Quantitative analysis of research trends in a leading ecological journal: bibliometric study during 2003-2012

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The journal Ecology *is one of the premier journals in the field of ecology, published by the Ecological Society of America. Ten volumes of the journal containing 120 issues from 2003 to 2012 have been taken into consideration for the present study that carries out a bibliometric analysis of the 3,359 papers and 164,369 references of this journal. The analysis covers parameters like growth pattern, authorship pattern and author productivity, with most productive countries and institutions. Out of 3,359 contributions, only 410 were single-authored and the rest were multi-authored with a Collaboration Coefficient of 0.21. Applicability of Lotka's Law has been tested. The most productive institution was the University of California at Davis, with 183 publications. The United States of America topped the list of countries with 2,188 papers, while South Africa occupied eighteenth position.*

Keywords: Ecology, bibliometrics, authorship pattern, mapping, VOSviewer, h-index, impact factor, South Africa

1 Introduction

Ecology is the scientific study concerned with the relationship between organisms and their past, present, and future environments. These relationships include the physiological responses of individuals, the structure and dynamics of populations, the interactions among species, the organisation of biological communities, and the processing of energy and matter in ecosystems. Unlike many other disciplines, in ecology the issues are similar across the world, encouraging comparative studies and the participation of an international community of researchers.

Bibliometrics (*biblion* meaning "book" and *metricus* meaning "measurement") is a quantitative method of study concerned primarily with the analysis and description of literature. Its task, immodestly enough, is to provide evolutionary models of science, technology, and scholarship (Egghe 1988: 179). Pritchard (1969: 348) states that bibliometrics deals with the application of mathematics and statistical methods to books and other media of communication. Researchers may use these methods of evaluation to determine the influence of a single writer or to describe the relationship between two or more writers or their works. In the present study, an attempt has been made to study the publication trends in the field of ecology over a ten-year period, by using bibliometric analysis of a leading journal in the domain.

Ecology (ISSN 0012-9658) is a monthly journal published by the Ecological Society of America, Washington DC. *Ecology* publishes essays and articles that report and interpret the results of original scientific research in basic and applied ecology. The journal publishes a broad array of research in this rapidly-expanding field, covering techniques, approaches, and concepts.

2 Literature review

A considerable number of studies have been carried out to explore individual journal publications and literature on specific subject areas:

Liu, Kong and Duan (2011) analysed twelve Chinese mainstream ecological journals' publishing index, citation index and internet reach, and grouped the journals. They stressed that the Chinese ecological journals should make up a community – a digital journal aggregation. Prozesky and Boshoff (2012) attempted to analyse gender-related factors in research performance within the field of invasion ecology. Their investigation was based on journals included in the Thomson Reuters Web of Science from 1990 to 2002, focusing on South African science. Narang and Kumar (2010) conducted a bibliometric analysis of 4,798 citations appended to 400 articles in the Indian *Journal of Pure and Applied Mathematics* from 2003 to 2007. Results indicated a decrease in the number of contributions in successive volumes and that most citations were from journals. Mohamed, Nagarajan and Jothi (2011) discussed authorship trends and

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collaborative research in the field of agricultural extension in the *Journal of Extension System* during the period 2000-2009. The results showed that multi-authored papers outnumbered single-authored papers. Sevukan and Sharma (2008) presented a detailed analysis of research performances of biotechnology faculties in Central Universities of India from 1997 to 2006. The results indicated that twin-authored publications dominated and validated the applicability of Lotka's Law. However, the application of Bradford's Law did not fit in to the literature analysed. Thanuskodi and Venkatalakshmi (2010) studied the growth and development of research on ecology in India through Web of Science publications from 1990 to 2006. Their results indicated that 80% of contributions were multi-authored. Aswathy and Gopikuttan (2012) analysed 780 papers from five volumes in the *Journal of Spacecraft and Rockets* during 2006-2010, finding that, in terms of publications, the United States of America (USA) had the biggest share of papers. India occupied seventh position, with the most contributions coming from its universities.

3 Objectives

The primary objective of this study was to quantify and assess the research performance of the journal *Ecology* by analysing its publication output during a period of ten years (2003 to 2012) using bibliometric indicators. We also aimed to study the applicability of Lotka's Law. Other objectives were to explore the h-index, highly cited publications, the impact of cited references and journals, and various collaborative issues over the ten-year period.

4 Method and materials

The data presented in this paper have been retrieved from the Science Citation Index Expanded, accessed via Web of Science, published by Thomson Reuters. The keyword "ecology" has been used as the search term in the field of "publication name" and the time period was limited to 2003 to 2012 (ten years). 3,359 papers from *Ecology* were retrieved. Microsoft Office Excel and Microsoft Office Word were used to analyse the final data collected in order to generate tables, charts, and graphs.

5 Data analysis and interpretation

In this paper, various statistical techniques are used for our analysis.

A total of 3,359 papers were included in five document types during the ten-year study period, comprising 3,119 (92.86%) articles and 147 (4.38%) editorial pieces. Less significant, were fifty reviews (1.49%), forty-two corrections (1.25%) and one reprint (0.03%).

5.1 Growth of *Ecology* literature from 2003 to 2012

During the period 2003-2012, the journal *Ecology* published 3,359 publications with an average of 279.92 publications per year. Fluctuations in publication patterns of ecology literature were noticed throughout the period of study. However, the highest number of publications was recorded in 2010 (387 papers; 11.52% of total publications in the ten-year period) while the lowest was in the year 2011 (240 papers; 7.14% of total publications in this period).

