Current Comments®

EUGENE GARFIELD
INSTITUTE FOR SCIENTIFIC INFORMATION®
3501 MARKET ST., PHILADELPHIA, PA 19104

Journal Citation Studies. 47. Which Oceanography Journals Make the Biggest Waves?

Number 48 November 30, 1987

Our last journal citation study—a three-part examination of physical-chemistry and chemical-physics journals—was published in January 1986.[1] In the two years before that we focused on surgery,[2] nursing,[3] and astrosciences journals.[4] Our focus for this study is a group of 21 significant journals in the field of oceanography.

Each of these journal studies relies on ISI®'s *Journal Citation Reports®* (*JCR®*), an annual compilation of citation links between journals that is derived from the *Science Citation Index®* (*SCI®*) database. (ISI also compiles a *JCR* for the *Social Sciences Citation Index®*.) Studying the citation linkages of a field on the journal level constitutes a moderately aggregated type of citation analysis—somewhere between that conducted for determining the global science enterprise and that for examining the work and impact of an individual researcher.

In each study, after assembling a group of core journals for a given field, we treat the set as a single macrojournal of that field. We then determine which journals the macrojournal cites and which journals cite it. Typically, we look at most-cited papers from the core journals as well.

Oceanography encompasses several distinct (and sometimes overlapping) subfields. There is geological oceanography, as well as physical, chemical, ecological, and biological, both faunal and floral, among others.

The nomenclature used to describe the general field, however, is not precise. William A. Nierenberg, director emeritus, Scripps Institution of Oceanography, University of California, San Diego, has observed: "Some writers have separated marine biology from oceanography (implying the term oceanography to embrace primarily physical oceanography, bottom relief, and sediments)."[5] He added that in such cases the designation "oceanology" is often used "as embracing all the science divisions of the marine hydrosphere."[5] For the purposes of this study, oceanography means, in general, chemical and physical oceanography. Marine biology is excluded. In the next few years, however, I hope to update a paper on the journal literature of marine biology, which I delivered at the 14th Pacific Science Congress, September 1979, held in Khabarovsk, USSR, and which was subsequently published in the Soviet journal *Biologiya Morya* in 1980.[6]

The data presented here were compiled by Elizabeth Fuseler-McDowell, ISI's manager of bibliographic research. She recently participated in the annual meeting of the International Association of Marine Science Libraries and Information Centers, held in Halifax, Nova Scotia, and delivered a lecture entitled "High Impact Journals in Oceanography." In her talk, Fuseler-McDowell quoted more detailed information than I am providing in this essay. Those who are interested in her in-depth treatment should consult her paper, which is to be published in the conference's proceedings volume.[7]

Table 1: Core journals in oceanography, listed alphabetically, with the year that each began publication, the editor(s), and the publisher.

Australian Journal of Marine and Freshwater Research (1950)
L.A. Bennett & M.F. Dobbie, eds.
CSIRO
Melbourne, Australia

Bulletin of Marine Science (1951)
W.J. Richards, ed.
Rosenstiel School of Marine and Atmospheric Science
Miami, FL

Continental Shelf Research (1982)
M.B. Collins & R.W. Sternberg, eds.
Pergamon Press
Oxford, United Kingdom

Deep-Sea Research Part A—Oceanographic Research Papers (1953)
J.D. Milliman, ed.
Pergamon Press
Elmsford, NY

Estuarine, Coastal and Shelf Science (1973)
Editorial Board
Academic Press, Inc.
London, United Kingdom

Helgolander Meeresuntersuchungen (1937)
H.P. Bulnheim, ed.
Biologische Anstalt Helgoland
Hamburg, Federal Republic of Germany

Initial Reports of the Deep Sea Drilling Project (1969)
J.H. Blakeslee & E. Whalen, eds.
Government Printing Office
Washington, DC

Izvestiya Akademii Nauk SSSR, Fizika Atmosfery i Okeana (1965)
A.M. Oboukhov, ed.
Akademiya Nauk SSSR
Moscow, USSR

Journal of Geophysical Research—Oceans (1984)
J.J. O'Brien, ed.
American Geophysical Union
Washington, DC

Journal of Marine Research (1937)
G. Veronis, ed.
Kline Geology Laboratory
Yale University
New Haven, CT

Journal of Physical Oceanography (1971)
R.L. Haney & E.J. Katz, eds.
American Meteorological Society
Boston, MA

Journal of the Oceanographical Society of Japan (1941)
K. Saruhashi, ed.
Oceanographical Society of Japan
Tokyo, Japan

Limnology and Oceanography (1956)
P.A. Jumars, ed.
American Society of Limnology and Oceanography, Inc.
Grafton, WI

