





## Policy Forums

# The emerging problem of the irrigation system for wildlife in the Brazilian Cerrado

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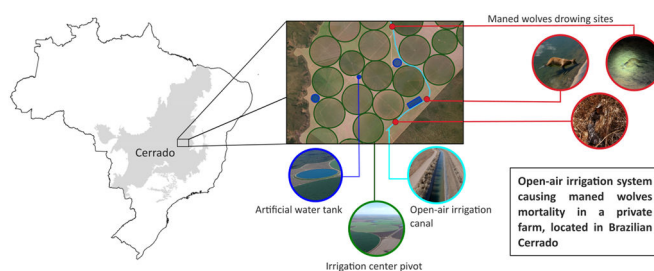
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## HIGHLIGHTS

- First documented maned wolf mortality in Brazilian open-air irrigation canals.
- Open-air canals are an overlooked but serious threat to Cerrado biodiversity.
- Maned wolf deaths highlight broader conservation risks in irrigated landscapes.
- Weak environmental licensing omits key mitigation for wildlife impacts.
- Integrated action needed: governance, market pressure and scientific evidence.

## GRAPHICAL ABSTRACT



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## ABSTRACT

The rapid expansion of irrigation infrastructure in the Brazilian Cerrado is creating new challenges for biodiversity conservation. In this study, we report the first documented cases of maned wolves (*Chrysocyon brachyurus*) killed by open irrigation canals in Brazil, a previously unrecognized threat to the species' survival in agricultural landscapes. Beyond its impact on maned wolves, these findings suggest that such structures pose a widespread but overlooked danger to native Cerrado fauna. Currently, environmental licensing for irrigation projects lacks legal requirements to mitigate wildlife impacts, representing a critical policy gap. To address this issue, coordinated efforts integrating scientific research, governance reforms, and market driven solutions are urgently needed to prevent further biodiversity loss in these rapidly changing ecosystems.

Open-air water canals are agricultural irrigation infrastructures that modify the landscape and pose a significant risk to wildlife, particularly vertebrates (Gómez-Ortiz et al., 2024). These structures act as physical barriers causing habitat fragmentation, constraint of animal movement, and genetic isolation (Azedo et al., 2022; Baechli et al., 2021; Ascensão et al., 2019), which ultimately promotes native species mortality. This

threat to wildlife has been observed in many countries, such as Spain (Peris and Morales, 2004; García, 2009), the United States (Krausman and Bucci, 2010), Portugal (Azedo et al., 2022), Serbia (Gačić et al., 2013), Argentina (Albanesi et al., 2016; Gallego-García and Sarasola, 2024), and Mexico (Gómez-Ortiz et al., 2024). However, the direct effect of water canals as a driver of wildlife drowning mortality and the

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potential trapping effect of such structure remains underestimated in Brazil.

Brazil is both a global leader in agricultural production and a megadiverse country, where the use of central pivot irrigation systems is expanding rapidly. Currently, pivot irrigation systems cover more than 2.2 million hectares in Brazil, an area 71 times larger than in 1985 and almost five times greater than in 2000 (Guimarães and Landau, 2024). The Cerrado biome (Brazilian savanna) accounts for 70% of the Brazilian amount (1.5 million hectares), becoming the newest Brazilian hotspot of primary vegetation deforestation (Caballero et al., 2023) and the main irrigation hub in Brazil (Guimarães and Landau, 2024). The dependence of irrigation system by the agribusiness in Cerrado comes from the high average temperatures and annual rainfall concentrated on a few months (Sano et al., 2024; Nascimento and Novais, 2020; Nascimento et al., 2021), raising in five to seven months of dry season with low rainfall up to severe drought (commonly in August and September) (Alvares et al., 2013). The combined effects of agribusiness expansion and weak legal protections in the Cerrado region are declining precipitation and evapotranspiration, which raise temperatures (Hofmann et al., 2021, 2023) and intensify the demand for additional water resources in agriculture.

Here, we report the mortality of three maned wolves (*Chrysocyon brachyurus*) on a private farm in Bahia state, within the Cerrado biome (Fig. 1). The Maned wolf is a charismatic species of the Brazilian Cerrado and the largest canid in South America, fulfilling ecological functions such as small-animal predation and seed dispersal. This species is currently classified as Vulnerable on the Brazilian list of threatened species (MMA, 2022) and Near Threatened (NT) by the IUCN (Paula and Dematteo, 2015). Although some studies suggest that maned wolves can persist in agricultural landscapes (Lyra-Jorge et al., 2008; Pönzio et al., 2023), agricultural expansion causes native habitat destruction and increases other anthropogenic pressures, representing one of the species' main threats (Rodden et al., 2004; Paula and Dematteo, 2015). Our report adds a new threat to maned wolf populations in agricultural lands.

