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# Documenting the Literature of Marine Biology

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A bibliometric analysis of marine biology citations identifies the core journals and their impacts. Interjournal connections are revealed by ranking the journals most cited by the core. For each core journal, a most-cited article is listed.

Last year (1987) at the International Association of Marine Science Libraries and Information Centers' (IAMSLIC) annual meeting in Halifax, Nova Scotia, Canada, I presented a study of the core journals in oceanography.[1] That study and this are

based on citation analysis of the data in the *Journal Citation Reports®* (*JCR®*). The *JCR* is a compilation of the citation links between the journals in the *Science Citation Index®* (*SCI®*). By analyzing these citation links it is possible to determine the important journals in a discipline through the journals the authors in that field reference. This is a good way to determine the key journals in specialized and/or closely linked fields. We have used those citation links in the 1987 *JCR* to show us about the literature of marine biology.

As I discussed in the oceanography journal study, oceanography and marine biology are closely linked fields. Oceanography is a multifaceted field of many overlapping subfields that attempt to describe and explain all the processes of the sea.[2] Often a distinction has been made between biological and physical/chemical oceanography. Looking at a list of the parent organizations of the membership of IAMSLIC, this division is the "working" separation of the field. These studies of the literature of both fields show the strong links between them.

## Marine Biology Journals

The *JCR* classifies 33 journals in the category marine and freshwater biology. The journals that ISI® has selected for inclusion in the *JCR* marine and freshwater biology category are those that cover scientific studies on living organisms in fresh- and saltwater.

To determine the marine biology core, we first studied all citations received and references given out by all 33 journals in the marine and freshwater subject category indexed in the 1987 *JCR*. The 23 journals were selected on the basis of their citation data, impact factors, and also to give representation to the international scope of marine biology. We have used this method to determine the core journals of many subject fields and are confident that this method gives us the significant journals of a particular field.[3] Therefore, we can say that these 23 journals are the most significant of the 33 in the category.

Two of the oldest journals in Table 1 started publication before 1900, the *Journal of the Marine Biological Association of the United Kingdom* (1887) and *Biological Bulletin* (1898). *Marine Mammal Science* (1985) is the newest journal on the list. In 1980 the title of the *Journal of the Fisheries Research Board of Canada* changed to the *Canadian Journal of Fisheries and Aquatic Sciences*. We have not combined the data for the two titles because we thought it interesting to see how many authors continue to cite papers in the older title. It was cited over 580 times in 1987. If they had been combined, it would have ranked first on the list of journals highly cited by the core journals (Table 2).

US and British publishers account for 12 of the journals in this study. The Federal Republic of Germany publishes three. Denmark and The Netherlands account for two each. The USSR, Australia, Norway, and Canada each account for one.

Eighteen of these journals are published in English and 1 in Russian with an English translation edition available. Four of the journals are multilingual. English is common to the entire set. Two journals publish in English, French, and German. One publishes in English and German, and one, in English and French.

The journals of marine biology were studied by Eugene Garfield in 1980.[4] There are six journals common to the core journals in that study and this one—the *Australian Journal of Marine and Freshwater Research*, the *Journal du Conseil*, the *Journal of Experimental Marine Biology and Ecology*, the *Journal of the Marine Biological Association of the United Kingdom*, *Marine Biology*, and *Sarsia*. Dr. Alexander Pudovkin, Institute of Marine Biology, Vladivostok, USSR, is currently on sabbatical at ISI to work on updating Garfield's earlier study. Today I am presenting only the core of the marine biology literature. Dr. Pudovkin's study will be an overview of the entire literature and will include a mapping of the "universe" of the marine biology literature.

There are eight overlapping journals between this core and the core oceanography journals presented last year at the IAMSLIC meeting in Halifax. This reinforces the close interrelationship between the physical and biological aspects of oceanography.

**Table 1: Core journals in marine biology** indexed in the *SCI*® in 1987, with the year that each began publication, the publisher, and the editor(s).

**Advances in Marine Biology** (1963)
Academic Press, San Diego, CA
J.H.S. Blaxter & F.S. Russell, eds.

**Australian Journal of Marine and Freshwater Research** (1950)
CSIRO, Melbourne, Australia
A. Grant, ed.

**Biological Bulletin** (1898)
Marine Biological Laboratory, Woods Hole, MA
C.B. Metz, ed.

**Biologiya Morya** (1975)
Cover-to-cover English translation: Soviet Journal of Marine Biology, Consultant's Bureau, New York
Institute of Marine Biology, Vladivostok, USSR
A.V. Zhirmunsky, ed.

**Bulletin of Marine Science** (1950)
Rosenstiel School of Marine and Atmospheric Science, Miami, FL
W.J. Richards, ed.

**Canadian Journal of Fisheries and Aquatic Sciences** (1934)
Department of Fisheries and Oceans, Ottawa, Ontario, Canada
D.G. Cook, ed.

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

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

**Journal du Conseil** (1926)
International Council for the Exploration of the Sea, Copenhagen, Denmark
R.J.H. Beverton, ed.

**Journal of Experimental Marine Biology and Ecology** (1967)
Elsevier Science Publishers, Amsterdam, The Netherlands
H. Barnes, ed.

**Journal of Fish Biology** (1969)
Fisheries Society of the British Isles
Southampton, United Kingdom
A.R. Margetts, ed.

**Journal of Plankton Research** (1979)
IRL Press, Oxford, United Kingdom
D.H. Cushing, ed.

**Journal of the Marine Biological Association of the United Kingdom** (1887)
Cambridge University Press, Cambridge, United Kingdom
E.J. Denton, ed.

