

Bibliometric Analysis for Papers on Topics Related to Water Quality Research (Papers Published 1995 to 1999)

This is a bibliometric analysis of the papers prepared by intramural and extramural researchers of the U.S. Environmental Protection Agency (EPA) on topics related to water quality research that were published from 1995 to 1999. For this analysis, 294 papers were reviewed.¹ These 294 papers were cited 7,687 times in the journals covered by Thomson's Web of Science.² Of these 294 papers, 289 (98.3%) have been cited at least once in a journal.

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. The chief indicators of output, or productivity, are journal article publication counts. For influence and impact measures, ESI employs both total citation counts and cites per paper scores. The former reveals gross influence while the latter shows weighted influence, also called impact. JCR 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.

Summary of Analysis

Nearly one-quarter of the water quality publications are highly cited papers. A review of the citations indicates that 73 (24.8%) of the water quality papers qualify as highly cited when using the ESI criteria for the top 10% of highly cited publications. Eleven (3.7%) of the water quality papers qualify as highly cited when using the criteria for the top 1%. Three (1.0%) of the water quality papers qualify as very highly cited (in the top 0.1%), and two (0.7%) actually meet the top 0.01% threshold.

The water quality papers are more highly cited than the average paper. Using the ESI average citation rates for papers published by field as the benchmark, in 7 of the 7 fields in which the EPA water quality papers were published, the ratio of actual to expected cites is greater than 1, indicating that the water quality papers are more highly cited than the average papers in those fields.

More than one-eighth of the water quality papers are published in very high impact journals. Thirty-nine (39) of 294 papers were published in the top 10% of journals ranked by JCR Impact Factor, representing 13.3% of EPA's water quality papers. Approximately one-

¹ The number of publications analyzed does not include all of the papers published by EPA's Water Quality Research Program from 1995 to 1999. It includes only those identified by the National Health and Environmental Effects Research Laboratory and the National Center for Environmental Research.

² Thomson's *Web of Science* provides access to current and retrospective multidisciplinary information from approximately 8,500 of the most prestigious, high impact research journals in the world. *Web of Science* also provides cited reference searching.

eighth of the water quality papers are published in the top 10% of journals ranked by JCR Immediacy Factor. Twenty-nine (29) of the 294 papers appear in the top 10% of journals, representing 9.9% of EPA’s water quality papers.

Seven of the water quality publications qualified as 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. Using the current hot paper thresholds established by ESI as a benchmark, seven of the water quality papers, representing 2.4% of the water quality publications, were identified as hot papers in the analysis.

The authors of the water quality papers cite themselves less than the average self-citation rate. Two hundred-nineteen (219) of the 7,687 cites are author self-cites. This 2.8% author self-citation rate is well below the accepted range of 10-30% author self-citation rate.

Highly Cited Water Quality Publications

The 294 water quality papers reviewed for this analysis covered 7 of the 22 ESI fields of research. The distribution of the papers among these 7 fields and the number of citations by field are presented in Table 1.

Table 1. Water Quality Papers by ESI Fields

No. of Citations	ESI Field	No. of EPA Water Quality Papers	Average Cites/Paper
6,512	Environment/Ecology	238	27.36
324	Engineering	17	19.06
298	Pharmacology & Toxicology	14	21.28
234	Biology & Biochemistry	7	33.43
183	Microbiology	8	22.88
72	Plant & Animal Science	5	14.40
64	Chemistry	5	12.80
Total = 7,687		Total = 294	26.15

There were 73 (24.8% of the papers analyzed) highly cited EPA water quality papers in 7 of the 7 fields—Environment/Ecology, Engineering, Pharmacology & Toxicology, Biology & Biochemistry, Microbiology, Plant & Animal Science, and Chemistry—when using the ESI criteria for the **top 10% of papers**. Table 2 shows the number of EPA papers in those seven fields that met the **top 10% threshold in ESI**.

Eleven (3.7%) of the papers analyzed qualified as highly cited when using the ESI criteria for the **top 1% of papers**. This number is nearly four times higher than would be expected. These papers were categorized in the fields of Environment/Ecology and Engineering. Three (1.0%) of the papers qualified as very highly cited when using the ESI criteria for the **top 0.1% of papers**, and two of these papers (Van den Berg and Daughton) actually met ESI's highest threshold for very highly cited papers (**top 0.01%**). These numbers are 10 times higher (for the top 0.1%) and 68 times higher (for the top 0.01%) than would be expected. Tables 3, 4 and 5 report the number of papers that met the **top 1% threshold in ESI**, the **top 0.1% threshold in ESI**, and the **top 0.01% threshold in ESI**, respectively. The citations for the highly cited papers in the top 1% are presented in Tables 6 and 7, and the citations for the very highly cited papers in the top 0.1% are listed in Table 8.