The maned wolf mortalities were detected by the Onçafari team, an NGO that operates a scientific station on Trijunção Farm, adjacent to the farm where the drowned animals were found. This region, located within MATOPIBA (which spans the Brazilian states of Minas Gerais, Tocantins, Piauí, and Bahia), is both a national deforestation hotspot and home to the iconic Grande Sertão Veredas National Park (GSVNP), a key protected area in the Cerrado. Reflecting this contrast, while Trijunção Farm focuses on conservation and ecotourism activities, the neighboring farm where the drownings occurred is dedicated to intensive grain production. Onçafari has been monitoring maned wolves with GPS collars in this region since December 2018. Between April and August 2023, Onçafari's team received mortality signals from the collars of three of the seven monitored individuals (SISBIO-65035-9), marking the first documented cases of wildlife drowning in open-air irrigation canals in Brazil (Table 1, Fig. 2).

The reported mortality for maned wolf is a superficial symptom of a major biodiversity crisis. The fast deforestation followed by the implementation of the irrigation hub comes at an ecological cost to the Cerrado (and potentially for other biomes), contributing to groundwater depletion (Marques et al., 2020), reduced streamflow (Uchôa et al., 2024), and increasing aridity in the region (Hofmann et al., 2023). These environmental changes will likely intensify wildlife's dependence on artificial water sources, thereby increasing their exposure to irrigation canals and associated risks. Several species found in the biome have been reported dead in water channels across other countries in Latin America, including *Pecari tajacu*, *Mazama gouazoubira*, *Myrmecophaga tridactyla*, *Tamandua tetradactyla*, and *Tapirus terrestris* (Albanesi et al., 2016; Bucci and Krausman, 2015; Peris and Morales, 2004; Gallego-García and Sarasola, 2024). Therefore, the cases of maned wolf mortality described here reflect a broader conservation challenge, underscoring the need for further research, the development of effective

mitigation strategies, and the establishment of appropriate legislation to address the issue in Brazil.

## Paths to mitigation

To reduce direct wildlife mortality in water canals, it is essential to minimize the risk of animal entrapment. The first risk factor is the attractiveness of water itself. Because water is vital for all living beings, wildlife in dry regions like the Cerrado may be forced to take dangerous risks to access it, making water channels particularly "attractive", despite their hazard. In our study case, the drowning happened from 3.2 up to 6.9 km of natural water body. Providing alternative water sources, such as catchments, has been proposed as a mitigation strategy to reduce wildlife mortality in canals (Rorabaugh and Garcia, 1983; Peris and Morales, 2004). Based on this knowledge, Onçafari's team installed and monitored alternative water sources, confirming their effectiveness, as some maned wolves were observed using them.

