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Conservation Challenges for Endangered Mammals: Research Gaps and Collaboration Needs Based on Stakeholder Bibliometric Analysis

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ABSTRACT

The global focus on endangered mammals highlights urgent, effective conservation strategies addressing habitat destruction, land-use changes, poaching, agricultural expansion, and encroachment. This study aims to identify research gaps in stakeholder engagement, map research trends and assess leading contributors of endangered mammal conservation, and explore opportunities for international collaboration for biodiversity conservation. This study was done using bibliometric analysis of 716 initial documents that were further selected to 85 publications based on PRISMA guidelines in R-Studio tools. This review highlights the fact that there is a limited focus on stakeholder engagement within mammal conservation research. Countries with high biodiversity, such as Indonesia, Mexico, and Brazil, contribute less to the scientific literature than high-income countries. This imbalance suggests the need for equitable research funding and expanded collaboration. Strengthening partnerships with research-intensive countries could increase publication output and knowledge sharing. Furthermore, regional cooperation with other original countries with similarly endangered species, like Malaysia and Thailand, is essential for improving research quality and optimizing resource exchange. The findings further highlight the importance of sustainable conservation practices and stakeholder engagement in effectively fostering the protection of endangered mammal species.

1. Introduction

Wildlife is an essential part of biodiversity, which can be significantly impacted by global climate change. Even mammals with historically small effective populations living in fragmented habitats face a higher risk of extinction than other mammal species (Wilder et al. 2024). The world's focus on endangered species, particularly flagship mammals like the Sumatran tiger (*Panthera tigris sumatrae*) and Tapanuli Orangutan (*Pongo tapanuliensis*) in Indonesia, or Amur leopard (*Panthera pardus orientalis*) in South Asia region that symbolize broader conservation needs (IPBES 2022; Lacher et al. 2019; Ticktin et al. 2022), is driven by significant impacts from land-use changes, habitat loss, hunting, agriculture, and encroachment (Achmad et al. 2023; Ceron

et al. 2023; Cornford et al. 2023; Pörtner et al. 2024; Suppula et al. 2023). This importance is reflected in data from the International Union for Conservation of Nature (IUCN) Red List, which shows that over 50% of the world's mammal species are considered endangered, with 37.7% classified as endangered (EN) and 15.2% as critically endangered (CR) collectively referred to as endangered mammal species. However, this proportion varies by country and region. The IUCN Red List also emphasizes that domestic regulations are insufficient for adequate habitat protection and management. Countries with endangered mammal species must implement education and awareness programs, enforce policies, and consider broader livelihood, economic, and incentive-based strategies.

Wildlife conservation and its management have a complexity of issue and problem-based, which is often categorized as a "wicked problem" (Defries and Nagendra 2017; Eastwood et al. 2020; Treves and Santiago-Ávila 2020). The involvement of multiple actors, including local communities, wildlife managers, state institutions, and sometimes profit-driven and nonprofit organizations (commonly known as NGOs), is a manifestation of that complexity. Therefore, stakeholder engagement is necessary in achieving environmental governance as well as for the conservation of endangered mammals, and that has become a challenge in today's world. In forestry research, for example, key stakeholders are needed to achieve management planning of mangrove or socio-economic ecosystems (Kurniati et al. 2023; Mustika et al. 2017; Suswadi et al. 2023). Another research found that the success of multi-actor conservation initiatives depends on: (1) the ecological characteristics of the species (Allen and Singh 2016), (2) the level of anthropogenic pressure on their habitat (Ntukey et al. 2022; Untari et al. 2020), (3) the socio-economic characteristics of local communities (Manfredo et al. 2021; Sorice et al. 2021), and (4) the governance frameworks of conservation institutions based on existing policies (Hanum et al. 2018; Maron et al. 2016). Based on that, theoretically, stakeholder engagement in conservation strategies should encompass all four aspects to ensure success (Pomeranz et al. 2021). However, empirical results might have been mixed (Hohbein and Abrams 2022). For example, in the conservation of red knot (*Calidris canutus rufa*) and black skimmer (*Rynchops niger*) in New Jersey project, the presence of a stakeholder network in securing pooled funding sources and coordinating with sand contractors for habitat restoration has provided a rapid response for better action (Burger et al. 2017), and in Kanduyi, Kenya, stakeholder collaboration positively correlated with conservation performance (Ipara and Kipchumba 2024). Inclusive stakeholder engagement in research related to the conservation of endangered mammal species needs to be further explored.

Delivering scientific knowledge is critical in defining stakeholder engagement in global endangered mammal governance. Studies have shown that collaborative approaches involving governments, resource managers, and local communities incorporating local knowledge can result in successful wildlife management outcomes (Camino et al. 2020; Pietersen and Challender 2019). Conservation decisions often involve various stakeholders, including governments, corporations, indigenous peoples, and local communities, all playing significant roles in determining outcomes (Mahajan et al. 2023). A bibliometric analysis of scientific publications in specific databases (hereinafter known as systematic literature reviews) can support stakeholders by fostering engagement and translating conservation governance into policy frameworks (Gaebel et al. 2024). Systematic reviews are valuable for identifying schools of thought, building trust, enhancing analytical depth (Walsh and Rowe 2023), addressing information gaps, and contributing to problem-solving (Ocaña-Fernández and Fuster-Guillén 2021). These reviews can also help explore research gaps and provide recommendations for future research (Thomas and Gupta 2022).

This study aims to identify research gaps in stakeholder engagement, map research trends and assess leading contributors of endangered mammal conservation, and explore opportunities for international research collaboration for biodiversity conservation. It is hoped that the findings of this review will contribute to the development of collaborative governance models in future research efforts, aiming to reduce biodiversity loss among endangered mammal species. The data presented in this article are particularly important for conservation planning, as most scientific reports on endangered mammals have focused primarily on assessing current ecological status and projecting future threats, with minimal attention to how stakeholder engagement can influence outcomes. While some literature has reviewed evidence of stakeholder engagement in biodiversity conservation up to 2016 (Sterling et al. 2017), an updated and comprehensive analysis still needs to be done.

2. Materials and Methods

2.1. Key Questions and Database Selection

For instance, this study discusses how far the whole research about the conservation of endangered mammals worldwide and includes and discusses stakeholder involvement. To address that need, this study addresses the following key questions:

1. How far do studies on the governance of endangered mammals address and involve aspects of stakeholder engagement?
2. Which scientific actors (institutions) from various countries focus on this issue? Do countries with endangered mammal populations adequately address conservation governance involving stakeholders?
3. What are the potential collaboration that exists between countries?

