Cumulative bibliometric studies of Seven Ecology journals from 2003 to 2012: A study

Govindaraj Saravanan, N. Krishnaswamy

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G. Saravanan[1] and N. Krishnaswamy[2]

[1]Librarian, French Institute of Pondicherry, # 11, Saint Louis Street, Pondicherry - 605 001, India &
Ph. D. Scholar, Department of Library and Information Science, Karpagam University, Coimbatore – 641 021, Tamil Nadu, India. Email: **saravanan.g@ifpindia.org**
[2]Research Guide, Librarian, Karpagam University, Coimbatore. E-mail: krish.kulibrarian@gmail.com

Abstract

The present study on bibliometric analysis (cumulative) of seven ecology journals reveals that 21,118 authors have contributed 11394 papers during 2003 to 2012. The study examines the year-wise, institution-wise distribution of contributions, relative growth rate and doubling time, authorship patterns, prolific authors, Degree of collaboration, Collaborative co-efficient, etc. The study reveals that multiple authorship was dominant with 78.61% for the study period. The DC and CC were 0.78 and 0.54 respectively. The University Calif. Davis was found to be the top ranked institution contributing 370 papers.

1. Introduction

Journals play an important role in the scientific communication process. They are published periodically, are topically focused, and have established standards of quality thanks to the peer-reviewing process. This paper provides valuable insights into the nature of academic papers published in a few key journals in the field of Ecology. The outcome of the study is an original research work with citation analysis of Ecology Publications.

Bibliometrics (*Biblio*- book, *metric*- measurement) is a method to analyse and quantify the bibliographic data. It offers a powerful set of method and measures for studying the structure and process of scholarly communication. Bibliometrics is one of the quantitative techniques of citation analysis to measure the records of human communication through the process of collection, counts analysis and interpretation of citations given in various types of literature and thereby helping in identification of significant sources of information. Pritchard (1969) [10] used the term bibliometrics to describe all studies which seek to quantify the process of written communication and defined it as the application of mathematics and statistical method to books and other media of communication. Bibliometric analysis helps in measuring the patterns of all forms of recorded information and their producers using statistics to describe the patterns of publication within a given field or body of literature.

Ecology is the branch of biology which deals with the study of living organisms and their interaction with the environment. The word is derived from the Greek *oikos*, meaning 'home'.

Ecology might therefore be thought of as the study of the 'home life' of living organisms. Odum (1969) [7] defined ecology as the study of the structure and function of ecosystems". Ecology deals with three levels of concern: the individual *organism*, the *population* (consisting of individuals of the same species) and the *community* (consisting of a greater or lesser number of populations). Ecology has an important role in agriculture, forestry, conservation of soil, control of floods, pest control, wild-life preservation, fresh-water biology and management of natural resources. Knowledge of ecology is essential for solving the problems of environment and population. The survival of human population depends on intelligent use of natural resources and maintenance of environmental quality by prevention of pollution. The present study has been taken up to quantify and map the literature published in Ecology journals and to know the growth of literature, authors collaboration, most productive countries rank list of journals. (Biradar et al., 2014) [4].

2. Review of Literature

There are several studies analyzing the contribution of different journals in the field of ecology. According to Prozesky et al. (2012) [11], citations to published work are gaining increasing prominence in evaluations of the research performance of scientists and showed that studies that have been conducted elsewhere tend to neglect in their analyses important gender-related and other factors, such as the sex composition of multi-authored papers and the extent of foreign co-authorship. The results indicate that foreign co-authorship is a better correlate of high citations than the sex of South African authors, and this is true irrespective of whether the annual citation rate or window period is used, whether or not self-citations are excluded, and whether or not the number of authors is controlled for by calculating fractional counts.

Bjurström and Polk (2011) [3] addressed whether interdisciplinary was a prominent feature of climate research by means of a co-citation analysis of the IPCC Third Assessment Report and based on 6417 references of the 96 most frequently used journals, demonstrating that the IPCC assessment of climate change was best characterized by its multidisciplinary approach where the physical, biological, bodily and societal dimensions were clearly separated.

Parker et al. (2010) [8] provided information on the understudied subjects of ecology by examining the social characteristics and opinions of 0.1% of the most cited environmental scientists and ecologists. Overall, the social characteristics of these researchers tend to reflect broader patterns of inequality in the global scientific community.

Pautasso and Schäfer (2010) [9] conducted a study in 22 ecology/interdisciplinary journals showing that higher impact factor was positively associated with the number of submissions and found that higher impact factor journals tend to be significantly quicker in moving from submission to acceptance so that journals which receive more submissions are not those which

take longer to get them through the peer review and revision processes and even though rejection rates are remarkably high throughout the journals analyzed, but tend to increase with increasing impact factor and with number of submissions.

Arlette (2007) [2] mapped the domain of earth and environmental sciences (EES) through his study and investigated the relationship between cognitive problem structures and internationalization patterns, drawing on the concepts of systemic versus cumulative global environmental change (GEC) and mutual task dependence in scientific fields. He found that scientific output concentration and internationalization were significantly higher in the systemic GEC fields of Meteorology & Atmospheric Sciences and Oceanography than in the cumulative GEC fields Ecology and Water Resources.

The review revealed that there were not many studies in the area of ecology literature, especially in more than two journals or cumulative journal studies. Hence this paper attempts to study the research trends in ecology literature in the selected seven ecology journals.

