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APPLICATION OF CHOICE EXPERIMENT METHOD IN PROTECTED AREA: A BIBLIOMETRIC ANALYSIS

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Abstract: Research on the application if the Choice Experiment (CE) method in protected areas has garnered increasing attention as a result of its efficacy in understanding complex socio-economic factors influencing conservation decision-making. However, a comprehensive and thorough analysis of the research landscape in this field has been scarce. This research aims to address the gap by conducting a bibliometric analysis to explore trends, key contributors, and thematic focuses in applying the CE method in protected areas. Using Scopus Analyser and VOSviewer software, data was analysed to answer seven research questions: (1) research trends in the CE method as per the publication year, (2) type of documents by the subject of research, (3) top 10 authors as per the citation by research, (4) map of co-authorship about the CE method application, (5) popular keywords associated to the research, (6) co-authorship countries' collaboration, and (7) network mapping based on citation by source type. Results revealed central figures in collaborative networks, key thematic areas, international collaboration patterns, and influential scholarly outlets. The findings highlight interdisciplinary research, an emphasis on collaboration, and advocate methodological advancements to tackle conservation challenges. It offers compelling evidence of the increasing significance and multidisciplinary character of research employing the CE method in protected areas. This study also contributes to a comprehensive understanding of socio-economic aspects in conservation and management, aiding in evidence-based policy-making and fostering sustainable conservation practices globally.

Keywords: Choice experiment, conservation, ecosystem service, protected area, willingness to pay.

Introduction

A protected area is an area that has been legally designated, recognised, dedicated, and managed in a manner that allows for the preservation of nature, along with any associated ecological services and cultural values (Demırel *et al*., 2021; Hasana *et al*., 2022). Protected areas include national parks, wildlife sanctuaries, nature reserves, and marine protected areas. These areas are crucial for biodiversity conservation, climate regulation, recreational and educational opportunities, and ecosystem services (Ervin, 2003; Starnes *et al.,* 2021; Hasana *et al.,* 2022; Chowdhury *et al.,* 2023). However, managing and conserving protected areas often involves making trade-offs between various stakeholders' interests, including conservation goals, recreational activities, and economic development (Yang *et al*., 2021) delays in problems with cognition, thyroid disorders, and 10-y risks of kidney failure and serious brain infection (i.e., progressive multifocal leukoencephalopathy [PML]. The Choice Experiment (CE) method is a powerful tool used in environmental economics and resource management to comprehend people's preferences as well as values regarding different aspects of natural resources and environmental conservation (Chang *et al*., 2021; Chenarides *et al*., 2022; Xu & He, 2022; Chen & Zhang, 2023). The CE method allows researchers to quantify

these trade-offs by providing respondents with hypothetical scenarios as well as asking them to choose between different attributes, such as access restrictions, biodiversity conservation measures, and recreational opportunities, each associated with different levels or costs (Caputo *et al*., 2018). By analysing respondents' choices, researchers can estimate the economic value people place on various aspects of protected area management. Moreover, in the case of protected areas, it can conserve biodiversity, preserve ecosystems, mitigate climate change, and provide essential ecosystem services. They support scientific research, offer recreational opportunities, and contribute to sustainable development, ensuring the well-being of both humans and nature.

In the context of protected areas, the CE method can be used to address various research questions and management challenges, such as assessing visitors' willingness to pay for improved facilities as well as services, evaluating the potential impacts of alternative management strategies on visitor satisfaction and conservation outcomes, and informing the design of sustainable financing mechanisms, such as entrance fees or conservation taxes (Dumitras *et al*., 2017; Su *et al*., 2022). Furthermore, the CE method can also explore non-market values related to protected areas, including the intrinsic value of biodiversity, the existence value of preserving natural landscapes, and the cultural significance of traditional land uses and indigenous knowledge systems (Koemle & Yu, 2020). By incorporating these non-market values into decision-making processes, policymakers and managers can better account for the full range of benefits provided by protected areas and enhance its long-term sustainability and resilience in the face of increasing threats like climate change, habitat loss, and overexploitation (Hynes *et al*., 2021).

In summary, the CE method offers a valuable approach to studying people's preferences and values, helping to bridge the gap between economic theory and real-world conservation practices as well as promote a more inclusive and evidence-based decision-making process. Traditional economic theories often fail to capture this complexity. However, using the CE technique makes it possible to quantitatively and systematically elicit stakeholder preferences, which provides insights into complex trade-offs. Recently, the CE method has been widely applied to environmental and resource economics. However, there is a significant gap in the available literature regarding bibliometric evaluations specifically focused on the CE method regarding protected areas. While bibliometric analyses have been conducted on CE applications in areas such as healthcare (Wang *et al*., 2021) and agriculture (Čop & Njavro, 2022), no comprehensive bibliometric evaluations that highlight the CE technique at the macro and global levels and take the scholarly landscape of CE applications in protected area management. This absence is notable given the increasing importance of sustainable management practices, especially in protected areas and the role of the CE method in eliciting stakeholder preferences and informing policy decisions. Therefore, a bibliometric analysis of a sample of papers from the Scopus database between 1983 and 2024 was conducted. A bibliometric analysis in this niche would not only fill a critical gap in the available literature but also provide valuable insights into research trends, influential works, and collaborative networks in this field, thereby guiding future research and policy-making efforts. The analysis aims to analyse the development of a choice experiment in the protected area.

Literature review

Applying the Choice Experiment (CE) method in protected areas (PAs) has emerged as a valuable tool for understanding societal preferences, values, and trade-offs in conservation efforts. Several studies have demonstrated the utility of CE in assessing willingness to pay (WTP) for preserving threatened species as well as evaluating the economic value of conservation

initiatives. For instance, Campos *et al*. (2022) emphasised the importance of determining consumers and their WTP for preserving threatened species, highlighting the need for effective conservation policies guided by societal preferences. Similarly, Melo-Guerrero *et al*. (2020) underscores the significance of incorporating user and visitor opinions in protected area management, showcasing the potential of CE in aligning conservation objectives with sustainable economic alternatives. On the other hand, studies by (Soliño, 2023), Martínez-Jauregui *et al*. (2023), and Mariyam *et al*. (2021) provide insights into societal preferences for conservation programmes and wildlife management principles. These studies reveal common trends across different regions, such as preferences for payments for environmental services and prioritising management in protected areas. While CE offers valuable insights into societal attitudes towards conservation, it also poses challenges in design complexity, sample representativeness, and interpretation of results.

