Bibliometric Analysis

for the U.S. Environmental Protection Agency/Office of Research and Development's Ecological Research Program

This is a bibliometric analysis of the papers prepared by intramural and extramural researchers of the U.S. Environmental Protection Agency's (EPA) Ecological Research Program. For this analysis, 2,152 papers were reviewed, and they were published from 1996 to 2006. These publications were cited 25,677 times in the journals covered by Thomson's *Web of Science*[1] and Scopus[2]. Of these 2,152 publications, 1,850 (85.97%) have been cited at least once in a journal.

Searches of Thomson Scientific's *Web of Science* and Elsevier's Scopus were conducted to obtain times cited data for the ecological journal publications. The analysis was completed using Thomson's *Essential Science Indicators (ESI)* and *Journal Citation Reports (JCR)* as benchmarks. *ESI* provides access to a unique and comprehensive compilation of essential science performance statistics and science trends data derived from Thomson's databases. For this analysis, the *ESI* highly cited papers thresholds as well as the hot papers thresholds were used to assess the influence and impact of the ecological papers. *JCR* is a recognized authority for evaluating journals. It presents quantifiable statistical data that provide a systematic, objective way to evaluate the world's leading journals and their impact and influence in the global research community. The two key measures used in this analysis to assess the journals in which the EPA ecological papers are published are the Impact Factor and Immediacy Index. The Impact Factor is a measure of the frequency with which the "average article" in a journal has been cited in a particular year. The Impact Factor helps evaluate a journal's relative importance, especially when compared to other journals in the same field. The Immediacy Index is a measure of how quickly the "average article" in a journal is cited. This index indicates how often articles published in a journal are cited within the same year and it is useful in comparing how quickly journals are cited.

The report includes a summary of the results of the bibliometric analysis, an analysis of the 2,152 ecological research papers analyzed by *ESI* field (e.g., environment/ecology, geosciences, plant & animal science), an analysis of the journals in which the ecological papers were published, a table of the highly cited researchers in the Ecological Research Program, a list of patents that have resulted from the program, and data on the books, book chapters, and reports produced by the program.

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[1] Thomson Scientific's *Web of Science* provides access to current and retrospective multidisciplinary information from approximately 8,830 of the most prestigious, high impact research journals in the world. *Web of Science* also provides cited reference searching.

[2] Scopus is a large abstract and citation database of research literature and quality Web sources designed to support the literature research process. Scopus offers access to 15,000 titles from 4,000 different publishers, more than 12,850 academic journals (including coverage of 535 Open Access journals, 750 conference proceedings, and 600 trade publications), 27 million abstracts, 245 million references, 200 million scientific Web pages, and 13 million patent records.

SUMMARY OF RESULTS

1. **More than one-fifth of the ecological publications are highly cited papers.** 453 (21.05%) of the ecological papers qualify as highly cited when using the *ESI* criteria for the top 10% of highly cited publications. This is 2.1 times the 10% of papers expected to be highly cited. 72 (3.35%) of the ecological papers qualify as highly cited when using the *ESI* criteria for the top 1%, which is 3.4 times the number expected. 10 (0.46%) of these papers qualify as very highly cited when using the criteria for the top 0.1%, which is nearly 5 times the number anticipated. 1 (0.05%) paper actually meets the 0.01% threshold for the most highly cited papers, which is 5 times the expected number for this program.

2. **The ecological papers are more highly cited than the average paper.** Using the *ESI* average citation rates for papers published by field as the benchmark, in 18 of the 20 fields in which the 2,152 EPA ecological papers were published, the ratio of actual to expected cites is greater than 1, indicating that the ecological papers are more highly cited than the average papers in those fields. For all 20 fields combined, the ratio of total number of cites to the total number of expected cites (25,677 to 14,822.74) is 1.73, indicating that the ecological papers are more highly cited than the average paper.

3. **More than one-fifth of the ecological papers are published in high impact journals.** 447 of the 2,152 papers were published in the top 10% of journals ranked by *JCR* Impact Factor, representing 20.77% of EPA's ecological papers. This number is 2.1 times higher than the expected 215.2 papers. 493 of the 2,152 papers appear in the top 10% of journals ranked by *JCR* Immediacy Index, representing 22.91% of EPA's ecological papers. This number is 2.3 times higher than the expected 215.2 papers.

4. **Fifty-five of the ecological papers qualify as hot papers.** Using the hot paper thresholds established by *ESI* as a benchmark, 55 hot papers, representing 2.56% of the ecological papers, were identified in the analysis. Hot papers are papers that were highly cited shortly after they were published. The number of ecological hot papers identified is 26 times higher than the expected 2.2 hot papers.

5. **The authors of the ecological papers cite themselves much less than the average author.** 1,237 of the 25,677 cites are author self-cites. This 4.82% author self-citation rate is well below the accepted range of 10-30% author self-citation rate.

6. **Eighty-four of the authors of the ecological papers are included in *ISIHighlyCited.com***, which is a database of the world's most influential researchers who have made key contributions to science and technology during the period from 1981 to 1999.

7. **There was 1 patent issued and 1 patent application filed** by investigators from 1996 to 2006 for research that was conducted under EPA's ecological research program.

8. **The 15 books from the program were cited 1,082 times with 12 (1.11%) self-cites, the 74 book chapters were cited 582 times with 29 (4.98%) self-cites, and the 3 reports were cited 166 times with 0 (0%) self-cites.** There is no *ESI* benchmark against which to compare these data.

Highly Cited Ecological Publications

All of the journals covered by *ESI* are assigned a field, and to compensate for varying citation rates across scientific fields, different thresholds are applied to each field. Thresholds are set to select highly cited papers to be listed in *ESI*. Different thresholds are set for both field and year of publication. Setting different thresholds for each year allows comparable representation for older and younger papers for each field.

The 2,152 ecological research papers reviewed for this analysis were published in journals that were assigned to 20 of the 22 *ESI* fields. The distribution of the papers among these 20 fields and the number of citations by field are presented in Table 1.

Table 1. Ecological Papers by *ESI* Fields

***ESI* Field**	**No. of Citations**	**No. of EPA Papers**	**Average Cites/Paper**
Environment/Ecology	11,695	1,094	10.69
Plant & Animal Science	4,597	439	10.47
Geosciences	2,297	168	13.67
Multidisciplinary	1,366	26	52.54
Biology & Biochemistry	1,200	59	20.34
Microbiology	975	50	19.50
Engineering	872	96	9.08
Pharmacology & Toxicology	778	19	40.95
Chemistry	578	50	11.56
Agricultural Sciences	370	18	20.56
Clinical Medicine	234	20	11.70
Social Sciences, general	212	35	6.06
Economics & Business	205	22	9.32
Computer Science	120	15	8.00
Mathematics	49	18	2.72
Molecular Biology & Genetics	48	7	6.86
Physics	35	9	3.89
Immunology	17	1	17.00
Materials Science	17	5	3.40
Neuroscience & Behavior	12	1	12.00
	Total = 25,677	**Total = 2,152**	**11.93**