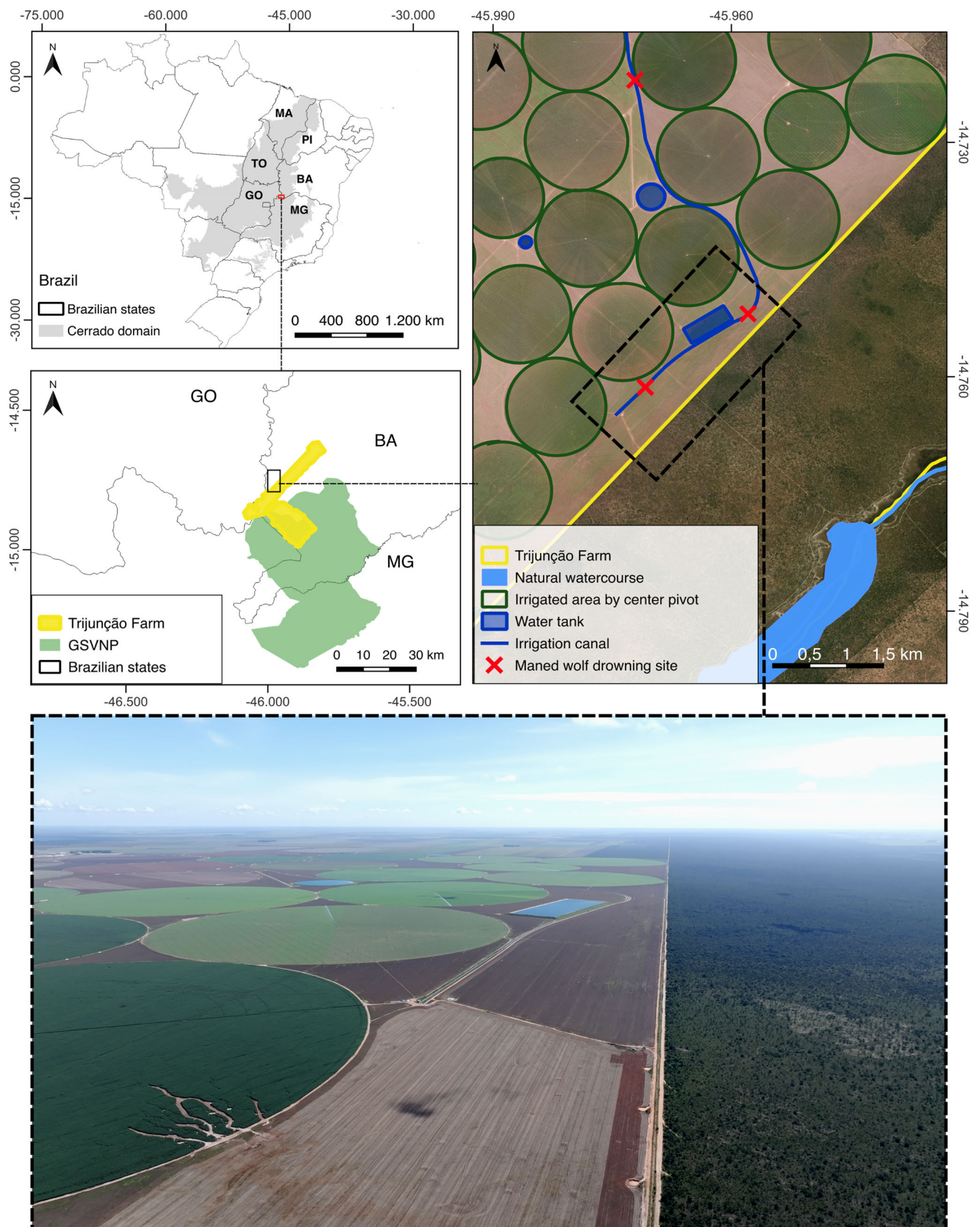
Providing alternative water sources was insufficient to prevent maned wolf drownings, so limiting animal access to canals through fencing is an essential complementary measure (Krausman and Bucci, 2010). This is one of the most discussed strategies, and its effectiveness has been demonstrated for other species, such as mule deer (Krausman and Bucci, 2010; Krausman et al., 1992). However, fencing presents several challenges, including high installation and maintenance costs and the potential for breaches (Gallego-García and Sarasola, 2024; Azedo et al., 2022; Gacić et al., 2013; Godinho and Onofre, 2013). Moreover, fences may also trap animals inside canals or further restrict movement, reinforcing the barrier effect of water channels (Baechli et al., 2021; Krausman and Bucci, 2010). To minimize these risks, fencing must be planned and designed with appropriate escape and crossing structures, allowing wildlife to move safely around and across water canals.

Additionally, escape structures like ramps, ladders, or roughened edges should be included in the irrigation canals, because they have been succeeding to allow large mammals to climb out and preventing drowning (Albanesi et al., 2016; Rautenstrauch and Krausman, 1989). However, escape structure must be tested for the native fauna of the Cerrado to ensure its efficiency not only for large species as maned wolf, but for the wide range of animal's body sizes, movement abilities, and other ecological traits.

Wildlife crossings offer a potential solution to mitigate drownings and the barrier effect of irrigation canals, but their success depends on surrounding landscape characteristics (Azedo et al., 2022; Baechli et al., 2021; Hamilton et al., 2024). Habitat composition (such as vegetation height, cover, and species composition) influences wildlife movement and shapes the effectiveness of water canals crossings (Azedo et al., 2022; Baechli et al., 2021). For example, in Spain, irrigation-driven monocultures have reduced landscape diversity, limiting wildlife movement across canals (Azedo et al., 2022). In contrast, crossings in more diverse landscapes, where resources are evenly distributed, support higher movement rates (Clevenger and Waltho, 2000). Specifically for mammals, 88.1% of species preferred crossings near forested or shrubby areas with vegetation taller than 50–70 cm (Peris and Morales, 2004). Although these studies were not conducted in the Cerrado or even in Brazil, they align with the broader conservation principle of landscape connectivity, which is essential for reducing isolation and the barrier effect of canals (Resasco, 2019; Fletcher et al., 2016).