Marine Chemistry (1972)
P.J. Wangersky, ed.
Elsevier Science Publishers
Amsterdam, The Netherlands

Marine Ecology—Progress Series (1979)
O. Kinne, ed.
Inter-Research
Amelinghausen, Federal Republic of Germany

Marine Geology (1964)
D.A. McManus, ed.
Elsevier Science Publishers
Amsterdam, The Netherlands

Netherlands Journal of Sea Research (1961)
J.J. Beukema, ed.
Netherlands Institute for Sea Research
Texel, The Netherlands

Oceanography and Marine Biology (1963)
H. Barnes, ed.
Aberdeen University Press
Aberdeen, United Kingdom

Oceanologica Acta (1978)
J. Boutler, ed.
C.D.R.—Centrale des Revues
Montrouge, France

Okeanologiya (1961)
L.A. Zenkevich, ed.
Akademiya Nauk SSSR
Moscow, USSR

Progress in Oceanography (1963)
M.V. Angel & R.L. Smith, eds.
Pergamon Press
Elmsford, NY

Drilling for the Core Journals of Oceanography

Table 1 lists the 21 core oceanography journals selected for this study. Clearly, this group does not represent all the field's journals nor does it include journals from other disciplines that publish oceanography articles. It does not even include all 40 journals listed in the 1986 *JCR* under the heading "oceanography." Rather, we have chosen these 21 as oceanography's *most significant* journals. They are, if you will, the *crème de la crème*.

To determine which are the most significant, we examined the citations received by

Table 2: The 51 journals most cited by core oceanography journals in the 1986 *SCI*®. Asterisks (*) indicate core journals. A=citations from core journals. B=citations from all journals. C=self-citations. D=percent of total citations that are core-journal citations (A/B). E=percent of total citations that are self-citations (self-cited rate, C/B). F=percent of core-journal citations that are self-citations (C/A). G= 1986 impact factor. H=1986 immediacy index. I=1986 total source items.

	A	B	C	D	E	F	G	H	I
*Limnol. Oceanogr.	2,196	7,283	699	30.15	9.60	31.83	3.120	0.813	128
*J. Phys. Oceanogr.	2,156	2,966	977	72.69	32.94	45.32	1.967	1.053	150
J. Geophys. Res.	2,010	29,841	—	6.74	—	—	6.133	2.102	443
*Deep-Sea Res. Pt. A—Oceanogr. Res.	1,743	3,166	424	55.05	13.39	24.33	2.092	0.639	108
Mar. Biol.	1,647	6,048	—	27.23	—	—	1.892	0.455	235
*Initial Rep. Deep Sea Drill. Pr.	1,321	3,177	1,118	41.58	35.19	84.63	0.757	0.240	200
Nature	1,018	147,048	—	0.69	—	—	15.252	3.255	1,165
Science	1,009	91,449	—	1.10	—	—	12.437	3.004	803
*J. Mar. Res.	995	1,876	93	53.04	4.96	9.35	2.515	0.382	34
*Mar. Ecol.—Progr. Ser.	921	2,409	501	38.23	20.80	54.40	2.172	0.360	225
Geochim. Cosmochim. Acta	761	9,966	—	7.64	—	—	3.020	0.742	248
J. Exp. Mar. Biol. Ecol.	699	2,882	—	24.25	—	—	1.482	0.251	179
Earth Planet. Sci. Lett.	584	7,910	—	7.38	—	—	3.173	0.758	182
*Estuar. Coast. Shelf Sci.	544	1,368	175	39.77	12.97	32.17	1.079	0.212	104
*Mar. Geology	511	1,599	244	31.96	15.26	47.75	1.236	0.435	85
J. Mar. Biol. Assn. UK	506	2,501	—	20.23	—	—	1.124	0.397	63
Ecology	477	9,503	—	5.02	—	—	2.633	0.514	175
*Izv. Akad. Nauk SSSR Fiz. Atm. Ok.	452	642	396	70.74	61.68	87.61	0.263	0.080	187
J. Fluid Mech.	395	8,569	—	4.61	—	—	1.509	0.457	289
Geol. Soc. Amer. Bull.	348	6,190	—	5.62	—	—	2.163	0.680	128
Appl. Environ. Microbiol.	343	9,214	—	3.72	—	—	2.126	0.339	522
*Aust. J. Mar. Freshwater Res.	329	904	152	36.39	16.81	46.20	0.879	02.68	63
†J. Fish. Res. Board Can.	319	4,402	—	7.25	—	—	—	—	0
*Bull. Mar. Sci.	305	916	137	33.30	14.96	44.92	0.794	0.926	81
J. Sediment. Petrol.	305	2,684	—	11.36	—	—	1.333	0.258	97
†Can. J. Fisheries Aquat. Sci.	294	3,126	—	9.40	—	—	1.790	0.635	288
*Mar. Chem.	291	835	154	34.85	18.44	52.92	1.825	0.308	65
Biol. Bull.	283	3,066	—	9.23	—	—	1.738	0.365	85
Oecologia	277	5,219	—	5.31	—	—	1.727	0.271	295
Amer. Naturalist	273	6,708	—	4.07	—	—	2.878	0.510	143
*Okeanologiya SSSR	266	485	160	54.85	32.99	60.15	0.236	0.094	149
*Oceanol. Acta	229	603	47	37.98	7.79	20.52	1.105	0.315	54
J. Atmos. Sci.	223	5,711	—	3.90	—	—	1.714	0.522	186
*Neth. J. Sea Res.	223	603	75	36.98	12.44	33.63	0.743	0.333	30
AAPG Bull.—Amer. Assn. Petrol. G.	220	3,449	—	6.38	—	—	1.619	0.330	100
Trans. Amer. Geophys. Un.	219	2,723	—	8.04	—	—	—	—	0
J. Phycol.	214	2,005	—	10.67	—	—	1.431	0.222	81
J. Plankton Res.	211	722	—	29.22	—	—	1.688	0.250	88
Mon. Weather Rev.	210	3,488	—	6.02	—	—	1.524	0.395	172
*Helgolander Meeresunters.	209	703	61	20.73	8.68	29.19	1.112	0.182	22
*J. Geophys. Res.—Oceans	209	283	105	73.85	37.10	50.24	0.703	0.171	193
Fish. Bull.	208	1,186	—	17.54	—	—	0.640	0.234	94
Ecol. Monogr.	194	2,469	—	7.86	—	—	5.658	1.111	18
Environ. Sci. Technol.	193	4,669	—	4.13	—	—	2.735	0.416	197
*Cont. Shelf Res.	184	219	159	84.02	72.60	86.41	0.449	2.145	69
*Prog. Oceanogr.	180	311	6	57.88	1.93	3.33	2.000	0.714	7
Tellus	172	1,237	—	13.90	—	—	—	—	0
Arch. Hydrobiol.	149	1,822	—	8.18	—	—	0.965	0.423	104
Geology	148	2,954	—	5.01	—	—	2.182	0.418	232
Hydrobiologia	142	2,313	—	6.14	—	—	0.579	0.309	375
Rev. Geophys.	142	1,980	—	7.17	—	—	3.774	1.667	33

