

Retrospective Review

A Comparative Bibliometric Analysis of Chinese and Foreign Articles in Fisheries Cooperation Research

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As a highly globalized sector, fisheries play a pivotal role in ensuring global food security, providing high-quality protein, and promoting socio-economic development. Due to its dependence on marine resources, the fisheries industry chain values close international resource sharing and cooperation that help facilitate sustainable utilization of fisheries resources, promote regional and international economic growth, maintain eco-balance, and address global challenges. This paper leverages 1253 articles from Web of Science (WOS) core collection data and 828 articles from China Knowledge Network (CNKI) journal literature as data sources to analyze the publication volume, author and research institution cooperation network, co-occurrence of Chinese and English keywords, citation clustering, and burst detection in this field from 1991 to 2022. This study finds that although a relatively stable publication growth trend has been observed in fisheries cooperation research, the fragmentation of collaboration networks indicates a lack of strong research partnerships. By conducting an in-depth analysis of the underlying factors and proposing policy recommendations, we aim to promote future international cooperation and research innovation in this field.

1. INTRODUCTION

Fisheries are pivotal in ensuring global food security, providing high-quality protein, and promoting socio-economic development. Currently, the long-term health of global marine fisheries resources is jointly challenged by climate change, overexploitation, environmental pollution, illegal, unreported, and unregulated (IUU) fishing, inadequate legal and governance structures, and multiple other factors, which offset the contribution of the fisheries sector. In response to such global management issues, fisheries cooperation can help promote technological collaboration and exchange, thus facilitating sustainable utilization of fisheries resources. Revisiting studies on fisheries partnership is conducive to mapping the scholarly effort in this area before figuring out appropriate philosophies and approaches to addressing relevant national, regional, and global eco-challenges.

International fisheries cooperation generally refers to the collective cooperation and adjustment of relationships between countries, and between countries and international organizations in areas such as production, scientific research, education and economy,¹ in order to promote better conservation and rational utilization of coastal and high seas fisheries resources by marine countries and regions. Since 1988, China's distant-water fisheries (DWF) vessels have been sailing abroad to waters such as the South Pacific, Atlantic and Indian Oceans, cooperating with foreign fishing governments and enterprises, and achieving fruitful results. China's marine fisheries function as an active part of international fisheries cooperation. In the early stage of DF development, China had established sound partnerships with fishing countries and regions such as Morocco, Senegal, Nigeria, and Las Palmas, Spain on the west coast of the Atlantic.^{2,3} Over the years, it has signed fisheries cooperation agreements with coastal countries represented by Russia, the United States, Australia, Japan, South Korea, Vietnam, Indonesia, South Africa and Brunei⁴⁻¹¹ to negoti-

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ate and regulate fishing operation, fisheries trade, seafood processing, aquaculture, personnel training and maritime law enforcement cooperation, and provide Chinese solutions for better fisheries governance. At present, research on international fisheries cooperation mainly focuses on the conservation and rational development of fisheries resources,^{12,13} scientific investigations into the oceans and their fisheries, such as climate change, marine pollution, resource overexploitation, and the impact and threat of invasive species on marine resources,^{14,15} as well as diverse socio-ecological system management models like fisheries quotas, fisheries communities, and marine protected area management, sustainable development of marine biological resources.¹⁶⁻¹⁸ In this context, this paper will revisit the current research literature in this field, and conduct bibliometric and knowledge mapping analysis to systematically explore the hotspots and development trends in international fisheries cooperation.

Bibliometric methods provide a useful decision-support toolkit for determining research priorities and tracking science evolution. Due to their data richness and convenient access, these methods have been quickly applied to various scientific fields. In addition, the wide availability of processing and analysis tools enables scientists of any expertise to employ current bibliometrics. The method offers a panoramic view of scholarly literature to promote effective identification of representative and influential studies, authors, journals, organizations, and countries over time. Therefore, this paper adopts the Bibliometric Analysis (BA) method, takes Web of Science (WOS) core collection database and China National Knowledge Infrastructure (CNKI) journal literature as data sources to search for literature related to fisheries cooperation as samples, and uses CiteSpace to explore the research hotspots in this field based on knowledge mapping and burst detection methods such as keyword co-occurrence and citation to reveal the research highlights and development trends, in hope of providing useful reference for promoting the management and sustainable development of marine fisheries resources.

2. MATERIALS AND METHODS

2.1. DATA SOURCE

Developed by Clarivate Analytics, Web of Science (WoS) is a professional information service platform with data sourced from a wide range of journals, books, patents, conference proceedings and online resources. China National Knowledge Infrastructure (CNKI) integrates more than 90% of China's knowledge and information resources in various forms, covering authoritative publications in multiple disciplines, including aquaculture and fisheries. To ensure representation, the English literature data for this study is sourced from the Web of Science (WOS) core collection database, with journal and conference papers as the targeted literature types, while the Chinese literature data is derived from the China National Knowledge Infrastructure (CNKI), mainly focusing on journal papers. The literature spanning from 1991 to 2022 was searched on March 25,

2023. The search formula in WOS is TS = "fisher* operation* or cooperation in fisher* industry". A total of 1,253 sample data were retrieved after obtaining journal, conference papers and other data from WOS and removing literature unrelated to fisheries cooperation. The search formula on CNKI is SU% = "fishery/fisheries Cooperation" (precise), retrieving altogether 1,034 records. After deleting invalid records (e.g. advertisements, briefings, solicitation information and conference promotion) from the results, a total of 828 literature data related to the topic were obtained. At the same time, the annual publication volume, source journals, citation frequencies, journal impact factors, and international scientific research cooperation data of the relevant literature, as well as the "full record and cited reference" data of the literature in WOS were downloaded for the subsequent knowledge graph visualization analysis.

2.2. SUBSECTION RESEARCH METHODS

CiteSpace is software for visualizing and analyzing trends and patterns in the scientific literature, as well as for constructing and viewing bibliometric maps of authors, journals, or references based on co-citation data, and keyword maps based on co-occurrence data. Co-citation analysis and Pathfinder Network Scaling (PDFNET) can identify critical paths and knowledge turning points during the evolution process of a subject area by measuring literature (collections) in a specific field. Visual mapping analysis facilitates a more intuitive understanding of the knowledge dynamics of relevant research and its development trajectory and uses clustering views to reveal research hotspots and key turning points in knowledge evolution and their intrinsic relationships. This user-friendly software activates complete software functions and analysis types with intuitive and beautiful visualization. In this study, insufficient information mining in the CiteSpace mapping analysis is fixed by reviewing and analyzing refined literature samples [30] to further clarify the development lineage, research hotspots, and development trends in the field. The bibliometric and visualization software Citespace6.2 R3¹⁹⁻²² is used to analyze the obtained literature data for Chinese and English keyword co-occurrence and citation clustering, author collaboration network, and burst detection. A co-author network map, keyword co-occurrence, and citation clustering map in fisheries cooperation are then developed to explore the main research author collaboration relationships and changes in research characteristics. The commonly-used Centrality in CiteSpace is leveraged to measure the importance of nodes in the network, displaying their importance in supporting research in this field that are highlighted with purple circles. Moreover, the accuracy of clustering analysis results is evaluated with network modularity Q and Mean Silhouette values. If Q is greater than 0.3, the network clustering effect is significant^{23,24}; if Silhouette is greater than 0.4, the clustering is reasonable.²⁵⁻²⁷

