7	1	protected
<i>Ilex oligoneura</i>	Loes.	1	1	1	form7	0	unprotected
<i>Ilex paujiensis</i>	Steerm.	1	1	1	form7	1	protected
<i>Ilex polita</i>	Steerm.	1	1	1	form7	1	protected

S	author	lat	population	ecoregion	Form	r	status
<i>Ilex psammophila</i>	Reissek	6	3	4	common	0.285714	partially protected
<i>Ilex pseudobuxus</i>	Reissek	4	3	3	common	0.347826	partially protected
<i>Ilex pseudovaccinium</i>	Reissek ex Maxim.	4	3	3	common	0.444444	partially protected
<i>Ilex retusa</i>	Klotzsch ex Reissek	10	3	11	common	0.555556	partially protected
<i>Ilex theezans</i>	Mart.	7	3	6	common	0.285714	partially protected
<i>Ilex vismüifolia</i>	Reissek	15	3	18	common	0.5	partially protected
<i>Indigofera blanchetiana</i>	Benth.	1	1	1	form7	0	unprotected
<i>Inga alba</i>	(Sw.) Willd.	3	1	2	form5	0.333333	partially protected
<i>Inga bourgonii</i>	(Aubl.) DC.	2	1	2	form5	0.5	partially protected
<i>Inga cabelo</i>	T.D.Penn.	1	1	1	form7	0.666667	partially protected
<i>Inga capitata</i>	Desv.	24	3	29	common	0.38806	partially protected
<i>Inga disticha</i>	Benth.	22	3	20	common	0.071429	partially protected
<i>Inga edulis</i>	Mart.	24	3	24	common	0.384615	partially protected
<i>Inga exfoliata</i>	T.D.Penn. & F.C.P. Garcia	2	1	1	form7	0.666667	partially protected
<i>Inga flagelliformis</i>	(Vell.)Mart.	2	1	1	form7	0.5	partially protected
<i>Inga heterophylla</i>	Willd.	26	3	22	common	0.310345	partially protected
<i>Inga hispida</i>	Benth.	2	1	1	form7	0.666667	partially protected
<i>Inga ingoides</i>	(Rich.)Willd.	8	3	8	common	0.272727	partially protected
<i>Inga lanceifolia</i>	Benth.	1	1	1	form7	1	protected
<i>Inga laurina</i>	(Sw.)Willd.	12	3	7	common	0.210526	partially protected
<i>Inga leptantha</i>	Benth.	2	3	1	form6	0.5	partially protected
<i>Inga nobilis</i>	Willd.	26	3	28	common	0.178571	partially protected
<i>Inga pilosula</i>	(Rich.)J.F.Macbr.	1	1	2	form5	0	unprotected
<i>Inga ruiziana</i>	G.Don	8	3	5	common	0.4	partially protected
<i>Inga splendens</i>	Willd.	20	3	20	common	0.380952	partially protected
<i>Inga stenoptera</i>	Benth.	16	3	16	common	0.173913	partially protected
<i>Inga striolata</i>	T.D.Penn.	6	3	4	common	0.285714	partially protected
<i>Inga subnuda</i>	Salzm. ex Benth.	2	1	1	form7	0.666667	partially protected
<i>Inga thibaudiana</i>	DC.	25	3	31	common	0.337838	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Inga vera</i>	Willd.	23	3	19	common	0.179856	partially protected
<i>Isertia parviflora</i>	Vahl	11	3	13	common	0.214286	partially protected
<i>Ixora brevifolia</i>	Benth.	15	3	5	common	0.153846	partially protected
<i>Jacaranda brasiliana</i>	(Lam.) Pers.	21	3	16	common	0.209434	partially protected
<i>Jacaranda carajasensis</i>	A.H.Gentry	1	1	1	form7	1	protected
<i>Jacaranda caroba</i>	(Vell.) DC.	13	3	8	common	0.166667	partially protected
<i>Jacaranda cuspidifolia</i>	Mart.	16	3	10	common	0.126126	partially protected
<i>Jacaranda irwinii</i>	A.H.Gentry	4	3	3	common	0.347826	partially protected
<i>Jacaranda jasminoides</i>	(Thunb.) Sandwith	9	3	5	common	0.32	partially protected
<i>Jacaranda micrantha</i>	Cham.	2	3	2	form4	0.333333	partially protected
<i>Jacaranda obovata</i>	Cham.	1	1	1	form7	1	protected
<i>Jacaranda praetermissa</i>	Sandwith	10	3	4	common	0.111111	partially protected
<i>Jacaranda puberula</i>	Cham.	7	3	2	common	0.235294	partially protected
<i>Jacaratia corumbensis</i>	Kuntze	9	3	6	common	0.090909	partially protected
<i>Jacaratia spinosa</i>	(Aubl.) A.DC.	21	3	13	common	0.291667	partially protected
<i>Jatropha curcas</i>	L.	15	3	14	common	0.428571	partially protected
<i>Jatropha mollissima</i>	(Pohl) Baill.	13	3	7	common	0.166667	partially protected
<i>Kielmeyera albopunctata</i>	Saddi	2	3	1	form6	0.5	partially protected
<i>Kielmeyera coriacea</i>	Mart. & Zucc.	22	3	17	common	0.134831	partially protected
<i>Kielmeyera cuspidata</i>	Saddi	3	3	3	form4	0.375	partially protected
<i>Kielmeyera grandiflora</i>	(Wawra) Saddi	15	3	8	common	0.155556	partially protected
<i>Kielmeyera lathrophyton</i>	Saddi	16	3	8	common	0.181159	partially protected
<i>Kielmeyera membranacea</i>	Casar.	1	1	1	form7	1	protected
<i>Kielmeyera neglecta</i>	Saddi	4	3	5	common	0	unprotected
<i>Kielmeyera occhioniana</i>	Saddi	2	3	1	form6	0.5	partially protected
<i>Kielmeyera paniculata</i>	Rusby	5	3	4	common	0.142857	partially protected
<i>Kielmeyera petiolaris</i>	Mart. & Zucc.	11	3	6	common	0.12963	partially protected
<i>Kielmeyera pulcherrima</i>	L.B. Sm.	1	1	1	form7	1	protected
<i>Kielmeyera reticulata</i>	Saddi	2	1	3	form5	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Kielmeyera rosea</i>	Mart. & Zucc.	13	3	6	common	0.147059	partially protected
<i>Kielmeyera rubriflora</i>	Cambess.	17	3	12	common	0.127143	partially protected
<i>Kielmeyera speciosa</i>	A. St.-Hil.	16	3	6	common	0.115854	partially protected
<i>Kielmeyera tomentosa</i>	Cambess.	5	3	4	common	0.210526	partially protected
<i>Kielmeyera variabilis</i>	Mart. & Zucc.	2	1	1	form7	0	unprotected
<i>Krameria tomentosa</i>	A. St.-Hil.	4	3	4	common	0.235294	partially protected
<i>Lacistema aggregatum</i>	(P.J.Bergius) Rusby	31	3	24	common	0.270531	partially protected
<i>Lacistema grandifolium</i>	Schnizl.	13	3	9	common	0.428571	partially protected
<i>Lacistema hasslerianum</i>	Chodat	18	3	12	common	0.170404	partially protected
<i>Lacistema polystachyum</i>	Schnizl.	18	3	10	common	0.2	partially protected
<i>Ladenbergia cujabensis</i>	Klotzsch	12	3	4	common	0.209677	partially protected
<i>Ladenbergia hexandra</i>	(Pohl) Klotzsch	3	1	3	form5	0.2	partially protected
<i>Laetia americana</i>	L.	12	3	8	common	0.555556	partially protected
<i>Lafoensia glyptocarpa</i>	Koehne	2	1	2	form5	0.5	partially protected
<i>Lafoensia pacari</i>	A. St.-Hil.	28	3	22	common	0.139623	partially protected
<i>Lafoensia vandelliana</i>	Cham. & Schltdl.	14	3	12	common	0.208333	partially protected
<i>Lamanonia cuneata</i>	(Cambess.) Kuntze	3	1	2	form5	0.4	partially protected
<i>Lamanonia ternata</i>	Vell.	10	3	5	common	0.265306	partially protected
<i>Lantana camara</i>	L.	2	3	2	form4	0	unprotected
<i>Lantana canescens</i>	Kunth	1	1	1	form7	0	unprotected
<i>Lantana cujabensis</i>	Schauer	1	3	1	form6	1	protected
<i>Lavoisiera nervulosa</i>	Naudin	2	1	2	form5	0	unprotected
<i>Leandra aurea</i>	(Cham.) Cogn.	14	3	8	common	0.285714	partially protected
<i>Leandra melastomoides</i>	Raddi	4	3	2	common	0.384615	partially protected
<i>Leandra rufescens</i>	(DC.) Cogn.	8	3	7	common	0.090909	partially protected
<i>Lecythis pisonis</i>	Cambess.	16	3	18	common	0.333333	partially protected
<i>Leocereus bahiensis</i>	Britton & Rose	5	3	3	common	0.4	partially protected
<i>Lepidaploa remotiflora</i>	(Rich.) H.Rob.	1	1	1	form7	0	unprotected
<i>Leptolobium brachystachyum</i>	(Benth.) Sch.Rodr. & A.M.G.Azevedo	4	3	3	common	0.47619	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Leptolobium glaziovianum</i>	(Harms) Sch.Rodr. & A.M.G.Azevedo (G.A. Aymard & V. Gonz�lez) Sch. Rodr. & A.M.G.	5	3	1	form2	0.4	partially protected
<i>Leptolobium stirtonii</i>	A.M.G.	3	3	3	form4	0.363636	partially protected
<i>Leucochloron incuriale</i>	(Vell.)Barneby & J.W.Grimes	2	1	3	form5	0.333333	partially protected
<i>Leucochloron minarum</i>	(Harms)Barneby & J.W.Grimes	1	1	1	form7	0	unprotected
<i>Libidibia ferrea</i>	(Mart. ex Tul.) L.P.Queiroz	6	3	4	common	0.16	partially protected
<i>Licania apetala</i>	(E.Mey.) Fritsch	28	3	28	common	0.267717	partially protected
<i>Licania blackii</i>	Prance	20	3	16	common	0.333333	partially protected
<i>Licania dealbata</i>	Hook.f.	12	3	4	common	0.246914	partially protected
<i>Licania egleri</i>	Prance	18	3	17	common	0.4	partially protected
<i>Licania gardneri</i>	(Hook.f.) Fritsch.	15	3	8	common	0.207547	partially protected
<i>Licania humilis</i>	Cham. & Schltdl.	13	3	10	common	0.117424	partially protected
<i>Licania hypoleuca</i>	Benth.	26	3	26	common	0.172414	partially protected
<i>Licania incana</i>	Aubl.	12	3	16	common	0.461538	partially protected
<i>Licania kunthiana</i>	Hook.f.	24	3	25	common	0.304348	partially protected
<i>Licania lasseri</i>	Maguire	3	3	2	form4	0.666667	partially protected
<i>Licania licaniflora</i>	(Sagot) S.F.Blake	13	3	14	common	0.545455	partially protected
<i>Licania minutiflora</i>	(Sagot) Fritsch	11	3	12	common	0.222222	partially protected
<i>Licania nitida</i>	Hook.f.	4	3	3	common	0.307692	partially protected
<i>Licania octandra</i>	(Hoffmanns. ex Schult.) Kuntze	7	3	3	common	0	unprotected
<i>Licania parvifolia</i>	Huber	20	3	17	common	0.173913	partially protected
<i>Licania rigida</i>	Benth.	6	3	5	common	0.5	partially protected
<i>Licania sclerophylla</i>	(Mart. ex Hook.f.) Fritsch	7	3	3	common	0.4	partially protected
<i>Licania steyermarkii</i>	Maguire	1	3	1	form6	1	protected
<i>Lindackeria latifolia</i>	Benth.	13	3	14	common	0.5	partially protected
<i>Lippia origanoides</i>	Kunth	2	1	1	form7	0.666667	partially protected
<i>Lithraea brasiliensis</i>	Marchand	2	1	1	form7	0	unprotected
<i>Lonchocarpus punctatus</i>	Kunth	1	3	1	form6	0	unprotected
<i>Lonchocarpus sericeus</i>	(Poir.)DC.	3	3	2	form4	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Luehea candicans</i>	Mart.	13	3	5	common	0.142857	partially protected
<i>Luehea cymulosa</i>	Spruce ex Benth.	4	3	1	form2	0.1	partially protected
<i>Luehea divaricata</i>	Mart.	13	3	4	common	0.183673	partially protected
<i>Luehea grandiflora</i>	Mart.	21	3	16	common	0.084034	partially protected
<i>Luehea paniculata</i>	Mart.	26	3	20	common	0.103343	partially protected
<i>Luehea speciosa</i>	Willd.	5	3	3	common	0.1875	partially protected
<i>Lueheopsis hoehnei</i>	Burret	6	3	4	common	0	unprotected
<i>Luetzelburgia auriculata</i>	(Allemao)Ducke	11	3	7	common	0.083333	partially protected
<i>Luetzelburgia praecox</i>	(Harms)Harms	11	3	3	common	0.181818	partially protected
<i>Luetzelburgia sotoi</i>	D. Cardoso, L.P. Queiroz & H.C. Lima	1	1	3	form5	0	unprotected
<i>Luxemburgia corymbosa</i>	A.St.-Hil.	1	1	1	form7	1	protected
<i>Luxemburgia mogolensis</i>	Feres	2	1	1	form7	0.5	partially protected
<i>Lychnophora crispa</i>	Mattf.	5	3	5	common	0.571429	partially protected
<i>Lychnophora diamantinana</i>	Coile & S.B.Jones	4	3	2	common	0	unprotected
<i>Lychnophora ericoides</i>	Mart.	10	3	7	common	0.217105	partially protected
<i>Lychnophora granmogolensis</i>	(Duarte) D.J.N.Hind	6	3	5	common	0.333333	partially protected
<i>Lychnophora humillima</i>	Sch.Bip.	1	1	3	form5	0.666667	partially protected
<i>Lychnophora markgravii</i>	G.M.Barroso	3	1	2	form5	0.5	partially protected
<i>Lychnophora pohlii</i>	Sch.Bip.	3	3	3	form4	0.333333	partially protected
<i>Lychnophora reticulata</i>	Gardner	6	3	3	common	0.340426	partially protected
<i>Lychnophora rosmarinifolia</i>	Mart.	6	3	5	common	0.214286	partially protected
<i>Lychnophora rupestris</i>	Semir	1	1	2	form5	0.5	partially protected
<i>Lychnophora salicifolia</i>	Mart.	10	3	6	common	0.176471	partially protected
<i>Lychnophora santosii</i>	H.Rob.	2	1	3	form5	0.25	partially protected
<i>Lychnophora sellowii</i>	Sch.Bip.	2	1	3	form5	0.333333	partially protected
<i>Lychnophora souzae</i>	H.Rob.	1	1	1	form7	0	unprotected
<i>Lychnophora staavioides</i>	Mart.	2	1	2	form5	0.25	partially protected
<i>Lychnophora tomentosa</i>	(Mart. ex DC.) Sch.Bip.	2	3	3	form4	0.25	partially protected
<i>Lychnophora villosissima</i>	Mart.	5	3	3	common	0.230769	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Lychnophoriopsis candelabrum</i>	(Sch.Bip.) H.Rob.	2	1	3	form5	0.2	partially protected
<i>Lychnophoriopsis damazioi</i>	(Beauverd) H.Rob.	2	1	2	form5	0.25	partially protected
<i>Lychnophoriopsis hatschbachii</i>	H.Rob.	1	1	1	form7	0	unprotected
<i>Mabea angustifolia</i>	Spruce ex Benth.	21	3	22	common	0.361702	partially protected
<i>Mabea anomala</i>	MÃfÂ¼ll.Arg.	3	1	2	form5	0.333333	partially protected
<i>Mabea fistulifera</i>	Mart.	22	3	16	common	0.181185	partially protected
<i>Mabea montana</i>	MÃfÂ¼ll.Arg.	1	1	1	form7	1	protected
<i>Mabea nitida</i>	Spruce ex Benth.	24	3	25	common	0.066667	partially protected
<i>Mabea paniculata</i>	Spruce ex Benth.	20	3	13	common	0.311475	partially protected
<i>Mabea pohliana</i>	(Benth.) MÃfÂ¼ll.Arg.	1	1	1	form7	0	unprotected
<i>Mabea subsessilis</i>	Pax & K.Hoffm.	21	3	23	common	0.285714	partially protected
<i>Mabea taquari</i>	Aubl.	14	3	15	common	0.074074	partially protected
<i>Macairea pachyphylla</i>	Benth.	20	3	16	common	0.541667	partially protected
<i>Macairea radula</i>	(Bonpl.) DC.	1	1	1	form7	0	unprotected
<i>Macairea thyrsoflora</i>	DC.	24	3	24	common	0.394737	partially protected
<i>Machaerium acutifolium</i>	Vogel	27	3	22	common	0.137239	partially protected
<i>Machaerium aristulatum</i>	(Benth.)Ducke	6	3	2	common	0.117647	partially protected
<i>Machaerium brasiliense</i>	Vogel	15	3	5	common	0.08642	partially protected
<i>Machaerium eriocarpum</i>	Benth.	5	3	3	common	0.181818	partially protected
<i>Machaerium ferox</i>	(Benth.)Ducke	3	3	4	form4	0.166667	partially protected
<i>Machaerium inundatum</i>	(Benth.)Ducke	1	1	1	form7	0	unprotected
<i>Machaerium isadelphum</i>	(E.Mey.)Standl.	13	3	9	common	0.121212	partially protected
<i>Machaerium lunatum</i>	(L.f.)Ducke	1	1	1	form7	0.333333	partially protected
<i>Machaerium mucronulatum</i>	Benth.	3	3	1	form6	0.4	partially protected
<i>Machaerium opacum</i>	Vogel	16	3	11	common	0.127371	partially protected
<i>Machaerium punctatum</i>	Pers.	2	1	1	form7	0.25	partially protected
<i>Machaerium quinata</i>	(Aubl.)Sandwith	3	1	2	form5	0.75	partially protected
<i>Machaerium villosum</i>	Vogel	14	3	9	common	0.150685	partially protected
<i>Machaonia brasiliensis</i>	(Hoffmanss. ex Humb.) Cham. & Schltdl.	11	3	10	common	0.3125	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Maclura tinctoria</i>	(L.) D.Don ex Steud.	32	3	29	common	0.149837	partially protected
<i>Macrolobium acaciifolium</i>	(Benth.)Benth.	2	1	2	form5	0.25	partially protected
<i>Macrolobium bifolium</i>	(Aubl.)Pers.	4	3	1	form2	0.1	partially protected
<i>Macrolobium campestre</i>	Huber	19	3	20	common	0.333333	partially protected
<i>Macrolobium latifolium</i>	Vogel	2	3	1	form6	0.333333	partially protected
<i>Macrolobium multijugum</i>	(DC.)Benth.	5	3	1	form2	0.071429	partially protected
<i>Macrolobium urupaense</i>	Hoehne	4	1	4	form1	0.5	partially protected
<i>Macropeplus ligustrinus</i>	(Tul.) Perkins	7	3	5	common	0.34375	partially protected
<i>Macropeplus schwackeanus</i>	(Perkins) I.Santos & Peixoto	1	1	2	form5	0.666667	partially protected
<i>Magnolia ovata</i>	(A.St.-Hil.) Spreng.	8	3	2	common	0.233333	partially protected
<i>Magonia pubescens</i>	A. St.-Hil.	21	3	14	common	0.116223	partially protected
<i>Malouetia pubescens</i>	Markgr.	2	1	2	form5	0	unprotected
<i>Malouetia tamaquarina</i>	(Aubl.) A.DC.	20	3	21	common	0.3	partially protected
<i>Malpighia emarginata</i>	DC.	1	3	1	form6	0	unprotected
<i>Manihot anomala</i>	Pohl	1	1	1	form7	0	unprotected
<i>Manihot caerulea</i>	Pohl	24	3	17	common	0.161491	partially protected
<i>Manihot esculenta</i>	Crantz	1	3	1	form6	1	protected
<i>Manihot jacobinensis</i>	MÃfÂ¼ll.Arg.	3	3	2	form4	0.571429	partially protected
<i>Manihot maracasensis</i>	Ule	1	1	1	form7	0	unprotected
<i>Manihot tripartita</i>	(Spreng.) MÃfÂ¼ll.Arg.	2	1	1	form7	0.5	partially protected
<i>Manilkara rufula</i>	(Miq.) H.J.Lam	1	1	2	form5	0	unprotected
<i>Manilkara salzmanii</i>	(A.DC.) H.J.Lam	4	3	3	common	0.333333	partially protected
<i>Manilkara subsericea</i>	(Mart.) Dubard	1	1	1	form7	0.666667	partially protected
<i>Manilkara triflora</i>	(AllemÃfÂ£o) Monach.	2	1	1	form7	0	unprotected
<i>Maprounea brasiliensis</i>	A.St.-Hil.	25	3	16	common	0.170068	partially protected
<i>Maprounea guianensis</i>	Aubl.	28	3	26	common	0.233766	partially protected
<i>Margaritaria nobilis</i>	L.f.	30	3	24	common	0.234783	partially protected
<i>Marlierea buxifolia</i>	Amshoff	1	3	1	form6	1	protected
<i>Marlierea excoriata</i>	Mart.	4	3	3	common	0.444444	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Marlierea involucrata</i>	(O.Berg) Nied.	1	1	1	form7	1	protected
<i>Marlierea maguirei</i>	McVaugh	1	1	1	form7	1	protected
<i>Marlierea neuwiedeanana</i>	(O.Berg) Nied.	2	3	1	form6	0.333333	partially protected
<i>Marlierea obscura</i>	O.Berg	2	3	2	form4	0.444444	partially protected
<i>Marlierea obversa</i>	D.Legrand	2	3	1	form6	0.5	partially protected
<i>Marlierea tomentosa</i>	Cambess.	2	3	1	form6	0.5	partially protected
<i>Martiodendron elatum</i>	(Ducke) Gleason	12	3	10	common	0.090909	partially protected
<i>Martiodendron mediterraneum</i>	(Mart. ex Benth.) R.C.Koeppen	4	3	4	common	0.105263	partially protected
<i>Matayba arborescens</i>	(Aubl.) Radlk.	23	3	22	common	0.319149	partially protected
<i>Matayba discolor</i>	Radlk.	1	1	1	form7	1	protected
<i>Matayba elaeagnoides</i>	Radlk.	4	3	2	common	0.133333	partially protected
<i>Matayba guianensis</i>	Aubl.	34	3	41	common	0.185658	partially protected
<i>Matayba heterophylla</i>	(Mart.) Radlk.	10	3	5	common	0.15625	partially protected
<i>Matayba inelegans</i>	Radlk.	2	1	1	form7	0	unprotected
<i>Matayba intermedia</i>	Radlk.	1	1	1	form7	1	protected
<i>Matayba mollis</i>	Radlk.	5	3	3	common	0.151515	partially protected
<i>Matayba opaca</i>	Radlk.	17	3	21	common	0.421053	partially protected
<i>Matayba punctata</i>	Radlk.	1	1	1	form7	0	unprotected
<i>Matayba purgans</i>	(Poepp.) Radlk.	13	3	10	common	0.25	partially protected
<i>Matelea maritima</i>	(Jacq.) Woodson	1	1	1	form7	0	unprotected
<i>Mauria thaumatophylla</i>	Loes.	1	1	2	form5	1	protected
<i>Mauritia flexuosa</i>	L.f.	30	3	31	common	0.24812	partially protected
<i>Mauritiella aculeata</i>	(Kunth) Burret	18	3	21	common	0.176471	partially protected
<i>Mauritiella armata</i>	(Mart.) Burret	24	3	29	common	0.367089	partially protected
<i>Maytenus boaria</i>	Molina	1	1	1	form7	0	unprotected
<i>Maytenus distichophylla</i>	Mart.	8	3	7	common	0.266667	partially protected
<i>Maytenus erythroxyla</i>	Reissek	9	3	9	common	0.28125	partially protected
<i>Maytenus gonoclada</i>	Mart.	11	3	5	common	0.211538	partially protected
<i>Maytenus guyanensis</i>	Klotzsch ex Reissek	19	3	23	common	0.428571	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Maytenus ilicifolia</i>	Mart. ex Reissek	7	3	2	common	0.083333	partially protected
<i>Maytenus imbricata</i>	Mart. ex Reiss.	3	3	1	form6	0.2	partially protected
<i>Maytenus laevis</i>	Reissek	8	3	8	common	1	protected
<i>Maytenus myrsinoides</i>	Reissek	7	3	8	common	0.625	partially protected
<i>Maytenus oblongata</i>	Reissek	3	3	2	form4	0	unprotected
<i>Maytenus obtusifolia</i>	Mart.	9	3	8	common	0.619048	partially protected
<i>Maytenus opaca</i>	Reissek	5	3	3	common	0.333333	partially protected
<i>Maytenus pittieriana</i>	Steyerm.	7	3	2	common	0	unprotected
<i>Maytenus planifolia</i>	A.C. Sm.	1	1	1	form7	1	protected
<i>Maytenus rigida</i>	Mart.	9	3	3	common	0.222222	partially protected
<i>Maytenus schumanniana</i>	Loes.	1	1	1	form7	1	protected
<i>Melanopsidium nigrum</i>	Colla	2	3	1	form6	0.5	partially protected
<i>Melicoccus oliviformis</i>	Kunth	9	3	8	common	0	unprotected
<i>Meliosma frondosa</i>	Cuatrec. & Idrobo	2	1	2	form5	1	protected
<i>Meriania urceolata</i>	Triana	19	3	17	common	0.5	partially protected
<i>Merianthera eburnea</i>	R.Goldenb. & Fraga	3	3	3	form4	0.307692	partially protected
<i>Merianthera sipolisii</i>	(Glaz. & Cogn.) Wurdack	3	3	3	form4	0.333333	partially protected
<i>Metrodorea mollis</i>	Taub.	6	3	3	common	0.263158	partially protected
<i>Mezilaurus crassiramea</i>	(Meisn.) Taub. ex Mez	18	3	9	common	0.131579	partially protected
<i>Mezilaurus itauba</i>	(Meisn.) Taub. ex Mez	1	1	1	form7	1	protected
<i>Mezilaurus vanderwerffii</i>	Alves, F.M. & Baitello	5	1	2	form1	0	unprotected
<i>Miconia affinis</i>	DC.	28	3	31	common	0.311475	partially protected
<i>Miconia alata</i>	(Aubl.) DC.	19	3	16	common	0.531915	partially protected
<i>Miconia albicans</i>	(Sw.) Steud.	35	3	32	common	0.165468	partially protected
<i>Miconia alternans</i>	Naudin	1	1	1	form7	1	protected
<i>Miconia amoena</i>	Triana	4	3	3	common	0.285714	partially protected
<i>Miconia ampla</i>	Triana	12	3	8	common	0.375	partially protected
<i>Miconia aplostachya</i>	(Bonpl.) DC.	18	3	20	common	0.22	partially protected
<i>Miconia argyrophylla</i>	DC.	20	3	21	common	0.24	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Miconia aureoides</i>	Cogn.	7	3	3	common	0	unprotected
<i>Miconia borjensis</i>	Wurdack	4	3	1	form2	0.071429	partially protected
<i>Miconia brevipes</i>	Benth.	8	3	7	common	0.875	partially protected
<i>Miconia burchellii</i>	Triana	14	3	6	common	0.28125	partially protected
<i>Miconia caudigera</i>	DC.	5	3	4	common	0.25	partially protected
<i>Miconia chamissois</i>	Naudin	18	3	8	common	0.149533	partially protected
<i>Miconia chrysophylla</i>	(Rich.) Urb.	20	3	19	common	0.444444	partially protected
<i>Miconia cinerascens</i>	Miq.	2	3	2	form4	0	unprotected
<i>Miconia corallina</i>	Spring	3	3	3	form4	0.47619	partially protected
<i>Miconia crassinervia</i>	Cogn.	19	3	12	common	0.090909	partially protected
<i>Miconia cuspidata</i>	Mart. ex Naudin	24	3	18	common	0.304348	partially protected
<i>Miconia elegans</i>	Cogn.	17	3	6	common	0.257143	partially protected
<i>Miconia fallax</i>	DC.	1	3	1	form6	1	protected
<i>Miconia ferruginata</i>	DC.	20	3	18	common	0.157986	partially protected
<i>Miconia flammea</i>	Casar.	1	1	3	form5	0.333333	partially protected
<i>Miconia herpetica</i>	DC.	1	1	2	form5	0	unprotected
<i>Miconia holosericea</i>	(L.) DC.	23	3	23	common	0.283019	partially protected
<i>Miconia hyemalis</i>	A. St.-Hil. & Naudin	2	3	1	form6	0.666667	partially protected
<i>Miconia irwinii</i>	Wurdack	5	3	4	common	0.363636	partially protected
<i>Miconia latecrenata</i>	(DC.) Naudin	7	3	2	common	0.277778	partially protected
<i>Miconia lepidota</i>	Schrank & Mart. ex DC.	2	1	2	form5	0.5	partially protected
<i>Miconia leucocarpa</i>	DC.	10	3	3	common	0.327586	partially protected
<i>Miconia ligustroides</i>	(DC.) Naudin	17	3	8	common	0.156584	partially protected
<i>Miconia lourteigiana</i>	Wurdack	9	3	6	common	0.625	partially protected
<i>Miconia lymanii</i>	Wurdack	1	1	1	form7	1	protected
<i>Miconia macrothyrsa</i>	Benth.	23	3	16	common	0.138686	partially protected
<i>Miconia minutiflora</i>	(Bonpl.) DC.	22	3	19	common	0.267857	partially protected
