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Research Letters

Habitat loss and the effectiveness of protected areas in the Cerrado Biodiversity Hotspot

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ABSTRACT

The definition of conservation targets is strategic for the protection of biodiversity and must ensure the representativeness and persistence of biodiversity components. This is especially critical in fast-disappearing ecosystems, such as in the Cerrado, where opportunities for conservation are rapidly diminishing. We evaluate how different categories of protected areas (PAs) in the Cerrado contribute to achieve the 17% conservation target defined by the Convention on Biological Diversity (CBD). Deforestation rates in sustainable use PAs (IUCN categories IV to VI) are similar to those outside PAs, indicating they are not adequate to ensure the protection of biodiversity. Conversely, strict PAs exhibit significantly less deforestation and should form most of the target content. Because strict PAs represent only 3% of the Cerrado, Brazil is far from achieving the 17% target defined by the Convention on Biological Diversity. Urgent measures toward the creation of strict PAs in the Cerrado are needed, to ensure the representativeness and persistence of its conspicuous biodiversity.

Introduction

Although mankind is facing an expressive biodiversity crisis (Peh, 2011), conserving nature's legacy is not an easy task. The establishment of reserves networks is an important tool to achieve conservation targets for biodiversity conservation (Margules et al., 2002). Conservation targets can originate from evidence-based studies or from policy-driven suggestions (Svancara et al., 2005). Ideally, reserve networks must be large enough to ensure adequate ecosystem representation and persistence (Gaston et al., 2006), but there is no consensus on the proportion of the natural landscape that must be maintained (Brooks et al., 2006).

A review of conservation goals for different countries and ecosystems indicated an average of 13.3% for policy-driven

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targets, whereas evidence-based targets were much larger (Svancara et al., 2005). There is a clear conflict between expectations of conservation scientists and policy makers (Wilhere et al., 2008), especially regarding how much land is needed to ensure biodiversity conservation. Protected areas (PAs) are routinely set on residual lands (Adams, 2005), where the land cost is more important than the biological value, rendering the PAs system extremely adverse for biodiversity maintenance (Venter et al., 2014).

The most widely applicable conservation targets are those stated by the Convention on Biological Diversity (CDB), linked to the United Nations Environment Program and signed by 168 countries, including Brazil. The revised and updated strategic plan for global biodiversity conservation for 2011–2020 was recently discussed in Aichi, Japan, and included the establishment of a conservation target of 17% for terrestrial and inland water ecosystems and 10% for marine and coastal ecosystems.

High deforestation rates, typical of tropical regions, are the main cause of biodiversity loss, affecting some of the most biologically diverse countries (Vié et al., 2009). However, even in forested areas biodiversity can be threatened by subsistence hunting and fragmentation processes that lead to defaunation (Peres, 2000), jeopardizing the maintenance of natural populations (Redford, 1992). In the Brazilian Cerrado, the largest and richest Neotropical savanna (Myers et al., 2000), according to the Brazilian deforestation monitoring, the levels of habitat destruction are rampant and only 50% of its natural cover remains. Although the Cerrado accounts for 30% of Brazilian biodiversity, a very small amount of its surface is protected. The main causes of Cerrado deforestation are commodity monocultures and pastures, whereas hydroelectric reservoirs and the expansion of urban areas are secondary causes. Some predictions show a very grim scenario for the native vegetation in a near future (Faleiro et al., 2013). According to the Brazilian government reports, the deforestation rate in the Cerrado in 2009 was 0.32%, more than twice the 0.14% rate observed in Amazonia.

In Brazil, PAs created by federal, state, or municipal governments fit in twelve categories, forming two groups: Integral Protection (IP) and Sustainable Use (SU) PAs (Brasil, 2000). While the primarily goal of the former is to protect natural resources, the latter aim to promote nature conservation and the sustainable use of natural resources. As the creation of PAs is the most effective framework for biodiversity protection, several countries (especially those signatories of the CBD) invest substantial resources for the identification, creation, and management of PAs (Gaston et al., 2006).

Because PAs receive financial resources and public trust, it is essential to understand their effectiveness for biodiversity conservation (Gaston et al., 2006). Considering that the main hallmarks of any successful conservation target are representation (all known or relevant ecosystems, species, and populations included in the system), redundancy (how much of ecosystems, species, and populations included), and persistence (how long they will remain), we assess the contribution of different PA categories to avoid habitat loss. We use deforestation inside IPs and SUs and on their vicinities to assess resilience and consider only the portion of PAs covered by natural vegetation as effectively protected. We specifically address the following questions: (1) Can PAs ensure Cerrado persistence? (2) How IPs and SUs compare in preventing habitat loss in Cerrado? (3) How efficient are IPs and SUs for the maintenance of Cerrado tree cover?

Material and methods

We obtained data of all PAs in the Brazilian Cerrado, except of RPPNs (available at http://www.ibama.gov.br/zoneamento-ambiental/ucs/), and clipped their limits according to official boundaries of Cerrado. We used Cerrado remnant shapefiles from Landsat and CBERS image classification, identifying patches larger than 2 ha, and cropped shapefiles of Brazilian PAs using the Cerrado boundaries.

We recorded the presence of Cerrado remnants inside PAs (IPs and SUs) and in a 10 km buffer surrounding them (Fig. 1). When PAs overlapped, we considered the amount of deforested area of the most restrictive category, because in these cases Brazilian law considers that standards applied to more restrictive PAs should be maintained (Brasil, 2000). We obtained the total area, total remnant area and total deforested area for 2008 using the Patch Analyst for ArcGis 9.3. Next, we calculated the proportion of total remnants and total deforested areas and arcsine-transformed all values prior to analyses.

We assessed the effects of use (IPs or SUs), jurisdiction (state, federal or municipal), and expropriation (yes or no) upon total deforestation inside and in the 10 km buffer, using factorial ANOVA and Tukey HSD tests. Some PA categories are expropriated after their creation (REBIO, ESEC, PARNA, FLONA, RESEX, and RDS). We assessed differences in percent deforestation inside and outside (10 km buffer) different PA categories with Wilcoxon tests. We report means $\pm$ 1 standard deviation and used the significance level of 5% for hypothesis testing.

Results

There are currently 285 protected areas in the Brazilian Cerrado (Table 1), comprising 155 state, 81 municipal and 49 federal reserves, covering 9.6% of the region. Nevertheless, after accounting for overlapping areas, they only represent 8.3% of the Cerrado. Considering only the fraction covered by native vegetation, this drops to 6.5% (Table 1). State PAs are more numerous, considering both IPs and SUs (Fig. 2A), and correspond to 54% of the total PA in the region (Fig. 2B). Municipal PAs, albeit more numerous than federal PAs, correspond to only 3.2% of the Cerrado total PA. Despite being less numerous, federal PAs protect most of the Cerrado in IPs.

Deforestation within PAs varied significantly with use, jurisdiction, as well as the interaction between jurisdiction and expropriation (Table S1). Deforestation was significantly lower inside IPs in relation to SUs (Table S2 and Table 2, Tukey HSD test, $p < 0.001$). Federal PAs were significantly less deforested than state or municipal PAs (Table S2 and Table 2, $p = 0.004$ and $p < 0.001$, respectively). Nevertheless, differences in deforestation inside PAs according to jurisdiction were dependent on expropriation: federal expropriated PAs had significantly less deforestation than either state expropriated ($p < 0.001$), municipal expropriated ($p = 0.013$), or municipal