**Limnology and Oceanography** (1956)
American Society of Limnology and Oceanography, Lawrence, KS
P.A. Jumars, ed.

**Marine Biology** (1980)
Springer International, New York, NY
O. Kinne, ed.

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

**Marine Ecology. Pubblicazioni della Stazione Zoologica di Napoli** (1929)
Paul Parey, Berlin, Federal Republic of Germany
R. Riedl & J. Ott, eds.

**Marine Environmental Research** (1978)
Elsevier Applied Science, Essex, United Kingdom
G. Roesijadi & R.B. Spies, eds.

**Marine Mammal Science** (1985)
Society for Marine Mammology, Lawrence, KS
D. Wartzok, ed.

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

**Oceanography and Marine Biology. An Annual Review** (1963)
Taylor-Carlisle, New York, NY
H. Barnes, ed.

**Ophelia** (1964)
Marine Biological Laboratory, University of Copenhagen, Helsingor, Denmark
K. Muus, ed.

**Sarsia** (1969)
University of Bergen, Department of Marine Biology, Blomsterdalen, Norway
T. Brattegard, ed.

In our journal studies we consider the journals in the field we are studying as if they composed a single "Macrojournal of Discipline X." Data were taken from the 1987 *JCR* to determine which journals this macrojournal cited and which journals cited *into* the macrojournal.

## Journal Statistics

In 1987 the 23 "core" marine biology journals published 1,945 articles. This represents slightly over 0.5 percent of the 410,806 research articles covered in the 1987 *JCR*. The articles in these 23 journals

**Table 2: The 49 journals most cited by the core marine biology journals** in the 1987 *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=1987 impact factor. H=1987 immediacy index. I=1987 total source items.

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| *Mar. Biol. | 2,663 | 5,454 | 726 | 48.83 | 13.31 | 27.26 | 1.484 | 0.239 | 226 |
| *Limnol. Oceanogr. | 2,566 | 6,859 | 623 | 37.41 | 9.08 | 24.28 | 3.286 | 0.432 | 132 |
| *J. Exp. Mar. Biol. Ecol. | 1,550 | 2,839 | 474 | 54.60 | 16.70 | 30.58 | 1.274 | 0.311 | 183 |
| *Mar. Ecol.—Progr. Ser. | 1,516 | 2,530 | 547 | 59.92 | 21.62 | 36.08 | 1.867 | 0.300 | 220 |
| *Can. J. Fisheries Aquat. Sci. | 1,153 | 3,018 | 674 | 38.20 | 22.33 | 58.46 | 1.507 | 0.394 | 203 |
| J. Fish. Res. Board Can. | 1,102 | 3,912 | — | 28.17 | — | — | — | — | 0 |
| *J. Mar. Biol. Assn. UK | 969 | 2,162 | 182 | 44.82 | 8.42 | 18.78 | 1.036 | 0.259 | 58 |
| Science | 798 | 97,700 | — | 0.82 | — | — | 14.304 | 3.491 | 813 |
| Ecology | 788 | 9,825 | — | 8.02 | — | — | 2.784 | 0.333 | 216 |
| Nature | 680 | 155,736 | — | 0.44 | — | — | 14.999 | 3.903 | 1,210 |
| *Biol. Bull. | 597 | 2,645 | 129 | 22.57 | 4.88 | 21.61 | 1.196 | 0.167 | 60 |
| *Estuar. Coast. Shelf Sci. | 596 | 1,409 | 156 | 42.30 | 11.07 | 26.17 | 1.127 | 0.108 | 111 |
| Deep-Sea Res. Pt. A—Oceanogr. Res. | 586 | 3,242 | — | 18.08 | — | — | 2.077 | 0.448 | 125 |