The CE method is also important for determining preferences and values related to conservation and management strategies in PAs. The diverse applications of CE in understanding stakeholder perceptions and estimating WTP for conservation initiatives (Kim *et al*., 2023) highlighted the potential of CE in designing payments for ecosystem services (PES) contracts, considering the preferences of both beneficiaries as well as providers for wetland protection. Similarly, Ribet & Brander (2020) examined the willingness of trail-running race participants to contribute to the sustainable use of country parks, showcasing the feasibility of using CE to estimate WTP for environmental conservation among recreational users. Meanwhile, Valasiuk *et al*. (2023) and Shi *et al*. (2023) explored public preferences for nature protection in transboundary areas and nature reserves, respectively, underscoring the importance of understanding societal demand for ecosystem services (ESs) to inform sustainable management practices.

In environmental studies, valuable insights into conservation strategies and stakeholder preferences are provided by the literature on using the CE method in protected areas. Dobson *et al*. (2022) explored the potential of conservation areas as flagships, highlighting the importance of community ownership and threatened species presence in attracting donors. Similarly, studies delved into the integration of conservation and economic development programs in rural communities and the evaluation of the benefits of ecosystem services (ES) in marine protected areas (MPAs) respectively. These studies underscore the diverse applications of CE in understanding local preferences and informing conservation policy decisions. However, while CE offers valuable insights, it also presents challenges in accurately capturing complex preferences and addressing stakeholder heterogeneity. Thus, emphasising the influence of demographic, economic, as well as socio-psychological factors on landowners' willingness to participate in conservation programmes highlights the need for a multidisciplinary approach (Puri *et al*., 2021).

In order to comprehend local preferences and values for ecosystem services obtained from protected areas such as Mole National Park (MNP) in Ghana, a group of researchers utilised CE (Obeng *et al*., 2021). These studies provide a favourable WTP for enhancements in a number of areas, such as access to hunting, ecotourism, wildlife habitat, and water quality. However, challenges exist in accurately capturing complex preferences and addressing stakeholder heterogeneity, as evidenced by differing preferences influenced by demographic factors and proposed programme costs (Obeng *et al*., 2021). Similarly, studies in Vietnam, Italy, and Austria demonstrate the importance of considering social as well as cultural factors in modelling respondent behaviour within choice experiments, indicating improved model fit when accounting for heterogeneity in the choice set formation (Börger *et al*., 2021; Arnberger *et al*., 2021; Franceschinis *et al*., 2022). Also,

research in Argentina shows how important it is to encourage conservation on private lands through incentive-based programmes such as payments for ecosystem services (PES). People's preferences will depend on their knowledge of existing programmes, why they own forests, and how they feel about conservation policy (Nunez Godoy *et al*., 2022). Integrating quantitative and qualitative methods, such as combining CE with institutional analysis, enhances the robustness of policy recommendations by addressing cultural and social perspectives (Louda *et al*., 2021). However, there are still issues with balancing conservation objectives with the growth of tourism, as seen by Maltese citizens' support for policies meant to safeguard marine ecosystems in designated Marine Protected Areas (Tyllianakis, 2022).

Despite the valuable insights CE studies provides, certain limitations and challenges exist. Lindberg *et al.* (2020) discussed the heterogeneity in responses across different groups and the complexities associated with contingent subjective well-being (SWB) models, emphasising the need to evaluate measurement approaches further. Additionally, Lara-Pulido *et al*. (2021) highlighted the importance of considering diverse attributes and preferences and addressing potential threats to ESs, such as habitat degradation and visitor congestion, in conservation planning. Moreover, the literature reveals gaps in knowledge regarding the economic valuation of conservation initiatives and the effectiveness of incentive-based programs. Meanwhile, M. Kim *et al*. (2021) discussed the economic tradeoffs associated with development projects in protected areas, emphasising the importance of considering environmental impacts in the decision-making processes. Additionally, Petcharat & Lee (2020) highlighted the significance of non-use values in assessing public WTP for conservation efforts, particularly for vulnerable species like dugongs. Apart from these advancements, more study is still required to resolve methodological issues and improve the application of CE to various conservation situations.

Hence, applying CE methods in protected areas has provided valuable insights into visitor preferences, donor priorities, local participation in conservation programmes, and the economic value of preserving threatened biodiversity. These studies underscore the importance of incorporating stakeholders' preferences into decision-making processes to enhance the effectiveness and sustainability of protected area management strategies. Future studies can focus on refining CE methodologies, integrating stakeholder feedback, and developing targeted conservation strategies to address environmental challenges in protected areas effectively.

Research Questions

There are seven research questions highlighted in the bibliometric analysis to address the application of the CE method in protected areas as follows:

RQ1: What are the research trends in the CE method according to the year of publication?

RQ2: What type of documents are used for the subject of research?

RQ3: Who are the top 10 authors based on citation by research?

RQ4: What is the map of co-authorship regarding the CE method application?

RQ5: What are the popular keywords related to the study?

RQ6: What are the collaborations of co-authorship countries?

RQ7: How is the network mapping based on citation by source type?

