

Trends and transitions: mapping a decade of conservation research in Brazil's federal protected areas

Tendências e transições: mapeando uma década de pesquisas em conservação em unidades de conservação federais do Brasil

Tendencias y transiciones: cartografía de una década de investigación en conservación en las áreas protegidas federales de Brasil

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Abstract: Investment in research in protected areas provides subsidies for improving the management and conservation of these environments, such as creating new conservation units and promoting sustainable tourism. This paper aimed to analyse the evolution of published studies on federally protected areas in Brazil through a systematic review of 2,282 papers in the Scopus database from 2011 to 2022. There was a growing increase in the number of articles till an abrupt decrease in 2022. The VosViewer software identified niches of the most used keywords linked to conservation, Atlantic Forest, and protected areas. The study highlights the challenges faced when performing research activities in federal protected areas in Brazil, such as access to remote areas and climate instability. The COVID-19 pandemic impacted research, together with the dismantling of scientific institutions by the Brazilian government compromised scientific progress, reflected in a decline of 54% in publications. International collaboration was emphasized, highlighting the importance of disseminating scientific knowledge for environmental preservation and carefully selecting keywords to promote the accessibility and visibility of articles.

Keywords: Research, Science, Brazil.

Resumo: O investimento em pesquisas em unidades de conservação fornece subsídios para melhorias na gestão e conservação destes ambientes, assim como para a criação de novas unidades de conservação e promoção de turismo sustentável. Este artigo

teve como objetivo analisar a evolução dos estudos publicados sobre as unidades de conservação federais do Brasil. A revisão sistemática foi realizada na base de dados Scopus no período de 2011 a 2022, onde foram identificados 2.282 artigos. Houve um aumento crescente no número de artigos até um abrupto decréscimo em 2022. Com o auxílio do software VosViewer foi possível identificar nichos de palavras-chaves mais utilizadas, sendo estas ligadas a conservação, Floresta Atlântica e áreas protegidas. O estudo destaca os desafios enfrentados, como o acesso a áreas remotas e a instabilidade climática, nas pesquisas em áreas protegidas federais no Brasil. A pandemia de COVID-19 impactou a pesquisa, que junto ao dismantelamento das instituições científicas pelo governo brasileiro comprometeu o progresso científico, refletido em uma queda de 54% nas publicações. A colaboração internacional foi enfatizada, ressaltando a importância da disseminação do conhecimento científico para a preservação ambiental, juntamente com a seleção cuidadosa de palavras-chave para promover a acessibilidade e visibilidade dos artigos.

Palavras-chave: Pesquisa, ciência, Brasil.

Resumen: La inversión en investigación en unidades de conservación proporciona subsidios para mejoras en la gestión y conservación de estos entornos, incluida la creación de nuevas unidades de conservación y la promoción del turismo sostenible. Este artículo tuvo como objetivo analizar la evolución de los estudios publicados sobre unidades federales de conservación en Brasil. La revisión sistemática se realizó en la base de datos Scopus desde 2011 hasta 2022, donde se identificaron 2.282 artículos publicados en este período. Hubo un aumento creciente en el número de artículos, sin embargo, con una disminución abrupta en 2022. Con la ayuda del software VosViewer, fue posible identificar nichos de las palabras clave más utilizadas, relacionadas con la conservación, el bosque atlántico y las áreas protegidas. El estudio destaca los desafíos enfrentados, como el acceso a áreas remotas y la inestabilidad climática, en las investigaciones en áreas protegidas federales en Brasil. La pandemia de COVID-19 impactó la investigación, y junto con el dismantelamiento de las instituciones científicas por parte del gobierno brasileño, comprometió el progreso científico, reflejado en una disminución del 54% en las publicaciones. Se enfatizó la colaboración internacional, resaltando la importancia de la difusión del conocimiento científico para la preservación ambiental, junto con la selección cuidadosa de palabras clave para promover la accesibilidad y visibilidad de los artículos.

Palabras clave: Buscar, Ciencia, Brasil.

INTRODUCTION

Conservation Units are the term that Brazilian law defines protected areas to preserve biodiversity. Since the 1930s, several categories of conservation units provided in Brazilian legislation. Brazil is a country with a large natural territory and home to the world's largest tropical forest and two conservation hotspots (Atlantic Forest and 'Cerrado'), so it is expected the government investment proportionate resources in environmental and forestry research.

Investment in research in protected areas can provide subsidies for studies that improve the management and conservation of nature, including the creation of new conservation units, the definition of priority areas, and the establishment of guidelines

for the sustainable exploration of natural resources, including the promotion of ecological and scientific tourism.