| *J. Fish Biol. | 560 | 1,858 | 381 | 30.14 | 20.51 | 68.04 | 0.695 | 0.139 | 187 |
| Oecologia | 507 | 5,547 | — | 9.14 | — | — | 1.614 | 0.230 | 331 |
| Appl. Environ. Microbiol. | 454 | 9,999 | — | 4.54 | — | — | 2.105 | 0.318 | 557 |
| Fish. Bull.—NOAA | 441 | 1,040 | — | 42.40 | — | — | 0.576 | 0.051 | 59 |
| J. Mar. Res. | 425 | 1,781 | — | 23.86 | — | — | 2.354 | 0.205 | 39 |
| *Bull. Mar. Sci. | 422 | 853 | 123 | 49.47 | 14.42 | 29.15 | 0.607 | 0.208 | 96 |
| *J. Plankton Res. | 422 | 767 | 117 | 55.02 | 15.25 | 27.73 | 1.348 | 0.144 | 90 |
| J. Phycol. | 394 | 1,683 | — | 23.41 | — | — | 1.323 | 0.284 | 88 |
| *Aust. J. Mar. Freshwater Res. | 376 | 767 | 156 | 49.02 | 20.34 | 41.49 | 0.805 | 0.755 | 49 |
| Can. J. Zool. | 361 | 4,992 | — | 7.23 | — | — | 0.869 | 0.205 | 425 |
| Hydrobiologia | 324 | 2,216 | — | 14.62 | — | — | 0.641 | 0.094 | 352 |
| Amer. Naturalist | 319 | 6,914 | — | 4.61 | — | — | 2.607 | 0.422 | 128 |
| *Neth. J. Sea Res. | 319 | 601 | 72 | 53.08 | 11.98 | 22.57 | 0.924 | 0.000 | 27 |
| Ecol. Monogr. | 307 | 2,447 | — | 12.55 | — | — | 4.231 | 0.563 | 16 |
| Trans. Amer. Fish. Soc. | 305 | 1,591 | — | 19.17 | — | — | 0.897 | 0.000 | 83 |
| *J. Conseil | 296 | 497 | 45 | 59.56 | 9.05 | 15.20 | 0.677 | 0.158 | 38 |
| *Helgolander Meeresunters. | 279 | 605 | 59 | 46.12 | 9.75 | 21.15 | 0.580 | 0.375 | 24 |
| Geochim. Cosmochim. Acta | 272 | 10,450 | — | 2.60 | — | — | 3.217 | 0.485 | 26 |
| *Oceanogr. Mar. Biol. | 253 | 544 | 18 | 46.51 | 3.31 | 7.11 | 2.647 | 0.667 | 9 |
| Arch. Hydrobiol. | 250 | 1,670 | — | 14.97 | — | — | 0.961 | 0.207 | 121 |
| J. Anim. Ecol. | 223 | 3,327 | — | 6.70 | — | — | 2.293 | 0.613 | 75 |
| Aquaculture | 221 | 1,838 | — | 12.02 | — | — | 0.752 | 0.414 | 249 |
| Comp. Biochem. Physiol. Pt. A | 213 | 3,632 | — | 5.86 | — | — | 0.826 | 0.102 | 432 |
| J. Exp. Biol. | 208 | 5,256 | — | 3.96 | — | — | 1.954 | 0.392 | 186 |
| *Ophelia | 196 | 435 | 23 | 45.06 | 5.29 | 11.73 | 0.431 | 0.091 | 22 |
| *Sarsia | 187 | 337 | 84 | 55.49 | 24.93 | 44.92 | 0.741 | 0.583 | 48 |
| Bull. Fish. Res. Board Can. | 180 | 468 | — | 38.46 | — | — | — | — | — |
| Mar. Pollut. Bull. | 179 | 1,507 | — | 16.93 | — | — | 1.421 | 0.234 | 107 |
| Crustaceana | 167 | 506 | — | 33.00 | — | — | 0.236 | 0.064 | 78 |
| J. Geophys. Res.—Oceans | 162 | 33,381 | — | 0.49 | — | — | 6.839 | 1.467 | 478 |
| Int. Rev. Gesamten. Hydrobiol. | 161 | 730 | — | 22.05 | — | — | 0.490 | 0.162 | 37 |
| Estuaries | 158 | 341 | — | 46.33 | — | — | 0.802 | 0.000 | 22 |
| Amer. Zool. | 157 | 2,593 | — | 6.05 | — | — | 1.778 | 1.143 | 70 |
| Environ. Biol. Fish. | 156 | 601 | — | 25.96 | — | — | 0.670 | 0.176 | 91 |
| Ver. Int. Ver. A Limnol. | 150 | 806 | — | 18.61 | — | — | — | — | 0 |
| Aquat. Bot. | 147 | 856 | — | 17.17 | — | — | 1.006 | 0.225 | 80 |