5.2 Relative Growth Rate and Doubling Time of Publications

Relative Growth Rate is the increase in the number of publications / pages per unit of time. The growth rate of total publications in *Ecology* has been calculated on the basis of Relative Growth Rate (RGR) and Doubling Time (DT) model developed by Mahapatra (1985). Mathematical representation of the mean Relative Growth Rate of articles over a specific period is derived by the following formula:

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

Here R(P) = Relative Growth Rate of articles over the specific period of time.
$\text{Log}_e 1P$ = Log of initial number of articles.
$\text{Log}_e 2P$ = Log of final number of articles.
$2^T - 1^T$ = The unit difference between the initial time and final times.

There exists a direct relationship between the Relative Growth Rate and Doubling Time. If the number of publications / pages of subject doubles during a given period, then the difference between the logarithms of the numbers at the beginning and at the end of the period must be the logarithms of the number 2. If one uses natural logarithms, this difference has the value of 0.693. Thus, the corresponding Doubling Time for publications and pages can be calculated by the following 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 for articles and citations respectively. The RGR and DT are used to express the nature of growth of knowledge. The Relative Growth Rate and Doubling Time of publications were derived and are presented in Table 1. It can be noticed that the Relative Growth Rate of publications decreased from 0.72 in 2004 to 0.09 in 2012. The mean relative growth for the first four years (2004 to 2007) was higher than during the last five years (2008 to 2012).

Table 1 Relative Growth Rate and Doubling Time of *Ecology* during 2003 to 2012

Year	No. of papers	Cumulative no. of papers	$Log_e 1^p$	$Log_e 2^p$	[R(P)]	Mean [R(P)]	[Dt(P)]	Mean [Dt(P)]
2003	327	327		5.79				
2004	348	675	5.79	6.51	0.72		0.96	
2005	357	1032	6.51	6.94	0.42		1.63	
2006	346	1378	6.94	7.23	0.29		2.40	
2007	336	1714	7.23	7.45	0.22	0.33	3.18	1.63
2008	374	2088	7.45	7.64	0.20		3.51	
2009	352	2440	7.64	7.80	0.16		4.45	
2010	387	2827	7.80	7.95	0.15		4.71	
2011	240	3067	7.95	8.03	0.08		8.50	
2012	292	3359	8.03	8.12	0.09	0.13	7.62	5.76

At the same time, the corresponding Doubling Time for different years gradually increased from 2004 to 2012. The mean Doubling Time for the first four years (i.e. 2004 to 2007) was only 1.63 which increased to 7.62 during the last five years (2008 to 2012). As the rate of growth of publication decreased, the corresponding Doubling Time increased. It could be deduced that in general there is a progressive increase in the number of publications for the study period. However, the Relative Growth Rate shows a downward trend which means the rate of increase is proportionately low, and this is highlighted by the Doubling Time for publications, which is higher than the Relative Growth Rate.

The mean relative growth of ecology literature has shown a declining trend. Consequently, mean Doubling Time has increased. These trends may be due to the communication pattern of ecologists. Many ecological communications may not appear in the form of journal articles, the primary source of materials for the abstracting journals.

5.3 Authorship pattern and Collaborative Coefficient

It can be seen in Table 2 that most of the papers investigated were multi-authored (87%).

Table 2 Distribution of Authorship pattern in *Ecology* during 2003 to 2012

Year	No. of Authors				Total	Collaborative Coefficient
	Single	Two	Multi (3-6)	Mega (More than 7)		
2003	62	108	146	12	328	0.14
2004	60	116	163	9	348	0.16
2005	38	112	191	16	357	0.24
2006	44	104	178	20	346	0.21
2007	50	91	168	26	335	0.18
2008	45	94	200	35	374	0.21
2009	30	95	198	29	352	0.26
2010	50	102	201	34	387	0.20
2011	12	49	157	22	240	0.30
2012	19	66	181	26	292	0.28
Total	410	937	1783	229	3359	0.21
Percentage	12.21	27.90	53.08	6.82	100	

Out of 3,359 papers, the highest number of papers was published by more than two authors (three to six authors): 1,783 in total (53.08%). The trend in this journal shows a preference for collaborations which, in turn, is an indication of team research. In other words, collaborative research was predominant in the journal during the study period. The mathematical formula to calculate Collaborative Coefficient (Ajiferuke, Burrel & Tague 1988) is:

$$CC=1-\frac{\sum_{j=1}^{A}\left(1/_j\right)f_j}{N},$$

where fj is the number of j-author 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. Based on the data presented in Table 2, the Collaborative Coefficient (CC) was calculated .The calculated value of CC for the study period does not vary much over the years. The value of CC is lowest (0.14) for 2003 and highest (0.30) for 2012. The CC usually will be between 0 and 1; if it is near 1, it is assumed that the collaboration is high and if it is near 0 it indicates less collaboration. This again indicates that the researchers in the field of ecology during the study period have been fairly collaborative.

5.4 Author productivity

Lotka's Law (Lotka 1926) is one of the three classic laws of bibliometrics and deals with the frequency of publication by authors in any given field. The generalised form of Lotka's Law can be expressed as

$$x^n y = k$$

where *y* is the number of authors with *x* articles, the exponent *n* and constant *k* are parameters to be estimated from a given set of author productivity data.