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

No. of Citations	ESI Field	No. of Papers	Average Cites/Paper	% of EPA Papers in Field
4,580	Environment/Ecology	55	83.27	23.11%
270	Engineering	9	30.00	52.94%
222	Pharmacology & Toxicology	5	44.40	35.71%
155	Biology & Biochemistry	1	155.00	14.29%
54	Microbiology	1	54.00	12.50%
37	Chemistry	1	37.00	20.00%
26	Plant & Animal Science	1	26.00	20.00%
Total = 5,344		Total = 73	73.20	

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

No. of Citations	ESI Field	No. of Papers	Average Cites/Paper	% of EPA Papers in Field
2,188	Environment/Ecology	8	273.50	3.36%
148	Engineering	3	49.33	17.65%
Total = 2,336		Total = 11	212.36	

Table 4. Number of Highly Cited Water Quality Papers by Field (top 0.1%)

No. of Citations	ESI Field	No. of Papers	Average Cites/Paper	% of EPA Papers in Field
1,419	Environment/Ecology	3	473.00	1.26%
Total = 1,419		Total = 3	473.00	

Table 5. Number of Highly Cited Water Quality Papers by Field (top 0.01%)

No. of Citations	ESI Field	No. of Papers	Average Cites/Paper	% of EPA Papers in Field
1,115	Environment/Ecology	2	557.50	0.84%
Total = 1,115		Total = 2	557.50	

Table 6. Citations of Highly Cited Water Quality Papers in the Field of Environment/Ecology (top 1%)

No. of Cites	First Author	Paper
792	Van den Berg M	Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. <i>Environmental Health Perspectives</i> 1998;106(12):775-792.
323	Daughton CG	Pharmaceuticals and personal care products in the environment: agents of subtle change? <i>Environmental Health Perspectives</i> 1999;107(Suppl 6):907-938.
304	Howarth RW	Regional nitrogen budgets and riverine N&P fluxes for the drainages to the North Atlantic Ocean: natural and human influences. <i>Biogeochemistry</i> 1996;35(1):75-139.
230	Folmar LC	Vitellogenin induction and reduced serum testosterone concentrations in feral male carp (<i>Cyprinus carpio</i>) captured near a major metropolitan sewage treatment plant. <i>Environmental Health Perspectives</i> 1996;104(10):1096-1101.
170	Poff NL	Functional-organization of stream fish assemblages in relation to hydrological variability. <i>Ecology</i> 1995;76(2):606-627.
130	Boynton WR	Inputs, transformations, and transport of nitrogen and phosphorus in Chesapeake Bay and selected tributaries. <i>Estuaries</i> 1995;18(1B):285-314.
128	Ankley GT	Technical basis and proposal for deriving sediment quality criteria for metals. <i>Environmental Toxicology and Chemistry</i> 1996;15(12):2056-2066.

No. of Cites	First Author	Paper
111	Erickson RJ	The effects of water chemistry on the toxicity of copper to fathead minnows. <i>Environmental Toxicology and Chemistry</i> 1996;15(2):181-193.

Table 7. Citations of Highly Cited Water Quality Papers in the Field of Engineering (top 1%)

No. of Cites	First Author	Paper
57	Jaworski NA	Atmospheric deposition of nitrogen oxides onto the landscape contributes to coastal eutrophication in the northeast United States. <i>Environmental Science & Technology</i> 1997;31(7):1995-2004.
50	Ankley GT	Effects of light-intensity on the phototoxicity of fluoranthene to a benthic macroinvertebrate. <i>Environmental Science & Technology</i> 1995;29(11):2828-2833.
41	Montgomery DR	Process domains and the river continuum. <i>Journal of the American Water Resources Association</i> 1999;35(2):397-410.

Table 8. Citations of Very Highly Cited Water Quality Papers (top 0.1%)

Field	No. of Cites	First Author	Paper
Environment/Ecology	792	Van den Berg M	Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. <i>Environmental Health Perspectives</i> 1998;106(12):775-792.
	323	Daughton CG	Pharmaceuticals and personal care products in the environment: agents of subtle change? <i>Environmental Health Perspectives</i> 1999;107(Suppl 6):907-938.
	304	Howarth RW	Regional nitrogen budgets and riverine N&P fluxes for the drainages to the North Atlantic Ocean: natural and human influences. <i>Biogeochemistry</i> 1996;35(1):75-139.

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 seven of the seven fields in which the EPA water quality papers were published, the ratio of actual to expected cites is greater than 1, indicating that the EPA papers are more highly cited than the average papers in those fields (see Table 9).

Table 9. Ratio of Average Cites to Expected Cites for Water Quality Papers by Field

ESI Field	Total Cites	Expected Cite Rate	Ratio
Environment/Ecology	6,512	2,989.26	2.18
Engineering	324	82.84	3.91
Pharmacology & Toxicology	298	189.02	1.58
Biology & Biochemistry	234	160.67	1.46
Microbiology	183	167.25	1.09
Plant & Animal Science	72	44.03	1.64
Chemistry	64	59.53	1.08

JCR Benchmarks

The 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 10 indicates the number of water quality papers published in the top 10% of journals, based on the JCR Impact Factor. Thirty-nine (39) of 294 papers were published in the top 10% of journals, representing 13.3% of EPA's water quality papers. This exceeds the expected number of 29 papers (10%) published in the top 10% of high impact journals.