3. Objectives

The main objective of this study is to understand and make an analysis of the status of research productivity in the area of "Ecology" research. This is realized through examining the quantitative growth of literature in the field of ecology during 2003-2012 from seven journals covering the following specific objectives: Find out the year-wise distribution of authorship; Find the highly productive authors; Analyze the collaboration pattern of authors by Degree of collaboration and Collaborative Coefficient, Subject-wise distribution, institution-wise distribution of contributors, and geographical representation of publications.

4. Material and Methods

The data taken for the present study were obtained from ISI Web of Science, which is available through BiblioVie portal (http://bibliovie.inist.fr/), thanks to the French Institute of Pondicherry's affiliation to the CNRS, France. The analysis included seven chosen journals in the field of ecology (Table 1). The choice of these journals was based primarily on Impact Factor. The seven journals were identified on the Web of Science ™ Core collection in the "Journal Citation Report ®" under the Subject Category Section 'Ecology' with the 2012 impact factor and sorted by 5-year impact factor in decreasing order. These records from the selected journals for the present study were collected from SCI Expanded Web of Science ™ Core collection. The Search was conducted as follows:

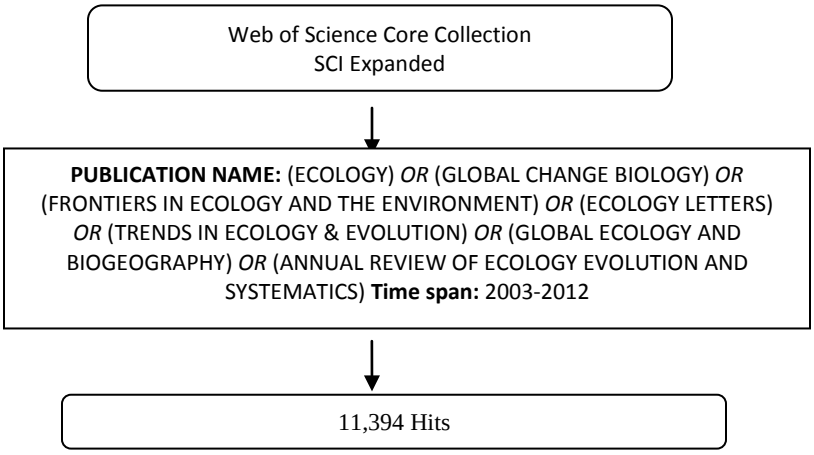


Figure 1. Schematic representation of formulated search strategy

The journals considered for the present study are presented in the Table 1. A total of 11394 records were retrieved. Once a marked list of papers was created, the resulting export file was processed by HistCite™ (Bibliometric Analysis and Visualization Software developed by Garfield et al., 2006) [5] in accordance with the stated objectives.

Table 1. List of seven selected ecology journals from Web of Science

Abbreviated Journal Title	Publisher, Country	ISSN	Issues/ Year	No. of papers [2003-12]	2012 Total Cites	2012 Impact Factor	5-Year Impact Factor
ECOL LETT	Wiley-Blackwell, England	1461-023X	12	1453	17533	17.949	18.495
TRENDS ECOL EVOL	Elsevier Science, England	0169-5347	12	1238	24279	15.389	17.112
ANNU REV ECOL EVOL S	Annual Reviews, USA	1543-592X	1	255	14909	10.375	16.831
FRONT ECOL ENVIRON	Ecological Society of America, USA	1751-7362	10	2156	6129	8.951	8.927
GLOBAL CHANGE BIOL	Wiley-Blackwell, England	1354-1013	12	2223	18398	6.91	7.819
GLOBAL ECOL BIOGEOGR	Wiley-Blackwell, England	1466-822X	12	710	5276	7.223	7.284

ECOLOGY	Ecological Society of America, USA	0012-9658	12	3359	50217	5.175	6.372
Total				11394			

5. Results and Discussion

Analysis of the data was done with a view to measure the growth of literature over the years, authors' productivity, subjects, institutions and country-wise distribution of papers in the selected seven journals, namely, *Ecology Letters*, *Trends in Ecology & Evolution*, *Annual Review of Ecology Evolution and Systematics*, *Frontiers in Ecology and the Environment, Global Change Biology, Global Ecology and Biogeography* and *Ecology*.

5.1. Growth of Ecology Literature

Table 2 presents the results of cumulative publications of the seven journals. It was observed that the growth of ecology literature increased from 1069 in 2003 to 1220 in 2012. Fluctuations in publication patterns of ecology literature are due to the frequency of journals, as there is an inconsistency in the number of issues published (Table 3). The percentage share of the research contribution comes to 9.38% (2003) and 10.71% (2012) respectively. It could be deduced that the increasing trend was observed in the growth of ecology literature during the period of study. An exponential growth in number of publication was observed during 2003 to 2012. A high growth rate of 108% was found during 2008 and 2012. A low growth rate was found in the year of 2011 with 1130 publications. The total exponential growth rate value is 9.14%. It is found that the average exponential growth rate is 0.91 % for the study period. The cumulative number of publication, cumulative number of percentages, Total Local Citation Score (TLCS) and Total Global Citation Score (TGCS) are also presented in the below table.

