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Mapping Two Decades of Marine Mammal Research in India: A Scientometric Perspective

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Abstract

Marine mammals are an important indicator of marine ecosystem health, and yet knowledge about the diversity, distribution and conservation status of these species has historically been sporadic in India. This study aims to present the scientometric analysis of marine mammal research in India so as to get insights on publication trends, authorship patterns, collaboration networks and thematic focus of future research which will be significant for biologists around the world. Data for the period of 2004-2024 were extracted from Web of Science with "Marine Mammals" as keyword and Indian-affiliated publications only, which was later processed in HistCite and BibExcel. A total of 2,263 publications written by 13,433 researchers on sixteen different document types were analysed. Research output was steadily growing and peak for total publications showed 243 papers in the year of 2024. The dominant publication types were multi-authorship based (8,984 publications). Some of the prolific contributors were Kajal Chakraborty (51), Rajendran Rajaram (16) and S Karutha Pandian (14). Consistent with Bradford's distribution, core journals namely Marine Pollution Bulletin (113), Science of the Total Environment (53), and Marine Mammal Science (51) contributed to the major share of publications. (4) The Top most Collaborative country is USA with 244 Publications and the Top most Collaborative Institutions are CSIR with 287 Publications. The study integrates research trends, species distribution/occurrence and monitoring data to highlight knowledge gaps and priority areas, with implications for future data collection efforts and informed decisions in management and conservation of marine mammals in India.

Keywords: Bibliometrics, Bradford's Law, Marine Mammals, Research Trends, Scientometrics

1. Introduction

Marine mammals, being species of immense ecological importance, contribute to the structural integrity of marine environments (Best, 2020). These include cetaceans (whales, dolphins and porpoises), pinnipeds (seals, sea lions and walruses), sirenians (manatees and dugongs) as

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well as sea otter and polar bear, all of which have evolved specific physiologies and behaviours to adapt to life submerged in water (Reynolds & Rommel, 1999). India, with a coastline of over 7,500 km and diverse marine diversity is home to several such species ranging from dugongs to different cetaceans. Scientific focus on marine mammals in India has become increasingly prominent over the last two decades due to growing concerns around habitat degradation, pollution, climate change and human-induced threats such as fisheries interactions and ship strikes. While interest in this field is growing, the research is scattered and our understanding of publication trends, collaboration patterns, and emerging areas of study are limited scientometric analysis where quantitative methods are applied to studying scientific publications provides a means for systematically assessing research output, designs and methodologies employed by authors in a discipline, collaboration networks that form over time and between disciplines as well as key journals contributing to the field. This study is to conduct scientometric analysis of marine mammal research in India, focusing on providing an overview of marine mammal knowledge and research so far, identifying knowledge gaps and highlighting essential areas for further studies including conservation planning.

1.1. Marine Mammal Research in India: An Overview

Indian marine mammal research has graduated from early descriptive works and stranded instances, to systematic works of ecology, ethology and conservation (Zubair, 2026). Studies increasingly stress the use of habitat, distribution modeling and conservation management. This is a move from what were previously just descriptive research methods, to a more all - encompassing approach which combines science as an interdisciplinary tool. The resultant body of research work will provide a base for monitoring Indian Ocean marine mammal populations and help determine strategies for protection. The marine mammal's in India are listed in Table 1.