gave out 62,410 references, which is about 0.7 percent of the over 9,464,000 references processed to create the *JCR* last year.

Articles from the 23 marine biology journals received a total of 38,515 citations in 1987 from all journals, or 0.4 percent of the almost 9.5 million *JCR* citations. Seven journals account for over 75 percent of the citations received: the *Canadian Journal of Fisheries and Aquatic Sciences*, including the *Journal of the Fisheries Research Board of Canada* (6,930); *Limnology and*

**Table 3: The 51 journals that most frequently cited core marine biology journals in the 1987 *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=1987 impact factor. H=1987 immediacy index. I=1987 total source items.

| | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| *Mar. Ecol.—Progr. Ser. | 2,653 | 7,800 | 547 | 34.01 | 7.01 | 20.62 | 1.867 | 0.300 | 220 |
| *Mar. Biol. | 2,375 | 7,333 | 726 | 32.39 | 9.90 | 30.57 | 1.484 | 0.239 | 226 |
| *J. Exp. Mar. Biol. Ecol. | 1,911 | 6,005 | 474 | 31.82 | 7.89 | 24.80 | 1.274 | 0.311 | 183 |
| *Can. J. Fisheries Aquat. Sci. | 1,231 | 6,416 | 674 | 19.19 | 10.50 | 54.75 | 1.507 | 0.394 | 203 |
| *Limnol. Oceanogr. | 1,221 | 4,159 | 623 | 29.36 | 14.98 | 51.02 | 3.286 | 0.432 | 132 |
| *J. Plankton Res. | 936 | 2,852 | 117 | 32.82 | 4.10 | 12.50 | 1.348 | 0.144 | 90 |
| *Estuar. Coast. Shelf Sci. | 798 | 3,275 | 156 | 24.37 | 4.76 | 19.55 | 1.127 | 0.108 | 111 |
| Hydrobiologia | 690 | 9,250 | — | 7.46 | — | — | 0.641 | 0.094 | 352 |
| *J. Fish Biol. | 653 | 4,094 | 381 | 15.95 | 9.31 | 58.35 | 0.695 | 0.139 | 187 |
| Deep-Sea Res. Pt. A—Oceanogr. Res. | 555 | 3,853 | — | 14.40 | — | — | 2.077 | 0.448 | 125 |
| *Bull. Mar. Sci. | 538 | 2,938 | 123 | 18.31 | 4.19 | 22.86 | 0.607 | 0.208 | 96 |
| Comp. Biochem. Physiol. Pt. A | 455 | 11,228 | — | 4.05 | — | — | 0.826 | 0.102 | 432 |
| Can. J. Zool. | 452 | 11,798 | — | 3.83 | — | — | 0.869 | 0.205 | 425 |
| Aquaculture | 440 | 5,127 | — | 8.58 | — | — | 0.752 | 0.414 | 249 |
| *J. Mar. Biol. Assn. UK | 436 | 1,350 | 182 | 32.30 | 13.48 | 41.74 | 1.036 | 0.259 | 58 |
| *Biol. Bull. | 402 | 1,976 | 129 | 20.30 | 6.53 | 32.09 | 1.196 | 0.167 | 60 |
| Ecology | 369 | 8,687 | — | 4.25 | — | — | 2.784 | 0.333 | 216 |
| J. Phycol. | 355 | 2,727 | — | 13.02 | — | — | 1.323 | 0.284 | 88 |
| Appl. Environ. Microbiol. | 354 | 13,801 | — | 2.57 | — | — | 2.105 | 0.318 | 557 |
| J. Water Pollut. Contr. Fed. | 352 | 6,738 | — | 5.22 | — | — | 0.949 | 0.151 | 146 |
| Freshwater Biol. | 350 | 3,028 | — | 11.56 | — | — | 1.077 | 0.333 | 96 |
| *Oceanogr. Mar. Biol. | 323 | 1,839 | 18 | 17.56 | 0.98 | 5.57 | 2.647 | 0.667 | 9 |
| Oecologia | 321 | 10,370 | — | 3.10 | — | — | 1.614 | 0.230 | 331 |
| Cont. Shelf Res. | 320 | 2,065 | — | 15.50 | — | — | 0.636 | 0.133 | 98 |
| *Sarsia | 315 | 1,199 | 84 | 26.27 | 7.01 | 26.67 | 0.741 | 0.583 | 48 |
| *Aust. J. Mar. Freshwater Res. | 308 | 1,141 | 156 | 26.99 | 13.67 | 50.65 | 0.805 | 0.755 | 49 |
| *Neth. J. Sea Res. | 295 | 809 | 72 | 36.46 | 8.90 | 24.41 | 0.924 | 0.000 | 27 |
| Arch. Hydrobiol. | 280 | 3,197 | — | 8.76 | — | — | 0.961 | 0.207 | 121 |
| Environ. Biol. Fish. | 279 | 2,826 | — | 9.87 | — | — | 0.670 | 0.176 | 91 |
| J. Mar. Res. | 265 | 1,436 | — | 18.45 | — | — | 2.354 | 0.205 | 39 |
| Geochim. Cosmochim. Acta | 257 | 11,369 | — | 2.26 | — | — | 3.217 | 0.485 | 268 |
| Polar Biol. | 248 | 1,801 | — | 13.77 | — | — | 1.224 | 0.414 | 58 |
| Rev. Geophys. | 245 | 26,491 | — | 0.92 | — | — | 3.109 | 0.406 | 143 |
| Aquat. Bot. | 236 | 2,179 | — | 10.83 | — | — | 1.006 | 0.225 | 80 |
| *Mar. Environ. Res. | 218 | 1,112 | — | 19.60 | — | — | 1.231 | 0.024 | 42 |
| Fish. Bull.—NOAA | 211 | 1,592 | — | 13.25 | — | — | 0.576 | 0.051 | 59 |
| *Helgolander Meeresunters. | 202 | 845 | 59 | 23.90 | 6.98 | 29.21 | 0.590 | 0.375 | 24 |
| J. Crustacean Biol. | 200 | 1,658 | — | 12.06 | — | — | 0.559 | 0.177 | 62 |
| Comp. Biochem. Physiol. Pt. B | 196 | 13,652 | — | 1.44 | — | — | 0.846 | 0.102 | 472 |
| Nippon Suisan Gakk. | 193 | 3,601 | — | 5.36 | — | — | 0.336 | 0.016 | 316 |
| Bot. Mar. | 192 | 1,679 | — | 11.44 | — | — | 0.903 | 0.045 | 66 |
| *Ophelia | 190 | 714 | 23 | 26.61 | 3.22 | 12.11 | 0.431 | 0.091 | 22 |
| Mar. Pollut. Bull. | 182 | 1,873 | — | 9.72 | — | — | 1.421 | 0.234 | 107 |
| J. Geophys. Res.—Oceans | 165 | 7,509 | — | 2.20 | — | — | 0.440 | 0.624 | 290 |
| Mar. Chem. | 164 | 1,936 | — | 8.47 | — | — | 1.836 | 0.209 | 67 |
| Oceanol. Acta | 160 | 1,024 | — | 15.63 | — | — | 0.873 | 0.135 | 37 |
| Coral Reef. | 158 | 638 | — | 24.76 | — | — | 0.960 | 0.182 | 22 |
| *J. Conseil | 153 | 713 | 45 | 21.46 | 6.31 | 29.41 | 0.677 | 0.158 | 38 |
| *Biol. Morya | 151 | 1,247 | 52 | 12.11 | 4.17 | 34.43 | 0.173 | 0.026 | 76 |
| Sci. Total Environ. | 149 | 5,147 | — | 2.89 | — | — | 0.571 | 0.165 | 267 |
| Water Res. | 149 | 4,020 | — | 3.71 | — | — | 1.181 | 0.075 | 199 |
| *Mar. Ecol. Publ. Stat. Zool. Napoli[1] | 126 | 627 | 5 | 20.10 | 0.80 | 3.97 | 0.522 | 0.000 | 17 |

[1]Mar. Ecol. Publ. Stat. Zool. Napoli was the 59th ranked journal by citations to the core marine biology journals. It is given here for the purposes of comparison to other core journals

*Oceanography* (6,859); *Marine Biology* (5,454); the *Journal of Experimental Marine Biology and Ecology* (2,839); *Marine Ecology—Progress Series* (2,530); *Biological Bulletin* (2,645); and the *Journal of the Marine Biological Association of the United Kingdom* (2,162).