In 2021, the National Payment Policy for Environmental Services was approved (Law n.14.119/2021). Its Article VI, Item III provides conservation units (Integral Protection Conservation Units, Extractive Reserves, and Sustainable Development Reserves) as one of the targets of the Payment Program for Environmental Services. The same law provides, in Article XI, that it will be up to the public power to provide technical assistance and training for the promotion of environmental services and the metric definition of valuation, validation, monitoring, verification, and certification of environmental services, as well as preservation and publication of the information. All these planned actions depend directly on the development of research and scientific dissemination.

Carrying out quantitative studies of these surveys may allow a better understanding of the range of analyses already carried out in protected areas and generate incentives to carry them out in areas poorly studied. Bearing in mind that science is going through a period of questioning about its pertinence and veracity, researchers must conduct research for real and practical collaboration (Ferreira et al., 2021). These studies should be disseminated to the stakeholders as well as to the academic area.

The question that arose for this research was: “What are the main topics researched in federal conservation units in Brazil and the extent to these publications been affected by the Brazilian policies in recent years? “

METHODOLOGY

We systematically reviewed papers published on conservation units=protected areas in Brazil using the Scopus database. Data collection was based on temporal and descriptive criteria.

The temporal criterion selected papers published in open-access national and international journals from 2011 to 2022. The descriptive criterion was the identification of papers that contained the following terms in the title/abstract/keywords: “Conservation* Units*” OR Ecological Station OR Biological Reserve OR National Park OR Natural Monument OR Wildlife Refuge OR Environmental Protection Area OR Area of Relevant Ecological Interest OR National Forest OR Extractive Reserve OR Sustainable Development Reserve OR Private Reserve of Natural Heritage AND “Brazil”. These nominations were elected according to the official Brazilian nomenclature for conservation units as stated by the SNUC (National System of Conservation Units), Law No. 9,985, July 18th, 2000.

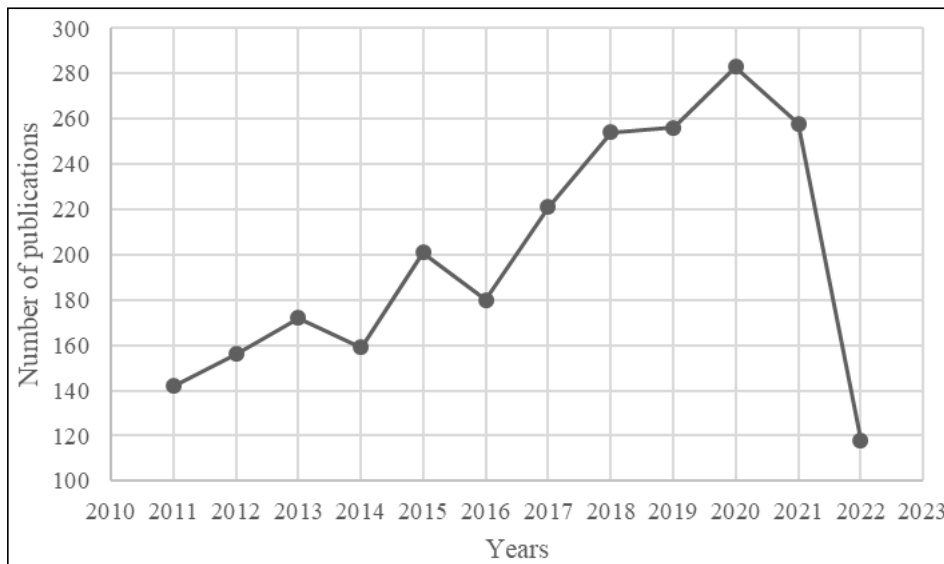
After data collection, we verified duplicate papers and search errors. In the statistical survey, we use Microsoft Excel and VosViewer software to analyse the number of publications per year, countries of origin, sources of funding, and keywords most used. According to Abreu et al. (2020), the software uses an association methodology between nodes. For the construction of this network, 5,151 keywords were identified, which were repeated more than 20 times among the 2,282 articles.

RESULTS

We found 2,282 manuscripts published in open access in national and international journals between 2011 and 2022 (Fig. 1). Over these years there has been a reasonable number of publications about conservation units even facing great challenges such as difficult access to forest areas, long distances to be covered in fieldwork, climate instability and high rainfall in some regions, scarcity and inconstancy of funding, government bureaucratic obstacles, etc.