Table 1: List of Marine Mammal's in India

Whales	Dolphins & Porpoises
Blue Whale (*Balaenoptera musculus*)	Finless Porpoise (*Neophocaena phocaenoides*)
Bryde's Whale (*Balaenoptera edeni*)	Fraser's Dolphin (*Lagenodelphis hosei*)
Cuvier's Beaked Whale (*Ziphius cavirostris*)	Indian Ocean Humpback Dolphin (*Sousa plumbea*)
Deraniyagala's beaked whale (Mesoplodon hotaula)	False Killer Whale (*Pseudorca crassidens*)
Dugong (*Dugong dugon*)	Smooth-coated Otter (*Lutrogale perspicillata*)
Dwarf Sperm Whale (*Kogia sima*)	Irrawaddy Dolphin (*Orcaella brevirostris*)
Fin Whale (*Balaenoptera physalus*)	Killer Whale / Orca (*Orcinus orca*)
Ginkgo-toothed beaked whale (Mesoplodon ginkgodens)	False Killer Whale (*Pseudorca crassidens*)
Humpback Whale (*Megaptera novaeangliae*)	Melon-headed Whale (*Peponocephala electra*)
Longman's Beaked Whale (*Indopacetus pacificus*)	Pantropical Spotted Dolphin (*Stenella attenuata*)
Minke Whale (*Balaenoptera acutorostrata*)	Risso's Dolphin (*Grampus griseus*)
Omura's Whale (*Balaenoptera omurai*)	Rough-toothed Dolphin (*Steno bredanensis*)
Pygmy killer whale (Feresa attenuata)	Bottlenose Dolphin (*Tursiops truncatus* & *Tursiops aduncus*)
Pygmy Sperm Whale (*Kogia breviceps*)	Short-finned Pilot Whale (*Globicephala macrorhynchus*)
Sei Whale (*Balaenoptera borealis*)	Spinner Dolphin (*Stenella longirostris*)
Sirenians (Dugongs & Manatees)	**Marine Mustelids (Otters)**
Sperm Whale (*Physeter macrocephalus*)	Striped Dolphin (*Stenella coeruleoalba*)

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The diverse groups of marine mammals observed in India are represented by whales, Sirenians, dolphins and porpoises as well as marine Mustelids(ZSI,2023). These species are the main focus of studies as they are ecologically important and also significant for conservation. This study performed a systematic information retrieval from the Web of Science database by targeting all titles and abstracts on Indian marine mammals published between 2004-2024resulting 2263 publications to date.

2. Review of Literature

Research on marine mammals has evolved over the past few decades and is driven by increasing concern for conservation of biodiversity, as well as human impacts. Kumarran (2012) studied that the most of the early studies in India were descriptive, reporting species occurrence and initial population assessments. Kumar (2024) provided the information on species diversity, revealing conservation gaps and needed management strategies. Research into marine mammals under human care has expanded. Hotspots of marine mammal diversity based on species richness, functional and phylogenetic diversity were also determined by Abouy etc al. (2017), finding poor correlations between functional and species richness and little overlap with human-threat areas. Aquatic and marine research trends can be frequently analyzed through scientometric and bibliometric studies. Bandara (2022) analyzed aquatic research in Sri Lanka based on SCOPUS and VOSviewer and reported the hallmarks of a transition from field to molecular approaches, with higher contributions by senior author's scientific papers as well as international collaborations. Applying Activity and Priority Index metrics to limnology research, Gunaseelan and Ranganathan (2023) identified research dominance within sub-disciplines of limnology using density procedures, illustrating collaboration patterns, and identifying emerging themes. Azra et al. (2022) and Oliveira et al. (2020) mapped out oyster and dinoflagellate research, pinpointing thematic clusters as well as leading countries and institutions. As per Szteren (2022) and Palacios et al. (2014) examined research outputs on marine mammals in South America, marking gradual increase over time, moderate levels of collaboration and emphasis on certain taxonomic groups, pollution, and phylogenetics. Although extensive research has been undertaken globally, information on Indian marine mammals is still scarce and the previous or current relevant literature remained unexplored. Tunga et al., Das and Pattnaik (2022) analysed authorship patterns in Journal of the Indian Society of Coastal Agricultural Research (2012-2021): A study based on productivity analysis with 288 articles and 3,429 indexed citationsindicated that multi-authored papers (84.86%)were in the majority, and the collaboration degree was very high (0.85) suggesting an increase of team based research in coastal agriculture. This greatly impedes understanding of the research landscape and conservation priorities. The current study attempts to fill this gap by adopting a scientometric approach to map the Indian marine mammal research, unveil trends and collaborations and provide insights for more focused future research efforts and conservation planning.

3. Objectives of the Study

The study sought to achieve the following objectives:

- To identify the Indian marine mammal species and examine their research trends
- To analyze publication trend of Marine mammals in Indian context.
- To examine trends in authorship, and author output with prolific authors.
- To measuring the dispersion of publications across journals by Bradford's Law.
- To evaluate country-wise and institutional collaborations.