The value of exponent *n* is calculated by the least-squares method described by Pao (1985) using the following formula:

$$n=\frac{\left[N\sum(\ln x.\ln g(x)-\sum\ln g(x)\sum\ln x\right]}{\left[N\sum(\ln x)^2-(\sum\ln x)^2\right]}$$, where N=10 (i.e. n = 2.23)

N = number of pairs of data
X = logarithm of x, i.e. number of articles
Y = logarithm of y, i.e. number of authors

The value of *k*, which is the theoretical number of authors with a single article, is determined from the following formula:

$$k=\frac{1}{\sum_{x=1}^{p-1}1/x^n+1/(n-1)(p^{n-1})+\frac{1}{2}pn+n/24\times(p-1)^{n+1}}$$

Table 3 Application of Lotka's Law in *Ecology* during 2003 to 2012

x	y	X (log x)	Y (Log y)	xX	XY	Observed	Cumulative observed	Expect	Cumulative expected	D
1	5335	0.000	3.727	0.000	0.000	0.736	0.736	0.680	0.680	0.056
2	1036	0.301	3.015	0.091	0.908	0.143	0.879	0.145	0.825	0.054
3	392	0.477	2.593	0.228	1.237	0.054	0.933	0.059	0.884	0.049
4	211	0.602	2.324	0.362	1.399	0.029	0.962	0.031	0.915	0.047
5	101	0.699	2.004	0.489	1.401	0.014	0.976	0.019	0.933	0.042
6	66	0.778	1.820	0.606	1.416	0.009	0.985	0.013	0.946	0.039
7	33	0.845	1.519	0.714	1.283	0.005	0.989	0.009	0.955	0.035
8	27	0.903	1.431	0.816	1.293	0.004	0.993	0.007	0.961	0.032
9	21	0.954	1.322	0.911	1.262	0.003	0.996	0.005	0.966	0.030
10	5	1.000	0.699	1.000	0.699	0.001	0.997	0.004	0.970	0.026
11	6	1.041	0.778	1.084	0.810	0.001	0.997	0.003	0.974	0.024
12	1	1.079	0.000	1.165	0.000	0.000	0.998	0.003	0.976	0.021
13	4	1.114	0.602	1.241	0.671	0.001	0.998	0.002	0.978	0.020
14	5	1.146	0.699	1.314	0.801	0.001	0.999	0.002	0.980	0.018
15	3	1.176	0.477	1.383	0.561	0.000	0.999	0.002	0.982	0.017
16	2	1.204	0.301	1.450	0.362	0.000	0.999	0.001	0.983	0.016

17	2	1.230	0.301	1.514	0.370	0.000	1.000	0.001	0.985	0.015
20	1	1.301	0.000	1.693	0.000	0.000	1.000	0.001	0.985	0.014
23	1	1.362	0.000	1.854	0.000	0.000	1.000	0.001	0.986	0.014
Total	7252	17.214	23.613	17.913	14.474				Max D	0.056

The productivity of the paper contribution of the journal *Ecology* was verified to be in conformity with Lotka's inverse square law using Pao's method, to know the values of *n* and C.

Here *n* is substituted with the value 2.23 and *k* is calculated as 0.68 using the equation, while *p* is assumed to be 20. By replacing the values of *n* and *k*, the difference is calculated (Table 3). Here *D* is the minimum and hence the present data set is in conformity with Lotka's Law. From the table it is clear that the maximum absolute difference value D_{max} which represents the maximum deviation is identified as 0.056. The table value or critical value of *D* in the Kolmogrov-Smirnov (K-S) test at 0.05 level of significance is 0.016. While the calculated value of *D*, 0.056, is less compared to the table value 0.019, it is clear that the calculated value of *D* falls within the critical value of *D*. Thus, the distribution of author productivity of the present data set confirms Lotka's Law.

5.5 Prolific authors in *Ecology*

Table 4 lists the most productive authors in the overall field of ecology and their h-index values while Table 4a depicts prolific authors who have produced more than 13 papers in the journal *Ecology* during the period of study. Their h-index values are also listed.

Table 4 Top Ten authors in the field of ecology

Author	No. of contributions	Sum of the times Cited	Sum of Times Cited without self-citations	Citing Articles	Citing articles without self-citations	Average citations per Item	h-index
Shine, R.	178	4581	4077	2813	2667	25.74	37
Luiselli, L.	113	1226	895	725	626	10.85	19
Poulin, R.	101	2679	2433	1700	1620	26.52	30
Baskin, C.C.	100	1474	1285	1041	971	14.74	21
Baskin, J.M.	98	1445	1258	1018	948	14.74	21
Macdonald, D.W.	92	2791	2687	2345	2294	30.34	29
Gaston, K.J.	85	3674	3563	3044	2990	43.22	36
Hobson, K.A.	85	3641	3479	2502	2442	42.84	31
Stenseth, N.C.	82	3951	3852	3231	3187	48.18	30
Cherel, Y.	81	2158	1891	1394	1323	26.64	29