Table 2. Cumulative distribution of ecology literature for the seven selected journals

Publication Year	No. of Publication	Cum. No. of Pub.	%	Cum.%	Exp. Gr.	TLCS	TGCS
2003	1069	1069	9.38	9.38		6221	64600
2004	1098	2167	9.64	19.02	1.03	5620	59844
2005	1108	3275	9.72	28.74	1.01	5360	57596
2006	1121	4396	9.84	38.58	1.01	4968	49300
2007	1094	5490	9.60	48.18	0.98	3984	40765
2008	1179	6669	10.35	58.53	**1.08**	3385	34767
2009	1161	7830	10.19	68.72	0.98	2408	26710
2010	1214	9044	10.65	79.37	1.05	1669	17623
2011	1130	10174	9.92	89.29	0.93	979	9269
2012	1220	11394	10.71	100.00	**1.08**	290	2592
Total	11394		100.00		9.14	34884	363066

				(0.91)			

Table 3 summarizes year-wise distribution of seven ecology journals in relation to their contribution in ecology research during 2003-2012. The table represents the Year-wise records, Percentage, Mean, Standard deviation, and coefficient of variation. *Ecology* with 29.84% stood first. The level of variation in research output is 0.05 which is the least amongst all the journals. The lowest coefficient of variance, in case of the journal Frontiers in *Ecology and the Environment*, speaks of the consistent performance of its publication strategy through the period of study.

Table 3. Year-wise distribution of ecology literature in the seven ecology journals

Journal	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total	%	Mean	SD	CV
EL	156	139	148	143	122	133	142	148	155	167	1453	12.75	145.30	12.67	0.09
TEE	137	134	130	131	115	114	114	107	130	126	1238	10.87	123.80	10.35	0.08
AREES	24	24	27	23	33	30	33	18	22	21	255	2.24	25.50	5.10	0.20
FEE	227	222	212	228	211	226	220	210	208	192	2156	18.92	215.60	11.22	0.05
GCB	150	174	181	192	199	226	233	265	294	309	2223	19.51	222.30	53.06	0.24
GEB	48	57	53	58	78	76	67	79	81	113	710	6.23	71.00	18.96	0.27
EC	327	348	357	346	336	374	352	387	240	292	3359	29.84	335.90	42.45	0.13
Total	1069	1098	1108	1121	1094	1179	1161	1214	1130	1220	11394	100	1139.40	51.90	0.05

EL - Ecology Letters; TEE - Trends in Ecology & Evolution; AREES - Annual Review of Ecology Evolution and Systematics; FEE - Frontiers in Ecology and the Environment; GCB - Global Change Biology; GEB - Global Ecology and Biogeography; EC - Ecology; % - Percentage; SD – Standard Deviation; CV – Coefficient of Variation

5.2. Pattern of growth of literature during 2003 – 2012

Relative growth rate is the increase in the number of publications / pages per unit of time. The growth rate of total publications in seven journals (cumulative) has been calculated on the basis of relative growth rate and doubling time model developed by Mahapatra (1985) [6]. Mathematical representation of the mean RGR of articles over a specific period of interval is derived by the following formula:

$$R(P) = \frac{\mathrm{Log}_e 2P - \mathrm{Log}_e 1P}{2^T - 1^T}$$

Here R(P) = Relative Growth Rate of articles over the specific period of time.

$\mathrm{Log}_e 1P$ = Log of initial number of articles.

$Log_e 2P$ = Log of final number of articles.

$2^T - 1^T$ = the unit difference between the initial time and final times.

Doubling Time (DT) is the time required for articles or citations to grow two-fold from the existing number, which is directly related to RGR. DT can be determined using the mathematical formula

$$DT = \frac{\text{Log}_e 2}{R(P)} = \frac{0.693}{R(P)}$$

Here, DT(p) and DT(c) are the average doubling time articles and citations respectively. The RGR and DT are used to express the nature of growth of knowledge.

Table 4. Relative Growth Rate & Doubling Time of ecology literature for the seven selected journals (Cumulative)

Year	No. of Publications	Cum. No. of Publications	$\text{Log}_e 1P$	$\text{Log}_e 2P$	[R(P)]	Mean [R(P)]	[Dt(p)]	Mean [Dt(p)]
2003	1069	1069		6.97				
2004	1098	2167	6.97	7.68	0.71		0.98	
2005	1108	3275	7.68	8.09	0.41		1.68	
2006	1121	4396	8.09	8.39	0.29		2.35	
2007	1094	5490	8.39	8.61	0.22	0.33	3.12	1.63
2008	1179	6669	8.61	8.81	0.19		3.56	
2009	1161	7830	8.81	8.97	0.16		4.32	
2010	1214	9044	8.97	9.11	0.14		4.81	
2011	1130	10174	9.11	9.23	0.12		5.89	
2012	1220	11394	9.23	9.34	0.11	0.15	6.12	4.94
Total	11394							