<i>Miconia paucidens</i>	DC.	4	3	2	common	0.193548	partially protected
<i>Miconia pepericarpa</i>	Mart. ex DC.	4	3	2	common	0.5	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Miconia phaeophylla</i>	Triana	16	3	22	common	0.466667	partially protected
<i>Miconia prasina</i>	(Sw.) DC.	26	3	26	common	0.239437	partially protected
<i>Miconia rubiginosa</i>	(Bonpl.) DC.	29	3	23	common	0.212598	partially protected
<i>Miconia ruficalyx</i>	Gleason	13	3	9	common	0.4	partially protected
<i>Miconia sclerophylla</i>	Triana	7	3	5	common	0.173913	partially protected
<i>Miconia sellowiana</i>	Naudin	11	3	5	common	0.364583	partially protected
<i>Miconia serialis</i>	DC.	8	3	9	common	0.333333	partially protected
<i>Miconia setosociliata</i>	Cogn.	2	3	1	form6	0.333333	partially protected
<i>Miconia staminea</i>	DC.	1	1	1	form7	1	protected
<i>Miconia stenostachya</i>	DC.	34	3	37	common	0.177479	partially protected
<i>Miconia stephananthera</i>	Ule	12	3	9	common	0.285714	partially protected
<i>Miconia tetraspermoides</i>	Wurdack	10	3	8	common	0.6	partially protected
<i>Miconia theizans</i>	(Bonpl.) Cogn.	12	3	6	common	0.19802	partially protected
<i>Miconia tiliifolia</i>	Naudin	1	3	1	form6	1	protected
<i>Miconia tillettii</i>	Wurdack	1	3	1	form6	1	protected
<i>Miconia tomentosa</i>	(Rich.) D. Don ex DC.	1	1	1	form7	1	protected
<i>Micranthocereus albicephalus</i>	(Buining & Brederoo) F. Ritter	2	1	2	form5	0.5	partially protected
<i>Micranthocereus purpureus</i>	(GÃfÂ¼rke) F. Ritter	5	3	3	common	0.363636	partially protected
<i>Micropholis gardneriana</i>	(A.DC.) Pierre	18	3	13	common	0.310345	partially protected
<i>Micropholis suborbicularis</i>	AubrÃfÂ©v.	1	1	1	form7	1	protected
<i>Micropholis venulosa</i>	(Mart. & Eichler ex Miq.) Pierre	5	3	4	common	0.333333	partially protected
<i>Mimosa acutistipula</i>	(Mart.) Benth.	17	3	10	common	0.254237	partially protected
<i>Mimosa adenophylla</i>	Taub.	1	1	1	form7	1	protected
<i>Mimosa arenosa</i>	(Willd.) Poir.	13	3	6	common	0.185185	partially protected
<i>Mimosa artemisiana</i>	Heringer & Paula	1	1	1	form7	0.666667	partially protected
<i>Mimosa bimucronata</i>	(DC.) Kuntze	10	3	4	common	0.045455	partially protected
<i>Mimosa caesalpinifolia</i>	Benth.	3	3	2	form4	0.173913	partially protected
<i>Mimosa clausenii</i>	Benth.	12	3	3	common	0.163934	partially protected
<i>Mimosa decorticans</i>	Barneby	4	3	1	form2	0.333333	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Mimosa exalbescens</i>	Barneby	2	1	2	form5	0	unprotected
<i>Mimosa flocculosa</i>	Burkart	1	3	1	form6	0	unprotected
<i>Mimosa gemmulata</i>	Barneby	13	3	6	common	0.144578	partially protected
<i>Mimosa glutinosa</i>	Malme	3	3	2	form4	0.1	partially protected
<i>Mimosa hexandra</i>	Micheli	9	3	5	common	0.4	partially protected
<i>Mimosa huanchacae</i>	Barneby	2	1	1	form7	1	protected
<i>Mimosa interrupta</i>	Benth.	6	3	2	common	0.108696	partially protected
<i>Mimosa irrigua</i>	Barneby	2	1	2	form5	0.25	partially protected
<i>Mimosa lewisii</i>	Barneby	3	3	3	form4	0.2	partially protected
<i>Mimosa manidea</i>	Barneby	4	3	2	common	0.555556	partially protected
<i>Mimosa micropteris</i>	Benth.	2	3	2	form4	0.6	partially protected
<i>Mimosa myuros</i>	Barneby	1	1	1	form7	1	protected
<i>Mimosa nothopteris</i>	Barneby	1	1	1	form7	0	unprotected
<i>Mimosa obovata</i>	Benth.	12	3	4	common	0.061538	partially protected
<i>Mimosa ophthalmocentra</i>	Benth.	3	1	2	form5	0.166667	partially protected
<i>Mimosa paraibana</i>	Barneby	1	1	1	form7	0	unprotected
<i>Mimosa pithecolobioides</i>	Benth.	8	3	5	common	0.112676	partially protected
<i>Mimosa pteridifolia</i>	Benth.	12	3	5	common	0.139241	partially protected
<i>Mimosa regina</i>	Barneby	1	1	1	form7	1	protected
<i>Mimosa regnellii</i>	Benth.	1	1	1	form7	1	protected
<i>Mimosa rheiptera</i>	Barneby	2	1	1	form7	0.5	partially protected
<i>Mimosa scabrella</i>	Benth.	2	1	2	form5	0	unprotected
<i>Mimosa schomburgkii</i>	Benth.	7	3	5	common	0	unprotected
<i>Mimosa sericantha</i>	Benth.	9	3	4	common	0.109375	partially protected
<i>Mimosa tenuiflora</i>	(Willd.)Poir.	5	3	2	common	0.25	partially protected
<i>Mimosa verrucosa</i>	Benth.	10	3	4	common	0.173077	partially protected
<i>Moldenhawera acuminata</i>	Afr. Fernandes & P. Bezerra	4	3	3	common	0.111111	partially protected
<i>Moldenhawera emarginata</i>	(Spreng.) L.P. Queiroz & Allkin	1	1	3	form5	0.666667	partially protected
<i>Moldenhawera nutans</i>	L.P. Queiroz, G.P. Lewis & Allkin	1	1	3	form5	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Mollia burchellii</i>	Sprague	10	3	5	common	0.172414	partially protected
<i>Mollia lepidota</i>	Spruce ex Benth.	19	3	18	common	0.307692	partially protected
<i>Mollinedia fruticulosa</i>	Perkins	1	1	1	form7	1	protected
<i>Mollinedia glabra</i>	(Spreng.) Perkins	1	1	1	form7	1	protected
<i>Moquinia racemosa</i>	(Spreng.) DC.	8	3	5	common	0.285714	partially protected
<i>Moquiniastrium blanchetianum</i>	(DC.) G. Sancho	11	3	6	common	0.195122	partially protected
<i>Moquiniastrium floribundum</i>	(Cabrera) G. Sancho	9	3	5	common	0.1875	partially protected
<i>Moquiniastrium hatschbachii</i>	(Cabrera) G. Sancho	2	1	2	form5	0.2	partially protected
<i>Moquiniastrium oligocephalum</i>	(Gardner) G. Sancho	7	3	6	common	0.4	partially protected
<i>Moquiniastrium paniculatum</i>	(Less.) G. Sancho	13	3	7	common	0.15493	partially protected
<i>Moquiniastrium polymorphum</i>	(Less.) G. Sancho	14	3	8	common	0.153846	partially protected
<i>Moquiniastrium pulchrum</i>	(Cabrera) G. Sancho	7	3	2	common	0.225806	partially protected
<i>Moquiniastrium velutinum</i>	(Bong.) G. Sancho	4	3	3	common	0.571429	partially protected
<i>Morithamnus ganophyllus</i>	(Matf. ex Pilg.) R.M.King & H.Rob.	2	1	2	form5	0.5	partially protected
<i>Mouriri apiranga</i>	Spruce ex Triana	15	3	16	common	0.482759	partially protected
<i>Mouriri arborea</i>	Gardner	2	3	1	form6	0.5	partially protected
<i>Mouriri cearensis</i>	Huber	4	3	4	common	0.75	partially protected
<i>Mouriri dumetosa</i>	Cogn.	10	3	10	common	0.1	partially protected
<i>Mouriri elliptica</i>	Mart.	20	3	9	common	0.103175	partially protected
<i>Mouriri glazioviana</i>	Cogn.	10	3	4	common	0.21875	partially protected
<i>Mouriri grandiflora</i>	DC.	19	3	21	common	0.380952	partially protected
<i>Mouriri guianensis</i>	Aubl.	30	3	27	common	0.192	partially protected
<i>Mouriri myrtilloides</i>	(Sw.) Poir.	8	3	5	common	0.2	partially protected
<i>Mouriri pusa</i>	Gardner ex Gardner	17	3	15	common	0.117117	partially protected
<i>Mouriri vernicosa</i>	Naudin	12	1	8	form1	0.6	partially protected
<i>Moutabea excoriata</i>	Mart. ex Miq.	12	3	6	common	0.380952	partially protected
<i>Moutabea guianensis</i>	Aubl.	18	3	20	common	0.142857	partially protected
<i>Muellera frutescens</i>	(Aubl.) Standl.	3	1	3	form5	0.333333	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Muelleria montana</i>	(M.J. Silva & A.M.G. Azevedo) M.J. Silva & A.M.G.	1	1	1	form7	0	unprotected
<i>Muelleria obtusa</i>	(Benth.) M.J. Silva & A.M.G. Azevedo	1	1	1	form7	0	unprotected
<i>Muntingia calabura</i>	L.	13	3	10	common	0.166667	partially protected
<i>Myracrodruon urundeuva</i>	AllemÃfÃfo	19	3	12	common	0.088235	partially protected
<i>Myrceugenia acutiflora</i>	(Kiaersk.) D.Legrand & Kausel	1	1	1	form7	1	protected
<i>Myrceugenia alpigena</i>	(DC.) Landrum	10	3	4	common	0.333333	partially protected
<i>Myrceugenia brevipedicellata</i>	(Burret) D.Legrand & Kausel	1	1	1	form7	1	protected
<i>Myrceugenia campestris</i>	(DC.) D.Legrand & Kausel	1	1	1	form7	1	protected
<i>Myrcia aegiphylloides</i>	Mattos	1	1	1	form7	0	unprotected
<i>Myrcia albidotomentosa</i>	(Amshoff) McVaugh	3	1	3	form5	1	protected
<i>Myrcia albotomentosa</i>	DC.	19	3	5	common	0.116667	partially protected
<i>Myrcia almasensis</i>	NicLugh.	2	1	3	form5	0.333333	partially protected
<i>Myrcia atramentifera</i>	Barb.Rodr.	8	3	8	common	0.666667	partially protected
<i>Myrcia bella</i>	Cambess.	15	3	10	common	0.139752	partially protected
<i>Myrcia bergiana</i>	O.Berg	3	3	3	form4	0.333333	partially protected
<i>Myrcia bolivarensis</i>	(Steyerm.) McVaugh	1	3	1	form6	1	protected
<i>Myrcia bracteata</i>	(Rich.) DC.	21	3	22	common	0.5	partially protected
<i>Myrcia brasiliae</i>	Mattos & D.Legrand	1	1	1	form7	0.666667	partially protected
<i>Myrcia brasiliensis</i>	Kiaersk.	2	3	1	form6	0.333333	partially protected
<i>Myrcia camapuanensis</i>	N.Silveira	15	3	3	common	0.12	partially protected
<i>Myrcia chapadensis</i>	S.Moore	1	1	1	form7	1	protected
<i>Myrcia citrifolia</i>	(Aubl.) Urb.	7	3	9	common	0	unprotected
<i>Myrcia cujabensis</i>	O.Berg	5	3	1	form2	0.2	partially protected
<i>Myrcia cuprea</i>	(O.Berg) Kiaersk.	9	3	11	common	0.541667	partially protected
<i>Myrcia decorticans</i>	DC.	16	3	13	common	0.2	partially protected
<i>Myrcia densa</i>	(DC.) Sobral	4	3	3	common	0.3	partially protected
<i>Myrcia eriocalyx</i>	DC.	5	3	3	common	0.285714	partially protected
<i>Myrcia fenzliana</i>	O.Berg	17	3	8	common	0.179775	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Myrcia filibracteata</i>	Mattos & D.Legrand	1	1	1	form7	0	unprotected
<i>Myrcia florida</i>	Lem.	1	1	1	form7	1	protected
<i>Myrcia guianensis</i>	(Aubl.) DC.	34	3	45	common	0.148814	partially protected
<i>Myrcia ilheosensis</i>	Kiaersk.	3	1	3	form5	0.5	partially protected
<i>Myrcia jacobinensis</i>	Mattos	7	3	5	common	0.3125	partially protected
<i>Myrcia lanuginosa</i>	O.Berg	5	3	3	common	0.104478	partially protected
<i>Myrcia laruotteana</i>	Cambess.	11	3	6	common	0.307692	partially protected
<i>Myrcia lutescens</i>	Cambess.	1	1	1	form7	0	unprotected
<i>Myrcia mansoniana</i>	O.Berg	4	3	2	common	0.4	partially protected
<i>Myrcia mischophylla</i>	Kiaersk.	9	3	5	common	0.22807	partially protected
<i>Myrcia multiflora</i>	(Lam.) DC.	33	3	33	common	0.237918	partially protected
<i>Myrcia mutabilis</i>	(O.Berg) N.Silveira	10	3	6	common	0.204545	partially protected
<i>Myrcia obovata</i>	(O.Berg) Nied.	4	3	2	common	0	unprotected
<i>Myrcia ochroides</i>	O.Berg	13	3	3	common	0.058824	partially protected
<i>Myrcia paivae</i>	O.Berg	14	3	14	common	0.4	partially protected
<i>Myrcia palustris</i>	DC.	2	1	1	form7	0	unprotected
<i>Myrcia parnahibensis</i>	(O.Berg) Kiaersk.	7	3	1	form2	0.333333	partially protected
<i>Myrcia platyclada</i>	DC.	4	3	3	common	1	protected
<i>Myrcia pubipetala</i>	Miq.	14	3	6	common	0.285714	partially protected
<i>Myrcia pulchra</i>	(O.Berg) Kiaersk.	6	3	4	common	0.129032	partially protected
<i>Myrcia racemosa</i>	(O.Berg) Kiaersk.	2	3	1	form6	0.4	partially protected
<i>Myrcia racemulosa</i>	DC.	9	3	4	common	0.162791	partially protected
<i>Myrcia ramuliflora</i>	(O.Berg) N.Silveira	3	3	3	form4	0.25	partially protected
<i>Myrcia recurvata</i>	O.Berg	1	1	1	form7	0	unprotected
<i>Myrcia reticulata</i>	Cambess.	1	1	1	form7	1	protected
<i>Myrcia retorta</i>	Cambess.	8	3	4	common	0.079545	partially protected
<i>Myrcia revolutifolia</i>	McVaugh	4	3	5	common	1	protected
<i>Myrcia rimosa</i>	Cambess.	1	1	2	form5	0	unprotected
<i>Myrcia rosangelae</i>	NicLugh.	4	3	5	common	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Myrcia rotundata</i>	(Amshoff) McVaugh	1	3	1	form6	1	protected
<i>Myrcia rotundifolia</i>	(O.Berg) Kiaersk.	1	1	1	form7	0	unprotected
<i>Myrcia rufipes</i>	DC.	1	1	1	form7	0	unprotected
<i>Myrcia spectabilis</i>	DC.	1	3	1	form6	1	protected
<i>Myrcia splendens</i>	(Sw.) DC.	34	3	46	common	0.175732	partially protected
<i>Myrcia subalpestris</i>	DC.	1	1	1	form7	0	unprotected
<i>Myrcia subavenia</i>	(O.Berg) N.Silveira	2	1	1	form7	0.333333	partially protected
<i>Myrcia subcordata</i>	DC.	3	1	2	form5	0	unprotected
<i>Myrcia subsessilis</i>	O.Berg	14	3	8	common	0.8125	partially protected
<i>Myrcia sylvatica</i>	(G.Mey.) DC.	21	3	30	common	0.309524	partially protected
<i>Myrcia tenuifolia</i>	(O.Berg) Sobral	1	1	1	form7	0	unprotected
<i>Myrcia tomentosa</i>	(Aubl.) DC.	33	3	28	common	0.149744	partially protected
<i>Myrcia uberavensis</i>	O.Berg	10	3	2	common	0.112903	partially protected
<i>Myrcia variabilis</i>	Mart. ex DC.	16	3	8	common	0.084906	partially protected
<i>Myrcia vauthiereana</i>	O.Berg	1	1	2	form5	0.333333	partially protected
<i>Myrcia venulosa</i>	DC.	13	3	8	common	0.188172	partially protected
<i>Myrcia vestita</i>	DC.	13	3	6	common	0.122449	partially protected
<i>Myrcia vittoriana</i>	Kiaersk.	2	3	1	form6	0.5	partially protected
<i>Myrcianthes cavalcantei</i>	Mattos	1	3	1	form6	0	unprotected
<i>Myrciaria cuspidata</i>	O.Berg	9	3	6	common	0.181818	partially protected
<i>Myrciaria delicatula</i>	(DC.) O.Berg	5	3	3	common	0.375	partially protected
<i>Myrciaria floribunda</i>	(H.West ex Willd.) O.Berg	28	3	29	common	0.27439	partially protected
<i>Myrciaria strigipes</i>	O.Berg	2	3	1	form6	0.5	partially protected
<i>Myrciaria tenella</i>	(DC.) O.Berg	21	3	16	common	0.275862	partially protected
<i>Myrocarpus fastigiatus</i>	AllemÃfÆ'Ã,Ãfo	1	1	1	form7	0	unprotected
<i>Myrospermum frutescens</i>	Jacq.	1	3	1	form6	0	unprotected
<i>Myroxylon peruiferum</i>	L.f.	10	3	3	common	0.25	partially protected
<i>Myrsine coriacea</i>	(Sw.) R.Br. ex Roem. & Schult.	19	3	12	common	0.179054	partially protected
<i>Myrsine emarginella</i>	Miq.	7	3	5	common	0.263158	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Myrsine guianensis</i>	(Aubl.) Kuntze	30	3	28	common	0.15796	partially protected
<i>Myrsine lancifolia</i>	Mart.	3	3	3	form4	0.37931	partially protected
<i>Myrsine leuconeura</i>	Mart.	10	3	6	common	0.119048	partially protected
<i>Myrsine lineata</i>	(Mez) Imkhan.	2	1	3	form5	0.333333	partially protected
<i>Myrsine monticola</i>	Mart.	12	3	5	common	0.155172	partially protected
<i>Myrsine nitida</i>	(Mez) Pipoly	2	3	2	form4	0.5	partially protected
<i>Myrsine parvifolia</i>	A. DC.	2	1	1	form7	0.333333	partially protected
<i>Myrsine parvula</i>	(Mez) Otegui	1	1	1	form7	0	unprotected
<i>Myrsine squarrosa</i>	(Mez) M.F.Freitas & Kin.-Gouv.	4	3	5	common	0.230769	partially protected
<i>Myrsine umbellata</i>	Mart.	22	3	20	common	0.175141	partially protected
<i>Myrsine venosa</i>	A. DC.	2	1	2	form5	0	unprotected
<i>Myrsine villosissima</i>	Mart.	1	1	1	form7	0.333333	partially protected
<i>Nectandra cissiflora</i>	Nees	24	3	16	common	0.184783	partially protected
<i>Nectandra cuspidata</i>	Nees & Mart.	3	3	2	form4	0.25	partially protected
<i>Nectandra hihua</i>	(Ruiz & Pav.) Rohwer	19	3	16	common	0.3	partially protected
<i>Nectandra megapotamica</i>	(Spreng.) Mez	6	3	2	common	0.111111	partially protected
<i>Nectandra psammophila</i>	Nees & C. Mart.	1	1	1	form7	1	protected
<i>Neea floribunda</i>	Poepp. & Endl.	18	3	18	common	0.3	partially protected
<i>Neea hermaphrodita</i>	S. Moore	1	1	1	form7	0	unprotected
<i>Neea macrophylla</i>	Poepp. & Endl.	21	3	16	common	0.4	partially protected
<i>Neea parviflora</i>	Poepp. & Endl.	9	1	9	form1	0.8	partially protected
<i>Neea theifera</i>	Oerst.	17	3	14	common	0.14321	partially protected
<i>Neocabreria pennivenia</i>	(B.L.Rob.) R.M.King & H.Rob.	2	1	2	form5	0.333333	partially protected
<i>Neomitranthes langsdorffii</i>	(O.Berg) Mattos	2	1	1	form7	0.5	partially protected
<i>Neomitranthes obscura</i>	(DC.) N.Silveira	1	1	1	form7	0	unprotected
<i>Norantea goyasensis</i>	Cambess.	2	3	1	form6	0.5	partially protected
<i>Ochthocosmus attenuatus</i>	Steyerm. & Luteyn	1	3	1	form6	1	protected
<i>Ochthocosmus barrae</i>	Hallier f.	3	3	2	form4	0.5	partially protected
<i>Ochthocosmus longipedicellatus</i>	Steyerm. & Luteyn	3	3	2	form4	0.5	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Ochthocosmus roraimae</i>	Benth.	4	3	3	common	0.666667	partially protected
<i>Ocotea aciphylla</i>	(Nees & Mart.) Mez	27	3	25	common	0.348837	partially protected
<i>Ocotea adamantina</i>	P.L.R. Moraes e van der Werff	2	1	2	form5	0.333333	partially protected
<i>Ocotea arenicola</i>	L.C.S. Assis e Mello-Silva	1	1	1	form7	1	protected
<i>Ocotea brachybotrya</i>	(Meisn.) Mez	3	1	2	form5	0	unprotected
<i>Ocotea canaliculata</i>	(Rich.) Mez	20	3	19	common	0.188679	partially protected
<i>Ocotea cernua</i>	(Nees) Mez	23	3	27	common	0.45098	partially protected
<i>Ocotea corymbosa</i>	(Meisn.) Mez	15	3	12	common	0.087629	partially protected
<i>Ocotea daphnifolia</i>	(Meisn.) Mez	3	1	3	form5	0.4	partially protected
<i>Ocotea diospyrifolia</i>	(Meisn.) Mez	11	3	6	common	0.152174	partially protected
<i>Ocotea duidensis</i>	Moldenke	3	3	2	form4	0.666667	partially protected
<i>Ocotea fasciculata</i>	(Nees) Mez	13	3	13	common	0.117647	partially protected
<i>Ocotea floribunda</i>	(Sw.) Mez	10	3	12	common	0.25	partially protected
<i>Ocotea glauca</i>	(Nees & Mart.) Mez	2	3	1	form6	0.5	partially protected
<i>Ocotea gracilis</i>	(Meisn.) Mez	23	3	21	common	0.178571	partially protected
<i>Ocotea lancifolia</i>	(Schott) Mez	11	3	7	common	0.243243	partially protected
<i>Ocotea langsдорffii</i>	(Meisn.) Mez	6	3	4	common	0.421053	partially protected
<i>Ocotea lobbii</i>	(Meisn.) Rohwer	1	1	1	form7	1	protected
<i>Ocotea minarum</i>	(Nees & Mart.) Mez	10	3	6	common	0.100719	partially protected
<i>Ocotea notata</i>	(Nees & Mart.) Mez	2	3	1	form6	0.5	partially protected
<i>Ocotea nutans</i>	(Nees) Mez	1	1	1	form7	1	protected
<i>Ocotea percoriacea</i>	Kosterm.	9	3	5	common	0.25	partially protected
<i>Ocotea polyantha</i>	(Nees & Mart.) Mez	4	3	3	common	0.25	partially protected
<i>Ocotea pomaderroides</i>	(Meisn.) Mez	10	3	6	common	0.208092	partially protected
<i>Ocotea pulchella</i>	(Nees & Mart.) Mez	10	3	8	common	0.101449	partially protected
<i>Ocotea rohweri</i>	P.L.R. Moraes van der Werff	1	1	1	form7	1	protected
<i>Ocotea semicompleta</i>	(Nees & Mart.) Mez	2	1	2	form5	0	unprotected
<i>Ocotea silvestris</i>	Vattimo	1	3	2	form4	0.5	partially protected
<i>Ocotea spectabilis</i>	(Meisn.) Mez	16	3	8	common	0.181818	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Ocotea spixiana</i>	(Nees) Mez	9	3	5	common	0.325843	partially protected
<i>Ocotea tristis</i>	(Nees & Mart.) Mez	7	3	5	common	0.3	partially protected
<i>Ocotea vaccinioides</i>	(Meisn.) Mez	1	1	2	form5	0.333333	partially protected
<i>Ocotea vegrandis</i>	P.L.R. Moraes et van der Werff	2	1	2	form5	0.333333	partially protected
<i>Ocotea velloziana</i>	(Meisn.) Mez	9	3	7	common	0.307692	partially protected
<i>Ocotea velutina</i>	(Nees) Mart. ex B.D.Jacks.	1	1	1	form7	0.5	partially protected
<i>Ocotea xanthocalyx</i>	(Nees) Mez	6	3	1	form2	0.2	partially protected
<i>Oenocarpus bataua</i>	Mart.	21	3	20	common	0.25	partially protected
<i>Oenocarpus distichus</i>	Mart.	20	3	12	common	0.404762	partially protected
<i>Oocephalus piranii</i>	(Harley) Harley & J.F.B. Pastore	1	1	1	form7	1	protected
<i>Opuntia monacantha</i>	(Willd.) Haw.	4	3	6	common	0	unprotected
<i>Ormosia arborea</i>	(Vell.)Harms	4	3	2	common	0.333333	partially protected
<i>Ormosia costulata</i>	(Miq.)Kleinhoonte	2	1	1	form7	0	unprotected
<i>Ormosia fastigiata</i>	Tul.	11	3	6	common	0.191489	partially protected
<i>Ouratea apurensis</i>	Sastre	1	1	1	form7	0	unprotected
<i>Ouratea blanchetiana</i>	Engl.	1	1	1	form7	0	unprotected
<i>Ouratea castaneifolia</i>	(DC.) Engl.	28	3	26	common	0.211832	partially protected
<i>Ouratea cuspidata</i>	Tiegh.	2	3	2	form4	0.5	partially protected
<i>Ouratea glaucescens</i>	Engl.	9	3	3	common	0.24	partially protected
<i>Ouratea grosourdyi</i>	(Tiegh.) Steyerm.	3	3	1	form6	0	unprotected
<i>Ouratea hexasperma</i>	(A. St.-Hil.) Baill.	24	3	17	common	0.121839	partially protected
<i>Ouratea ovalis</i>	Engl.	1	1	1	form7	1	protected
<i>Ouratea polyantha</i>	(Triana & Planch.) Engl.	9	3	8	common	0.041667	partially protected
<i>Ouratea polygyna</i>	Engl.	11	3	8	common	0.5625	partially protected
<i>Ouratea roraimae</i>	Engl.	11	3	10	common	0	unprotected
<i>Ouratea salicifolia</i>	Engl.	6	3	4	common	0.166667	partially protected
<i>Ouratea sellowii</i>	Engl.	1	1	1	form7	1	protected
<i>Ouratea semiserrata</i>	(Mart. & Nees) Engl.	4	3	3	common	0.333333	partially protected
<i>Ouratea spectabilis</i>	(Mart. ex Engl.) Engl.	22	3	14	common	0.130064	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Ouratea subamplexicaulis</i>	Maguire & Steyerm.	1	3	1	form6	1	protected
<i>Ouratea tatei</i>	Gleason	1	3	1	form6	1	protected
<i>Oxandra reticulata</i>	Maas	13	3	6	common	0.2	partially protected
<i>Oxandra sessiliflora</i>	R.E.Fr.	14	3	10	common	0.173913	partially protected
<i>Pachira flaviflora</i>	(Pulle) Fern.Alonso	3	3	3	form4	1	protected
<i>Pachira minor</i>	(Sims) Hemsl.	4	3	3	common	0.666667	partially protected
<i>Pachira nitida</i>	Kunth	15	3	15	common	0.307692	partially protected
<i>Pachira paraensis</i>	(Ducke) W.S.Alverson	13	3	12	common	0.444444	partially protected
<i>Pagamea capitata</i>	Benth.	11	3	11	common	0.625	partially protected
<i>Pagamea guianensis</i>	Aubl.	24	3	27	common	0.333333	partially protected
<i>Pagamea thyrsoflora</i>	Spruce ex Benth.	16	3	14	common	0.5625	partially protected
<i>Palicourea blanchetiana</i>	Schltl.	2	3	1	form6	0.333333	partially protected
<i>Palicourea crocea</i>	(Sw.) Schult.	1	1	1	form7	1	protected
<i>Palicourea grandifolia</i>	(Willd. ex Schult.) Standl.	1	1	1	form7	1	protected
<i>Palicourea guianensis</i>	Aubl.	21	3	25	common	0.384615	partially protected
<i>Palicourea longistipulata</i>	Standl.	3	1	2	form5	0.2	partially protected
<i>Palicourea marcgravii</i>	A.St.-Hil.	1	1	1	form7	0	unprotected
<i>Palicourea nitidella</i>	(MÃfÂ¼ll.Arg.) Standl.	3	3	4	form4	0.142857	partially protected
<i>Palicourea rigida</i>	Kunth	32	3	24	common	0.165511	partially protected
<i>Panopsis rubescens</i>	(Pohl) Pittier	1	1	1	form7	0	unprotected
<i>Panopsis sessilifolia</i>	(Rich.) Sandwith	8	3	12	common	0.75	partially protected
<i>Paralychnophora bicolor</i>	(DC.) MacLeish	9	3	5	common	0.368421	partially protected
<i>Paralychnophora glazouana</i>	Loeulle	5	3	2	common	0.25	partially protected
<i>Paralychnophora harleyi</i>	(H. Rob.) D.J.N. Hind	4	3	3	common	0.444444	partially protected
<i>Parinari campestris</i>	Aubl.	15	3	20	common	0.257143	partially protected
<i>Parinari maguirei</i>	Prance	3	1	3	form5	1	protected
<i>Parinari obtusifolia</i>	Hook.f.	14	3	7	common	0.124402	partially protected
<i>Parkia cachimboensis</i>	H.C.Hopkins	6	1	4	form1	0	unprotected
<i>Parkia pendula</i>	(Willd.)Walp.	1	1	1	form7	1	protected