†J. Fish. Res. Board Can. changed its title to Can. J. Fisheries Aquat. Sci. in 1980.

and given out by all 40 *JCR*-listed journals. In addition to citation frequencies, we also examined impact factors and immediacy indexes, which I will describe shortly.

The oldest journals in the group are the *Journal of Marine Research* and *Helgoländer Meeresuntersuchungen*, both launched in 1937. The most recently appearing is the *Journal of Geophysical Research—Oceans*, which grew out of the splintering into separate sections of the *Journal of Geophysical Research* in 1984. (Since many authors continue to cite the offshoot journals simply as the *Journal of Geophysical Research*, we cannot determine in those instances which are citations to *Oceans*; however, if the *Oceans* section was explicitly cited, we kept those citations apart. Thus, both the parent journal and the offspring *Oceans* appear in our tables. If precise citations to *Oceans* were available, it would undoubtedly have ranked even higher than it does now.)

Eleven of the core journals are published in the US and UK, three in The Netherlands, two each in the Federal Republic of Germany and the USSR, and one each in Australia, France, and Japan. Twelve are published in English, two in Russian, and seven are multilingual (with English common to all in the multilingual set).

Although it is not yet indexed in any ISI product, the *Journal of the Oceanographical Society of Japan* is included in the core list in Table 1. (We are now evaluating coverage of this journal.) While we do not process the references contained in this Japanese journal, we do, of course, index citations to it from the other journals. It serves in this study as a representative oceanography journal from an Asian nation.

A Macrojournal of Oceanography

In 1986 the 21 core journals collectively published about 2,000 source items processed in the *JCR*—articles and review articles, for example, but not editorials, news reports, obituaries, and other miscellanies. These articles constitute roughly 0.5 percent of the 408,000 articles included in the 1986 *JCR* database. These 2,000 articles gave out just over 57,000 citations, representing about 0.8 percent of the 7.6 million citations in the *JCR* for last year.