Table 4a Most productive authors in the journal *Ecology* during 2003-2012

Author	No. of contributions	Sum of the times Cited	Sum of times cited without self-citations	Citing articles	Citing articles without self-citations	Average citations per Item	h-index
Agrawal, A.A.	23	921	913	829	824	40.04	13
Nichols, J.D.	20	1251	1227	951	939	62.55	13
Ives, A.R.	17	408	403	392	389	24	10
Royle, J.A.	17	901	874	613	600	53	13
Bertness, M.D.	16	533	524	470	463	33.31	13
Clark, J.S.	16	980	962	854	846	61.25	10
Callaway, R.M.	15	1010	1001	884	878	67.33	13
Legendre, P.	15	1483	1464	1155	1146	98.87	13
Shine, R.	15	461	456	413	408	30.73	13
Hines, J.E.	14	761	746	660	652	54.36	10
Jackson, R.B.	14	1333	1329	1260	1257	95.21	11

Reich, P.B.	14	567	566	549	548	40.5	9
Trussell, G.C.	14	518	495	415	406	37	10
Wright, S.J.	14	797	780	660	651	56.93	12

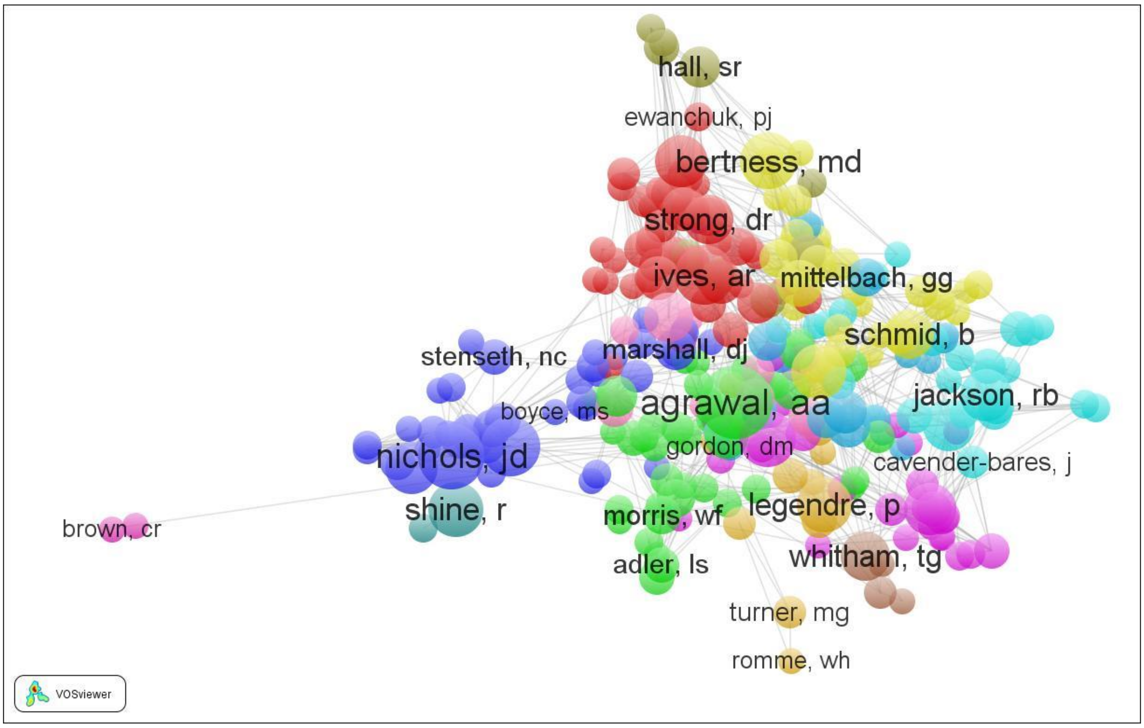
The h-index is an index that quantifies both the actual scientific productivity and the apparent scientific impact of a scientist. The index is based on the set of most-cited papers of a scientist and the number of citations that such a set of papers has received in other publications. Hirsch (2005) postulates that

> A scientist has an index h if h of his or her Np papers has at least h citations each and the other (Np – h) papers have less than h citations each. The value of h is equal to the number of papers (N) in the list that have N or more citations.

To identify the h-index values of the prominent authors, we used the ‘‘create citation report’’ tool of the Web of Knowledge database. The information relating to the ‘‘sum of the times cited’’, “sum of times cited without self-citations”, “citing articles”, “citing articles without self-citations”, ‘‘average citations per item’’, and ‘‘h-index’’ were noted down.

VOSviewer is primarily intended to be used for analysing 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).

Figure 1 Label view of VOSviewer of bibliographical coupling of authors in *Ecology*



For the study period, we employed VOSviewer to analyse the publications in the journal (Figure 1). With the fractional counting method, documents with more than five authors were selected. Of the 7,253 authors, 278 met the threshold. For each of the 278 authors, the number of bibliographic coupling links was calculated. The authors with the largest number of links (277 items) were connected in fourteen clusters with different colours. In the label view, 277 items are indicated both by their label and by a circle. For each item, the font size of the item’s label and the size of the item’s circle vary depending on the weight of the item. If items have been assigned to clusters, the colour of the circle of an item can be determined by the cluster to which the item belongs. This clearly shows the most prolific authors, among them A.A. Agrawal, J.D. Nichols, and A.R. Ives.