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4. Research Methodology

A quantitative scientometric research design was used in the current study to analyze Indian marine mammal research. Data used were retrieved from the Web of Science database, selected because of its standards on rigorous journals, reliable citation indexing and availability of structured bibliographic metadata. The years of the study period from 2004 to 2024 were selected because publications before 2004 were not indexed enough, and after 2004, it became possible for indexing more evenly and fully. Therefore, data can be used reliably in trend assessments long term. The study adopted a web-based literature survey methodology using the keyword "Marine Mammals" and associated terms, filtered to publish with Indian affiliations. This was a complete enumeration study that covered all the available records collected from the database. In total retrieved 2,263 documents across sixteen different document types to cover a wide range of elements of the scholarly output. Patterns, trends and visualizations from the data were drawn using BibExcel and VOSviewer. Only the chosen database and time frame were studied; results could differ if different databases or analytical techniques had been employed.

5. Data Analysis and Interpretation

The present study utilized scientometric approaches to analyze the obtained dataset and assess the advancement and significance of research within the selected field. Analysis was performed using standard indicators, such as publication output, citation impact, author patterns, institutional productivity and trends were used for the analysis. These indicators are used to get a deeper understanding of growth, collaboration dynamics and academic impact within the field. The findings are presented with following interpretation in subsequent sections.

Table 2: General information of the Marine Mammals Research literature in India

Study Coverage & Database	**Bibliometric Tools**
Period of Study: 2004-2024	HistCite,& BibExcel
Database: Web of Science	Publication Sources
Bibliometric Indicators	Journals Covered: 694
Total Publications: 2,263	Document Types: 16
h-index: 122	Open Access Publication:1555
Total Citations: 78,000	Research Coverage
Average Publications per Year: 374.29	Countries Represented: 344
Average Citations per Item: 34.47	Research Areas: 125
Authorship Patterns	Affiliations: 1,625
Total Authors: 13,433	Affiliations with Subdivisions: 2199
Unique Authors: 10,928	Funding Agencies:1759
Single-authored Documents: 54	Language,Keywords& Domain
Multi-authored Documents: 13379	Languages: 6
Authors per Document : 6	Domains: 6
Documents per Author :0.167	Total Keywords: 6,247

5.1. Growth Pattern of Research Publications

The year-wise growth of research literature on Indian marine mammals indicates a gradual increase in the past two decades. The late 1990s and early 2000s saw an increase in the number of publications

(16-51 per year from 2004 to 2010) as scientific interest on this topic began to develop. The number of publications was steadily increasing from 2011 to 2017, for a total of 114 in 2017, which suggests high interest from researchers and institutions.

Table 3: Year-wise growth pattern

Year	Records	% of Total	Annual Growth Rate (AGR %)	Cumulative Records
2004	16	0.71	-	16
2005	33	1.46	106.25	49
2006	29	1.28	-12.12	78
2007	24	1.06	-17.24	102
2008	39	1.72	62.5	141
2009	51	2.25	30.77	192
2010	44	1.94	-13.73	236
2011	61	2.7	38.64	297
2012	82	3.63	34.43	379
2013	96	4.24	17.07	475
2014	91	4.02	-5.21	566
2015	100	4.42	9.89	666
2016	90	3.98	-10	756
2017	114	5.04	26.67	870
2018	116	5.13	1.75	986
2019	180	7.95	55.17	1166
2020	199	8.79	10.56	1365
2021	191	8.44	-4.02	1556
2022	226	9.99	18.32	1782
2023	238	10.52	5.31	2020
2024	243	10.74	2.1	2263

5.2. Authorship Pattern and Productivity

Authorship Trends (Table 4) the total number of authors at Indian marine mammal research sector (2004-2024) stood up to be 13433 but the actual publications were only 2263. The number of single-author papers was relatively small at 53(0.06%), whereas the majority involved collaborative efforts, with 5 or more authors contributing to 8,984 publications showing a clear trend toward multi-author research. The average number of authors per publication had risen substantially, indicating growing collaboration among researchers nationally and internationally, towards larger team-based research projects in the marine mammal sciences.