Materials and Methods

Data Source

The study of compiling, organising, and examining bibliographic information from scientific publications is known as bibliometrics (Verbeek *et al*., 2002; Alves *et al*., 2021;

Assyakur & Rosa, 2022). Information about publishing journals, publication years, and the main author is just one type of descriptive statistics (Wu & Wu, 2017). More advanced methods are also included, such as document co-citation analysis. Finding the right keywords, searching the literature, and carefully analysing the results are all part of a good literature review (Fahimnia *et al*., 2015). This process must be repeated many times to get reliable results. As a result, the study focusses on top-level papers because they provide helpful information about the theoretical views shaping the research area's growth. The study used the Scopus database to collect data to ensure accuracy (di Stefano *et al*., 2010; Khiste & Paithankar, 2017; Al-Khoury *et al*., 2022). Additionally, only papers published in scholarly journals subject to rigorous peer review were taken into consideration, ensuring that only publications of the highest quality were included. At the same time, books and lecture notes were purposely excluded (Gu *et al*., 2019). Notably, Elsevier's Scopus, renowned for its comprehensive coverage, made it possible to gather articles from 1983 to March 2024 for further analysis.

Data Search Strategy

This study uses a screening process to find the search terms that would be used to find the articles as presented in the diagram flow for the bibliometric search (Figure 1). The study began by searching the Scopus database, which found 22,449 articles that could be read online. After that, the query string was been changed so that the search word "choice experiment" would only show results in the protected area. Table 1 deploys the final search string, and the filtration criterion for the document search is presented in Table 2, resulting in the elimination of 21095 articles. The tuning process found 1189

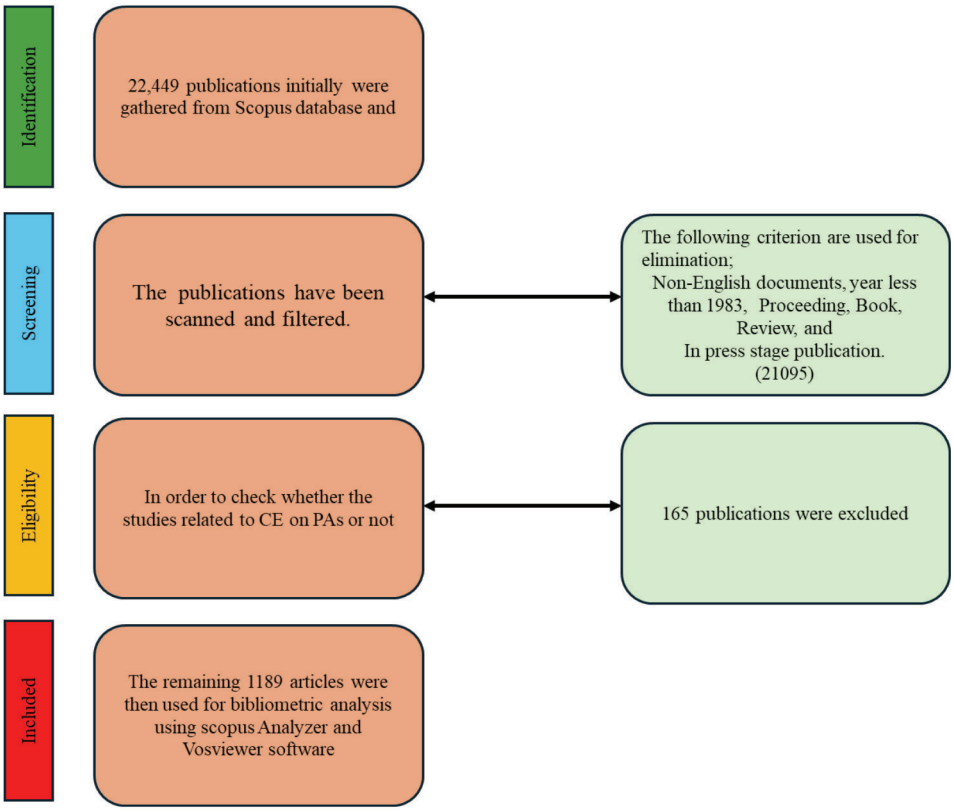

Figure 1: Flow of Diagram for Bibliometric Search (Sudakova *et al.,* 2022)

Table 1: The search strings

Scopus	(TITLE-ABS-KEY (“choice experiment “ OR “Discrete choice experiment” OR “Discrete Choice Model” OR “Choice modelling” OR “stated choice” OR “Stated Preferences”) AND ALL (“protected area” OR “Ecological reserve” OR “conservation area” OR “State Park” OR “National Park” OR “Marine Park”)) AND (LIMIT-TO (SRCTYPE, “j”)) AND (LIMIT-TO (PUBSTAGE, “final”)) AND (LIMIT-TO (DOCTYPE, “ar”)) AND (LIMIT-TO (LANGUAGE, “English”))

Table 2: The selection criterion of searching

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	1983 – 2024	< 1983
Literature type	Journal (Article)	Proceeding, Book, Review
Publication stage	Final paper	In press

articles that were then used for bibliometric analysis. As of March 2024, all articles from the Scopus database that linked the term to choice experiments and protected areas were added to the study.

Data Analysis

VOSviewer, developed by Nees Jan van Eck and Ludo Waltman at Leiden University, Netherlands, stands out as a user-friendly bibliometric software widely employed for visualising and analysing scientific literature (van Eck & Waltman, 2010, 2017). Its speciality lies in creating intuitive network visualisations, clustering related items, and generating density maps, offering researchers a comprehensive understanding of research landscapes. The software’s versatility allows for examining co-authorship, co-citation, and keyword co-occurrence networks, facilitating an efficient exploration of large datasets through its interactive interface and continuous updates. VOSviewer’s ability to compute metrics and customise visualisations and its compatibility with various bibliometric data sources make it invaluable for scholars seeking insight into complex research domains.

A notable feature of VOSviewer is its capability to transform intricate bibliometric datasets into visually interpretable maps and charts, with a particular focus on network visualisation and clustering-related items (van Eck & Waltman, 2010, 2017). Its user-friendly interface enables both novice and experienced users to explore research landscapes efficiently. VOSviewer’s constant development keeps it at the forefront of bibliometric analysis, providing insightful computation of metrics and customizable visualisations. VOSviewer’s versatility in handling various bibliometric data types, including co-authorship and citation networks, makes it an essential tool for scholars looking for deeper insights and comprehension in their respective fields of study.