Table 2 shows the data for the 49 journals most frequently cited by the core. It includes 18 of the core journals, which are marked with an asterisk (*). They are listed in decreasing order by the number of citations they received from the core that year. The table also provides total citations from all journals (B), self-citations for each journal (C), the 1987 impact factors (G) and immediacy indexes (H), and the number of 1987 source items (I). The impact factor is a measure of the frequency with which the "average article" of a journal has been cited in a given year, while the immediacy index is a measure of how quickly the "average article" in a particular field gets cited. Seven of the top 10 highly cited journals, including the *Journal of the Fisheries Research Board of Canada*, are core marine biology journals. Also in the top 10 are *Science* and *Nature*. This occurs because, in addition to citing journals in their specialties, researchers cite a common set of basic research journals. These basic journals are cited by scientists in numerous specialties and serve to link the fields of science.[5]

**Table 4: Half-lives.** The 1987 *SCI*® cited and citing half-lives of core marine biology journals listed in alphabetic order. A=cited half-life. B=citing half-life.

| | A | B |
|---|---|---|
| Advan. Mar. Biol. | >10.0 | — |
| Aust. J. Mar. Freshwater Res. | 7.0 | 8.6 |
| Biol. Bull. | >10.0 | 8.0 |
| Biol. Morya | 6.5 | >10.0 |
| Bull. Mar. Sci. | 7.3 | >10.0 |
| Can. J. Fisheries Aquat. Sci. | 4.4 | 8.1 |
| Estuar. Coast. Shelf Sci. | 6.0 | 8.5 |
| Helgolander Meeresunters. | 9.6 | >10.0 |
| J. Conseil | >10.0 | 9.5 |
| J. Exp. Mar. Biol. Ecol. | 5.8 | 8.5 |
| J. Fish Biol. | 7.3 | 9.0 |
| J. Mar. Biol. Assn. UK | >10.0 | >10.0 |
| J. Plankton Res. | 4.0 | 8.2 |
| Limnol. Oceanogr. | 9.0 | 7.5 |
| Mar. Biol. | 7.4 | 8.5 |
| Mar. Ecol.—Progr. Ser. | 3.8 | 7.0 |
| Mar. Ecol. Publ. Stat. Zool. Napoli | — | 9.2 |
| Mar. Environ. Res. | 3.4 | 7.6 |
| Neth. J. Sea Res. | 8.2 | 7.6 |
| Oceanogr. Mar. Biol. | 8.8 | >10.0 |
| Ophelia | 9.2 | >10.0 |
| Sarsia | 7.2 | 8.7 |

**Table 5: Core journal impact factors.** The 1978-1987 *JCR*® impact factors of core journals.

| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|---|---|
| Advan. Mar. Biol. | — | 1.800 | 1.778 | 2.444 | 5.000 | — | — | 0.500 | 1.167 | 1.857 |
| Aust. J. Mar. Freshwater Res. | 0.563 | 0.547 | 0.661 | 0.701 | 0.599 | 0.909 | 0.766 | 0.941 | 0.879 | 0.805 |
| Biol. Bull. | 1.203 | 1.352 | 1.346 | 1.357 | 2.014 | 1.762 | 1.844 | 1.710 | 1.738 | 1.196 |
| Biol. Morya | — | — | 0.196 | 0.244 | 0.122 | 0.138 | 0.113 | 0.164 | 0.192 | 0.173 |
| Bull. Mar. Sci. | 1.140 | 0.826 | 0.427 | 0.529 | 0.908 | 0.582 | 0.768 | 0.608 | 0.794 | 0.607 |
| Can. J. Fisheries Aquat. Sci. | 1.401 | — | 1.530 | 1.836 | 1.359 | 1.727 | 1.375 | 1.473 | 1.790 | 1.507 |
| Estuar. Coast. Shelf Sci. | 1.385 | 1.401 | 1.134 | 1.132 | 1.373 | 1.306 | 0.962 | 1.341 | 1.079 | 1.127 |
| Helgolander Meeresunters. | 0.862 | 1.083 | 0.912 | 0.620 | 1.030 | 0.759 | 0.968 | 0.616 | 1.112 | 0.580 |
| J. Conseil | 0.604 | 0.333 | 0.452 | 0.343 | 0.657 | 0.465 | 0.652 | 0.432 | 0.513 | 0.677 |
| J. Exp. Mar. Biol. Ecol. | 0.900 | 1.296 | 1.318 | 1.420 | 1.510 | 1.118 | 1.478 | 1.331 | 1.482 | 1.274 |
| J. Fish Biol. | 0.811 | 1.053 | 0.979 | 0.706 | 0.996 | 1.114 | 0.848 | 0.950 | 0.833 | 0.695 |
| J. Mar. Biol. Assn. UK | 1.340 | 1.373 | 1.325 | 1.177 | 1.119 | 1.052 | 1.120 | 1.190 | 1.124 | 1.036 |
| J. Plankton Res. | — | — | — | — | — | — | 1.202 | 1.543 | 1.688 | 1.348 |
| Limnol. Oceanogr. | 2.155 | 2.487 | 2.404 | 2.492 | 3.029 | 2.535 | 2.628 | 2.852 | 3.120 | 3.286 |
| Mar. Biol. | 1.382 | 1.506 | 1.681 | 1.453 | 1.945 | 1.664 | 1.811 | 1.667 | 1.892 | 1.484 |
| Mar. Ecol.—Progr. Ser. | — | — | 0.652 | 0.866 | 1.431 | 1.974 | 2.189 | 2.041 | 2.172 | 1.867 |
| Mar. Ecol. Publ. Stat. Zool. Napoli | — | — | — | — | — | — | — | — | 0.667 | 0.522 |
| Mar. Environ. Res. | — | — | — | — | — | 0.962 | 0.859 | 0.798 | 0.802 | 1.231 |
| Neth. J. Sea Res. | 0.630 | 0.563 | 0.274 | 0.684 | 1.433 | 0.726 | 0.877 | 0.673 | 0.743 | 0.924 |
| Oceanogr. Mar. Biol. | — | — | — | — | — | 2.000 | — | 2.526 | 1.571 | 2.647 |
| Ophelia | 0.452 | 0.724 | 0.893 | 0.424 | 1.317 | 1.097 | 0.839 | 1.379 | 1.034 | 0.431 |
| Sarsia | 0.677 | 0.800 | 0.810 | 0.556 | 0.538 | 0.575 | 0.500 | 0.645 | 0.482 | 0.741 |