Articles published in the 21 core journals received about 31,000 citations in 1986 from all indexed journals, or about 0.4 percent of the 7.6 million citations that year. Eight journals received 70 percent of these 31,000 citations. They are *Limnology and Oceanography* (7,283), *Initial Reports of the Deep Sea Drilling Project* (3,177), *Deep-Sea Research Part A—Oceanographic Research Papers* (3,166), *Journal of Physical Oceanography* (2,966), *Marine Ecology—Progress Series* (2,409), *Journal of Marine Research* (1,876), *Marine Geology* (1,599), and *Estuarine, Coastal and Shelf Science* (1,368).

Which Journals the Core Cites

Table 2 lists, in descending order, the 51 journals most frequently cited by the 21 core journals in 1986. (Core journals are marked with an asterisk; 19 of the 21 appear in the table.) These 51 journals received almost 27,500 citations from the core group, or, as we have dubbed it, the macrojournal of oceanography. That number represents 6.3 percent of all the citations they received in 1986. It is also 45.7 percent of the citations given out by the core that year.

Column G lists the 1986 impact factor of each of the 51 journals. An impact factor measures the frequency with which the "average article" published in a given journal is cited during a particular year. For example, the average article from the 1984 and 1985 *Deep-Sea Research Part A* was cited about twice in 1986. Column H gives each journal's 1986 immediacy index, a measure of how often a journal's articles were cited in the same year they were published. For *Deep-Sea Research Part A*, an immediacy index of roughly 0.6 means that about one in two articles published in this journal has been cited in the same year it was published.

Table 3: The 50 journals that most frequently cited core oceanography journals in the 1986 *SCI®*. Asterisks (*) indicate core journals. A=citations to core journals. B=citations to all journals. C=self-citations. D=percent of total citations that are core-journal citations (A/B). E=percent of total citations that are self-citations (self-citing rate, C/B). F=percent of core-journal citations that are self-citations (C/A). G=1986 impact factor. H=1986 immediacy index. I=1986 total source items.

	A	B	C	D	E	F	G	H	I
*Mar. Ecol.—Progr. Ser.	1,830	8,917	501	20.52	5.62	27.38	2.172	0.360	225
*J. Phys. Oceanogr.	1,482	3,615	977	41.00	27.03	65.92	1.967	1.053	150
*Initial Rep. Deep Sea Drill. Pr.	1,295	5,564	1,118	23.27	20.09	86.33	0.757	0.240	200
*Deep-Sea Res. Pt. A—Oceanogr. Res.	1,219	3,594	424	33.92	11.80	34.78	2.092	0.639	108
*J. Geophys. Res.—Oceans	1,210	5,125	105	23.61	2.05	8.68	0.703	0.171	193
Mar. Biol.	1,152	7,698	—	14.96	—	—	1.892	0.455	235
*Limnol. Oceanogr.	1,076	4,385	699	24.33	15.94	65.51	3.120	0.813	128
Can. J. Fisheries Aquat. Sci.	778	10,426	—	7.46	—	—	1.790	0.635	288
J. Exp. Mar. Biol. Ecol.	733	5,853	—	12.52	—	—	1.482	0.251	179
*Cont. Shelf Res.	732	2,561	159	28.58	6.21	21.72	0.449	2.145	69
*Estuar. Coast. Shelf Sci.	694	3,378	175	20.54	5.18	25.22	1.079	0.212	104
Hydrobiologia	650	10,754	—	6.04	—	—	0.579	0.309	375
J. Plankton Res.	616	3,031	—	20.32	—	—	1.688	0.250	88
*Mar. Geology	555	3,000	244	18.50	8.13	43.96	1.236	0.435	85
*Izv. Akad. Nauk SSSR Fiz. Atm. Ok.	468	2,167	396	21.60	18.27	84.62	0.263	0.080	187
*Mar. Chem.	433	2,193	154	19.74	7.02	35.57	1.825	0.308	65
*J. Mar. Res.	414	1,233	93	33.58	7.54	22.46	2.515	0.382	34
Geochim. Cosmochim. Acta	411	10,689	—	3.85	—	—	3.020	0.742	248
*Oceanol. Acta	382	1,738	47	21.98	2.70	12.30	1.105	0.315	54
*Bull. Mar. Sci.	358	3,439	137	10.41	3.98	38.27	0.794	0.926	81
*Okeanologiya SSSR	355	1,758	160	20.19	9.10	45.07	0.236	0.094	149
Nature	351	35,096	—	1.00	—	—	15.252	3.255	1,165
*Neth. J. Sea Res.	296	1,081	75	27.38	6.94	25.34	0.743	0.333	30
Appl. Environ. Microbiol.	278	12,642	—	2.20	—	—	2.126	0.339	522
Palaeogeogr. Palaeoclimatol.	274	3,858	—	7.10	—	—	0.654	0.402	92
Arch. Hydrobiol.	259	3,034	—	8.54	—	—	0.965	0.423	104
*Aust. J. Mar. Freshwater Res.	256	1,636	152	15.65	9.29	59.38	0.879	0.286	63
Sci. Total Envir.	253	5,955	—	4.25	—	—	0.699	0.135	237
Mar. Micropaleontol.	228	1,390	—	16.40	—	—	1.333	0.176	34
Proc. Roy. Soc. Edinburgh Sect. B	224	2,205	—	10.16	—	—	0.546	0.344	61
J. Geophys. Res.—Solid Earth Pl.	203	19,544	—	1.04	—	—	0.372	0.249	462
*Prog. Oceanogr.	196	560	6	35.00	1.07	3.06	2.000	0.714	7
Earth Planet. Sci. Lett.	191	6,343	—	3.01	—	—	3.173	0.758	182
Science	181	28,600	—	0.63	—	—	12.437	3.004	803
Freshwater Biol.	178	2,304	—	7.73	—	—	1.434	0.391	69
Chem. Geol.	169	4,522	—	3.74	—	—	0.827	0.341	135
J. Water Pollut. Contr. Fed.	166	6,767	—	2.45	—	—	0.987	0.146	158
Ecology	163	6,993	—	2.33	—	—	2.633	0.514	175
Dokl. Akad. Nauk SSSR	158	20,630	—	0.77	—	—	0.343	0.064	2,297
Mar. Pollut. Bull.	150	1,662	—	9.03	—	—	1.429	0.108	83
Oecologia	150	9,394	—	1.60	—	—	1.727	0.271	295
Coral Reef.	144	1,302	—	11.06	—	—	1.700	0.265	34
Polar Biol.	143	1,555	—	9.20	—	—	1.013	0.217	60
*Oceanogr. Mar. Biol.	135	3,077	12	4.39	0.39	8.89	1.571	0.125	8
Water Res.	132	4,681	—	2.82	—	—	1.324	0.190	210
*Helgolander Meeresunters.	131	1,018	61	12.87	5.99	46.56	1.112	0.182	22
J. Fluid Mech.	129	7,119	—	1.81	—	—	1.509	0.457	289
J. Phycol.	124	2,280	—	5.44	—	—	1.431	0.222	81
Geol. Rundsch.	122	2,115	—	5.77	—	—	0.510	0.145	55
Rev. Geophys.	122	3,904	—	3.13	—	—	3.774	1.667	33