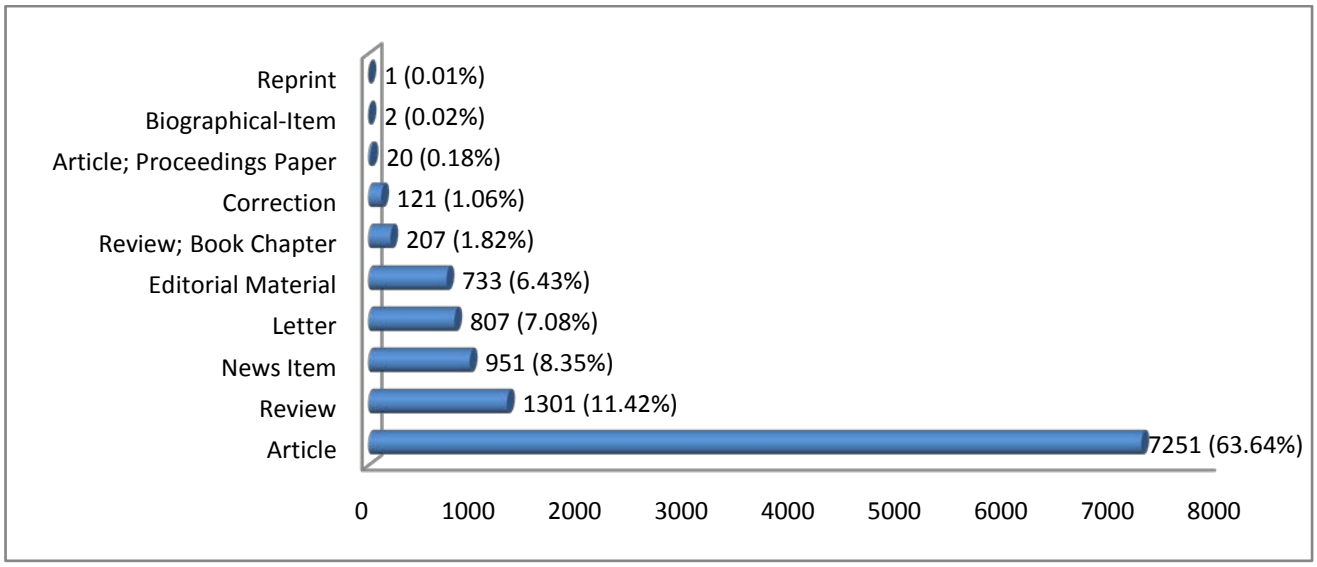
Table 4 presents data on the relative growth rate and doubling time of research output for the study period. The relative growth rate has shown a gradually declining trend (from 0.71 in 2004 to 0.11 in 2012). Contrarily, the doubling time for papers of seven journals (cumulative) has increased from 0.98 in 2004 to 6.12 in 2012. It could be deduced that in general there is a progressive increase in the number of publications of research output of seven journals (cumulative). However, relative growth rate showed a down trend which means the rate of increase was low in terms of proportion, and this is highlighted by the doubling time for

publications, which is higher than the relative growth rate. The mean RGR had declined from 0.33 to 0.15 and the steady growth is visible with increase in mean DT from 1.63 to 4.94 respectively.

5.3. Sources of Publication

Figure 2 presents the distribution of sources of publications made by the seven ecology journals (cumulative) published in ten different forms *i.e.* Article, Review , News Item, Letter, Editorial Materials, Review, Book Chapter, Corrections, Article, Proceedings paper, Biographical-Item and Reprint. The analysis of publications of 11394 papers revealed that journal articles occupy predominant position sharing 7251 papers (63.64%) of total research output. The other ranked sources are review (1301, 11.42%), news item (951, 8.35%) and the remaining are listed in the figure. It is clear that the ecology scientists got their research published predominantly by journal articles.

Figure 2. Distribution of Sources of Publications of Ecology Literature for the seven selected journals (Cumulative)



5.4. Authorship pattern and Collaborative measures

Table 5. Authorship Pattern and Collaborative measures in Ecology Literature

NA	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TA	%	AP
1	30	304	248	259	253	253	221	224	186	166	2434	21.39	2434
2	279	275	274	273	264	258	256	217	195	207	2498	21.95	4996
3	205	200	226	217	192	201	231	232	203	213	2120	18.63	6360
4	110	124	139	145	138	162	158	170	165	181	1492	13.11	5968

5	60	74	83	96	85	114	92	135	114	149	1002	8.80	5010
6	36	49	55	41	52	53	65	78	78	93	600	5.27	3600
7	16	23	25	26	30	44	38	41	56	46	345	3.03	2415
8	13	15	23	15	20	29	21	25	34	38	233	2.05	1864
9	6	9	8	11	11	16	20	20	34	31	166	1.46	1494
10	2	3	8	5	7	8	9	21	19	12	94	0.83	940
11	2	2	2	5	4	6	11	5	9	13	59	0.52	649
12	9	6	2	8	6	7	6	7	8	15	74	0.65	888
13	1	2	2	5	5	6	5	7		13	46	0.40	598
14	3	5	3	1	5	6	5	4	1	9	42	0.37	588
15	2	2		1	5		3	5	2	6	26	0.23	390
16	1		2	1	2	2	2	4	4	7	25	0.22	400
17	1	2	1	1	2	1	3	6	1	1	19	0.17	323
18		2	1	2	2	2	2	2	3	3	19	0.17	342
19				1	1			2	2	3	9	0.08	171
20			3		1		1		1	2	8	0.07	160
21		1				2	3	1		2	9	0.08	189
22					1		1		2	1	5	0.04	110
23							2	3	2		7	0.06	161
24						1		2			3	0.03	72
25>	0	1	2	5	5	5	5	3	11	8	45	0.40	1638
TMA	746	795	859	859	838	923	939	990	944	1053	8946	100	41760
TA	1066	1099	1107	1118	1091	1176	1160	1214	1130	1219	11380		
DC	0.70	0.72	0.78	0.77	0.77	0.78	0.81	0.82	0.84	0.86	Ave = 0.78		
CC	0.46	0.48	0.52	0.52	0.52	0.54	0.56	0.58	0.60	0.63	Ave = 0.54		