S	author	lat	population	ecoregion	Form	r	status
<i>Parkia platycephala</i>	Benth.	14	3	9	common	0.166667	partially protected
<i>Paubrasilia echinata</i>	(Lam.) E. Gagnon, H.C.	1	1	1	form7	0	unprotected
<i>Peltogyne campestris</i>	Ducke	2	1	1	form7	0.5	partially protected
<i>Peltogyne confertiflora</i>	(Hayne)Benth.	20	3	9	common	0.103448	partially protected
<i>Peltogyne crenulata</i>	Afr.Fern.	1	1	1	form7	0	unprotected
<i>Peltogyne maranhensis</i>	Ducke	2	1	2	form5	0	unprotected
<i>Peltophorum dubium</i>	(Spreng.) Taub.	9	3	3	common	0.085714	partially protected
<i>Pera bicolor</i>	(Klotzsch) MÃfÂ¼ll.Arg.	1	1	1	form7	1	protected
<i>Pera decipiens</i>	(MÃfÂ¼ll.Arg.) MÃfÂ¼ll.Arg.	1	1	1	form7	1	protected
<i>Pera distichophylla</i>	(Mart.) Baill.	17	3	16	common	0.222222	partially protected
<i>Pera furfuracea</i>	MÃfÂ¼ll.Arg.	1	1	1	form7	1	protected
<i>Pera glabrata</i>	(Schott) Poepp. ex Baill.	34	3	41	common	0.151079	partially protected
<i>Pera heteranthera</i>	(Schrank) I.M.Johnst.	8	3	7	common	0.5	partially protected
<i>Pereskia guamacho</i>	F.A.C.Weber	3	3	1	form6	0	unprotected
<i>Persea alba</i>	Nees & Mart.	6	3	5	common	0.272727	partially protected
<i>Persea fusca</i>	Mez	5	3	1	form2	0.444444	partially protected
<i>Persea glabra</i>	van der Werff	2	1	2	form5	0	unprotected
<i>Persea pedunculosa</i>	Meisn.	2	1	2	form5	0.5	partially protected
<i>Persea rufotomentosa</i>	Nees & C. Mart.	2	1	1	form7	0	unprotected
<i>Persea splendens</i>	Meisn.	9	3	2	common	0	unprotected
<i>Persea venosa</i>	Nees & Mart.	1	1	1	form7	0	unprotected
<i>Phyllanthus acuminatus</i>	Vahl	25	3	21	common	0.169492	partially protected
<i>Phyllanthus attenuatus</i>	Miq.	13	3	13	common	0.347826	partially protected
<i>Phyllanthus bahiensis</i>	MÃfÂ¼ll.Arg.	2	1	2	form5	0	unprotected
<i>Phyllanthus juglandifolius</i>	Willd.	18	3	19	common	0.5	partially protected
<i>Physocalymma scaberrimum</i>	Pohl	18	3	14	common	0.247706	partially protected
<i>Picramnia ciliata</i>	Mart.	2	3	3	form4	0.6	partially protected
<i>Picramnia guianensis</i>	(Aubl.) Jans.-Jac.	4	1	4	form1	1	protected
<i>Picramnia sellowii</i>	Planch.	22	3	16	common	0.125	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Pilocarpus microphyllus</i>	Stapf ex Wardleworth	5	3	4	common	0.777778	partially protected
<i>Pilosocereus aurisetus</i>	(Werderm.) Byles & G.D. Rowley	5	3	3	common	0.307692	partially protected
<i>Pilosocereus brasiliensis</i>	(Britton & Rose) Backeb.	1	1	1	form7	1	protected
<i>Pilosocereus cattingicola</i>	(GÃfÂ¼rke) Byles & G.D. Rowley	8	3	6	common	0.25	partially protected
<i>Pilosocereus densiareolatus</i>	F. Ritter	2	1	2	form5	0.5	partially protected
<i>Pilosocereus flavipulvinatus</i>	(Buining & Brederoo) F. Ritter	1	1	1	form7	0	unprotected
<i>Pilosocereus fulvilanatus</i>	(Buining & Brederoo) F.Ritter	3	1	2	form5	0.333333	partially protected
<i>Pilosocereus glaucochrous</i>	(Werderm.) Byles & G.D. Rowley	3	1	2	form5	0.5	partially protected
<i>Pilosocereus gounellei</i>	(F.A.C.Weber ex K.Schum.) Byles & G.D.Rowley	2	3	2	form4	0	unprotected
<i>Pilosocereus jauruensis</i>	(Buining & Brederoo) P.J.Braun	7	3	4	common	0.066667	partially protected
<i>Pilosocereus machrisii</i>	(E.Y.Dawson) Backeb.	12	3	3	common	0.130435	partially protected
<i>Pilosocereus pachycladus</i>	F. Ritter	6	3	3	common	0.2	partially protected
<i>Pilosocereus pentaedrophorus</i>	(Labour.) Byles & G.D. Rowley	2	1	2	form5	1	protected
<i>Pilosocereus piauhyensis</i>	(GÃfÂ¼rke) Byles & G.D. Rowley	1	1	1	form7	0	unprotected
<i>Pilosocereus tuberculatus</i>	(Werderm.) Byles & G.D. Rowley	1	3	1	form6	0	unprotected
<i>Pilosocereus vilaboensis</i>	(Diers & Esteves) P.J. Braun	1	1	2	form5	0.5	partially protected
<i>Pimenta pseudocaryophyllus</i>	(Gomes) Landrum	7	3	6	common	0.4	partially protected
<i>Piper aduncum</i>	L.	27	3	26	common	0.177419	partially protected
<i>Piper amalago</i>	L.	19	3	13	common	0.206897	partially protected
<i>Piper arboreum</i>	Aubl.	29	3	26	common	0.288462	partially protected
<i>Piper hispidum</i>	Sw.	23	3	19	common	0.446809	partially protected
<i>Piper mollicomum</i>	Kunth	12	3	9	common	0.466667	partially protected
<i>Piper tuberculatum</i>	Jacq.	23	3	21	common	0.241379	partially protected
<i>Piptadenia gonoacantha</i>	(Mart.)J.F.Macbr.	5	3	3	common	0	unprotected
<i>Piptadenia macradenia</i>	Benth.	5	3	3	common	0.266667	partially protected
<i>Piptadenia robusta</i>	Pittier	5	3	3	common	0.166667	partially protected
<i>Piptadenia stipulacea</i>	(Benth.)Ducke	3	3	2	form4	0.2	partially protected
<i>Piptadenia viridiflora</i>	(Kunth)Benth.	4	3	4	common	0.25	partially protected
<i>Piptocarpha macropoda</i>	(DC.) Baker	1	1	1	form7	1	protected

