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Birdwatching and its environmental impact: a bibliometric analysis

El birdwatching y su impacto medioambiental: un análisis bibliométrico

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Abstract

Research on birdwatching and its environmental impact has gained relevance due to its connection with sustainability, biodiversity conservation, and responsible tourism. This article analyzes the evolution of scientific output on birdwatching and its environmental effects in the Scopus database during the period 1994–2024. Publication trends, the most productive authors and countries, international collaboration networks, and emerging topics linked to environmental conservation were identified. The bibliometric study was based on the analysis of 262 indexed documents, using the Bibliometrix package in R Studio to evaluate annual scientific productivity, collaboration indicators, institutional co-authorship, and keyword frequency. The results show that the United States and China lead in scientific output and constitute the main hubs of international collaboration. The most frequent keywords were “environmental conservation,” “bird tourism,” and “climate change,” reflecting a growing interest in evaluating the ecological and social impacts of birdwatching. A sustained increase in publications was observed between 2010 and 2020, followed by a slight slowdown in recent years. Finally, the analysis demonstrates the continued expansion of this area as an interdisciplinary field between environmental science and sustainable tourism, underscoring the need to strengthen international cooperation and promote research with greater ecological and social impact, geared towards conservation and sustainable development.

Keywords: birdwatching, biodiversity conservation, environmental impact.

Resumen

La investigación sobre *birdwatching* y su impacto ambiental ha ganado relevancia debido a su relación con la sostenibilidad, la conservación de la biodiversidad y el turismo responsable. Este artículo analiza la evolución de la producción científica sobre *birdwatching* y su efecto ambiental en la base de datos Scopus durante el periodo 1994-2024. Se identificaron tendencias de publicación, autores y países más productivos, redes de colaboración internacional y temas emergentes vinculados a la conservación ambiental. El estudio bibliométrico se basó en el análisis de 262 documentos registrados, utilizando el paquete Bibliometrix en R Studio para evaluar la productividad científica anual, los indicadores de colaboración, la coautoría institucional y la frecuencia de palabras clave. Los resultados muestran que Estados Unidos y China lideran la producción científica y constituyen

los principales nodos de colaboración internacional. Las palabras clave más frecuentes fueron “conservación ambiental”, “turismo de aves” y “cambio climático”, lo que refleja un interés creciente en evaluar los impactos ecológicos y sociales de la observación de aves. Se observó un aumento sostenido en las publicaciones entre 2010 y 2020, seguido de una ligera desaceleración en años recientes. Finalmente, el análisis evidencia la expansión constante de esta área como un campo interdisciplinario entre ciencias ambientales y turismo sostenible, subrayando la necesidad de fortalecer la cooperación internacional y promover investigaciones con mayor impacto ecológico y social orientadas a la conservación y al desarrollo sostenible.

Palabras clave: *birdwatching*, conservación de la biodiversidad, impacto medioambiental.

Introduction

Over recent decades, birdwatching has evolved from a recreational pastime into an activity of considerable scientific, educational, and economic significance. Worldwide, millions of individuals observe and record birds in their natural habitats, forging a direct connection between nature appreciation and environmental conservation (Sekercioglu, 2002; Sullivan et al., 2009). Beyond its recreational value, the practice yields valuable data on species distribution, migratory patterns, and the effects of climate change, establishing it as a fundamental tool for ornithological research and biodiversity management.

The rise of technological platforms has substantially accelerated the growth of birdwatching as both a scientific and citizen-based endeavor. Notably, the development of eBird by Cornell University has enabled millions of observers worldwide to register data on avian presence and behavior, thereby strengthening global databases and facilitating environmental decision-making (Sullivan et al., 2009; Callaghan et al., 2020). These platforms not only democratize science but also engage the public in ecosystem protection, fostering a culture of active environmental participation. In this way, birdwatching has shed its elitist connotations and has become a space where science and citizenship converge.