NA – Number of authors; TA – Total authors; % - Percentage; AP – Authorship pattern; TMA – Total Multi authors; DC – Degree of Collaboration; CC – Collaborative Co-efficient

Table 5 visualizes the distribution of papers on the basis of authorship pattern of the seven journals (cumulative).Out of 1139 papers, 14 papers were anonymous. Hence 11380 papers were included for authorship pattern. Multiple-authorship was dominant in the present study which indicates that researchers normally prefer co-operative and collaborative works. It was found that two authored papers (2498 papers, 21.95%), were followed by three authored papers (2120 papers, 18.63%), while the contribution of single authored ones (2434 papers, 21.39%) was low. In essence, this shows a clear trend towards multi-authored papers (78.61%).

Author collaboration is the act where by two or more people agree to execute a certain project, be it intellectual or non-intellectual. Subramanyam (1983) [13] proposed the Degree of Collaboration as a measure of the strength of collaboration in a discipline. The Degree of Collaboration among authors is the ratio of the number of collaborative publications to the

total number of publications published in a discipline during certain period of time, which can be calculated for both publications and citations. The mathematical expression of the formula is $C = \frac{Nm}{Nm + Ns}$, where C = Degree of collaboration, Nm = Number of multi-authored papers and Ns = Number of single authored papers. It is found that the year wise DC is almost constant and does not varies year to year and the average value of DC is 0.78 for the present data set which provides the hint towards the high collaborative pattern amongst the authors in seven ecology journals (cumulative).

The mathematical formula to calculate Collaborative Coefficient (Ajiferuke and Tague, 1988) [1] is $CC=1-\frac{\sum_{j=1}^{A}\left(1/j\right)f_j}{N}$. Where fj is the number of j-authors papers published in a discipline during a certain period of time; N is the total number of papers published in a discipline during a certain period of time; and J is the greatest number of authors per paper in a discipline. Here the value of CC varies during the study period. CC was observed 0.46 during 2003 and 0.63 during 2012 and the average value of CC was 0.54. The CC increased year to year which shows the increase in the productivity of multi-authored papers.

5.5. Most Productive Authors

Table 6. Top 20 authors of ecology literature for the seven selected journals (cumulative)

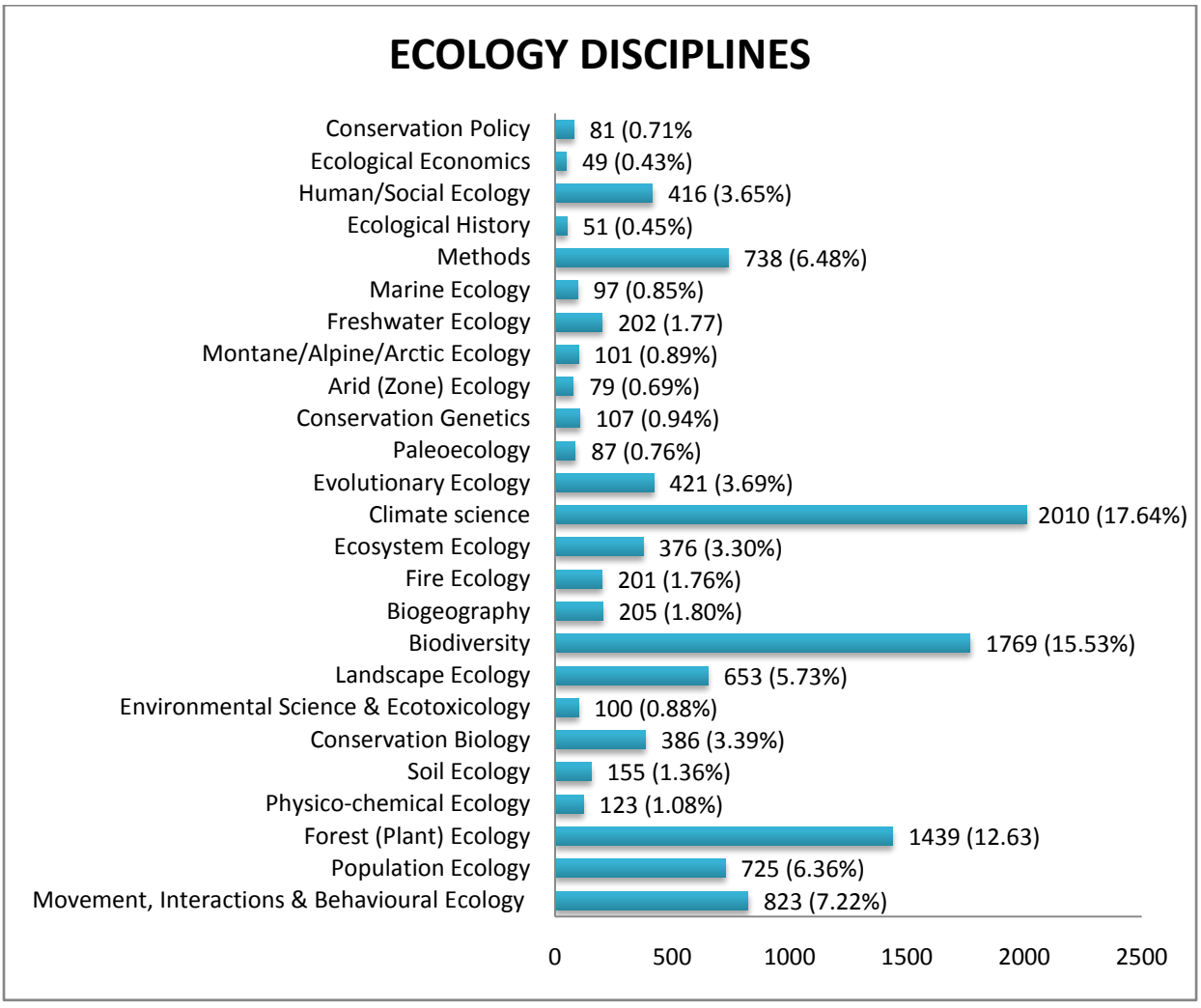
Author (Country)	No. of Papers	%	TLCS	TGCS
Burton A (USA)	111	0.27	0	20
Miller C (USA)	80	0.19	1	54
Senior K (USA)	80	0.19	1	15
Ellison K (USA)	75	0.18	2	14
Gewin V (USA)	73	0.17	1	2
Rohrman DF (USA)	61	0.15	0	2
Bradbury J (USA)	58	0.14	1	3
Reich PB (USA)	52	0.12	335	2064
Sharma DC (USA)	52	0.12	0	30
Thuiller W (France)	43	0.10	598	4341
Gaston KJ (England)	39	0.09	239	1437
Parks N (USA)	38	0.09	0	4
Agrawal AA (USA)	37	0.09	241	1568
Bazilchuk N (USA)	37	0.09	0	3
Clark JS (USA)	34	0.08	256	1474
Orellana C (USA)	34	0.08	0	0
Possingham HP (Australia)	32	0.08	67	1231
Bienen L (USA)	31	0.07	0	24