The extant literature was retrieved from the Dimensions platform database. This contemporary publication indexing system facilitates the exploration of relationships across diverse research datasets, including publications, grants, patents, clinical data, and altimetric attention, offering graphical representations of heterogeneous research outputs (Hook et al. 2018). This database employs an Application Programming Interface (API) that enables query execution using a Domain-Specific Language (DSL) (García-Sánchez et al. 2019). Dimensions were selected due to their broader coverage, more common database indexer, and more publications not only indexed by Scopus or Web of Science (WoS). Bibliometric studies that utilize Dimensions searches offer novel opportunities for institutional and global-level analysis, serving as alternatives to Scopus and WoS (Guerrero-Bote et al. 2021; Moral-muñoz et al. 2020; Singh et al. 2021). This option is particularly relevant for this study because research in certain countries is often published locally and has not yet been indexed in reputable international databases.

2.2. PRISMA Guidelines: Extraction of Publications, Inclusion, and Exclusion Criteria

The PRISMA guidelines (http://prisma-statement.org/) were employed to systematically identify, evaluate, and interpret all relevant published research from the global database (**Fig. 1**). This process consisted of four stages: identification, screening, eligibility assessment, and inclusion. The process consisted of four stages: identification, screening, eligibility assessment, and inclusion. During the screening stage, abstracts were reviewed to exclude publications that did not explicitly address stakeholder engagement or focused solely on ecological assessments without

stakeholder implications. The resulting initial publication extraction was refined based on inclusion and exclusion criteria. This systematic approach ensured the selection of documents relevant to the study topic and research question.

The keywords used in the search process were carefully selected to align with the study objectives. To extract literature data from scientific databases, this study used more global keywords, such as "stakeholders," "wildlife conservation," and "endangered mammals." These keywords applied on the Dimensions platform utilized the Boolean syntax, with quotation marks ensuring exact phrase matching, asterisks (*) capturing various word forms, and keyword restrictions. The keyword inputs were:

*"Wildlife Conservation" OR "Endangered Mammals" AND Stakeholders**

This search yielded 716 publications, comprising 323 scientific articles, 146 edited books, 137 book chapters, 67 monographs, eight preprints, and one proceeding. This is much more than the other well-known indexing database, which only produced 329 documents using the same keywords and query string.

Inclusion and exclusion criteria were applied as follows. First, only research articles and proceedings published within the last 20 years (2004–2024) were selected. This resulted in a pool of 287 documents. Further screening involved a thorough reading of abstracts, leading to the exclusion of 202 publications. Ultimately, 85 publications were analyzed in this study. The reasons for exclusion applied based on considerations to avoid bias in the analysis consist of:

1. The article did not address stakeholders despite focusing on endangered species or vice versa;
2. The "stakeholder" aspect was not the primary focus of the research;
3. The article was a review journal.

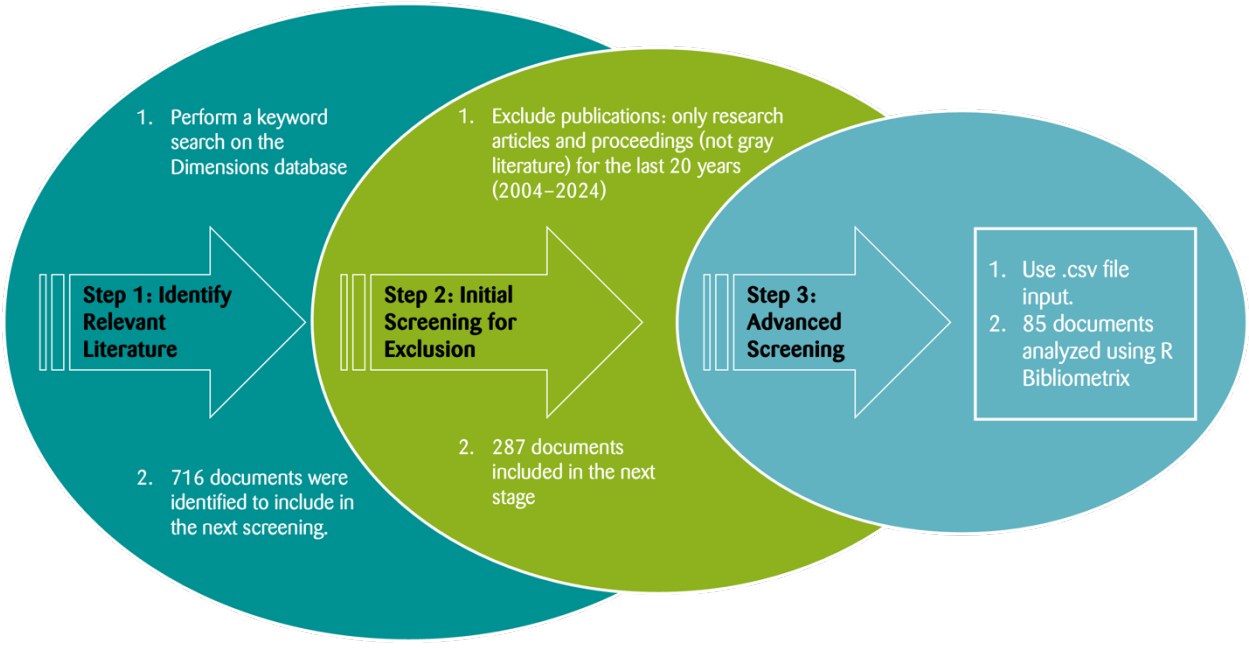

Fig. 1. Publications collection and selection flow.

2.3. Data Analysis: Bibliometrics, Visualization, and Data Integration

The bibliometric analysis was conducted using Bibliometrix version 4.3.2, runs in R-Studio Version 2024.09.1+394 (2024.09.1+394), an Integrated Development Environment (IDE) for the R programming language, and visualized using Biblioshiny, a web-based graphical interface

(GUI) which is available directly in the Bibliometrix (Aria and Cuccurullo 2017). As part of the Bibliometrix package, Biblioshiny provides multiple advantages specific to literature analysis, such as producing detailed statistical summaries, calculating various bibliometric indices, conducting network analysis to visualize relationships among authors, keywords, and citations, and creating comprehensive knowledge maps that highlight key trends and research gaps (Wei and Jiang 2023).