From an economic standpoint, birdwatching tourism represents a driver of sustainable development in numerous regions across the globe. Studies have shown that destinations with high avian diversity generate substantial revenue through specialized tourism, thereby incentivizing the conservation of natural habitats (Steven et al., 2014). In Latin America, countries such as Costa Rica, Colombia, Ecuador, and Peru have positioned themselves as leaders in nature tourism, capitalizing on their megadiverse biological heritage. In the Peruvian case, for instance, birdwatching contributes to the dynamism of local economies, particularly in rural communities where it promotes environmental education and the protection of endemic species. Regions like Huánuco, recognized for their biological richness and ecotourism potential, offer ideal natural settings for this activity, which effectively marries environmental sustainability with territorial identity.

The environmental impact of birdwatching has been widely debated in the scientific literature. While the practice fosters ecosystem appreciation and environmental education, inadequate management can give rise to ecological disturbances. Large tourist influxes or insufficient oversight in sensitive areas may disrupt avian behavior patterns, reduce reproductive success, or interfere with migratory processes (Blumstein et al., 2017). Likewise, the construction of tourism infrastructure within natural habitats can fragment the landscape and compromise ecological stability. For these reasons, environmental agencies and local governments have promoted strategies for responsible birdwatching, aimed at balancing tourism development with environmental conservation (Mallord et al., 2007).

Notwithstanding the growing importance of birdwatching across scientific, economic, and environmental domains, systematic analyses of its academic evolution remain scarce. Although studies have addressed its conservation impacts or tourism potential, few have explored publication trends, collaboration networks, and citation patterns that reflect the development of knowledge in this area (Aria & Cuccurullo, 2017). In this regard, bibliometric analysis offers an apt tool for understanding the structure and dynamics of scientific production, enabling the identification of the most productive authors, institutions, and countries, as well as emerging thematic lines and future research opportunities.

Against this backdrop, the present study aims to analyze the evolution of scientific research on birdwatching and its environmental impact during the period 1994–2024, using data from the Scopus database and the Bibliometrix package in R Studio. The work seeks to identify global trends, the most influential authors and institutions, international collaboration networks, and emerging themes linked to biodiversity conservation. The findings will not only contribute to understanding the current state of research but also highlight gaps and opportunities that may guide future academic and environmental management initiatives, particularly in biodiverse regions such as Huánuco, where birdwatching represents a sustainable alternative for local development.

Methodology

This study is quantitative in nature and bibliometric in type, with an observational, longitudinal, and retrospective design, as the variables were not manipulated but rather the existing publication patterns within the Scopus database were analyzed. The aim was to provide a comprehensive overview of the evolution of research on birdwatching and its environmental impact, identifying collaboration trends, predominant thematic areas, and the main scientific actors involved.

The literature search was conducted on May 30, 2024, through an exhaustive review of the Elsevier Scopus database, recognized for its breadth and quality in academic publications (Visconti-López et al., 2022). A total of 262 documents were collected, including scientific articles, reviews, conference proceedings, and book chapters. No restrictions were imposed by document type, with the objective of covering as much scientific evidence related to the topic as possible.

The completeness level of the metadata for these 262 documents was assessed using the "Completeness of Bibliographic Metadata" tool in Bibliometrix, the results of which are shown in Figure 1. This analysis verified that most essential variables (title, abstract, year of publication, affiliation, document type, among others) exhibited an "Excellent" or "Good" level, ensuring adequate data quality for the bibliometric analysis.

Figure 1

Metadata completeness level

Completeness of bibliographic metadata - **262** documents from **Scopus**

Metadata	Description	Missing Counts	Missing %	Status
AB	Abstract	0	0.00	Excellent
DT	Document Type	0	0.00	Excellent
SO	Journal	0	0.00	Excellent
LA	Language	0	0.00	Excellent
PY	Publication Year	0	0.00	Excellent
TI	Title	0	0.00	Excellent
TC	Total Citation	0	0.00	Excellent
AU	Author	1	0.38	Good
CR	Cited References	2	0.76	Good
C1	Affiliation	6	2.29	Good
DI	DOI	23	8.78	Good
DE	Keywords	44	16.79	Acceptable
RP	Corresponding Author	51	19.47	Acceptable
ID	Keywords Plus	138	52.67	Critical
WC	Science Categories	262	100.00	Completely missing