Emery C (USA)	31	0.07	0	1
Enquist BJ (France)	30	0.07	302	1547

Author productivity is a measure for ranking authors according to their publication output. From 2003 to 2012, 11394 papers were published by 22,118 authors in the seven selected journals (cumulative). The Table 6 shows the top 20 most productive authors during 2003-2012. Among the top 20 authors who contributed to the seven journals, 16 were from the USA, 2 from France, and one each from England and Australia. The highest number of papers was published by A. Burton with 111 (0.27%). The other productive authors, in decreasing order, are also provided in table.

5.6. Subject areas embracing the literature in Ecology

Figure 3. Discipline-wise publications and their percentages (parentheses) in seven ecology journals



As the ecology as a discipline is interrelated with many other disciplines, an analysis was carried out to identify the subfields or sub-disciplines in ecology. 25 subfields were identified by using the Library Congress Subject Headings along with three of our domain experts (Raman, Prasad & Cheryl) in ecology during the study period. The total output of 11394 subject keywords was classified and as expected the highest contributions were in the disciplines of Climate change (2010 papers, 17.64%) and Biodiversity (1769 papers, 15.53%) and others sub-disciplines are listed in the Figure 3.

5.7. Institution wise distribution of ecology literature

Analysis of references reveals that most of the research works in ecology were being pursued in universities and other higher education institutions. Research institutes/laboratories were more active in the field of ecology. 11394 papers were published in the journals during 2003-2012 with contributions from 3943 institutions. Table 7 shows the top 20 institutions during 2003-2012, where 15 (75%) were from USA (15 out of 20 institutions) and one each from Canada, England, France, China, and Australia. The University Calif. Davis, USA was the topmost contributor in the list with 370 papers (1.36%) and reaming 19 institutions are listed in the Table.