The detailed statistics in question are powerful in the R-Studio Bibliometric analysis presented in the Biblioshiny interface, which consists of analyzing publication sources, authors, document clusters, topic diversity and clustering, country and author involvement, and even presenting topic and country distribution maps. Among all the features in Biblioshiny, according to the need to answer the research questions, this study chose to present the diversity of publication sources, topic distribution and clustering (Callon and Rank of Density and Centrality), and the level and network of collaboration. This data was generated using the Edge-Betweenness algorithm. The answers to other research questions, such as forms of stakeholder engagement and research gaps, were obtained from a manual review of 85 selected papers. A combination (or integration) of data extracted from Biblioshiny analysis results with secondary data from the IUCN Red List database filtered by protection status and Animalia–phylum Chordata group.

3. Results and Discussion

The results of the bibliometric analysis highlight several key patterns in authorship and international collaboration within the context of stakeholder engagement in endangered mammal conservation. Based on the final results of the bibliometric analysis in the R-Studio App, 85 final documents that were identified and fixed before were published in 62 sources or scientific journals around the world. These are either indexed by Scopus or WoS or indexed by other databases. Information about published journal sources is presented in **Fig. 2** (for the top 20 sources).

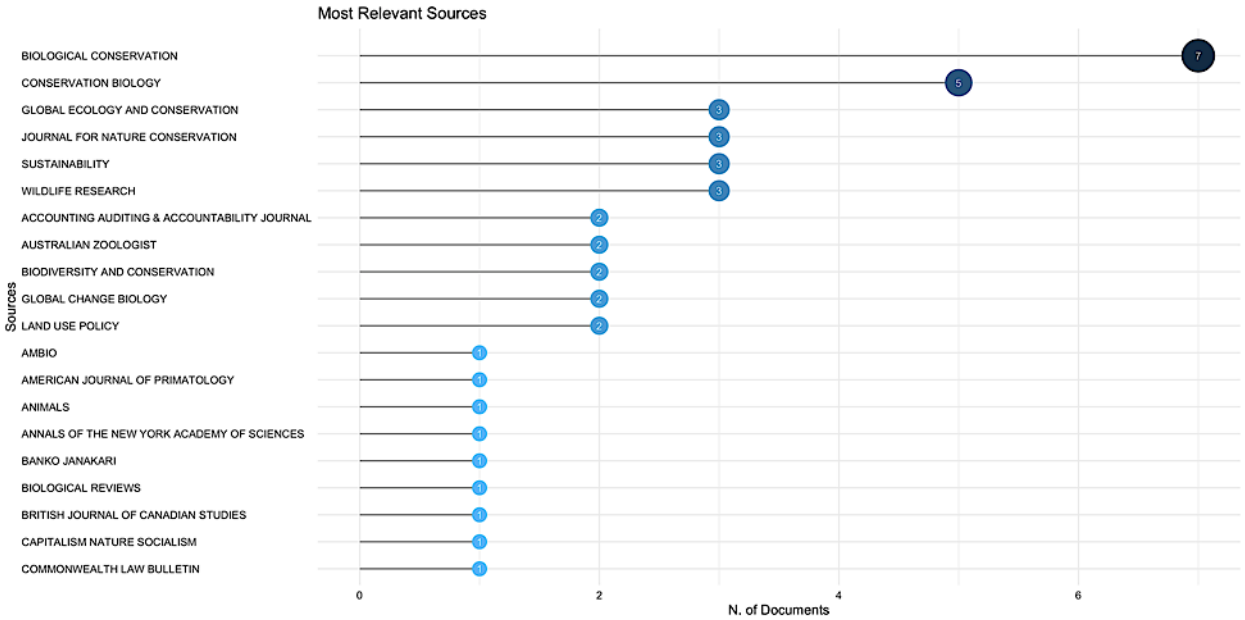

Fig. 2. Distribution of the most relevant sources (Big 20) by number of documents in bibliometric analysis.

The R-Studio application has also analyzed the authors' number and authorship category (individual or group). More than 500 authors in the 85 journals were analyzed. Among these, Bibliometrix analysis has captured 13 authors in the single-authored docs. The remaining 85% of documents fall into the co-publication category, either written in the same country or by different authors. Unfortunately, of the 85% collaboratively authored documents, international co-authorship (authors from different countries) is still less than 50%, at 30.59%. In stakeholder engagement studies, the low level of international co-authorship indicates limited global partnerships. Previous research records for collaborative publications in tropical ecology, environmental issues, or more general conservation literature found an increase in the number of countries of author affiliation (Chernysh and Roubík 2020; Perez and Hogan 2018), despite geopolitical conflicts (Wang et al. 2023).

3.1. The Form of Stakeholder Engagement in Research Topics within Scientific Publications in Supporting Endangered Mammal Conservation

3.1.1. Distribution of variation research topics related to stakeholder engagement

From the 85 final journals analyzed, 11 clusters of research topics relevant to stakeholder engagement emerged in the context of endangered mammal conservation efforts in the world. Detailed information about the 11 clusters of research topics is presented in **Table 1**. In contrast, their positions and functions in the network map are presented in **Fig. 3**.

Table 1. The measures of network connectivity: cluster analysis of research themes in endangered mammals conservation related to stakeholder engagements

No.	Cluster	Callon's Centrality	Callon's Density	Rank Centrality	Rank Density	Cluster Frequency
1	Conservation efforts	8.02	130.83	11	11	78
2	Biodiversity conservation	6.33	96.49	10	9	103
3	Decision makers	5.24	108.33	9	10	69
4	Climate change	3.30	94.70	8	8	34
5	Challenges faced	1.25	66.67	7	7	6
6	Inform conservation	1.13	43.75	6	1	6
7	Biodiversity protection	1	62.50	5	5.5	4
8	Conservation status	0.83	50	4	2.5	5
9	Wildlife conservation	0.50	58.33	3	4	8
10	National park	0.44	50	2	2.5	5
11	Conservation biology	0.25	62.50	1	5.5	4