After duplicating the number of papers in 2020 since 2011, there was an abrupt decrease in the year 2022, with the number of publications falling from 258 to 118.

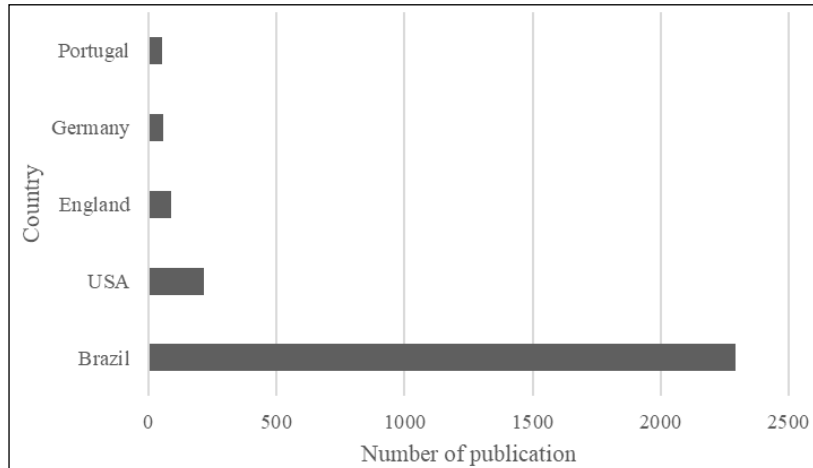
Figure 1 - Papers published from 2011 to 2022.



The most cited paper in this period was “Improving density estimates for elusive carnivores: Accounting for sex-specific detection and movements using spatial capture-recapture models for jaguars in central Brazil”, published in 2011, by Sollmann et al., with 172 citations, related to the Emas National Park at Cerrado biome.

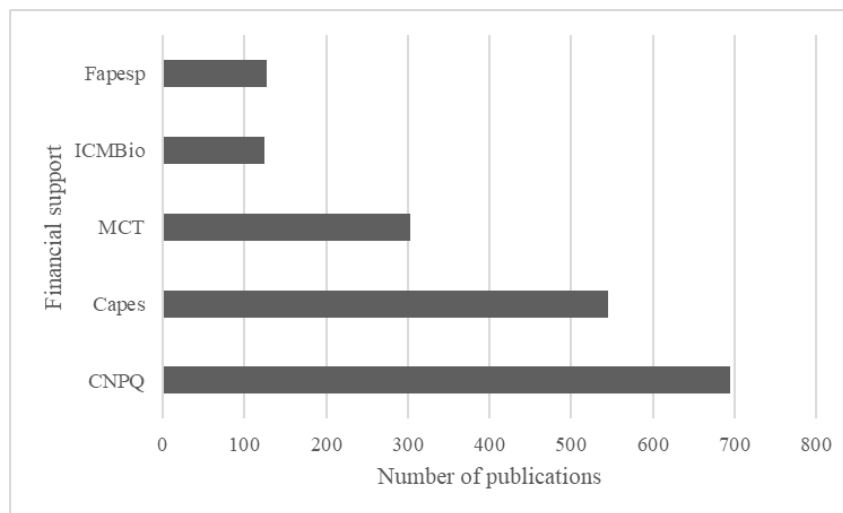
Figure 2 highlights the international interest in researching protected areas within Brazilian territory by showing the countries in which these surveys were published, including the United States and England.

Figure 2 - Countries of publication origin.



Related to the origin of the supporting fundings, the graph illustrates the top five foundations that have provided the most substantial support to these research endeavours, being the Brazilian government foundations for academic research CNPQ¹ and CAPES² stand out 69% of the investment in studies in federal conservation units in recent years, coming afterwards the MCT³, ICMBio⁴ and Fapesp⁵ (Fig. 3). None of the investment funds allocated to these research endeavours are international, indicating that the primary investments in this area are internal.

Figure 3 - Financial support origin.



- 1 National Council for Scientific and Technological Development;
- 2 Coordination for the Improvement of Higher Education Personnel;
- 3 Ministry of Science and Technology;
- 4 Chico Mendes Institute for Biodiversity Conservation;
- 5 São Paulo State Research Support Foundation.

In the Network analysis we have found five connection groups (Fig. 4), represented by clusters of coloured connected lines, the most expressive being the red sequence, led by “Atlantic Forest, conservation, and protected areas” and the green line, following “Taxonomy, Caatinga and diversity” (Table 1).

Figure 4 – Keywords Network.