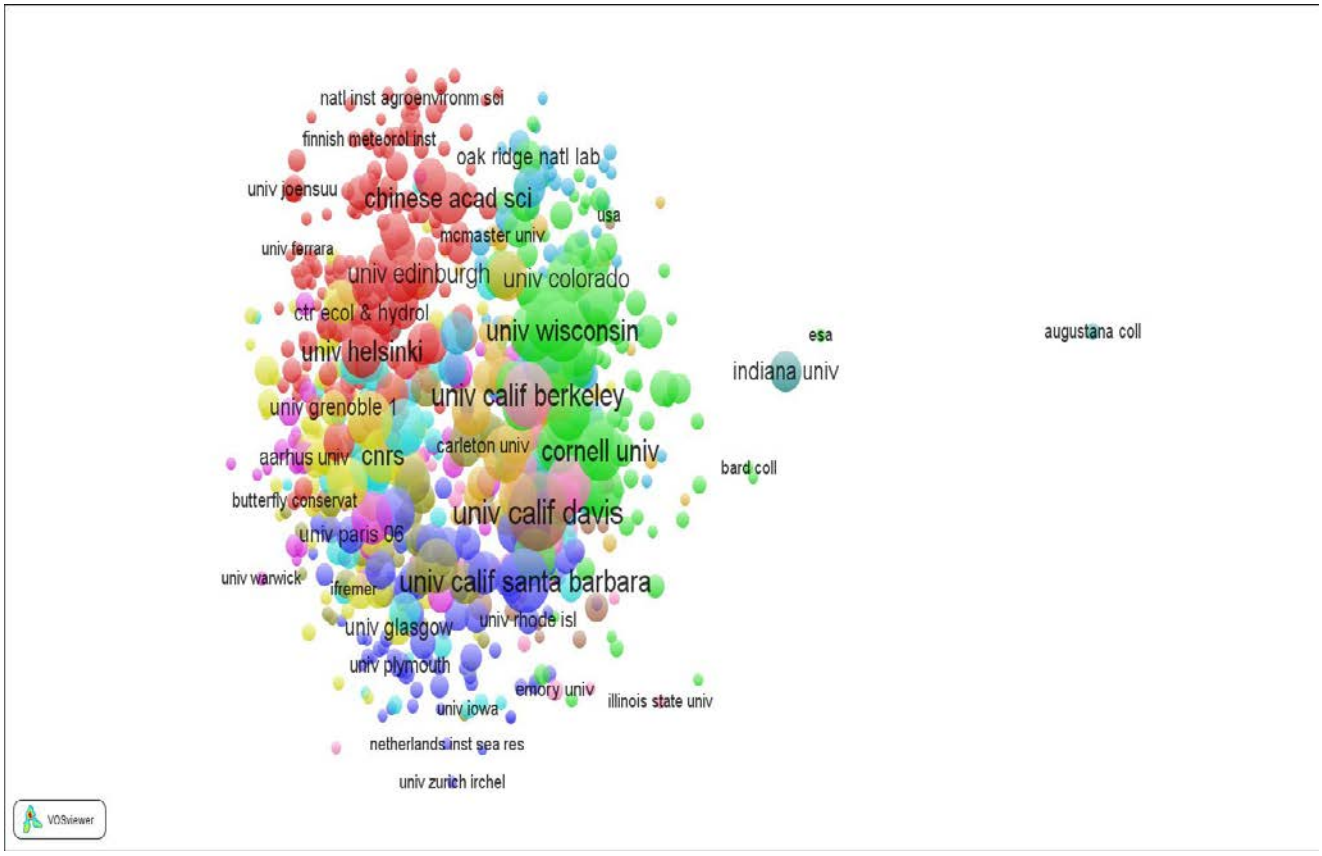
Table 7. Top 20 Institution-wise distribution of ecology literature for the seven selected journals (cumulative)

Institution (Country)	Records	Percentage	TLCS	TGCS
Univ Calif Davis (USA)	370	1.36	2062	17652
Univ Calif Berkeley (USA)	250	0.92	1192	10940
Univ Calif Santa Barbara (USA)	238	0.87	1608	13284
Univ Wisconsin (USA)	222	0.81	1184	10988
Duke Univ (USA)	219	0.80	1070	8994
Colorado State Univ (USA)	199	0.73	1032	9742
Cornell Univ (USA)	197	0.72	763	7281
Univ Minnesota (USA)	192	0.70	1059	8932
Univ Florida (USA)	186	0.68	820	7144
US Geol Survey (USA)	176	0.65	539	6195
Univ British Columbia (Canada)	173	0.64	954	8730
Oregon State Univ (USA)	171	0.63	678	6846
Univ Sheffield (England)	167	0.61	660	5633
US Forest Serv (USA)	162	0.59	543	5788
CNRS (France)	160	0.59	975	7483
Chinese Acad Sci (China)	157	0.58	363	3347
Stanford Univ (USA)	157	0.58	613	5977
Univ Queensland (Australia)	151	0.55	378	5478

Univ Washington (USA)	150	0.55	397	4876
Michigan State Univ (USA)	149	0.55	918	6393

VOSviewer is primarily intended to be used for analyzing bibliometric networks. The program can, for instance, be used to create maps of publications, authors, or journals based on a co-citation network and also to create maps of keywords based on a co-occurrence network. VOSviewer (version 1.5.4) (http://www.vosviewer.com/), a freely available computer program is used for constructing distance-based maps based on co-occurrence data. VOSviewer has been written in the Java programming language and runs on most hardware and operating system platforms (Van Eck and Waltman, 2010) [14].

Figure 4. Label view of VOSviewer of Bibliographical coupling of Organizations in seven ecology journals (cumulative)



The out file is called from VOSviewer to create a map based on a network to bibliographic coupling of organization (Figure 4). With the fractional counting method more than 5 documents of organizations were selected. Of the 4087 organizations, 768 items met the threshold. For each of the 768 organizations, the number of bibliographic coupling links was calculated. The organizations with the largest number of links, i.e. 768 items, were connected in

12 clusters with colours (Blue-Green-Red). These clusters are collaboration clusters in terms number of publication done jointly. In the label view, 768 items are indicated by a label and by default, also by a circle. In the figure, different colour coded regions show different clusters. Colours indicate the clusters to which an organization was assigned by the clustering technique. The 12 clusters correspond to 768 organizations which produced more than 5 documents in the study period.