There are 453 (21.05% of the papers analyzed) highly cited EPA ecological papers in 17 of the 20 fields—Environment/Ecology, Plant & Animal Science, Geosciences, Multidisciplinary, Biology & Biochemistry, Pharmacology & Toxicology, Engineering, Microbiology, Agricultural Sciences, Chemistry, Economics & Business, Social Sciences, Clinical Medicine, Computer Science, Mathematics, Materials Science, and Physics—when using the *ESI* criteria for the **top 10% of papers**. Table 2 shows the number of EPA papers in those 17 fields that meet the **top 10% threshold in *ESI***. Seventy-two (3.35%) of the papers analyzed qualify as highly cited when using the *ESI* criteria for the **top 1% of papers**. These papers cover 11 fields—Environment/Ecology, Multidisciplinary, Plant & Animal Science, Biology & Biochemistry, Pharmacology & Toxicology, Geosciences, Agricultural Sciences, Engineering, Social Sciences, Mathematics, and Materials Science. Table 3 shows the 72 papers by field that meet the **top 1% threshold in *ESI***. The citations for these 72 papers are provided in Tables 4 through 14. There were 10 (0.46%) very highly cited ecological papers in the fields of Agricultural Sciences, Engineering, Environment/Ecology, Materials Science, Pharmacology & Toxicology, and Plant & Animal Science. These papers, which met the **top 0.1% threshold in *ESI,*** are listed in Table 15. One (0.05%) of the ecological papers met the **top 0.01% threshold in *ESI***, which is eight times the expected number of papers that should meet this threshold for this analysis. This paper is listed in Table 16.

Table 2. Number of Highly Cited Ecological Papers by Field (top 10%)

***ESI* Field**	**No. of Citations**	**No. of Papers**	**Average Cites/Paper**	**% of Papers in Field**
Environment/Ecology	6,376	175	36.43	16.00%
Plant & Animal Science	3,124	111	28.14	25.28%
Geosciences	1,473	39	37.77	23.21%
Multidisciplinary	1,350	20	67.50	76.92%
Biology & Biochemistry	777	9	86.33	15.25%
Pharmacology & Toxicology	688	8	86.00	42.11%
Engineering	633	31	20.42	32.29%
Microbiology	572	11	52.00	22.00%
Agricultural Sciences	322	7	46.00	38.89%
Chemistry	257	6	42.83	12.00%
Economics & Business	163	6	27.17	27.27%
Social Sciences, general	131	10	13.10	28.57%
Clinical Medicine	127	3	42.33	15.00%
Computer Science	114	9	12.67	60.00%
Mathematics	46	6	7.67	33.33%
Materials Science	12	1	12.00	20.00%
Physics	9	1	9.00	11.11%
	Total = 16,174	**Total = 453**	**35.70**	**21.05%**

Table 3. Number of Highly Cited Ecological Papers by Field (top 1%)

***ESI* Field**	**No. of Citations**	**No. of Papers**	**Average Cites/Paper**	**% of EPA Papers in Field**
Environment/Ecology	3,027	27	112.11	2.47%
Multidisciplinary	875	6	145.83	23.08%
Plant & Animal Science	843	16	52.69	3.64%
Biology & Biochemistry	477	2	238.50	3.39%
Pharmacology & Toxicology	455	4	113.75	21.05%
Geosciences	319	5	63.80	2.98%
Agricultural Sciences	219	3	73.00	16.67%
Engineering	192	4	48.00	4.17%
Social Sciences, general	63	2	31.50	5.71%
Mathematics	16	2	8.00	11.11%
Materials Science	12	1	12.00	20.00%
	Total = 6,498	**Total = 72**	**90.25**	**3.35%**

Table 4. Highly Cited Ecological Papers in the Field of Environment/Ecology (top 1%)

No. of Cites	**First Author**	**Paper**
151	Mason RP	Uptake, toxicity, and trophic transfer of mercury in a coastal diatom. *Environmental Science & Technology* 1996;30(6):1835-1845.
170	Morel FMM	The chemical cycle and bioaccumulation of mercury. *Annual Review of Ecology and Systematics* 1998;29:543-566.
480	Carpenter SR	Nonpoint pollution of surface waters with phosphorus and nitrogen. *Ecological Applications* 1998;8(3):559-568.
209	Huston MA	Local processes and regional patterns: appropriate scales for understanding variation in the diversity of plants and animals. *Oikos* 1999;86(3):393-401.
295	Stohlgren TJ	Exotic plant species invade hot spots of native plant diversity. *Ecological Monographs* 1999;69(1):25-46.
332	Lonsdale WM	Global patterns of plant invasions and the concept of invisibility. *Ecology* 1999;80(5):1522-1536.
94	Pickett STA	Urban ecological systems: linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. *Annual Review of Ecology and Systematics* 2001;32:127-157.

No. of Cites	First Author	Paper
131	Phillips DL	Uncertainty in source partitioning using stable isotopes. *Oecologia* 2001;127(2):171-179.
192	Di Toro DM	Biotic ligand model of the acute toxicity of metals. 1. Technical basis. *Environmental Toxicology and Chemistry* 2001;20(10):2383-2396.
308	Sakai AK	The population biology of invasive species. *Annual Review of Ecology and Systematics* 2001;32:305-332.
63	Wu JG	Key issues and research priorities in landscape ecology: an idiosyncratic synthesis. *Landscape Ecology* 2002;17(4):355-365.
83	Phillips DL	Incorporating concentration dependence in stable isotope mixing models. *Oecologia* 2002;130(1):114-125.
44	Mazdai A	Polybrominated diphenyl ethers in maternal and fetal blood samples. *Environmental Health Perspectives* 2003;111(9):1249-1252.
44	Cade BS	A gentle introduction to quantile regression for ecologists. *Frontiers in Ecology and the Environment* 2003;1(8):412-420.
47	Law BE	Changes in carbon storage and fluxes in a chronosequence of ponderosa pine. *Global Change Biology* 2003;9(4):510-524.
31	Zhu LY	Temporal trends and spatial distributions of brominated flame retardants in archived fishes from the Great Lakes. *Environmental Science & Technology* 2004;38(10):2779-2784.
41	Li HB	Use and misuse of landscape indices. *Landscape Ecology* 2004;19(4):389-399.
42	Wu JG	Effects of changing scale on landscape pattern analysis: scaling relations. *Landscape Ecology* 2004;19(2):125-138.
52	Gurevitch J	Are invasive species a major cause of extinctions? *Trends in Ecology & Evolution* 2004;19(9):470-474.
141	Hites RA	Polybrominated diphenyl ethers in the environment and in people: a meta-analysis of concentrations. *Environmental Science & Technology* 2004;38(4):945-956.
15	Zhu LY	Brominated flame retardants in sediment cores from lakes Michigan and Erie. *Environmental Science & Technology* 2005;39(10):3488-3494.
17	Hoh E	Brominated flame retardants in the atmosphere of the east-central United States. *Environmental Science & Technology* 2005;39(20):7794-7802.
21	Bossdorf O	Phenotypic and genetic differentiation between native and introduced plant populations. *Oecologia* 2004;144(1):1-11.
4	Stoddard JL	Setting expectations for the ecological condition of streams: The concept of reference condition. *Ecological Applications* 2006;16(4):1267-1276.