Table 10. Water Quality Papers in Top 10% of Journals by JCR Impact Factor

EPA Water Quality Papers in that Journal	Journal	Impact Factor (IF)	JCR IF Rank
11	Environmental Science & Technology	3.557	540
10	Limnology and Oceanography	3.024	737
7	Environmental Health Perspectives	3.929	439
6	Applied and Environmental Microbiology	3.810	470
2	Ecological Applications	3.287	623
1	Analytical Chemistry	5.450	243
1	Ecology	4.104	394
1	Toxicological Sciences	3.391	591
Total = 39			

Immediacy Index

The journal 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 11 indicates the number of EPA water quality papers published in the top 10% of journals, based on the JCR Immediacy Index. Twenty-nine (29) of the 294 papers appear in the top 10% of journals, representing 9.9% of EPA’s water quality papers. This is equivalent to the expected number of 29 papers (10%) published in the top 10% of high impact journals.

Table 11. Water Quality Papers in Top 10% of Journals by JCR Immediacy Index

EPA Water Quality Papers in that Journal	Journal	Immediacy Index (II)	JCR II Rank
11	Environmental Science & Technology	0.623	617
7	Environmental Health Perspectives	1.202	202
2	Ecological Applications	0.747	466
2	Hydrobiologia	0.681	532
1	Freshwater Biology	0.664	558
1	Analytical Chemistry	0.885	346

EPA Water Quality Papers in that Journal	Journal	Immediacy Index (II)	JCR II Rank
1	Ecology	0.590	676
1	Ecotoxicology	1.450	151
1	Climatic Change	1.235	195
1	Ambio	1.435	156
1	X-Ray Spectrometry	0.580	685
Total = 29			

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 most recently completed 2-month period (i.e., September-October 2005), but there were two hot papers identified from previous periods.

Using the current hot paper thresholds established by ESI as a benchmark, seven of the water quality papers, representing 2.4% of the water quality publications, were identified in the field of Environment/Ecology. The hot papers are listed in Table 12.

Table 8. Hot Papers Identified Using Current ESI Thresholds

Field	ESI Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Environment/ Ecology	7	20 cites in November-December 2000	Van den Berg M, et al. Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. <i>Environmental Health Perspectives</i> 1998;106(12):775-792.
	8	13 cites in December 1996	Berry WJ, et al. Predicting the toxicity of metal-spiked laboratory sediments using acid-volatile sulfide and interstitial water normalizations. <i>Environmental Toxicology and Chemistry</i> 1996;15(12):2067-2079.

Field	ESI Hot Papers Threshold	No. of Cites in 2-Month Period	Paper
Environment/ Ecology	8	11 cites in December 1996	Hansen DJ, et al. Chronic effect of cadmium in sediments on colonization by benthic marine organisms: an evaluation of the role of interstitial cadmium and acid-volatile sulfide in biological availability. <i>Environmental Toxicology and Chemistry</i> 1996;15(12):2126-2137.
	8	10 cites in December 1996	Hansen DJ, et al. Predicting the toxicity of metal-contaminated field sediments using interstitial concentration of metals and acid-volatile sulfide normalizations. <i>Environmental Toxicology and Chemistry</i> 1996;15(12):2080-2094.
	7	10 cites in November-December 1996	Pesch CE, et al. The role of acid volatile sulfide and interstitial water metal concentrations in determining bioavailability of cadmium and nickel from contaminated sediments to the marine polychaete <i>Neanthes arenaceodentata</i> . <i>Environmental Toxicology and Chemistry</i> 1995;14(1):129-141.
	8	9 cites in December 1996	Liber K, et al. Effects of acid-volatile sulfide on zinc bioavailability and toxicity to benthic macroinvertebrates: a spiked-sediment field experiment. <i>Environmental Toxicology and Chemistry</i> 1996;15(12):2113-2125.
	6	6 cites in July-August 1997	Howarth RW. Regional nitrogen budgets and riverine N&P fluxes for the drainages to the North Atlantic Ocean: natural and human influences. <i>Biogeochemistry</i> 1996;35(1):75-139.

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 water quality papers. Of the 7,687 total cites, 219 are author self-cites—a 2.8% author self-citation rate. Garfield and Sher³ found that authors working in research-based disciplines tend to cite themselves on the average of 20% of the time. MacRoberts and MacRoberts⁴ claim that approximately 10% to 30% of all the citations listed

³ Garfield E, Sher IH. New factors in the evaluation of scientific literature through citation indexing. *American Documentation* 1963;18(July):195-201.

⁴ MacRoberts MH, MacRoberts BR. Problems of citation analysis: a critical review. *Journal of the American*

fall into the category of author self-citation. Therefore, the 2.8% self-cite rate for the water quality papers is well below the range for author self-citation.