## A call for action

Environmental licensing for irrigation projects in Brazil fails to address their impacts on wildlife. Although a National Irrigation Law sets federal guidelines (Brasil 2013), the responsibility for licensing falls to state agencies. This misalignment creates a regulatory gap with serious implications for Brazilian biodiversity and natural resources. A clear example comes from Bahia state: after Onçafari reported the

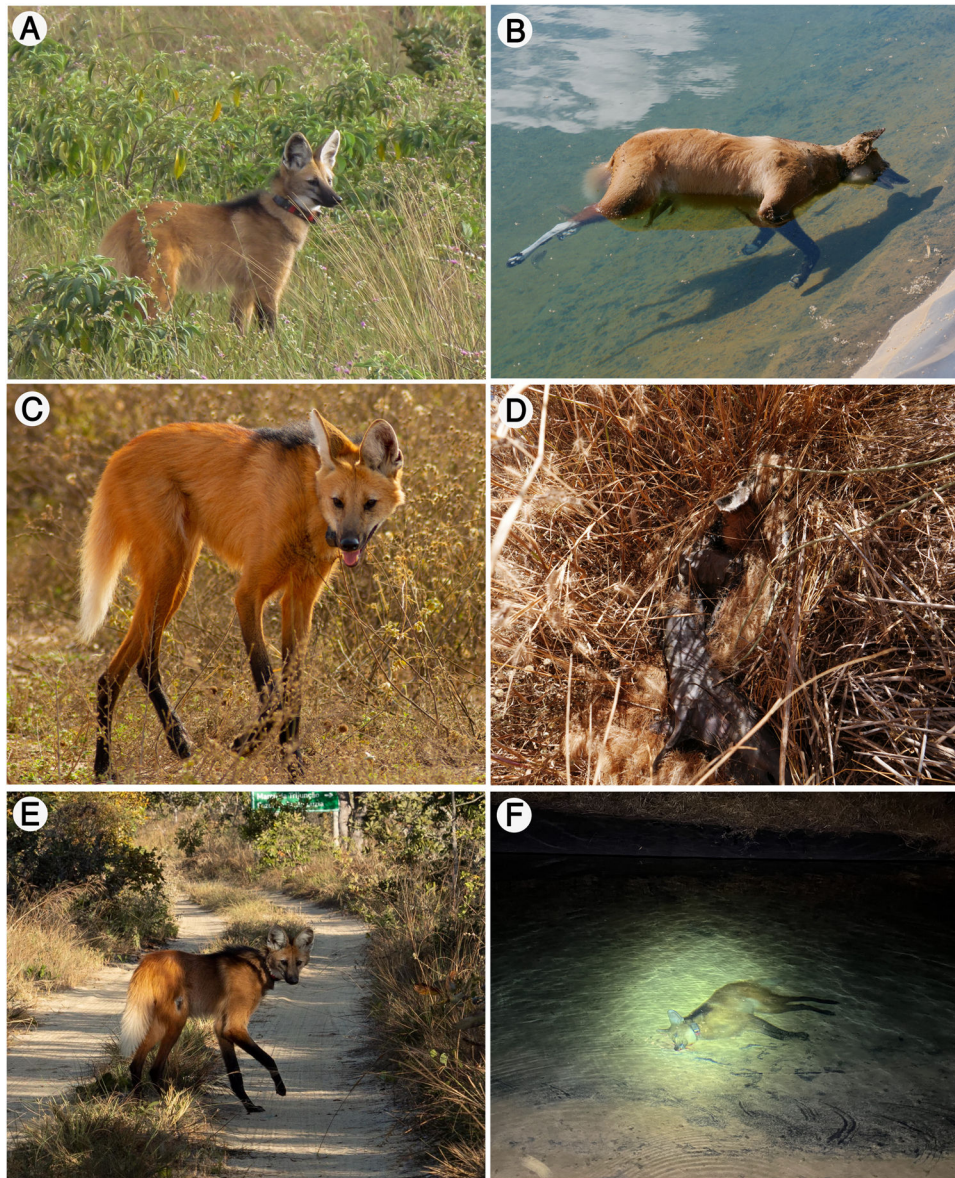


**Fig. 1.** Study area map, including its position within the Cerrado biome and at the border of the states of Minas Gerais (MG), Bahia (BA), and Goiás (GO), Brazil. The bottom image is an aerial photograph of the border between Fazenda Trijunção (preserved area in the right) and the property where maned wolves were found drowned in irrigation canals (intensive agriculture area in the left). This photograph was taken by César Leite, who kindly granted us permission to use it.