No. of Cites	First Author	Paper
4	Kania-Korwel I	Distribution of chiral PCBs in selected tissues in the laboratory rat. *Environmental Science & Technology* 2006;40(12):3704-3710.
8	Groffman P	Ecological thresholds: the key to successful environmental management or an important concept with no practical application? *Ecosystems* 2006;9(1):1-13.
8	Garrison AW	Probing the enantioselectivity of chiral pesticides. *Environmental Science & Technology* 2006;40(1):16-23.

Table 5. Highly Cited Ecological Papers in the Field of Multidisciplinary (top 1%)

No. of Cites	First Author	Paper
236	Matson PA	Agricultural intensification and ecosystem properties. *Science* 1997;277(5325):504-509.
228	Stoddard JL	Regional trends in aquatic recovery from acidification in North America and Europe. *Nature* 1999;401(6753):575-578.
124	Wolfenbarger LL	Biotechnology and ecology–The ecological risks and benefits of genetically engineered plants. *Science* 2000;290(5499):2088-2093.
90	Clark JS	Ecological forecasts: an emerging imperative. *Science* 2001;293(5530):657-660.
90	McKane RB	Resource-based niches provide a basis for plant species diversity and dominance in arctic tundra. *Nature* 2002;415(6867):68-71.
107	Kolar CS	Ecological predictions and risk assessment for alien fishes in North America. *Science* 2002;298(5596):1233-1236.

Table 6. Highly Cited Ecological Papers in the Field of Plant & Animal Science (top 1%)

No. of Cites	First Author	Paper
109	Hairston NG	Zooplankton egg banks as biotic reservoirs in changing environments. *Limnology and Oceanography* 1996;41(5):1087-1092.
182	Burkholder JM	Pfiesteria piscicida and other Pfiesteria-like dinoflagellates: behavior, impacts, and environmental controls. *Limnology and Oceanography* 1997;42(5):1052-1075.
99	Moran MA	Carbon loss and optical property changes during long-term photochemical and biological degradation of estuarine dissolved organic matter. *Limnology and Oceanography* 2000;45(6):1254-1264.

No. of Cites	First Author	Paper
126	Zak DR	Elevated atmospheric CO_2, fine roots and the response of soil microorganisms: a review and hypothesis. *New Phytologist* 2000;147(1):201-222.
61	Sponseller RA	Relationships between land use, spatial scale and stream macroinvertebrate communities. *Freshwater Biology* 2001;46(10):1409-1424.
68	Burkholder JM	Overview and present status of the toxic Pfiesteria complex (Dinophyceae). *Phycologia* 2001;40(3):186-214.
71	Wiens JA	Riverine landscapes: taking landscape ecology into the water. *Freshwater Biology* 2002;47(4):501-515.
41	Roy AH	Stream macroinvertebrate response to catchment urbanisation (Georgia, USA). *Freshwater Biology* 2003;48(2):329-346.
42	Andersen CP	Source-sink balance and carbon allocation below ground in plants exposed to ozone. *New Phytologist* 2003;157(2):213-228.
14	Roepke TA	Estradiol and endocrine disrupting compounds adversely affect development of sea urchin embryos at environmentally relevant concentrations. *Aquatic Toxicology* 2005;71(2):155-173.
4	Corstanje R	Typha latifolia and Cladium jamaicense litter decay in response to exogenous nutrient enrichment. *Aquatic Botany* 2006;84(1):70-78.
4	Howarth RW	Nitrogen as the limiting nutrient for eutrophication in coastal marine ecosystems: evolving views over three decades. *Limnology and Oceanography* 2006;51(1):364-376.
4	Wang L	Effects of levels of human disturbance on the influence of catchment, riparian, and reach-scale factors on fish assemblages. *American Fisheries Society Symposium* 2006;2006(48):199-219.
4	Paerl HW	Anthropogenic and climatic influences on the eutrophication of large estuarine ecosystems. *Limnology and Oceanography* 2006;51(1):448-462.
5	Herlihy AT	Landscape clusters based on fish assemblages in the conterminous USA and their relationship to existing landscape classifications. *American Fisheries Society Symposium* 2006;2006(48):87-112.
9	Kaufmann PR	Geomorphic and anthropogenic influences on fish and amphibians in pacific northwest coastal streams. *American Fisheries Society Symposium* 2006;2006(48):429-455.

Table 7. Highly Cited Ecological Papers in the Field of Biology & Biochemistry (top 1%)

No. of Cites	First Author	Paper
321	Aber J	Nitrogen saturation in temperate forest ecosystems–hypotheses revisited. *Bioscience* 1998;48(11):921-934.
156	Driscoll CT	Acidic deposition in the northeastern United States: sources and inputs, ecosystem effects, and management strategies. *Bioscience* 2001;51(3):180-198.

Table 8. Highly Cited Ecological Papers in the Field of Pharmacology & Toxicology (top 1%)

No. of Cites	First Author	Paper
235	Nimrod AC	Environmental estrogenic effects of alkylphenol ethoxylates. *Critical Reviews in Toxicology* 1996;26(3):335-364.
141	Oberdorster G	Pulmonary effects of inhaled ultrafine particles. *International Archives of Occupational and Environmental Health* 2001;74(1):1-8.
27	Oberdorster G	Principles for characterizing the potential human health effects from exposure to nanomaterials: elements of a screening strategy. *Particle and Fibre Toxicology* 2005;2:Art. No. 8.
52	Monteiro-Riviere NA	Multi-walled carbon nanotube interactions with human epidermal keratinocytes. *Toxicology Letters* 2005;155(3):377-384.

Table 9. Highly Cited Ecological Papers in the Field of Geosciences (top 1%)

No. of Cites	First Author	Paper
86	Chase TN	Simulated impacts of historical land cover changes on global climate in northern winter. *Climate Dynamics* 2000;16(2-3):93-105.
69	Marchesiello P	Open boundary conditions for long-term integration of regional oceanic models. *Ocean Modelling* 2001;3(1-2):1-20.
84	Pielke RA	Influence of the spatial distribution of vegetation and soils on the prediction of cumulus convective rainfall. *Review of Geophysics* 2001;39(2):151-177.
39	Marchesiello P	Equilibrium structure and dynamics of the California Current System. *Journal of Physical Oceanography* 2003;33(4):753-783.
41	Cohen WB	An improved strategy for regression of biophysical variables and Landsat ETM+ data. *Remote Sensing of Environment* 2003;84(4):561-571.

Table 10. Highly Cited Ecological Papers in the Field of Agricultural Sciences (top 1%)

No. of Cites	First Author	Paper
62	Goldstein AH	Effects of climate variability on the carbon dioxide, water, and sensible heat fluxes above a ponderosa pine plantation in the Sierra Nevada (CA). *Agricultural and Forest Meteorology* 2000;101(2-3):113-129.
49	Davidson EA	Belowground carbon allocation in forests estimated from litterfall and IRGA-based soil respiration measurements. *Agricultural and Forest Meteorology* 2002;113(1-4):39-51.
108	Law BE	Environmental controls over carbon dioxide and water vapor exchange of terrestrial vegetation. *Agricultural and Forest Meteorology* 2002;113(1-4):97-120.