The Callon Centrality and Callon Density shown in **Table 1** are an overview of the position of clusters in the network based on the relationships between the nodes analyzed, namely the keywords in the Abstract. The Edge-Betweenness algorithm automatically determined these results, identifying clusters strongly connected to other themes while maintaining robust internal coherence. From the size of the Callon (indicated by the highest value), the first cluster, "conservation efforts," is indeed the most dominating position regarding network centralization and density. This first cluster is marked with a highlighted red circle, which contains the research topics: "conservation efforts," "endangered species," and "biodiversity loss" in **Fig. 3**. This finding means that any research that relates to endangered mammals conservation efforts and stakeholders is inseparable from the topic of study aimed at conservation efforts at large. This is logical because, according to Jachowski et al. (2024), research on endangered species has increased, but only a

small fraction has been incorporated into recovery planning, pointing to a gap between science and practice. Jachowski et al. (2024) also highlighted that only certain endangered species (larger or more popular) tend to be more studied and receive more funding for conservation projects. This means that certain influencing factors, such as the national policies of certain countries or the intervention of international conventions, affect the direction of funding for certain research topics. Meta-analytic studies have shown that research on climate change, ecosystem services, and protected areas are among the world's top research priorities (Dey et al. 2020; Massiri 2023). The determination of this conservation decision must involve stakeholders and even wider constituents (Tsang et al. 2021).

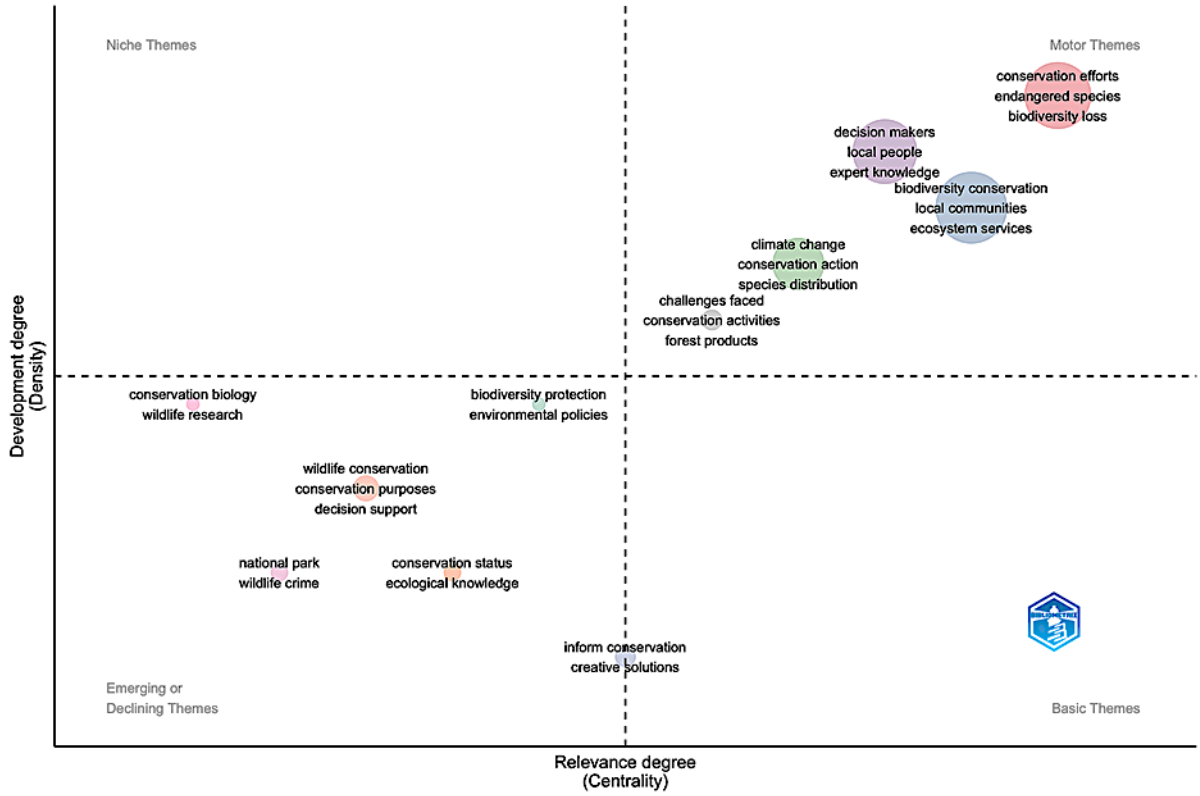

Fig. 3. Group research topics over 20 years with abstract keyword extraction using the Edge Betweeness algorithm. The X-axis indicates the centrality of the topic (relevance), and the Y-axis is the impact produced by the topic. The circle's color indicates the cluster of topics, while the circle's size indicates the study's intensity using the topic.

In addition to the cluster "conservation efforts", there are four other research topic clusters that are primary driver topics (Motor Themes quadrant, **Fig. 3**), based on the Callon value, of which 2 clusters have the greatest value, namely 1) cluster "biodiversity conservation," "local communities," and "ecosystem services" also 2) cluster "decision makers," "local people," and "expert knowledge." This indicates that stakeholder engagement, often cross-sectoral and multi-interest by nature, enhances the relevance of these themes across clusters. For instance, ecosystem-based approaches frequently involve multiple actors in decision-making processes, further emphasizing the cross-cluster connectivity of themes with high Callon values.

Despite being part of the Motor Theme and recognized as a critical component in conservation programs, research specifically addressing "conservation action" in published literature remains limited, focusing more on conceptual or management aspects rather than actual

implementation in the field. In contrast to "decision makers," "local people," "local communities," and "expert knowledge," which appear across various studies. Stakeholder involvement is evident through these keywords based on the Callon values. This gap may stem from several factors. First, implementation challenges often arise due to the complex, multi-stakeholder nature of conservation action, requiring coordination among diverse actors such as governments, NGOs, local communities, and private entities, each with differing priorities and capacities. Second, limited funding for actionable conservation programs, particularly in biodiversity-rich but economically constrained regions, restricts the ability of researchers to explore practical approaches. Third, scientific focus has historically been skewed toward ecological assessments and theoretical frameworks, which, while valuable, do not always translate into practical, on-the-ground conservation strategies. This indicates the need for further research focusing on case studies or practical approaches that can support evidence-based conservation actions (Salafsky et al. 2018; Sutherland et al. 2021).