The metadata for each record included title, authors, affiliation, country, year of publication, abstract, keywords, citation count, and other fields, all of which were exported to a CSV file for processing and analysis. The search strategy employed in Scopus used the following combination of keywords in the *TITLE-ABS-KEY* field: (“*birdwatching*” *OR* “*bird tourism*” *OR* “*avianwatching*”) *AND* (“*environmental impact*” *OR* “*climate change*” *OR* “*ecological protection*” *OR* “*biodiversity conservation*” *OR* “*ecosystem service*” *OR* “*sustainability*”) *AND PUBYEAR* > 1993 *AND PUBYEAR* < 2025.

This equation retrieved relevant publications linking birdwatching to environmental conservation, climate change, ecosystem services, and sustainable development. The bibliometric analysis was performed on the collected documents using the Bibliometrix package (Aria & Cuccurullo, 2017), implemented in the RStudio environment, along with its Biblioshiny interface, which facilitates visual and statistical data analysis. This procedure enabled the identification of key indicators of scientific productivity, such as annual article production,

growth rate, average citations per year, most prolific authors, institutions and countries with the greatest contributions, and journals with the highest number of publications.

Classical bibliometric laws were also applied: Lotka's Law to determine author productivity; Bradford's Law to analyze the concentration of publications in the most relevant sources; and Zipf's Law to examine the frequency of keyword occurrence. Additionally, co-occurrence maps of keywords, co-authorship networks, and international collaboration maps were constructed to identify knowledge clusters and emerging themes within the field of birdwatching.

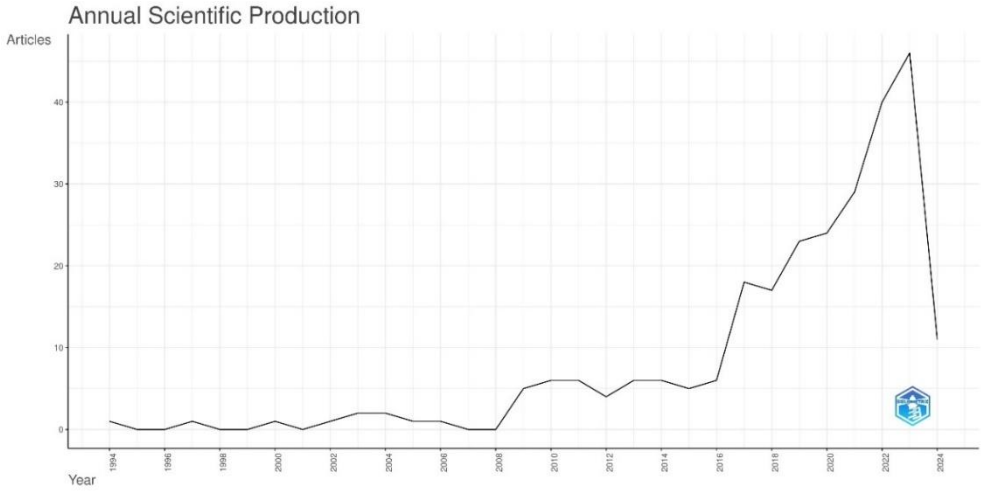
Results and discussion

Annual scientific production

Figure 2 presents the evolution of scientific production on birdwatching and its environmental impact between 1994 and 2024. In the early years of the analyzed period, research activity was limited, with very few registered works, reflecting that the topic had yet to attract the academic interest it commands today. From 2010 onward, a slight increase in publications can be observed, driven by the rise of ecotourism and growing global concern for bird and biodiversity conservation. Between 2015 and 2019, production showed sustained growth, peaking in 2022 with over 45 scientific publications. This increase coincides with the consolidation of nature tourism and the use of digital platforms such as eBird, which strengthened citizen participation in bird observation. During this same period, birdwatching began to be regarded not merely as a recreational activity but also as a tool for environmental research and monitoring.

