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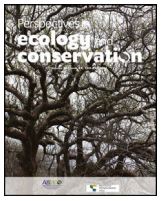

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Strengthening top-down strategies are also required for conservation of the Araucaria Forest

As indicated in Tagliari et al. (2021), the majority of the Araucaria Forest remains in private lands, where their protection is theoretically ensured under legal instruments, such as Legal Reserve and Permanent Protected Areas. However, several landowners have deforested more than permitted under previous legislation (Brasil, 1965), especially in Brazilian Atlantic Forest, where Araucaria Forest is embedded. For example, Paraná state lost 15,867 km^2 of Araucaria Forest from 1965 to 1980 (Amancio et al., 1988). It was the state that most lost areas of the Atlantic Forest since the 1980s about 4,685 km^2, mainly Araucaria Forest (Fundação SOS Mata Atlântica and INPE, 2021). The current forest debt in riparian areas of Atlantic Forest is estimated in at least 5 million hectares (Rezende et al., 2018). This demonstrates that enforcing the law on private properties is very difficult. Besides, there has been considerable pressure to reduce or even eliminate native forest protection on private lands (Metzger et al., 2019).

The enormous deforestation rates in the Atlantic Forest Biome demanded an special legislation to protect threatened tree species, such as the Paraná pine (*Araucaria angustifolia*) (Brasil, 2006; CONAMA, 2001). However, we disagree with the statement by Tagliari et al. (2021) that the current legislation prohibits any timber management. For example, cutting Paraná pine trees located in open areas is allowed if it is for own use in private properties. It is also possible to exploit dead trees within Legal Reserves (CONAMA, 2001; IBAMA/SEMA/IAP, 2008). In fact, the biggest complaint from some sectors, such as landowners and logging companies, is about the restriction on logging of Paraná pine within forest remnants (Bremmatti, 2015; OJC, 2020). Prohibiting selective logging within native forest is important because it increases the density of adult Paraná pines, leading to greater recruitment in forest remnants (Brocardo et al., 2018). Furthermore, the exploitation of Paraná pine in reforestation systems has never been prohibited (Eisfeld et al., 2020), placing it among the main endangered native trees marketed in the Brazilian timber trade (Brandes et al., 2020). It has been argued that bureaucracy would discourage reforestation systems (Eisfeld et al., 2020; Tagliari et al., 2021), however we understand that it is necessary to keep this activity under control by environmental agencies, due to the misuse of licenses to "legalize" illegal timber (Brancalion et al., 2018; see G1, 2021). Moreover, the decline in the reforestation using Paraná pine has been occurring since the 1970s, especially due to the landowners' preference for exotic faster growing trees (Brepohl, 1980), indicating an economically based choice.

Other economic activities in Araucaria Forest remnants are not prohibited on private lands and sustainable Protected Areas (PAs), such as the harvesting of yerba-matte leaves (*Ilex paraguariensis*) and *pinhões* (Paraná pine seeds). This use is highlighted by Tagliari et al. (2021) as a conservation strategy, although they did not address possible negative impacts on forest resilience. In 2019 alone, more than nine thousand tons of *pinhões* were officially harvested (IBGE, 2020), and we are short of scientific knowledge about the impacts on Paraná pine regeneration (Souza et al., 2008) or on the fauna, for which these seeds are key-source of food (Bogoni et al., 2020). Thus, considering TEK and the valuation of forest products may encourage the cultivation of Paraná pine, which could help its conservation, as discussed by Tagliari et al. (2021). Nevertheless, conservation efforts should not be based on a single species. Instead, such efforts should aim to maintain biodiversity and ecological interactions, which are necessary for ecosystem resilience (Gladstone-Gallagher et al., 2019). For example, most of Araucaria Forest remnants have lost mammal diversity (Bogoni et al., 2018), while in strictly PAs such diversity has been less affected (Brocardo et al., 2019). This is a disturbing situation as only 1.5 % of Araucaria Forest comprises strictly PAs (Fig. 1; Table S1). Although, the creation of strictly PAs may locally exacerbate conflicts due to use restriction, as indicated by Tagliari et al. (2021), we argue that even in strictly PAs, stakeholders' participation in conservation decisions may still occur. In fact, three quarters of strictly PAs in Araucaria Forest are Parks (IUCN Category II), where access is not excluded, on the contrary, their objective is to facilitate human interaction with natural habitats. Many PAs have deliberative or advisory councils that include several sectors of the society, such as landowners, researchers, non-governmental organizations and local government representatives (ICMBIO, 2014). Moreover, PA Management Plans typically account for society's participation (D'Amico et al., 2020). However, we recognize the limits and difficulties to implement participatory processes as part of PA management, demanding efforts to improve the society's participation (Teixeira and Limont, 2007).