Nonetheless, the potential for increased study of conservation action exists. This can be seen in **Table 2,** which highlights that within the Motor Themes category, "conservation action" and "climate change" are the most influential connectors, with linkage values of 1548.721 and 1714.971, respectively. The highlighted keywords within the Motor Themes category predominantly belong to the "climate change" cluster, indicating that existing research consistently connects its findings to climate change aspects. As noted by Jewell et al. (2023), one of the primary challenges climate change poses for stakeholders in wildlife conservation is the clear communication of complex information, ensuring that stakeholders understand how it impacts wildlife habitats, behaviors, and survival —critical aspects frequently overlooked by policymakers. Integrating climate change vulnerability research with the effectiveness of conservation actions is critical to protecting species, as demonstrated in the case of European seabirds (Hakkinen et al. 2022).

Table 2. Centrality measures of keywords related to "Climate Change" in scientific literature

No.	Words	Occurrences	Cluster_Label	Btw_Centrality	Clos_Centrality
1	Species distributions	2	climate change	33.55	0.00
2	Threatening processes	2	climate change	33.55	0.00
3	Distribution modeling	2	climate change	33.55	0.00
4	Biodiversity data	2	climate change	99.63	0.00
5	Developing countries	2	climate change	120.39	0.00
6	Future conservation	2	climate change	164.57	0.00
7	Threatened species	3	climate change	265.41	0.00
8	Species distribution	4	climate change	277.97	0.00
9	Conservation action	7	climate change	1548.72	0.00
10	Climate change	8	climate change	1714.97	0.00

Notes: Cluster_Label = Certain themes group or keywords, Btw_Centrality = Betweenness Centrality (Centrality measure of nodes or node pairs in the network), Clos_Centrality = Closeness Centrality (A measure of the keyword's closeness to all other nodes).

In addition to identifying topic drivers, a key highlight of this study, shown in **Fig. 3**, is the analysis of "Emerging or Declining Themes" within published literature, even when these topics are connected to stakeholder engagement in endangered mammal conservation. Notable themes include research on "ecological knowledge," "environmental policies," and "wildlife crime." The topic "wildlife crime" is part of a cluster with "national park" and exhibits very low Betweenness and Closeness scores (less than 0.01), placing it in the bottom left quadrant and indicating limited prominence in current literature.

Wildlife crime is a transnational environmental crime (Mogomotsi et al. 2020). However, in practice at the site level, the literature states that this is closely related to the survival strategies of local communities as a consequence of the proximity of the inhabited area to the habitat of animals (Atuo et al. 2020; Nepal 2002; Nyirenda et al. 2024). Studies on policies on wildlife and its crimes involving various stakeholders should be much more publicized. Unfortunately, of the 85 final papers analyzed, there are 10 papers related to this "wildlife crime," but only one paper discusses it. This finding has implications for the high novelty of research related to this because of the difficulty of obtaining data, and most of the published data must consider the ethical aspects of the people involved in the research.

One interesting fact added to this study's findings is that "ecological knowledge" is clustered with "conservation status," suggesting that these two keywords frequently co-occur in the literature or research analyzed. This association highlights that stakeholder engagement in endangered wildlife or mammal governance is becoming increasingly significant in academic discourse. In practical terms, this trend implies that effective conservation efforts heavily rely on applying stakeholders' ecological knowledge, particularly at the site level, to assess and update the conservation status of species or ecosystems. Such integration can enhance the effectiveness of conservation initiatives by ensuring that local and site-specific insights are factored into decision-making processes. In Kenya, for example, local ecological knowledge (LEK) from former hunters provides critical insights into species behavior and habitat preferences, which are not available through scientific methods alone (Sheppard et al. 2024).

3.1.2. The position of stakeholder engagement within the research selected

The bibliometric analysis of the documents most relevant to these research questions reveals that many studies on endangered mammal species do not directly examine stakeholder engagement in conservation efforts within their respective countries. While the IUCN's recommendations concerning policy, legislation, and capacity building are frequently referenced, they need to be systematically integrated into the primary framework of mainstream research. Stakeholder engagement should be considered a core component from the outset of research design, including data collection, analysis, and interpretation. This integration ensures that the role of stakeholders is not merely an implication of research findings but an active focus in shaping conservation strategies and governance models.

Of the total 85 articles that were finally filtered in this study, most topics related to stakeholder engagement were in the position of "research objectives or interventions" (**Fig. 4**). This means that the discussion of stakeholder engagement in the context of protected mammal conservation in many papers is often presented as an indirect result rather than as a central theme. Several papers extracted from the Bibliometrix Analysis R-Studio in this study explain why the findings found that the form of stakeholder engagement in animal conservation is generally only an implication of the research results (n=50%). These challenges can be attributed to the high social and political dynamics in ecological planning and practice. Stakeholder engagement often fails to address deep-rooted social conflicts that hinder cooperation (Hodgson et al. 2022) as the relationship between conservation projects and communities erodes over time (Domínguez and Luoma 2020). This is usually done because the conservation project agendas are often imposed without local context or are not decided in a participatory manner (Erbaugh 2022; Goyes and South 2019; Rai et al. 2023).

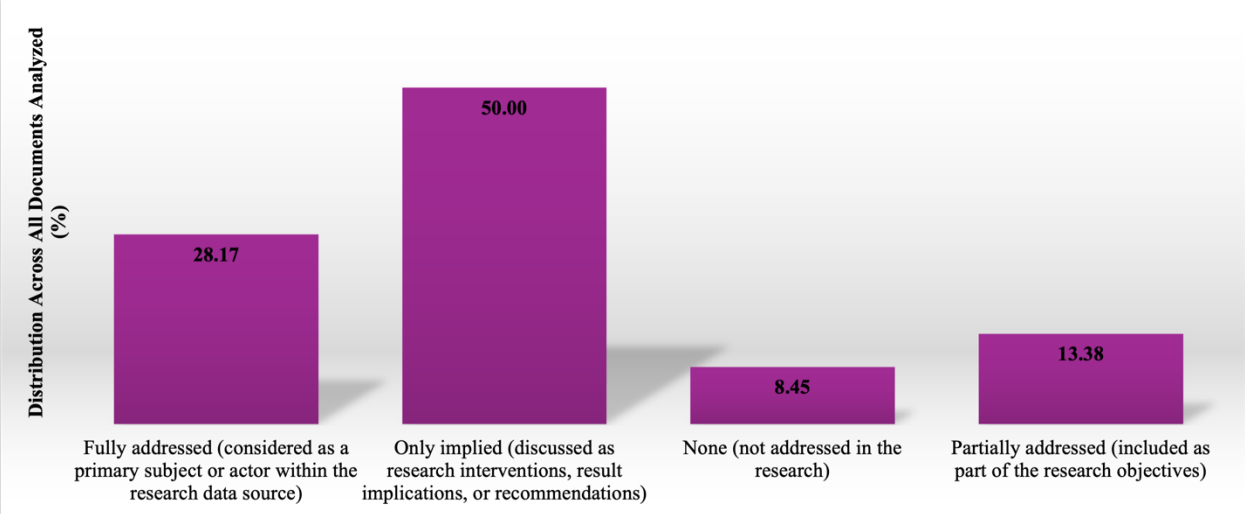

Fig. 4. The position of themes related to stakeholder engagement in various studies published in scientific journals.