Figure 2

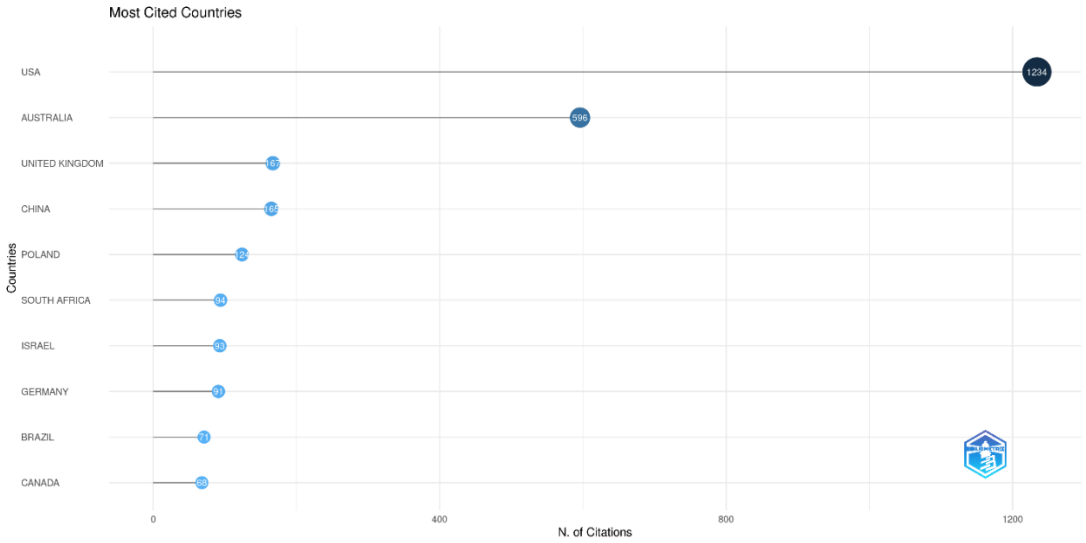
Annual scientific production (2004-2024)



Scientific production and most cited countries

Figure 3 presents the countries with the highest number of citations in studies on birdwatching and its environmental relationship. The United States ranks first with 1,234 citations, demonstrating its leadership in scientific production linked to bird observation and ecosystem conservation. Australia ranks second with 596 citations, distinguished by its interest in research on biodiversity and sustainable tourism. Following are the United Kingdom and China, with 167 and 165 citations, respectively, evidencing their participation in studies focused on avian behavior and environmental management. Poland, South Africa, Israel, Germany, Brazil, and Canada also stand out, and although they have lower citation counts, they contribute valuable insights on conservation and environmental education.

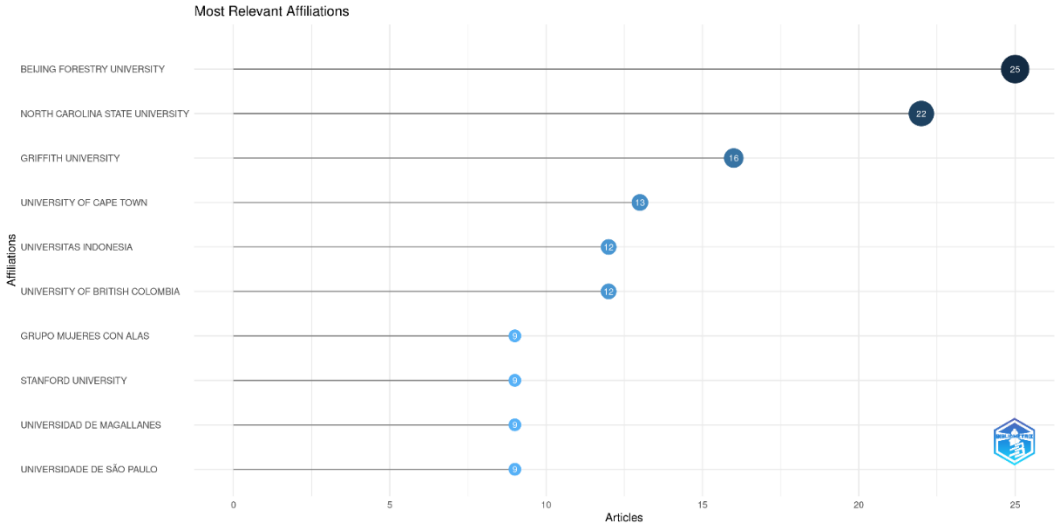
Figure 3
Most relevant countries by citations