Data sets in PlainText format that included the publication year, title, author name, journal, citation, and keywords were taken from the Scopus database. The information is available from the year 1983 until March 2024. The VOSviewer software, version 1.6.20, was used to assess the datasets. This software made it possible to use VOS clustering and mapping algorithms for analysis and map building. By arranging things in low-dimensional spaces, VOSViewer offers an alternative to Multidimensional Scaling (MDS). It guarantees that the proximity of two objects accurately conveys their similarity and relatedness (van Eck & Waltman, 2010a). VOSViewer and the MDS method (Appio *et al*., 2014) share a commonality. Nonetheless, the method offered by VOS is more appropriate for normalising co-

occurrence frequencies compared to MDS. VOS focuses on computing similarity metrics such as cosine and Jaccard indices using the association strength (AS*ij*) defined by (Van Eck & Waltman, 2007). The equation (AS*ij*) is defined as the ratio of Cij divided by the product of Wi and Wj.

$$\mathrm{AS}ij = \frac{c_{ij}}{w_i w_j}$$

where,

AS*ij* = Association strength between item *i* and item *j*.

C_{ij} = Number of co-occurrences between item *i* and item *j*. For example, if *i* and *j* are authors, C\(_{*ij*}) would be the number of papers they co-authored.

W_i = Total number of occurrences of item *i*. This could be the total number of papers authored by the author *i*, the total number of citations for a document *i*, etc.

W_j = Total number of occurrences of item *j*, defined similarly to W\(_*i*).

Suppose we assume that the co-occurrences of *i* and *j* are statistically independent. In that case, the relationship can be determined by calculating the ratio between the observed number of co-occurrences of i and j and the anticipated number of co-occurrences of i and j. The citation for this information is from the work of (van Eck & Waltman, 2010, p. 531). A higher value of AS*ij* indicates a stronger association between the two items, meaning they co-occur more frequently than expected based on their individual occurrences. Consequently, VOSviewer uses this index to minimise the total weighted sum of squared distances between all pairs of items in order to arrange things on a map. Appio *et al*. (2014) adopted the LinLog/modularity normalisation, as stated in their research. In addition, the data set was analysed using VOSviewer, a tool for visualising data. This study revealed patterns based on mathematical correlations and allowed for other analyses, including keyword co-occurrence, citation analysis, and co-citation analysis.

Results and Discussion

(i) What are the research trends in the CE method according to the year of publication?

Important insights into the temporal trends in research on the implementation of the CE method in protected areas can be gained from the year-based analysis of publications (Figure 2). The number of publications has steadily increased over the last few decades, with a noteworthy uptick in recent years. In particular,

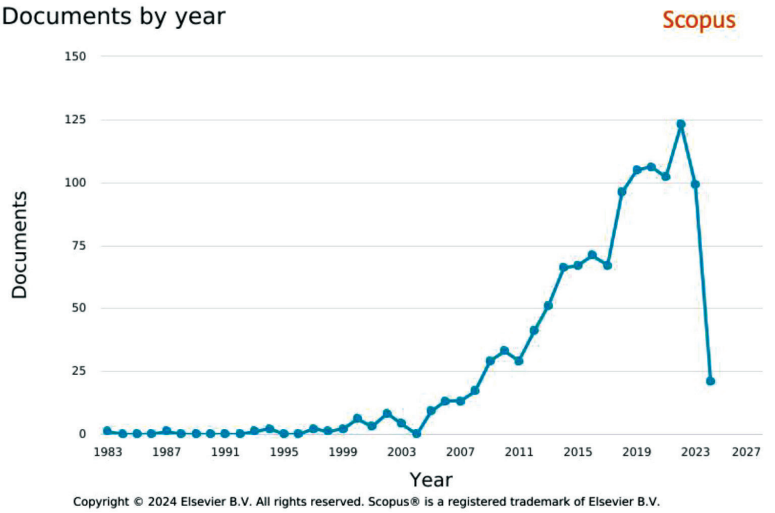

Figure 2: Plotting document publication by years

the number of publications has consistently increased between 2012 and 2024, suggesting an increasing interest and level of engagement in this field of study. With 123 papers, 2022 had the largest number of publications, closely followed by 2023, suggesting a steady trend in research output. However, the study showed a decrease in in research output for 2024 owing to the fact that the data being calculated was only for the 1st quarter of that year. This trend indicates a heightened focus on exploring the application of the CE method in understanding and managing protected areas, likely driven by increasing recognition of the method's utility in addressing conservation challenges and informing policy and management decisions.

Furthermore, the distribution of publications across different years highlights certain periods of heightened activity or shifts in research priorities. For instance, between 2019 and 2021 saw relatively stable publication numbers, indicating a period of consolidation or continued exploration within the field. In contrast, publication numbers between 2012 and 2018 witnessed a more pronounced increase in output, suggesting a phase of rapid expansion and exploration of new research avenues. Such temporal variations may reflect shifts in funding priorities, changes in research agendas, or the emergence of new methodologies and technologies that influence research practices in protected areas management. Additionally, the presence of publications dating back to the late 20th century and early 21st century underscores the longevity and enduring relevance of research on the application of the CE method, indicating a sustained interest in this topic over time.

Overall, the analysis of publications based on the year of publication provides valuable insights into the dynamic evolution of research on the application of the CE method in Protected Areas. The steady increase in publication output over the past few decades, coupled with fluctuations in publication numbers across different years, highlights the multi-faceted nature of research within this field and underscores the importance of continued scholarly engagement and exploration to address pressing conservation challenges and inform evidence-based management practices in protected areas worldwide.

(ii) What are the types of documents used for the subject of research?