The journals in Table 2 received almost 16,000 citations from the 23 core journals, which is 27.9 percent of the total citations they received. This is 41.5 percent of the references given out by the core journals in 1987. *Limnology and Oceanography* (3.286) is the highest impact journal in the core. This is often the case with review journals.

The immediacy index measures how often a journal's articles were cited in the same year that they were published. Marine biology, as a whole, is a field that ranks high in immediacy as compared to the *JCR* as a whole. Ten of the core journals rank in the top one-quarter of the *JCR* ranked by immediacy factor.

Table 3 shows the 51 journals that most frequently cited the core marine biology journals in 1987. *Marine Ecology—Progress Series*, the journal that most frequently cited the core, was not in existence when Garfield did his earlier study. *Marine Biology* and the *Journal of Experimental Marine Biology and Ecology*, which rank second and third in this study, ranked first and second, respectively, in the Garfield study. Eight of the top 10 journals ranked by the number of citations to core journals are themselves core journals. The core journals in Table 3 provided over 57,000 references that year. Over 15,000, or slightly over 26 percent of these, were to core journals. The remainder were

**Table 6: The 1987 *SCI*® source data listing.** S = source items. R = reference items. R/S = ratio of reference items to source items.

| Journal Name | Nonreview Articles | | | Review Articles | | | Combined Total Nonreview & Review | | |
|---|---|---|---|---|---|---|---|---|---|
| | S | R | R/S | S | R | R/S | S | R | R/S |
| Aust. J. Mar. Freshwater Res. | 48 | 1,213 | 25.2 | 1 | 46 | 46.0 | 49 | 1,259 | 25.6 |
| Biol. Bull. | 58 | 1,823 | 31.4 | 2 | 195 | 97.5 | 60 | 2,018 | 33.6 |
| Biol. Morya | 76 | 1,282 | 16.8 | 0 | 0 | 0 | 76 | 1,282 | 16.8 |
| Bull. Mar. Sci. | 95 | 3,112 | 32.7 | 1 | 15 | 15.0 | 96 | 3,127 | 32.5 |
| Can. J. Fisheries Aquat. Sci. | 202 | 6,836 | 33.8 | 1 | 163 | 163.0 | 203 | 6,999 | 34.4 |
| Estuar. Coast. Shelf Sci. | 111 | 3,510 | 31.6 | 0 | 0 | 0 | 111 | 3,510 | 31.6 |
| Helgolander Meeresunters. | 23 | 722 | 31.3 | 1 | 142 | 142.0 | 24 | 864 | 36.0 |
| J. Conseil | 36 | 599 | 16.6 | 2 | 153 | 76.5 | 38 | 752 | 19.7 |
| J. Exp. Mar. Biol. Ecol. | 183 | 6,329 | 34.5 | 0 | 0 | 0 | 183 | 6,329 | 34.5 |
| J. Fish Biol. | 187 | 4,280 | 22.8 | 0 | 0 | 0 | 187 | 4,280 | 22.8 |
| J. Mar. Biol. Assn. UK | 57 | 1,315 | 23.0 | 1 | 99 | 99.0 | 58 | 1,414 | 24.3 |
| J. Plankton Res. | 90 | 2,965 | 32.9 | 0 | 0 | 0 | 90 | 2,965 | 32.9 |
| Limnol. Oceanogr. | 132 | 4,285 | 32.4 | 0 | 0 | 0 | 132 | 4,285 | 32.4 |
| Mar. Biol. | 226 | 7,661 | 33.8 | 0 | 0 | 0 | 226 | 7,661 | 33.8 |
| Mar. Ecol.—Progr. Ser. | 214 | 7,882 | 36.8 | 6 | 395 | 65.8 | 220 | 8,277 | 37.6 |
| Mar. Ecol. Publ. Stat. Zool. Napoli | 17 | 662 | 38.9 | 0 | 0 | 0 | 17 | 662 | 38.9 |
| Mar. Environ. Res. | 42 | 1,197 | 28.5 | 0 | 0 | 0 | 42 | 1,197 | 28.5 |
| Mar. Mammal Sci. | 25 | 463 | 18.5 | 2 | 234 | 117.0 | 27 | 697 | 25.8 |
| Neth. J. Sea Res. | 27 | 857 | 31.7 | 0 | 0 | 0 | 27 | 857 | 31.7 |
| Oceanogr. Mar. Biol. | 3 | 249 | 83.0 | 6 | 1,737 | 289.5 | 9 | 1,986 | 220.6 |
| Ophelia | 22 | 740 | 33.6 | 0 | 0 | 0 | 22 | 740 | 33.6 |
| Sarsia | 46 | 1,066 | 23.1 | 2 | 183 | 91.5 | 48 | 1,249 | 26.0 |
| Totals | 1,920 | 59,048 | 31.5 | 25 | 3,362 | 134.8 | 1,945 | 62,410 | 32.1 |
| *SCI JCR*® Totals | 400,436 | 8,470,613 | 21.1 | 10,370 | 993,841 | 95.8 | 410,806 | 9,464,454 | 23.0 |
| Marine Biology % of *JCR* Totals | 0.5 | 0.7 | 149.3 | 0.2 | 0.3 | 57.1 | 0.5 | 0.7 | 139.6 |