Table 11. Highly Cited Ecological Papers in the Field of Engineering (top 1%)

No. of Cites	First Author	Paper
69	Wu J	Hierarchy and scaling: extrapolating information along a scaling ladder. *Canadian Journal of Remote Sensing* 1999;25(4):367-380.
68	Douglas EM	Trends in floods and low flows in the United States: impact of spatial correlation. *Journal of Hydrology* 2000;240(1-2):90-105.
47	Schultz MM	Fluorinated alkyl surfactants. *Environmental Engineering Science* 2003;20(5):487-501.
8	Byun D	Review of the governing equations, computational algorithms, and other components of the models-3 Community Multiscale Air Quality (CMAQ) modeling system. *Applied Mechanics Reviews* 2006;59(1-6):51-76.

Table 12. Highly Cited Ecological Papers in the Field of Social Sciences, general (top 1%)

No. of Cites	First Author	Paper
29	Irwin EG	Interacting agents, spatial externalities and the evolution of residential land use patterns. *Journal of Economic Geography* 2002;2(1):31-54.
34	Irwin EG	The effects of open space on residential property values. *Land Economics* 2002;78(4):465-480.

Table 13. Highly Cited Ecological Papers in the Field of Mathematics (top 1%)

No. of Cites	First Author	Paper
6	Hall P	Theory for penalised spline regression. *Biometrika* 2005;92(1):105-118.
10	Stein ML	Space-time covariance functions. *Journal of the American Statistical Association* 2005;100(469):310-321.

Table 14. Highly Cited Ecological Papers in the Field of Materials Science (top 1%)

No. of Cites	First Author	Paper
12	Teng XW	Synthesis of porous platinum nanoparticles. *Small* 2006;2(2):249-253.

Table 15. Very Highly Cited Ecological Papers (top 0.1%)

ESI Field	No. of Cites	First Author	Paper
Agricultural Sciences	108	Law BE	Environmental controls over carbon dioxide and water vapor exchange of terrestrial vegetation. *Agricultural and Forest Meteorology* 2002;113(1-4):97-120.
Engineering	8	Byun D	Review of the governing equations, computational algorithms, and other components of the models-3 Community Multiscale Air Quality (CMAQ) modeling system. *Applied Mechanics Reviews* 2006;59(1-6):51-76.
Environment/ Ecology	480	Carpenter SR	Nonpoint pollution of surface waters with phosphorus and nitrogen. *Ecological Applications* 1998;8(3):559-568.
	295	Stohlgren TJ	Exotic plant species invade hot spots of native plant diversity. *Ecological Monographs* 1999;69(1):25-46.
	332	Lonsdale WM	Global patterns of plant invasions and the concept of invisibility. *Ecology* 1999;80(5):1522-1536.
	308	Sakai AK	The population biology of invasive species. *Annual Review of Ecology and Systematics* 2001;32:305-332.
	141	Hites RA	Polybrominated diphenyl ethers in the environment and in people: a meta-analysis of concentrations. *Environmental Science & Technology* 2004;38(4):945-956.
Materials Science	12	Teng XW	Synthesis of porous platinum nanoparticles. *Small* 2006;2(2):249-253.

ESI Field	No. of Cites	First Author	Paper
Pharmacology & Toxicology	52	Monteiro-Riviere NA	Multi-walled carbon nanotube interactions with human epidermal keratinocytes. *Toxicology Letters* 2005;155(3):377-384.
Plant & Animal Science	9	Kaufmann PR	Geomorphic and anthropogenic influences on fish and amphibians in pacific northwest coastal streams. *American Fisheries Society Symposium* 2006;2006(48):429-455.

Table 16. Extremely Highly Cited Ecological Paper in the Field of Environment/Ecology (top 0.01%)

No. of Cites	First Author	Paper
141	Hites RA	Polybrominated diphenyl ethers in the environment and in people: a meta-analysis of concentrations. *Environmental Science & Technology* 2004;38(4):945-956.

Ratio of Actual Cites to Expected Citation Rates

The expected citation rate is the average number of cites that a paper published in the same journal in the same year and of the same document type (article, review, editorial, etc.) has received from the year of publication to the present. Using the *ESI* average citation rates for papers published by field as the benchmark, in 18 of the 20 fields in which the EPA ecological papers were published, the ratio of actual to expected cites is greater than 1, indicating that the ecological papers are more highly cited than the average papers in those fields (see Table 17). For all 20 fields combined, the ratio of total number of cites to the total number of expected cites (25,677 to 14,822.74) is 1.73, indicating that the ecological papers are more highly cited than the average paper.

Table 17. Ratio of Actual Cites to Expected Cites for Ecological Papers by Field

ESI Field	Total Cites	Expected Cite Rate	Ratio
Agricultural Sciences	370	89.69	4.12
Biology & Biochemistry	1,200	711.40	1.69
Chemistry	578	458.80	1.26
Clinical Medicine	234	175.05	1.34
Computer Science	120	37.60	3.19
Economics & Business	205	79.52	2.58
Engineering	872	342.64	2.54

***ESI* Field**	**Total Cites**	**Expected Cite Rate**	**Ratio**
Environment/Ecology	11,695	8,240.65	1.42
Geosciences	2,297	1,165.41	1.97
Immunology	17	14.49	1.17
Materials Science	17	11.10	1.53
Mathematics	49	18.48	2.65
Microbiology	975	570.06	1.71
Molecular Biology & Genetics	48	171.63	0.28
Multidisciplinary	1,366	108.84	12.55
Neuroscience & Behavior	12	7.82	1.53
Pharmacology & Toxicology	778	197.31	3.94
Physics	35	61.09	0.57
Plant & Animal Science	4,597	2,244.50	2.05
Social Sciences, general	212	116.66	1.82
TOTAL	**25,677**	**14,822.74**	**1.73**

***JCR* Benchmarks**

Impact Factor. The *JCR* Impact Factor is a well known metric in citation analysis. It is a measure of the frequency with which the "average article" in a journal has been cited in a particular year. The Impact Factor helps evaluate a journal's relative importance, especially when compared to others in the same field. The Impact Factor is calculated by dividing the number of citations in the current year to articles published in the 2 previous years by the total number of articles published in the 2 previous years.

Table 18 indicates the number of ecological papers published in the top 10% of journals, based on the *JCR* Impact Factor. Four hundred forty-seven (447) of 2,152 papers were published in the top 10% of journals, representing 20.77% of EPA's ecological papers. This indicates that more than one-fifth of the ecological papers are published in the highest quality journals as determined by the *JCR* Impact Factor, which is 2.1 times higher than the expected percentage.