The pie chart analysis in Figure 3 showed the document by subject of research to provide

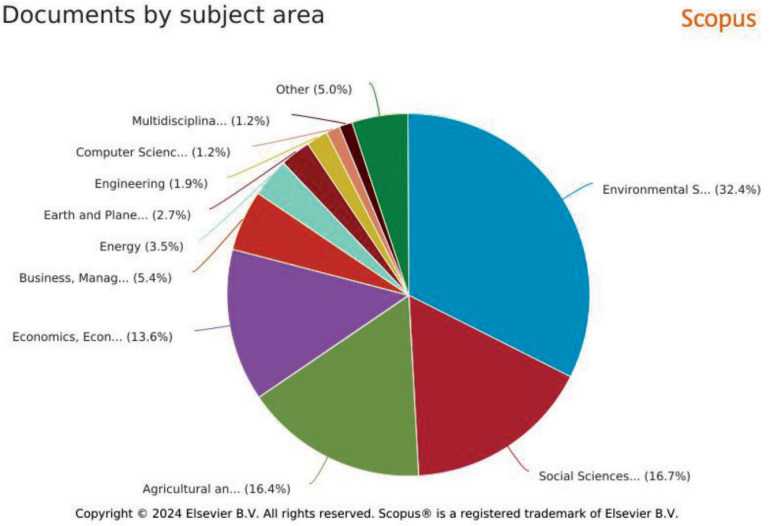

Figure 3: Fractioning the documents by subject area

insights into the distribution of documents across different subject areas. This feature helps researchers and analysts to understand the disciplinary focus and interdisciplinary reach of a particular set of documents as presented in this paper. The result presented that the most significant percentage of documents (32.4%) is concentrated in the field of Environmental Science. This finding aligns with the thematic focus of the study titled "Application of the CE method in Protected Areas." Environmental Science, being intricately linked to the research and implementation of protected area management strategies, naturally emerges as the primary domain for research in this context. However, it is noteworthy that the second largest pie chart slice (16.7%) belongs to Social Sciences, which likely delves into the human dimensions of protected area management. Understanding human values, behaviours, and interactions with protected areas is crucial for devising effective management strategies that garner local communities' and stakeholders' support and cooperation.

Economics, Econometrics and Finance for 13.6% of the documents indicate significant interest in the economic valuation of protected areas. Choice experiments serve as a valuable tool in estimating the willingness of individuals to pay for the benefits derived from protected areas, thereby aiding decision-making processes regarding investment and resource allocation. Moreover, Business, Management, and Accounting (5.4%), as well as Agricultural and Biological Sciences (16.4%), contribute substantially to the research landscape. The former may explore the management of the tourism industry in improving the benefits accruing to protected areas. At the same time, the latter might investigate the ecological impacts of protected areas on surrounding agricultural lands and the biodiversity within these protected areas. This multidisciplinary approach underscores the complexity inherent in managing protected areas, necessitating a holistic understanding of environmental, social, and economic dynamics for effective conservation and sustainability efforts.

(iii) Who are the top 10 authors based on citation by research?

The top 10 researchers, relying on the number of citations, present a diverse array of studies spanning several disciplines within environmental and ecological sciences, as shown in Table 3. From the earliest publication in 1994 to the most recent in 2012, a noticeable trend was observed regarding the evolution and diversification of methodologies used in environmental valuation and conservation. Early works by Adamowicz *et al*. (1994) pioneered the combination of revealed as well as stated preference methods, laying the groundwork for subsequent studies seeking to understand environmental amenities' value. Similarly, the research by Hanley *et al*. (1998) introduced the use of contingent valuation and choice experiments in estimating the advantages of environmentally sensitive areas, reflecting a shift towards more sophisticated valuation techniques in environmental economics.

Furthermore, there is a discernible trend towards interdisciplinary research, with studies exploring topics ranging from WTP for electric vehicles Hidrue *et al*., (2011) to visual mate choice in poison frogs (Summers *et al*., 1999). This interdisciplinary approach recognises the complex interactions between humans and the environment and the need for holistic methodologies to address conservation challenges effectively. Additionally, there is a notable emphasis on methodological advancements, such as the application of choice experiments Birol *et al*., (2006) Rolfe *et al*., (2000), conjoint analysis Alvarez-Farizo & Hanley, (2002), and discrete choice models Cooper & Millspaugh, (1999), highlighting a concerted effort to refine and improve environmental valuation techniques over time.

Moreover, the geographic scope of research is broad, with studies examining environmental issues and valuation methodologies across different regions, including Greece, Spain, Scotland, and tropical rainforests. This global perspective underscores environmental

Table 3: Top 10 authors based on research citation

Authors	Title	Year	Source Title	Cited by
Adamowicz *et al*. (1994)	Combining revealed and stated preference methods for valuing environmental amenities	1994	Journal of Environmental Economics and Management	939
Hidrue *et al*. (2011)	Willingness to pay for electric vehicles and their attributes	2011	Resource and Energy Economics	748
Birol *et al*. (2006)	Using a choice experiment to account for preference heterogeneity in wetland attributes: The case of Cheimaditida wetland in Greece	2006	Ecological Economics	359
Hanley *et al*. (1998)	Contingent valuation versus choice experiments: Estimating the benefits of environmentally sensitive areas in Scotland	1998	Journal of Agricultural Economics	270
Alvarez-Farizo & Hanley, (2002)	Using conjoint analysis to quantify public preferences over the environmental impacts of wind farms. An example from Spain	2002	Energy Policy	226
Summers *et al*. (1999)	Visual mate choice in poison frogs	1999	Proceedings of the Royal Society B: Biological Sciences	204
Spash, (2007)	Deliberative monetary valuation (DMV): Issues in combining economic and political processes to value environmental change	2007	Ecological Economics	198
Lopez-Mosquera & Sánchez, (2012)	Theory of Planned Behaviour and the Value-Belief-Norm Theory explaining willingness to pay for a suburban park	2012	Journal of Environmental Management	197
Rolfe *et al*., (2000)	Choice modelling and its potential application to tropical rainforest preservation	2000	Ecological Economics	185
Cooper & Millspaugh, (1999)	The application of discrete choice models to wildlife resource selection studies	1999	Ecology	181

conservation's universal significance and valuation methods' applicability in diverse socio-ecological contexts. Overall, the trends observed in the top 10 researchers' works reflect the dynamic nature of environmental research, characterised by methodological innovation, interdisciplinary collaboration, and a global outlook toward addressing pressing environmental challenges.