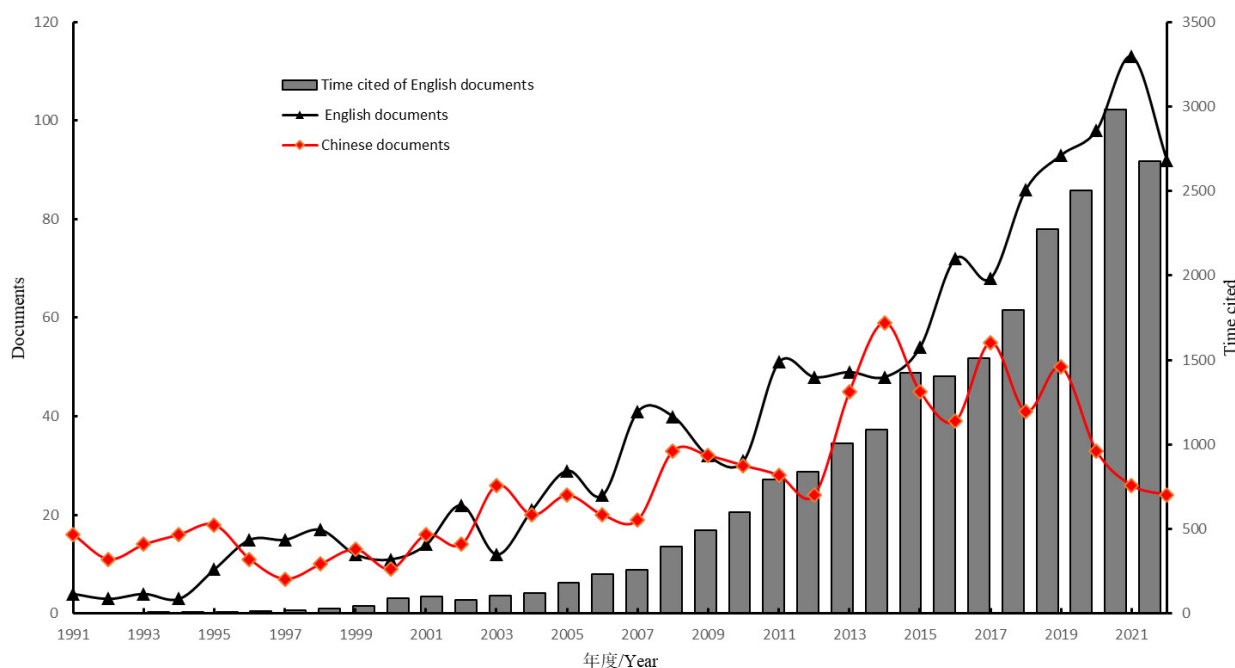


Figure 1. Annual distribution of literature and citations in fisheries cooperation

3. RESULTS AND ANALYSIS

3.1. RESEARCH OVERVIEW

3.1.1. GROWTH PATTERN OF LITERATURE

The annual publication volume and citation frequencies of literature can directly reflect the development status of a certain discipline as a key indicator to measure the academic influence.^{28,29} In WOS, there were a total of 1,253 English literature on fisheries cooperation from 1991 to 2022, including 1,024 journal papers (52 reviews), accounting for 81.72%, and 222 conference papers, accounting for 17.72%. About 38 papers were published annually. From a temporal perspective, the number of papers increased from 4 published in 1991 to a maximum of 113 in 2021, and slightly decreased to 92 in 2022, displaying a steady upward trend overall (Fig. 1). This figure illustrates the growth trend in the number of published papers and citations over time from 1991 to 2022. It reveals an overall upward trajectory, peaking in 2021. Notably, while there was a downturn in publication volume in 2022, the broader trend indicates a growing interest and scholarly output in fisheries cooperation research.

From the general development trend, there is plenty of space for the continuous growth of research on fisheries cooperation in future. The increasing number of publications and citations underscores the rising importance of fisheries cooperation in addressing global issues. It suggests that the academic community is increasingly recognizing the critical role of collaborative efforts in sustainable fisheries management. Furthermore, the peak in publication volume may indicate a response to emerging challenges such as climate

change and resource depletion, driving researchers to seek cooperative solutions.

In CNKI, there were a total of 828 Chinese journal articles on fisheries cooperation from 1991 to 2022, showing a dynamic fluctuation trend. During 1991 and 2012, the year with the least number of publications was 1997 (7 papers), while the year with the most publications was 2008 (33 papers). Compared with developed countries, China's fisheries organizations for cooperation developed relatively late but at a fast speed. The number of relevant publications increased significantly, reaching 45 in 2013 and increasing further to 59 in 2014. In addition to the number of references, statistical analysis is conducted on the citation of fisheries cooperation research in WOS. The results show that from 1991 to 2022, a total of 23,639 research papers were cited, with an average citation frequency of 18.87 times per paper and a maximum citation frequency of 1,051 times per paper.³⁰ The total number of cited papers reached 19,838, and the h-index was 69. There were 5 highly-cited ESI papers in this field, namely Hobday *et al.*,³¹ Oliver *et al.*,³¹ Hintz *et al.*,³² Santora,³³ and Xu *et al.*,³⁴ with citation frequencies of 368, 157, 112, 93, and 12 times, respectively. It can be found that Chinese literature on fisheries cooperation is less cited than its English counterparts, showing a necessity to further promote sci-tech cooperation and exchange in this field between the East and the West. The complexity and global nature of fish-related resources give rise to the multi-disciplinary feature of fisheries, and a comprehensive cooperation framework across multiple disciplines and industries needs to be developed. In summary, the scope of knowledge system in international fisheries cooperation is constantly expanding, indicating that research in this field is gradually thriving.

Table 1. Statistics of source publications characteristics of WOS literature (Top 20)

Source publications	Literature quantity	Impact factor (2021)	JCR quartile
Marine Policy	136	4.315	Q1
Ocean and Coastal Management	40	4.295	Q1
Fisheries Research	35	2.817	Q2
Frontiers in Marine Science	33	5.247	Q1
Ices journal of Marine Science	19	3.906	Q1
Plos One	18	3.752	Q2
Ecological Economics	17	6.536	Q1
Fisheries	17	3.539	Q1
Ocean Development and International Law	17	1.278	Q3
Sustainability	17	3.889	Q2
Fish and Fisheries	16	7.401	Q1
Ecology and Society	15	4.653	Q1
Environmental Resource Economics	13	4.955	Q1
Journal of Theoretical Biology	12	2.405	Q3
Marine Resource Economics	12	2.811	Q2
Journal of Environmental Economics and Management	11	5.84	Q1
Coastal Management	10	3.925	Q2
Aquatic Ecosystem Health Management	8	1.6	Q3
Scientific Reports	8	4.997	Q1
Fisheries Science	7	2.148	Q3

3.1.2. DISTRIBUTION PATTERN OF JOURNALS

Through the analysis of literature journal sources, it is found that the sources of literature in fisheries cooperation are distributed among more than 630 journals such as *Marine Policy*, *Ocean and Coastal Management*, and *Fisheries Research*. The top 20 journals in terms of publication volume have published 461 papers related to fisheries cooperation, accounting for 36.79% of the total literature in this field (Table 1). This table lists the top 20 journals contributing to fisheries cooperation research, identifying *Marine Policy* as the leading journal in terms of publications (136 papers) and high impact factor, 14 journals have an impact factor greater than 3, with an average impact factor of 4.015. Among them, the journal with the highest impact factor is *Fish and Fisheries*, a core journal featuring fisheries sciences, with an impact factor of 7.401 (JCR partition, Q1). In addition, *Fisheries Research*, *Fisheries*, and *Fisheries Science* are also important journals in this field. As for the JCR partition of journals, except for the four journals with Q3, all other journals have Q1 and Q2 partitions, and their impact factors remain high in various disciplinary classifications. From journal impact factor and JCR partition, the top 20 journals in this field have a great influence in publication volume, and are all key sources of attention for relevant researchers.