S	author	lat	population	ecoregion	Form	r	status
<i>Piptocarpha regnellii</i>	(Sch.Bip.) Cabrera	1	1	1	form7	0	unprotected
<i>Piptocarpha rotundifolia</i>	(Less.) Baker	21	3	11	common	0.116395	partially protected
<i>Piptocoma roraimensis</i>	(Steyerm.) Pruski	1	1	1	form7	1	protected
<i>Piptocoma schomburgkii</i>	(Sch.Bip.) Pruski	5	3	5	common	0.666667	partially protected
<i>Piptolepis monticola</i>	Loeuille	1	1	1	form7	0	unprotected
<i>Piranhea trifoliata</i>	Baill.	12	3	13	common	0.25	partially protected
<i>Pithecellobium dulce</i>	(Roxb.)Benth.	1	1	1	form7	0	unprotected
<i>Pithecellobium roseum</i>	(Vahl) Barneby & J.W. Grimes	5	3	3	common	0.1875	partially protected
<i>Pityrocarpa moniliformis</i>	(Benth.) Luckow & R. W. Jobson	16	3	9	common	0.15873	partially protected
<i>Pityrocarpa obliqua</i>	(Pers.) Brenan	1	1	1	form7	0	unprotected
<i>Plathymenia foliolosa</i>	Benth.	1	1	1	form7	1	protected
<i>Plathymenia reticulata</i>	Benth.	26	3	23	common	0.145125	partially protected
<i>Platonia insignis</i>	Mart.	20	3	21	common	0.157895	partially protected
<i>Platymiscium floribundum</i>	Vogel	16	3	7	common	0.243902	partially protected
<i>Platymiscium pinnatum</i>	(Jacq.) Dugand	22	3	17	common	0.208333	partially protected
<i>Platypodium elegans</i>	Vogel	24	3	20	common	0.136139	partially protected
<i>Plenckia bahiensis</i>	Loes.	1	1	2	form5	1	protected
<i>Plenckia populnea</i>	Reissek	18	3	13	common	0.135501	partially protected
<i>Pleroma candolleana</i>	(Mart. ex DC.) Triana	1	1	1	form7	0	unprotected
<i>Pleroma echinata</i>	Gardner	2	1	2	form5	0	unprotected
<i>Pleroma foveolata</i>	(Naudin) Triana	2	1	2	form5	0	unprotected
<i>Pleroma stenocarpa</i>	(Schrank et Mart. ex DC.) Triana	4	3	2	common	0	unprotected
<i>Podocarpus celatus</i>	de Laub.	3	1	3	form5	0.666667	partially protected
<i>Podocarpus lambertii</i>	Klotzsch ex Endl.	4	1	2	form1	0.25	partially protected
<i>Podocarpus sellowii</i>	Klotzsch ex Endl.	12	3	9	common	0.30303	partially protected
<i>Podocarpus transiens</i>	(Pilg.) de Laub.	3	1	3	form5	0.25	partially protected
<i>Poecilandra retusa</i>	Tul.	3	3	2	form4	0.5	partially protected
<i>Poecilanthe falcata</i>	(Vell.)Heringer	1	1	1	form7	0	unprotected
<i>Poecilanthe ulei</i>	(Harms)Arroyo & Rudd	1	1	1	form7	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Poeppigia procera</i>	C.Presl	13	3	10	common	0.285714	partially protected
<i>Pogonophora schomburgkiana</i>	Miers ex Benth.	17	3	24	common	0.352941	partially protected
<i>Poincianella bracteosa</i>	(Tul.) L.P.Queiroz	10	3	6	common	0.125	partially protected
<i>Posoqueria latifolia</i>	(Rudge) Schult.	2	1	1	form7	0.666667	partially protected
<i>Pouteria andarahiensis</i>	T.D.Penn.	4	3	3	common	0.333333	partially protected
<i>Pouteria caimito</i>	(Ruiz & Pav.) Radlk.	20	3	26	common	0.45	partially protected
<i>Pouteria coelomatica</i>	Rizzini	2	1	1	form7	0.5	partially protected
<i>Pouteria cuspidata</i>	(A.DC.) Baehni	19	3	21	common	0.411765	partially protected
<i>Pouteria furcata</i>	T.D.Penn.	5	3	2	common	0.026316	partially protected
<i>Pouteria gardneri</i>	(Mart. & Eichler ex Miq.) Baehni	6	3	3	common	0	unprotected
<i>Pouteria gardneriana</i>	(A.DC.) Radlk.	11	3	8	common	0.166667	partially protected
<i>Pouteria grandiflora</i>	(A.DC.) Baehni	2	1	2	form5	0.333333	partially protected
<i>Pouteria guianensis</i>	Aubl.	19	3	23	common	0.354839	partially protected
<i>Pouteria macahensis</i>	T.D.Penn.	2	1	1	form7	0.333333	partially protected
<i>Pouteria peduncularis</i>	(Mart. & Eichler ex Miq.) Baehni	2	1	2	form5	0.25	partially protected
<i>Pouteria psammophila</i>	(Mart.) Radlk.	6	3	5	common	0.25	partially protected
<i>Pouteria ramiflora</i>	(Mart.) Radlk.	28	3	23	common	0.15732	partially protected
<i>Pouteria reticulata</i>	(Engl.) Eyma	24	3	27	common	0.323944	partially protected
<i>Pouteria rigida</i>	(Mart. & Eichler ex Miq.) Radlk.	7	3	6	common	0.75	partially protected
<i>Pouteria tenuisepala</i>	Pires & T.D.Penn.	5	3	4	common	0.142857	partially protected
<i>Pouteria torta</i>	(Mart.) Radlk.	29	3	34	common	0.125592	partially protected
<i>Pradosia beardii</i>	(Monach.) T.D.Penn.	3	3	5	form4	1	protected
<i>Pradosia lactescens</i>	(Vell.) Radlk.	1	1	1	form7	1	protected
<i>Pradosia longipedicellata</i>	Alves-Araújo & M.Alves	1	1	1	form7	0	unprotected
<i>Priogymnanthus hasslerianus</i>	(Chodat) P.S.Green	21	3	9	common	0.111111	partially protected
<i>Protium bahianum</i>	D.C. Daly	1	1	1	form7	0	unprotected
<i>Protium brasiliense</i>	Engl.	1	1	1	form7	0	unprotected
<i>Protium heptaphyllum</i>	(Aubl.) Marchand	34	3	44	common	0.175875	partially protected
<i>Protium icicariba</i>	(DC.) Marchand	2	3	1	form6	0.5	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Protium ovatum</i>	Engl.	15	3	9	common	0.131343	partially protected
<i>Protium spruceanum</i>	(Benth.) Engl.	28	3	27	common	0.231405	partially protected
<i>Protium unifoliolatum</i>	Engl.	22	3	26	common	0.265625	partially protected
<i>Prunus myrtifolia</i>	(L.) Urb.	22	3	21	common	0.175758	partially protected
<i>Pseudobombax campestre</i>	(Mart. & Zucc.) A. Robyns	8	3	5	common	0.125	partially protected
<i>Pseudobombax grandiflorum</i>	(Cav.) A. Robyns	5	3	4	common	0.333333	partially protected
<i>Pseudobombax longiflorum</i>	(Mart. & Zucc.) A. Robyns	20	3	17	common	0.133603	partially protected
<i>Pseudobombax marginatum</i>	(A. St.-Hil.) A. Robyns	21	3	15	common	0.181818	partially protected
<i>Pseudobombax minimum</i>	Carv.-Sobr. & L.P. Queiroz	4	3	3	common	0.074074	partially protected
<i>Pseudobombax parvifolium</i>	Carv.-Sobr. & L.P. Queiroz	1	1	1	form7	1	protected
<i>Pseudobombax riopretensis</i>	Ravenna	1	1	2	form5	0.4	partially protected
<i>Pseudobombax tomentosum</i>	(Mart. & Zucc.) A. Robyns	18	3	9	common	0.124722	partially protected
<i>Pseudobrickellia angustissima</i>	(Spreng. ex Baker) R.M. King & H. Rob.	9	3	5	common	0.293333	partially protected
<i>Pseudolmedia laevigata</i>	TrÃ¶fÃ©cul	1	1	1	form7	1	protected
<i>Pseudopiptadenia brenanii</i>	G.P. Lewis & M.P. Lima	4	3	2	common	0.333333	partially protected
<i>Pseudoxandra polyphleba</i>	(Diels) R.E. Fr.	1	1	1	form7	0	unprotected
<i>Psidium acutangulum</i>	Mart. ex DC.	9	3	8	common	0.266667	partially protected
<i>Psidium appendiculatum</i>	Kiaersk.	6	3	5	common	0.375	partially protected
<i>Psidium brownianum</i>	Mart. ex DC.	2	3	1	form6	0.5	partially protected
<i>Psidium canum</i>	Mattos	5	3	1	form2	0.277778	partially protected
<i>Psidium cattleianum</i>	Afzel. ex Sabine	6	3	3	common	0.2	partially protected
<i>Psidium firmum</i>	O. Berg	1	1	1	form7	0	unprotected
<i>Psidium guajava</i>	L.	22	3	20	common	0.296296	partially protected
<i>Psidium guineense</i>	Sw.	34	3	39	common	0.2	partially protected
<i>Psidium myrsinites</i>	DC.	22	3	13	common	0.139368	partially protected
<i>Psidium nutans</i>	O. Berg	6	3	4	common	0.214286	partially protected
<i>Psidium oligospermum</i>	Mart. ex DC.	11	3	4	common	0.24	partially protected
<i>Psidium rufum</i>	Mart. ex DC.	12	3	4	common	0.155556	partially protected
<i>Psidium salutare</i>	var. decussatum (DC.) Landrum	3	3	1	form6	0.25	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Psidium schenckianum</i>	Kiaersk.	1	1	1	form7	0	unprotected
<i>Psychotria bahiensis</i>	DC.	1	1	1	form7	0	unprotected
<i>Psychotria carthagenensis</i>	Jacq.	25	3	20	common	0.123288	partially protected
<i>Psychotria colorata</i>	(Willd. ex Schult.) MÃfÂ¼ll.Arg.	1	1	1	form7	0	unprotected
<i>Psychotria deflexa</i>	DC.	21	3	21	common	0.354839	partially protected
<i>Psychotria ernestii</i>	K.Krause	8	1	8	form1	1	protected
<i>Psychotria hoffmannseggiana</i>	(Willd. ex Schult.) MÃfÂ¼ll.Arg.	2	1	2	form5	0	unprotected
<i>Psychotria mapourioides</i>	DC.	24	3	22	common	0.368421	partially protected
<i>Psychotria vellosiana</i>	Benth.	10	3	6	common	0.152174	partially protected
<i>Pterocarpus officinalis</i>	Jacq.	12	3	14	common	0.285714	partially protected
<i>Pterocarpus rohrii</i>	Vahl	24	3	23	common	0.354839	partially protected
<i>Pterocarpus santalinoides</i>	DC.	1	1	2	form5	0.5	partially protected
<i>Pterocarpus villosus</i>	(Benth.)Benth.	3	3	3	form4	0.333333	partially protected
<i>Pterocarpus violaceus</i>	Vogel	2	3	1	form6	0.5	partially protected
<i>Pterodon abruptus</i>	(Moric.)Benth.	4	3	4	common	0.166667	partially protected
<i>Pterodon emarginatus</i>	Vogel	21	3	13	common	0.122563	partially protected
<i>Pterogyne nitens</i>	Tul.	17	3	12	common	0.078431	partially protected
<i>Ptilochaeta bahiensis</i>	Turcz.	7	3	6	common	0.138889	partially protected
<i>Quadrella odoratissima</i>	(Jacq.) Hutch.	3	3	2	form4	0	unprotected
<i>Qualea acuminata</i>	Spruce ex Warm.	13	3	13	common	0	unprotected
<i>Qualea cordata</i>	Spreng.	16	3	9	common	0.13	partially protected
<i>Qualea cryptantha</i>	(Spreng.) Warm.	4	3	4	common	0.5	partially protected
<i>Qualea densiflora</i>	Warm.	8	3	2	common	0.272727	partially protected
<i>Qualea dichotoma</i>	(Mart.) Warm. ex Wille	15	3	8	common	0.163934	partially protected
<i>Qualea elegans</i>	Taub. ex Benoist	1	1	1	form7	0	unprotected
<i>Qualea grandiflora</i>	Mart.	26	3	23	common	0.137775	partially protected
<i>Qualea hannekesaskiarum</i>	Marc.-Berti	3	3	1	form6	0.6	partially protected
<i>Qualea lundii</i>	(Warm.) Warm.	1	1	1	form7	1	protected
<i>Qualea multiflora</i>	Mart.	20	3	17	common	0.132302	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Qualea parviflora</i>	Mart.	23	3	16	common	0.133202	partially protected
<i>Quiabentia zehntneri</i>	(Britton & Rose) Britton & Rose	3	1	2	form5	0	unprotected
<i>Randia aculeata</i>	L.	2	3	1	form6	0	unprotected
<i>Randia armata</i>	(Sw.) DC.	29	3	29	common	0.258278	partially protected
<i>Randia calycina</i>	Cham.	25	3	19	common	0.313131	partially protected
<i>Randia hebecarpa</i>	Benth.	2	3	1	form6	0	unprotected
<i>Randia obcordata</i>	S.Watson	1	3	1	form6	0	unprotected
<i>Raputia brevipedunculata</i>	Kallunki	2	1	3	form5	1	protected
<i>Rauvolfia mattfeldiana</i>	Markgr.	4	1	2	form1	0.5	partially protected
<i>Remijia amazonica</i>	K.Schum.	12	3	9	common	0.25	partially protected
<i>Remijia densiflora</i>	Benth.	4	3	4	common	0.666667	partially protected
<i>Remijia ferruginea</i>	(A.St.-Hil.) DC.	5	3	3	common	0.214286	partially protected
<i>Remijia firmula</i>	(Mart.) Wedd.	19	3	17	common	0.384615	partially protected
<i>Remijia roraimae</i>	(Benth.) K.Schum.	5	3	3	common	0.75	partially protected
<i>Retiniphyllum kuhlmannii</i>	Standl.	8	3	5	common	0.102564	partially protected
<i>Retiniphyllum laxiflorum</i>	(Benth.) N.E.Br.	5	3	5	common	0.666667	partially protected
<i>Retiniphyllum schomburgkii</i>	(Benth.) MÃfÂ¼ll.Arg.	2	1	2	form5	0.5	partially protected
<i>Rhamnidium elaeocarpum</i>	Reissek	19	3	13	common	0.105386	partially protected
<i>Rhynchanthera cordata</i>	DC.	1	1	1	form7	0	unprotected
<i>Rhynchanthera grandiflora</i>	(Aubl.) DC.	1	1	1	form7	0	unprotected
<i>Richeria grandis</i>	Vahl	22	3	23	common	0.333333	partially protected
<i>Rinorea guianensis</i>	Aubl.	19	3	21	common	0.2	partially protected
<i>Rinorea pubiflora</i>	(Benth.) Sprague & Sandwith	17	3	17	common	0.166667	partially protected
<i>Rinorea riana</i>	Kuntze	12	3	9	common	0.615385	partially protected
<i>Rinoreocarpus ulei</i>	(Melch.) Ducke	14	3	12	common	0.636364	partially protected
<i>Rochefortia spinosa</i>	(Jacq.) Urb.	2	3	2	form4	0	unprotected
<i>Rogersonanthus arboreus</i>	(Britton) Maguire & B.M.Boom	2	3	2	form4	0.5	partially protected
<i>Rosenbergiodendron densiflorum</i>	(K.Schum.) Fagerl.	8	3	6	common	0.157895	partially protected
<i>Rosenbergiodendron formosum</i>	(Jacq.) Fagerl.	8	3	3	common	0.086957	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Roucheria schomburgkii</i>	Planch.	1	1	1	form7	0.5	partially protected
<i>Roupala dielsii</i>	J.F. Macbr.	1	1	1	form7	1	protected
<i>Roupala meisneri</i>	Sleumer	2	1	2	form5	0.4	partially protected
<i>Roupala montana</i>	Aubl.	35	3	32	common	0.163007	partially protected
<i>Rourea discolor</i>	Baker	1	1	1	form7	1	protected
<i>Rourea doniana</i>	Baker	1	1	1	form7	0	unprotected
<i>Rourea gardneriana</i>	Planch.	1	1	1	form7	1	protected
<i>Rourea induta</i>	Planch.	21	3	13	common	0.1258	partially protected
<i>Rourea martiana</i>	Baker	1	1	1	form7	0	unprotected
<i>Rudgea burchelliana</i>	MÃfÂ¼ll.Arg.	4	3	1	form2	0.2	partially protected
<i>Rudgea cornifolia</i>	(Kunth) Standl.	23	3	21	common	0.290323	partially protected
<i>Rudgea crassiloba</i>	(Benth.) B.L.Rob.	16	3	17	common	0.083333	partially protected
<i>Rudgea erioloba</i>	Benth.	12	3	8	common	0.105263	partially protected
<i>Rudgea hostmanniana</i>	Benth.	3	1	3	form5	1	protected
<i>Rudgea palicouroides</i>	(Mart.) MÃfÂ¼ll.Arg.	1	1	1	form7	0	unprotected
<i>Rudgea viburnoides</i>	(Cham.) Benth.	24	3	18	common	0.103203	partially protected
<i>Ruizterania retusa</i>	(Spruce ex Warm.) Marc.-Berti	18	3	15	common	0.166667	partially protected
<i>Ruprechtia brachysepala</i>	Meisn.	16	3	12	common	0.133333	partially protected
<i>Ruprechtia exploratricis</i>	Sandwith	5	3	5	common	0.333333	partially protected
<i>Ryania canescens</i>	Eichler	1	1	1	form7	1	protected
<i>Ryania dentata</i>	(Kunth) Miq.	5	3	5	common	0.047619	partially protected
<i>Ryania riedeliana</i>	Eichler	1	1	2	form5	0.5	partially protected
<i>Ryania speciosa</i>	Vahl	23	3	20	common	0.176471	partially protected
<i>Sacoglottis guianensis</i>	Benth.	26	3	29	common	0.34375	partially protected
<i>Sacoglottis mattogrossensis</i>	Malme	21	3	21	common	0.391304	partially protected
<i>Salacia crassifolia</i>	(Mart. ex Schult.) G. Don	20	3	13	common	0.140523	partially protected
<i>Salacia elliptica</i>	(Mart.) G. Don	16	3	7	common	0.2	partially protected
<i>Salacia grandifolia</i>	(Mart.) G. Don	1	1	1	form7	0	unprotected
<i>Salvertia convallariodora</i>	A. St.-Hil.	25	3	20	common	0.133047	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Salzmannia nitida</i>	DC.	2	1	2	form5	1	protected
<i>Samanea inopinata</i>	(Harms)Barneby & J.W.Grimes	2	1	2	form5	0.5	partially protected
<i>Samanea tubulosa</i>	(Benth.)Barneby & J.W.Grimes	9	3	7	common	0.181818	partially protected
<i>Sambucus australis</i>	Cham. & Schltdl.	7	3	8	common	0.555556	partially protected
<i>Sapindus saponaria</i>	L.	24	3	17	common	0.166667	partially protected
<i>Sapium argutum</i>	(MÃfÂ¼ll.Arg.) Huber	5	3	4	common	0.285714	partially protected
<i>Sapium glandulosum</i>	(L.) Morong	32	3	29	common	0.25	partially protected
<i>Sapium haemospermum</i>	MÃfÂ¼ll.Arg.	10	3	5	common	0.045455	partially protected
<i>Sapium obovatum</i>	Klotzsch ex MÃfÂ¼ll.Arg.	1	1	1	form7	0	unprotected
<i>Sapium pallidum</i>	(MÃfÂ¼ll.Arg.) Huber	4	3	3	common	0	unprotected
<i>Sapium sellowianum</i>	(MÃfÂ¼ll.Arg.) Klotzsch ex Baill.	2	1	3	form5	0.333333	partially protected
<i>Sarcaulus brasiliensis</i>	(A.DC.) Eyma	19	3	17	common	0.222222	partially protected
<i>Savia sessiliflora</i>	(Sw.) Willd.	3	3	4	form4	0.4	partially protected
<i>Schefflera burchellii</i>	(Seem.) Frodin & Fiaschi	14	3	5	common	0.117117	partially protected
<i>Schefflera coriacea</i>	(Marchal ex Thurn) Harms	2	3	2	form4	0.5	partially protected
<i>Schefflera distractiflora</i>	(Harms) Frodin	16	3	9	common	0.229167	partially protected
<i>Schefflera macrocarpa</i>	(Cham. & Schltdl.) Frodin	13	3	11	common	0.123994	partially protected
<i>Schefflera malmei</i>	(Harms) Frodin	13	3	5	common	0.086957	partially protected
<i>Schefflera morototoni</i>	(Aubl.) Maguire, Steyerm. & Frodin	13	3	5	common	0	unprotected
<i>Schefflera selloi</i>	(Marchal) Frodin & Fiaschi	1	1	1	form7	1	protected
<i>Schefflera sessiliflora</i>	Frodin	1	1	1	form7	1	protected
<i>Schefflera varisiana</i>	Frodin	7	3	6	common	0.347826	partially protected
<i>Schefflera villosissima</i>	Fiaschi & Pirani	1	1	1	form7	1	protected
<i>Schefflera vinosa</i>	(Cham. & Schltdl.) Frodin & Fiaschi	20	3	13	common	0.136674	partially protected
<i>Schinopsis brasiliensis</i>	Engl.	9	3	10	common	0.212766	partially protected
<i>Schinus terebinthifolius</i>	Raddi	19	3	12	common	0.121622	partially protected
<i>Schizocalyx cuspidatus</i>	(A.St.-Hil.) Kainul. & B.Bremer	2	1	1	form7	0.666667	partially protected
<i>Schoepfia brasiliensis</i>	A.DC.	14	3	9	common	0.448276	partially protected
<i>Schoepfia lucida</i>	Pulle	6	3	6	common	0.3	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Sebastiania brasiliensis</i>	Spreng.	16	3	10	common	0.169811	partially protected
<i>Sebastiania brevifolia</i>	(MÃ¶fÂ¼ll.Arg.) MÃ¶fÂ¼ll.Arg.	2	1	2	form5	0.5	partially protected
<i>Sebastiania commersoniana</i>	(Baill.) L.B.Sm. & Downs	6	3	2	common	0.214286	partially protected
<i>Seguiera americana</i>	L.	11	3	10	common	0.285714	partially protected
<i>Seguiera macrophylla</i>	Benth.	12	3	11	common	0.357143	partially protected
<i>Seguiera paraguayensis</i>	Morong	5	3	3	common	0	unprotected
<i>Senaea coerulea</i>	Taub.	1	1	1	form7	0	unprotected
<i>Senegalia bahiensis</i>	(Benth.) Seigler & Ebinger	8	3	6	common	0	unprotected
<i>Senegalia bonariensis</i>	(Gillies ex Hook. & Arn.) Seigler & Ebinger	3	1	2	form5	1	protected
<i>Senegalia globosa</i>	(Bocage & Miotto) L.P. Queiroz	3	1	3	form5	0.166667	partially protected
<i>Senegalia langsdorffii</i>	(Benth.) Seigler & Ebinger	11	3	4	common	0.285714	partially protected
<i>Senegalia lewisii</i>	(Bocage & Miotto) L.P. Queiroz	2	1	1	form7	0.666667	partially protected
<i>Senegalia loretensis</i>	(J.F. Macbr.) Seigler & Ebinger	2	1	2	form5	0.5	partially protected