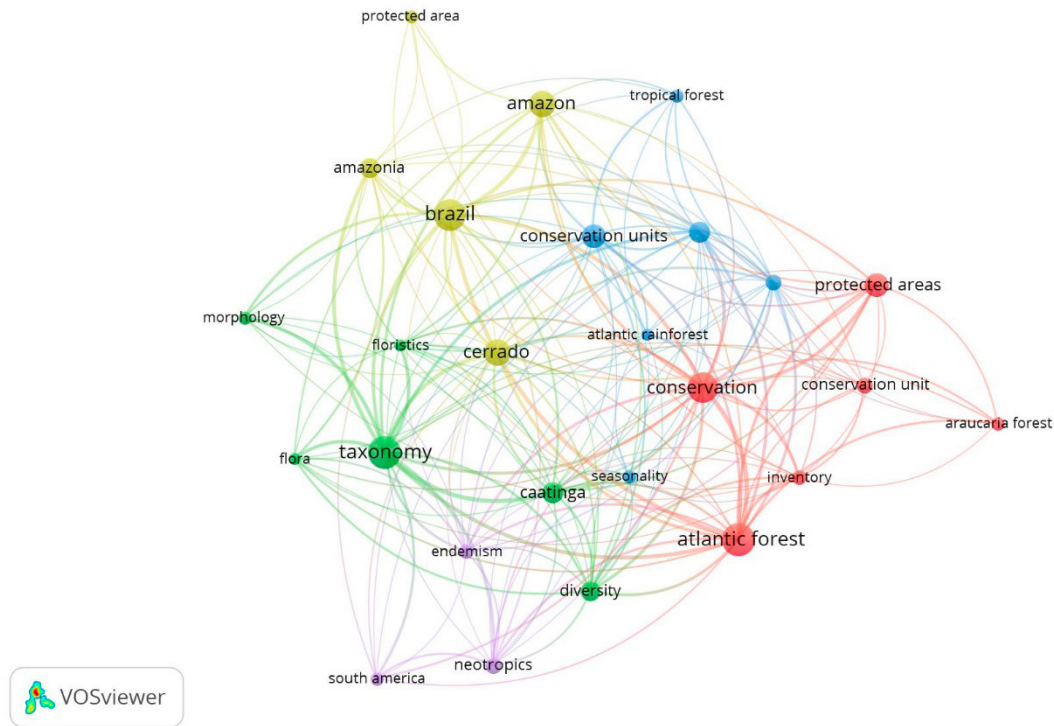


Table 1 - Clusters of keywords

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Conservation	Taxonomy	Brazil	Conservation Units	Neotropics
Atlantic forest	Caatinga	Amazon	Tropical forest	Endemism
Protected areas	Diversity	Cerrado	Atlantic rainforest	South America
Conservation unit	Morphology	Amazonia	Seasonality	
Inventory	Floristics	Protected areas		
Araucaria forest	Flora			

In this research, the most used keywords were “Conservation”, “Atlantic Forest”, and “Taxonomy”. Even though the Amazon Forest stands out in international interest, according to WWF (2019) and has de 28% of the protected areas in the country and Atlantic forest has 9.5%, the high number of interest in Atlantic Forest may be because of the specific federal legislation, the Atlantic Forest Law (Law No. 11,428, dated December 22, 2006).

Another factor that may influence the greater number of studies on the Atlantic Forest, is the fact that the Amazon Rainforest is vast, remote, and often difficult to access

for research purposes, linked also to the greater number of universities in the South and Southeast of the country, located in the Atlantic Forest biome, which also hold the largest number of investments in science.

Lima-Ribeiro et al. (2007) through a scientometric analysis of “Thomson ISI” site population ecology keywords between the years 1942 to 2005, concluded that in Ecology, the most studied themes were “conservation biology” and “community ecology”. Bittencourt & Paula (2012), who analyzed scientific research in federal conservation units in the Scielo database up to 2012, found that the most used keywords so far were “zoology”, “botany” and “ecology”.

DISCUSSION

Brazil faced the dismantling of scientific institutions, which affected the areas of education, environmental preservation, and public health by the government, which took office in 2019. Systematic cuts in the scientific budget, including a 92% reduction in the CNPQ budget, in October 2021 are equivalent to US\$ 106.3 million (Viegas, Hipólito & Ferrante, 2021). Additionally, in 2019, the government interrupted the Amazon Fund, which aims to raise donations for non-reimbursable investments in actions to prevent, monitor, and combat deforestation, and to promote the conservation and sustainable use of the Legal Amazon⁶ (Fundo Amazônia, 2023). The result of a governmental policy discredited science in the last years that led to the poor credibility in science for major the population.