The identification of high-impact journals plays a crucial role in guiding researchers toward reputable sources for publishing their work. It can also inform stakeholders about influential literature that shapes research and policy in fisheries science, underscoring the importance of engaging

with these key publications for advancing knowledge in the field.

An analysis of the journals publishing fisheries cooperation articles in CNKI shows that the publications in this field are relatively scattered in different sources. Table 2 lists the top 10 journals with the highest publication volume, all of which are core Chinese journals, with *South China Fisheries Science* (5 papers) and *China Rural Economy* (4 papers) ranking the top 1 and 2. The journal with the highest composite impact factor is *China Rural Economy* (14.046), followed by *Agricultural Economic Issues* (8.399). The composite impact factors of the top 10 journals are high in various disciplinary classifications in China, whose influence is also rather high.

3.1.3. DISCIPLINARY DISTRIBUTION OF LITERATURE

It is discovered that the English research literature in fisheries cooperation involves a total of 147 WOS discipline categories. Ranked by publication volume, Environmental Studies tops the list with 295 papers published (23.54%); the second discipline is Environmental Sciences with 223 papers (17.80%); the third is Fisheries with 210 papers (17.85%); and the fourth is International Relations with 183 papers (16.76%). The disciplines publishing over a hundred papers include Marine Freshwater Biology, Economics, and Ecology, etc. Those with over 40 papers are Oceanography, Water Resources, Law and Multidisciplinary Sciences, etc.

As revealed by a statistical analysis of the disciplinary distribution of research literature in fisheries cooperation in CNKI, the main disciplines in this field include Aqua-

Table 2. Top 10 journals publishing papers in fisheries cooperation in CNKI

Source publications	Literature quantity	Core journal or not	Composite Impact factor (2022)
South China Fisheries Science	5	Yes	1.967
Chinese Rural Economy	4	Yes	14.046
Journal of China Agricultural University	3	Yes	2.753
Zhejiang Academic Journal	3	Yes	2.222
Zhejiang Social Sciences	2	Yes	2.419
Resources Science	2	Yes	6.525
International Studies	2	Yes	3.74
Northeast Asia Forum Northeast Asia Forum	2	Yes	4.255
Issues in Agricultural Economy	1	Yes	8.399
Economic Geography	1	Yes	7.291

culture and Fisheries (651 papers), followed by Agricultural Economy (646 papers), and Economic System Reform (86 papers), International Law (46 papers), Chinese Politics and International Politics (35 papers), Trade Economy (25 papers) and Oceanography (18 papers). The literature may overlap among various disciplines.

3.2. COOPERATIVE NETWORK ANALYSIS

3.2.1. CO-AUTHOR NETWORK ANALYSIS

In WOS, there are 3,889 authors researching fisheries cooperation. [Fig. 2](#) shows a network map of co-authors with no less than 3 references. The dots in the map represent the author nodes, and their sizes signal the number of publications: the larger the node, the greater the number of publications. The lines indicate the collaboration between authors, while their thickness indicates the number of collaborative contributions: the thicker the line, the greater the number of collaborative papers. According to [Fig. 2](#), this map visualizes the collaborative network among authors in fisheries cooperation research, with nodes representing authors and lines indicating the strength of their collaborative ties. It identifies key contributors, such as Shen Yuan (15 papers) and Win Moe Z (11 papers) with significant publication volume in this field. t and Sumaila U Rashid (10 papers) and Daura Jorge FG (10 papers) rank the third. Other authors have published less than 10 papers in relatively scattered topics, failing to form a core author group in fisheries cooperation. Meanwhile, there are few connections between research authors in this field, and only a small number of authors have cooperative partnerships. For instance, Basurto Xavier and Gelcich Stefan work together to conduct certain research. Xavier's research examines the governance of small-scale fisheries and sustainable management of fisheries resources, while Stefan explores the social ecological dimensions of eco-conservation and marine fisheries management. Both authors focus on how to promote sustainable management of fisheries resources through multi-level governance strategies. As can be seen, research literature in this field is centered on sim-

ilar topics, but stable and good cooperative relationships have not been developed among authors.

In CNKI, 942 authors publish papers on fisheries cooperation. [Fig. 3](#) shows a collaborative network map drawn by authors with no less than 2 papers, containing 383 author nodes and 66 connecting lines. The authors with the highest volume of publications are Zhu Wenbin and Ma Zhuojun (7 papers), the former investigating the prospects and risks of China's tightened fisheries cooperation with neighboring countries, while the latter on inter-regional fisheries sci-tech cooperation between Chinese and foreign fisheries. The two authors are followed by Huang Shuolin, Liu Huang, Zheng Sining, Wang Jiadi and Miao Miao (6 papers), and Chen Jun, Lu Yanan, Chen Feng and Ge Hui (5 papers), while the other authors have fewer papers published. Likewise, the papers published by Chinese authors focus on different topics, with no core author group formed in the subject of fisheries cooperation. Moreover, few scholarly connections are detected in this field, and only a small number of authors have cooperative partnerships, such as Lu Yanan and Fang Hai, Ruan Wen, etc. Overall, relevant research literature in CNKI is also rather scattered, and no good cooperative relationship is observed. The co-author network highlights the collaborative dynamics within fisheries research. The limited cooperation among authors suggests a fragmented research landscape, where few authors form strong collaborative partnerships. This fragmentation may hinder the development of robust methodologies and comprehensive solutions in fisheries science, emphasizing the need for fostering collaborative networks. However, many Chinese authors investigate the prospects and measures of China's fisheries partnership with other countries, which may be driven by China's active promotion of blue economy cooperation under the "the Belt and Road" initiative in recent years.

2.2.2. NETWORK ANALYSIS OF COOPERATIVE INSTITUTIONS

There are 1749 institutions in WOS that have published research literature related to fisheries cooperation, of which the top 10 institutions produce 285 papers, accounting for

Table 3. Statistics of authors' institutions in fisheries cooperation (top10)

No.	Institution	Publication volume	Percentage (%)	Country	Main discipline
1	University of California System	46	3.67	The US	Environmental Sciences, Economics, Ecology, Marine Freshwater Biology
2	University of British Columbia	41	3.27	Canada	Environmental Sciences, Fisheries, International Relations, Marine Freshwater Biology
3	National Oceanic Atmospheric Administration (NOAA)	32	2.55	The US	Environmental Science, Marine Freshwater Biology, Fisheries and Ecology
4	Centre National De La Recherche Scientifique (CNRS)	29	2.00	France	Environmental Sciences, Economics, Ecology, Mathematics, Computational Biology
5	Wageningen University	25	2.85	The Netherlands	Environmental Science, International Relations, Ecology, Economics
6	UDICE French Research Universities	24	1.92	France	Environmental Sciences, Ecology, Economics, Mathematics, Computational Biology
7	Stockholm University	23	1.84	Sweden	Environmental Sciences, Ecology, Interdisciplinary, Biodiversity Conservation
8	The Arctic University of Norway	23	1.84	Norway	Environmental Sciences, Fisheries, International Relations, Oceanography
9	State University System of Florida	21	1.68	The US	Biodiversity conservation, Ecology, International Relations, Anthropology
10	University of Helsinki	21	1.68	Finland	Fisheries, Environmental Science, Economics, Marine Freshwater Biology

scholarly institutions studying fisheries cooperation are loosely connected.