<i>Senegalia piauhiensis</i>	(Benth.) Seigler & Ebinger	1	1	1	form7	0	unprotected
<i>Senegalia polyphylla</i>	(DC.) Britton	15	3	8	common	0.076923	partially protected
<i>Senegalia riparia</i>	(Kunth) Britton	2	3	2	form4	0	unprotected
<i>Senegalia tamarindifolia</i>	(L.) Britton & Rose	1	3	1	form6	0	unprotected
<i>Senegalia tenuifolia</i>	(L.) Britton & Rose	26	3	24	common	0.241758	partially protected
<i>Senna acuruensis</i>	(Benth.) H.S. Irwin & Barneby	3	3	2	form4	0.125	partially protected
<i>Senna affinis</i>	(Benth.) H.S. Irwin & Barneby	2	1	1	form7	0.5	partially protected
<i>Senna alata</i>	(L.) Roxb.	26	3	19	common	0.246154	partially protected
<i>Senna appendiculata</i>	(Vogel) Wiersema	1	1	1	form7	1	protected
<i>Senna atomaria</i>	(L.) H.S. Irwin & Barneby	4	3	1	form2	0.166667	partially protected
<i>Senna bacillaris</i>	(L.f.) H.S. Irwin & Barneby	14	3	12	common	0.235294	partially protected
<i>Senna biglandularis</i>	A.O. Araujo & V.C. Souza	7	3	2	common	0.157895	partially protected
<i>Senna cearensis</i>	Afr. Fern.	2	3	2	form4	0.333333	partially protected
<i>Senna corifolia</i>	(Benth.) H.S. Irwin & Barneby	4	3	4	common	0.315789	partially protected
<i>Senna gardneri</i>	(Benth.) H.S. Irwin & Barneby	1	3	1	form6	0	unprotected
<i>Senna georgica</i>	H.S. Irwin & Barneby	15	3	13	common	0.307692	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Senna lechriosperma</i>	H.S.Irwin & Barneby	2	1	2	form5	0	unprotected
<i>Senna macranthera</i>	(Collad.)H.S.Irwin & Barneby	13	3	9	common	0.153846	partially protected
<i>Senna macrophylla</i>	(Kunth)H.S.Irwin & Barneby	1	3	1	form6	0	unprotected
<i>Senna multijuga</i>	(Rich.) H.S.Irwin & Barneby	29	3	24	common	0.298077	partially protected
<i>Senna oblongifolia</i>	(Vogel)H.S.Irwin & Barneby	1	1	1	form7	0	unprotected
<i>Senna quinquangulata</i>	(Rich.)H.S.Irwin & Barneby	6	3	8	common	0.3	partially protected
<i>Senna reniformis</i>	(G.Don)H.S.Irwin & Barneby	7	3	4	common	0.259259	partially protected
<i>Senna reticulata</i>	(Willd.)H.S.Irwin & Barneby	7	3	8	common	0.166667	partially protected
<i>Senna rizzinii</i>	H.S.Irwin & Barneby	4	3	3	common	0.294118	partially protected
<i>Senna robiniiifolia</i>	(Benth.)H.S.Irwin & Barneby	2	3	2	form4	0.25	partially protected
<i>Senna rostrata</i>	(Mart.)H.S.Irwin & Barneby	1	1	1	form7	0	unprotected
<i>Senna rugosa</i>	(G.Don)H.S.Irwin & Barneby	24	3	16	common	0.125402	partially protected
<i>Senna silvestris</i>	(Vell.) H.S.Irwin & Barneby	29	3	32	common	0.236152	partially protected
<i>Senna skinneri</i>	(Benth.)H.S.Irwin & Barneby	1	3	1	form6	0	unprotected
<i>Senna spectabilis</i>	(DC.)H.S.Irwin & Barneby	11	3	9	common	0.057143	partially protected
<i>Senna trachypus</i>	(Benth.)H.S.Irwin & Barneby	4	3	3	common	0.444444	partially protected
<i>Senna velutina</i>	(Vogel)H.S.Irwin & Barneby	19	3	9	common	0.164706	partially protected
<i>Senna viciifolia</i>	(Benth.)H.S.Irwin & Barneby	1	1	1	form7	0	unprotected
<i>Senna wurdackii</i>	H.S.Irwin & Barneby	3	3	1	form6	0.2	partially protected
<i>Sida ulei</i>	Ulbr.	1	1	1	form7	0	unprotected
<i>Sida viarum</i>	A.St.-Hil.	1	1	1	form7	0	unprotected
<i>Sideroxylon obtusifolium</i>	(Roem. & Schult.) T.D.Penn.	11	3	8	common	0.125	partially protected
<i>Sigmatanthus trifolius</i>	Huber ex Emmerich	2	1	2	form5	1	protected
<i>Simaba ferruginea</i>	A. St.-Hil.	1	1	2	form5	0.5	partially protected
<i>Simaba floribunda</i>	A. St.-Hil.	4	3	3	common	0.25	partially protected
<i>Simaba insignis</i>	A. St.-Hil. & Tul.	2	1	1	form7	0.333333	partially protected
<i>Simaba maiana</i>	Casar.	13	3	5	common	0.136364	partially protected
<i>Simaba orinocensis</i>	Kunth	17	3	16	common	0.26087	partially protected
<i>Simaba polyphylla</i>	(Cavalcante) W.W. Thomas	1	1	1	form7	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Simaba subcymosa</i>	A. St.-Hil. & Tul.	1	1	1	form7	1	protected
<i>Simarouba amara</i>	Aubl.	25	3	27	common	0.343511	partially protected
<i>Simarouba versicolor</i>	A. St.-Hil.	24	3	21	common	0.158898	partially protected
<i>Simira corumbensis</i>	(Standl.) Steyer.	14	3	7	common	0.102941	partially protected
<i>Simira hexandra</i>	(S.Moore) Steyer.	5	3	3	common	0.111111	partially protected
<i>Simira rubescens</i>	(Benth.) Bremek. ex Steyer.	1	1	1	form7	1	protected
<i>Siparuna brasiliensis</i>	(Spreng.) A. DC.	13	3	4	common	0.125	partially protected
<i>Siparuna guianensis</i>	Aubl.	31	3	38	common	0.185381	partially protected
<i>Siphoneugena crassifolia</i>	(DC.) ProenÃfÂa & Sobral	1	1	2	form5	0.666667	partially protected
<i>Siphoneugena densiflora</i>	O.Berg	9	3	6	common	0.162011	partially protected
<i>Siphoneugena dussii</i>	(Krug & Urb.) ProenÃfÂa	2	1	2	form5	0.5	partially protected
<i>Sloanea eichleri</i>	K.Schum.	21	3	21	common	0.266667	partially protected
<i>Sloanea retusa</i>	Uittien	1	1	1	form7	1	protected
<i>Sloanea terniflora</i>	(Moc. & SessÃfÂ© ex DC.) Standl.	3	1	4	form5	0.6	partially protected
<i>Socratea exorrhiza</i>	(Mart.) H.Wendl.	1	3	1	form6	0.381818	partially protected
<i>Solanum asperum</i>	Rich.	22	3	12	common	0.159091	partially protected
<i>Solanum bicolor</i>	Willd. ex Roem. & Schult.	5	3	2	common	0.055556	partially protected
<i>Solanum caavurana</i>	Vell.	4	3	3	common	0.444444	partially protected
<i>Solanum campaniforme</i>	Roem. & Schult.	11	3	12	common	0.875	partially protected
<i>Solanum conglobatum</i>	Dunal	4	3	3	common	0.428571	partially protected
<i>Solanum crinitum</i>	Lam.	25	3	20	common	0.247706	partially protected
<i>Solanum itatiaiae</i>	Glaz. ex Edmonds	1	1	1	form7	1	protected
<i>Solanum lacerdae</i>	DusÃfÂ©n	1	1	1	form7	1	protected
<i>Solanum lycocarpum</i>	A. St.-Hil.	19	3	12	common	0.091803	partially protected
<i>Solanum mauritianum</i>	Scop.	4	3	1	form2	0.25	partially protected
<i>Solanum proteanthum</i>	Bohs	17	3	12	common	0.238095	partially protected
<i>Solanum pseudoquina</i>	A. St.-Hil.	1	1	1	form7	0	unprotected
<i>Solanum rhytidoandrum</i>	Sendtn.	1	3	1	form6	0	unprotected
<i>Solanum rufescens</i>	Sendtn.	1	1	1	form7	0.5	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Solanum scuticum</i>	M. Nee	1	1	1	form7	0	unprotected
<i>Solanum stipulaceum</i>	Roem. & Schult.	4	3	2	common	0.375	partially protected
<i>Solanum swartzianum</i>	Roem. & Schult.	3	3	5	form4	0.571429	partially protected
<i>Solanum velleum</i>	Roem. & Schult.	3	3	2	form4	0.444444	partially protected
<i>Sorocea bonplandii</i>	(Baill.) W.C.Burger, Lanj. & de Boer	2	1	2	form5	0	unprotected
<i>Sorocea duckei</i>	W.C. Burger	1	1	1	form7	0	unprotected
<i>Sorocea guilleminiana</i>	Gaudich.	24	3	21	common	0.24	partially protected
<i>Sorocea hilarii</i>	Gaudich.	2	3	1	form6	0.5	partially protected
<i>Sorocea sprucei</i>	(Baill.) J.F.Macbr.	14	3	11	common	0.116279	partially protected
<i>Sphinctanthus microphyllus</i>	K.Schum.	5	1	3	form1	0.5	partially protected
<i>Sphinga platyloba</i>	(DC.)Barneby & J.W.Grimes	1	3	1	form6	0	unprotected
<i>Spiranthera odoratissima</i>	A. St.-Hil.	1	1	1	form7	0	unprotected
<i>Spiranthera parviflora</i>	Sandwith	5	1	8	form1	1	protected
<i>Spondias mombin</i>	L.	30	3	24	common	0.284672	partially protected
<i>Spondias tuberosa</i>	Arruda	5	3	4	common	0.4	partially protected
<i>Staminodianthus racemosus</i>	(Hoehne) D.B.O.S.Cardoso & H.C.Lima	18	3	15	common	0.222222	partially protected
<i>Stenopadus talaumifolius</i>	S.F.Blake	4	1	2	form1	1	protected
<i>Sterculia striata</i>	A. St.-Hil. & Naudin	19	3	11	common	0.107843	partially protected
<i>Stigmaphyllon paralias</i>	A.Juss.	2	1	2	form5	0.5	partially protected
<i>Stillingia argutedentata</i>	Jabl.	1	1	1	form7	1	protected
<i>Stillingia bodenbenderi</i>	(Kuntze) D.J.Rogers	1	1	1	form7	1	protected
<i>Stillingia oppositifolia</i>	Baill. ex MÃfÂ¼ll.Arg.	1	1	1	form7	0	unprotected
<i>Stillingia saxatilis</i>	MÃfÂ¼ll.Arg.	8	3	5	common	0.35	partially protected
<i>Stillingia trapezoidea</i>	Ule	3	1	2	form5	0.2	partially protected
<i>Stillingia uleana</i>	Pax & K.Hoffm.	8	3	5	common	0.333333	partially protected
<i>Strychnos pseudoquina</i>	A. St.-Hil.	18	3	10	common	0.106195	partially protected
<i>Strychnos rubiginosa</i>	A.DC.	1	3	1	form6	0	unprotected
<i>Stryphnodendron adstringens</i>	(Mart.)Coville	21	3	13	common	0.13089	partially protected
<i>Stryphnodendron coriaceum</i>	Benth.	14	3	6	common	0.083333	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Stryphnodendron fissuratum</i>	Martins	2	1	3	form5	0.333333	partially protected
<i>Stryphnodendron guianense</i>	(Aubl.) Benth.	18	3	23	common	0.172414	partially protected
<i>Stryphnodendron polyphyllum</i>	Mart.	15	3	5	common	0.072581	partially protected
<i>Stryphnodendron pulcherrimum</i>	(Willd.)Hochr.	2	3	2	form4	0	unprotected
<i>Stryphnodendron rotundifolium</i>	Mart.	22	3	18	common	0.136087	partially protected
<i>Stylogyne orinocensis</i>	(Kunth) Mez	14	3	10	common	0.2	partially protected
<i>Stylogyne serpentina</i>	Mez	6	1	5	form1	0.666667	partially protected
<i>Stylosanthes capitata</i>	Vogel	1	1	1	form7	0	unprotected
<i>Stylosanthes guianensis</i>	(Aubl.) Sw.	1	1	1	form7	0	unprotected
<i>Styrax aureus</i>	Mart.	4	3	3	common	0.388889	partially protected
<i>Styrax camporum</i>	Pohl	19	3	10	common	0.146293	partially protected
<i>Styrax ferrugineus</i>	Nees & Mart.	20	3	13	common	0.143048	partially protected
<i>Styrax glaber</i>	Sw.	3	1	3	form5	0	unprotected
<i>Styrax griseus</i>	P.W. Fritsch	11	3	4	common	0.193548	partially protected
<i>Styrax maninul</i>	B.Walln.	4	3	3	common	0.344828	partially protected
<i>Styrax martii</i>	Seub.	5	3	3	common	0.242424	partially protected
<i>Styrax pallidus</i>	A.DC.	4	3	3	common	0.666667	partially protected
<i>Styrax pauciflorus</i>	A. DC.	1	1	1	form7	0	unprotected
<i>Styrax pedicellatus</i>	(Perkins) B.Walln.	7	3	5	common	0.333333	partially protected
<i>Styrax rotundatus</i>	(Perkins) P.W.Fritsch	8	3	5	common	0.357143	partially protected
<i>Swartzia acuminata</i>	Willd. ex Vogel	8	3	14	common	0.5	partially protected
<i>Swartzia acutifolia</i>	Vogel	4	3	2	common	0.5	partially protected
<i>Swartzia apetala</i>	Raddi	14	3	11	common	0.162162	partially protected
<i>Swartzia aptera</i>	DC.	4	1	4	form1	0	unprotected
<i>Swartzia aymardii</i>	Barneby	1	1	1	form7	1	protected
<i>Swartzia bahiensis</i>	R.S.Cowan	2	1	2	form5	0	unprotected
<i>Swartzia brachyrachis</i>	Harms	15	3	18	common	0.888889	partially protected
<i>Swartzia capixabensis</i>	Mansano	1	1	1	form7	1	protected
<i>Swartzia dipetala</i>	Vogel	3	3	1	form6	0.142857	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Swartzia flaemingii</i>	Raddi	19	3	14	common	0.227273	partially protected
<i>Swartzia grandifolia</i>	Benth.	2	3	2	form4	0.571429	partially protected
<i>Swartzia jorori</i>	Harms	11	3	8	common	0.173913	partially protected
<i>Swartzia latifolia</i>	Benth.	11	3	8	common	0.35	partially protected
<i>Swartzia laurifolia</i>	Benth.	18	3	20	common	0.419355	partially protected
<i>Swartzia laxiflora</i>	Benth.	1	1	1	form7	1	protected
<i>Swartzia macrostachya</i>	Benth.	9	3	8	common	0.111111	partially protected
<i>Swartzia parvifolia</i>	Schery	1	3	1	form6	1	protected
<i>Swartzia rondoniensis</i>	Torke & Mansano	2	1	2	form5	0	unprotected
<i>Swartzia xanthopetala</i>	Sandwith	2	3	3	form4	0.2	partially protected
<i>Sweetia fruticosa</i>	Spreng.	17	3	11	common	0.057471	partially protected
<i>Syagrus cocoides</i>	Mart.	13	3	12	common	0.222222	partially protected
<i>Syagrus comosa</i>	(Mart.) Mart.	19	3	12	common	0.190955	partially protected
<i>Syagrus deflexa</i>	Noblick & Lorenzi	2	1	1	form7	0.6	partially protected
<i>Syagrus flexuosa</i>	(Mart.) Becc.	21	3	12	common	0.142367	partially protected
<i>Syagrus glaucescens</i>	Glaz. ex Becc.	2	1	2	form5	0	unprotected
<i>Syagrus oleracea</i>	(Mart.) Becc.	15	3	8	common	0.063492	partially protected
<i>Syagrus romanzoffiana</i>	(Cham.) Glassman	6	3	3	common	0.25	partially protected
<i>Syagrus sancona</i>	(Kunth) H.Karst.	5	3	5	common	0.25	partially protected
<i>Syagrus schizophylla</i>	(Mart.) Glassman	3	3	4	form4	0.333333	partially protected
<i>Symmeria paniculata</i>	Benth.	22	3	21	common	0.263158	partially protected
<i>Symphonia globulifera</i>	L.f.	24	3	25	common	0.352941	partially protected
<i>Symphyopappus itatiayensis</i>	(Hieron.) R.M.King & H.Rob.	2	1	2	form5	0	unprotected
<i>Symphyopappus lymanismithii</i>	B.L.Rob.	1	1	1	form7	1	protected
<i>Symplocos angulata</i>	Brand	2	1	1	form7	0.5	partially protected
<i>Symplocos arbutifolia</i>	Casar.	3	3	3	form4	0.3	partially protected
<i>Symplocos celastrinea</i>	Mart. ex Miq.	11	3	4	common	0.258065	partially protected
<i>Symplocos glabarrima</i>	Gontsch.	3	1	2	form5	0.166667	partially protected
<i>Symplocos guianensis</i>	(Aubl.) GÃ¶rke	7	3	6	common	0.555556	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Symplocos microstyla</i>	Aranha, P.W.Fritsch & Almeda	1	1	1	form7	0	unprotected
<i>Symplocos nitens</i>	(Pohl) Benth.	17	3	12	common	0.114286	partially protected
<i>Symplocos oblongifolia</i>	Casar.	12	3	7	common	0.205128	partially protected
<i>Symplocos platyphylla</i>	(Pohl) Benth.	6	3	1	form2	0.125	partially protected
<i>Symplocos pubescens</i>	Klotzsch ex Benth.	12	3	7	common	0.258065	partially protected
<i>Symplocos pycnobotrya</i>	Mart. ex Miq.	1	1	1	form7	0	unprotected
<i>Symplocos pycnophylla</i>	Sleumer	1	3	1	form6	1	protected
<i>Symplocos rhamnifolia</i>	A. DC.	4	3	2	common	0.333333	partially protected
<i>Symplocos tenuifolia</i>	Brand	4	3	3	common	0.285714	partially protected
<i>Symplocos tetrandra</i>	Mart.	1	3	1	form6	0	unprotected
<i>Syzygium jambos</i>	(L.) Alston	5	3	1	form2	0.3	partially protected
<i>Tabebuia aurea</i>	(Silva Manso) Benth. & Hook.f. ex S.Moore	29	3	27	common	0.149688	partially protected
<i>Tabebuia cassinoides</i>	(Lam.) DC.	2	3	1	form6	0.333333	partially protected
<i>Tabebuia elliptica</i>	(DC.) Sandwith	2	3	1	form6	0.333333	partially protected
<i>Tabebuia insignis</i>	(Miq.) Sandwith	28	3	21	common	0.180952	partially protected
<i>Tabebuia nodosa</i>	(Griseb.) Griseb.	6	3	4	common	0.125	partially protected
<i>Tabebuia pilosa</i>	A.H.Gentry	2	1	2	form5	0	unprotected
<i>Tabebuia roseoalba</i>	(Ridl.) Sandwith	20	3	15	common	0.116564	partially protected
<i>Tabebuia stenocalyx</i>	Sprague & Stapf	2	3	1	form6	0.333333	partially protected
<i>Tabernaemontana catharinensis</i>	A.DC.	8	3	7	common	0.421053	partially protected
<i>Tabernaemontana flavicans</i>	Willd. ex Roem. & Schult.	18	3	19	common	0.388889	partially protected
<i>Tabernaemontana hystrix</i>	Steud.	3	3	3	form4	0.125	partially protected
<i>Tabernaemontana laeta</i>	Mart.	3	3	2	form4	0.5	partially protected
<i>Tabernaemontana siphilitica</i>	(L.f.) Leeuwenb.	27	3	22	common	0.166667	partially protected
<i>Tachigali aurea</i>	Tul.	21	3	13	common	0.134935	partially protected
<i>Tachigali pilgeriana</i>	(Harms) Oliveira-Filho	2	1	1	form7	0.666667	partially protected
<i>Tachigali rubiginosa</i>	(Mart. ex Tul.) Oliveira-Filho	16	3	10	common	0.264368	partially protected
<i>Tachigali subvelutina</i>	(Benth.) Oliveira-Filho	18	3	13	common	0.140065	partially protected
<i>Tachigali vulgaris</i>	L.F. Gomes da Silva & H.C. Lima	22	3	15	common	0.159091	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Talisia esculenta</i>	(A. St.-Hil.) Radlk.	21	3	22	common	0.106796	partially protected
<i>Talisia hexaphylla</i>	Vahl	11	1	7	form1	0.25	partially protected
<i>Talisia subalbans</i>	(Mart.) Radlk.	2	3	1	form6	0.5	partially protected
<i>Tapirira guianensis</i>	Aubl.	32	3	42	common	0.249042	partially protected
<i>Tapirira obtusa</i>	(Benth.) J.D.Mitch.	23	3	20	common	0.233766	partially protected
<i>Tapura amazonica</i>	Poepp.	10	3	4	common	0.291667	partially protected
<i>Taralea cordata</i>	Ducke	14	3	17	common	0.454545	partially protected
<i>Taralea crassifolia</i>	(Benth.)Ducke	2	1	2	form5	1	protected
<i>Taralea reticulata</i>	(Benth.)Ducke	1	1	1	form7	1	protected
<i>Terminalia actinophylla</i>	Mart.	14	3	5	common	0.235294	partially protected
<i>Terminalia argentea</i>	Mart.	20	3	13	common	0.115385	partially protected
<i>Terminalia eichleriana</i>	Alwan & Stace	1	1	1	form7	1	protected
<i>Terminalia fagifolia</i>	Mart.	21	3	13	common	0.14486	partially protected
<i>Terminalia glabrescens</i>	Mart.	21	3	11	common	0.12628	partially protected
<i>Terminalia lucida</i>	Hoffmanns. ex Mart.	15	3	12	common	0.4	partially protected
<i>Terminalia triflora</i>	(Griseb.) Lillo	4	3	2	common	0.333333	partially protected
<i>Ternstroemia brasiliensis</i>	Cambess.	6	3	4	common	0.5	partially protected
<i>Ternstroemia candolleana</i>	Wawra	14	3	10	common	0.44	partially protected
<i>Ternstroemia carnosa</i>	Cambess.	6	3	5	common	0.285714	partially protected
<i>Ternstroemia dentata</i>	(Aubl.) Sw.	20	3	22	common	0.230769	partially protected
<i>Ternstroemia punctata</i>	(Aubl.) Sw.	16	3	14	common	0.7	partially protected
<i>Tessaria integrifolia</i>	Ruiz & Pav.	11	3	11	common	0.083333	partially protected
<i>Tetragastris altissima</i>	(Aubl.) Swart	22	3	21	common	0.253521	partially protected
<i>Thespesia populnea</i>	(L.) Sol. ex CorrÃfÂa	1	3	1	form6	0	unprotected
<i>Thilsea glaucocarpa</i>	(Mart.) Eichler	14	3	10	common	0.171429	partially protected
<i>Thyrsodium spruceanum</i>	Benth.	18	3	20	common	0.428571	partially protected
<i>Tibouchina macrochiton</i>	Cogn.	2	3	1	form6	0.4	partially protected
<i>Tibouchina papyrus</i>	(Pohl) Toledo	5	3	2	common	0.206897	partially protected
<i>Tibouchina rigidula</i>	(Naudin) Wurdack	2	1	2	form5	0	unprotected