Author-institution collaboration

Figure 4 shows the institutions with the greatest participation in publications on birdwatching and environmental impact. Beijing Forestry University leads the ranking with 25 articles, consolidating its position as one of the most active universities in biodiversity and bird conservation studies. In second place is North Carolina State University with 22 publications, reflecting its commitment to applied research in ecology and sustainable tourism. Following are Griffith University with 16 articles, the University of Cape Town with 13, and Universitas Indonesia with 12 publications. These institutions stand out for their work in regions with high biological richness, where birdwatching represents a tool for conservation and local development. Other relevant universities include the University of British Columbia, Stanford University, and the Universidad de Magallanes, which contribute studies focused on the relationship between bird observation, environmental education, and sustainability. Overall, the results reflect a diverse and collaborative academic network, in which both developed and emerging countries contribute to scientific knowledge on avian protection and their natural environments.

Figure 4
Author-institution collaboration

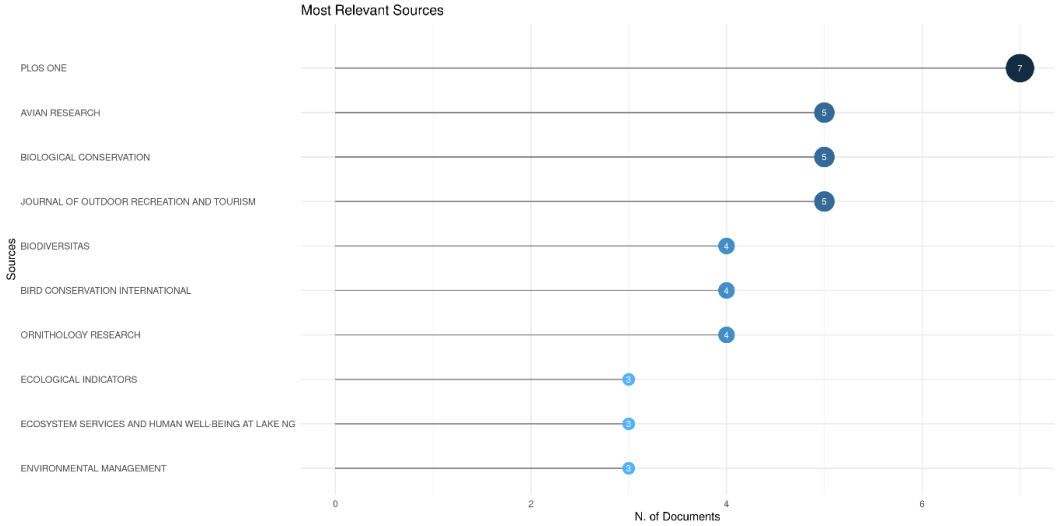


Scientific journals

Figure 5 presents the scientific journals that concentrate the largest number of publications on birdwatching and its environmental impact. In first place is PLOS ONE, with 7 articles, recognized for its multidisciplinary approach and its contribution to the study of biodiversity and species conservation. Following are Avian Research, Biological Conservation, and the Journal of Outdoor Recreation and Tourism, each with 5 publications, which primarily address topics in ecology, sustainable tourism, and wildlife management. Likewise, journals such as Biodiversitas, Bird Conservation International, and Ornithology Research, with 4 articles each, reinforce the importance of bird conservation in various ecological contexts. At lower production levels appear Ecological Indicators, Ecosystem Services and Human Well-Being, and Environmental Management, each with 3 articles, evidencing the diversity of approaches from which the relationship between bird observation, ecosystems, and human well-being is studied. Collectively, these journals constitute the core of scientific dissemination on the subject, contributing relevant information for environmental management and the strengthening of bird tourism as a sustainable global activity.