Fig. 4 shows a network map of institutional cooperation in fisheries cooperation concerning English literature. The dots in the map represent institutional nodes, with their size signaling the number of publications by the institutions and the connecting lines displaying the cooperation among institutions. The thicker and denser the connecting lines, the higher the number of collaborations and the closer the degree of their cooperation. A total of 512 institutional nodes with no less than 2 papers and 1,037 connections are obtained. As shown in Fig. 4, the main research institutions in this field include the University of California System, the University of British Columbia, the National Oceanic and Atmospheric Administration (NOAA) and Centre National De La Recherche Scientifique (CNRS), all of which have developed good cooperative relationships with each other. For instance, the University of California System enjoys stable academic partnership with institutions such as the Scripps Institution of Oceanography and CNRS, and further cooperates with more than 140 international institutions. The University of British Columbia has established research partnerships with over 70 institutions, including Stockholm University, Stanford University, and the University of Tasmania. As can be seen, the University of California System, the University of British Columbia, NOAA and CNRS are the core institutions in this field.

403 institutions have publications in CNKI related to fisheries cooperation, among which Shanghai Ocean University (41 papers) ranks first in terms of publication vol-

ume, followed by Ocean University of China (31 papers), and China Academy of Fishery Sciences (CAFS) (28 papers). The map demonstrates that key institutions breed effective cooperation, which is vital for pooling resources, expertise, and data in fisheries research. These collaborative efforts can lead to more impactful research outcomes, influencing policy and management practices in fisheries governance. It also suggests the importance of institutional frameworks in fostering research partnerships across disciplines and borders. Fig. 5 shows the institutional cooperation network map of Chinese literature in fisheries cooperation, with 302 institutional nodes and 99 connections. This visualization depicts the collaborative landscape among Chinese institutions engaged in fisheries cooperation research. The data reveals a limited number of connections and a lack of strong collaborative networks. The map only exhibits institutional nodes with no less than 2 publications. As shown in the figure, there is relatively little cooperation among Chinese institutions in this field, with only a small number of institutions having established exchange and cooperation relationships.

The weak inter-institutional cooperation points to potential inefficiencies and missed opportunities in addressing fisheries management challenges in China. Strengthening these ties could leverage collective knowledge and resources, thus leading to enhanced research effectiveness and better-informed policy decisions. For instance, some scholars at Shanghai Ocean University work together with their counterparts at Ocean University of China, CAFS, the Freshwater Fisheries Center, and the Fisheries Bureau of

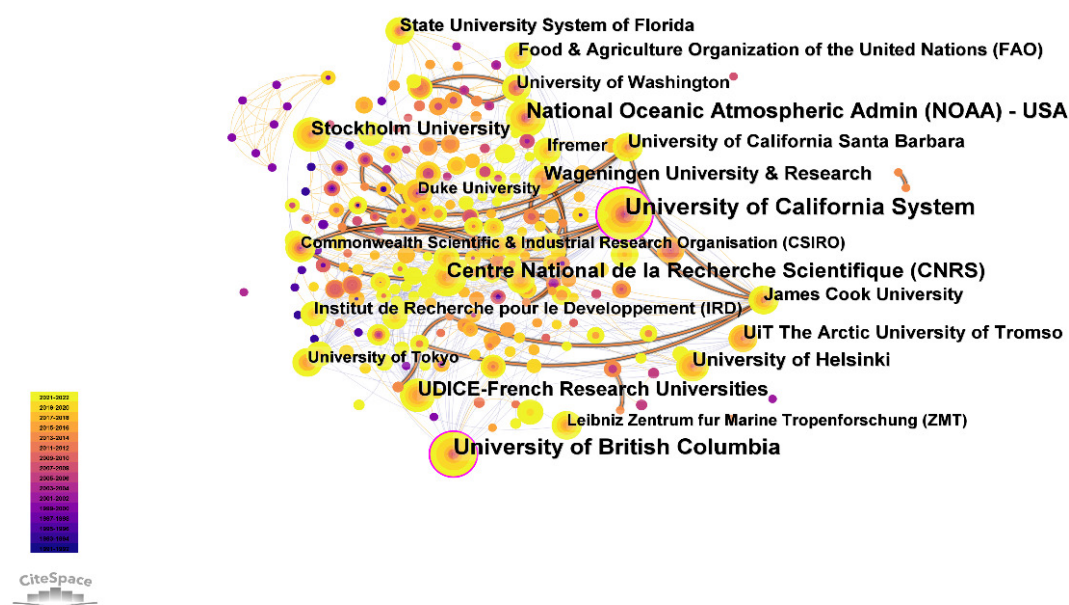


Figure 4. Analysis map of institutional cooperation network in fisheries cooperation of WOS literature



Figure 5. Analysis map of institutional cooperation network in fisheries cooperation of CNKI literature

the Ministry of Agriculture and Rural Affairs of PRC. Currently, close research partnerships are not observed in most fisheries' cooperation institutions.

3.3. CO-OCCURRENCE OF ENGLISH AND CHINESE KEYWORDS

3.3.1. CO-OCCURRENCE OF ENGLISH KEYWORDS

A co-occurrence analysis is conducted on the keywords in WOS concerning English and Chinese literature (Fig. 6) by duplicating the keywords and removing the meaningless words and phrases. This figure presents a network of keywords from the WOS literature, indicating that “fisheries management” and “international cooperation” are among

the most frequently co-occurring terms, highlighting prevalent topics in the literature.

In terms of significance, the keyword co-occurrence analysis reveals the focal areas of research within fisheries cooperation. The prominence of themes related to management and cooperation underscores their critical role in addressing global fisheries challenges. Understanding these research hotspots can guide future investigations and policy formulations, directing efforts toward effective resource management strategies. As a result, a total of 365 keywords with a co-occurrence frequency of no less than 2 times are obtained, and 34 keywords have a co-occurrence frequency of no less than 10 times (Table 4). This table enumerates the most frequently occurring keywords in the WOS litera-

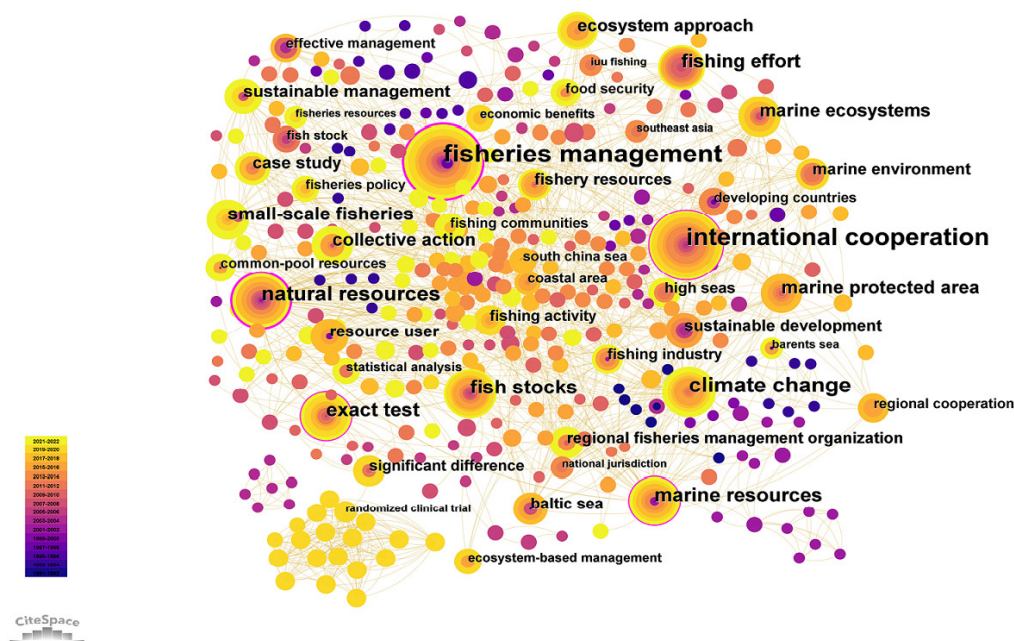


Figure 6. Analysis map of keywords co-occurrence network in fisheries cooperation of WOS literature