3.2. Scientific Research Gaps in Addressing the Stakeholder Engagement of Endangered Mammal Conservation

The gap identified in this study stems from the disproportionate relationship between the number of scientific publications and the number of endangered mammal species in a country. Based on the IUCN database, Indonesia (13.12%; n=103), Mexico (9.04%; n=71), China (7%; n=55), India (7%; n=55), and Brazil (5.98%; n=47) rank as the top five countries with the highest number of endangered mammal species globally. Beyond these five, an additional 64 countries, representing 69 out of 216 countries worldwide, also host significant numbers of endangered mammal species. However, there is an imbalance, so bridging the gap to relevant research is essential to ensure that conservation efforts are informed by local expertise and adequately reflect the scope of biodiversity challenges in the countries highlighted. Information on this is presented in **Fig. 5** only for the top 30 countries.

Australia and the United States, despite hosting comparatively fewer endangered mammal species, demonstrate a strong commitment to conservation through extensive scientific contributions. Over the past 20 years, Australia and the United States have produced 299 and 83 publications, often addressing stakeholder engagement. This consistent research output reflects their robust academic infrastructure and significant investment in conservation-focused research and development.

In Australia, wildlife management has faced criticism for its reliance on descriptive statistical studies (Hayward et al. 2015). Although there have been successes with mechanistic conservation efforts, the need for improved monitoring and management strategies remains (Woinarski et al. 2015). Tulloch et al. (2023) have noted that many mammal species in Australia are at risk or near risk due to predation by invasive mammal species. The keyword “invasive species” also emerged in this study in relation to conservation status and threat levels (refer to the blue circle in **Fig. 3**). Consequently, Australia has enhanced its conservation focus through collaborative stakeholder efforts. However, challenges persist due to gaps in knowledge about impacts and effective management strategies, as seen in wild deer management (Davis et al. 2016).

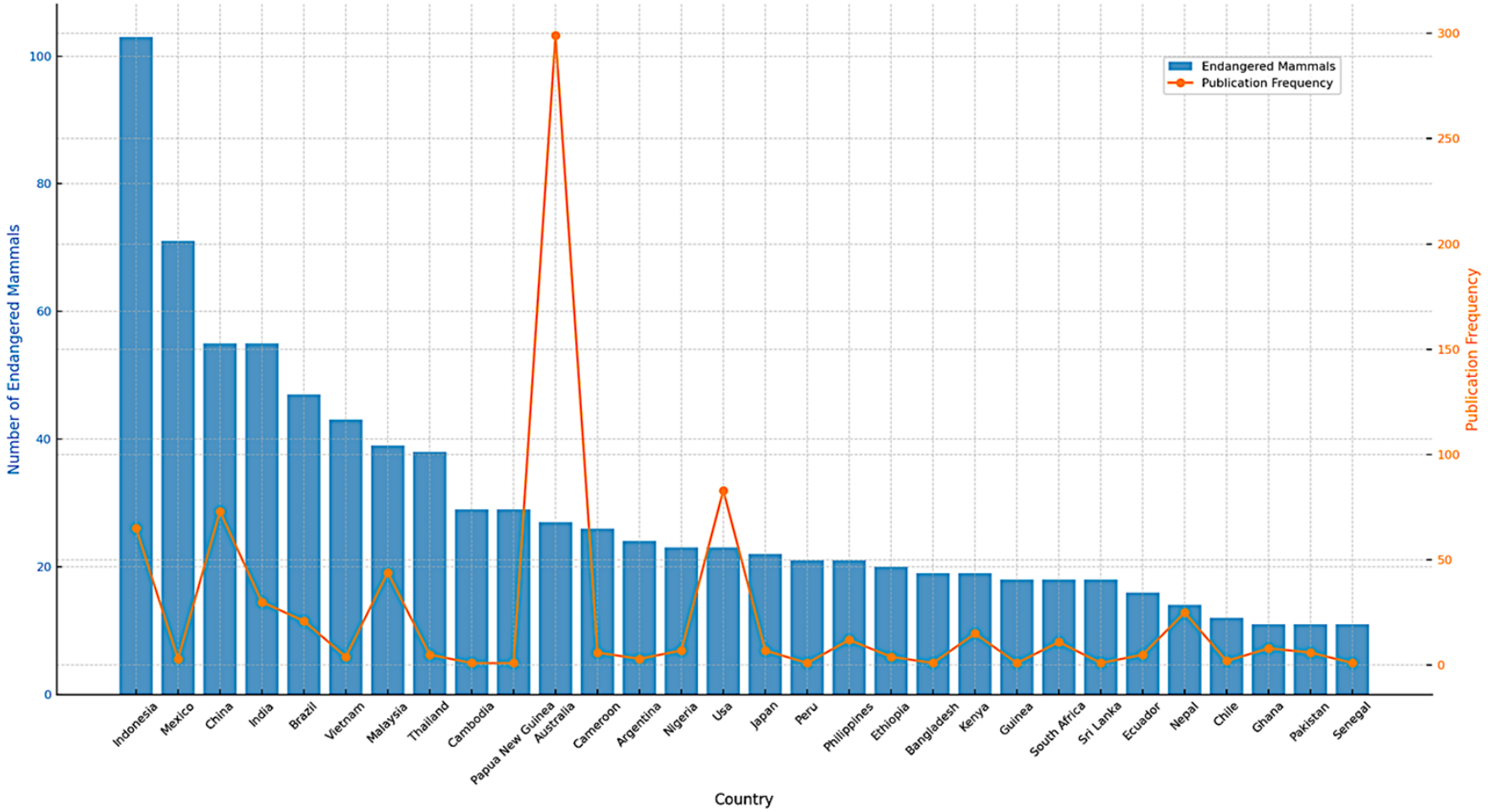

Fig. 5. Top 30 countries: endangered mammals versus publication frequency.