(iv) What is the map of co-authorship for the CE method application?

The network visualisation map generated through VOSviewer software in Figure 4 illustrates the

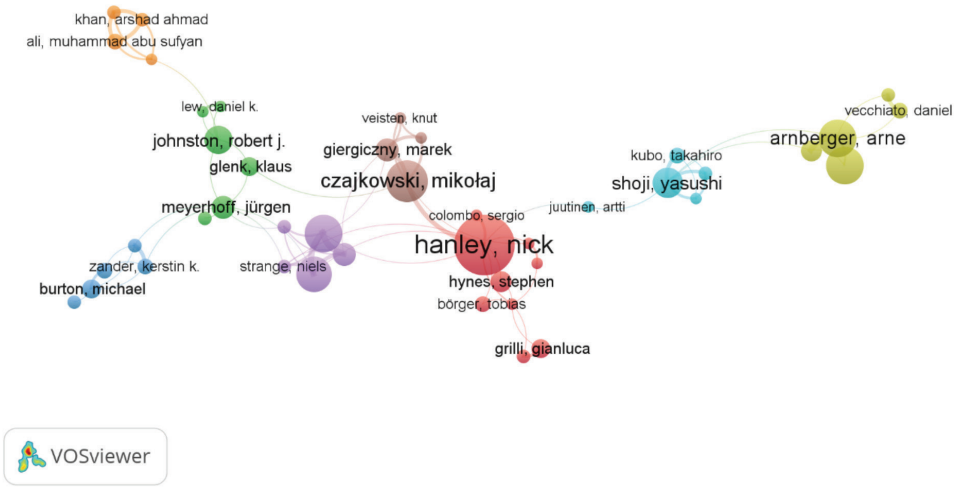

Figure 4: Network visualisation map of Co-Authorship

co-authorship patterns within the domain of applying the CE method in protected areas. The analysis reveals notable contributors and their collaborative connections. Several authors stand out in their prolificacy and influence within this research domain. For instance, Hanley, Nick, Jacobsen, Jette Bredahl, and Czajkowski, Mikołaj demonstrate high document counts, citations, and total link strength, indicating their significant contributions and strong collaborative ties within the research community. These findings suggest a cohesive network of researchers actively engaged in exploring the application of the CE method in the context of protected areas, likely fostering knowledge exchange and advancements in the field.

Furthermore, the analysis uncovers variations in author productivity and impact. While some authors exhibit substantial document counts and citations, others contribute to the network with fewer documents and citations but maintain considerable link strength, indicating their importance in bridging different research groups or subfields within this domain. Additionally, the presence of authors with relatively low document counts or citations but high link strength underscores the significance of their collaborative efforts in facilitating knowledge dissemination and integration across diverse research perspectives. Overall, the co-authorship network analysis provides valuable insights into the research's collaborative dynamics and interdisciplinary nature in applying CE methods in protected areas, emphasising the importance of collaboration and knowledge exchange in advancing scientific inquiry and addressing real-world conservation challenges.

(v) What are the popular keywords related to the study?

Figure 5 displayed a bibliometric analysis of well-known keywords related to applying the CE method in protected areas, providing valuable insights into the research landscape within this domain. Based on the result, the selected keyword was displayed from 2014 to 2020 due to the time frame in which these keywords were most frequently used, which was analysed from Vosviewer software. The result also addressed that the only keyword with the greatest total link strength was selected (van Eck & Waltman, 2010b; Waltman *et al*., 2010). Thus, the keyword "choice experiment" emerges as the most prevalent, with 316 occurrences and a total link strength of 485, indicating a significant focus on this methodological approach within the literature. Similarly, keywords such as "willingness to pay" and "ecosystem services" demonstrate considerable attention, with 167