ture, revealing “fisheries management” and “international cooperation” as central themes.

By identifying prevalent keywords, this table reflects the primary areas of focus within the research community, illustrating the themes that hold the greatest scholarly interest. This insight can inform future research directions and collaborative studies, especially those aimed at developing integrated fisheries management strategies. It can be seen that “fisheries management” and “international cooperation” have the highest co-occurrence frequencies, with 78 and 69 co-occurrence times, respectively. Other active keywords include “climate change”, “natural resources”, “fish stocks”, “small-scale fisheries”, “exact test”, “fishing effort”, “collective action”, “case studies”, “marine ecosystems” and “marine resources” and “fishing effort”, all having appeared for over 20 times. Moreover, the co-occurrence frequencies of keywords such as sustainable development, fisheries resources, high seas, national jurisdiction, sustainable management, and fishing communities are also relatively high. The keywords with high co-occurrence frequencies and a centrality of no less than 0.1 include “case studies” (0.21), “fisheries management” (0.20), “international cooperation” (0.13), “actual test” (0.13), “marine resources” (0.11), “climate change” (0.10) and “natural resources” (0.10), etc. From keyword co-occurrence analysis, it can be noted that relevant researchers seem to be more interested in areas such as fisheries management, fisheries cooperation, marine resources and climate change.

3.3.2. CO-OCCURRENCE OF CHINESE KEYWORDS

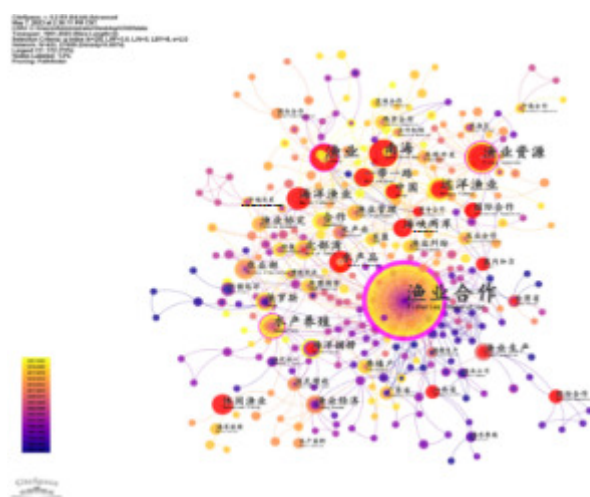
Fig. 7 showcases the network of keywords for Chinese literature, with “fisheries cooperation” as the most frequently

occurring term, followed by “fishery resources” and “South China Sea”. and 136 keywords with a co-occurrence frequency of no less than 2 times, of which 15 keywords have a co-occurrence frequency of no less than 10 times (Table 5). It can be seen that the most frequently occurring keyword is “fishery/fisheries cooperation”, with 141 occurrences, followed by “fishery/fisheries” (40 occurrences), “fishery/fisheries resources” (27 co-occurrences), “South China Sea” (23 co-occurrences), “aquaculture” (21 co-occurrences), and “distant fisheries” (19 occurrences).

The keyword patterns reflect China’s specific concerns and priorities in fisheries research, particularly in regional contexts like the South China Sea. Highlighting these areas can aid in aligning academic research with strategic national interests and regional cooperation efforts, potentially influencing future research directions and policy frameworks. The only keywords with a high co-occurrence frequency and a centrality of no less than 0.1 are “fishery/fisheries cooperation” (0.79), “fishery/fisheries” (0.16), “fishery/fisheries resources” (0.16) and “aquaculture” (0.13). Researchers of Chinese literature are more interested in fisheries cooperation, fisheries resource conservation, South China Sea fisheries, aquaculture and distant-water fisheries. At present, research on international fisheries cooperation mainly focuses on the conservation and rational development of fisheries resources,^{12,13} oceans and their fisheries, and the impact and threat of invasive species on marine resources,^{14,15} as well as diverse socio-ecological system management models such as fisheries quotas, fisheries communities, marine protected area management, and promotion of sustainable marine biological resources.^{16,35} It can be noted that Chinese research prioritizes economic, strategic, and technological aspects, while international research pays closer attention to sub-

Table 4. Statistics of high-frequency keywords in WOS literature (≥ 10)

No.	Keywords	Frequency	Centrality	No.	Keywords	Frequency	Centrality
1	fisheries management	78	0.2	18	fishing communities	17	0.06
2	international cooperation	69	0.13	19	recent years	16	0.13
3	climate change	47	0.1	20	important role	16	0.02
4	natural resources	33	0.1	21	regional cooperation	16	0
5	fish stocks	31	0.07	22	marine protected areas	15	0.08
6	exact test	29	0.11	23	ecosystem approach	15	0.07
7	marine resources	27	0.11	24	fishing industry	14	0.08
8	small-scale fisheries	26	0.01	25	marine environment	14	0.04
9	fishing effort	22	0.06	26	common-pool resources	13	0.03
10	collective action	20	0.07	27	South China sea	13	0.01
11	case studies	20	0.21	28	European Union	12	0.03
12	marine ecosystems	20	0.03	29	developing countries	11	0.02
13	sustainable development	19	0.04	30	resource users	11	0.03
14	fishery resources	18	0.05	31	fishing grounds	11	0.02
15	high seas	18	0.01	32	Baltic sea	10	0.04
16	national jurisdiction	18	0.02	33	high levels	10	0.01
17	sustainable management	17	0.01	34	IUU fishing	10	0.06

**Figure 7. Analysis map of keywords co-occurrence network in fisheries cooperation of CNKI literature**

jects like ecosystem management, sustainable development and social equity.

3.4. RESEARCH BASIS AND HOTSPOT

In bibliometrics, research hotspots and their trends over time in a certain field are usually described using keywords

co-occurrence, literature co-citation, citation clustering, or burst detection methods. This study employs citation clustering and burst detection in Citespace to analyze fisheries cooperation's research basis and hotspot.