5.6 Organisation-wise distribution

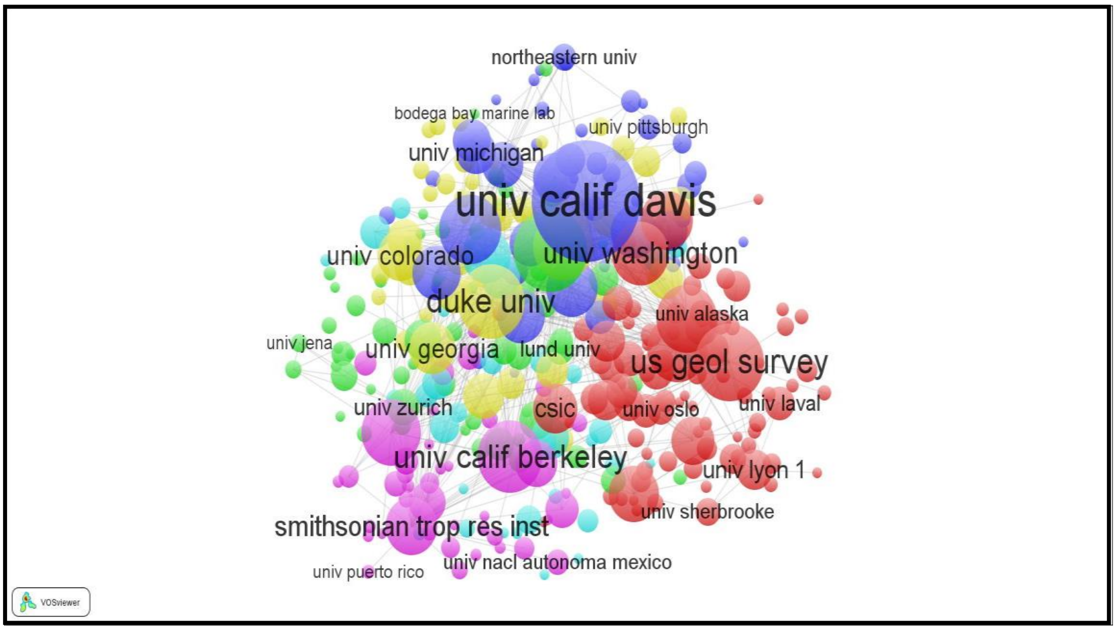
There were 1,483 organisations or institutions involved in publications in the journal during 2003-2012. Of the 1,483 institutions, 816 (55.02%) contributed single-institutional publications and the remaining 667 (44.98%) contributed inter-institutionally collaborated publications. The performance of the top fifteen most productive institutions was examined and is presented in Table 5. Of the top fifteen most productive institutions, fourteen are in the USA and one in Canada. Universities remain the dominant contributors in *Ecology*.

Table 5 Organisation-wise distribution of *Ecology*, 2003-2012 (first 15 countries)

Organisations	Country	No. of Papers	% of 3359
University Calif Davis	USA	182	5.41
University Calif Santa Barbara	USA	103	3.06
University Calif Berkeley	USA	92	3.06
US Geol Survey	USA	92	2.73
Duke University	USA	92	2.73
University Wisconsin	USA	83	2.47
University Florida	USA	77	2.29
Colorado State University	USA	76	2.26
Cornell University	USA	76	2.26
University Minnesota	USA	75	2.23
University Washington	USA	71	2.11
Oregon State University	USA	69	2.05
University British Columbia	Canada	60	1.78
University Montana	USA	59	1.75
University Calif Santa Cruz	USA	58	1.72

VOSviewer constructs a map based on a co-occurrence matrix. The construction of a map is a process that consists of three steps. In the first step, a similarity matrix is calculated based on the co-occurrence matrix. In the second step, a map is constructed by applying the VOS mapping technique to the similarity matrix. And finally, in the third step, the map is translated, rotated, and reflected (van Eck and Waltman 2010).

Figure 2 Label view of VOSviewer of bibliographical coupling of organisations in *Ecology*



The output file from VOSviewer (Figure 2) is a map based on a network of bibliographic couplings according to organisation With the fractional counting method, more than five documents of organisations were selected. Of the 1,483 organisations, 314 items met the threshold. For each of the 314 organisations, the number of bibliographic coupling links was calculated. The organisations with the largest number of links (314 items) were connected in thirteen clusters with colours (blue, green and red). These clusters are collaboration clusters in terms of the number of publications produced jointly. In the label view, 314 items are indicated by a label and by a circle. In the figure, different colour-coded regions show different clusters. Colours indicate the clusters to which an organisation is assigned. The thirteen clusters correspond to 314 organisations which produced more than five documents in the research period. Table 6 shows the details of the thirteen collaboration clusters and the colour coding details.

Table 6 Collaboration clusters in organisation

Cluster	Cluster Colours	No. of Items (No. of organisations)	No. of documents	Cluster top most organisation
1		55	629	CNRS
2		38	603	University of British Columbia
3		37	706	University of Calif Davis
4		35	767	US Geological Survey
5		31	474	Yale University
6		22	352	University of Illinois
7		18	250	University of Wisconsin
8		17	339	Cornell University
9		15	380	University of Florida
10		13	375	Duke University
11		12	229	University Calif Santa Cruz
12		11	116	Lund University
13		10	185	University Toronto

VOS mapping technique is to minimise a weighted sum of the squared Euclidean distances between all pairs of items. The higher the similarity between two items, the higher the weight of their squared distance in the summation. The distance based measurement stratifies different clusters here based on the publication number occurring as a pair. The map clearly depicts the most prolific organisations.

5.7 Geographical distribution of contributors

Country-wise distribution of the authors (Table 7) indicates that most of the papers were contributed by USA, followed by Canada and England. Being the originating country, and host to more scientific institutions, it is not surprising that the USA was the top contributing country.