Table 4: The 1986 impact factors of selected core journals using different two-year bases. Journals are listed in alphabetic order. A = 1984-1985. B = 1983-1984. C = 1982-1983. D = 1981-1982. E = 1980-1981.

	A	B	C	D	E
Aust. J. Mar. Freshwater Res.	0.879	1.184	1.240	1.000	0.862
Bull. Mar. Sci.	0.794	1.146	0.775	0.563	1.028
Cont. Shelf Res.	0.449	0.333	0.861	2.091	—
Deep-Sea Res. Pt. A—Oceanogr. Res.	2.092	2.136	2.230	2.493	2.326
Estuar. Coast. Shelf Sci.	1.079	1.288	1.483	1.397	2.463
Helgolander Meeresunters.	1.112	1.253	1.064	1.222	0.889
Initial Rep. Deep Sea Drill. Pr.	0.757	0.849	0.936	0.993	1.073
Izv. Akad. Nauk SSSR Fiz. Atm. Ok.	0.263	0.336	0.332	0.313	0.262
J. Mar. Res.	2.515	2.562	3.978	4.232	3.640
J. Phys. Oceanogr.	1.967	2.102	2.226	2.151	1.843
Limnol. Oceanogr.	3.120	3.593	3.704	3.610	3.661
Mar. Chem.	1.825	2.366	2.155	2.039	1.623
Mar. Ecol.—Progr. Ser.	2.172	2.642	3.084	2.953	2.133
Mar. Geology	1.236	1.330	1.646	1.706	1.371
Neth. J. Sea Res.	0.743	1.041	1.562	1.548	1.433
Oceanogr. Mar. Biol.	1.571	3.263	—	5.421	—
Oceanol. Acta	1.105	1.343	1.500	1.786	1.650
Okeanologiya SSSR	0.236	0.242	0.229	0.197	0.180
Prog. Oceanogr.	2.000	3.231	3.800	—	—

Noteworthy in Table 2 is the appearance and high ranking (in citations, impact, and immediacy) of the journals *Nature* and *Science*. Multidisciplinary journals of wide distribution and reputation, such as these two, link up specialty fields, like oceanography, with the rest of science.

The journal *Limnology and Oceanography* is the most-cited core journal and highest in impact (3.120). Next in total citations is the *Journal of Physical Oceanography*, another core journal, and it ranks sixth in impact (1.967). Other most-cited core journals include *Deep-Sea Research Part A*, ranking fourth in total citations, and *Initial Reports of the Deep Sea Drilling Project*, ranking sixth in citations.