Table 18. Ecological Papers in Top 10% of Journals by *JCR* Impact Factor

EPA Ecological Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
12	Science	30.927	6
8	Nature	29.273	11
1	Lancet	23.407	17
1	JAMA—Journal of the American Medical Association	23.332	19
1	Trends in Ecology & Evolution	14.864	46
2	PLoS Biology	14.672	47
1	Gastroenterology	12.386	65
2	Proceedings of the National Academy of Sciences of the United States of America	10.231	88
4	Annual Review of Ecology and Systematics	10.104	92
1	Pharmacology & Therapeutics	8.357	135
1	Reviews of Geophysics	7.742	152
1	Nucleic Acids Research	7.552	162
1	Molecular Biology of the Cell	6.520	198
1	Molecular Biology and Evolution	6.233	211
1	Plant Physiology	6.114	219
9	Analytical Chemistry	5.635	242
1	Human Reproduction Update	5.449	247
14	Environmental Health Perspectives	5.342	257
1	Mutation Research—Reviews in Mutation Research	5.333	259
1	Emerging Infectious Diseases	5.308	264
10	Ecology Letters	5.151	282
1	Critical Reviews in Toxicology	5.000	297
5	Ecological Monographs	4.855	320
3	Frontiers in Ecology and the Environment	4.745	334
21	Bioscience	4.708	336
1	Journal of Neurochemistry	4.604	350
2	Journal of Applied Ecology	4.594	351

EPA Ecological Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
3	Environmental Microbiology	4.559	355
21	Ecology	4.506	366
1	American Naturalist	4.464	376
4	Molecular Ecology	4.301	414
7	New Phytologist	4.285	417
2	Evolution	4.155	444
12	Conservation Biology	4.110	455
8	Global Change Biology	4.075	464
58	Environmental Science & Technology	4.054	467
1	International Journal of Epidemiology	4.045	470
1	Epidemiology	4.043	471
1	Journal of Physical Chemistry B	4.033	474
1	Drug Metabolism and Disposition	4.015	481
2	Geochimica et Cosmochimica Acta	3.897	521
3	Electrophoresis	3.850	536
1	Biochemistry	3.848	538
29	Applied and Environmental Microbiology	3.818	544
54	Ecological Applications	3.804	548
1	Langmuir	3.705	569
4	Plant Cell and Environment	3.601	606
1	American Journal of Public Health	3.566	619
4	Proceedings of the Royal Society of London Series B-Biological Sciences	3.510	636
1	Climate Dynamics	3.468	655
1	Critical Reviews in Plant Sciences	3.467	656
1	Biosensors & Bioelectronics	3.463	658
15	Ecosystems	3.455	661
1	Carbon	3.419	672
6	Journal of Climate	3.402	681

EPA Ecological Papers in that Journal	Journal	Impact Factor (IF)	*JCR* IF Rank
3	Journal of Animal Ecology	3.399	682
8	Global Biogeochemical Cycles	3.373	687
2	Diversity and Distributions	3.345	696
1	Journal of Experimental Botany	3.336	701
8	Oikos	3.309	711
25	Limnology and Oceanography	3.249	725
1	Journal of Economic Geography	3.222	733
2	Toxicology and Applied Pharmacology	3.148	765
1	Reproduction	3.136	768
8	Journal of Chromatography A	3.096	779
4	Toxicological Sciences	3.088	781
1	Critical Reviews in Environmental Science and Technology	3.080	786
2	Reviews in Fisheries Science	3.062	793
2	Bulletin of the American Meteorological Society	3.055	797
16	Oecologia	3.032	805
9	Water Research	3.019	810
1	Geology	2.982	833
1	Chemical Geology	2.940	851
1	Environment International	2.856	879
Total = 447			

Immediacy Index. The *JCR* Immediacy Index is a measure of how quickly the *average article* in a journal is cited. It indicates how often articles published in a journal are cited within the year they are published. The Immediacy Index is calculated by dividing the number of citations to articles published in a given year by the number of articles published in that year.

Table 19 indicates the number of ecological papers published in the top 10% of journals, based on the *JCR* Immediacy Index. Four hundred ninety-three (493) of the 2,152 papers appear in the top 10% of journals, representing 22.91% of the ecological papers. This indicates that more than one-fifth of the ecological papers are published in the highest quality journals as determined by the *JCR* Immediacy Index, which is 2.3 times higher than the expected percentage.

Table 19. Ecological Papers in Top 10% of Journals by *JCR* Immediacy Index

EPA Ecological Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
1	Lancet	7.347	5
12	Science	6.398	7
8	Nature	5.825	11
1	JAMA-Journal of the American Medical Association	5.082	17
2	PLoS Biology	3.734	34
1	Gastroenterology	2.226	75
1	Trends in Ecology & Evolution	2.031	87
1	Molecular Biology and Evolution	1.832	109
1	International Journal of Epidemiology	1.791	111
2	Proceedings of the National Academy of Sciences of the United States of America	1.746	121
1	Molecular Biology of the Cell	1.556	143
5	Ecological Monographs	1.448	158
1	Nucleic Acids Research	1.391	173
1	International Journal of Toxicology	1.309	193
1	Epidemiology	1.298	198
2	Journal of Aquatic Animal Health	1.267	206
1	Small	1.255	211
1	Global and Planetary Change	1.253	213
2	Ecology and Society	1.232	218
1	Mutation Research-Reviews in Mutation Research	1.143	251
3	Ambio	1.140	253
7	New Phytologist	1.125	257
1	Ocean Modelling	1.019	305
1	Plant Physiology	1.014	307
1	Pharmacology & Therapeutics	1.000	311
14	Environmental Health Perspectives	0.955	346
10	Ecology Letters	0.950	350

EPA Ecological Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
2	Fisheries	0.941	357
6	Journal of Paleolimnology	0.938	359
1	International Journal of Mass Spectrometry	0.898	386
4	Plant Cell and Environment	0.891	397
1	Human Ecology	0.879	410
10	Ecotoxicology	0.846	434
1	Emerging Infectious Diseases	0.840	440
8	Global Biogeochemical Cycles	0.838	443
1	Heredity	0.817	462
2	Diversity and Distributions	0.814	466
1	Journal of Sea Research	0.809	470
1	American Journal of Public Health	0.805	475
24	Journal of the North American Benthological Society	0.797	479
1	Biochemistry	0.777	494
1	Human Reproduction Update	0.767	497
1	Journal of Hydrometeorology	0.757	505
1	Drug Metabolism and Disposition	0.733	534
21	Bioscience	0.731	538
8	Science of the Total Environment	0.731	538
2	Journal of Applied Ecology	0.726	551
9	Analytical Chemistry	0.713	569
1	Journal of Physical Chemistry B	0.705	578
22	Freshwater Biology	0.699	582
2	Aquatic Conservation-Marine and Freshwater Ecosystems	0.696	585
1	Journal of Experimental Biology	0.684	601
1	Journal of Neurochemistry	0.682	604
1	American Naturalist	0.679	610
1	Chemical Geology	0.678	612
6	Ecological Engineering	0.663	640

EPA Ecological Papers in that Journal	Journal	Immediacy Index (II)	*JCR* II Rank
1	Carbon	0.649	660
1	Biotropica	0.636	682
1	Climate Dynamics	0.630	695
1	Journal of Experimental Botany	0.630	695
14	Journal of Geophysical Research-Atmospheres	0.630	695
9	Journal of Geophysical Research-Oceans	0.630	695
29	Human and Ecological Risk Assessment	0.628	698
2	Geochimica et Cosmochimica Acta	0.622	707
21	Ecology	0.621	709
3	Environmental Microbiology	0.620	713
4	Toxicological Sciences	0.617	715
1	International Journal of Systematic and Evolutionary Microbiology	0.615	716
1	Langmuir	0.610	723
11	Climatic Change	0.610	723
1	Basic and Applied Ecology	0.604	729
4	Molecular Ecology	0.598	741
2	Evolution	0.597	745
1	Biosensors & Bioelectronics	0.597	745
5	Biological Conservation	0.589	761
1	Marine Geology	0.585	767
3	Journal of Animal Ecology	0.579	784
25	Limnology and Oceanography	0.566	814
4	Environmental Research	0.551	847
54	Ecological Applications	0.543	869
10	Journal of Soil and Water Conservation	0.543	869
2	Bulletin of the American Meteorological Society	0.542	871
58	Environmental Science & Technology	0.541	874
Total = 493			

Hot Papers

ESI establishes citation thresholds for hot papers, which are selected from the highly cited papers in different fields, but the time frame for citing and cited papers is much shorter—papers must be cited within 2 years of publication and the citations must occur in a 2-month time period. Papers are assigned to 2-month periods and thresholds are set for each period and field to select 0.1% of papers. There were no hot papers identified for the current 2-month period (i.e., September-October 2006), but there were a number of hot papers identified from previous periods.