Table 5. Statistics of high-frequency keywords in CNKI literature (≥ 10)

No.	Keywords	Frequency	Centrality
1	fisheries cooperation	141	0.79
2	fisheries	40	0.16
3	fisheries resources	27	0.16
4	South China Sea	23	0.03
5	aquaculture	21	0.13
6	distant fisheries	19	0.06
7	marine fisheries	16	0.04
8	aquatic product	14	0.02
9	Beibu Gulf	14	0.05
10	China	12	0.05
11	cross-Strait	12	0.02
12	cooperation	11	0.02
13	Belt and Road Initiative	11	0.04
14	fisheries production	10	0.06
15	fisheries agreement	10	0.04

3.4.1. CLUSTER ANALYSIS OF CITATION

There are 66,999 valid citation data in English literature in fisheries cooperation. After clustering analysis, a total of 118 cluster groups are obtained, with a modular Q value of 0.8867 and an average Mean Silhouette value of 0.9266, indicating that such cluster groups are significant and highly reliable (Fig. 8). Among them, there are 11 cluster groups with more than 10 citations (Table 6), and the Mean Silhouette values of these cluster groups are all greater than 0.7, showing that their clustering fitting is significant and the results are highly reliable. The clustering analysis enhances the understanding of how research in fisheries cooperation has evolved over time, providing insight into critical themes and successful management strategies. Identifying these clusters can help researchers and policymakers target areas that require further exploration and investment, ultimately contributing to the sustainable management of marine resources. The clustering of citations into distinct groups provides a nuanced view of the research landscape, highlighting how specific themes have developed over time. Such insights can shape future funding and research priorities, guiding stakeholders in identifying areas that require further exploration or intervention. Group A focuses on studying the need for strong management measures and effective governance in sustainable fisheries. As can be seen, small-scale fisheries are not often covered by formal management institutions, so fishing communities and fishers tend to adopt localized and community-based resource management methods to manage fisheries resources, and promote and maintain community cohesion. Group B mainly studies individual fisheries cooperation and its sustainable development, conservation of common pool fisheries resources, sustainable utilization of fisheries resources in territorial waters, and other relevant topics. Group C conducts research on fisheries management issues related to the unregulated fishing and overfishing in seven

large marine ecosystems (LMEs) in the South China Sea and the African continent, namely the Canary Current, Guinea Current, Benguela Current, Agulhas Current, Somali Coastal Current, Red Sea, and Mediterranean LMEs. Group D carries out research on Chile's coastal marine resources and fishing operation on high seas under regional management agreements. Group E concentrates on international issues such as regional fisheries management organizations (RFMOs), fisheries resources within national jurisdiction and biodiversity agreements, similar to the issues studied by Group G, yet the latter focuses more on voluntary cooperation between RFMOs. Group F mainly studies fisheries spatial allocation rights, renewable resources, Swedish coastal fisheries management and joint management arrangements. Group H researches the management of the Southern Ocean and its non-cooperative fisheries, IUU fishing and biodiversity. Group I centers on ecosystem-based fisheries management, global models, and current fisheries governance structures. Group J explores international fisheries management issues related to multi-species fisheries, joint development, and changes in fisheries resource populations. Group K themes on multi criteria analysis methods, ecosystem-based fisheries management and Icelandic cod fisheries, etc.

3.4.2. BURST DETECTION

The strength of citation bursts can characterize the evolution of hot topics in a research field. A co-citation analysis of research literature in fisheries cooperation obtains 707 citation nodes and 1,497 lines connecting the nodes, indicating close connections between such citation nodes. 17 key citation references with mutations are obtained (Table 7) through citation bursts. Table 7 identifies the key references that have experienced significant citation bursts, providing insights into influential works that have driven research interest in fisheries cooperation.

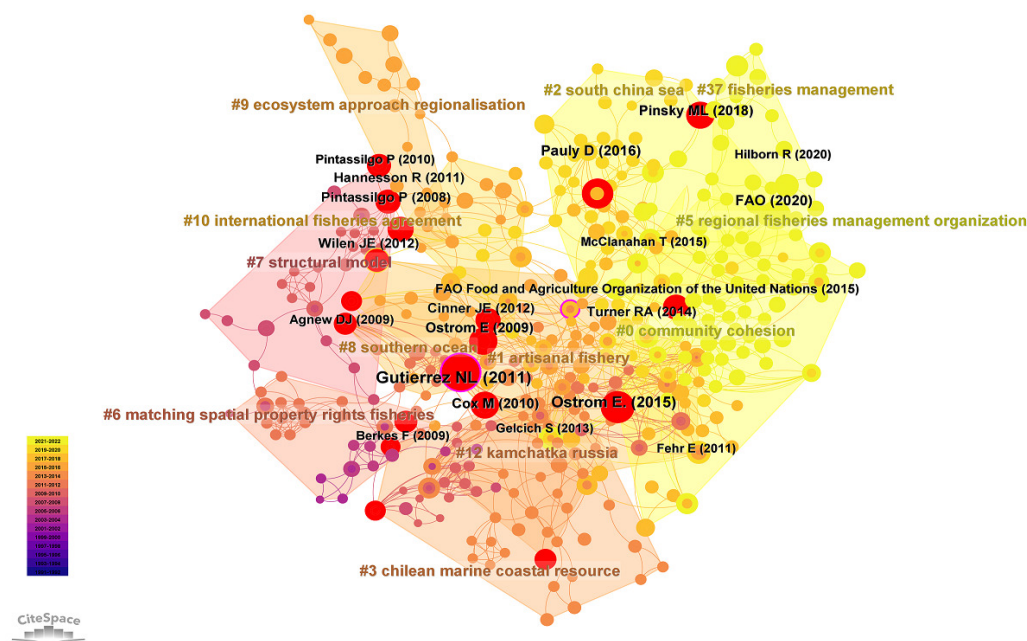


Figure 8. Cluster analysis of citations in fisheries cooperation

Table 6. Twelve principal clusters of citation cluster analysis

No.	Cluster label	Literature Quantity	Silhouette	Begin year	End year	Duration	Mean year
a	Fishing community cohesion /small-scale fisheries	70	0.94	2019	2022	4	2016
b	artisanal fishery	66	0.795	2013	2020	8	2010
c	South China Sea	53	0.973	2018	2022	5	2015
d	Chilean marine coastal resources	44	0.942	2007	2011	5	2008
e	Regional fisheries management organization	27	0.957	2014	2020	7	2017
f	Fisheries spatial allocation rights/ international commons management	27	0.981	2011	2016	6	2004
g	Structural model / marine protected area planning	25	0.933	2009	2016	8	2004
h	Southern Ocean / non-cooperative fisheries management	20	0.976	2011	2017	7	2009
i	Ecosystem approach regionalization	18	1.000	2010	2014	5	2010
j	International fisheries agreement	15	0.929	2015	2019	5	2012
k	Kamchatka (Russia) / using multi-criteria analysis	12	0.893	2013	2014	2	2006

The strong citation bursts indicate pivotal studies that have catalyzed thought and research in fisheries cooperation. Recognizing these foundational works allows current researchers to build upon established knowledge and explore emerging themes, fostering continuity and innovation in the field.