Since scientific research takes months to years to publish, owing to the various stages of hypothesis formulation, the number of publications in a year may be affected by the consequences of acts from previous years. The decrease in publications in 2022 about conservation units may be linked to the lack of stimulation to research that began to affect science in 2019, conveyed in acts and words by the former Brazilian president, Jair Bolsonaro, which led the setback in the country's scientific and technological advances (Viegas, Hipólito & Ferrante, 2021).

There is also the impact of COVID-19, which made it impossible for scientists to do field and laboratory work for a certain period during the lockdown, which lasted longer than expected. Lisboa et al. (2023), demonstrate that other areas, such as accounting sciences, also had impacts on scientific production during the pandemic period. Professors from the Federal University of Paraná report difficulties in writing papers, as during the pandemic period they had to deal with personal concerns, health problems, and social isolation.

Delays in the correct approach to the pandemic also affected isolation time. According to José & Cohn (2021), the director of one of the most respected institutes in the world, the Butantan Institute, stated that the Federal Government refused three offers of vaccines, at the height of the pandemic, when hundreds of thousands of people were already dying from the worsening of the Severe Acute Respiratory Syndrome by Coronavirus 2

⁶ The states of Amazonas, Acre, Rondônia, Roraima, Pará, Maranhão, Amapá, Tocantins, and Mato Grosso.

(SARS-CoV-2). At the end of May 2021, when the director of the Butantan Institute gave his testimony, Brazil already had 462,092 fatalities due to COVID-19 (Worldometers, 2021).

Deforestation increased during COVID-19, probably through relaxed legal enforcement during the outbreak. Vale et al. (2021) argued that the pandemic led to the weakening of environmental regulation. This link between the pandemic and the dismantling of environmental protection in Brazil was confirmed when the Brazilian Supreme Court releases a video footage of a ministerial meeting that took place in April 2020, as part of an inquiry at the request of the Attorney General's Office (Spring, 2020). In the meeting, the Brazilian Environment Minister, Ricardo Salles, advised other ministers to take advantage that "the media attention is almost exclusive on COVID" (The Lancet, 2020), "to open the flood gates and change all the rules and simplify norms". The actions included weakening environmental legislation and institutions, which legalizes deforestation in key ecosystems, reduced environmental standards, and law enforcement in protected areas (Vale et al., 2021).

Conducting research within conservation areas holds significant importance not only for the country where the research area is located. Research carried out in protected areas during the studied period had other contributing countries, such as the USA and England. Collaboration between researchers from different countries can stimulate the exchange of information, experiences, and research techniques, enriching scientific production and improving conservation practices and environmental management around the world. These surveys also promote cooperation and dialogue between countries, strengthening diplomatic relations and building global partnerships for environmental conservation.

Science must disseminate all the knowledge it generates to an audience far beyond the academy so that managers of protected areas receive the results of scientific research and collaborate with the dissemination of science. In this case, it is important to translate the study results into an accessible and easy-to-understand language, making this knowledge used in decision-making processes (Cvitanovic et al., 2016). Sharing scientific knowledge has become increasingly accessible to the public through new media, yet this valuable tool faces challenges in reaching broader audiences due to limitations such as inadequate formal education coverage across all regions of the country, functional illiteracy, and insufficient preparation of scientists.

Padua & Chiaravalloti (2013) argue that when we use knowledge generated and tested over time by traditional peoples or scientists, the generation of reliable information is more guaranteed, and this credibility of science must return to the population. In addition, the dissemination of these surveys can sensitize international public opinion to the importance of preserving these protected areas, contributing to the mobilization of resources and political support for their conservation.

During this study, researchers have recognized the importance of selecting keywords for placement in scientific articles to ensure accurate indexing and facilitate database searches, thereby promoting access to relevant scientific information. Authors should carefully choose keywords to reflect the main themes and concepts addressed in the article.

Moreover, keywords can enhance article visibility, broaden its audience, and identify research gaps.

CONCLUSION

Brazil's position as a country with large areas of forest, with the greatest biodiversity on the planet, gives it the responsibility to preserve and gather as much knowledge as possible from these protected areas. Political choices and global events, such as COVID-19, affect studies in protected areas, which affect the surrounding society. It is of great importance to strengthen alliances between science, population, and politics, for future gains in the environment and society.

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