Using the hot paper thresholds established by *ESI* as a benchmark, 55 hot papers, representing 2.56% of the ecological papers, were identified in nine fields—Agricultural Sciences, Biology & Biochemistry, Economics & Business, Engineering, Environment/Ecology, Multidisciplinary, Pharmacology & Toxicology, Plant & Animal Science, and Social Sciences. The number of ecological hot papers is 26 times higher than expected. The hot papers are listed in Table 20.

Table 20. Hot Papers Identified Using *ESI* Thresholds

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Agricultural Sciences	3	4 cites in February-March 2001	Goldstein, et al. Effects of climate variability on the carbon dioxide, water, and sensible heat fluxes above a ponderosa pine plantation in the Sierra Nevada (CA). *Agricultural and Forest Meteorology* 2000;101(2-3):113-129.
	4	4 cites in October-November 2002	Law BE, et al. Estimation of leaf area index in open-canopy ponderosa pine forests at different successional stages and management regimes in Oregon. *Agricultural and Forest Meteorology* 2002;113(1-4):97-120.
	5	6 cites in September-October 2004	Law BE, et al. Environmental controls over carbon dioxide and water vapor exchange of terrestrial vegetation. *Agricultural and Forest Meteorology* 2002;113(1-4):97-120.
Biology & Biochemistry	3	3 cites in August 2002	Poff, NL, Hart DD. How dams vary and why it matters for the emerging science of dam removal. *Bioscience* 2002;52(8):659-668.
Economics & Business	3	3 cites in November 2002	Irwin EG, Bockstael NE. The problem of identifying land use spillovers: measuring the effects of open space on residential property values. *American Journal of Agricultural Economics* 2001;83(3):698-704.
Engineering	2	3 cites in March 2002	Marcus WA. Mapping of stream microhabitats with high spatial resolution hyperspectral imagery. *Journal of Geographical Systems* 2002;4(1):113-126.
	2	2 cites in May-June 2002	Pang YB, et al. $PM_{2.5}$ semivolatile organic material at Riverside, California: implications for the $PM_{2.5}$ Federal Reference Method sampler. *Aerosol Science and Technology* 2002;36(3):277-288.

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Environment/ Ecology	3	3 cites in May 1998	Stoddard JL, et al. Can site-specific trends be extrapolated to a region? An acidification example for the northeast. *Ecological Applications* 1998;8(2):288-299.
	3	3 cites in May 2000	Neff RR, et al. Impact of climate variation and change on Mid-Atlantic Region hydrology and water resources. *Climate Research* 2000;14(3):207-218.
Environment/ Ecology	3	8 cites in May 2000	Polsky C, et al. The Mid-Atlantic Region and its climate: past, present, and future. *Climate Research* 2000;14(3):161-173.
	7	8 cites in July-August 2000	Carpenter SR, et al. Nonpoint pollution of surface waters with phosphorus and nitrogen. *Ecological Applications* 1998;8(3):559-568.
	6	6 cites in September-October 2001	Glasgow HB, Burkholder JM. Water quality trends and management implications from a five-year study of a eutrophic estuary. *Ecological Applications* 2000;10(4):1024-1046.
	3	3 cites in October 2001	Rublee PA, et al. Use of molecular probes to assess geographic distribution of Pfiesteria species. *Environmental Health Perspectives* 2001;109(Suppl 5):765-767.
	3	3 cites in June 2002	Suter GW, et al. A methodology for inferring the causes of observed impairments in aquatic ecosystems. *Environmental Toxicology and Chemistry* 2002;21(6):1101-1111.
	5	14 cites in September 2002	Di Toro DM, et al. Biotic ligand model of the acute toxicity of metals. 1. Technical basis. *Environmental Toxicology and Chemistry* 2001;20(10):2383-2396.
	4	4 cites in September 2003	Leibowitz SG, Vining KC. Temporal connectivity in a prairie pothole complex. *Wetlands* 2003;23(1):13-25.
	6	6 cites in September-October 2004	Law BE, et al. Changes in carbon storage and fluxes in a chronosequence of ponderosa pine. *Global Change Biology* 2003;9(4):510-524.
	3	3 cites in June 2004	Bradley MP, Smith E. Using science to assess environmental vulnerabilities. *Environmental Monitoring and Assessment* 2004;94(1-3):1-7.
	3	3 cites in June 2004	Jackson, et al. A regional approach to projecting land-use change and resulting ecological vulnerability. *Environmental Monitoring and Assessment* 2004;94(1-3):231-248.

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
	3	4 cites in April 2004	Berger PA, Bolte JP. Evaluating the impact of policy options on agricultural landscapes: an alternative-futures approach. *Ecological Applications* 2004;14(2):342-354.
	3	4 cites in April 2004	Dole D, Niemi E. Future water allocation and in-stream values in the Willamette River Basin: a basin-wide analysis. *Ecological Applications* 2004;14(2):355-367.
Environment/ Ecology	3	9 cites in December 2004	Campbell DE. Evaluation and emergy analysis of the Cobscook Bay ecosystem. *Northeastern Naturalist* 2004;11:355-424.
	3	3 cites in April 2004	Van Sickle J, et al. Projecting the biological condition of streams under alternative scenarios of human land use. *Ecological Applications* 2004;14(2):368-380.
	3	5 cites in April 2004	Hulse DW, et al. Envisioning alternatives: using citizen guidance to map future land and water use. *Ecological Applications* 2004;14(2):325-341.
	3	4 cites in April 2004	Baker JP, et al. Alternative futures for the Willamette River Basin, Oregon. *Ecological Applications* 2004;14(2):313-324.
	3	4 cites in April 2004	Schumaker NH, et al. Projecting wildlife responses to alternative future landscapes in Oregon's Willamette Basin. *Ecological Applications* 2004;14(2):381-400.
	6	6 cites in March-April 2005	Cade BS, Noon BR. A gentle introduction to quantile regression for ecologists. *Frontiers in Ecology and the Environment* 2003;1(8):412-420.
	5	6 cites in August-September 2005	Gurevitch J, Padilla DK. Are invasive species a major cause of extinctions? *Trends in Ecology & Evolution* 2004;19(9):470-474.
	7	13 cites in January-February 2006	Hites RA. Polybrominated diphenyl ethers in the environment and in people: a meta-analysis of concentrations. *Environmental Science & Technology* 2004;38(4):945-956.
	3	3 cites in May-June 2006	Groffman P, et al. Ecological thresholds: the key to successful environmental management or an important concept with no practical application? *Ecosystems* 2006;9(1):1-13.
	5	5 cites in July-August 2006	Hoh E, Hites RA. Brominated flame retardants in the atmosphere of the east-central United States. *Environmental Science & Technology* 2005;39(20):7794-7802.