Note: Advan. Mar. Biology was not received in 1987.

to a variety of journals, many in other marine science fields. The percentages in column D of Table 3—the percent of citations that are core-journal citations—are sometimes referred to as specialty factors. For example, *Marine Ecology—Progress Series* and the *Netherlands Journal of Sea Research* cite the core literature more than one-third of the time, thereby having the highest citing specialty rate.

A journal's half-life figures give us more information about the nature of that journal. Half-life is the median age of a journal's cit*ed* or cit*ing* literature. Table 4 lists the cit*ed* and cit*ing* half-lives for 22 of the core journals. Because *Advances in Marine Biology* was not received in time for processing in the 1987 *SCI*, we cannot determine the current citing half-life for it.

Cit*ed* half-life is the median age of the articles from each journal that were cited in 1987. The average cit*ed* half-life for marine biology journals is over seven. In other words, on the average, half of the 1987 citations to core marine biology journals were to articles published within the past seven years. Four journals had cited half-lives of over 10 years—*Advances in Marine Biology,*

**Table 7: The most-cited article from each core marine biology journal** cited at least 50 times in the *SCI®*, *1955-1987*, listed in alphabetic order by first author. A = 1955-1987 citations. B = number of papers from that journal cited at least 50 times.

| A | Bibliographic Data | B |
|---|---|---|
| 260 | **Anderson J W, Neff J M, Cox B A, Tatem H E & Hightower G M.** Characteristics of dispersions and water-soluble extracts of crude and refined oils and their toxicity to estuarine crustaceans and fish. *Mar. Biol.* 27:75-88, 1974. | 125 |
| 159 | **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.* 10:257-64, 1983. | 14 |
| 71 | **Bayly I A E & Williams W D.** Chemical and biological studies on some saline lakes of southeast Australia. *Aust. J. Mar. Freshwater Res.* 17:177-228, 1966. | 6 |
| 74 | **Berland B.** Nematodes from some Norwegian marine fishes. *Sarsia* 2:1-50, 1961. | 1 |
| 76 | **Duursma E K.** Dissolved organic carbon, nitrogen and phosphorus in the sea. *Neth. J. Sea Res.* 1:1-85, 1961. | 9 |
| 104 | **Ellis A E.** Leukocytes of fish. *J. Fish Biol.* 11:453-91, 1977. | 14 |
| 191 | **Eppley R W, Holmes R W & Strickland J D H.** Sinking rates of marine phytoplankton measured with a fluorometer. *J. Exp. Mar. Biol. Ecol.* 1:191-208, 1967. | 32 |
| 240 | **Fenchel T.** The ecology of marine microbenthos. IV. Structure and function of the benthic ecosystem, its chemical and physical factors and the microfauna communities with special reference to the ciliated protozoa. *Ophelia* 6:1-182, 1969. | 12 |
| 429 | **Harding J P.** The use of probability paper for the graphical analysis of polymodal frequency distributions. *J. Mar. Biol. Assn. UK* 28:141-53, 1949. | 149 |
| 414 | **Holm-Hansen O, Lorenzen C J, Holmes R W & Strickland J D H.** Fluorometric determination of chlorophyll. *J. Conseil* 30:3-15, 1965. | 16 |
| 127 | **Lang J.** Interspecific aggression by scleractinian corals. 2. Why the race is not always to the swift. *Bull. Mar. Sci.* 23:260-79, 1973. | 12 |
| 224 | **Loosanoff V L & Davis H C.** Rearing of bivalve mollusks. *Advan. Mar. Biol.* 1:1-136, 1963. | 26 |
| 197 | **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 |
| 774 | **Mazia D, Brewer P A & Alfert M.** The cytochemical staining and measurement of protein with mercuric bromphenol Blue. *Biol. Bull.* 104:57-67, 1953. | 204 |
| 103 | **Paffenhofer G-A.** Cultivation of *Calanus helgolandicus* under controlled conditions. *Helgolander Meeresunters.* 20:346-59, 1970. | 13 |
| 436 | **Ricker W E.** Linear regressions in fishery research. *J. Fish. Res. Board Can.* 30:409-34, 1973. | 231 |
| 129 | **Rowland S J & Volkman J K.** Biogenic and pollutant aliphatic hydrocarbons in *Mytilus edulis* from the North Sea. *Mar. Environ. Res.* 7:117-30, 1982. | 1 |
| 269 | **Smayda T J.** The suspension and sinking of phytoplankton in the sea. *Oceanogr. Mar. Biol.* 8:353-414, 1970. | 30 |
| 868 | **Solorzano L.** Determination of ammonia in natural waters by the phenolhypochlorite method. *Limnol. Oceanogr.* 14:799-801, 1969. | 360 |
| 53 | **Urrere M A & Knauer G A.** Zooplankton fecal pellet fluxes and vertical transport of particulate organic material in the pelagic environment. *J. Plankton Res.* 3:369-88, 1981. | 1 |
| 101 | **Young J Z.** The preparation of isotonic solutions for use in experiments with fish. *Mar. Ecol. Publ. Stat. Zool. Napoli* 12:425-31, 1933. | 6 |