These findings and their significance underscore the importance of fisheries cooperation research, highlighting the need for enhanced collaboration, better management practices, and ongoing academic inquiry to address global fisheries challenges effectively. It is found that the research pa-

per published in Nature by Gutierrez *et al.*³⁶ on leadership, social costs and incentive measures to promote fisheries development has the strongest burst (7.21), covering a time span of 6 years. This is followed by the research paper published in Science by Ostrom³⁷ on building a basic framework for social ecological systems to analyze sustainable resource development (5.78), with a time span of 6 years. The paper published in Nature by Pauly³⁸ on globally achieving sustainable fisheries development in Nature ranks the third (4.86), with a time span of 4 years. These publications with strong bursts mainly explore the diverse social-ecological

Table 7. Key references with the strongest citation bursts

Citation author	Strength	Publication Year	Beginning	End	Time span	DOI
Pauly D	4.86	2002	2007	2010	4	10.1038/nature01017
Myers RA	4.49	2003	2007	2012	6	10.1038/nature01610
Pintassilgo P	4.42	2008	2009	2016	8	10.1142/S0219198908001959
Berkes F	3.76	2009	2011	2016	6	10.1016/j.jenvman.2008.12.001
Pintassilgo P	3.76	2010	2011	2016	6	10.1007/s10640-010-9346-9
Agnew DJ	3.67	2009	2011	2018	8	10.1371/journal.pone.0004570
Ostrom E	5.78	2009	2013	2018	6	10.1126/science.1172133
Cox M	4.78	2010	2013	2018	6	--
Nowak MA	4.27	2006	2013	2014	2	10.1126/science.1133755
Cinner JE,	4.04	2012	2013	2018	6	10.1073/pnas.1121215109
Gutierrez NL	7.21	2011	2015	2020	6	10.1038/nature09689
Hannesson R	4.27	2011	2015	2020	6	10.1146/annurev-resource-083110-120107
Wilen JE	4.86	2012	2017	2020	4	10.1093/reep/res012
Pauly D	3.53	2016	2017	2022	6	10.1038/ncomms10244
Ovando DA	3.52	2013	2017	2020	4	10.1016/j.marpol.2012.03.012
Pinsky ML	4.82	2018	2019	2022	4	10.1126/science.aat2360
FAO	3.58	2015	2019	2022	4	--

systems led by government or regional organizations, governed with individual or community quotas for fisheries, social cohesion and marine protected areas, in an attempt to jointly manage and solve the many problems faced by the global fishing industry and promote sustainable fisheries. Meanwhile, these papers witness a long span of bursts in fisheries cooperation, thus serving as a strong driver for the development of this field. The research hotspots of fisheries cooperation have evolved from early co-development of fisheries resources to management and maintenance after resource depletion, and then to the current stage of fisheries co-management models based on social-ecological ecosystems.

Based on the above analysis and the review of literature in fisheries cooperation, relevant research hotspots are listed as follows. The first are approaches to address the challenges of climate change to fisheries resource management. Climate change has a significant impact on marine biological resources, involving physical oceans, biological populations, economic and social parameters in the Arctic (e.g. ice cover, species distribution, economic activities, and regional governance frameworks). International fisheries cooperation requires joint effort in areas such as oceanography and ecology, economics, political science, and international law.^{39,40} The second are concerned with challenges of ecosystem-based fisheries management. Conducting fisheries investigation activities and knowing important biodiversity and marine environmental variables can help address challenges to fisheries management caused by ocean heat waves, ocean acidification, and pollutant leakage. Increasing cross-survey analysis and coop-

eration can enhance regional capacity in response to new challenges^{16,41} and promote sustainable development of marine ecosystems and fisheries. The third is sustainable governance and management of small-scale fisheries. It is important to apply resource management methods based on localized fishing communities to manage fisheries resources, and promote the formation and maintenance of community cohesion to ensure the sustainable development of small-scale fisheries.⁴² The fourth involves fisheries cooperation management model based on socio-ecological ecosystem. It is imperative to collaborate with coastal governments or regional organizations, leverage fisheries individual or community quotas, social cohesion, marine protected areas and other coordinated management measures to solve the multiple problems faced by global fisheries and promote sustainable fisheries.^{35,43}

4. CONCLUSION AND POLICY IMPLICATION

4.1. CONCLUSION

This paper uses WOS and CNKI to obtain literature data in the field of fisheries cooperation, and adopts bibliometrics and knowledge map analysis methods to analyze the publication volume, author and research institution cooperation network, English and Chinese keyword co-occurrence, citation clustering and burst detection in this field from 1991 to 2022, in an effort to develop cooperation network map, keyword co-occurrence map and literature co-citation clustering map concerning fisheries cooperation, and ex-

plore the development trends and research hotspots, reaching the following conclusions:

1. The number and citation frequency of research literature in fisheries cooperation show a dynamic increasing trend over time. There is an obvious growth of both English and Chinese literature in WOS, but the overall publications are not yet saturated and will continue to grow in future. The total volume of citations, average number of citations per article, and h-index of the literature are rather high, with a certain number of ESI highly-cited papers. It can be seen that the scope of the knowledge system of fisheries cooperation in English literature is constantly expanding, indicating that research in this field enjoys stable and facilitated development, attracting great interest from international scholars. While in recent years, Chinese literature has shown a downward trend, and researchers tend to publish relevant articles in English.
2. Through cooperative network analysis, it is found that the research literature of Chinese and foreign authors in fisheries cooperation is scattered in different journals, without stable and good cooperative relationships between the authors. In WOS, authors with a large number of publications include Shen Yuan, Win Moe Z, Sumaila U Rashid, and Daura Jorge FG, among others. The remaining authors have published less than 10 papers on diversified topics or journals, forming no core author group in this field. In CNKI, authors with a large number of publications include Zhu Wenbin, Ma Zhuojun, Huang Shuolin, etc., while other authors have published fewer papers and have not developed a core author group. From institutional cooperation, the institutions that publish relevant literature in fisheries cooperation are also scattered. In WOS, sound cooperative relationships can be observed among institutions such as the University of California System, the University of British Columbia, NOAA and CNRS. As the core institutions studying this field, they produce a large number of publications. There is relatively little cooperation between Chinese institutions, with only a small number of institutions developing exchange and cooperation relationships.
3. The research hotspots and evolution trends of fisheries cooperation have been revealed through analysis methods including co-occurrence of English and Chinese keywords, citation clustering, and burst detection. The research hotspots of this topic can be divided into four aspects: 1) Approaches to address the challenges of climate change on fisheries resource management; 2) challenges of ecosystem-based fisheries management; 3) sustainable governance and management of small-scale fisheries; 4) fisheries cooperation management model based on social-ecological ecosystem.

While bibliometric analysis offers valuable insights into research trends and hotspots within the field of fisheries

cooperation, there are inherent limitations that must be acknowledged. First, the selection of databases, specifically the Web of Science (WOS) and China National Knowledge Infrastructure (CNKI), may introduce potential biases, as these platforms may not comprehensively capture all relevant literature, especially from non-Western sources. Furthermore, the focus on English-language publications in WOS could neglect significant contributions made in other languages, limiting the analysis's overall scope and inclusivity. It is crucial to recognize that such limitations may influence the interpretation of the findings, highlighting the necessity for a more holistic approach in future studies that includes a broader range of databases and considers the contributions of non-English publications.

4.2. POLICY IMPLICATIONS

The recent bibliometric analysis of fisheries cooperation research unveils a wealth of insights that can greatly inform and enhance the efforts of policymakers and researchers in fostering international collaboration. As our understanding of fisheries management's complexities evolves, it becomes increasingly clear that the challenges we face require a multifaceted approach. We can bridge the gaps between ecological, economic, and social perspectives by promoting interdisciplinary partnerships. It is essential for policymakers to cultivate robust collaborations that unite universities, governmental bodies, and the private sector. Such networks can create a synergistic environment where diverse expertise converges to tackle the pressing issues of fisheries management effectively. Moreover, the importance of international agreements cannot be overstated. Strengthening and developing accords that advocate for sustainable fisheries practices is crucial for the health of our marine ecosystems. The bibliometric analysis reveals specific research hotspots, such as the impacts of climate change and the principles of ecosystem-based management, which should inform the direction of these agreements. By aligning international initiatives with these critical research areas, we can ensure that global policies are responsive to emerging challenges in fisheries sustainability.