Table 7 Country-wise distribution of *Ecology* during 2003-2012

Countries	No. of Publications	Percentage	Rank
USA	2188	65.13	1
Canada	389	11.58	2
England	246	7.32	3
Australia	224	6.66	4
France	173	5.15	5
Germany	151	4.49	6
Sweden	134	3.98	7
Netherlands	131	3.9	8
Switzerland	122	3.63	9
Spain	106	3.15	10
New Zealand	91	2.70	11
Norway	72	2.14	12
Scotland	68	2.02	13

Table 7 Country-wise distribution of *Ecology* during 2003-2012

Countries	No. of Publications	Percentage	Rank
Finland	61	1.81	14
Panama	47	1.39	15
Japan	44	1.31	16
Brazil	39	1.16	17
South Africa	37	1.10	18
Argentina	36	1.07	19
Mexico	36	1.07	19
Denmark	34	1.01	20
Peoples R China	34	1.01	20
Belgium	32	0.95	21
Israel	28	0.83	22
Chile	21	0.62	23
Italy	21	0.62	24
Ireland	19	0.56	25
Wales	17	0.50	26
Czech Republic	16	0.47	27
Portugal	15	0.44	28
India	14	0.41	29

5.8 Most highly cited papers of journal *Ecology* in 2003

The bibliographic details of highly-cited papers for the year of commencement of the study, 2003, for *Ecology* are listed in Appendix 1. Fourteen of the most cited papers of 2003 originated from the USA (seven), followed by Canada (three), New Zealand (two), Sweden (one) and South Africa (one). The highest cited papers from South Africa for the study period are provided in Appendix 2.

5.9 Growth of cited references in the journal *Ecology*

Citations and references are the backbone of any article. Supporting the content of a manuscript with proper references plays an important role in its reliability. The annual distribution of cited references (Table 8) reveals that the highest cited references were in the year 2010, followed by 2008, while the lowest were in the year 2011.

Table 8 Distribution of cited references and Impact Factors in journal *Ecology*, 2003-2012

Year	No of Articles	No of Cited References	Cumulative No. of Cited References	%	Impact Factor
2003	327	17338	17338	10.55	*
2004	348	17013	34351	10.35	4.104
2005	357	16687	51038	10.15	4.506
2006	346	16986	68024	10.33	4.782
2007	336	15747	83771	9.58	4.822
2008	374	18750	102521	11.41	4.874
2009	352	17382	119903	10.57	4.411
2010	387	18881	138784	11.49	5.073
2011	240	10577	149361	6.43	4.849
2012	292	15008	164369	9.13	5.175
Total	3359	164369		100	

*** 2003 IF was not available in Web of Science**

Impact Factor (IF) is calculated and published in the Journal Citation Reports brought out by Thomson Reuters, providing a practical tool for evaluating scientific production. The journal impact factor is a measure of the frequency with which the “average article” in a journal has been cited in a particular year. It measures the number of citations given in a journal in the previous year to the citable items published in the two years prior, divided by citable items published in the two prior years (Garfield 1976). For example, the IF calculation for the journal *Ecology* in 2012 is given below:

Cites in 2012 to articles published in 2011	928	
Cites in 2012 to articles published in 2010	2110	
Sum	3038	Cites to recent articles
Number of articles published in 2011	230	
Number of articles published in 2010	357	
Sum	587	Number of recent articles

Calculation	Cites to recent articles	=	3038
	Number of recent articles	=	587
2012 IF for the journal *Ecology*			**5.175**

The IF for the study period was sourced from Web of Knowledge in the Journal Citation Reports (JCR) from 2004 to 2012 (Table 8).

6 Results and discussion

The total number of articles published in *Ecology* available in Web of Science was 3,359 for 2003-2012. The majority of papers appeared in the year 2010 (387 papers). The h-index of the most prolific author, A.A. Agrawal, with 22 papers, was found to be thirteen. The authorship pattern showed that most papers were multiple-authored (three to six authors) (1,783 papers, 53.08). This number may be compared to single-author papers (410 papers, 12.21%). In the distribution of articles according to country, the USA occupies the first place with 2,188 articles (65.13%). The University of California at Davis contributed the most, ranking first according to institution, with 182 papers (5.41%).

Though this study considered only one journal in the vast field of ecology for bibliometric studies, the journal *Ecology* is recognised as a leading journal, given its high impact factor and popularity. It can be argued that the patterns discerned from this study therefore might well be reflective of the emerging trends in the discipline of ecology. It will be interesting to classify the broad issues addressed in the journal and study their trends over a period of time.

7 Conclusion

The present work has taken up a detailed analysis of the journal *Ecology* over a ten-year period (2003-2012). The work provides a reasonable glimpse of the field of ecology, using a reputed journal indicating the direction in which the discipline is going. It is heartening to note that in this scientific discipline, researchers from across the world have shown a strong inclination towards collaborative research which is significant in the present-day context. It will be interesting to replicate this work in a few years from now to observe the changes in the discipline.