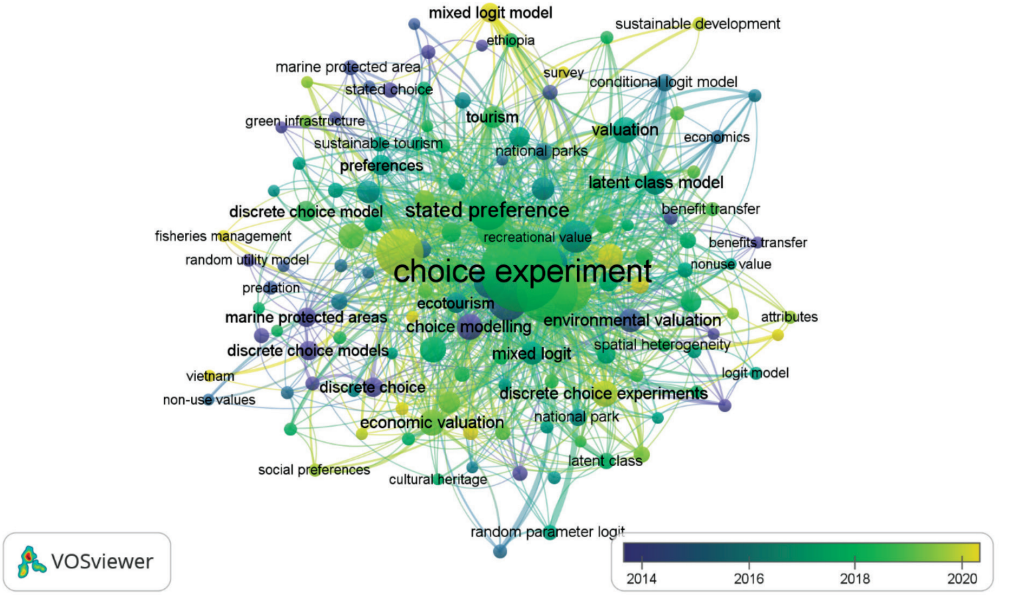

Figure 5: Overlay visualisation map of keywords' co-occurrence

occurrences and 73 occurrences, respectively, accompanied by substantial total link strengths of 329 and 145. These findings strongly emphasise understanding economic preferences and the valuation of ecosystem services in the context of protected areas, focusing on the importance of incorporating economic perspectives into conservation and management strategies. Furthermore, the analysis reveals various keywords encompassing various methodological approaches, economic concepts, and ecological aspects related to protected areas research. Terms like "discrete choice experiment," "contingent valuation," and "non-market valuation" underscore the prevalence of stated preference methods and economic valuation techniques in studying human preferences and behaviours towards protected areas. Moreover, keywords such as "biodiversity," "climate change," and "conservation" reflect the interdisciplinary nature of research within this field, highlighting the integration of ecological principles and conservation objectives with economic analyses. Overall, the prominence of specific keywords alongside the breadth of topics covered in the literature underscores the multi-faceted nature of research on applying the CE method in Protected Areas, indicating a rich and diverse research landscape that addresses both methodological advancements and practical conservation challenges.

(vi) What are the collaborations of co-authorship countries?

The co-authorship collaboration analysis among countries in applying the CE method within protected areas in Figure 6 revealed several significant partnerships and patterns. Notably, countries like the United Kingdom, the United States as well as Australia exhibit greater levels of collaboration, as evidenced by their substantial citations, document counts, and total link strengths. These countries serve as key hubs for research collaboration, attracting scholars from diverse backgrounds and facilitating interdisciplinary approaches to studying protected areas management. Additionally, collaborations between European countries, for instance, Italy, Germany and the Netherlands, as well as between Scandinavian nations like Norway and Sweden, demonstrate a strong regional focus on cooperative research efforts. These collaborations likely foster knowledge exchange and the development of innovative

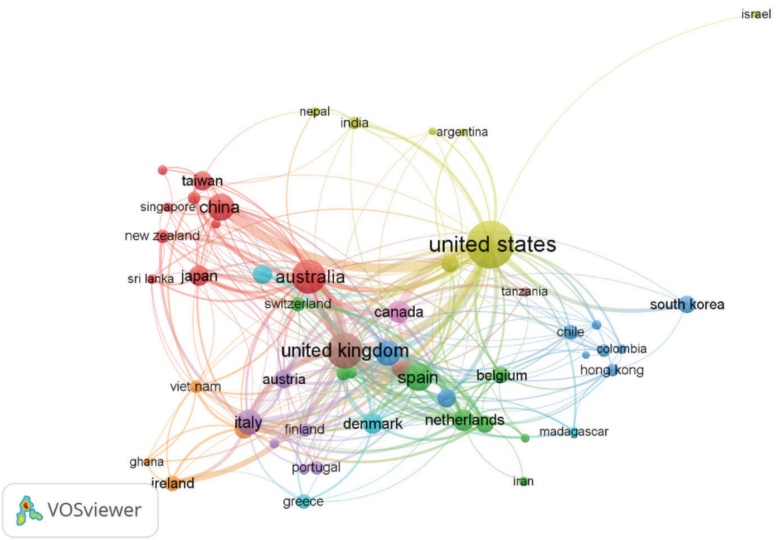

Figure 6: Network visualisation maps of the authorship country's collaboration in the CE method

solutions to conservation challenges within specific geographical contexts.

Furthermore, the analysis highlights emerging partnerships and collaborations among countries with growing research outputs in the field of protected areas management. Countries such as China, Canada, and Brazil demonstrate increasing levels of collaboration, reflected in their rising document counts and citations, alongside moderate to high total link strengths. Such collaborations signify a global shift towards inclusivity and diversity in research partnerships, allowing for integrating different perspectives and methodologies in addressing complex conservation issues. Moreover, collaborations between countries from various continents, such as Indonesia, the Netherlands, Thailand, and Australia, illustrate the global nature of research networks in protected areas management. These cross-continental collaborations are essential for promoting knowledge transfer and sharing best practices across diverse socio-ecological contexts, ultimately contributing to advancing sustainable conservation practices worldwide.

(vii) What density mapping is based on citation by source type?

Figure 7 depicts the citations by source type and sheds light on the diverse scholarly outlets contributing to the discourse on applying the CE method in protected areas. Ecological economics emerges as a prominent source, with a substantial document count of 90 and citations totalling 3970. It reflects its significant influence and interdisciplinary approach to studying the interactions between ecological systems and economic activities. Similarly, journals such as Environmental and Resource Economics, Environmental Management, and Journal of Environmental Management demonstrate high citation counts alongside moderate to high document counts. These journals serve as vital platforms for disseminating research findings and facilitating scholarly dialogue within the interdisciplinary environmental and conservation economics field. Moreover, Ecosystem Services and Land Use Policy also demonstrate significant contributions, reflecting the importance of specialised journals in addressing specific aspects of protected areas management, such as ecosystem valuation and land-use planning. The analysis highlights the interdisciplinary nature of research on the CE method, with contributions from journals