Figure 5

Most relevant sources



Keywords (co-words)

Figure 6 presents the keywords most frequently used by authors in research related to birdwatching and its environmental impact. The co-occurrence analysis allows for the identification of the main thematic lines and research trends within this field. Among the most frequent keywords are *biodiversity* (8%), *bird* (8%), *ecosystem* (4%), *aves* [birds] (5%), and *ecosystem service* (3%), which reflect a sustained interest in nature conservation and the valuation of ecosystem services. Terms linked to the social and environmental dimensions of bird tourism also appear, such as *human, ecotourism, recreation, environmental protection,* and *climate change*, evidencing the relationship between tourism activity and conservation efforts. Other concepts such as su*stainability, species conservation, protected area, tourism,* and *perception* complete the landscape, showing the variety of approaches from which bird observation is addressed.

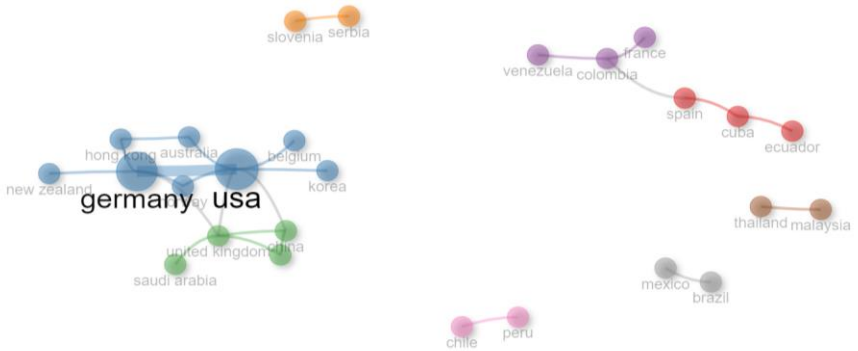
Figure 6
Keyword tree map



Collaboration network

Figure 7 shows the network of scientific collaboration among countries researching birdwatching and its environmental impact. The United States occupies a central position and acts as the main axis of international cooperation, establishing links with nations such as China, Australia, Sweden, the United Kingdom, and Brazil, reflecting its predominant role in the generation and dissemination of scientific knowledge in this field.

Figure 7
Country collaboration



The results obtained in this bibliometric study evidence a sustained growth in scientific production related to birdwatching and its environmental impact from 2010 onward, with a notable increase between 2017 and 2021. This growth reflects the global interest in ecotourism and biodiversity conservation, coinciding with the rise of research in sustainable tourism. According to Steven, Morrison, and Castley (2014), bird observation has evolved from a recreational activity to an environmental and educational phenomenon that promotes the sustainability of natural ecosystems. Likewise, Sekercioglu (2002) had already pointed out that birdwatching tourism not only generates economic benefits but also contributes directly to the preservation of threatened species and to the environmental education of local communities.

The temporal analysis demonstrates that the increase in publications is associated with the emergence of citizen science platforms such as eBird, which have transformed the way ecological data are collected and analyzed. According to Sullivan et al. (2009), these technological tools have enabled millions of observers to contribute useful information for biodiversity management, strengthening the relationship between scientific knowledge and citizen participation. However, the slight decrease in publications in 2023 could be explained by thematic saturation or by reduced funding for environmental tourism projects following the COVID-19 pandemic (Callaghan et al., 2020).