Which Journals Cite the Core

Table 3 lists, in descending order, the 50 journals that most frequently cited the core group of 21, or the macrojournal of oceanography, in 1986. (The only core journal not appearing in Table 3 is the *Journal of the Oceanographical Society of Japan*.) The core group received over 13,500 citations from these 50 journals, which represents 25.8 percent of all citations given out by the 50. It is also 44.5 percent of all the citations received by the core journals in 1986.

We find among the top 10 most-cited journals the *Journal of Physical Oceanography*, *Initial Reports of the Deep Sea Drilling Project*, *Deep-Sea Research Part A*, and *Limnology and Oceanography*, which also ranked among the top 10 in Table 2.

Marine Biology—not a core journal in this study—nonetheless ranks high in Tables 2 and 3 (fifth and sixth, respectively). Kenneth T. Morse, physical science and engineering reference bibliographer, University of Rhode Island, Kingston, who read an advance copy of this essay, commented: "The frequent citation of *Marine Biology* by the core journals and of the core journals by *Marine Biology* results from a disproportionate number of papers in marine biology published by the core journals. The core list has a significant marine biology bias. It is citation by marine biologists, not physical oceanographers, that accounts for the prominence of *Marine Biology* in the statistics."[8]

Impact over Time

Table 4 supplies data on a number of high-impact core journals, showing how their impacts vary when different two-year bases are used. *Limnology and Oceanography*, the *Journal of Marine Research*,

Table 5: The most-cited article from each core oceanography journal that had an article cited at least 50 times in the *SCI®*, 1955-1986. Articles are listed in alphabetic order by first author. A = 1955-1986 citations. B = total number of papers from that journal cited at least 50 times. *Izv. Akad. Nauk SSSR Fiz. Atm. Ok.*, *Cont. Shelf Res.*, *Okeanologiya*, and *J. Geophys. Res.—Oceans* had no papers that have been cited 50 times or more.

A	Bibliographic Data	B
109	**Azam F, Fenchel T, Field J G, Gray J S, Meyer-Reil L A & Thingstad F.** The ecological role of water-column microbes in the sea. *Mar. Ecol.—Progr. Ser.* 10:257-63, 1983.	9
99	**Batley G E & Florence T M.** Determination of the chemical forms of dissolved cadmium, lead and copper in seawater. *Mar. Chem.* 4:347-63, 1976.	8
69	**Bayly I A E & Williams W D.** Chemical and biological studies on some saline lakes of south-east Australia. *Aust. J. Mar. Freshwater Res.* 17:177-228, 1966.	6
70	**Berger W H, Killingley J S & Vincent E.** Stable isotopes in deep-sea carbonates: Box Core ERDC-92, West Equatorial Pacific. *Oceanol. Acta* 1:203-16, 1978.	2
105	**Bumpus D F.** A description of the circulation on the continental shelf of the east coast of the United States. *Prog. Oceanogr.* 6:111-57, 1973.	5
209	**Davis R E.** Predictability of sea surface temperature and sea level pressure anomalies over the North Pacific Ocean. *J. Phys. Oceanogr.* 6:249-66, 1976.	59
122	**Lang J.** Interspecific aggression by scleractinian corals. 2. Why the race is not only to the swift. *Bull. Mar. Sci.* 23:260-79, 1973.	10
356	**Lyman J & Fleming R H.** Composition of sea water. *J. Mar. Res.* 3:134-46, 1940.	85
169	**Lynn D C & Bonatti E.** Mobility of manganese in diagenesis of deep-sea sediments. *Mar. Geology* 3:457-74, 1965.	31
181	**Mantoura R F C, Dickson A & Riley J P.** The complexation of metals with humic materials in natural waters. *Estuar. Coast. Shelf Sci.* 6:387-408, 1978.	10
99	**Paffenhofer G-A.** Cultivation of *Calanus helgolandicus* under controlled conditions. *Helgolander Meeresunters.* 20:346-59, 1970.	13
145	**Parsons T R, LeBrasseur R J & Fulton J D.** Some observations on the dependence of zooplankton grazing on the cell size and concentration of phytoplankton blooms. *J. Oceanogr. Soc. Japan* 23:10-7, 1967.	1
243	**Shackleton N J & Kennett J P.** Paleotemperature history of the Cenozoic and the initiation of Antarctic glaciation: oxygen and carbon isotope analyses in DSDP sites 277, 279, and 281. *Initial Rep. Deep Sea Drill. Pr.* 29:743-55, 1975.	26
252	**Smayda T J.** The suspension and sinking of phytoplankton in the sea. *Oceanogr. Mar. Biol.* 8:353-414, 1970.	30
786	**Solorzano L.** Determination of ammonia in natural waters by the phenolhypochlorite method. *Limnol. Oceanogr.* 14:799-801, 1969.	359
140	**Thorson G.** Some factors influencing the recruitment and establishment of marine benthic communities. *Neth. J. Sea Res.* 3:267-93, 1966.	11
449	**Yentsch C S & Menzel D W.** A method for the determination of phytoplankton chlorophyll and phaeophytin by fluorescence. *Deep-Sea Res. Pt. A—Oceanogr. Res.* 10:221-31, 1963.	151