In the United States, conservation faces unique challenges, including funding crises influenced by differing perspectives and values. Research in Michigan highlights the importance of substantial financial support and tiered funding frameworks to enforce conservation policies effectively (Glikman et al. 2022). Stakeholder engagement has been recognized as a critical element, supported by methodologies and strategies such as the Conflict Levels and Conservation Conflict Transformation models (Henderson et al. 2021; Marino et al. 2023). These strategies facilitate dialog, negotiation, and conflict resolution, promoting equitable resolution by incorporating local customs and cultural values (Ndonye et al. 2021). However, power imbalances often marginalize certain groups, including Indigenous Peoples, weakening conservation efforts' effectiveness and fairness (Maestre-Andrés et al. 2018).

In contrast, countries such as Indonesia, Mexico, India, and Brazil, which host substantial numbers of endangered mammals, exhibit much lower levels of research output. This disparity underscores a critical knowledge gap, as conservation in these regions is often underfunded or overshadowed by more immediate challenges, such as illegal wildlife trade. According to Cooney et al. (2017) and Lusseau and Lee (2016), conservation funding in many low-income countries is diverted to address poaching and trade, leaving little room for comprehensive research. This redirection fosters an atmosphere of distrust and prioritizes training and public awareness over scientific publication.

However, the gap in research output is not solely due to funding limitations. Cultural, political, and logistical factors also play significant roles. Low-income countries are not indifferent to conservation but often face systemic barriers, as Hickisch et al. (2019) noted. For example, bureaucratic hurdles and limited access to international collaboration networks can discourage research activity in these regions. Especially in Indonesia, conservation research often faces limited funding and difficult access to remote areas where endangered species are located, which are obstructed by political priorities, sometimes trading environmental conservation over economic development.

While many researchers in these countries generate innovative ideas with practical implications, limited resources and recognition often hinder their realization (Doi and Takahara 2016). High-income researchers frequently conduct studies in these regions, increasing publication output but sometimes overshadowing local expertise (Zhang et al. 2023). This highlights the need for more equitable research partnerships that prioritize capacity building and acknowledge the contributions of local researchers. Bridging the global research gap requires more inclusive and collaborative efforts, where both high- and low-income countries contribute equitably to conservation science. Addressing these imbalances is critical to ensuring that conservation efforts are scientifically robust, socially just, and contextually relevant.

3.3. Potential for Collaboration

Insights from previous analysis of research gaps underscore the need for a more equitable distribution of scientific research efforts, particularly in countries with high concentrations of endangered mammal species. Collaborative partnerships between nations with limited research capacity and those with robust resources and expertise can significantly enhance conservation initiatives. By pooling funding, technical knowledge, and human resources, such partnerships address immediate conservation needs and build local capacities to sustain these efforts. Non-governmental organizations (NGOs) and international institutions are critical in supporting these

collaborations, offering supplementary resources and guidance (Boiral and Heras-Saizarbitoria 2017).

While promoting collaboration is crucial for enhancing stakeholder involvement in conserving endangered mammalian species, publication bias remains an obstacle. Scientific journals must mitigate biases associated with a nation's economic conditions throughout the peer review process. Investigations from economically disadvantaged countries frequently exhibit a lack of the complexity observed in research conducted within more affluent nations; however, this fact does not undermine their significance in tackling conservation-related issues.

This study's bibliometric analysis provides valuable insights into existing collaborative patterns in endangered mammal conservation research. For instance, Australia demonstrates a significant balance between Single-Country Publications (SCPs) and Multi-Country Publications (MCPs), reflecting its strong domestic research infrastructure and active international partnerships. Conversely, the United States predominantly produces SCPs, which, while highlighting its robust domestic research capabilities, indicate limited international collaboration (**Fig. 6**). In contrast, low-income countries like Indonesia and India show limited collaboration in their scientific output. However, Indonesia has recently taken steps to strengthen its research partnerships through the IUCN Species Survival Commission (SSC) Indonesia Species Specialist Group, aligning its efforts with post-2020 global conservation targets (Sheherazade et al. 2023).