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Appendix 1

Bibliographic details of highly cited papers in the journal *Ecology* for the year 2003

S. NO.	Title/Source (*Ecology*) from WoS in 2003	Times Cited (WoS)	Country of origin of first author
1	Energy, water, and broad-scale geographic patterns of species richness. By Hawkins, BA; Field, R; Cornell, HV; et al. Volume: 84 (12): 3105-3117	730	USA
2	A review of trait-mediated indirect interactions in ecological communities. By Werner, EE; Peacor, SD. Volume: 84 (5): 1083-1100	604	USA
3	Confronting multicollinearity in ecological multiple regression. By Graham, MH. Volume: 84 (11): 2809-2815	550	USA
4	Canonical analysis of principal coordinates: A useful method of constrained ordination for ecology. By Anderson, MJ; Willis, TJ. Volume: 84 (2): 511-525	508	New Zealand
5	Propagule dispersal in marine and terrestrial environments: A community perspective. By Kinlan, BP; Gaines, SD. Volume: 84 (8): 2007-2020	403	USA
6	Estimating site occupancy, colonization, and local extinction when a species is detected imperfectly. By MacKenzie, DI; Nichols, JD; Hines, JE; et al. Volume: 84 (8): 2200-2207	401	New Zealand
7	Variation in plant response to native and exotic arbuscular mycorrhizal fungi. By Klironomos, JN. Volume: 84 (9): 2292-2301	360	Canada
8	Estimating abundance from repeated presence-absence data or point counts. By Royle, JA; Nichols, JD. Volume: 84 (3): 777-790	288	USA
9	Community and ecosystem genetics: A consequence of the extended phenotype. By Whitham, TG; Young, WP; Martinsen, GD; et al. Volume: 84 (3): 559-573	286	USA
10	Herbivore-mediated linkages between aboveground and belowground communities. By Bardgett, RD; Wardle, DA. Volume: 84 (9): 2258-2268	281	Sweden
11	Plant diversity, soil microbial communities, and ecosystem function: Are there any links? By Zak, DR; Holmes, WE; White, DC; et al. Volume: 84 (8): 2042-2050	246	USA
12	Meta-analysis of cod-shrimp interactions reveals top-down control in oceanic food webs. By Worm, B; Myers, RA. Volume: 84 (1): 162-173	240	Canada
13	Piecewise regression: A tool for identifying ecological thresholds. By Toms, JD; Lesperance, ML. Volume: 84(8): 2034-2041	230	Canada
14	Effects of fire and herbivory on the stability of savanna ecosystems. By van Langevelde, F; van de Vijver, CADM; Kumar, L; et al. Volume: 84 (2): 337-350	217	South Africa

Appendix 2

South African contributions to journal *Ecology*, 2003-2012

S.NO.	Title/Source	Times Cited (WoS)
1	Effects of fire and herbivory on the stability of savanna ecosystems. By: van Langevelde, F; van de Vijver, CADM; Kumar, L; et al. *Ecology*, 84 (2): 337-350, Feb. 2003	217
2	Pollination success in a deceptive orchid is enhanced by co-occurring rewarding magnet plants. By: Johnson, SD; Peter, CI; Nilsson, LA; et al. *Ecology*, 84 (11): 2919-2927, Nov. 2003	125
3	Interactions between environment, species traits, and human uses describe patterns of plant invasions. By: Thuiller, Wilfried; Richardson, David M.; Rouget, Mathieu; et al. *Ecology*, 87 (7): 1755-1769, Jul. 2006	111
4	Effects of four decades of fire manipulation on woody vegetation structure in savanna By: Higgins, Steven I.; Bond, William J.; February, Edmund C.; et al. *Ecology*, 88 (5): 1119-1125, May 2007	110
5	Habitat loss, trophic collapse, and the decline of ecosystem services By: Dobson, Andrew; Lodge, David; Alder, Jackie; et al. *Ecology*. 87 (8):1915-1924, Aug. 2006	102
6	Relating plant traits and species distributions along bioclimatic gradients for 88 Leucadendron taxa By: Thuiller, W; Lavorel, S; Midgley, G; et al. *Ecology*, 85 (6): 1688-1699, Jun. 2004	91
7	Surface-water constraints on herbivore foraging in the Kruger National Park, South Africa By: Redfern, JV; Grant, R; Biggs, H; et al. *Ecology*, 84 (8): 2092-2107, Aug. 2003	91
8	Microbial nitrogen limitation increases decomposition By: Craine, Joseph M.; Morrow, Carl; Fierer, Noah. *Ecology*, 88 (8): 2105-2113, Aug. 2007	85
9	Dark, bitter-tasting nectar functions as a filter of flower visitors in a bird-pollinated plant By: Johnson, Steven D.; Hargreaves, Anna L.; Brown, Mark. *Ecology*, 87 (11): 2709-2716, Nov. 2006	83
10	Phenotypic variation of larks along an aridity gradient: Are desert birds more flexible? By: Tieleman, BI; Williams, JB; Buschur, ME; et al. *Ecology*, 84 (7): 1800-1815, Jul. 2003	65
11	Collapse of a pollination web in small conservation areas By: Pauw, Anton. *Ecology*, 88 (7): 1759-1769, Jul. 2007	57
12	Environmental constraints on a global relationship among leaf and root traits of grasses By: Craine, JM; Lee, WG; Bond, WJ; et al. Ecology, 86 (1): 12-19, Jan. 2005	50
13	Mimics and magnets: The importance of color and ecological facilitation in floral deception By: Peter, Craig I.; Johnson, Steven D. *Ecology*, 89 (6):1583-1595, Jun. 2008	37
14	Shifting prey selection generates contrasting herbivore dynamics within a large-mammal predator-prey web By: Owen-Smith, Norman; Mills, M. G. L. *Ecology*, 89 (4): 1120-1133, Apr. 2008	36
15	Community convergence in disturbed subtropical dune forests By: Wassenaar, TD; van Aarde, RJ; Pimm, SL; et al. *Ecology*, 86 (3): 655-666, Mar. 2005	32
16	Tree cover in sub-Saharan Africa: Rainfall and fire constrain forest and savanna as alternative stable states By: Staver, A. Carla; Archibald, Sally; Levin, Simon. *Ecology*, 92 (5): 1063-1072, May 2011	30
17	A mutualism with a native membracid facilitates pollinator displacement by Argentine ants By: Lach, Lori. *Ecology*, 88 (8): 1994-2004, Aug. 2007 Published: AUG 2007	30
18	Photosynthesis and sink activity of wasp-induced galls in Acacia pycnantha By: Dorchin, Netta; Cramer, Michael D.; Hoffmann, John H. *Ecology*, 87 (7): 1781-1791, Jul. 2006	24
19	Hidden effects of chronic tuberculosis in African buffalo By: Jolles, AE; Cooper, DV; Levin, SA. *Ecology*, 86 (9): 2358-2364, Sep. 2005	23
20	Spatial autocorrelation and the scaling of species-environment relationships By: de Knegt, H. J.; van Langevelde, F.; Coughenour, M. B.; et al. *Ecology*, 91 (8): 2455-2465, Aug. 2010	21
21	Minimizing predation risk in a landscape of multiple predators: effects on the spatial distribution of African ungulates By: Thaker, Maria; Vanak, Abi T.; Owen, Cailey R.; et al. *Ecology*, 92 (2): 398-407, Feb. 2011	19