**Table 8: The 1987 *SCI®/SSCI®* research fronts** that include at least 50 citing documents published in the core marine biology journals. A = number of articles from core journals citing into the core of each front. B = total number of citing documents. C = total number of core documents.

| Number | Name | A | B | C |
|---|---|---|---|---|
| 87-0213 | Evolutionary aspects of reproduction and sexual variations in populations | 52 | 346 | 26 |
| 87-1438 | Bacterial biomass productivity in the marine environment | 72 | 253 | 17 |
| 87-1649 | Early life history, growth, and survival of larval fish, including vulnerability to predation | 66 | 123 | 15 |
| 87-2223 | Photosynthesis and growth of marine phytoplankton | 73 | 136 | 8 |
| 87-2632 | Echinoderm larval biology | 53 | 79 | 6 |
| 87-3546 | Distribution, settlement, and recruitment of marine invertebrate larvae | 58 | 89 | 10 |
| 87-4337 | Disturbance, competition, and predation in intertidal algal communities | 70 | 560 | 20 |
| 87-5117 | Marine phytoplankton growth and development | 73 | 136 | 8 |
| 87-5810 | Growth, mortality, and secondary production of marine crustaceans | 57 | 87 | 9 |

*Biological Bulletin*, the *Journal du Conseil*, and the *Journal of the Marine Biological Association of the United Kingdom*. This shows the longevity of highly cited articles in the field. Six journals had citing half-lives of over 10 years. The average citing half-life was over nine years. This shows the "durability" of the classic articles in the field.

Table 5 contains data for the core journals that show how their impacts have varied over the 10 years. Most of the journals have been remarkably consistent. The exception is *Marine Ecology—Progress Series*, which has continued to grow in impact on the field since it began publication in 1979.

Table 6 presents data for two types of articles—nonreview and review—published by each of the core journals in 1987 and the number of reference items for each type. *Advances in Marine Biology* was again omitted because it was not received by us in time for inclusion in the 1987 data set. The combined total number of references per nonreview and review article in marine biology (32.1) is about one-third higher than the average number of references per nonreview and review article in the *JCR* (23.0). Nonreview marine biology articles had on the average almost one and one-half times (31.5) the references of the average for the *JCR* (21.1).

## Most-Cited Papers

In addition to examining the journals, we looked at the individual papers published in the core journals. Table 7 lists the most-cited article from each core marine biology journal as determined by citations in the *SCI*, 1955-1987, if a journal had an article cited at least 50 times. Two journals (*Biologiya Morya* and *Marine Mammal Science*) are not represented in this table because they did not meet that selection criterion. This occurs in many small fields. The figures in column B give the total number of papers each journal published that were cited at least 50 times. These articles contribute to the high-impact long-term cumulative citation counts to these journals.

There is often a relationship between the age of a journal and the number of articles from it cited 50 times or more. In most of our studies, older journals have the greatest number of published articles cited 50 times or more. *Biological Bulletin* and the *Journal of the Marine Biological Association of the United Kingdom* have the third and fourth highest number of published articles in this category. *Marine Mammal Science*, the newest journal in the core (only three years old), has not had much time to accumulate highly cited articles.

The most-cited paper in this study was published in *Limnology and Oceanography* by Lucia Solórzano of the Institute of Marine Resources, Scripps Institution of Oceanography, University of California, San Diego. This paper discusses a method for determining ammonia in seawater. If you look at the most-cited lists in other areas of science you will find that many of the more highly cited papers are methodology papers. While this paper is not marine biology in the strictest sense, it presents a technique that is often

used in marine biological studies. It was also the most-cited paper in the oceanography journal study.

Daniel Mazia, Philip A. Brewer, and Max Alfert, then of the Department of Zoology, University of California, Berkeley, coauthored the second most-cited paper. Also a methods paper, it presents a staining technique that is widely used in cytochemical studies.

The third most-cited paper, by William E. Ricker, of the Fisheries Research Board of Canada, is a methods paper on the use of linear regression in fisheries research. Over one-third of the 21 articles on this table are methods papers.

Looking at the titles in Tables 7 and 8 you can see how often articles dealing with plankton are cited by the marine biology journals. This lends more support to the idea that all of the marine sciences are closely interrelated.


## Summary

When we compare the data for the core journals in Tables 2 and 3, we find that 4 of the 23 core journals (*Marine Biology*, the *Journal of Experimental Marine Biology and Ecology*, the *Canadian Journal of Fisheries and Aquatic Sciences*, and *Marine Ecology—Progress Series*) appear among the top 10 journals in both tables. These journals rank among the top nine core journals when ranked by impact factor. The same 4 journals rank among the top 10 core journals when ranked by immediacy factor. *Limnology and Oceanography* and the *Canadian Journal of Fisheries and Aquatic Sciences* provide a bridge to the literature of the other aquatic sciences—limnology, oceanography, and fisheries. Clearly these four journals are the most influential in marine biology and would be of importance to anyone looking at the history of marine biology research.




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