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
	6	8 cites in July-August 2006	Bossdorf O, et al. Phenotypic and genetic differentiation between native and introduced plant populations. *Oecologia* 2005;144(1):1-11.
	3	3 cites in August 2006	Stoddard JL. Setting expectations for the ecological condition of streams: the concept of reference condition. *Ecological Applications* 2006;16(4):1267-1276.
Multidisciplinary	14	17 cites in August-September 2001	Stoddard JL, et al. Regional trends in aquatic recovery from acidification in North America and Europe. *Nature* 1999;401(6753):575-578.
Pharmacology & Toxicology	7	9 cites in July-August 2006	Monteiro-Riviere NA, et al. Multi-walled carbon nanotube interactions with human epidermal keratinocytes. *Toxicology Letters* 2005;155(3):377-384.
Plant & Animal Science	3	3 cites in March 1999	Karr JR. Defining and measuring river health. *Freshwater Biology* 1999;41(2):221-234.
	3	6 cites in September 2000	van Sickle J, Hughes RM. Classification strengths of ecoregions, catchments, and geographic clusters for aquatic vertebrates in Oregon. *Journal of the North American Benthological Society* 2000;19(3):370-384.
	3	3 cites in September 2000	Pan YD, et al. Ecoregions and benthic diatom assemblages in Mid-Atlantic Highlands streams, USA. *Journal of the North American Benthological Society* 2000;19(3):518-540.
	3	4 cites in July 2000	Zak DR, et al. Elevated atmospheric CO_2, fine roots and the response of soil microorganisms: a review and hypothesis. *New Phytologist* 2000;127(1):201-222.
	3	3 cites in December 2001	Watts JW, et al. Thermal, mixing, and oxygen regimes of the Salton Sea, California, 1997-1999. *Hydrobiologia* 2001;466(1-3):159-176.
	3	10 cites in October 2001	Glasgow HB, et al. A second species of ichthyotoxic Pfiesteria (Dinamoebales, Dinophyceae). *Phycologia* 2001;40(3):234-245.
	3	3 cites in April 2002	Rogerson A, Hauer G. Naked amoebae (Protozoa) of the Salton Sea, California. *Hydrobiologia* 2002;473(1-3):161-177.
	6	6 cites in August-September 2004	Brooks JR, et al. Hydraulic redistribution of soil water during summer drought in two contrasting Pacific Northwest coniferous forests. *Tree Physiology* 2002;22(15-16):1107-1117.
	3	4 cites in April 2002	Wiens JA. Riverine landscapes: taking landscape ecology into the water. *Freshwater Biology* 2002;47(4):501-515.

Field	*ESI* Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
	3	4 cites in April 2003	Breitburg DL, et al. The pattern and influence of low dissolved oxygen in the Patuxent River, a seasonally hypoxic estuary. *Estuaries* 2003;26(2A):280-297.
	3	4 cites in December 2003	Hubert TD. Environmental fate and effects of the lampricide TFM: a review. *Journal of Great Lakes Research* 2003;29(Suppl 1):456-474.
Plant & Animal Science	4	5 cites in August-September 2004	Trudell SA, et al. Nitrogen and carbon stable isotope abundances support the myco-heterotrophic nature and host-specificity of certain achlorophyllous plants. *New Phytologist* 2003;160(2):391-401.
	3	5 cites in September 2005	Groffman PM, et al. N processing within geomorphic structures in urban streams. *Journal of the North American Benthological Society* 2005;24(3):613-625.
	3	3 cites in December 2005	Rocke T, et al. The impact of disease in the American White Pelican in North America. *Waterbirds* 2005;28(Sp Iss 1):87-94.
	3	4 cites in December 2006	Wang L, et al. Effects of levels of human disturbance on the influence of catchment, riparian, and reach-scale factors on fish assemblages. *American Fisheries Society Symposium* 2006;2006(48):199-219.
	3	5 cites in December 2006	Herlihy AT, et al. Landscape clusters on fish assemblages in the conterminous USA and their relationship to existing landscape classifications. *American Fisheries Society Symposium* 2006;2006(48):87-112.
	3	8 cites in December 2006	Kaufmann PR, Hughes RM. Geomorphic and anthropogenic influences on fish and amphibians in Pacific Northwest coastal streams. *American Fisheries Society Symposium* 2006;2006(48):429-455.
Social Sciences, general	4	4 cites in November 2002	Irwin EG, Bockstael NE. Interacting agents, spatial externalities and the evolution of residential land use patterns. *Journal of Economic Geography* 2002;2(1):31-54.
	3	3 cites in August-September 2004	Drake JM. Allee effects and the risk of biological invasion. *Risk Analysis* 2004;24(4):795-802.
	4	4 cites in December 2005	Neubert MG, Parker IM. Projecting rates of spread for invasive species. *Risk Analysis* 2004;24(4):817-831.

Author Self-Citation

Self-citations are journal article references to articles from that same author (i.e., the first author). Because higher author self-citation rates can inflate the number of citations, the author self-citation rate was calculated for the ecological papers. Of the 25,677 total cites, 1,237 are author self-cites—a 4.8% author self-citation rate. Garfield and Sher[3] found that authors working in research-based disciplines tend to cite themselves on the average of 20% of the time. MacRoberts and MacRoberts[4] claim that approximately 10% to 30% of all the citations listed fall into the category of author self-citation. Kovacic and Misak[5] recently reported a 20% author self-citation rate for medical literature. Therefore, the 4.8% self-cite rate for the ecological papers is well below the range for author self-citation.

Highly Cited Researchers

A search of Thomson's *ISIHighlyCited.com* revealed that 84 (1.84%) of the 4,572 authors of the ecological papers are highly cited researchers. *ISIHighlyCited.com* is a database of the world's most influential researchers who have made key contributions to science and technology during the period from 1981 to 1999. The highly cited researchers identified during this analysis of the ecological publications are presented in Table 21.

Table 21. Highly Cited Researchers Authoring Ecological Publications

Highly Cited Researcher	Affiliation	*ESI* Field
Aber, John D.	University of New Hampshire	Environment/Ecology
Allen, Herbert E.	University of Delaware	Environment/Ecology
Anderson Donald M.	Woods Hole Oceanographic Institution	Plant & Animal Science
Ankley, Gerald	U.S. Environmental Protection Agency	Environment/Ecology
Berk, Richard A.	University of California–Los Angeles	Social Sciences, general
Brown, Sandra	Winrock International	Environment/Ecology
Callaghan, Terry V.	University of Sheffield	Environment/Ecology
Campana, Steven E.	Bedford Institute of Oceanography	Plant & Animal Science
Canham, Charles D.	Institute of Ecosystem Studies	Environment/Ecology
Carpenter, Stephen R.	University of Wisconsin	Environment/Ecology
Christensen, Thomas H.	Technical University of Denmark	Environment/Ecology

[3] Garfield E, Sher IH. New factors in the evaluation of scientific literature through citation indexing. *American Documentation* 1963;18(July):195-210.