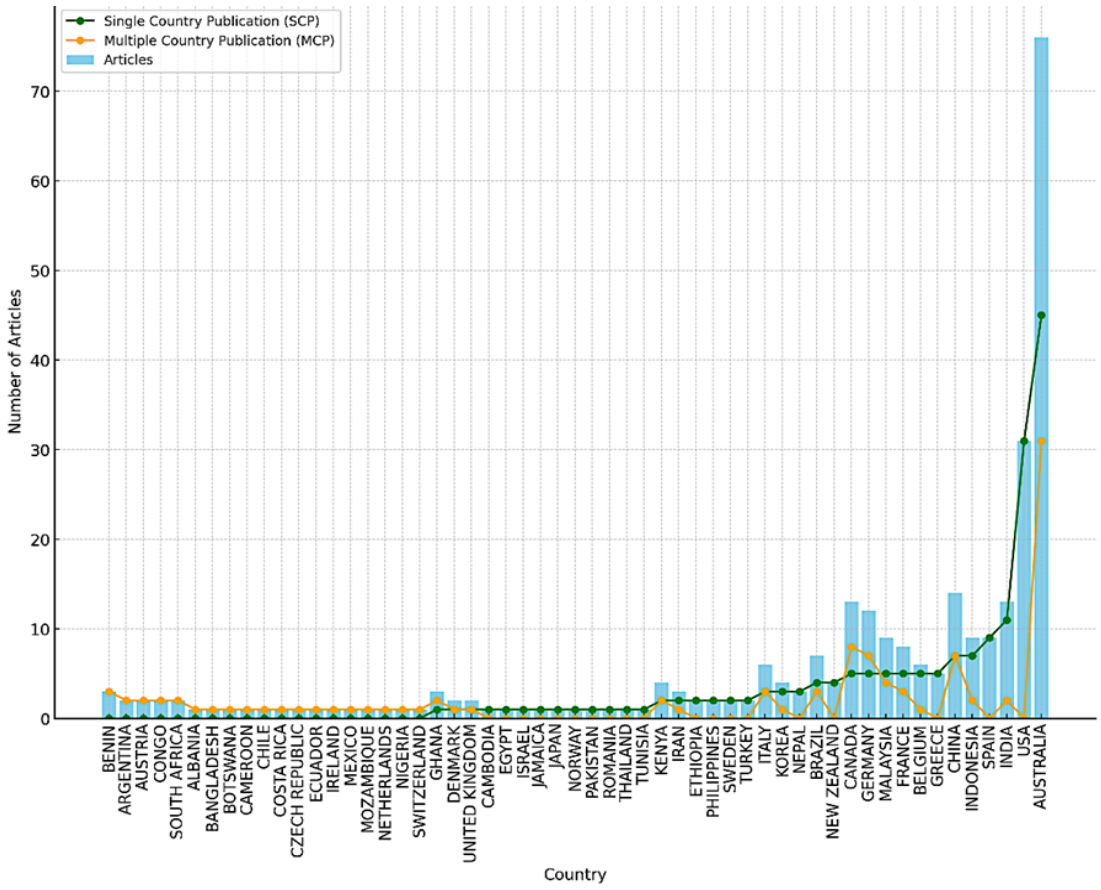

Fig. 6. Collaboration between countries worldwide on stakeholder engagement research to conserve endangered mammal species.

Expanding international collaborations, particularly with Australia, presents significant opportunities for countries with limited research output. Partnering with Australia could facilitate

knowledge exchange, resource sharing, and exposure to diverse perspectives, enriching research quality and capacity. For Australia, such collaborations enhance its global scientific standing and increase the visibility of its conservation research. Similarly, bibliometric analysis suggests that countries like Indonesia and India could strengthen ties with nations such as Malaysia, the Philippines, South Africa, Thailand, and Japan. These partnerships would help overcome resource constraints and improve research output and quality (**Fig. 7**).

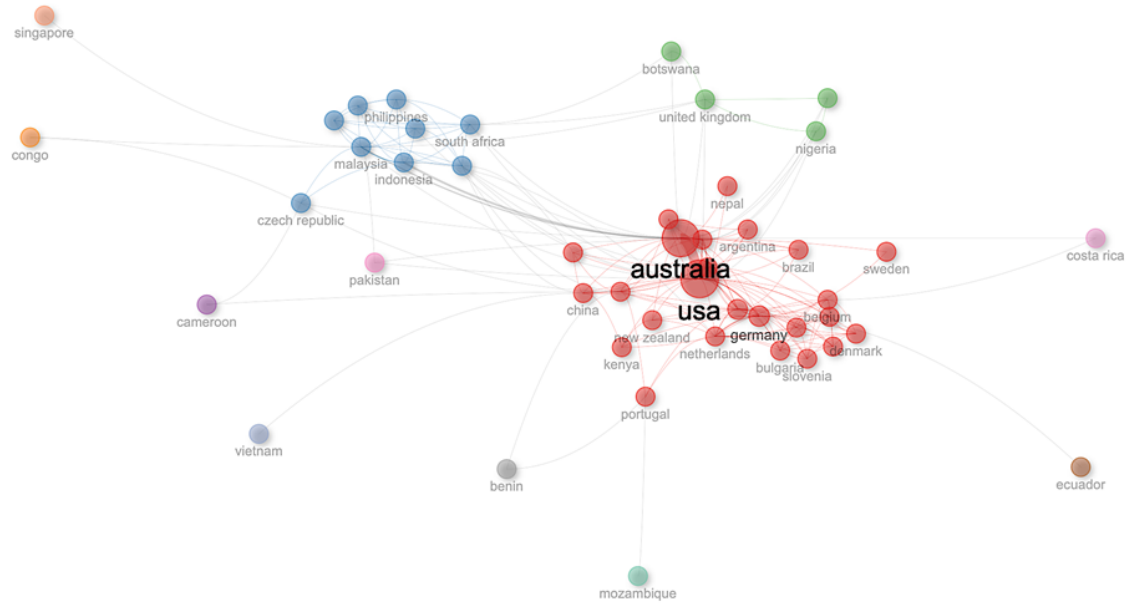

Fig. 7. A network of proximity between countries in research on stakeholder engagement in the conservation of endangered mammals.

There are several considerations, including the fact that each country has diverse endangered species, so national biodiversity strategies and action plans involving various stakeholders also exist (Horgan and Kudavidanage 2022). In addition, the landscapes in these countries are also attempted to be maintained, and they may have more resources focused on developing research related to conservation governance. One country has at least the potential for one of these considerations. Many forms of cooperation have been established between universities or research institutions in these countries. The ASEAN Foundation has even facilitated Indonesia and other ASEAN countries. Some examples of successful implementation include the ASEAN Research Collaborative Fund (ARCF) and the Heart of Borneo Initiative with WWF, which tries to preserve landscapes to support the lives of orangutans. Other successful implementations between Indonesia and Japan include JICA funding for blue carbon (BlueCARES) and the Biodiversity Conservation Center Rejuvenation Project (ODA). The various successes achieved (Takahashi 2006) are highly recommended for improvement and expansion.

Assessing international collaborations often involves analyzing joint publications in peer-reviewed journals (Gui et al. 2019). The findings from this study highlight the importance of fostering such collaborations to enhance the depth and breadth of conservation knowledge. Countries with established collaborative networks tend to sustain and expand their partnerships, reinforcing global research contributions. To join these networks, nations with limited connections should prioritize interdisciplinary approaches integrating stakeholder engagement with broader social and environmental issues. This strategy strengthens their role in global conservation efforts

and promotes equitable contributions to addressing biodiversity challenges. Decision-making still predominantly lies with wildlife managers and policymakers, grounded in scientific evidence and involving diverse local stakeholders (Lute and Gore 2014).

4. Conclusions

In conclusion, while the conservation of endangered mammals has received significant global attention over the past 20 years and progress is visible, stakeholder engagement is often limited to the implications of research results. Their participation and engagement are not systematically embedded in governance frameworks due to various gaps in terms of resource limitations and economic constraints in certain countries. The main drivers remain anthropocentric and influenced by political and ecological issues. The potential for international collaboration, which is believed to be enormous, is expected to bridge knowledge and resource gaps, leveraging complementary strengths to improve research quality and impact. This systematic literature review underscores the need for a paradigm shift in conservation strategies and encourages interdisciplinary approaches.

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