Attention was drawn to the fact that most of strictly PAs in Araucaria Forest do not have land tenure regularization, including important sites such as São Joaquim National Park and Campos Gerais National Park, where agriculture and livestock activities are still ongoing (Kilca et al., 2020). This increases pressure for degazettement, downsizing or downgrading of PAs (Bragança, 2019; Menegassi, 2020), a recurring problem faced in Brazil (Prasniewski et al., 2020). Undoubtedly, forest protection and recovery on private properties is also an important requirement for biodiversity conservation and resilience of the Araucaria Forest in the face of climate change (Tagliari et al., 2021), especially if these areas connect to PAs. These areas also have the potential to increase human well-being, which can be supported by bottom-up strategies and economic incentives, increasing people's engagement in forest conservation, as indicated by Tagliari et al. (2021). However, while we agree that the diversification of conservation strategies represents the best way for the future of this ancient forest, it is

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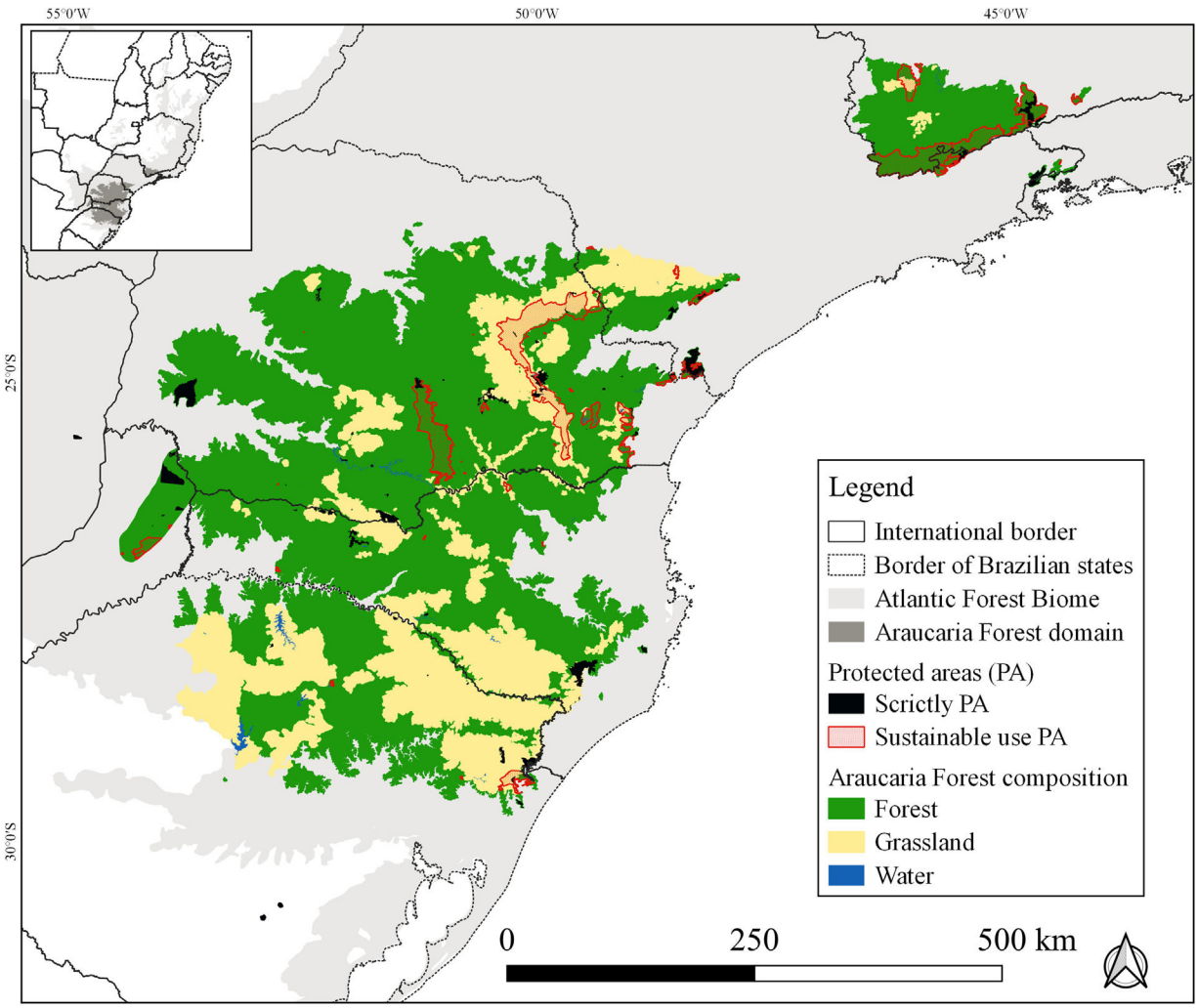

Fig. 1. Protection in Araucaria Forest domain (for details see SM).

clear that strictly PAs should be maintained and expanded, which must be accompanied by better government and civil society support. Strictly PAs have a greater conservation effect, not only for one, but for several species, as well as for ecological services. It is necessary, especially in a highly impacted ecosystem such as Araucaria Forest, where human activities are the rule rather than the exception.

Conflict of interest

The authors declare that there is no conflict of interest, the data presented here are original and are not being submitted to another journal. All financial sources are recognized.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.pecon.2022.01.002.

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