Table 4: Authorship pattern and productivity

Year	1	2	3	4	5	5+	Total Authors
2004	1	4	6	8	15	38	72
2005	4	6	21	20	20	89	150
2006	4	8	21	8	25	52	118
2007	1	4	9	21	15	64	114
2008	2	18	21	32	1	215	289

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2009	4	18	36	24	15	136	233
2010	1	10	24	32	11	297	375
2011	1	26	39	36	65	102	269
2012	3	38	63	56	40	127	327
2013	3	24	75	48	75	230	455
2014	0	26	63	11	85	292	477
2015	3	38	48	84	55	315	543
2016	2	22	54	40	85	285	488
2017	3	46	66	76	80	238	509
2018	2	44	42	68	115	339	610
2019	2	40	72	40	135	786	1075
2020	4	44	78	120	130	844	1220
2021	5	68	93	66	95	1028	1355
2022	1	38	66	140	150	1111	1506
2023	2	58	90	124	170	1161	1605
2024	5	38	81	164	120	1235	1643
Total	53	618	1068	1218	1502	8984	13,433

5.3. Most Prolific Authors

Out of the total 13,433 authors who have published papers in the Indian marine mammal research domain, the top three most prolific authors are Kajal Chakraborty (51 publications, TGCS 254, h-index 29, Central Marine Fisheries Research Institute), Rajendran Rajaram (16, 339, 33, Bharathidasan University), and S Karutha Pandian(14, 699, 56, Alagappa University).

Table 5: Most prolific top ten Authors

Authors	Recs	TGCS	h-Index	Affiliated Institution
Chakraborty Kajal	51	254	29	C M F R I
Rajaram Rajendran	16	339	33	Bharathidasan University
Pandian S Karutha	14	699	56	Alagappa University
Shalini Rajendran	13	178	14	TNV & AS University
Kurup G. Muraleedhara	12	273	15	University of Kerala
Shakila Robinson Jeya	12	185	27	Dr J Jayalalithaa Fisheries Univ
Arthur Rohan	11	447	27	Nat Conservat FdnOceans & Coasts Programme,Mysuru
Kelkar Nachiket	11	331	17	Wildlife Conservat Trust,Mumbai
Se-Kwon Kim	11	581	103	Pukyong National University
Sarkar Santosh Kumar	11	592	37	University of Calcutta

5.4. Most Productive Top Ten Journals

The research outputs of Indian marine mammal studies between 2004 and 2024 are widely distributed across journals, with the most productive journals are Marine Pollution Bulletin (113 records, TGCS 4770), followed by Current Science (53735) and the International Journal of Biological Macromolecules (512126).

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Table 6: Most productive Journals (Top ten only)

Sl No.	Journal Name	Records	TGCS
1	Marine Pollution Bulletin	113	4770
2	Current Science	53	735
3	International Journal of Biological Macromolecules	51	2126
4	Indian Journal of Geo-Marine Sciences	49	270
5	Science of The Total Environment	49	2699
6	Environmental Science And Pollution Research	40	2181
7	Environmental Monitoring And Assessment	33	760
8	Chemosphere	31	2693
9	Frontiers In Marine Science	29	892
10	Marine Drugs	29	2168

5.5. Bradford's Journal Distribution

The distribution of 2263 articles from Indian marine mammal research (2004-2024) across 694 journals is in accordance with Bradford's Law of Scattering(Bradford, 1934) revealing a definite concentration of research output in a few core journals. About one-third of the total articles (756) are contributed by the first zone with 24 journals, while the second zone of 111 journals produces another third (722) of the articles. The third zone includes 559 journals, accounting for the final third (785). The pattern shows a strong Bradford-type concentration of few journals constitute the core of the output and productivity decreases significantly in successive zones.