S	author	lat	population	ecoregion	Form	r	status
<i>Tibouchina robusta</i>	Cogn.	1	1	1	form7	1	protected
<i>Tibouchina sellowiana</i>	Cogn.	1	1	1	form7	1	protected
<i>Tibouchina stenocarpa</i>	(DC.) Cogn.	21	3	14	common	0.180685	partially protected
<i>Tibouchina trichopoda</i>	Baill.	2	1	1	form7	0.333333	partially protected
<i>Tococa guianensis</i>	Aubl.	27	3	23	common	0.292308	partially protected
<i>Tocoyena brasiliensis</i>	Mart.	21	3	15	common	0.295775	partially protected
<i>Tocoyena bullata</i>	(Vell.) Mart.	10	3	8	common	0.259259	partially protected
<i>Tocoyena formosa</i>	(Cham. & Schltdl.) K.Schum.	30	3	28	common	0.157788	partially protected
<i>Tocoyena hispidula</i>	Standl.	6	3	7	common	0.296296	partially protected
<i>Tocoyena longiflora</i>	Aubl.	4	3	1	form2	0.5	partially protected
<i>Tocoyena neglecta</i>	N.E.Br.	2	3	3	form4	0.428571	partially protected
<i>Tocoyena sellowiana</i>	(Cham. & Schltdl.) K.Schum.	3	1	2	form5	0.125	partially protected
<i>Toulicia crassifolia</i>	Radlk.	7	3	3	common	0.114286	partially protected
<i>Tournefortia rubicunda</i>	Salzm. ex DC.	1	1	1	form7	0	unprotected
<i>Trema micrantha</i>	(L.) Blume	28	3	34	common	0.190184	partially protected
<i>Trembleya laniflora</i>	(D. Don) Cogn.	3	3	3	form4	0.466667	partially protected
<i>Trembleya parviflora</i>	(D. Don) Cogn.	14	3	8	common	0.193548	partially protected
<i>Trichilia casaretti</i>	C. DC.	2	1	1	form7	0.5	partially protected
<i>Trichilia clausenii</i>	C. DC.	1	1	1	form7	0	unprotected
<i>Trichilia elegans</i>	A.Juss.	26	3	16	common	0.161616	partially protected
<i>Trichilia pallida</i>	Sw.	26	3	21	common	0.191667	partially protected
<i>Trichilia stellatotomentosa</i>	Kuntze	11	3	5	common	0.190476	partially protected
<i>Triplaris americana</i>	L.	22	3	21	common	0.188679	partially protected
<i>Triplaris caracasana</i>	Cham.	2	3	2	form4	0	unprotected
<i>Triplaris gardneriana</i>	Wedd.	2	1	1	form7	0	unprotected
<i>Trischidium molle</i>	(Benth.) H.E. Ireland	2	3	2	form4	0	unprotected
<i>Unonopsis aurantiaca</i>	Maas & Westra	1	1	1	form7	0.5	partially protected
<i>Unonopsis bahiensis</i>	Maas & Orava	1	1	1	form7	1	protected
<i>Unonopsis floribunda</i>	Diels	16	3	14	common	0.294118	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Unonopsis guatterioides</i>	(A.DC.) R.E.Fr.	27	3	26	common	0.226563	partially protected
<i>Vachellia farnesiana</i>	(L.) Wight & Arn.	18	3	14	common	0.173333	partially protected
<i>Vachellia macracantha</i>	(Humb. & Bonpl. ex Willd.) Seigler & Ebinger	4	3	2	common	0.130435	partially protected
<i>Vantanea bahiaensis</i>	Cuatrec.	2	3	1	form6	0.4	partially protected
<i>Vantanea compacta</i>	(Schnizl.) Cuatrec.	5	3	4	common	0.26087	partially protected
<i>Vantanea minor</i>	Benth.	3	3	2	form4	0.666667	partially protected
<i>Vantanea morii</i>	Cuatrec.	1	1	1	form7	1	protected
<i>Vantanea obovata</i>	(Nees & Mart.) Benth.	9	3	4	common	0.36	partially protected
<i>Vasconcellea glandulosa</i>	A. DC.	1	1	2	form5	0.5	partially protected
<i>Vasconcellea microcarpa</i>	(Jacq.) A.DC.	14	3	11	common	0.111111	partially protected
<i>Vatairea fusca</i>	(Ducke)Ducke	1	3	1	form6	0	unprotected
<i>Vatairea macrocarpa</i>	(Benth.)Ducke	26	3	20	common	0.142857	partially protected
<i>Vellozia gigantea</i>	N.L.Menezes & Mello-Silva	2	1	2	form5	0.666667	partially protected
<i>Vellozia squamata</i>	Pohl	14	3	3	common	0.284211	partially protected
<i>Vellozia tubiflora</i>	(A.Rich.) Kunth	1	1	1	form7	0	unprotected
<i>Verbesina glabrata</i>	Hook. & Arn.	3	3	4	form4	0.444444	partially protected
<i>Verbesina luetzelburgii</i>	Mattf.	3	1	2	form5	0.25	partially protected
<i>Vernonanthura discolor</i>	H.Rob.	1	3	1	form6	1	protected
<i>Vernonanthura divaricata</i>	(Spreng.) H.Rob.	4	3	1	form2	0.363636	partially protected
<i>Vernonanthura fagifolia</i>	(Gardner) H.Rob.	3	1	3	form5	0.285714	partially protected
<i>Vernonia brasiliensis</i>	(L.) Druce	1	1	1	form7	0	unprotected
<i>Virola sebifera</i>	Aubl.	33	3	35	common	0.171895	partially protected
<i>Virola subsessilis</i>	(Benth.) Warb.	12	3	3	common	0.086957	partially protected
<i>Vismia cayennensis</i>	(Jacq.) Pers.	8	3	7	common	0.153846	partially protected
<i>Vismia gracilis</i>	Hieron.	22	3	15	common	0.321101	partially protected
<i>Vismia guianensis</i>	(Aubl.) Pers.	30	3	32	common	0.261538	partially protected
<i>Vismia japurensis</i>	Rchb.f.	4	3	2	common	0	unprotected
<i>Vismia martiana</i>	Reichardt	5	3	4	common	0.75	partially protected
<i>Vismia micrantha</i>	Mart. ex A. St.-Hil.	3	3	3	form4	0.466667	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Vismia minutiflora</i>	Ewan	13	3	10	common	0.153846	partially protected
<i>Vismia pentagyna</i>	(Spreng.) Ewan	1	1	1	form7	0	unprotected
<i>Vismia schultesii</i>	N.Robson	12	3	11	common	0.375	partially protected
<i>Vismia tenuinervia</i>	(M.E.Berg) N.Robson	7	3	6	common	0.4	partially protected
<i>Vitex cymosa</i>	Bertero ex Spreng.	10	3	6	common	0.166667	partially protected
<i>Vitex flavens</i>	Kunth	7	3	7	common	0.538462	partially protected
<i>Vitex gardneriana</i>	Schauer	1	1	1	form7	1	protected
<i>Vitex megapotamica</i>	(Spreng.) Moldenke	6	3	2	common	0.142857	partially protected
<i>Vitex orinocensis</i>	Kunth	15	3	17	common	0.1875	partially protected
<i>Vitex panshiniana</i>	Moldenke	11	3	9	common	0.291667	partially protected
<i>Vitex polygama</i>	Cham.	24	3	19	common	0.185096	partially protected
<i>Vitex pseudolea</i>	Rusby	7	3	3	common	0.375	partially protected
<i>Vitex rufescens</i>	A.Juss.	6	3	6	common	0.4375	partially protected
<i>Vitex schaueriana</i>	Moldenke	5	3	3	common	0.428571	partially protected
<i>Vitex sellowiana</i>	Cham.	1	1	3	form5	0.5	partially protected
<i>Vitex triflora</i>	Vahl	1	1	1	form7	1	protected
<i>Vochysia cinnamomea</i>	Pohl	16	3	8	common	0.057554	partially protected
<i>Vochysia discolor</i>	Warm.	2	1	3	form5	0.285714	partially protected
<i>Vochysia divergens</i>	Pohl	11	3	7	common	0.235294	partially protected
<i>Vochysia elliptica</i>	Mart.	14	3	6	common	0.142857	partially protected
<i>Vochysia emarginata</i>	Vahl	9	3	5	common	0.310345	partially protected
<i>Vochysia ferruginea</i>	Mart.	24	3	26	common	0.21875	partially protected
<i>Vochysia gardneri</i>	Warm.	16	3	7	common	0.176849	partially protected
<i>Vochysia glaberrima</i>	Warm.	2	1	2	form5	1	protected
<i>Vochysia haenkeana</i>	Mart.	16	3	12	common	0.280255	partially protected
<i>Vochysia petraea</i>	Warm.	1	1	1	form7	0.4	partially protected
<i>Vochysia pruinosa</i>	Pohl	10	3	3	common	0.170732	partially protected
<i>Vochysia rufa</i>	Mart.	17	3	14	common	0.139808	partially protected
<i>Vochysia thyrsoidea</i>	Pohl	16	3	11	common	0.190594	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Vochysia tucanorum</i>	Mart.	22	3	17	common	0.158333	partially protected
<i>Vochysia venezuelana</i>	Stafleu	5	3	4	common	0.129032	partially protected
<i>Weinmannia discolor</i>	Gardner	2	1	2	form5	0	unprotected
<i>Weinmannia guyanensis</i>	Klotzsch ex Engl.	1	3	1	form6	1	protected
<i>Weinmannia humilis</i>	Engl.	1	1	1	form7	0.333333	partially protected
<i>Weinmannia paulliniifolia</i>	Pohl	2	3	3	form4	0.2	partially protected
<i>Wunderlichia azulensis</i>	Maguire & G.M.Barroso	1	1	1	form7	1	protected
<i>Wunderlichia bahiensis</i>	Maguire & G.M.Barroso	2	1	2	form5	0.5	partially protected
<i>Wunderlichia cruelsiana</i>	Taub.	9	3	6	common	0.24	partially protected
<i>Wunderlichia mirabilis</i>	Riedel ex Baker	10	3	6	common	0.257732	partially protected
<i>Ximenia americana</i>	L.	21	3	19	common	0.183099	partially protected
<i>Ximenia coriacea</i>	Engl.	3	1	2	form5	0.166667	partially protected
<i>Ximenia intermedia</i>	(Chodat & Hassl.) DeFilipps	16	3	8	common	0.083333	partially protected
<i>Xylopia aromatica</i>	(Lam.) Mart.	33	3	39	common	0.146377	partially protected
<i>Xylopia frutescens</i>	Aubl.	19	3	17	common	0.37037	partially protected
<i>Xylopia laevigata</i>	(Mart.) R.E. Fr.	2	1	1	form7	0.666667	partially protected
<i>Xylopia sericea</i>	A.St.-Hil.	21	3	19	common	0.209738	partially protected
<i>Xylosma benthamii</i>	(Tul.) Triana & Planch.	26	3	26	common	0.111111	partially protected
<i>Xylosma venosa</i>	N.E.Br.	3	1	1	form7	0	unprotected
<i>Zanthoxylum acuminatum</i>	(Sw.) Sw.	11	3	8	common	0.25	partially protected
<i>Zanthoxylum caribaeum</i>	Lam.	23	3	19	common	0.271186	partially protected
<i>Zanthoxylum fagara</i>	(L.) Sarg.	15	3	7	common	0.125	partially protected
<i>Zanthoxylum hamadryadicum</i>	Pirani	1	1	1	form7	0	unprotected
<i>Zanthoxylum rhoifolium</i>	Lam.	29	3	31	common	0.137815	partially protected
<i>Zanthoxylum riedelianum</i>	Engl.	22	3	19	common	0.110778	partially protected
<i>Zanthoxylum rigidum</i>	Humb. & Bonpl. ex Willd.	9	3	5	common	0.08	partially protected
<i>Zanthoxylum stelligerum</i>	Turcz.	6	3	3	common	0.222222	partially protected
<i>Zanthoxylum syncarpum</i>	Tul.	4	3	4	common	0.294118	partially protected
<i>Zeyheria montana</i>	Mart.	20	3	15	common	0.127451	partially protected