22	Likelihood ridges and multimodality in population growth rate models. By: Polansky, Leo; de Valpine, Perry; Lloyd-Smith, James O.; et al. *Ecology*, 90 (8): 2313-2320, Aug. 2009	18
23	Does the self-similar species distribution model lead to unrealistic predictions? By: Hui, Cang; McGeoch, Melodie A. *Ecology*, 89 (10): 2946-2952, Oct. 2008	15
24	From moonlight to movement and synchronized randomness: Fourier and wavelet analyses of animal location time series data By: Polansky, Leo; Wittemyer, George; Cross, Paul C.; et al. *Ecology*, 91 (5): 1506-1518, May 2010	14
25	Thermal benefits of melanism in cordylid lizards: a theoretical and field test. By: Clusella-Trullas, Susana; van Wyk, Johannes H.; Spotila, James R.. *Ecology*, 90 (8): 2297-2312, Aug. 2009	13
26	Bioengineers and their associated fauna respond differently to the effects of biogeography and upwelling By: Cole, Victoria J.; McQuaid, Christopher D. *Ecology*, 91 (12): 3549-3562, Dec. 2010	12
27	Salt marsh ecosystem biogeochemical responses to nutrient enrichment: a paired N-15 tracer study By: Drake, D. C.; Peterson, Bruce J.; Galvan, Kari A.; et al. *Ecology*, 90 (9): 2535-2546, Sep. 2009	12
28	Methods for assessing movement path recursion with application to African buffalo in South Africa By: Bar-David, Shirli; Bar-David, Israel; Cross, Paul C.; et al. *Ecology*, 90 (9): 2467-2479, Sep. 2009	11
29	Do novel genotypes drive the success of an invasive bark beetle-fungus complex? Implications for potential reinvasion By: Lu, Min; Wingfield, Michael J.; Gillette, Nancy; et al. Ecology, 92 (11): 2013-2019, Nov. 2011	10
30	Dynamics and management of infectious disease in colonizing populations By: Bar-David, S; Lloyd-Smith, JO; Getz, WM. *Ecology*, 87 (5): 1215-1224, May 2006	10
31	Metabolic rate throughout the annual cycle reveals the demands of an Arctic existence in Great Cormorants By: White, Craig R.; Gremillet, David; Green, Jonathan A.; et al. *Ecology*, 92 (2): 475-486, Feb. 2011	8
32	Native pollen thieves reduce the reproductive success of a hermaphroditic plant, Aloe maculate By: Hargreaves, Anna L.; Harder, Lawrence D.; Johnson, Steven D. *Ecology*, 91 (6): 1693-1703, Jun. 2010	8
33	Inferring ecological and behavioral drivers of African elephant movement using a linear filtering approach By: Boettiger, Alistair N.; Wittemyer, George; Starfield, Richard; et al. *Ecology*, 92 (8): 1648-1657, Aug. 2011	7
34	Defoliation synchronizes aboveground growth of co-occurring C-4 grass species. By: Swemmer, Anthony M.; Knapp, Alan K. Ecology, 89 (10): 2860-2867, Oct. 2008	6
35	Tree allometries reflect a lifetime of herbivory in an African savanna By: Moncrieff, Glenn R.; Chamaille-Jammes, Simon; Higgins, Steven I.; et al. *Ecology*, 92 (12): 2310-2315, Dec. 2011	5
36	Spatial and temporal changes in group dynamics and range use enable anti-predator responses in African buffalo By: Tambling, Craig J.; Druce, Dave J.; Hayward, Matt W.; et al. *Ecology*, 93 (6):1297-1304, Jun. 2012	4
37	Spatial scale and species identity influence the indigenous-alien diversity relationship in springtails By: Terauds, Aleks; Chown, Steven L.; Bergstrom, Dana M. *Ecology*, 92 (7): 1436-1447, Jul. 2011	4