Marine Ecology—Progress Series, and *Progress in Oceanography* stand out as continuously high-impact journals over time.

Articles to Count On

Tables 5 and 6 list a number of articles of proven interest to oceanographers. Table 5 lists the most-cited article from each core journal that has been cited at least 50 times in the *SCI*, 1955-1986, while Table 6 lists articles published in non-core journals that have been cited at least 14 times by authors publishing in core journals. Table 6 demonstrates how citation data can reveal links between specialty journals in one field and those of other fields.

Figure 1: Year-by-year citation counts to the *Citation Classic®* by L. Solórzano in *Limnol. Oceanogr.* 14:799-801, 1969.

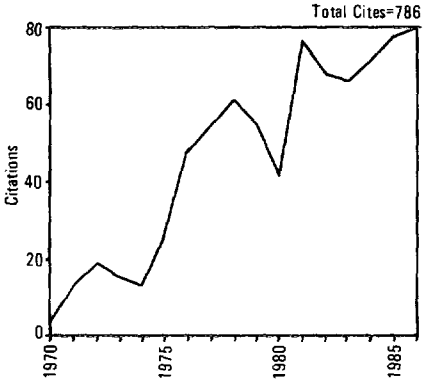

Table 6: Papers published in non-core journals that were cited at least 14 times by core oceanography journals in the *SCI®*. Articles are listed in alphabetic order by first author. A = 1986 citations from core oceanography journals. B = total 1986 citations. C = total 1955-1986 citations.

A	B	C	Bibliographic Data
15	20	147	**Bunker A F.** Computations of surface energy flux and annual air-sea interaction cycles of the North Atlantic Ocean. *Mon. Weather Rev.* 104:1112-40, 1976.
22	34	146	**Eppley R W & Peterson B J.** Particulate organic matter flux and planktonic new production in the deep ocean. *Nature* 282:677-80, 1979.
30	34	172	**Ericson D B & Wollin G.** Pleistocene climates and chronology in deep-sea sediments. *Science* 162:1227-34, 1968.
16	37	167	**Fuhrman J A & Azam F.** Bacterioplankton secondary production estimates for coastal waters of British Columbia, Antarctica, and California. *Appl. Environ. Microbiol.* 39:1085-95, 1980.
19	54	145	**Fuhrman J A & Azam F.** Thymidine incorporation as a measure of heterotrophic bacterioplankton production in marine surface waters: evaluation and field results. *Mar. Biol.* 66:109-20, 1982.
14	20	132	**Gibbs R J.** The geochemistry of the Amazon River system: part I. The factors that control salinity and composition and concentration of suspended solids. *Geol. Soc. Amer. Bull.* 78:1203-32, 1967.
14	31	179	**Goldman J C, McCarthy J J & Peavey D G.** Growth rate influence on the chemical composition of phytoplankton in oceanic waters. *Nature* 279:210-5, 1979.
16	90	898	**Guillard R R L & Ryther J H.** Studies of marine planktonic diatoms. I. *Cyclotella nana* Hustedt, and *Detonula confervacea* (Cleve) Gran. *Can. J. Microbiol.* 8:229-39, 1962.
32	112	586	**Hobbie J E, Daley R J & Jasper S.** Use of Nuclepore filters for counting bacteria by fluorescence microscopy. *Appl. Environ. Microbiol.* 33:1225-8, 1977.
15	37	378	**Holm-Hansen O, Lorenzen C J, Holmes R W & Strickland J D H.** Fluorometric determination of chlorophyll. *J. Conseil* 30:3-15, 1965.
16	23	84	**Okada H & Bukry D.** Supplementary modification and introduction of code numbers to the low-latitude coccolith biostratigraphic zonation (Bukry, 1973; 1975). *Mar. Micropaleontol.* 5:321-5, 1980.
14	51	381	**Ricker W E.** Linear regressions in fishery research. *J. Fish. Res. Board Can.* 30:409-34, 1973.
14	22	82	**Suess E.** Particulate organic carbon flux in the oceans—surface productivity and oxygen utilization. *Nature* 288:260-3, 1980.
14	30	187	**Watson S W, Novitsky T J, Quinby H L & Valois F W.** Determination of bacterial number and biomass in the marine environment. *Appl. Environ. Microbiol.* 33:940-6, 1977.
15	33	85	**Williams P J leB.** Incorporation of microheterotrophic processes into the classical paradigm of the planktonic food web. *Kieler Meeresforsch.* 5:1-28, 1981.