S	author	lat	population	ecoregion	Form	r	status
<i>Zeyheria tuberculosa</i>	(Vell.) Bureau ex Verl.	7	3	4	common	0	unprotected
<i>Ziziphus cotinifolia</i>	Reissek	1	1	1	form7	0	unprotected
<i>Ziziphus joazeiro</i>	Mart.	14	3	10	common	0.121212	partially protected
<i>Zollernia glabra</i>	(Spreng.)Yakovlev	2	1	1	form7	0.333333	partially protected
<i>Zollernia ilicifolia</i>	(Brongn.)Vogel	2	1	2	form5	0.333333	partially protected
<i>Zygia cataractae</i>	(Kunth)L.Rico	1	1	1	form7	0.333333	partially protected
<i>Zygia claviflora</i>	(Spruce ex Benth.) Barneby & J.W. Grimes	3	3	1	form6	0.125	partially protected
<i>Zygia coccinea</i>	(G.Don)L.Rico	2	1	2	form5	0.5	partially protected
<i>Zygia inaequalis</i>	(Willd.)Pittier	1	1	1	form7	0.333333	partially protected
<i>Zygia latifolia</i>	(L.)Fawc. & Rendle	5	3	5	common	0.333333	partially protected

Table 4. Proportion of protected species in each form of rarity.

Status of protected	common	form1	form2	form3	form4	form5	form6	form7	total/status of protected
unprotected	45	17	2		27	53	39	165	348
partially protected	1,254	20	24	1	95	123	59	74	1,650
protected	6	8			6	21	29	135	205
Total species/form of rarity	1,305	45	26	1	128	197	127	374	2,203

Table 5. The ratio (r) between the occurrence into PA and total occurrences for each form and common species. The form of rarity (Forms), the number of species per form (S), the number of all records per form (n), the r minimum (rMin) maximum (rMax) median (rMD) and semi-amplitude of the 95% confidence interval (SCI).

Forms	S	n	rMin	rMax	rMD	SCI
Common	1,254	177,858	0.02	0.88	0.14	0.0003
Form1	20	256	0.12	0.80	0.13	0.023
Form2	24	336	0.07	0.6	0.20	0.013
Form3	1	10	0.6	0.6	0.6	0
Form4	95	1,027	0.07	0.72	0.37	0.009
Form5	123	684	0.12	0.80	0.38	0.012
Form6	59	482	0.10	0.66	0.38	0.01
Form7	74	282	0.20	0.66	0.50	0.01

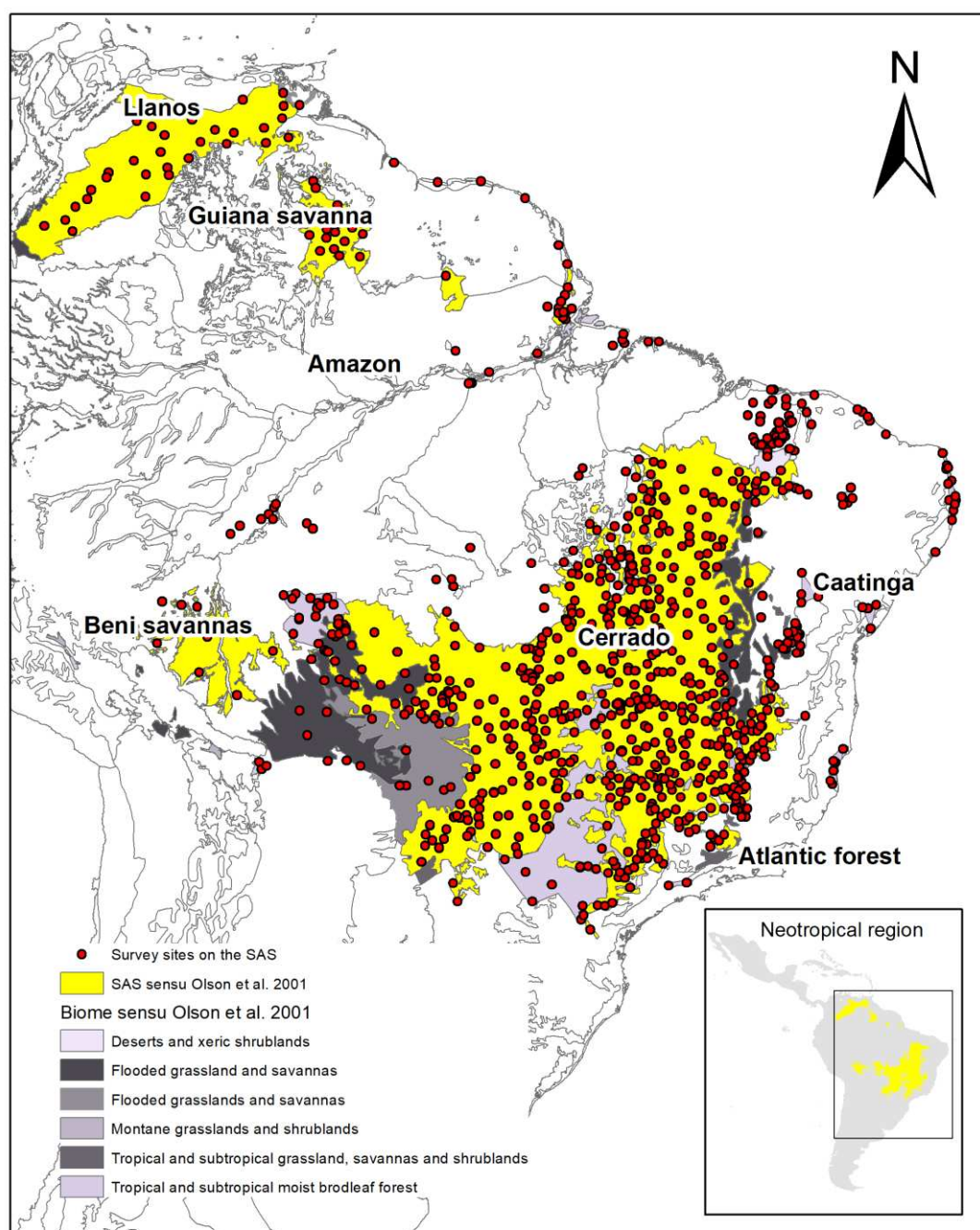


Fig. 1. Main ecoregions of the South American savannas (SAS). In yellow, the restrict concept of Olson et al. (2001). The red points indicate the localisation of the surveys (n=949).

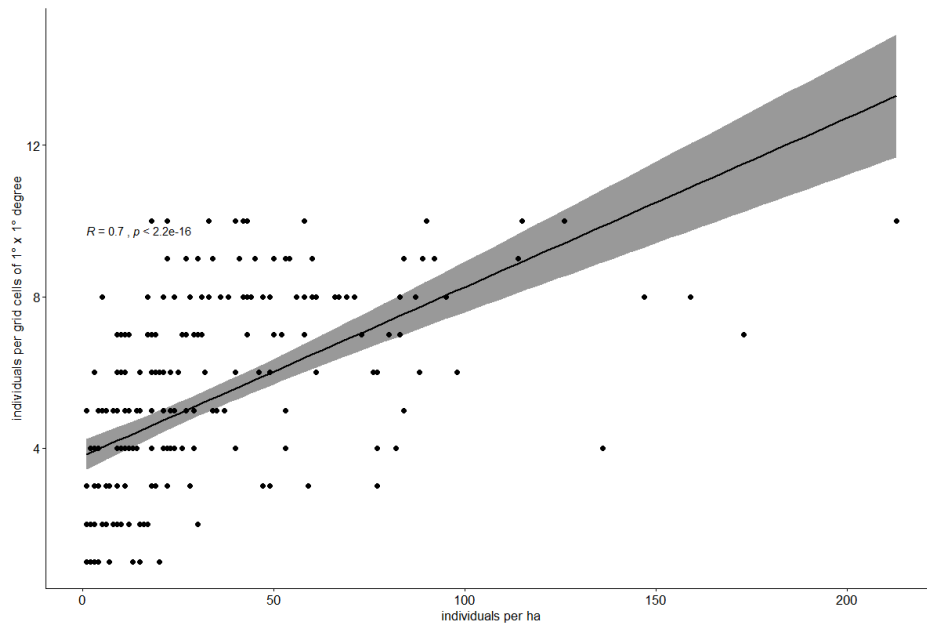


Fig. 2. Scatter plot showing the correlation between the number of individuals per site and grid cells. On the x and y axis are both number of individuals per species. Because for South America savannas the phytosociological surveys are scarce, we used Brazilian Cerrado as a base area. A site corresponds to an area with a minimum size of one hectare with $\text{DBH} \geq 4.7\text{cm}$ as a minimum sample size made in Cerrado. The grid area comprises grid cells by 1×1 degree for all Cerrado as in the Maciel and Martins (2019). The line shows the fit of the spearman model and the gray band the 95% confidence interval. The spearman coefficient (R) and the p-value for 0.05 (p) are displayed.