Regarding international collaboration, the network analysis reveals a structure predominantly led by the United States and China, followed by countries such as Australia, the United Kingdom, Germany, and Brazil. These

results are consistent with the findings of Grima et al. (2016) and Callaghan et al. (2020), who highlight the centrality of the United States in ecology and conservation research, attributed to its capacity to articulate interdisciplinary networks between universities and conservation organizations. On the other hand, Latin American participation remains limited, evidencing a collaboration gap that restricts regional scientific production (Steven et al., 2014; Moller et al., 2009). This panorama underscores the need to strengthen alliances among South American countries with high biodiversity potential, such as Peru, Colombia, and Ecuador, to foster more representative and context-sensitive research.

Similarly, the keyword analysis reveals that the terms *biodiversity, ecosystem services, conservation, ecotourism, and climate change* are the most recurrent, reflecting an interdisciplinary focus that links environmental conservation with sustainable tourism. In agreement, Connell (2009) states that birdwatching fosters ecological knowledge and environmental awareness among visitors, generating educational and economic benefits. Similarly, Ghermandi et al. (2020) argue that the valuation of ecosystem services derived from bird tourism reinforces the need for sustainable management policies and territorial planning.

In synthesis, the results of this study confirm that research on birdwatching is at a stage of scientific maturity, characterized by high productivity, a solid framework of international collaboration, and a clear orientation toward environmental sustainability. Nevertheless, the challenge remains to strengthen the presence of research from local contexts, especially in megadiverse regions such as the Amazon and the Peruvian Andes, where bird tourism represents a strategic opportunity for sustainable development and the conservation of endemic species (Sekercioglu, 2012; Balmford et al., 2015; Callaghan et al., 2020).

Conclusion

From the perspective of scientific production, the results show sustained growth from 2010 onward, with a peak in 2021. However, this increase does not always translate into a proportional increase in citations, suggesting that a gap still exists between quantity and quality of academic impact. This trend coincides with what Steven et al. (2014) pointed out, emphasizing that the development of birdwatching requires greater integration of applied research into conservation and sustainable natural resource management.

With regard to international collaboration, countries with the greatest scientific leadership are the United States and China, followed by Australia, the United Kingdom, Germany, and Brazil. These nations concentrate the largest number of publications and cooperation networks, which coincides with what Callaghan et al. (2020) and Grima (2016) have noted, highlighting the capacity of these countries to articulate global conservation and ecotourism projects. However, in the Latin American context, participation is still limited, revealing the need to strengthen academic and scientific ties in megadiverse regions such as South America, where Peru holds strategic potential due to its variety of ecosystems and endemic species.

From the perspective of scientific sources, journals such as *PLOS ONE, Biological Conservation, Bird Conservation International, the Journal of Outdoor Recreation and Tourism,* and *Ecological Indicators* stand out, as they concentrate the largest number of publications and citations in the field. This concentration reaffirms the consolidation of the field in high-impact indexed journals, reflecting the interdisciplinary nature of the topic, which encompasses both the biological sciences and tourism and sustainability studies (Connell, 2009; Moller et al., 2009).

Regarding the keyword analysis, the most frequent terms —*biodiversity, ecosystem services, conservation, ecotourism,* and *climate change*— evidence a convergence between studies of tourism, environment, and biodiversity. These concepts reflect a trend toward research that links the bird tourism experience with ecosystem conservation, coinciding with the contributions of Sekercioglu (2012) and Ghermandi et al. (2020), who argue that bird observation tourism has become an educational, economic, and environmental tool of great value for local communities.

Finally, this study demonstrates that research on birdwatching is in a phase of scientific maturity, characterized by the formation of solid collaboration networks, growing production, and a clear orientation toward environmental sustainability. However, challenges persist, such as the low participation of researchers from tropical countries and the need to integrate more contextualized studies on the impact of bird tourism on local ecosystems. Promoting research grounded in territory, with community and ecological approaches, will make it possible to strengthen scientific knowledge on biodiversity and position bird tourism as a key axis for the sustainable development of regions such as Huánuco and the Peruvian Amazon.

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