Furthermore, the analysis highlights specific gaps in the existing research landscape, particularly regarding the limited representation of certain regions and topics. Thus, targeted funding initiatives are necessary to explore under-researched areas, such as the South China Sea and small-scale fisheries management. Allocating resources to these domains not only aids in creating high-quality publications but also enhances their visibility and impact within the global research community. Supporting local studies—especially those that address regional nuances and traditions—can further enrich our understanding of fisheries management. Encouraging researchers to disseminate their findings in multiple languages would ensure that this knowledge is accessible to a wider audience, facilitating a more inclusive global discourse.

In the realm of technology and innovation, the establishment of data-sharing platforms is a pivotal step toward enhancing transparency and improving cooperation among countries. Such platforms can serve as centralized hubs for

disseminating research findings and data, thereby facilitating more informed decision-making. Utilizing advanced technologies, such as blockchain, can significantly bolster traceability within fisheries, directly addressing issues related to illegal, unreported, and unregulated (IUU) fishing.

In addition to these technical advancements, capacity building and education play a vital role in fostering sustainable fisheries practices. Organizing workshops and training programs that engage both local fishers and scientists can bridge the gap between scientific research and community knowledge. By doing so, we not only empower local communities but also ensure that their insights are integrated into effective fisheries management strategies. Coupled with awareness campaigns tailored for policymakers and stakeholders, these initiatives can elucidate the vital importance of sustainable fisheries for food security, economic growth, and ecological balance.

Lastly, establishing robust monitoring and evaluation mechanisms is critical for tracking the success of international fisheries cooperation initiatives. By developing clear metrics informed by the bibliometric findings, policymakers can effectively gauge progress and adapt management strategies as necessary. Creating feedback loops that facilitate ongoing dialogue between researchers and policymakers can refine research priorities, ensuring that they remain aligned with both policy needs and community concerns.

In summary, the insights gleaned from the bibliometric analysis serve as a rich foundation for advancing international collaboration in fisheries management. By embracing these strategies, stakeholders can collectively navigate the complexities of fisheries sustainability, ultimately leading to more effective and resilient management practices.

5. DISCUSSION AND PROSPECT

5.1. DISCUSSION

The phenomenon of fragmentation in fisheries cooperation research arises from multiple interrelated factors. Firstly, uneven funding distribution significantly impacts the formation of academic collaborations. In many instances, funding for fisheries research may be skewed towards certain regions, disciplines, or institutions, limiting the ability of researchers in less funded areas to participate in broader collaborative networks, resulting in more isolated research efforts. Moreover, a competitive funding environment often drives institutions to focus on short-term projects rather than long-term cooperation, further deepening this fragmentation.

Secondly, the priorities of different research institutions often differ due to variations in regional contexts, missions, and available resources. For example, some institutions may concentrate on local fisheries issues, while others may focus on broader global challenges. This divergence creates an island effect among researchers, leading them to operate independently to address specific ecological, economic, or social problems without engaging in broader interdisciplinary or international perspectives. The lack of a unified re-

search agenda or common goals exacerbates the fragmentation of research.

Additionally, geopolitical factors significantly influence cooperation in fisheries research. Different countries have varying priorities in marine resource access, leading to differences in fisheries management. Political tensions or territorial disputes may hinder collaborative research, as countries often hesitate to share data or collaborate on studies involving disputed areas. Furthermore, differing fisheries legal frameworks can pose barriers to cooperation, as researchers must navigate complex regulatory environments for cross-border research.

Cultural and language barriers also present challenges for international collaboration. When it comes to fisheries research, integrating local knowledge with scientific expertise is particularly crucial; however, different cultures and languages can lead to misunderstandings or misaligned objectives. This challenge is particularly pronounced in fisheries research, where researchers may face difficulties communicating findings and methodologies in multiple languages, thus limiting the potential for collaboration.

Finally, fisheries research spans various disciplines, including ecology, economics, sociology, and law. When researchers from different fields fail to interact effectively, fragmentation further intensifies, resulting in a lack of interdisciplinary approaches vital for understanding complex fisheries issues. Separating disciplines may lead to isolated experimental results, which cannot contribute synergistically to comprehensive fisheries management strategies.

Establishing interdisciplinary funding opportunities is an effective approach to address these issues and promote collaboration. Creating dedicated funding mechanisms to facilitate cross-disciplinary and international cooperation can help bridge the existing gaps in current research efforts. Additionally, developing international collaborative platforms for sharing research, data, and methodologies will effectively connect researchers and institutions, fostering links between shared interests. By engaging stakeholders to co-develop a common research agenda and simplifying and coordinating the legal and regulatory environments for fisheries research, cross-border collaboration can be encouraged, creating clear pathways for data and methodology sharing.

At the same time, enhancing capacity-building and training efforts and providing training programs in collaboration skills, interdisciplinary approaches, and cross-cultural communication can empower researchers to conduct more effective collaborations. These initiatives aim to increase the participation capacity of researchers in less funded areas, enabling them to engage better in collaborative research. By actively addressing these factors and fostering a culture of cooperation, fisheries cooperation research can become more interconnected, ultimately resulting in more impactful outcomes in sustainable fisheries management.

5.2. DEVELOPMENT TREND AND OUTLOOK

With the rising threat of overfishing in global marine fisheries resources and the eroded sustainability of fisheries re-

sources, major marine countries have experienced varying degrees of depletion in the past 60 years. According to FAO statistics, approximately 34% of assessed fish populations in the ocean are at biologically unsustainable levels.^{44,45} At the same time, the repercussions of climate change on fisheries resources are further intensifying. Therefore, countries and international organizations are seeking fisheries cooperation in response to increasingly complex external challenges in future, in order to ensure the sustainable utilization of fisheries resources. Major maritime countries and regional organizations worldwide, represented by the United States, Norway, Japan, and South Korea, have implemented comprehensive management of their coastal fisheries resources and achieved good results. Regional cooperation will be adopted for joint management of fisheries resources in waters beyond national jurisdiction. The future fisheries cooperation model can adopt an interdisciplinary approach and integrate factors such as geography, ecology, society, and economy, as well as fishers' behaviors and their impact on fisheries management. Dynamic fisheries development strategies are supposed to be formulated to adapt to changes in resource abundance, environmental conditions, and market or regulatory restrictions. In addition, it is important to carry out in-depth assessment of biological economic social management strategies for fisheries resources, and propose a sustainable utilization evaluation system and method for fisheries resources to scientifically guide the management and conservation of fisheries resources,⁴⁶ promoting sustainable fisheries.

AUTHORS' CONTRIBUTION

Conceptualization: Jipeng Wei (Equal), Shuolin Huang (Equal). Methodology: Jipeng Wei (Equal), Shuolin Huang (Equal), Xinluan Tian (Equal). Formal Analysis: Jipeng Wei

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COMPETING OF INTEREST – COPE

The authors declare that the research was conducted without any commercial or financial relationships that could potentially create a conflict of interest.

ETHICAL CONDUCT APPROVAL – IACUC

This study did not involve any experimental research on animals or plants.

INFORMED CONSENT STATEMENT

All authors and institutions have confirmed this manuscript for publication.

DATA AVAILABILITY STATEMENT

All are available upon reasonable request.

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