5.8. Geographical distribution of ecology literature

Table 8. Top 20 country-wise distribution of ecology literature for the seven selected journals (cumulative)

Country	No. of Papers	Percentage	TLCS	TGCS
USA	5357	32.52	21250	206595
UK	1580	9.59	5814	63664
Canada	1057	6.42	4451	46448
Australia	892	5.42	2592	31692
France	617	3.75	2757	27875
Germany	589	3.58	2148	21330
Sweden	435	2.64	1677	17121
Netherlands	401	2.43	1366	16415
Spain	380	2.31	1548	15765
Switzerland	377	2.29	1366	15300
Finland	268	1.63	1030	10201
Peoples R China	261	1.58	541	5622
New Zealand	216	1.31	799	8814
Brazil	176	1.07	747	6805
Norway	176	1.07	581	6045
Denmark	165	1.00	704	6732
Japan	161	0.98	581	5864
Italy	160	0.97	533	6406
Belgium	152	0.92	523	5217
South Africa	139	0.84	710	7894

Table 8 presents the geographical analysis of papers revealed that during the period of study contributions from the selected seven ecology journals numbered 11394 papers from 104 countries. The USA (5357 papers, 32.52%) has come in the top position followed by UK. Nearly 92% of the publications have been contributed by authors from 20 countries; none of these

countries is from the third world, clearly indicating the dominance of advanced countries in carrying out ecological research.

5.9. Funding Agencies of ecology literature

Table 9. Distribution of Funding Agencies

Funding Agency	No. of Publication	%
NSF	448	3.93
NATIONAL SCIENCE FOUNDATION	411	3.61
AUSTRALIAN RESEARCH COUNCIL	122	1.07
NSERC	81	0.71
NERC	71	0.62
NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL OF CANADA	68	0.60
EU	63	0.55
SWISS NATIONAL SCIENCE FOUNDATION	61	0.54
U S NATIONAL SCIENCE FOUNDATION	60	0.53
NATIONAL NATURAL SCIENCE FOUNDATION OF CHINA	60	0.53
NASA	57	0.50
EUROPEAN COMMISSION	55	0.48
ACADEMY OF FINLAND	48	0.42
US NATIONAL SCIENCE FOUNDATION	40	0.35
SWEDISH RESEARCH COUNCIL	38	0.33
NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL OF CANADA NSERC	37	0.32
ANDREW W MELLON FOUNDATION	35	0.31
CHINESE ACADEMY OF SCIENCES	34	0.30
EUROPEAN UNION	33	0.29
STATE OF CALIFORNIA	32	0.28

As far as research is concerned, meeting the requirements in terms of infrastructure which includes manpower, technical expertise sophisticated tools and equipment is difficult to afford by an individual researcher or an organization (Sevukan, 2014) [12]. Thus the researchers or the scientists have to rely on some funding agencies to conduct research particularly at large scale. In view of the above, an attempt was made to analyze the funding agencies. Table 9 shows that out of 11394 publications made by seven ecology journals (cumulative) for a period of ten years (2003-2012), 4691 publications were found to be produced out of sponsored projects. Out of

various funding agencies the top twenty funding agencies are listed in the table. NSF ranks first sharing 3.93% of total publications followed by National Science Foundation (3.61%) and remaining respectively.

6. Findings and Conclusion

This paper examines the Exponential Growth, Mean, Standard Deviation, Coefficient of Variation, RGR & DT., authorship pattern, Degree of Collaboration, Collaborative Coefficient in the present data set. The present work has taken up a detailed analysis of 11394 papers from ecology literature over a ten year period (2003-2012) based on seven leading journals, viz, *Ecology Letters; Trends in Ecology & Evolution; Annual Review of Ecology Evolution and Systematics; Frontiers in Ecology and the Environment; Global Change Biology; Global Ecology and Biogeography; Ecology.* The year 2012 showed the maximum number of contributions (1220 publications). Average Exponential Growth was 0.91. The Mean, Standard Deviation and Coefficient of Variation are 1139.40, 51.90 and 0.05 respectively. The mean RGR had declined from 0.33 to 0.15 and the steady growth is visible with increase in mean DT from 1.63 to 4.94 respectively. Journal articles occupy top position (63.64%) of total research output in Document-wise distribution. The trend towards collaborative research is increasing; here also multi-authored papers (78.61%) number more than single-authored papers (21.39%). Degree of collaboration (0.78), and Collaboration Coefficient (0.54) were calculated. Most prolific author was Dr. A. Burton, USA with 111 papers. Climate change & Biodiversity leads in subject-wise with 2010 (17.64%) papers and 1769 (15.53%) papers respectively. The findings of research institution-wise papers showed that University Calif. Davis, USA contributed more and ranks first with 370 papers. Country-wise analysis indicates that USA was in the top position (32.52%). NSF ranks first sharing 3.93% of the total publications in terms of funding.

Bibliometric analysis is a reliable tool to evaluate the development and quality of scientific production. It is recognized that there are some limitations to the present study. The seven selected journals may not really be representative of all ecology journals listed in the annual JCR. It has been noted during and from the study that there has been a consistent trend towards increase in collaborative research in ecology. Collaborative research has gained

importance due to such factors as the emergence of interdisciplinary subjects, mission-oriented and specialized research activities. As a consequence, studies of collaborative trends of authorship in a given discipline have also been gaining importance in recent years.

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