Table 5 contains at least three *Citation Classics®* of oceanography.[9] The most-cited paper in Table 5 is "Determination of ammonia in natural waters by the phenol-hypochlorite method," published in 1969 in *Limnology and Oceanography* by Lucia Solórzano, Institute of Marine Resources, Scripps Institution of Oceanography. This methods paper has been cited nearly 800 times in 17 years, or an average of 44 times a year since 1969.

Classic methods papers, as I've stated on many occasions, tend to accumulate a large number of citations—more than the average well-cited paper. Moreover, if they describe a procedure that is not improved upon for a number of years, neither do their year-by-year citation counts conform to the norm. As Figure 1 shows, last year Solórzano's classic received more citations than in any previous year—some 18 years after its publication. Figure 1 tells us that the procedure described in this paper is still important; the mounting citations also reflect the growth of the oceanography literature since the late 1960s.

The second most-cited paper in the list, with some 450 citations, is also a methods paper: "A method for the determination of phytoplankton chlorophyll and phaeophytin by fluorescence," published in 1963 in *Deep-Sea Research Part A* by Charles S. Yentsch and David W. Menzel, both of Woods Hole Oceanographic Institution, Massachusetts. The third most-cited paper, also a *Citation Classic*, is "Composition of

sea water," published by John Lyman and Richard H. Fleming, Scripps Institution of Oceanography, in the *Journal of Marine Research* in 1940. It has accumulated over 350 citations.

Others papers in the list would also probably qualify as *Citation Classics*. If a journal is specialized to the degree that it defines a discrete field, then the most-cited article in that journal is very likely a *Citation Classic*.

Table 6 lists articles published in non-core journals that were cited at least 14 times by core oceanography journals. The list shows some of the interconnections between the core oceanography journals and other journals.

Conclusion

This examination of the most significant journals in chemical and physical oceanography has not only pointed out the interconnections among the group of core journals but also their relationship to broad, multidisciplinary journals, such as *Science* and *Nature*, and to specialty journals outside the core, especially in marine biology. Emerging from the citation data in Tables 2 and 3, and from the impact factors and immediacy indexes, are a group of five outstandingly significant journals in oceanography: *Limnology and Oceanography*, the *Journal of Physical Oceanography*, *Deep-Sea Research Part A, Initial Reports of the Deep Sea Drilling Project*, and *Marine Ecology—Progress Series*. The last would seem to serve as a bridge to marine biology. These journals represent, then, the central core of the oceanography journal literature.

* * * * *

My thanks to Elizabeth Fuseler-McDowell and David A. Pendlebury for their help in the preparation of this essay.

© 1987 ISI

REFERENCES

1. **Garfield E.** Journal citation studies. 46. Physical chemistry and chemical physics journals. Parts 1-3. *Current Contents* (1):3-10, 6 January 1986; (2):3-10, 13 January 1986; (3):3-12, 20 January 1986.
2. ----------. Journal citation studies. 45. Surgery journals: another operation in citation analysis. *Essays of an information scientist: ghostwriting and other essays*. Philadelphia: ISI Press, 1986. Vol. 8. p. 197-212.
3. ----------. Journal citation studies. 44. Citation patterns in nursing journals, and their most-cited articles. *Ibid.*, 1985. Vol. 7. p. 336-45.
4. ----------. Journal citation studies. 43. Astrosciences journals—what they cite and what cites them. *Ibid.* p. 152-63.
5. **Nierenberg W A.** Oceanography. *McGraw-Hill encyclopedia of science and technology*. New York: McGraw-Hill, 1977. Vol. 9. p. 309-15.
6. **Garfield E.** Slovesnost' ob morya biologiya. *Biologiya Morya* 3:3-20, 1980. (Also published as: The literature of marine biology. *Sov. J. Mar. Biol.* 7:137-52, 1981.)
7. **Fuseler-McDowell E.** High impact journals in oceanography. *Proceedings of the International Association of Marine Science Libraries and Information Centers*, 5-9 October 1987, Halifax, Nova Scotia, Canada. (In press.)
8. **Morse K T.** Personal communication. 29 October 1987.
9. **Garfield E.** The 100 most-cited papers ever and how we select *Citation Classics*. *Essays of an information scientist: the awards of science and other essays*. Philadelphia: ISI Press, 1985. Vol. 7. p. 175-81.