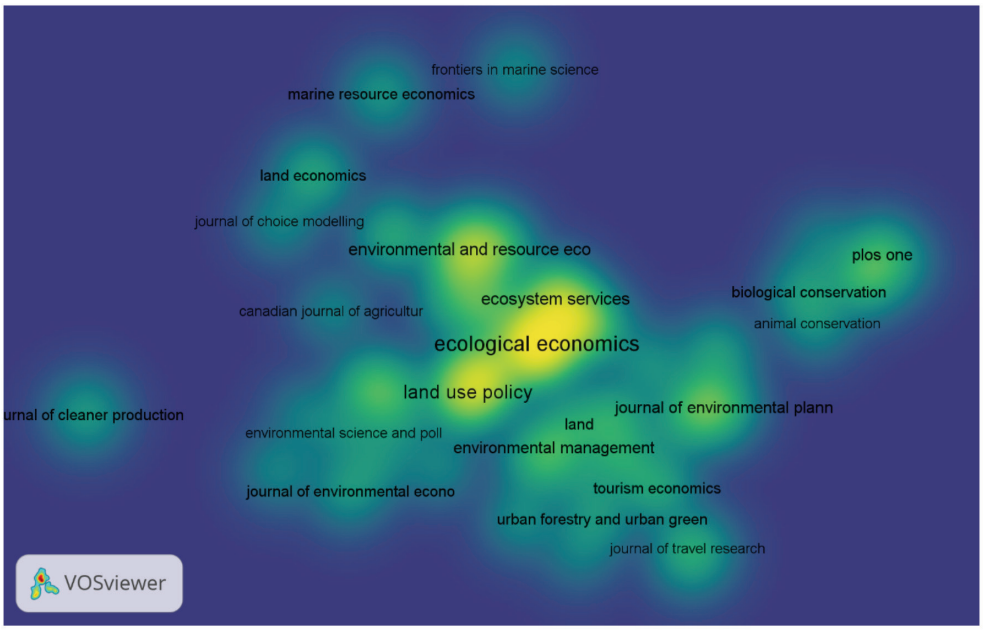

Figure 7: Density visualisation mapping based on citation by source type

spanning various disciplines, including environmental science, economics, tourism, and urban planning, underscoring the multi-faceted approach required to address complex conservation challenges effectively.

In addition, the analysis reveals the influence of high-impact interdisciplinary journals such as Science of the Total Environment and PLOS ONE, which attract a wide range of research on protected areas management, including studies employing the CE method. These journals play a crucial role in reaching broader audiences and fostering collaborations across disciplines, thereby enhancing the visibility and impact of research in the field. Additionally, the presence of specialised outlets like Marine Policy and the Journal of Sustainable Tourism underscore the importance of niche publications in catering to specific research interests and fostering in-depth discussions on relevant topics within protected areas management. Overall, the diversity of scholarly outlets reflected in the analysis underscores the interdisciplinary and global nature of research on applying the CE method in protected areas, highlighting the need for collaboration and knowledge exchange across disciplines and geographical boundaries to effectively address conservation challenges.

Discussion and Conclusion

The comprehensive bibliometric analysis of applying the CE method in protected areas research provides valuable insights into this field's evolving trends, key contributors, and disciplinary perspectives. This discussion synthesises the findings from the analysis and concludes the state of the research, its implications, and potential future directions.

Analysing research trends in applying the CE method within protected areas reveals a dynamic evolution over time. A consistent upward trajectory in publication output between 2012 and 2024 suggests a growing interest in utilising CE methodology to address conservation challenges and inform policy decisions. This publication surge reflects a recognition of the CE method's utility, likely driven by its effectiveness in understanding complex interactions within protected areas. Moreover, the multidisciplinary nature of research, as evidenced by contributions from

Environmental Science, Social Sciences, Economics, and other fields, underscores the holistic approach required for effective protected area management. These findings emphasise the importance of continued scholarly engagement and methodological innovation to address global conservation challenges. The top 10 authors, based on citations, present a diverse array of studies spanning several disciplines within environmental and ecological sciences. Their contributions reflect methodological innovation, interdisciplinary collaboration, and a global outlook toward addressing environmental challenges. Pioneering works by researchers such as Adamowicz *et al*. (1994) and Hanley *et al*. (1998) have laid the groundwork for subsequent studies, showcasing the evolution of environmental valuation methodologies. Furthermore, the emphasis on methodological advancements, including applying choice experiments and other valuation techniques, highlights a concerted effort to refine environmental valuation practices over time. The geographic scope of research, spanning different regions globally, underscores the universal significance of environmental conservation and the applicability of valuation methods across diverse socio-ecological contexts.

What is more interesting is that the bibliometric analysis conducted revealed a comprehensive understanding of research trends, collaboration dynamics, and interdisciplinary approaches within this domain. Exploring co-authorship patterns reveals a robust collaborative network among researchers, with influential figures such as Hanley, Nick, Jacobsen, Jette Bredahl, and Czajkowski, Mikołaj, fostering knowledge exchange and advancements in the field. Additionally, the prominence of keywords like "choice experiment" and "willingness to pay" underscores the significant focus on economic valuation methodologies. At the same time, the diversity of topics covered, from ecosystem services to biodiversity and climate change, highlights the interdisciplinary nature of research within the field. International collaboration analysis demonstrates significant partnerships among countries like the United Kingdom, the United States as well as Australia, serving as key hubs for research collaboration, while regional collaborations within Europe and Scandinavia foster knowledge exchange within specific geographical contexts. Emerging partnerships among countries with growing research outputs signify a global shift towards inclusivity and diversity in research partnerships, ultimately contributing to advancing sustainable conservation practices worldwide. The density mapping of citations by source type showcases the diverse scholarly outlets contributing to the discourse on the CE method in protected areas research. High-impact interdisciplinary journals like Ecological Economics and Science of the Total Environment are crucial in disseminating research findings and fostering collaborations across disciplines. In contrast, specialised outlets such as Marine Policy and the Journal of Sustainable Tourism enrich scholarly dialogue on specific research interests within protected areas management.

In conclusion, this bibliometric analysis offers compelling evidence of the increasing significance and interdisciplinary character of research employing the CE method in protected areas. The rise in publications, contributions from key researchers, and diverse disciplinary perspectives highlight the dynamic nature of this field. Continued scholarly engagement and interdisciplinary collaboration are essential for addressing complex conservation challenges and ensuring the long-term preservation of biodiversity and ecosystem services within protected areas. Finally, the insights gained contribute to a comprehensive understanding of socio-economic aspects in conservation and management, aiding in evidence-based policy-making and fostering sustainable conservation practices.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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