[4] MacRoberts MH, MacRoberts BR. Problems of citation analysis: a critical review. *Journal of the American Society of Information Science* 1989;40(5):342-349.

[5] Kavaci N, Misak A. Author self-citation in medical literature. *Canadian Medical Association Journal* 2004;170(13):1929-1930.

Highly Cited Researcher	Affiliation	*ESI* Field
Cole, Jonathan J.	Institute of Ecosystem Studies	Plant & Animal Science
Coleman, David C.	University of Georgia	Environment/Ecology
Colwell, Rita R.	Canon U.S. Life Sciences, Inc.	Microbiology
Cosby, Bernard Jackson	University of Virginia	Environment/Ecology
Costanza, Robert	Gund Institute for Ecological Economics	Environment/Ecology
Cressie, Noel	Ohio State University	Mathematics
David, Mark B.	University of Illinois at Urbana–Champaign	Environment/Ecology
DiToro, Dominic M.	University of Delaware	Environment/Ecology
Driscoll, Charles T.	Syracuse University	Environment/Ecology
Ellstrand, Norman C.	University of California–Riverside	Environment/Ecology
Estes, Mary Clarke Kolb	Baylor College of Medicine	Microbiology
Galloway, James Neville	University of Virginia	Environment/Ecology
Gaston, Kevin J.	University of Sheffield	Environment/Ecology
Gelfand, Alan E.	Duke University	Mathematics
Gray, Jr., Leon Earl	U.S. Environmental Protection Agency	Pharmacology
Groffman, Peter Mark	Institute of Ecosystem Studies	Environment/Ecology
Gschwend, Philip Michael	Massachusetts Institute of Technology	Environment/Ecology Engineering
Guillette, Louis J.	University of Florida	Environment/Ecology
Hites, Ronald Atlee	Indiana University School of Public and Environmental Affairs	Environment/Ecology
Hobbs, Richard J	Murdoch University	Environment/Ecology
Holt, Robert D.	University of Florida	Environment/Ecology
Hornberger, George M.	University of Virginia	Environment/Ecology
Howarth, Robert W.	Cornell University	Environment/Ecology
Huston, Michael A.	Texas State University	Environment/Ecology
Jacob, Daniel J.	Harvard University	Geosciences
Johnson, Dale W.	University of Nevada–Reno	Environment/Ecology

Highly Cited Researcher	Affiliation	*ESI* Field
Koutrakis, Petros	Harvard School of Public Health	Environment/Ecology
Lauenroth, William K.	Colorado State University	Environment/Ecology
Likens, Gene E.	Institute of Ecosystem Studies	Environment/Ecology
Lippmann, Morton	Nelson Institute of Environmental Medicine	Environment/Ecology
Luthy, Richard G.	Stanford University	Environment/Ecology
McLachlan, John A.	Tulane University	Environment/Ecology
McWilliams, James C.	University of California–Los Angeles	Geosciences
Morel, François	Princeton University	Environment/Ecology
Muir, Derek C.G.	Environment Canada	Environment/Ecology
Nadelhoffer, Knute J.	University of Michigan	Environment/Ecology
Naiman, Robert J.	University of Washington	Environment/Ecology
Noss, Reed Frederick	University of Central Florida	Environment/Ecology
O'Neill, Robert V.	Oak Ridge National Laboratory	Environment/Ecology
Oechel, Walter C.	San Diego State University	Environment/Ecology
Ojima, Dennis Shoji	Colorado State University	Environment/Ecology
Pace, Michael L.	Institute of Ecosystem Studies	Plant & Animal Science
Paerl, Hans E.	University of North Carolina–Chapel Hill Institute of Marine Sciences	Plant & Animal Science
Pankow, James F.	Oregon Health and Science University	Environment/Ecology
Parton, William J.	Colorado State University	Environment/Ecology
Peterson, Bruce J.	Marine Biological Laboratory–Woods Hole	Environment/Ecology
Peterson, Richard E.	University of Wisconsin–Madison	Pharmacology
Pielke, Sr., Roger A.	University of Colorado	Geosciences
Pressey, Robert L.	Department of Environment and Conservation, Australia	Environment/Ecology
Prospero, Joseph M.	University of Miami	Geosciences
Reddy, K. Ramesh	University of Florida	Environment/Ecology
Running, Steven W.	University of Montana	Environment/Ecology
Sala, Osvaldo E.	Brown University	Environment/Ecology

Highly Cited Researcher	Affiliation	*ESI* Field
Schimel, David S.	National Center for Atmospheric Research	Environment/Ecology
Schlesinger, William H.	Duke University	Environment/Ecology
Schwarzenbach, René P.	Vorsteher Institut für Gewässerschutz und Wassertechnologie	Environment/Ecology
Sharpley Andrew N.	USDA Agricultural Research Service	Environment/Ecology
Shaver, Gaius R.	Marine Biological Laboratory	Environment/Ecology
Sih, Andrew	University of California–Davis	Environment/Ecology
Smol, John P.	Queen's University	Plant & Animal Science
Stahl, David Allan	University of Washington	Microbiology
Stoecker, Diane K.	University of Maryland Center for Environmental Studies	Plant & Animal Science
Thompson, John N.	University of Californinia–Santa Cruz	Environment/Ecology
Tiedje, James M.	Michigan State University	Environment/Ecology
Traina, Samuel Justin	University of California–Merced	Environment/Ecology
Turco, Richard P.	University of California–Los Angeles	Geosciences
Turner, Monica G.	University of Wisconsin–Madison	Environment/Ecology
Walker, Lawrence R.	University of Nevada–Las Vegas	Environment/Ecology
Warwick, Richard M.	Plymouth Marine Laboratory	Plant & Animal Science
Whitford, Walter G.	U.S. Department of Agriculture–Las Cruces, NM	Environment/Ecology
Wiens, John A.	Nature Conservancy	Environment/Ecology
Wofsy, Steven C.	Harvard University	Geosciences
Zepp, Richard G.	U.S. Environmental Protection Agency	Environment/Ecology
Total = 84		

Patents

There was 1 patent issued and 1 patent application filed by investigators from 1996 to 2006 for research that was conducted under EPA's ecological research program. The patent and patent application are listed in Table 22.

Table 22. Patent and Patent Application from the Ecological Research Program (1996-2006)

Patent or Patent Application No.	Inventor(s)	Title	Patent/Patent Application Date	Patents that Referenced This Patent
U.S. Patent Application No. 20020182739	Sadik O, Breimer M, Masila M	Rapid detection of aromas using integrated gas chromatography with multiarray sensors	December 5, 2002	None
World Patent No. 2006037226	Cohen N Nadeau JL	Use of quantum dots for biological labels and sensors	April 13, 2006	None

Books, Book Chapters, and Reports

Fifteen books, 74 book chapters, and 3 reports produced by the program from 1996 to 2006 were included in the analysis. Of these publications, the books were cited 1,082 times with 12 (1.11%) self-cites, the book chapters were cited 582 times with 29 (4.74%) self-cites, and the reports were cited 166 times with 0 (0%) self-cites. There is no *ESI* benchmark against which to measure these data.

This bibliometric analysis was prepared by
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