**Table 1**

Information on the three maned wolves (*Chrysocyon brachyurus*) individuals found drowned in an open-air irrigation canal in Bahia, Brazil. The mortality coordinates and dates were obtained through the GPS collars. The *Distance natural watercourse (km)* column indicates the distance from the mortality point to the nearest natural water body. M = Male; F = Female; S = Subadult; A = Adult.

Individual (#number – “name”)	Sex	Age	Monitoring period	Last alive observation	Mortality coordinates	Date of mortality	Distance natural watercourse (km)
#1 – “Formoso”	M	S	14 April 2023 to 31 May 2023	30 May 2023, foraging and healthy	14°45'40.82"S 45°58'15.03"W	31-May-23	3.2
#2 – “Nhorinhá”	F	A	14 December 2018 to 17 June 2023	29 May 2023, foraging and healthy	14°43'19.33"S 45°58'19.75"W	17-Jun-23	6.9
#3 – “Urucuia”	M	S	11 June 2023 to 06 August 2023	07 July 2023, foraging and healthy	14°45'6.98"S 45°57'28.49"W	5 or 6 August 2023	3.3



**Fig. 2.** (A) Individual #1 (“Formoso”) observed healthy in the Fazenda Trijunção region. Photo by Chiara Bortoloto, (B) Carcass of Individual #1 floating in the canal where it drowned. Photo by Bárbara Dias. (C) Individual #2 (“Nhorinhá”) observed healthy in the Fazenda Trijunção region. Photo by João Bachur. (D) Carcass of Individual #2, recently removed from the canal where it drowned. Photo by Bárbara Dias. (E) Individual #3 (“Urucuia”) observed healthy in the Fazenda Trijunção region. Photo by Bárbara Dias. (F) Carcass of Individual #3 at the bottom of the canal where it drowned. Photo by Carlos Eduardo Fragoso.

drowning deaths of maned wolves, INEMA (Bahia’s Institute for the Environment and Water Resources) imposed a fine and mandated the installation of fencing along the farm’s open canals. However, as of July 2025, no preventive measures had been implemented at the specific site

where the animals were found dead. This problem is not restricted to Bahia or the MATOPIBA region. Across Brazil, many irrigation systems operate without proper licensing, contributing to the overexploitation of water resources. In Goiás state, one of Brazil’s major grain-producing

regions, more than 2,600 irrigation pivots were operating without permits in 2018 (Latrubesse et al., 2019). The lack of integrated planning, appropriate legislation, and effective water resource management has already triggered water scarcity conflicts in Brazilian river basins (Costa et al., 2021).

Addressing the threat that open irrigation canals pose to wildlife in Brazil requires both stronger public policy enforcement and market-driven accountability. The Brazilian government is a major financier of irrigation initiatives across the country, which should allow better regulation of irrigation projects. Public funding could be made conditional on the implementation of mitigation and compensation plans to reduce wildlife impacts. This is particularly urgent for large-scale, export-oriented farms, which play a critical role in reconciling agricultural production and conservation goals (Machado et al., 2024) and already receive substantial public financial support (Corcioli et al., 2022). At the same time, international market-based conservation strategies can complement national efforts by leveraging supply chain accountability. For example, illegal deforestation in the Cerrado has been linked to export commodities, including those traded with the European Union (Rajão et al., 2020). Since Brazilian agricultural production is largely export-oriented, enforcing stricter environmental safeguards across supply chains could strengthen conservation outcomes (Ermgassen et al., 2020).

Finally, further research is needed to assess the direct wildlife mortality associated with open-air irrigation canals in Brazil. Our long-term GPS collar monitoring was crucial in detecting previously undocumented maned wolf drownings. Therefore, additional studies and surveys are necessary to understand the broader impacts of irrigation canals on native Brazilian fauna. Scientific research supports the development of mitigation strategies, ensuring that conservation efforts remain adaptive and evidence-based. Ultimately, combining stronger governance, market-based conservation measures, and robust scientific research will be essential to achieving a more sustainable balance between agricultural development and biodiversity conservation in the Cerrado (Strassburg et al., 2017).

## Declaration of competing interest

All authors declare that they have no conflict of interest.

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