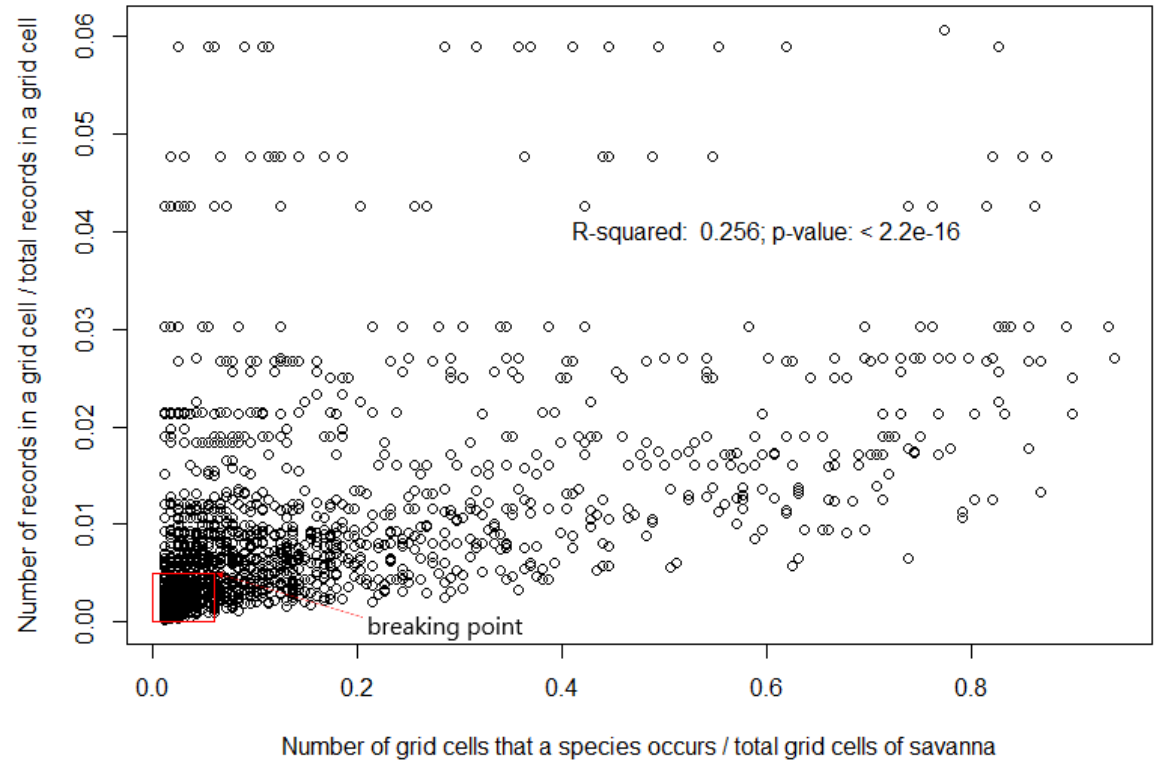


Fig. 3. Scatter plot with the breaking poin (indicated by red arrow). Each circle indicates a species. The species within the red square were considered scarce population.

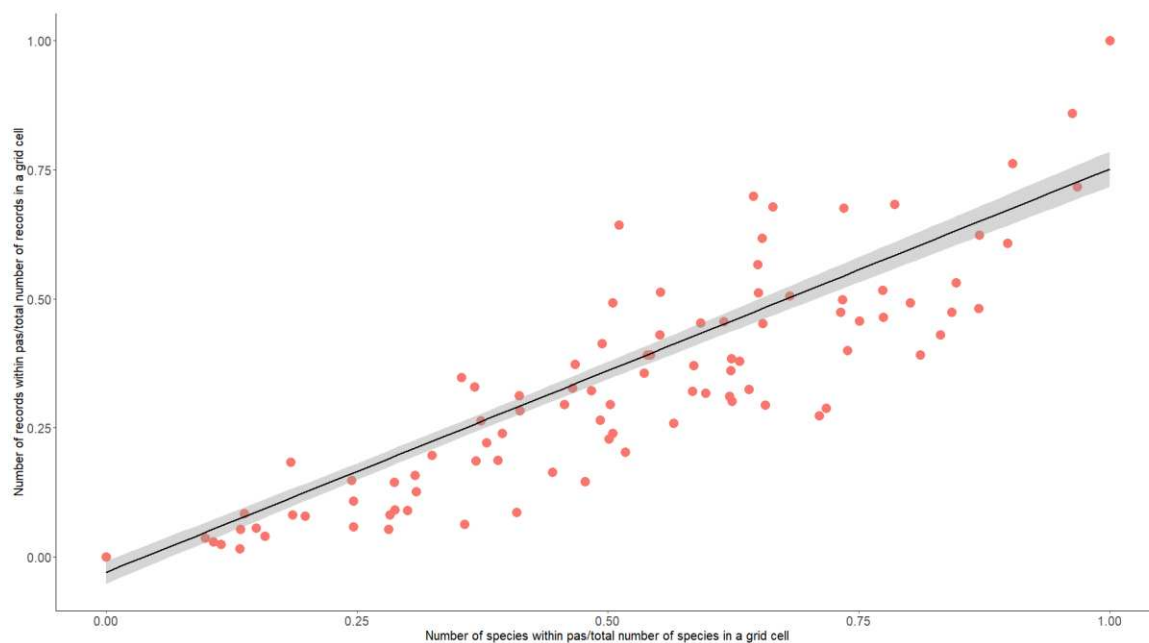


Fig. 4. Scatterplot with a straight line of the best fit generalized linear model. The x-axis is the ratio between the number of records within the protected areas and all records in each grid cell of 1° of latitude by 1° of longitude. The y-axis is the ratio between the number of species within PAs and the total species per grid cells (A).

Supplementary material chapter 4

Supplementary information

Model the dynamics of the vegetation in FORMIND (details could be found in Fischer et al. 2016)

FORMIND calculates biomass using the following general equation:

$$B = 4 \cdot D^2 \cdot H \cdot f$$

where the calculation represents the volume of the tree stem (according to its geometry) multiplied by three factors, which describe the biomass content more concisely. First, f [-] denotes a type-specific form factor, which accounts for deviations of the stem from a cylindrical shape. Second, the parameter ρ [tODM/m³] represents wood density, which describes how much organic dry matter per unit of volume the stem contains. Third, division by the parameter σ [tODM/tODM], which represents the fraction of the total aboveground biomass attributed to the stem, results in the total aboveground biomass (B).

Table 1. Reproduction capacity (RP) and seeders (SE), phenologic leaf with deciduously (DC) or evergreen (EV), animal (ZO), and no animal dispersal (NZ). More details for plant functional types parametrization can be also find in Dantas et al. 2018.

Parameter	Description	Unit	PFT1	PFT2	PFT3	PFT4	PFT5	PFT6	PFT7	PFT8	Reference
Reproduction			SE	SE	SE	SE	RP	RP	RP	RP	
Phenology			DC	DC	EV	EV	DC	DC	EV	EV	
Dispersal spectra			NZ	ZO	NZ	ZO	NZ	ZO	NZ	ZO	(Hughes et al., 1994)
TimeEnd	Total simulation time	Years	1000								
K	Light extinction coefficient	m ² ground m ⁻² leaf	0.6								
I ₀	average irradiance above canopy	Mmol (photons) m ⁻² s ⁻¹	700								
I _{seed}	Minimum light intensity (relative to full light above canopy) required for establishment of seeds	% of I ₀	0.7								
Hmax	Maximum size (height) of 10 a tree	m	7	7	8	6.5	8	7	6.5	7.5	derived from inventory data

Parameter	Description	Unit	PFT1	PFT2	PFT3	PFT4	PFT5	PFT6	PFT7	PFT8	Reference
	function of a single tree										
A	Slope of light response curve	$\mu\text{mol (CO}_2\text{)}$. μmol (photons) ⁻¹	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	(Franco et al., 2005).
A	predator efficiency	-	0.1								(Dantas et al., 2018)
Th	predator handling time	Years	0.0001								
Fire tolerance = probability for death (1: no tolerance 4: tolerant against fire) (group-specific)			2	2	2	2	3	3	3	3	(da Silva Rios and Sousa-Silva, 2017) (Ojeda et al.,

Table 2. Inventories data for three areas. Reproduction capacity (RP) and seeders (SE), phonologic leaf with deciduously (DC) or evergreen (EV), animal (ZO), and no animal dispersal (NZ).

Site	PFT	Reproduction	Leaf phenology	Dispersal mode	No of species	Stems (ha ⁻¹)	Max. height	Basal area (m ² ha ⁻¹)	Max. increment of stem (mm years ⁻¹)
WS1	1	SE	DC	NZ	15	196	7	1.554	2.757
	2	SE	DC	ZO	9	163	7	1.31	2.547
	3	SE	EV	NZ	6	16	8	0.122	0.740
	4	SE	EV	NZ	15	240	6.5	1.724	2.070
	5	RP	DC	ZO	9	447	8	3.038	2.604
	6	RP	DC	NZ	17	372	7	2.428	1.877
	7	RP	EV	ZO	2	177	5	0.833	1.700
	8	RP	EV	NZ	9	164	7.5	1.182	1.220
WS2	1	SE	DC	ZO	16	240	9	2.164	3.175
	2	SE	DC	NZ	20	274	9	4.815	3.632
	3	SE	EV	ZO	1	10	5	0.127	0.537
	4	SE	EV	NZ	9	69	8.5	0.709	3.527
	5	RP	DC	NZ	6	105	7.5	1.335	2.373
	6	RP	DC	ZO	11	71	6.5	0.711	1.248
	7	RP	EV	NZ	2	16	6	0.135	0.957
	8	RP	EV	ZO	5	68	8	0.575	0.650
WS3	1	SE	DC	NZ	16	115	12	1.801	1.336
	2	SE	DC	ZO	18	354	12	6.981	4.269
	3	SE	EV	NZ	3	35	10	1.099	3.825
	4	SE	EV	ZO	10	92	11	1.196	4.442
	5	RP	DC	NZ	7	244	14	2.744	1.601
	6	RP	DC	ZO	19	339	9	3.067	2.534
	7	RP	EV	NZ	3	82	8.5	0.712	1.112
	8	RP	EV	ZO	8	130	8	1.287	1.671

Table 3. Aboveground biomass (ABV) for three phytophysiognomy of Cerrado, open savanna (OS), wood savanna (WS) and Savanna Woodlands (SW). Control scenario (C), climate change scenario (CC), climate change + defaunation (CC .DE), climate change + fire change scenario (CC.CF), and synergism (CC.CF.DE).

Phytophysiognomy	ABV	Reference
OS	8.03	(Barbosa and Fearnside, 2005)
	8.62	(Kauffman et al., 1994)
WS	23.66	
	28.2	(Fearnside et al., 2009)
	25.2	(Felfili et al., 2004)
	12.4	(Felfili et al., 2004)
	15.3	(Felfili et al., 2004)
	16.1	(Felfili et al., 2004)
	8.9	(Felfili et al., 2004)
	17.2	(Felfili et al., 2002)
	55.6	(Torello-Raventos et al., 2013)
	34.1	(Torello-Raventos et al., 2013)
SW	51.21	(Fearnside et al., 2009)
	76.47	(Teodoro, 2014)

Table 4. Parameters used in each model. Control scenario (C), climate change scenario (CC), climate change + defaunation (CC .DE), climate change + change in the fire (CC.CF), and synergism (CC.DS.CF).

Scenario	Climate variable		Fire variable	Defaunation variable	
Change parameter	Annual temperature (°C)	Dry season	Fire frequency in 10 years	Seed predator attack efficiency	Survival rate of seeds – post disperse
C	Mean 25	6	2-3	10%	10%
CC	+2 °C	7	2-3	10%	10%
CC.DS	+2 °C	7	2-3	50%	5%
CC.FC	+2 °C	7	5	10%	10%
CC.DS.FC	+2 °C	7	5	50%	5%



Fig. 1. Aboveground biomass (mean $\pm$ SD) in eight Neotropical savanna communities in baseline scenario for open savanna (a), woody savanna (b, c, d, e, and f, respectively) and savanna woodland (g and h). Different areas are indicated by letters. Red lines indicate the mean and minimum biomass recorded for each community in previous studies (references in Table S4).

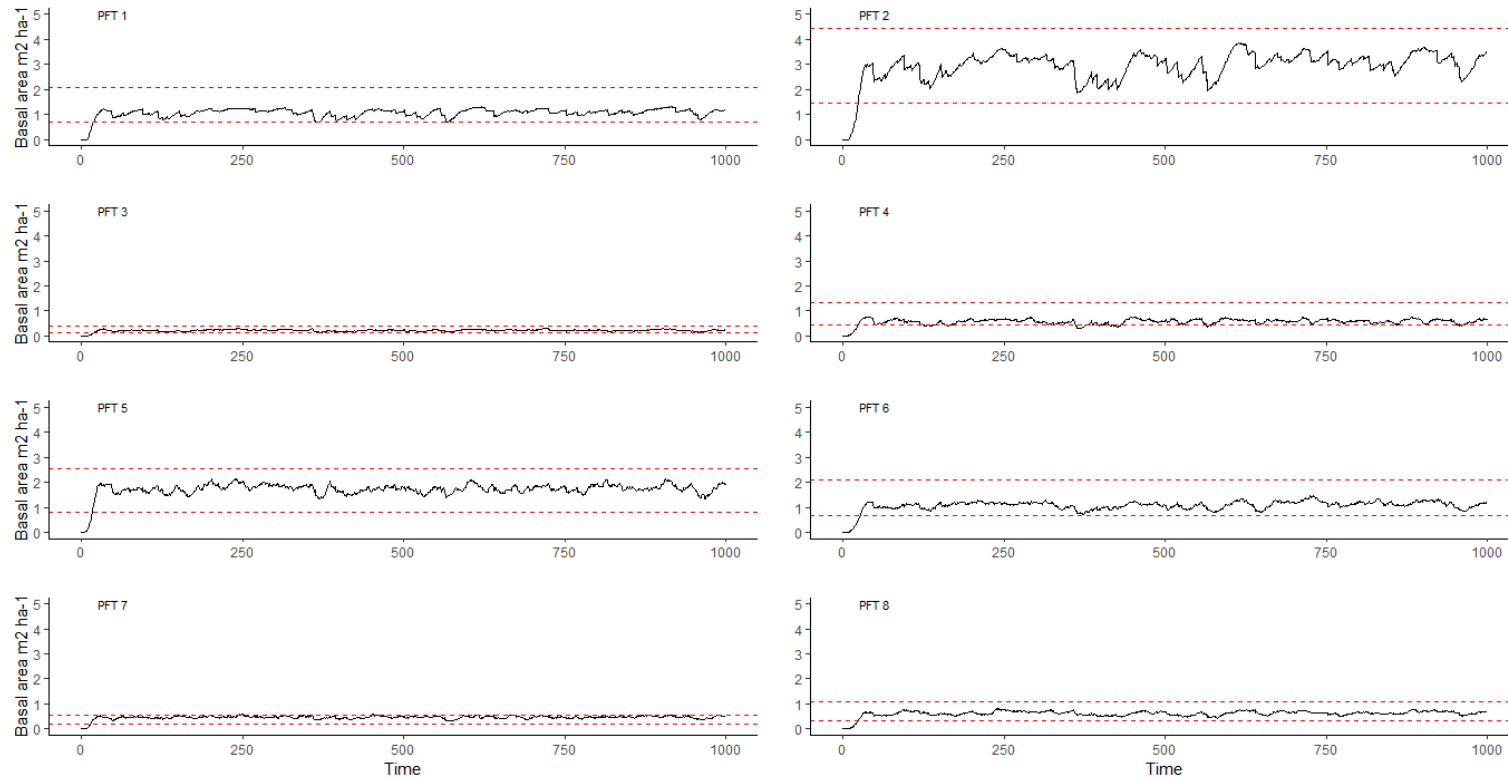


Fig. 2. The models validation for each plant functional type (PFT). The black line is a base area modeled in FORMIND and red line is a base area derived from data inventory. More details about model validation can be find in Dantas et al. 2018.

Anexo 1 Declaração de Bioética



COORDENADORIA DE PÓS-GRADUAÇÃO
INSTITUTO DE BIOLOGIA
Universidade Estadual de Campinas
Caixa Postal 6109.13083-970, Campinas, SP, Brasil
Fone (19) 3521-6378. email: cpgib@unicamp.br



DECLARAÇÃO

Em observância ao §5º do Artsgo 1º da Informação CCPG-UNICAMP/001/15, referente a Bioética e Biossegurança, declaro que o conteúdo de minha Tese de Doutorado, intitulada *LINKING PATTERNS AND PROCESSES IN TREE PLANT COMMUNITIES TO CONSERVATBON AND MANAGEMENT OF THE SOUTH AMERICAN SAVANNAS*”, desenvolvida no Programa de Pós-Graduação em Biociências e Tecnologia de Produtos Bioativos do Instituto de Biologia da Unicamp, não versa sobre pesquisa envolvendo seres humanos, animais ou temas afetos a Biossegurança.

Assinatura

A handwritten signature in blue ink, reading "Everton Alves Maciel", written over a light blue rectangular background.

Nome do(a) aluno(a): Everton Alves Maciel

Assinatura:

A handwritten signature in blue ink, reading "Fernando R. Martins", written over a light blue rectangular background.

Nome do(a) orientador(a): Fernando Roberto Martins

Data: 18 de setembro de 2020

Anexo 2 Declaração dos Direitos Autorais**Declaração**

As cópias de artigos de minha autoria ou de minha co-autoria, já publicados ou submetidos para publicação em revistas científicas ou anais de congressos sujeitos a arbitragem, que constam da minha Dissertação/Tese de Mestrado/Doutorado, intitulada L PATTERNS AND PROCESSES IN TREE PLANT COMMUNITIES TO CONSERVATION AND MANAGEMENT OF THE SOUTH AMERICAN SAVANNAS, não infringem os dispositivos da Lei n.º 9.610/98, nem o direito autoral de qualquer editora.

Campinas, 18 de setembro de 2020

Assinatura: _____

Nome do(a) autor(a): Everton Alves Maciel

RG n.º 359585553

Assinatura : _____

Nome do(a) autor(a): Fernando Roberto Martins

RG n.º 4.652.992-5