Table 7: Bradford's Law of journal distribution

No. of Journal	No. Article	Total No. Article	Cumulative No. of Articles
1	113	113	113
1	53	53	166
1	51	51	217
2	49	98	315
1	40	40	355
1	33	33	388
1	31	31	419
2	29	58	477
2	26	52	529
1	25	25	554
1	23	23	577
2	22	44	621
1	21	21	642
2	17	34	676
5(24)	16	80(756)	756
2	15	30	786
1	14	14	800
1	13	13	813

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6	12	72	885
1	11	11	896
4	10	40	936
10	9	90	1026
10	8	80	1106
9	7	63	1169
11	6	66	1235
19	5	95	1330
37(111)	4	148(722)	1478
49	3	147	1625
128	2	256	1881
382(559)	1	382(785)	2263
694		2263	

5.6. Collaborative Countries and Institutions

Out of 344 nations contributing to marine mammal research, USA in first place (224 records, 1958 citation(s), PEI 0.25), Saudi Arabia with a total of (135 records, 2110 citations), PEI 0.45). The organizations CSIR, ICAR and CSIR-NIO show head of 287 (13%), 219 (11.36%) and 111 (5.68%) publications respectively; among institutes, IITs accounts for a total of 109 records while Bharathidasan University has contributed a total published output of 101 showing significant collaboration on marine mammals research within country.

Table 8: Country-wise contribution to Indian Marine Mammal Research

Sl No.	Countries	Records	Citation	Citation/Rec.	PEI
1	India	899	25914	28.85	0.84
2	USA	224	1958	8.74	0.25
3	Saudi Arabia	135	2110	15.63	0.45
4	South Korea	120	1654	13.78	0.4
5	Peoples R china	113	1326	11.73	0.34
6	England	82	457	5.57	0.16
7	Australia	78	703	9.01	0.26
8	Germany	74	284	3.84	0.11
9	Malaysia	72	237	3.29	0.1
10	Japan	66	521	7.89	0.23

6. Discussion

The analysis showed robust growth of Indian marine mammal research, reflecting global patterns in marine biodiversity research. Early works were mostly descriptive, focusing on species occurrence and preliminary assessments (Kumarran, 2012). The present analysis indicates a shift toward more structured research, examining 32 species and addressing diversity and conservation priorities. Kumar (2024) highlighted conservation gaps and the need for species specific management strategies, while Albouy et al. (2017) advocated incorporating functional and phylogenetic diversity into conservation planning. Even soresearch remains at the level of occurrence and distribution, suggesting room for more detailed ecological studies.Authorship patterns reveal a strong preference for multi-author publications, reflecting

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collaborative research. Similar trends are observed in Indian coastal agricultural and limnology research, emphasizing institutional collaborations and common research agendas (Tunga et al., 2023; Gunaseelan & Ranganathan, 2023). In marine mammal studies, a few key contributors have driven thematic focus and output. Although institutional participation has expanded, international collaboration remains moderate compared with stronger global partnerships seen in Sri Lankan aquatic research (Bandara, 2022). Greater international engagement could enhance research impact.Bradford's Law analysis shows a stable journal structure, comparable to patterns in studies on oysters, dinoflagellates, and South American marine mammals (Azra et al., 2022; Oliveira et al., 2020; Szteren, 2022; Palacios et al., 2014). Citation metrics also indicate rising productivity and influence. The scientometric assessment identified 2,263 publications from 2004-2024, covering 16 types of information sources and 13,433 contributing authors, reflecting both research development and collaboration. While this study used Web of Science, future analyses should include Scopus and AFSA databases and employ tools like VOSviewer and Biblioshiny for enhanced visualization of research trends.Indian marine mammal research has evolved from basic documentation to more systematic investigations. Indian marine mammal research has progressed from basic documentation to more systematic investigations. Collaborative efforts, expanding institutional involvement, and steady publication growth indicate positive movement toward addressing conservation priorities, though greater ecological depth and international partnerships remain key areas for future research.

7. Conclusion

Analysis of marine mammal publications (2004 -2024) in India reveals typical growth patterns in both number and collaborations with exponential trend of publications over the time and more multi-authorship publications. A handful of productive authors and journals drive much of this work, while a diverse spectrum of institutions and nations get credit for its expansion. The significance of this study is that it provides a comprehensive summary of research trends, authorship patterns, the distribution of journals and collaborations between institutions, as well as contributions by country which would be useful for researchers in addition to policy makers and conservationists. It identifies gaps in research and may serve to guide future efforts of collaboration while also helping to highlight the visibility and impact of Indian marine mammal work. Systematic increase on of qualitative databases, collaboration with scholars from diverse field and publications in high rise journals can enhance and accelerate research productivity to conserve marine plants and animals.

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